

101518597

# 2021

## Edition

# ARKANSAS FIRE PREVENTION CODE

VOLUME I FIRE  
VOLUME II BUILDING  
VOLUME III RESIDENTIAL

Based on the 2021 International Fire Code®,  
International Building Code®,  
and International Residential Code®



# ARKANSAS FIRE PREVENTION CODE

## 2021 EDITION



### VOLUMES I, II and III

**Based on the 2021 International Fire Code<sup>®</sup>,  
International Building Code<sup>®</sup> and International Residential Code<sup>®</sup>**



**2021**  
**Edition**

# **ARKANSAS**

# **FIRE PREVENTION CODE**

## **VOLUME I FIRE**

**Based on the 2021 International  
Fire Code®**



# ARKANSAS FIRE PREVENTION CODE 2021 EDITION



**VOLUME I**

**OFFICE OF THE  
ARKANSAS STATE FIRE MARSHAL**

**Based on the 2021  
International Fire Code®**



2021 Arkansas Fire Prevention Code, Volume I–Fire

First Printing: October 2022

ISBN: 978-1-958581-56-8 (loose-leaf edition)

COPYRIGHT © 2022  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This 2021 *Arkansas Fire Prevention Code* contains substantial copyrighted material from the 2021 *International Fire Code*®, second printing, which is a copyrighted work owned by the International Code Council, Inc. (“ICC”). Without separate written permission from the copyright owner, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example, and not limitation, photocopying or recording by or in an information storage and/or retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

Trademarks: “International Code Council,” the “International Code Council” logo, “ICC,” the “ICC” logo, “International Fire Code,” “IFC” and other names and trademarks appearing in this publication are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission.

PRINTED IN THE USA

T028247



### TO THE PEOPLE OF THE STATE OF ARKANSAS:

The *Arkansas Fire Prevention Code* ("AFPC" or "Fire Code" or "Code") 2021 edition, which supersedes the 2012 edition, has been developed to assist in preventing and controlling fires in and outside of structures in the State of Arkansas. The proper use of this Code can result in saving lives and property through the prevention of fires in our state.

I encourage Arkansas cities and counties to join with the Arkansas State Fire Marshal's Office in our effort to enforce the AFPC by adopting the Fire Code as a local ordinance. The adoption of the AFPC 2021 edition is important, and it is my hope that every citizen will use this Code to their fullest advantage in fire prevention.

### ORDER

Pursuant to the authority vested in the Director of the Division of Arkansas State Police by Section 6 of Act 254 of 1955 (A.C.A. §12-13-105), as amended, I promulgate these rules for the prevention of fire hazards in the State of Arkansas. The rules are set out in detail in the copy attached hereto.

IT IS THEREFORE ORDERED that said rules are to become effective January 1, 2023, in compliance with the Administrative Procedure Act of the State of Arkansas (A.C.A. §25-15-201 through §25-15-214), and shall be known as the *Arkansas Fire Prevention Code*, 2021 edition.

IN WITNESS WHEREOF, I have hereto affixed my signature as Director of the Department of Arkansas State Police this June 20, 2022.

A handwritten signature in black ink, reading "William J. Bryant".

Colonel William J. Bryant  
Director, Arkansas State Police and  
Arkansas Department of Public Safety



## FOREWORD

The *Arkansas Fire Prevention Code* was developed using the nationally and internationally recognized and accepted *International Fire Code*, *International Building Code* and *International Residential Code*, with revisions based on recommendations from Arkansas-based subject matter experts.

There are countless individuals who contributed to the 2021 successful revision of the *Arkansas Fire Prevention Code*. The following Arkansans unselfishly devoted their time and expertise to serve on the informal Arkansas Fire Prevention Code Revision Committee. The State Fire Marshal's Office extends its heartfelt thanks to everyone who participated in the revision process:

Wally Bailey, Director of Community Development, City of Fort Smith  
 James Birchfield, Senior Manager, Fire Code Compliance, Walmart  
 Barry Burke, Inspector, State Fire Marshal's Office  
 Brian Cotton, Associate Vice Chancellor of Operations, UAMS, Design and Construction  
 Charles Covington, Chief State Electrical Inspector, AR Department of Labor  
 Jimmie Deer, Building Official, City of Fort Smith  
 Roderick Edwards, President, Triple-S Alarm Co., Inc.  
 James Engstrom, President, H. James Engstrom and Associates, Inc.  
 Jake Feemster, Fire Marshal, Bentonville Fire Department  
 Steven Ferren, Executive Vice President, Arkansas Oil Marketers Association  
 Dennis Free, Inspector, State Fire Marshal's Office  
 Dustin Free, Captain, North Little Rock Fire Department  
 (William) Guy Grady, Fire Inspector, Searcy Fire Department  
 Paul Hankins, Area Supervisor, Arkansas Department of Human Services Child Care Licensing Division  
 J.D. Harper, Executive Director, Arkansas Manufactured Housing Association  
 Jimmy Hart, Judge, Conway County Judge  
 Joe Hillard, Director of Engineering, Cromwell Architects & Engineers  
 Lorel Hoffman, President, Austin Permit Services  
 Joseph Jerabeck, Captain, Rogers Fire Department  
 Kevin Lang, Fire Chief, Paragould Fire Department  
 Chris A. Lorton, Commercial Building Inspector, City of Rogers  
 Robert Medford, Fire Chief, Camden Fire Department  
 Duane Miller, Fire Marshal, Springdale Fire Department  
 Robert Morgan, Inspector Supervisor, Arkansas Department of Environmental Quality  
 Michael Moyer, Captain, ASP/Regulatory and Building Operations  
 Kevin Pfalser, Director, Liquefied Petroleum Gas Board  
 Tim Quetsch, Engineer, Arkansas Department of Environmental Quality  
 Jerry Robinson, Fire Marshal, North Little Rock Fire Department  
 Bill Rumsey, Captain, Rogers Fire Department, Community Risk Reduction Division  
 Mike Scott, Chief Building Official, City of Hot Springs  
 Brian Sloat, Fire Marshal, Fayetteville Fire Department  
 Matthew Swaim, Architect, WER Architects/Planners  
 Darrell Tessman, Assistant Director, ADE Facilities and Transportation  
 Clayton Vaden, Architect, Lewis Architects Engineers  
 Phil Watkins, Building Official, City of Searcy  
 Mark Wheeler, Vice President/District Manager, VSC Fire and Security  
 Mark Whitaker, Plan Reviewer, State Fire Marshal's Office  
 Jason Wills, Fire Marshal, Jonesboro Fire Department  
 Keith Wingfield, President, River Rock Builders

The intent of the *Arkansas Fire Prevention Code* is to reduce the number of fires in Arkansas and reduce the number of other hazard-related concerns. The *Arkansas Fire Prevention Code* establishes minimum rules dealing with fire and building safety.

Written communications for the State Fire Marshal's Office should be directed to:

State Fire Marshal's Office  
Division of Arkansas State Police  
Arkansas Department of Public Safety  
1 State Police Plaza Drive  
Little Rock, AR 72209

The State Fire Marshal's Office can be contacted by telephone at 501-618-8624 (until further notice). The fax number for the State Fire Marshal's Office is 501-618-8621 (until further notice).



Major Lindsey Williams  
State Fire Marshal's Office  
Division of Arkansas State Police  
Arkansas Department of Public Safety



# STATE OF ARKANSAS

## ARKANSAS FIRE PREVENTION CODE RULES

### 2021 EDITION

#### DEFINITIONS

- These Rules are promulgated by the Director of the Division of Arkansas State Police, who serves by operation of law as the Arkansas State Fire Marshal under the authority granted by Arkansas Act 254 of 1955, codified at A.C.A. §12-13-101 to A.C.A. §12-13-116, as amended. The purpose of these Rules is to aid in the implementation, interpretation and enforcement of the *Arkansas Fire Prevention Code* (AFPC), 2021 edition.
- The *International Fire Code*, 2021 edition, the *International Building Code*, 2021 edition, and the *International Residential Code*, 2021 edition, as published by the International Code Council and the rules, as amended and adopted by the Arkansas State Fire Marshal, shall constitute the *Arkansas Fire Prevention Code*, 2021 edition. These Rules shall be effective January 1, 2023.

The following shall be defined as:

INTERNATIONAL PLUMBING CODE shall mean the *Arkansas State Plumbing Code*.

INTERNATIONAL PRIVATE SEWAGE DISPOSAL CODE is replaced by “Arkansas Department of Health Rules and Regulations Pertaining to Onsite Wastewater Systems.”

INTERNATIONAL MECHANICAL CODE shall mean the *mechanical code for Arkansas*.

INTERNATIONAL FUEL GAS CODE shall mean the *Arkansas State Gas Code*.

INTERNATIONAL ENERGY CONSERVATION CODE shall mean the *Arkansas Energy Code*.

INTERNATIONAL FIRE CODE shall mean the *Arkansas Fire Prevention Code*, Volume I.

INTERNATIONAL BUILDING CODE shall mean the *Arkansas Fire Prevention Code*, Volume II.

INTERNATIONAL RESIDENTIAL CODE shall mean the *Arkansas Fire Prevention Code*, Volume III.

NATIONAL ELECTRICAL CODE shall mean the *electrical code for the State of Arkansas*.

BUILDING OFFICIAL shall mean any governmental official having authority to enforce that aspect of the code.

Dotted lines in the margin indicate Arkansas revisions.



Solid stars in the margin indicate Arkansas deletions.



# TABLE OF CONTENTS

<i>Part I—Administrative</i> .....	<b>1-1</b>	308 Open Flames .....	3-3
<b>CHAPTER 1 SCOPE AND ADMINISTRATION</b> ..	<b>1-1</b>	309 Powered Industrial Trucks and Equipment .....	3-5
<b>PART 1—GENERAL PROVISIONS</b> .....	<b>1-1</b>	310 Smoking .....	3-6
Section		311 Vacant Premises .....	3-6
101 Scope and General Requirements .....	1-1	312 Vehicle Impact Protection .....	3-7
102 Applicability .....	1-1	313 Fueled Equipment .....	3-8
<b>PART 2—ADMINISTRATION AND ENFORCEMENT</b> .....	<b>1-3</b>	314 Indoor Displays .....	3-8
Section		315 General Storage .....	3-8
103 Code Compliance Agency .....	1-3	316 Hazards to Fire Fighters .....	3-10
104 Duties and Powers of the Fire Code Official .....	1-4	317 Landscaped Roofs .....	3-11
105 Permits .....	1-6	318 Laundry Carts .....	3-11
106 Construction Documents .....	1-14	319 Mobile Food Preparation Vehicles .....	3-11
107 Fees .....	1-15	320 Additive Manufacturing (3D Printing) .....	3-13
108 Inspections .....	1-15	321 Artificial Combustible Vegetation .....	3-14
109 Maintenance .....	1-16	<b>CHAPTER 4 EMERGENCY PLANNING AND PREPAREDNESS</b> .....	<b>4-1</b>
110 Service Utilities .....	1-16	Section	
111 Means of Appeals .....	1-16	401 General .....	4-1
112 Violations .....	1-16	402 Definitions .....	4-1
113 Stop Work Order .....	1-17	403 Emergency Preparedness Requirements .....	4-1
114 Unsafe Structures or Equipment .....	1-17	404 Fire Safety, Evacuation and Lockdown Plans .....	4-7
<b>CHAPTER 2 DEFINITIONS</b> .....	<b>2-1</b>	405 Emergency Evacuation Drills .....	4-8
Section		406 Employee Training and Response Procedures .....	4-9
201 General .....	2-1	407 Hazard Communication .....	4-10
202 General Definitions .....	2-1	<i>Part III—Building and Equipment Design Features</i> ..	<b>5-1</b>
<i>Part II—General Safety Provisions</i> .....	<b>3-1</b>	<b>CHAPTER 5 FIRE SERVICE FEATURES</b> .....	<b>5-1</b>
<b>CHAPTER 3 GENERAL REQUIREMENTS</b> .....	<b>3-1</b>	Section	
Section		501 General .....	5-1
301 General .....	3-1	502 Definitions .....	5-1
302 Definitions .....	3-1	503 Fire Apparatus Access Roads .....	5-1
303 Asphalt Kettles .....	3-1	504 Access to Building Openings and Roofs .....	5-2
304 Combustible Waste Material .....	3-2	505 Premises Identification .....	5-3
305 Ignition Sources .....	3-2	506 Key Boxes .....	5-3
306 Motion Picture Projection Rooms and Film .....	3-3	507 Fire Protection Water Supplies .....	5-3
307 Open Burning, Recreational Fires and Portable Outdoor Fireplaces .....	3-3	508 Fire Command Center .....	5-4
		509 Fire Protection and Utility Equipment Identification and Access .....	5-5
		510 Emergency Responder Communication Coverage .....	5-6



## TABLE OF CONTENTS

### CHAPTER 6 BUILDING SERVICES AND SYSTEMS ..... 6-1

#### Section

601	General. ....	6-1
602	Definitions. ....	6-1
603	Electrical Equipment, Wiring and Hazards. ....	6-1
604	Elevator Operation, Maintenance and Fire Service Keys. ....	6-3
605	Fuel-fired Appliances. ....	6-4
606	Commercial Cooking Equipment and Systems. ....	6-7
607	Commercial Cooking Oil Storage. ....	6-8
608	Mechanical Refrigeration. ....	6-9
609	Hyperbaric Facilities. ....	6-12
610	Clothes Dryer Exhaust Systems. ....	6-12

### CHAPTER 7 FIRE AND SMOKE PROTECTION FEATURES. .... 7-1

#### Section

701	General. ....	7-1
702	Definitions. ....	7-1
703	Penetrations. ....	7-2
704	Joints and Voids. ....	7-2
705	Door and Window Openings. ....	7-2
706	Duct and Air Transfer Openings. ....	7-3
707	Concealed Spaces. ....	7-3
708	Spray Fire-resistant Materials and Intumescent Fire-resistant Materials. ....	7-3

### CHAPTER 8 INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS ..... 8-1

#### Section

801	General. ....	8-1
802	Definitions. ....	8-1
803	Interior Wall and Ceiling Finish in Existing Buildings. ....	8-1
804	Interior Wall and Ceiling Trim and Interior Floor Finish in New and Existing Buildings. ....	8-3
805	Upholstered Furniture and Mattresses in New and Existing Buildings. ....	8-4
806	Natural Decorative Vegetation in New and Existing Buildings. ....	8-7
807	Decorative Materials and Artificial Decorative Vegetation in New and Existing Buildings. ....	8-7

808	Furnishings Other than Upholstered Furniture and Mattresses or Decorative Materials in New and Existing Buildings. ....	8-9
-----	---	-----

### CHAPTER 9 FIRE PROTECTION AND LIFE SAFETY SYSTEMS ..... 9-1

#### Section

901	General. ....	9-1
902	Definitions. ....	9-4
903	Automatic Sprinkler Systems. ....	9-4
904	Alternative Automatic Fire-extinguishing Systems. ....	9-12
905	Standpipe Systems. ....	9-16
906	Portable Fire Extinguishers. ....	9-18
907	Fire Alarm and Detection Systems. ....	9-21
908	Emergency Alarm Systems. ....	9-33
909	Smoke Control Systems. ....	9-34
910	Smoke and Heat Removal. ....	9-42
911	Explosion Control. ....	9-44
912	Fire Department Connections. ....	9-45
913	Fire Pumps. ....	9-46
914	Fire Protection Based on Special Detailed Requirements of Use and Occupancy. ....	9-47
915	Carbon Monoxide Detection. ....	9-50
916	Gas Detection Systems. ....	9-51
917	Mass Notification Systems. ....	9-52

### CHAPTER 10 MEANS OF EGRESS ..... 10-1

#### Section

1001	Administration. ....	10-1
1002	Definitions. ....	10-1
1003	General Means of Egress. ....	10-2
1004	Occupant Load. ....	10-3
1005	Means of Egress Sizing. ....	10-5
1006	Numbers of Exits and Exit Access Doorways. ....	10-6
1007	Exit and Exit Access Doorway Configuration. ....	10-9
1008	Means of Egress Illumination. ....	10-10
1009	Accessible Means of Egress. ....	10-11
1010	Doors, Gates and Turnstiles. ....	10-13
1011	Stairways. ....	10-23
1012	Ramps. ....	10-27
1013	Exit Signs. ....	10-28
1014	Handrails. ....	10-29
1015	Guards. ....	10-30

1016	Exit Access .....	10-32
1017	Exit Access Travel Distance .....	10-33
1018	Aisles .....	10-34
1019	Exit Access Stairways and Ramps .....	10-34
1020	Corridors .....	10-35
1021	Egress Balconies .....	10-36
1022	Exits .....	10-36
1023	Interior Exit Stairways and Ramps .....	10-37
1024	Exit Passageways .....	10-39
1025	Luminous Egress Path Markings .....	10-40
1026	Horizontal Exits .....	10-41
1027	Exterior Exit Stairways and Ramps .....	10-42
1028	Exit Discharge .....	10-43
1029	Egress Courts .....	10-44
1030	Assembly .....	10-44
1031	Emergency Escape and Rescue .....	10-51
1032	Maintenance of the Means of Egress .....	10-52

## **CHAPTER 11 CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS ..... 11-1**

### Section

1101	General .....	11-1
1102	Definitions .....	11-1
1103	Fire Safety Requirements for Existing Buildings .....	11-1
1104	Means of Egress for Existing Buildings .....	11-8
1105	Construction Requirements for Existing Group I-2 .....	11-13
1106	Requirements for Outdoor Operations .....	11-17

## **CHAPTER 12 ENERGY SYSTEMS ..... 12-1**

### Section

1201	General .....	12-1
1202	Definitions .....	12-1
1203	Emergency and Standby Power Systems .....	12-1
1204	Portable Generators .....	12-3
1205	Solar Photovoltaic Power Systems .....	12-4
1206	Stationary Fuel Cell Power Systems .....	12-6
1207	Electrical Energy Storage Systems (ESS) .....	12-7

## **CHAPTERS 13 through 19 RESERVED. .... 13-19-1**

## **Part IV—Special Occupancies and Operations. .... 20-1**

## **CHAPTER 20 AVIATION FACILITIES ..... 20-1**

### Section

2001	General .....	20-1
2002	Definitions .....	20-1
2003	General Precautions .....	20-1
2004	Aircraft Maintenance .....	20-1
2005	Portable Fire Extinguishers .....	20-2
2006	Aircraft Fueling .....	20-2
2007	Helistops and Heliports .....	20-7

## **CHAPTER 21 DRY CLEANING..... 21-1**

### Section

2101	General .....	21-1
2102	Definitions .....	21-1
2103	Classifications .....	21-1
2104	General Requirements .....	21-1
2105	Operating Requirements .....	21-2
2106	Spotting and Pretreating .....	21-2
2107	Dry Cleaning Systems .....	21-3
2108	Fire Protection .....	21-3

## **CHAPTER 22 COMBUSTIBLE DUST-PRODUCING OPERATIONS .... 22-1**

### Section

2201	General .....	22-1
2202	Definitions .....	22-1
2203	Dust Explosion Prevention .....	22-1
2204	Dust Explosion Screening Tests .....	22-4
2205	Standards .....	22-4

## **CHAPTER 23 MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES ..... 23-1**

### Section

2301	General .....	23-1
2302	Definitions .....	23-1
2303	Location of Dispensing Devices .....	23-1
2304	Dispensing Operations .....	23-2
2305	Operational Requirements .....	23-3
2306	Flammable and Combustible Liquid Motor Fuel-dispensing Facilities .....	23-4

## TABLE OF CONTENTS

2307	Liquefied Petroleum Gas Motor Fuel-dispensing Facilities . . . . .	23-8
2308	Compressed Natural Gas Motor Fuel-dispensing Facilities . . . . .	23-9
2309	Hydrogen Motor Fuel-dispensing and Generation Facilities . . . . .	23-11
2310	Marine Motor Fuel-dispensing Facilities . . . . .	23-13
2311	Repair Garages . . . . .	23-14

## CHAPTER 24 FLAMMABLE FINISHES . . . . . 24-1

### Section

2401	General . . . . .	24-1
2402	Definitions . . . . .	24-1
2403	Protection of Operations . . . . .	24-1
2404	Spray Finishing . . . . .	24-3
2405	Dipping Operations . . . . .	24-7
2406	Powder Coating . . . . .	24-8
2407	Electrostatic Apparatus . . . . .	24-9
2408	Organic Peroxides and Dual-component Coatings . . . . .	24-10
2409	Indoor Manufacturing of Reinforced Plastics . . . . .	24-10
2410	Floor Surfacing and Finishing Operations . . . . .	24-11

## CHAPTER 25 FRUIT AND CROP RIPENING... 25-1

### Section

2501	General . . . . .	25-1
2502	Definitions . . . . .	25-1
2503	Ethylene Gas . . . . .	25-1
2504	Sources of Ignition . . . . .	25-1
2505	Combustible Waste . . . . .	25-1
2506	Ethylene Generators . . . . .	25-1
2507	Warning Signs . . . . .	25-1

## CHAPTER 26 FUMIGATION AND INSECTICIDAL FOGGING . . . . . 26-1

### Section

2601	General . . . . .	26-1
2602	Definitions . . . . .	26-1
2603	Fire Safety Requirements . . . . .	26-1

## CHAPTER 27 SEMICONDUCTOR FABRICATION FACILITIES . . . . . 27-1

### Section

2701	General . . . . .	27-1
2702	Definitions . . . . .	27-1

2703	General Safety Provisions . . . . .	27-1
2704	Storage . . . . .	27-5
2705	Use and Handling . . . . .	27-6

## CHAPTER 28 LUMBER YARDS AND AGRO- INDUSTRIAL, SOLID BIOMASS AND WOODWORKING FACILITIES. . . . . 28-1

### Section

2801	General . . . . .	28-1
2802	Definitions . . . . .	28-1
2803	General Requirements . . . . .	28-1
2804	Fire Protection . . . . .	28-2
2805	Plywood, Veneer and Composite Board Mills . . . . .	28-2
2806	Log Storage Areas . . . . .	28-2
2807	Storage of Wood Chips and Hogged Materials Associated with Timber and Lumber Production Facilities . . . . .	28-2
2808	Storage and Processing of Wood Chips, Hogged Materials, Fines, Compost, Solid Biomass Feedstock and Raw Product Associated with Yard Waste, Agro-industrial and Recycling Facilities . . . . .	28-3
2809	Exterior Storage of Finished Lumber and Solid Biofuel Products . . . . .	28-3
2810	Outdoor Storage of Pallets at Pallet Manufacturing and Recycling Facilities . . . . .	28-4

## CHAPTER 29 MANUFACTURE OF ORGANIC COATINGS . . . . . 29-1

### Section

2901	General . . . . .	29-1
2902	Definition . . . . .	29-1
2903	General Precautions . . . . .	29-1
2904	Electrical Equipment and Protection . . . . .	29-1
2905	Process Structures . . . . .	29-2
2906	Process Mills and Kettles . . . . .	29-2
2907	Process Piping . . . . .	29-2
2908	Raw Materials in Process Areas . . . . .	29-3
2909	Raw Materials and Finished Products . . . . .	29-3

## CHAPTER 30 INDUSTRIAL OVENS . . . . . 30-1

### Section

3001	General . . . . .	30-1
3002	Definitions . . . . .	30-1
3003	Location . . . . .	30-1
3004	Fuel Piping . . . . .	30-1



## TABLE OF CONTENTS

3005	Interlocks .....	30-1	3311	Access for Fire Fighting .....	33-4
3006	Fire Protection .....	30-1	3312	Means of Egress .....	33-5
3007	Operation and Maintenance .....	30-2	3313	Water Supply for Fire Protection .....	33-5
<b>CHAPTER 31 TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES .... 31-1</b>			3314	Standpipes .....	33-5
Section			3315	Automatic Sprinkler System .....	33-6
3101	General .....	31-1	3316	Portable Fire Extinguishers .....	33-6
3102	Definitions .....	31-1	3317	Motorized Construction Equipment .....	33-6
3103	Temporary Tents and Membrane Structures ...	31-1	3318	Safeguarding Roofing Operations .....	33-6
3104	Temporary and Permanent Tents and Membrane Structures .....	31-4	<b>CHAPTER 34 TIRE REBUILDING AND TIRE STORAGE ..... 34-1</b>		
3105	Temporary Special Event Structures .....	31-4	Section		
3106	Outdoor Assembly Events .....	31-5	3401	General .....	34-1
3107	Operational Requirements .....	31-6	3402	Definitions .....	34-1
<b>CHAPTER 32 HIGH-PILED COMBUSTIBLE STORAGE ..... 32-1</b>			3403	Tire Rebuilding .....	34-1
Section			3404	Precautions against Fire .....	34-1
3201	General .....	32-1	3405	Outdoor Storage .....	34-1
3202	Definitions .....	32-2	3406	Fire Department Access .....	34-2
3203	Commodity Classification .....	32-2	3407	Fencing .....	34-2
3204	Designation of High-piled Storage Areas .....	32-11	3408	Fire Protection .....	34-2
3205	Housekeeping and Maintenance .....	32-12	3409	Indoor Storage Arrangement .....	34-2
3206	General Fire Protection and Life Safety Features .....	32-12	<b>CHAPTER 35 WELDING AND OTHER HOT WORK ..... 35-1</b>		
3207	Solid-piled and Shelf Storage .....	32-15	Section		
3208	Rack Storage .....	32-15	3501	General .....	35-1
3209	Automated Storage .....	32-16	3502	Definitions .....	35-1
3210	Specialty Storage .....	32-17	3503	General Requirements .....	35-1
<b>CHAPTER 33 FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION ..... 33-1</b>			3504	Fire Safety Requirements .....	35-1
Section			3505	Gas Welding and Cutting .....	35-2
3301	General .....	33-1	3506	Electric Arc Hot Work .....	35-3
3302	Definitions .....	33-1	3507	Calcium Carbide Systems .....	35-3
3303	Owner's Responsibility for Fire Protection ...	33-1	3508	Acetylene Generators .....	35-3
3304	Temporary Heating Equipment .....	33-2	3509	Piping Manifolds and Hose Systems for Fuel Gases and Oxygen .....	35-4
3305	Precautions against Fire .....	33-3	3510	Hot Work on Flammable and Combustible Liquid Storage Tanks .....	35-4
3306	Flammable and Combustible Liquids .....	33-4	<b>CHAPTER 36 MARINAS..... 36-1</b>		
3307	Flammable Gases .....	33-4	Section		
3308	Explosive Materials .....	33-4	3601	Scope .....	36-1
3309	Portable Generators .....	33-4	3602	Definitions .....	36-1
3310	Fire Reporting .....	33-4	3603	General Precautions .....	36-1
			3604	Fire Protection Equipment .....	36-1
			3605	Marine Motor Fuel-dispensing Facilities .....	36-2

## TABLE OF CONTENTS

### CHAPTER 37 COMBUSTIBLE FIBERS..... 37-1

#### Section

3701	General .....	37-1
3702	Definitions .....	37-1
3703	General Precautions .....	37-1
3704	Loose Fiber Storage .....	37-1
3705	Baled Storage .....	37-2

### CHAPTER 38 HIGHER EDUCATION LABORATORIES ..... 38-1

#### Section

3801	General .....	38-1
3802	Definitions .....	38-1
3803	General Safety Provisions .....	38-1
3804	Laboratory Suite Construction .....	38-2
3805	Nonsprinklered Laboratories .....	38-3
3806	Existing Sprinklered Laboratories .....	38-4

### CHAPTER 39 PROCESSING AND EXTRACTION FACILITIES..... 39-1

#### Section

3901	General .....	39-1
3902	Definitions .....	39-1
3903	Processing and Extraction .....	39-1
3904	Systems and Equipment .....	39-1
3905	Safety Systems .....	39-2

### CHAPTER 40 STORAGE OF DISTILLED SPIRITS AND WINES ..... 40-1

#### Section

4001	General .....	40-1
4002	Definitions .....	40-1
4003	Precautions against Fire .....	40-1
4004	Storage .....	40-2
4005	Fire Protection .....	40-2
4006	Signage .....	40-2

### CHAPTERS 41 through 49 RESERVED ..... 41–49-1

### *Part V—Hazardous Materials ..... 50-1*

### CHAPTER 50 HAZARDOUS MATERIALS— GENERAL PROVISIONS ..... 50-1

#### Section

5001	General .....	50-1
5002	Definitions .....	50-4

5003	General Requirements .....	50-4
5004	Storage .....	50-19
5005	Use, Dispensing and Handling .....	50-22

### CHAPTER 51 AEROSOLS .....51-1

#### Section

5101	General .....	51-1
5102	Definitions .....	51-1
5103	Classification of Aerosol Products .....	51-1
5104	Inside Storage of Aerosol Products .....	51-1
5105	Outside Storage .....	51-4
5106	Retail Display .....	51-5
5107	Manufacturing Facilities .....	51-6

### CHAPTER 52 RESERVED.....52-1

### CHAPTER 53 COMPRESSED GASES .....53-1

#### Section

5301	General .....	53-1
5302	Definitions .....	53-1
5303	General Requirements .....	53-1
5304	Storage of Compressed Gases .....	53-5
5305	Use and Handling of Compressed Gases .....	53-5
5306	Medical Gases .....	53-6
5307	Compressed Gases Not Otherwise Regulated .....	53-6

### CHAPTER 54 CORROSIVE MATERIALS .....54-1

#### Section

5401	General .....	54-1
5402	Definition .....	54-1
5403	General Requirements .....	54-1
5404	Storage .....	54-1
5405	Use .....	54-1

### CHAPTER 55 CRYOGENIC FLUIDS.....55-1

#### Section

5501	General .....	55-1
5502	Definitions .....	55-1
5503	General Requirements .....	55-1
5504	Storage .....	55-3
5505	Use and Handling .....	55-4

### CHAPTER 56 EXPLOSIVES AND FIREWORKS.....56-1

#### Section

5601	General .....	56-1
------	---------------	------

## TABLE OF CONTENTS

5602	Definitions . . . . .	56-4	<b>CHAPTER 60</b>	<b>HIGHLY TOXIC AND TOXIC MATERIALS . . . . .</b>	<b>60-1</b>
5603	Record Keeping and Reporting. . . . .	56-5			
5604	Explosive Materials Storage and Handling . . . .	56-5		Section	
5605	Manufacture, Assembly and Testing of Explosives, Explosive Materials and Fireworks . . . . .	56-11	6001	General . . . . .	60-1
5606	Small Arms Ammunition and Small Arms Ammunition Components. . . . .	56-14	6002	Definitions . . . . .	60-1
5607	Blasting. . . . .	56-16	6003	Highly Toxic and Toxic Solids and Liquids . . .	60-1
5608	Fireworks Display. . . . .	56-17	6004	Highly Toxic and Toxic Compressed Gases . . .	60-2
5609	Temporary Storage of Consumer Fireworks . .	56-18	6005	Ozone Gas Generators . . . . .	60-7
<b>CHAPTER 57 FLAMMABLE AND COMBUSTIBLE LIQUIDS. . . . .</b>			<b>CHAPTER 61 Deleted in its entirety. Refer to the Arkansas Liquefied Petroleum Gas Code . . . . .</b>		
<b>57-1</b>			<b>61-1</b>		
Section			Section		
5701	General . . . . .	57-1	6201	General . . . . .	62-1
5702	Definitions . . . . .	57-1	6202	Definition . . . . .	62-1
5703	General Requirements. . . . .	57-2	6203	General Requirements . . . . .	62-1
5704	Storage . . . . .	57-6	6204	Storage . . . . .	62-1
5705	Dispensing, Use, Mixing and Handling . . . . .	57-26	6205	Use . . . . .	62-3
5706	Special Operations . . . . .	57-32			
5707	On-demand Mobile Fueling Operations . . . . .	57-41	<b>CHAPTER 63 OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS . . . . .</b>		
<b>CHAPTER 58 FLAMMABLE GASES AND FLAMMABLE CRYOGENIC FLUIDS . . . . .</b>			<b>63-1</b>		
<b>58-1</b>			Section		
Section			6301 General . . . . .		
5801	General . . . . .	58-1	6302	Definitions . . . . .	63-1
5802	Definitions . . . . .	58-1	6303	General Requirements . . . . .	63-1
5803	General Requirements. . . . .	58-1	6304	Storage . . . . .	63-2
5804	Storage . . . . .	58-2	6305	Use . . . . .	63-4
5805	Use . . . . .	58-2	6306	Liquid Oxygen in Home Health Care. . . . .	63-4
5806	Flammable Cryogenic Fluids . . . . .	58-2	<b>CHAPTER 64 PYROPHORIC MATERIALS . . . .</b>		
5807	Metal Hydride Storage Systems . . . . .	58-3	<b>64-1</b>		
5808	Hydrogen Fuel Gas Rooms. . . . .	58-4	Section		
<b>CHAPTER 59 FLAMMABLE SOLIDS . . . . .</b>			6401	General . . . . .	64-1
<b>59-1</b>			6402	Definition . . . . .	64-1
Section			6403	General Requirements . . . . .	64-1
5901	General . . . . .	59-1	6404	Storage . . . . .	64-1
5902	Definitions . . . . .	59-1	6405	Use . . . . .	64-2
5903	General Requirements. . . . .	59-1	<b>CHAPTER 65 PYROXYLIN (CELLULOSE NITRATE) PLASTICS . . . . .</b>		
5904	Storage . . . . .	59-1	<b>65-1</b>		
5905	Use . . . . .	59-1	Section		
5906	Magnesium . . . . .	59-1	6501	General . . . . .	65-1
			6502	Definitions . . . . .	65-1



## TABLE OF CONTENTS

6503	General Requirements .....	65-1
6504	Storage and Handling .....	65-1

### **CHAPTER 66 UNSTABLE (REACTIVE) MATERIALS..... 66-1**

#### Section

6601	General .....	66-1
6602	Definition .....	66-1
6603	General Requirements .....	66-1
6604	Storage .....	66-2
6605	Use .....	66-2

### **CHAPTER 67 WATER-REACTIVE SOLIDS AND LIQUIDS ..... 67-1**

#### Section

6701	General .....	67-1
6702	Definition .....	67-1
6703	General Requirements .....	67-1
6704	Storage .....	67-1
6705	Use .....	67-2

### **CHAPTERS 68 through 79 RESERVED ..... 68–79-1**

### ***Part VI—Referenced Standards..... 80-1***

### **CHAPTER 80 REFERENCED STANDARDS.... 80-1**

### ***Part VII—Appendices..... APPENDIX A-1***

### **APPENDIX A Deleted in its entirety .. APPENDIX A-1**

### **APPENDIX B FIRE-FLOW REQUIREMENTS FOR BUILDINGS .... APPENDIX B-1**

#### Section

B101	General .....	APPENDIX B-1
B102	Definitions .....	APPENDIX B-1
B103	Modifications .....	APPENDIX B-1
B104	Fire-flow Calculation Area.....	APPENDIX B-1
B105	Fire-flow Requirements for Buildings.....	APPENDIX B-1
B106	Referenced Standards.....	APPENDIX B-3

### **APPENDIX C FIRE HYDRANT LOCATIONS AND DISTRIBUTION..... APPENDIX C-1**

#### Section

C101	General.....	APPENDIX C-1
C102	Number of Fire Hydrants.....	APPENDIX C-1
C103	Fire Hydrant Spacing .....	APPENDIX C-1
C104	Consideration of Existing Fire Hydrants .....	APPENDIX C-2
C105	Referenced Standard .....	APPENDIX C-2

### **APPENDIX D FIRE APPARATUS ACCESS ROADS..... APPENDIX D-1**

#### Section

D101	General.....	APPENDIX D-1
D102	Required Access.....	APPENDIX D-1
D103	Minimum Specifications .....	APPENDIX D-1
D104	Commercial and Industrial Developments.....	APPENDIX D-2
D105	Aerial Fire Apparatus Access Roads .....	APPENDIX D-2
D106	Multiple-family Residential Developments.....	APPENDIX D-3
D107	One- or Two-family Residential Developments.....	APPENDIX D-3
D108	Referenced Standards.....	APPENDIX D-3

### **APPENDIX E HAZARD CATEGORIES..... APPENDIX E-1**

#### Section

E101	General.....	APPENDIX E-1
E102	Hazard Categories .....	APPENDIX E-1
E103	Evaluation of Hazards .....	APPENDIX E-5
E104	Referenced Standards.....	APPENDIX E-6

### **APPENDIX F HAZARD RANKING...APPENDIX F-1**

#### Section

F101	General.....	APPENDIX F-1
F102	Referenced Standards.....	APPENDIX F-1

### **APPENDIX G CRYOGENIC FLUIDS— WEIGHT AND VOLUME EQUIVALENTS..... APPENDIX G-1**

#### Section

G101	General.....	APPENDIX G-1
------	--------------	--------------

### **APPENDIX H HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS..... APPENDIX H-1**

## TABLE OF CONTENTS

Section		L106	Inspection, Testing and Maintenance. . . . .	APPENDIX L-3
H101	HMMP . . . . .	L107	Referenced Standards . . . . .	APPENDIX L-3
H102	HMIS . . . . .			
H103	Emergency Plan . . . . .			
H104	Security . . . . .			
H105	Referenced Standards . . . . .			
<b>APPENDIX I</b>	<b>FIRE PROTECTION SYSTEMS—NONCOMPLIANT CONDITIONS. . . . .</b>	<b>APPENDIX M</b>	<b>HIGH-RISE BUILDINGS— RETROACTIVE AUTOMATIC SPRINKLER REQUIREMENT . . . . .</b>	<b>APPENDIX M-1</b>
Section		Section		
I101	Noncompliant Conditions . . . . .	M101	Scope . . . . .	APPENDIX M-1
I102	Referenced Standards . . . . .	M102	Where Required . . . . .	APPENDIX M-1
		M103	Compliance. . . . .	APPENDIX M-1
<b>APPENDIX J</b>	<b>BUILDING INFORMATION SIGN. . . . .</b>	<b>APPENDIX N</b>	<b>INDOOR TRADE SHOWS AND EXHIBITIONS. . . . .</b>	<b>APPENDIX N-1</b>
Section		Section		
J101	General . . . . .	N101	General . . . . .	APPENDIX N-1
J102	Referenced Standards . . . . .	N102	Definitions . . . . .	APPENDIX N-1
		N103	Public Safety for Events . . . . .	APPENDIX N-1
		N104	Interior Finish and Decorative Materials . . . . .	APPENDIX N-2
		N105	Multiple-level Booths . . . . .	APPENDIX N-2
<b>APPENDIX K</b>	<b>CONSTRUCTION REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES. . . . .</b>	N106	Covered Booths . . . . .	APPENDIX N-2
Section		N107	Display and Storage of Hazardous and Combustible Materials. . . . .	APPENDIX N-2
K101	General . . . . .	N108	Means of Egress . . . . .	APPENDIX N-3
K102	Fire Safety Requirements for Existing Ambulatory Care Facilities. . . . .	N109	Referenced Standards . . . . .	APPENDIX N-3
K103	Incidental Uses in Existing Ambulatory Care Facilities. . . . .			
K104	Means of Egress Requirements for Existing Ambulatory Care Facilities . . . . .	<b>APPENDIX O</b>	<b>DAY CARE FACILITIES COMPILATION . . . . .</b>	<b>APPENDIX O-1</b>
K105	Referenced Standards . . . . .	Section		
		O101	General . . . . .	APPENDIX O-1
<b>APPENDIX L</b>	<b>REQUIREMENTS FOR FIRE FIGHTER AIR REPLENISHMENT SYSTEMS . . . . .</b>	<b>INDEX. . . . .</b>	<b>INDEX-1</b>	
Section				
L101	General . . . . .	<b>RESOURCE A</b>	<b>RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI) . . . . .</b>	<b>RESOURCE A-1</b>
L102	Definitions . . . . .			
L103	Permits . . . . .			
L104	Design and Installation . . . . .			
L105	Acceptance Tests . . . . .			





# Part I—Administrative

## CHAPTER 1 SCOPE AND ADMINISTRATION

### User note:

**About this chapter:** Chapter 1 establishes the limits of applicability of the code and describes how the code is to be applied and enforced. Chapter 1 is in two parts: Part 1—General Provisions (Sections 101–102) and Part 2—Administrative Provisions (Sections 103–114). Section 102 identifies which buildings and structures come under its purview and references other I-Codes as applicable.

This code is intended to be adopted as a legally enforceable document, and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 1 establish the authority and duties of the code official appointed by the authority having jurisdiction and also establish the rights and privileges of the design professional, contractor and property owner.

**Code development reminder:** Code change proposals to this chapter will be considered by the Administrative Code Development Committee during the 2022 (Group B) Code Development Cycle.

Portions of this chapter were extensively reorganized for the 2021 edition. For clarity, the relocation marginal markings have not been included. For complete information, see the relocations table in the preface information of this code.

### PART 1—GENERAL PROVISIONS

#### SECTION 101 SCOPE AND GENERAL REQUIREMENTS

**[A] 101.1 Title.** These rules shall be known as the *Arkansas Fire Prevention Code*.

**[A] 101.2 Scope.** This code establishes regulations affecting or relating to structures, processes, premises and safeguards regarding all of the following:

1. The hazard of fire and explosion arising from the storage, handling or use of structures, materials or devices.
2. Conditions hazardous to life, property or public welfare in the occupancy of structures or premises.
3. Fire hazards in the structure or on the premises from occupancy or operation.
4. Matters related to the construction, extension, repair, alteration or removal of fire protection systems.
5. Conditions affecting the safety of fire fighters and emergency responders during emergency operations.

**[A] 101.2.1 Appendices.** Provisions in the appendices shall not apply unless specifically adopted. Appendices B, C, D, E, F, G and O are adopted by the State of Arkansas. Other appendices shall not apply unless adopted by local ordinance. Requests for exceptions to Appendix D may be appealed to the Arkansas State Fire Marshal (State Fire Marshal).

**101.2.2 Locally adopted codes.** Each district, county, municipality or other political subdivision of this state shall only adopt and enforce the provisions of the *Arkansas Fire Prevention Code*, 2021 Edition. The AFPC 2021 Edition shall be the only foundation document available for modification by local jurisdictions should they choose to adopt

more stringent provisions. It shall be the responsibility of local authorities having jurisdiction to bring the proposed specific rule or provision up to the minimum standards of the AFPC 2021 Edition. The State Fire Marshal shall advise local jurisdictions of any requirement that is less stringent than the AFPC 2021 Edition.

**[A] 101.3 Purpose.** The purpose of this code is to establish the minimum requirements consistent with nationally recognized good practice for providing a reasonable level of life safety and property protection from the hazards of fire, explosion or dangerous conditions in new and existing buildings, structures and premises, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

**[A] 101.4 Severability.** If a section, subsection, sentence, clause or phrase of this code is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code.

**[A] 101.5 Validity.** In the event any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions hereof, which are determined to be legal; and it shall be presumed that this code would have been adopted without such illegal or invalid parts or provisions.

#### SECTION 102 APPLICABILITY

**[A] 102.1 Construction and design provisions.** The construction and design provisions of this code shall apply to:

1. Structures, facilities and conditions arising after the adoption of this code.
2. Existing structures, facilities and conditions not legally in existence at the time of adoption of this code.

## SCOPE AND ADMINISTRATION

3. Existing structures, facilities and conditions where required in Chapter 11.
4. Existing structures, facilities and conditions that, in the opinion of the *fire code official*, constitute a distinct hazard to life or property.

**[A] 102.2 Administrative, operational and maintenance provisions.** The administrative, operational and maintenance provisions of this code shall apply to:

1. Conditions and operations arising after the adoption of this code.
2. Existing conditions and operations.

**[A] 102.3 Change of use or occupancy.** A change of occupancy shall not be made unless the use or occupancy is made to comply with the requirements of this code and the *International Existing Building Code*.

**Exception:** Where *approved* by the *fire code official*, a change of occupancy shall be permitted without complying with the requirements of this code and the *International Existing Building Code*, provided that the new or proposed use or occupancy is less hazardous, based on life and fire risk, than the existing use or occupancy.

- **[A] 102.4 Application of building code.** The design and construction of new structures shall comply with the *Arkansas Fire Prevention Code*, Volume II, and any *alterations*, additions, changes in use or changes in structures required by this code, which are within the scope of the *Arkansas Fire Prevention Code*, Volume II, shall be made in accordance therewith.

- **[A] 102.5 Application of residential code.** Where structures are designed and constructed in accordance with the *Arkansas Fire Prevention Code*, Volume III, the provisions of this code shall apply as follows:

1. Construction and design provisions of this code pertaining to the exterior of the structure shall apply including, but not limited to, premises identification, fire apparatus access and water supplies. Where interior or exterior systems or devices are installed, construction permits required by Section 105.6 shall apply.
2. Administrative, operational and maintenance provisions of this code shall apply.

**[A] 102.6 Historic buildings.** The provisions of this code relating to the construction, *alteration*, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and classified by the state or local jurisdiction as historic buildings where such buildings or structures do not constitute a distinct hazard to life or property. Fire protection in designated historic buildings shall be provided with an *approved* fire protection plan as required in Section 1103.1.1.

**[A] 102.7 Referenced codes and standards.** The codes and standards referenced in this code shall be those that are listed in Chapter 80, and such codes and standards shall be considered to be part of the requirements of this code to the prescribed extent of each such reference and as further regulated by Sections 102.7.1 and 102.7.2.

**[A] 102.7.1 Conflicts.** Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**[A] 102.7.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

**[A] 102.8 Subjects not regulated by this code.** Where applicable standards or requirements are not set forth in this code, or are contained within other laws, codes, regulations, ordinances or bylaws adopted by the jurisdiction, compliance with applicable standards of the National Fire Protection Association or other nationally recognized fire safety standards, as *approved*, shall be deemed as prima facie evidence of compliance with the intent of this code. Nothing herein shall derogate from the authority of the *fire code official* to determine compliance with codes or standards for those activities or installations within the *fire code official's* jurisdiction or responsibility.

**[A] 102.9 Matters not provided for.** Requirements that are essential for the public safety of an existing or proposed activity, building or structure, or for the safety of the occupants thereof, that are not specifically provided for by this code, shall be determined by the *fire code official*.

**[A] 102.10 Conflicting provisions.** Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in a specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

**[A] 102.11 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

**[A] 102.12 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

**102.13 Health care memorandum of understanding. MEMORANDUM OF UNDERSTANDING—HEALTH CARE FACILITIES.** This Memorandum of Understanding will specify and serve as a method to resolve conflicts between the Arkansas Fire Prevention Code Rules, 2021 Edition (hereinafter "*Arkansas Fire Prevention Code*" or "AFPC") adopted and enforced by the Arkansas State Fire Marshal's Office, under the authority of the Director of the Division of the Arkansas State Police, and other federal or state rules governing Arkansas' health care and long-term care facilities, by law regulated by the Arkansas Department of Health and the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), among others.

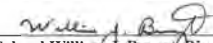
1. The Arkansas Department of Health and the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA) will have inspectors and/or plan reviewers obtain

## SCOPE AND ADMINISTRATION

- training related to the implementation and application of the National Fire Protection Association Life Safety Code (NFPA 101) and the *Arkansas Fire Prevention Code*.
2. The Arkansas Department of Health will have concurrent authority to do Fire and Life Safety Code inspections in health care facilities regulated by the Arkansas Department of Health. The Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), will have concurrent authority to do Fire and Life Safety Code inspections in long-term care facilities regulated by the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA). The Arkansas Department of Health's authority and the authority of the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA) will be concurrent with the current authority of any other relevant federal, state or local government agency having authority to do said inspections.
  3. The *Arkansas Fire Prevention Code* is the fire prevention code for the State of Arkansas.
  4. When there is a conflict between the *Arkansas Fire Prevention Code* and the National Fire Protection Association Life Safety Code (NFPA 101), New Health Care Occupancies Chapter, Existing Health Care Occupancies Chapter, New Ambulatory Health Care Occupancies Chapter, and Existing Ambulatory Health Care Occupancies Chapter, as adopted by the United States Department of Health and Human Services, Centers for Medicare Medicaid Services, per Title 42 Code of Federal Regulations, the aforementioned chapters in the Life Safety Code shall govern.
  5. For new construction, when one of the affected agencies [Arkansas Department of Health, Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), local fire official, or local building official] determines or perceives that a conflict exists between the *Arkansas Fire Prevention Code* and the National Fire Protection Association Life Safety Code (NFPA 101), as it relates to types of construction or allowable area requirements, they shall provide written notification of the perceived conflict to the project architect or engineer and the other affected agencies. The agency alleging the conflict will convene a meeting with the other affected agencies to resolve the conflict. The resolution of the conflict must be unanimous. If the group is unable to resolve the conflict unanimously, the issue will be referred to the Arkansas State Fire Marshal for final resolution.


Agreed to as evidenced by the signatures of the participating parties for their respective offices or associations below:

Arkansas State Fire Marshal, and Director of Arkansas State Police or his designee

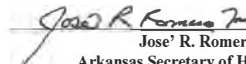
  
Colonel William J. Bryant, Director of Division of Arkansas State Police

  
Major Lindsey Williams, Arkansas State Fire Marshal

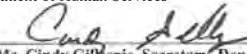
Arkansas Hospital Association

  
Mr. Bo Ryal, President and Chief Operating Officer

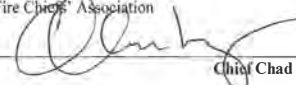
Arkansas Department of Health

  
Jose R. Romero, MD, FAAP, FIDSA, FPIDS, FAAAS,  
Arkansas Secretary of Health, Director, Arkansas Department of Health


Arkansas Department of Human Services

  
Ms. Cindy Gillespie, Secretary, Department of Human Services

Arkansas Fire Chiefs' Association

  
Chief Chad Mosby

Arkansas Fire Marshals' Association

  
Battalion Chief/Fire Marshal Jason Wills

Code Officials of Arkansas Chapter of International Code Council ("ICC")

  
Ms. Jackie Baker

## PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION 103  
CODE COMPLIANCE AGENCY

[A] **103.1 Creation of agency.** The [INSERT NAME OF DEPARTMENT] is hereby created and the official in charge thereof shall be known as the *fire code official*. The function of the agency shall be the implementation, administration and enforcement of the provisions of this code.

[A] **103.2 Appointment.** The *fire code official* shall be appointed by the chief appointing authority of the jurisdiction.

[A] **103.3 Deputies.** In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the *fire code official* shall have the authority to appoint a deputy *fire code official*, other related technical officers, inspectors and other employees. Such employees shall have powers as delegated by the *fire code official*.



## SECTION 104 DUTIES AND POWERS OF THE FIRE CODE OFFICIAL

**[A] 104.1 General.** The *fire code official* is hereby authorized to enforce the provisions of this code. The *fire code official* shall have the authority to render interpretations of this code and to adopt policies, procedures, rules and regulations in order to clarify the application of its provisions. Such interpretations, policies, procedures, rules and regulations shall be in compliance with the intent and purpose of this code. Such policies, procedures, rules and regulations shall not have the effect of waiving requirements specifically provided for in this code.

**[A] 104.2 Applications and permits.** The *fire code official* is authorized to receive applications, review *construction documents* and issue permits for construction regulated by this code, issue permits for operations regulated by this code, inspect the premises for which such permits have been issued and enforce compliance with the provisions of this code.

**[A] 104.3 Right of entry.** Where it is necessary to make an inspection to enforce the provisions of this code, or where the *fire code official* has reasonable cause to believe that there exists in a building or on any premises any conditions or violations of this code that make the building or premises unsafe, dangerous or hazardous, the *fire code official* shall have the authority to enter the building or premises at all reasonable times to inspect or to perform the duties imposed on the *fire code official* by this code. If such building or premises is occupied, the *fire code official* shall present credentials to the occupant and request entry. If such building or premises is unoccupied, the *fire code official* shall first make a reasonable effort to locate the *owner*, the *owner's* authorized agent or other person having charge or control of the building or premises and request entry. If entry is refused, the *fire code official* has recourse to every remedy provided by law to secure entry.

**[A] 104.3.1 Warrant.** Where the *fire code official* has first obtained a proper inspection warrant or other remedy provided by law to secure entry, an *owner*, the *owner's* authorized agent or occupant or person having charge, care or control of the building or premises shall not fail or neglect, after proper request is made as herein provided, to permit entry therein by the *fire code official* for the purpose of inspection and examination pursuant to this code.

### 104.3.2 State Fire Marshal jurisdiction.

- (a) The State Fire Marshal's Office has statewide jurisdiction to inspect all places in Arkansas insofar as it is necessary for the enforcement of all laws, ordinance and law, or ordinances and lawful orders requiring any place to be safe from fire. The State Fire Marshal or his/her duly authorized representative(s) shall be charged with the enforcement of this Code as granted under the authority of Act 254 of 1955, as amended.

- (b) The fire official shall have primary responsibility for the safety of places in his/her own district, city or county. Rules of the State Fire Marshal's Office establishing minimum standards shall not prevent any district, city or county from enacting more stringent regulations; and the State Fire Marshal's Office shall cooperate with the fire official in enforcing all fire safety laws and ordinances of the state or its political subdivisions. Inspections of property in the territory served by the fire department shall be made as often as practicable or as often as the city or county legislative body or other political subdivision fire officials may direct.

- (c) A written report of continued violations should be sent to the State Fire Marshal, who will cooperate with local authorities to secure compliance with the *Arkansas Fire Prevention Code* and other laws, ordinances and rules of the state and its political subdivisions relating to matters within the scope and jurisdiction of the State Fire Marshal's Office.

- (d) Town, city or county building officials: When a jurisdiction establishes a building department and a building official as set out in Volume II. Section 103 of the code, the primary responsibility for administering and enforcing Volume II (Building Code) of the AFPC shall fall to that established administrative authority.

**[A] 104.4 Identification.** The *fire code official* shall carry proper identification when inspecting structures or premises in the performance of duties under this code.

**[A] 104.5 Notices and orders.** The *fire code official* is authorized to issue such notices or orders as are required to affect compliance with this code in accordance with Sections 112.1 and 112.2.

**[A] 104.6 Official records.** The *fire code official* shall keep official records as required by Sections 104.6.1 through 104.6.4. Such official records shall be retained for not less than 5 years or for as long as the structure or activity to which such records relate remains in existence, unless otherwise provided by other regulations.

**[A] 104.6.1 Approvals.** A record of approvals shall be maintained by the *fire code official* and shall be available for public inspection during business hours in accordance with applicable laws.

**[A] 104.6.2 Inspections.** The *fire code official* shall keep a record of each inspection made, including notices and orders issued, showing the findings and disposition of each.

**104.6.3 Fire records.** The fire department shall keep a record of fires occurring within its jurisdiction and of facts concerning the same, including statistics as to the extent of such fires and the damage caused thereby, together with other information as required by the *fire code official*.



[A] **104.6.4 Administrative.** Application for modification, alternative methods or materials and the final decision of the *fire code official* shall be in writing and shall be officially recorded in the permanent records of the *fire code official*.

[A] **104.7 Liability.** The *fire code official*, member of the board of appeals, officer or employee charged with the enforcement of this code, while acting for the jurisdiction, in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance, shall not thereby be rendered civilly or criminally liable personally, and is hereby relieved from all personal liability for any damage accruing to persons or property as a result of an act or by reason of an act or omission in the discharge of official duties.

[A] **104.7.1 Legal defense.** Any suit or criminal complaint instituted against any officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by the legal representatives of the jurisdiction until the final termination of the proceedings. The *fire code official* or any subordinate shall not be liable for costs in an action, suit or proceeding that is instituted in pursuance of the provisions of this code; and any officer of the department of fire prevention, acting in good faith and without malice, shall be free from liability for acts performed under any of its provisions or by reason of any act or omission in the performance of official duties in connection therewith.

[A] **104.8 Approved materials and equipment.** Materials, equipment and devices *approved* by the *fire code official* shall be constructed and installed in accordance with such approval.

[A] **104.8.1 Material and equipment reuse.** Materials, equipment and devices shall not be reused or reinstalled unless such elements have been reconditioned, tested and placed in good and proper working condition and *approved*.

[A] **104.8.2 Technical assistance.** To determine the acceptability of technologies, processes, products, facilities, materials and uses attending the design, operation or use of a building or premises subject to inspection by the *fire code official*, the *fire code official* is authorized to require the owner or owner's authorized agent to provide, without charge to the jurisdiction, a technical opinion and report. The opinion and report shall be prepared by a qualified engineer, specialist, laboratory or fire safety specialty organization acceptable to the *fire code official* and shall analyze the fire safety properties of the design, operation or use of the building or premises and the facilities and appurtenances situated thereon, to recommend necessary changes. The *fire code official* is authorized to require design submittals to be prepared by, and bear the stamp of, a *registered design professional*.

[A] **104.9 Modifications.** Where there are practical difficulties involved in carrying out the provisions of this code, the *fire code official* shall have the authority to grant modifications for individual cases, provided that the *fire code official*

shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, life and fire safety requirements. The details of action granting modifications shall be recorded and entered in the files of the department of fire prevention.

[A] **104.10 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *fire code official* finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability and safety. Where the alternative material, design or method of construction is not *approved*, the *fire code official* shall respond in writing, stating the reasons why the alternative was not *approved*.

[A] **104.10.1 Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

[A] **104.10.2 Tests.** Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *fire code official* shall have the authority to require tests as evidence of compliance to be made without expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *fire code official* shall approve the testing procedures. Tests shall be performed by an *approved* agency. Reports of such tests shall be retained by the *fire code official* for the period required for retention of public records.

**104.10.3 Performance-based options.** When acceptable to the building official, the most current edition of the *ICC Performance Code for Buildings and Facilities* or the *SFPE Engineering Guide to Performance-Based Fire Protection* may be followed.

**104.11 Fire investigations.** The *fire code official*, the fire department or other responsible authority shall have the authority to investigate the cause, origin and circumstances of any fire, explosion or other hazardous condition. Information that could be related to trade secrets or processes shall not be made part of the public record, except as directed by a court of law.

**104.11.1 Assistance from other agencies.** Police and other enforcement agencies shall have authority to render necessary assistance in the investigation of fires when requested to do so.

## SCOPE AND ADMINISTRATION

**104.11.2 Report of fire fatalities.** Fire departments responding to fires resulting in a fatal injury shall report in writing such fatalities to the State Fire Marshal's Office within 3 business days of the occurrence.

**104.11.3 Changes in fire department information.** All fire departments shall submit, on or before June 30 of each year, the name of the officer in charge, the mailing address and electronic mailing address, telephone and facsimile numbers of the fire department and other information to the State Fire Marshal's Office on a form provided by the State Fire Marshal's Office. Any change in the pertinent information during the year shall be sent to the State Fire Marshal's Office in writing, no later than 30 days after the change occurs.

**104.11.4 Reports of fireworks accidents.** Accidents involving fireworks resulting in death, serious injury or major property damage shall be reported immediately to the State Fire Marshal's Office by the responding fire or police department or the holder of a fireworks license or public display permit.

**104.12 Authority at fires and other emergencies.** The *fire chief* or officer of the fire department in charge at the scene of a fire or other emergency involving the protection of life or property, or any part thereof, shall have the authority to direct such operation as necessary to extinguish or control any fire, perform any rescue operation, investigate the existence of suspected or reported fires, gas leaks or other hazardous conditions or situations, or take any other action necessary in the reasonable performance of duty. In the exercise of such power, the *fire chief* is authorized to prohibit any person, vehicle, vessel or thing from approaching the scene, and is authorized to remove, or cause to be removed or kept away from the scene, any vehicle, vessel or thing that could impede or interfere with the operations of the fire department and, in the judgment of the *fire chief*, any person not actually and usefully employed in the extinguishing of such fire or in the preservation of property in the vicinity thereof.

**104.12.1 Barricades.** The *fire chief* or officer of the fire department in charge at the scene of an emergency is authorized to place ropes, guards, barricades or other obstructions across any street, alley, place or private property in the vicinity of such operation so as to prevent accidents or interference with the lawful efforts of the fire department to manage and control the situation and to handle fire apparatus.

**104.12.2 Obstructing operations.** Persons shall not obstruct the operations of the fire department in connection with extinguishment or control of any fire, or actions relative to other emergencies, or disobey any lawful command of the *fire chief* or officer of the fire department in charge of the emergency, or any part thereof, or any lawful order of a police officer assisting the fire department.

**104.12.3 Systems and devices.** Persons shall not render a system or device inoperative during an emergency unless by direction of the *fire chief* or fire department official in charge of the incident.

## SECTION 105 PERMITS

**[A] 105.1 General.** Permits shall be in accordance with Sections 105.1.1 through 105.6.24.

**[A] 105.1.1 Permits required.** Where required by the *fire code official*, a property owner or owner's authorized agent who intends to conduct an operation or business or install or modify systems and equipment that are regulated by this code, or to cause any such work to be performed, shall first make application to the *fire code official* and obtain the required permit.

**105.1.1.1 General—Fireworks licenses or public display permits.** Permits shall be obtained as required below. Such permits will be issued when the requirements of the State Fire Marshal's office have been met; and they may be suspended or revoked if the requirements are violated. Application for "State Permits" required as follows, shall be made in writing, on forms required, to the State Fire Marshal, Arkansas State Police, 1 State Police Plaza Drive, Little Rock, AR 72209-2971. The State Fire Marshal's Office telephone number is 501-618-8624 until further notice.

1. **Fees.** No fee is required for a state fireworks license or public display permit except as prescribed for licenses relating to fireworks and except as hereafter otherwise provided by law and these rules.
2. **State permits.** A permit or license shall be obtained from the State Fire Marshal for any of the following:
  - (a) Dealing in fireworks as set out in state fireworks laws.
  - (b) Public fireworks display permit for indoor and outdoor displays.
  - (c) Installation of aboveground storage tanks for combustible liquids, flammable liquids and hazardous chemicals.

### Exceptions:

1. Tanks that are part of emergency generator systems.
2. Temporary tanks (period of use not to exceed 6 months).
3. Tanks less than 500 gallons (1893 L) in capacity and not used for retail dispensing.
3. **Local permits.** Where provisions are made by a municipality or county or other political subdivision of the state for the issuance of permits, and where such rules are at least as stringent as those of the State Fire Marshal, a permit from an authorized city or county official or other political subdivision official shall be obtained for the construction or substantial remodeling of any of the following:
  - (a) Asylums, hospitals, nursing or convalescent homes or other health care facilities, regardless of capacity.

- (b) Schools and educational institutions having a capacity in excess of 50 pupils, and residence buildings, including dormitories, having sleeping accommodations for 50 or more persons.
  - (c) Auditoriums, theaters, indoor stadiums, gymnasiums, churches or other places of assembly having a capacity in excess of 100 or more persons.
  - (d) Department stores or factories having a capacity in excess of 200 persons or for any other building if located within the city or county fire service jurisdiction or other political subdivision. A city, county or other political subdivision of the state may, by ordinance, set out other permits that may be required for new or existing structures.
4. **Building permits.** Where a jurisdiction has established a building department in accordance with Volume II, Section 103 of the code, permits within the corporate limits of the jurisdiction for new construction or remodeling shall be required in accordance with Volume II, Section 105 of the code.

**105.1.2 Types of permits.** There shall be two types of permits as follows:

1. Operational permit. An operational permit allows the applicant to conduct an operation or a business for which a permit is required by Section 105.5 for either:
  - 1.1. A prescribed period.
  - 1.2. Until renewed or revoked.
2. Construction permit. A construction permit allows the applicant to install or modify systems and equipment for which a permit is required by Section 105.6.

**105.1.3 Multiple permits for the same location.** Where more than one permit is required for the same location, the *fire code official* is authorized to consolidate such permits into a single permit provided that each provision is listed in the permit.

**[A] 105.1.4 Emergency repairs.** Where equipment replacement and repairs must be performed in an emergency situation, the permit application shall be submitted within the next working business day to the *fire code official*.

**[A] 105.1.5 Repairs.** Application or notice to the *fire code official* is not required for ordinary repairs to structures, equipment or systems. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or change of any required *means of egress*, or rearrangement of parts of a structure affecting the egress requirements; nor shall any repairs include addition to, *alteration* of, replacement or relocation of any standpipe, fire protection water supply, *automatic sprinkler system*, fire alarm system or other work affecting fire protection or life safety.

**[A] 105.1.6 Annual permit.** Instead of an individual construction permit for each alteration to an already *approved* system or equipment installation, the *fire code official* is authorized to issue an annual permit on application therefor to any person, firm or corporation regularly employing one or more qualified tradespersons in the building, structure or on the premises owned or operated by the applicant for the permit.

**[A] 105.1.6.1 Annual permit records.** The person to whom an annual permit is issued shall keep a detailed record of alterations made under such annual permit. The *fire code official* shall have access to such records at all times or such records shall be filed with the *fire code official* as designated.

**[A] 105.2 Application.** Where required by the *fire code official*, an application for a permit under this code shall be made to the *fire code official* in such form and detail as prescribed by the *fire code official*. Applications for permits shall be accompanied by such plans as prescribed by the *fire code official*.

**[A] 105.2.1 Refusal to issue permit.** If the application for a permit describes a use that does not conform to the requirements of this code and other pertinent laws and ordinances, the *fire code official* shall not issue a permit, but shall return the application to the applicant with the refusal to issue such permit. Such refusal shall, where requested, be in writing and shall contain the reasons for refusal.

**[A] 105.2.2 Inspection authorized.** Before a new operational permit is *approved*, the *fire code official* is authorized to inspect the receptacles, vehicles, buildings, devices, premises, storage spaces or areas to be used to determine compliance with this code or any operational constraints required.

**[A] 105.2.3 Time limitation of application.** An application for a permit for any proposed work or operation shall be deemed to have been abandoned 180 days after the date of filing, unless such application has been diligently prosecuted or a permit shall have been issued; except that the *fire code official* is authorized to grant one or more extensions of time for additional periods not exceeding 90 days each. The extension shall be requested in writing and justifiable cause demonstrated.

**[A] 105.2.4 Action on application.** The *fire code official* shall examine or cause to be examined applications for permits and amendments thereto within a reasonable time after filing. If the application or the *construction documents* do not conform to the requirements of pertinent laws, the *fire code official* shall reject such application in writing, stating the reasons therefor. If the *fire code official* is satisfied that the proposed work or operation conforms to the requirements of this code and laws and ordinances applicable thereto, the *fire code official* shall issue a permit therefor as soon as practicable.

**[A] 105.3 Conditions of a permit.** A permit shall constitute permission to maintain, store or handle materials; or to conduct processes that produce conditions hazardous to life or property; or to install equipment utilized in connection



## SCOPE AND ADMINISTRATION

with such activities; or to install or modify any *fire protection system* or equipment or any other construction, equipment installation or modification in accordance with the provisions of this code where a permit is required by Section 105.5 or 105.6. Such permission shall not be construed as authority to violate, cancel or set aside any of the provisions of this code or other applicable regulations or laws of the jurisdiction.

**[A] 105.3.1 Expiration.** An operational permit shall remain in effect until reissued, renewed or revoked, or for such a period of time as specified in the permit. Construction permits shall automatically become invalid unless the work authorized by such permit is commenced within 180 days after its issuance, or if the work authorized by such permit is suspended or abandoned for a period of 180 days after the time the work is commenced. Before such work recommences, a new permit shall be first obtained and the fee to recommence work, if any, shall be one-half the amount required for a new permit for such work, provided that changes have not been made and will not be made in the original *construction documents* for such work, and provided further that such suspension or abandonment has not exceeded one year. Permits are not transferable and any change in occupancy, operation, tenancy or ownership shall require that a new permit be issued.

**[A] 105.3.2 Extensions.** A permittee holding an unexpired permit shall have the right to apply for an extension of the time within which the permittee will commence work under that permit where work is unable to be commenced within the time required by this section for good and satisfactory reasons. The *fire code official* is authorized to grant, in writing, one or more extensions of the time period of a permit for periods of not more than 180 days each. Such extensions shall be requested by the permit holder in writing and justifiable cause demonstrated.

**[A] 105.3.3 Occupancy prohibited before approval.** The building or structure shall not be occupied prior to the *fire code official* issuing a permit and conducting associated inspections indicating the applicable provisions of this code have been met.

**[A] 105.3.4 Conditional permits.** Where permits are required and on the request of a permit applicant, the *fire code official* is authorized to issue a conditional permit to occupy the premises or portion thereof before the entire work or operations on the premises is completed, provided that such portion or portions will be occupied safely prior to full completion or installation of equipment and operations without endangering life or public welfare. The *fire code official* shall notify the permit applicant in writing of any limitations or restrictions necessary to keep the permit area safe. The holder of a conditional permit shall proceed only to the point for which approval has been given, at the permit holder's own risk and without assurance that approval for the occupancy or the utilization of the entire premises, equipment or operations will be granted.

**[A] 105.3.5 Posting the permit.** Issued permits shall be kept on the premises designated therein at all times and shall be readily available for inspection by the *fire code official*.

**[A] 105.3.6 Compliance with code.** The issuance or granting of a permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a permit based on *construction documents* and other data shall not prevent the *fire code official* from requiring the correction of errors in the *construction documents* and other data. Any addition to or alteration of *approved construction documents* shall be *approved* in advance by the *fire code official*, as evidenced by the issuance of a new or amended permit.

**[A] 105.3.7 Information on the permit.** The *fire code official* shall issue all permits required by this code on an *approved* form furnished for that purpose. The permit shall contain a general description of the operation or occupancy and its location and any other information required by the *fire code official*. Issued permits shall bear the signature of the *fire code official* or other *approved* legal authorization.

**[A] 105.3.8 Validity of permit.** The issuance or granting of a permit shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinances of the jurisdiction. Permits presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a permit based on *construction documents*, operational documents and other data shall not prevent the *fire code official* from requiring correction of errors in the documents or other data.

**[A] 105.4 Revocation.** The *fire code official* is authorized to revoke a permit issued under the provisions of this code where it is found by inspection or otherwise that there has been a false statement or misrepresentation as to the material facts in the application or *construction documents* on which the permit or approval was based including, but not limited to, any one of the following:

1. The permit is used for a location or establishment other than that for which it was issued.
2. The permit is used for a condition or activity other than that listed in the permit.
3. Conditions and limitations set forth in the permit have been violated.
4. There have been any false statements or misrepresentations as to the material fact in the application for permit or plans submitted or a condition of the permit.
5. The permit is used by a different person or firm than the name for which it was issued.

6. The permittee failed, refused or neglected to comply with orders or notices duly served in accordance with the provisions of this code within the time provided therein.
7. The permit was issued in error or in violation of an ordinance, regulation or this code.

- **105.5 Operational permits.** Where required, the *fire code official* is authorized to issue operational permits for the operations set forth in Sections 105.5.2 through 105.5.52.

**105.5.1 Additive manufacturing.** An operational permit is required to conduct additive manufacturing operations regulated by Section 320.3.

**105.5.2 Aerosol products, aerosol cooking spray products and plastic aerosol 3 products.** An operational permit is required to manufacture, store or handle an aggregate quantity of Level 2 or Level 3 aerosol products, aerosol cooking spray products or plastic aerosol 3 products in excess of 500 pounds (227 kg) net weight.

**105.5.3 Amusement buildings.** An operational permit is required to operate a special amusement building.

**105.5.4 Aviation facilities.** An operational permit is required to use a Group H or Group S occupancy for aircraft servicing or repair and aircraft fuel-servicing vehicles. Additional permits required by other sections of this code include, but are not limited to, hot work, hazardous materials and flammable or combustible finishes.

**105.5.5 Carnivals and fairs.** An operational permit is required to conduct a carnival or fair.

**105.5.6 Cellulose nitrate film.** An operational permit is required to store, handle or use cellulose nitrate film in a Group A occupancy.

**105.5.7 Combustible dust-producing operations.** An operational permit is required to operate a grain elevator, flour starch mill, feed mill, or a plant pulverizing aluminum, coal, cocoa, magnesium, spices or sugar, or other operations producing *combustible dusts* as defined in Chapter 2.

**105.5.8 Combustible fibers.** An operational permit is required for the storage and handling of *combustible fibers* in quantities greater than 100 cubic feet (2.8 m<sup>3</sup>).

**Exception:** A permit is not required for agricultural storage.

**105.5.9 Compressed gases.** An operational permit is required for the storage, use or handling at *normal temperature and pressure* (NTP) of *compressed gases* in excess of the amounts listed in Table 105.5.9.

**Exception:** Vehicles equipped for and using *compressed gas* as a fuel for propelling the vehicle.

**TABLE 105.5.9  
PERMIT AMOUNTS FOR COMPRESSED GASES**

TYPE OF GAS	AMOUNT (cubic feet at NTP)
Carbon dioxide used in carbon dioxide enrichment systems	875 (100 lb)
Carbon dioxide used in insulated liquid carbon dioxide beverage dispensing applications	875 (100 lb)
Corrosive	200
Flammable (except cryogenic fluids and liquefied petroleum gases)	200
Highly toxic	Any Amount
Inert and simple asphyxiant	6,000
Oxidizing (including oxygen)	504
Pyrophoric	Any Amount
Toxic	Any Amount

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>.

**105.5.10 Covered and open mall buildings.** An operational permit is required for:

1. The placement of retail fixtures and displays, concession equipment, displays of highly combustible goods and similar items in the mall.
2. The display of liquid- or gas-fired equipment in the mall.
3. The use of open-flame or flame-producing equipment in the mall.

**105.5.11 Cryogenic fluids.** An operational permit is required to produce, store, transport on site, use, handle or dispense *cryogenic fluids* in excess of the amounts listed in Table 105.5.11.

**Exception:** Permits are not required for vehicles equipped for and using *cryogenic fluids* as a fuel for propelling the vehicle or for refrigerating the lading.

**TABLE 105.5.11  
PERMIT AMOUNTS FOR CRYOGENIC FLUIDS**

TYPE OF CRYOGENIC FLUID	INSIDE BUILDING (gallons)	OUTSIDE BUILDING (gallons)
Flammable	More than 1	60
Inert	60	500
Oxidizing (includes oxygen)	10	50
Physical or health hazard not indicated above	Any Amount	Any Amount

For SI: 1 gallon = 3.785 L.

**105.5.12 Cutting and welding.** An operational permit is required to conduct cutting or welding operations within the jurisdiction.



## SCOPE AND ADMINISTRATION

**105.5.13 Dry cleaning.** An operational permit is required to engage in the business of dry cleaning or to change to a more hazardous cleaning solvent used in existing dry cleaning equipment.

**105.5.14 Energy storage systems.** An operational permit is required for stationary and mobile energy storage systems regulated by Section 1207.

**105.5.15 Exhibits and trade shows.** An operational permit is required to operate exhibits and trade shows.

**105.5.16 Explosives.** An operational permit is required for the manufacture, storage, handling, sale or use of any quantity of *explosives*, *explosive materials*, fireworks or pyrotechnic special effects within the scope of Chapter 56.

**Exception:** Storage in Group R-3 occupancies of smokeless propellant, black powder and small arms primers for personal use, not for resale and in accordance with Section 5606.

**105.5.17 Fire hydrants and valves.** An operational permit is required to use or operate fire hydrants or valves intended for fire suppression purposes that are installed on water systems and provided with ready access from a fire apparatus access road that is open to or generally used by the public.

**Exception:** A permit is not required for authorized employees of the water company that supplies the system or the fire department to use or operate fire hydrants or valves.

**105.5.18 Flammable and combustible liquids.** An operational permit is required:

1. To use or operate a pipeline for the transportation within facilities of *flammable* or *combustible liquids*. This requirement shall not apply to the off-site transportation in pipelines regulated by the Department of Transportation (DOTn) nor does it apply to piping systems.
2. To store, handle or use Class I liquids in excess of 5 gallons (19 L) in a building or in excess of 10 gallons (37.9 L) outside of a building, except that a permit is not required for the following:
  - 2.1. The storage or use of Class I liquids in the fuel tank of a motor vehicle, aircraft, motorboat, mobile power plant or mobile heating plant, unless such storage, in the opinion of the *fire code official*, would cause an unsafe condition.
  - 2.2. The storage or use of paints, oils, varnishes or similar flammable mixtures where such liquids are stored for maintenance, painting or similar purposes for a period of not more than 30 days.
3. To store, handle or use Class II or Class IIIA liquids in excess of 25 gallons (95 L) in a building or in excess of 60 gallons (227 L) outside a building, except for fuel oil used in connection with oil-burning equipment.

4. To store, handle or use Class IIIB liquids in tanks or portable tanks for fueling motor vehicles at motor fuel-dispensing facilities or where connected to fuel-burning equipment.

**Exception:** Fuel oil and used motor oil used for space heating or water heating.

5. To remove Class I or II liquids from an underground storage tank used for fueling motor vehicles by any means other than the *approved*, stationary on-site pumps normally used for dispensing purposes.
6. To operate tank vehicles, equipment, tanks, plants, terminals, wells, fuel-dispensing stations, refineries, distilleries and similar facilities where *flammable* and *combustible liquids* are produced, processed, transported, stored, dispensed or used.
7. To place temporarily out of service (for more than 90 days) an underground, protected above-ground or above-ground *flammable* or *combustible liquid* tank.
8. To change the type of contents stored in a *flammable* or *combustible liquid* tank to a material that poses a greater hazard than that for which the tank was designed and constructed.
9. To manufacture, process, blend or refine *flammable* or *combustible liquids*.
10. To engage in the dispensing of liquid fuels into the fuel tanks of motor vehicles at commercial, industrial, governmental or manufacturing establishments in accordance with Section 5706.5.4 or to engage in on-demand mobile fueling operations in accordance with Section 5707.
11. To utilize a site for the dispensing of liquid fuels from tank vehicles into the fuel tanks of motor vehicles, marine craft and other special equipment at commercial, industrial, governmental or manufacturing establishments in accordance with Section 5706.5.4 or, where required by the *fire code official*, to utilize a site for on-demand mobile fueling operations in accordance with Section 5707.

**105.5.19 Floor finishing.** An operational permit is required for floor finishing or surfacing operations exceeding 350 square feet (33 m<sup>2</sup>) using Class I or Class II liquids.

**105.5.20 Fruit and crop ripening.** An operational permit is required to operate a fruit- or crop-ripening facility or conduct a fruit-ripening process using ethylene gas.

**105.5.21 Fumigation and insecticidal fogging.** An operational permit is required to operate a business of fumigation or insecticidal fogging, and to maintain a room, vault or chamber in which a toxic or flammable fumigant is used.

**105.5.22 Hazardous materials.** An operational permit is required to store, transport on site, dispense, use or handle hazardous materials in excess of the amounts listed in Table 105.5.22.

**TABLE 105.5.22**  
**PERMIT AMOUNTS FOR HAZARDOUS MATERIALS**

TYPE OF MATERIAL	AMOUNT
Combustible liquids	See Section 105.5.18
Corrosive materials	
Gases	See Section 105.5.9
Liquids	55 gallons
Solids	1,000 pounds
Explosive materials	See Section 105.5.16
Flammable materials	
Gases	See Section 105.5.9
Liquids	See Section 105.5.18
Solids	100 pounds
Highly toxic materials	
Gases	See Section 105.5.9
Liquids	Any Amount
Solids	Any Amount
Organic peroxides	
Liquids	
Class I	Any Amount
Class II	Any Amount
Class III	1 gallon
Class IV	2 gallons
Class V	No Permit Required
Solids	
Class I	Any Amount
Class II	Any Amount
Class III	10 pounds
Class IV	20 pounds
Class V	No Permit Required
Oxidizing materials	
Gases	See Section 105.5.9
Liquids	
Class 4	Any Amount
Class 3	1 gallon <sup>a</sup>
Class 2	10 gallons
Class 1	55 gallons
Solids	
Class 4	Any Amount
Class 3	10 pounds <sup>b</sup>
Class 2	100 pounds
Class 1	500 pounds
Pyrophoric materials	
Gases	Any Amount
Liquids	Any Amount
Solids	Any Amount
Toxic materials	
Gases	See Section 105.5.9
Liquids	10 gallons
Solids	100 pounds

(continued)

**105.5.23 HPM facilities.** An operational permit is required to store, handle or use hazardous production materials.

**TABLE 105.5.22—continued**  
**PERMIT AMOUNTS FOR HAZARDOUS MATERIALS**

TYPE OF MATERIAL	AMOUNT
Unstable (reactive) materials	
Liquids	
Class 4	Any Amount
Class 3	Any Amount
Class 2	5 gallons
Class 1	10 gallons
Solids	
Class 4	Any Amount
Class 3	Any Amount
Class 2	50 pounds
Class 1	100 pounds
Water-reactive materials	
Liquids	
Class 3	Any Amount
Class 2	5 gallons
Class 1	55 gallons
Solids	
Class 3	Any Amount
Class 2	50 pounds
Class 1	500 pounds

For SI: 1 gallon = 3.785 L, 1 pound = 0.454 kg.

- 22 gallons where Table 5003.1.1(1) Note k applies and hazard identification signs in accordance with Section 5003.5 are provided for quantities of 22 gallons or less.
- 220 pounds where Table 5003.1.1(1) Note k applies and hazard identification signs in accordance with Section 5003.5 are provided for quantities of 220 pounds or less.

**105.5.24 High-piled storage.** An operational permit is required to use a building or portion thereof with more than 500 square feet (46 m<sup>2</sup>), including aisles, of *high-piled combustible storage*.

**105.5.25 Hot work operations.** An operational permit is required for hot work including, but not limited to:

- Public exhibitions and demonstrations where hot work is conducted.
- Use of portable hot work equipment inside a structure.

**Exception:** Work that is conducted under a construction permit.

- Fixed-site hot work equipment, such as welding booths.
- Hot work conducted within a wildfire risk area.
- Application of roof coverings with the use of an open-flame device.
- Where *approved*, the *fire code official* shall issue a permit to carry out a hot work program. This program allows *approved* personnel to regulate their facility's hot work operations. The *approved* personnel shall be trained in the fire safety aspects denoted in this chapter and shall be responsible for issuing permits requiring compliance with the requirements found in Chapter 35. These permits shall be issued only to their employees or hot work operations under their supervision.

## SCOPE AND ADMINISTRATION

**105.5.26 Industrial ovens.** An operational permit is required for operation of industrial ovens regulated by Chapter 30.

**105.5.27 Lumber yards and woodworking plants.** An operational permit is required for the storage or processing of lumber exceeding 100,000 board feet (8,333 ft<sup>3</sup>) (236 m<sup>3</sup>).

**105.5.28 Liquid- or gas-fueled vehicles or equipment in assembly buildings.** An operational permit is required to display, operate or demonstrate liquid- or gas-fueled vehicles or equipment in assembly buildings.

**105.5.29 LP-gas.** An operational permit is required for:

1. Storage and use of LP-gas.

**Exception:** A permit is not required for individual containers with a 500-gallon (1893 L) water capacity or less or multiple container systems having an aggregate quantity not exceeding 500 gallons (1893 L), serving occupancies in Group R-3.

2. Operation of cargo tankers that transport LP-gas.

**105.5.30 Magnesium.** An operational permit is required to melt, cast, heat treat or grind more than 10 pounds (4.54 kg) of magnesium.

**105.5.31 Miscellaneous combustible storage.** An operational permit is required to store in any building or on any premises in excess of 2,500 cubic feet (71 m<sup>3</sup>) gross volume of combustible empty packing cases, boxes, barrels or similar containers, combustible pallets, rubber tires, rubber, cork or similar combustible material.

**105.5.32 Mobile food preparation vehicles.** A permit is required for mobile food preparation vehicles equipped with appliances that produce smoke or grease-laden vapors.

**105.5.33 Motor fuel-dispensing facilities.** An operational permit is required for the operation of automotive, marine and fleet motor fuel-dispensing facilities.

**105.5.34 Open burning.** An operational permit is required for the kindling or maintaining of an open fire or a fire on any public street, alley, road, or other public or private ground. Instructions and stipulations of the permit shall be complied with.

**Exception:** *Recreational fires.*

**105.5.35 Open flames and torches.** An operational permit is required to remove paint with a torch, or to use a torch or open-flame device in a wildfire risk area.

**105.5.36 Open flames and candles.** An operational permit is required to use open flames or candles in connection with assembly areas, dining areas of restaurants or drinking establishments.

**105.5.37 Organic coatings.** An operational permit is required for any organic-coating manufacturing operation producing more than 1 gallon (4 L) of an organic coating in one day.

**105.5.38 Outdoor assembly event.** An operational permit is required to conduct an *outdoor assembly event* where planned attendance exceeds 1,000 persons.

**105.5.39 Places of assembly.** An operational permit is required to operate a place of assembly.

**105.5.40 Plant extraction systems.** An operational permit is required to use plant extraction systems.

**105.5.41 Private fire hydrants.** An operational permit is required for the removal from service, use or operation of private fire hydrants.

**Exception:** A permit is not required for private industry with trained maintenance personnel, private fire brigade or fire departments to maintain, test and use private hydrants.

**105.5.42 Pyrotechnic special effects material.** An operational permit is required for use and handling of pyrotechnic special effects material.

**105.5.43 Pyroxylin plastics.** An operational permit is required for storage or handling of more than 25 pounds (11 kg) of cellulose nitrate (pyroxylin) plastics, and for the assembly or manufacture of articles involving pyroxylin plastics.

**105.5.44 Refrigeration equipment.** An operational permit is required to operate a mechanical refrigeration unit or system regulated by Chapter 6.

**105.5.45 Repair garages and motor fuel-dispensing facilities.** An operational permit is required for operation of repair garages.

**105.5.46 Rooftop heliports.** An operational permit is required for the operation of a rooftop heliport.

**105.5.47 Spraying or dipping.** An operational permit is required to conduct a spraying or dipping operation utilizing *flammable* or *combustible liquids*, or the application of combustible powders regulated by Chapter 24.

**105.5.48 Storage of scrap tires and tire byproducts.** An operational permit is required to establish, conduct or maintain storage of scrap tires and tire byproducts that exceeds 2,500 cubic feet (71 m<sup>3</sup>) of total volume of scrap tires, and for indoor storage of tires and tire byproducts.

**105.5.49 Temporary membrane structures and tents.** An operational permit is required to operate an air-supported temporary membrane structure, a temporary *special event structure* or a tent having an area in excess of 400 square feet (37 m<sup>2</sup>).

#### Exceptions:

1. Tents used exclusively for recreational camping purposes.
2. Tents open on all sides, which comply with all of the following:
  - 2.1. Individual tents having a maximum size of 700 square feet (65 m<sup>2</sup>).
  - 2.2. The aggregate area of multiple tents placed side by side without a fire break clearance of not less than 12 feet

(3658 mm) shall not exceed 700 square feet (65 m<sup>2</sup>) total.

- 2.3. A minimum clearance of 12 feet (3658 mm) to structures and other tents shall be provided.

**105.5.50 Tire-rebuilding plants.** An operational permit is required for the operation and maintenance of a tire-rebuilding plant.

**105.5.51 Waste handling.** An operational permit is required for the operation of wrecking yards, junk yards and waste material-handling facilities.

**105.5.52 Wood products.** An operational permit is required to store chips, hogged material, lumber or plywood in excess of 200 cubic feet (6 m<sup>3</sup>).

**[A] 105.6 Required construction permits.** Where required, the *fire code official* is authorized to issue construction permits for work as set forth in Sections 105.6.1 through 105.6.24.

**[A] 105.6.1 Automatic fire-extinguishing systems.** A construction permit is required for installation of or modification to an automatic fire-extinguishing system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.2 Compressed gases.** Where the *compressed gases* in use or storage exceed the amounts listed in Table 105.5.9, a construction permit is required to install, repair damage to, abandon, remove, place temporarily out of service, or close or substantially modify a *compressed gas* system.

**Exceptions:**

1. Routine maintenance.
2. For emergency repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.

**[A] 105.6.3 Cryogenic fluids.** A construction permit is required for installation of or *alteration* to outdoor stationary *cryogenic fluid* storage systems where the system capacity exceeds the amounts listed in Table 105.5.11. Maintenance performed in accordance with this code is not considered to be an *alteration* and does not require a construction permit.

**[A] 105.6.4 Emergency responder communication coverage system.** A construction permit is required for installation of or modification to in-building, two-way emergency responder communication coverage systems and related equipment. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

**105.6.5 Energy storage systems.** A construction permit is required to install energy storage systems regulated by Section 1207.

**[A] 105.6.6 Fire alarm and detection systems and related equipment.** A construction permit is required for installation of or modification to fire alarm and detection

systems and related equipment. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

**[A] 105.6.7 Fire pumps and related equipment.** A construction permit is required for installation of or modification to fire pumps and related fuel tanks, jockey pumps, controllers and generators. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.

**[A] 105.6.8 Flammable and combustible liquids.** A construction permit is required:

1. To install, repair or modify a pipeline for the transportation of *flammable* or *combustible liquids*.
2. To install, construct or alter tank vehicles, equipment, tanks, plants, terminals, wells, fuel-dispensing stations, refineries, distilleries and similar facilities where *flammable* and *combustible liquids* are produced, processed, transported, stored, dispensed or used.
3. To install, alter, remove, abandon or otherwise dispose of a *flammable* or *combustible liquid tank*.

**[A] 105.6.9 Fuel cell power systems.** A construction permit is required to install *stationary fuel cell power systems*.

**[A] 105.6.10 Gas detection systems.** A construction permit is required for the installation of or modification to gas detection systems. Maintenance performed in accordance with this code is not considered a modification and shall not require a permit.

**[A] 105.6.11 Gates and barricades across fire apparatus access roads.** A construction permit is required for the installation of or modification to a gate or barricade across a fire apparatus access road.

**[A] 105.6.12 Hazardous materials.** A construction permit is required to install, repair damage to, abandon, remove, place temporarily out of service, or close or substantially modify a storage facility or other area regulated by Chapter 50 where the hazardous materials in use or storage exceed the amounts listed in Table 105.5.22.

**Exceptions:**

1. Routine maintenance.
2. For repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.

**[A] 105.6.13 High-piled combustible storage.** A construction permit is required for the installation of or modification to a structure with more than 500 square feet (46 m<sup>2</sup>), including aisles, of *high-piled combustible storage*. Maintenance performed in accordance with this code is not considered to be a modification and does not require a construction permit.



## SCOPE AND ADMINISTRATION

**[A] 105.6.14 Industrial ovens.** A construction permit is required for installation of industrial ovens regulated by Chapter 30.

### Exceptions:

1. Routine maintenance.
2. For repair work performed on an emergency basis, application for permit shall be made within two working days of commencement of work.

**[A] 105.6.15 LP-gas.** A construction permit is required for installation of or modification to an LP-gas system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.16 Motor vehicle repair rooms and booths.** A construction permit is required to install or modify a motor vehicle repair room or booth. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.17 Plant extraction systems.** A construction permit is required for installation of or modification to plant extraction systems. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.18 Private fire hydrants.** A construction permit is required for the installation or modification of private fire hydrants. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.19 Smoke control or smoke exhaust systems.** Construction permits are required for installation of or alteration to smoke control or smoke exhaust systems. Maintenance performed in accordance with this code is not considered to be an alteration and does not require a permit.

**[A] 105.6.20 Solar photovoltaic power systems.** A construction permit is required to install or modify solar photovoltaic power systems. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.21 Special event structure.** A single construction permit is required to erect and take down a *temporary special event structure*.

**[A] 105.6.22 Spraying or dipping.** A construction permit is required to install or modify a spray room, dip tank or booth. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.23 Standpipe systems.** A construction permit is required for the installation, modification or removal from service of a standpipe system. Maintenance performed in accordance with this code is not considered to be a modification and does not require a permit.

**[A] 105.6.24 Temporary membrane structures and tents.** A construction permit is required to erect an air-supported temporary membrane structure, a temporary

stage canopy or a tent having an area in excess of 400 square feet (37 m<sup>2</sup>).

### Exceptions:

1. Tents used exclusively for recreational camping purposes.
2. Funeral tents and curtains, or extensions attached thereto, when used for funeral services.
3. Tents and awnings open on all sides, which comply with all of the following:
  - 3.1. Individual tents shall have a maximum size of 700 square feet (65 m<sup>2</sup>).
  - 3.2. The aggregate area of multiple tents placed side by side without a fire break clearance of not less than 12 feet (3658 mm) shall not exceed 700 square feet (65 m<sup>2</sup>) total.
  - 3.3. A minimum clearance of 12 feet (3658 mm) to structures and other tents shall be maintained.

## SECTION 106 CONSTRUCTION DOCUMENTS

**[A] 106.1 Submittals.** *Construction documents* and supporting data shall be submitted in two or more sets with each application for a permit and in such form and detail as required by the *fire code official*. The *construction documents* shall be prepared by a *registered design professional* where required by the statutes of the jurisdiction in which the project is to be constructed.

**Exception:** The *fire code official* is authorized to waive the submission of *construction documents* and supporting data not required to be prepared by a *registered design professional* if it is found that the nature of the work applied for is such that review of *construction documents* is not necessary to obtain compliance with this code.

**[A] 106.2 Examination of documents.** The *fire code official* shall examine or cause to be examined the accompanying *construction documents* and shall ascertain by such examinations whether the work indicated and described is in accordance with the requirements of this code.

**[A] 106.2.1 Information on construction documents.** *Construction documents* shall be drawn to scale on suitable material. Documents in a digital format are allowed to be submitted where *approved* by the *fire code official*. *Construction documents* shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations as determined by the *fire code official*.

**[A] 106.2.2 Fire protection system shop drawings.** Shop drawings for the fire protection system(s) shall be submitted to indicate compliance with this code and the *construction documents*, and shall be *approved* prior to



the start of installation. Shop drawings shall contain all information as required by the referenced installation standards in Chapter 9.

**[A] 106.2.3 Applicant responsibility.** It shall be the responsibility of the applicant to ensure that the *construction documents* include all of the fire protection requirements and the shop drawings are complete and in compliance with the applicable codes and standards.

**[A] 106.2.4 Approved documents.** *Construction documents approved* by the *fire code official* are *approved* with the intent that such *construction documents* comply in all respects with this code. Review and approval by the *fire code official* shall not relieve the applicant of the responsibility of compliance with this code.

**[A] 106.2.4.1 Phased approval.** The *fire code official* is authorized to issue a permit for the construction of part of a structure, system or operation before the *construction documents* for the whole structure, system or operation have been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such permit for parts of a structure, system or operation shall proceed at the holder's own risk with the building operation and without assurance that a permit for the entire structure, system or operation will be granted.

**[A] 106.3 Amended construction documents.** Work shall be installed in accordance with the *approved construction documents*, and any changes made during construction that are not in compliance with the *approved construction documents* shall be resubmitted for approval as an amended set of *construction documents*.

**[A] 106.4 Retention of construction documents.** One set of *construction documents* shall be retained by the *fire code official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws. One set of *approved construction documents* shall be returned to the applicant, and said set shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress.

## SECTION 107 FEES

**[A] 107.1 Fees.** A permit shall not be issued until the fees have been paid, nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

**[A] 107.2 Schedule of permit fees.** Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**107.3 Permit valuations.** The applicant for a permit shall provide an estimated permit value at the time of application. Permit valuations shall include the total value of work, including materials and labor, for which the permit is being issued, such as electrical, gas, mechanical, plumbing equipment and permanent systems. If, in the opinion of the *fire*

*code official*, the valuation is underestimated on the application, the permit shall be denied unless the applicant can show detailed estimates to meet the approval of the *fire code official*. Final permit valuation shall be set by the *fire code official*.

**[A] 107.4 Work commencing before permit issuance.** A person who commences any work, activity or operation regulated by this code before obtaining the necessary permits shall be subject to a fee established by the applicable governing authority, which shall be in addition to the required permit fees.

**[A] 107.5 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

**[A] 107.6 Refunds.** The applicable governing authority is authorized to establish a refund policy.

## SECTION 108 INSPECTIONS

**[A] 108.1 Inspection authority.** The *fire code official* is authorized to enter and examine any building, structure, marine vessel, vehicle or premises in accordance with Section 104.3 for the purpose of enforcing this code.

**[A] 108.2 Inspections.** The *fire code official* is authorized to conduct such inspections as are deemed necessary to determine the extent of compliance with the provisions of this code and to approve reports of inspection by *approved* agencies or individuals. Reports of such inspections shall be prepared and submitted in writing for review and approval. Inspection reports shall be certified by a responsible officer of such *approved* agency or by the responsible individual. The *fire code official* is authorized to engage such expert opinion as deemed necessary to report on unusual, detailed or complex technical issues subject to the approval of the governing body.

**[A] 108.2.1 Inspection requests.** It shall be the duty of the holder of the permit or their duly authorized agent to notify the *fire code official* when work is ready for inspection. It shall be the duty of the permit holder to provide access to and means for inspections of such work that are required by this code.

**[A] 108.2.2 Approval required.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *fire code official*. The *fire code official*, on notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the permit holder or his or her agent wherein the same fails to comply with this code. Any portions that do not comply shall be corrected, and such portion shall not be covered or concealed until authorized by the *fire code official*.

## SCOPE AND ADMINISTRATION

[A] **108.3 Concealed work.** It shall be the duty of the permit applicant to cause the work to remain visible and able to be accessed for inspection purposes. Where any installation subject to inspection prior to use is covered or concealed without having first been inspected, the *fire code official* shall have the authority to require that such work be made visible and able to be accessed for inspection. Neither the *fire code official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

[A] **108.4 Approvals.** Approval as the result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel provisions of this code or of other ordinances of the jurisdiction shall not be valid.

## SECTION 109 MAINTENANCE

[A] **109.1 Maintenance of safeguards.** Where any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance with the provisions of this code, or otherwise installed, such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be continuously maintained in accordance with this code and applicable referenced standards.

[A] **109.2 Testing and operation.** Equipment requiring periodic testing or operation to ensure maintenance shall be tested or operated as specified in this code.

[A] **109.2.1 Reinspection and testing.** Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the *fire code official* for inspection and testing.

[A] **109.3 Recordkeeping.** A record of periodic inspections, tests, servicing and other operations and maintenance shall be maintained on the premises or other *approved* location for not less than 3 years, or a different period of time where specified in this code or referenced standards. Records shall be made available for inspection by the *fire code official*, and a copy of the records shall be provided to the *fire code official* on request.

The *fire code official* is authorized to prescribe the form and format of such recordkeeping. The *fire code official* is authorized to require that certain required records be filed with the *fire code official*.

[A] **109.4 Supervision.** Maintenance and testing shall be under the supervision of a responsible person who shall ensure that such maintenance and testing are conducted at specified intervals in accordance with this code.

**109.5 Rendering equipment inoperable.** Portable or fixed fire-extinguishing systems or devices, and fire-warning systems, shall be provided with *ready access* and shall not be rendered inoperative, except as necessary during emergen-

cies, maintenance, repairs, *alterations*, drills or prescribed testing.

[A] **109.6 Overcrowding.** Overcrowding or admittance of any person beyond the *approved* capacity of a building or a portion thereof shall not be allowed. The *fire code official*, on finding any overcrowding conditions or obstructions in *aisles*, passageways or other *means of egress*, or on finding any condition that constitutes a life safety hazard, shall be authorized to cause the event to be stopped until such condition or obstruction is corrected.

## SECTION 110 SERVICE UTILITIES

[A] **110.1 Authority to disconnect service utilities.** The *fire code official* shall have the authority to authorize disconnection of utility service to the building, structure or system in order to safely execute emergency operations or to eliminate an immediate hazard. The *fire code official* shall notify the serving utility and, where possible, the *owner* or the *owner's* authorized agent and the occupant of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnection, then the *owner*, the *owner's* authorized agent or occupant of the building, structure or service system shall be notified in writing as soon as practical thereafter.

## SECTION 111 MEANS OF APPEALS

[A] **111.1 Board of appeals established.** Any county or municipality or other political subdivision may establish a local board of adjustments and appeals to review orders given by the local *fire code official*; and to consist of five (5) members appointed by the applicable governing body.

[A] **111.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equivalent or better form of construction is proposed. The board shall not have authority to waive requirements of this code or interpret the administration of this code.

[A] **111.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training to pass on matters pertaining to hazards of fire, explosions, hazardous conditions or *fire protection systems*, and are not employees of the jurisdiction.

[A] **111.4 Administration.** The *fire code official* shall take immediate action in accordance with the decision of the board.

## SECTION 112 VIOLATIONS

[A] **112.1 Unlawful acts.** It shall be unlawful for a person, firm or corporation to erect, construct, alter, repair, remove, demolish or utilize a building, occupancy, premises or

system regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

**[A] 112.2 Owner/occupant responsibility.** Correction and abatement of violations of this code shall be the responsibility of the *owner* or the *owner's* authorized agent. Where an occupant creates, or allows to be created, hazardous conditions in violation of this code, the occupant shall be held responsible for the abatement of such hazardous conditions.

**[A] 112.3 Notice of violation.** Where the *fire code official* finds a building, premises, vehicle, storage facility or outdoor area that is in violation of this code, the *fire code official* is authorized to prepare a written notice of violation describing the conditions deemed unsafe and, where compliance is not immediate, specifying a time for reinspection.

**[A] 112.3.1 Service.** A notice of violation issued pursuant to this code shall be served on the *owner*, the *owner's* authorized agent, operator, occupant or other person responsible for the condition or violation, either by personal service, mail or by delivering the same to, and leaving it with, some person of responsibility on the premises. For unattended or abandoned locations, a copy of such notice of violation shall be posted on the premises in a conspicuous place at or near the entrance to such premises and the notice of violation shall be mailed by certified mail with return receipt requested or a certificate of mailing, to the last known address of the *owner*, the *owner's* authorized agent, or occupant.

**[A] 112.3.2 Compliance with orders and notices.** A notice of violation issued or served as provided by this code shall be complied with by the *owner*, the *owner's* authorized agent, operator, occupant or other person responsible for the condition or violation to which the notice of violation pertains.

**[A] 112.3.3 Prosecution of violations.** If the notice of violation is not complied with promptly, the *fire code official* is authorized to request the legal counsel of the jurisdiction to institute the appropriate legal proceedings at law or in equity to restrain, correct or abate such violation or to require removal or termination of the unlawful occupancy of the structure in violation of the provisions of this code or of the order or direction made pursuant hereto.

**[A] 112.3.4 Unauthorized tampering.** Signs, tags or seals posted or affixed by the *fire code official* shall not be mutilated, destroyed or tampered with, or removed, without authorization from the *fire code official*.

**[A] 112.4 Violation penalties.** Persons who shall violate a provision of this code or shall fail to comply with any of the requirements thereof or who shall erect, install, alter, repair or do work in violation of the *approved construction documents* or directive of the *fire code official*, or of a permit or certificate used under provisions of this code, shall be guilty of a **Class A Misdemeanor**, punishable by a fine of not more than **\$1,000.00** or by imprisonment not exceeding **1 year**, or both such fine and imprisonment. Each day that a violation continues after due notice has been served shall be deemed a separate offense.

**[A] 112.4.1 Abatement of violation.** In addition to the imposition of the penalties herein described, the *fire code official* is authorized to institute appropriate action to prevent unlawful construction or to restrain, correct or abate a violation; or to prevent illegal occupancy of a structure or premises; or to stop an illegal act, conduct of business or occupancy of a structure on or about any premises.

## SECTION 113 STOP WORK ORDER

**[A] 113.1 Authority.** Where the *fire code official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code, or in a dangerous or unsafe manner, the *fire code official* is authorized to issue a stop work order.

**[A] 113.2 Issuance.** The stop work order shall be in writing and shall be given to the *owner* of the property, the *owner's* authorized agent or the person performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order and the conditions under which the cited work is authorized to resume.

**[A] 113.3 Emergencies.** Where an emergency exists, the *fire code official* shall not be required to give a written notice prior to stopping the work.

**[A] 113.4 Failure to comply.** Any person, or other legal entity (corporation, limited liability company, limited liability partnership, etc.) who shall continue any work after having been served with a stop work order, except such work as that person or entity is directed to perform to remove a violation or unsafe condition, shall be subject to penalties imposed by the circuit or district court having jurisdiction.

## SECTION 114 UNSAFE STRUCTURES OR EQUIPMENT

**[A] 114.1 General.** If during the inspection of a premises, a structure, or any building system, in whole or in part, constitutes a clear and inimical threat to human life, safety or health, the *fire code official* shall issue such notice or orders to remove or remedy the conditions as shall be deemed necessary in accordance with this section, and shall refer the building to the building official for any repairs, *alterations*, remodeling, removing or demolition required.

**[A] 114.1.1 Unsafe conditions.** Structures or existing equipment that are or hereafter become unsafe, insanitary or deficient because of inadequate *means of egress*, inadequate light and ventilation, or that constitute a fire hazard, are otherwise dangerous to human life or the public welfare, or involve illegal or improper occupancy or inadequate maintenance, shall be deemed an unsafe condition. Unsafe structures shall be taken down and removed or made safe, as the *fire code official* deems necessary and as provided for in this section. A vacant structure that is not secured against unauthorized entry shall be deemed unsafe.

## SCOPE AND ADMINISTRATION

[A] **114.1.2 Structural hazards.** Where an apparent structural hazard is caused by the faulty installation, operation or malfunction of any of the items or devices governed by this code, the *fire code official* shall immediately notify the building code official in accordance with Section 114.1.

[A] **114.2 Evacuation.** The *fire code official* or the fire department official in charge of an incident shall be authorized to order the immediate evacuation of any occupied structure deemed unsafe where such structure has hazardous conditions that pose an imminent danger to structure occupants. Persons so notified shall immediately leave the structure or premises and shall not enter or re-enter until authorized to do so by the *fire code official* or the fire department official in charge of the incident.

[A] **114.3 Record.** The *fire code official* shall cause a report to be filed on an unsafe condition. The report shall state the occupancy of the structure and the nature of the unsafe condition.

[A] **114.4 Notice.** If an unsafe condition is found, the *fire code official* shall serve on the *owner* of the structure or the *owner's* authorized agent a written notice that describes the condition deemed unsafe and specifies the required repairs or improvements to be made to abate the unsafe condition, or requires the unsafe structure to be demolished within a stipulated time. Such notice shall require the person thus notified to declare immediately to the *fire code official* acceptance or rejection of the terms of the order.

[A] **114.5 Method of service.** Such notice shall be deemed properly served where a copy thereof is served in accordance with one of the following methods:

1. A copy is delivered to the *owner* personally.
2. A copy is sent by certified or registered mail addressed to the *owner* at the last known address with return receipt requested.
3. A copy is delivered in any other manner as prescribed by local law.

If the certified or registered letter is returned showing that the letter was not delivered, a copy thereof shall be posted in a conspicuous place in or about the structure affected by such notice. Service of such notice in the foregoing manner on the *owner's* authorized agent shall constitute service of notice on the *owner*.

[A] **114.6 Restoration or abatement.** The structure or equipment determined to be unsafe by the *fire code official* is permitted to be restored to a safe condition. The *owner*, the *owner's* authorized agent, operator or occupant of a structure, premises or equipment deemed unsafe by the *fire code official* shall abate or cause to be abated or corrected such unsafe conditions either by repair, rehabilitation, demolition or other *approved* corrective action. To the extent that repairs, *alterations* or additions are made or a change of occupancy occurs during the restoration of the structure, such repairs, *alterations*, additions or change of occupancy shall comply with the requirements of Section 105.1.5 and the *International Existing Building Code*.

[A] **114.7 Summary abatement.** Where conditions exist that are deemed hazardous to life and property, the *fire code official* or fire department official in charge of the incident is authorized to abate summarily such hazardous conditions that are in violation of this code.



## CHAPTER 2

# DEFINITIONS

### User note:

**About this chapter:** Codes, by their very nature, are technical documents. Every word, term and punctuation mark can add to or change the meaning of a technical requirement. It is necessary to maintain a consensus on the specific meaning of each term contained in the code. Chapter 2 performs this function by stating clearly what specific terms mean for the purpose of the code.

### SECTION 201 GENERAL

**201.1 Scope.** Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings shown in this chapter.

**201.2 Interchangeability.** Words used in the present tense include the future; words stated in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

**201.3 Terms defined in other codes.** Where terms are not defined in this code and are defined in the *International Mechanical Code*; the *Arkansas Fire Prevention Code*, Volume II; the *Arkansas Fuel Gas Code*; or the *Arkansas Plumbing Code*, such terms shall have the meanings ascribed to them as in those codes.

**201.4 Terms not defined.** Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies. *Merriam Webster's Collegiate Dictionary, 11th Edition*, shall be considered as providing ordinarily accepted meanings.

### SECTION 202 GENERAL DEFINITIONS

**[BG] 24-HOUR BASIS.** The actual time that a person is an occupant within a facility for the purpose of receiving care. It shall not include a facility that is open for 24 hours and is capable of providing care to someone visiting the facility during any segment of the 24 hours.

**3D PRINTER.** A machine used in the additive manufacturing process for fabricating objects through the deposition of a material using a print head, nozzle or other printer technology.

**[M] ACCESS (TO).** That which enables a device, appliance or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel or similar obstruction [see also "*Ready access (to)*"].

**[BE] ACCESSIBLE MEANS OF EGRESS.** A continuous and unobstructed way of egress travel from any *accessible* point in a building or facility to a *public way*.

**[BE] ACCESSIBLE ROUTE.** A continuous, unobstructed path that complies with Chapter 11 of the *International Building Code*.

**ACTIVE RF EMITTING DEVICE.** Any type of circuit component that requires an AC or DC power source with the ability to electrically control electron flow and/or amplification of RF signal, including but not limited to signal boosters, repeaters, bidirectional amplifiers and fiber-distributed antenna systems.

**ADDITIVE MANUFACTURING.** A process of joining materials to make objects from 3D model data, usually layer upon layer, sometimes referred to as 3D printing. This code recognizes two types of additive manufacturing:

**Industrial additive manufacturing.** 3D printing operations that typically utilize combustible powders or metals, an inert gas supply, a *combustible dust* collection system, or that create a hazardous (classified) location area or zone outside the equipment.

**Nonindustrial additive manufacturing.** 3D printing operations that do create a hazardous (classified) location area outside the equipment and do not utilize an inert gas supply or a *combustible dust* collection system.

**AEROSOL CONTAINER.** A metal can or plastic container up to a maximum size of 33.8 fluid ounces (1000 ml) or a glass bottle up to a maximum size of 4 fluid ounces (118 ml) designed and intended to dispense an aerosol.

**AEROSOL COOKING SPRAY PRODUCTS.** Aerosol cooking spray products are those aerosol products designed to deliver a vegetable oil or a solid or nonflammable liquid to reduce sticking on cooking and baking surfaces, or to be applied to food, or both. These products have a chemical heat of combustion that is greater than 8600 Btu/lb. (20 kJ/g) and contain no more than 18 percent by weight of flammable propellant.

**AEROSOL PRODUCT.** A combination of a container, a propellant and a material that is dispensed. Aerosol products shall be classified by means of the calculation of their chemical heats of combustion and shall be designated Level 1, Level 2 or Level 3.

**Level 1 aerosol products.** Those with a total chemical heat of combustion that is less than or equal to 8,600 British thermal units per pound (Btu/lb) (20 kJ/g).

**Level 2 aerosol products.** Those with a total chemical heat of combustion that is greater than 8,600 Btu/lb (20 kJ/g), but less than or equal to 13,000 Btu/lb (30 kJ/g).

**Level 3 aerosol products.** Those with a total chemical heat of combustion that is greater than 13,000 Btu/lb (30 kJ/g).



## DEFINITIONS

**AEROSOL PRODUCT WAREHOUSE.** A building used for warehousing aerosol products.

**AGENCY.** Any emergency responder department within the jurisdiction that utilizes radio frequencies for communication. This could include, but not be limited to, various public safety agencies such as fire departments, emergency medical services and law enforcement.

**AGENT.** A person who shall have charge, care or control of any structure as *owner*, or agent of the *owner*, or as executor, executrix, administrator, administratrix, trustee or guardian of the estate of the *owner*. Any such person representing the actual *owner* shall be bound to comply with the provisions of this code to the same extent as if that person was the *owner*.

**[BG] AGRICULTURAL BUILDING.** A structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. This structure shall not be a place of human habitation or a place of employment where agricultural products are processed, treated or packaged, nor shall it be a place used by the public.

**AGRO-INDUSTRIAL.** A facility, or portion thereof, housing operations involving the transforming of raw agricultural products into intermediate or consumable products.

**AIRCRAFT MOTOR-VEHICLE FUEL-DISPENSING FACILITY.** That portion of property where *flammable* or *combustible liquids* or gases used as motor fuels are stored and dispensed from fixed automotive-type equipment into the fuel tanks of aircraft.

**AIRCRAFT OPERATION AREA (AOA).** Any area used or intended for use for the parking, taxiing, takeoff, landing or other ground-based aircraft activity.

**[BG] AIR-INFLATED STRUCTURE.** A structure that uses air-pressurized membrane beams, arches or other elements to enclose space. Occupants of such a structure do not occupy the pressurized areas used to support the structure.

**AIRPORT.** An area of land or structural surface that is used, or intended for use, for the landing and taking off of aircraft with an overall length greater than 39 feet (11 887 mm) and an overall exterior fuselage width greater than 6.6 feet (2012 mm), and any appurtenant areas that are used or intended for use for airport buildings and other airport facilities.

**[BG] AIR-SUPPORTED STRUCTURE.** A structure wherein the shape of the structure is attained by air pressure, and occupants of the structure are within the elevated pressure area. Air supported structures are of two basic types:

**Double skin.** Similar to a single skin, but with an attached liner that is separated from the outer skin and provides an airspace which serves for insulation, acoustic, aesthetic or similar purposes.

**Single skin.** Where there is only the single outer skin and the air pressure is directly against that skin.

**[BE] AISLE.** An unenclosed *exit access* component that defines and provides a path of egress travel.

**[BE] AISLE ACCESSWAY.** That portion of an *exit access* that leads to an *aisle*.

**ALARM, NUISANCE.** See “*Nuisance alarm*.”

**ALARM DEVICE, MULTIPLE STATION.** See “*Multiple-station alarm device*.”

**ALARM NOTIFICATION APPLIANCE.** A fire alarm system component such as a bell, horn, speaker, light or text display that provides audible, tactile or visible outputs, or any combination thereof. See also “*Audible alarm notification appliance*” or “*Visible alarm notification appliance*.”

**ALARM SIGNAL.** A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

**ALARM VERIFICATION FEATURE.** A feature of automatic fire detection and alarm systems to reduce unwanted alarms wherein smoke detectors report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period, after being automatically reset, in order to be accepted as a valid alarm-initiation signal.

**ALCOHOL-BASED HAND RUB.** An alcohol-containing preparation designed for application to the hands for reducing the number of viable microorganisms on the hands and containing ethanol or isopropanol in an amount not exceeding 95-percent by volume.

**ALCOHOL-BLENDED FUELS.** *Flammable* liquids consisting of greater than 10 percent, by volume, ethanol or other alcohols blended with gasoline.

**[A] ALTERATION.** Any construction or renovation to an existing structure other than a repair or addition.

**[BE] ALTERNATING TREAD DEVICE.** A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.

**[BG] AMBULATORY CARE FACILITY.** Buildings or portions thereof used to provide medical, surgical, psychiatric, nursing or similar care on a less-than-24-hour basis to persons who are rendered *incapable of self-preservation* by the services provided or staff has accepted responsibility for care recipients already incapable.

**AMMONIUM NITRATE.** A chemical compound represented by the formula  $\text{NH}_4\text{NO}_3$ .

**ANNUNCIATOR.** A unit containing one or more indicator lamps, alphanumeric displays or other equivalent means in which each indication provides status information about a circuit, condition or location.

**[A] APPROVED.** Acceptable to the *fire code official*.

**[BG] AREA, BUILDING.** The area included within surrounding *exterior walls* (or *exterior walls* and *fire walls*) exclusive of vent shafts and *courts*. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above.

**[BE] AREA OF REFUGE.** An area where persons unable to use *stairways* can remain temporarily to await instructions or assistance during emergency evacuation.

**ARRAY.** The configuration of storage. Characteristics considered in defining an array include the type of packaging, flue spaces, height of storage and compactness of storage.

**ARRAY, CLOSED.** A storage configuration having a 6-inch (152 mm) or smaller width vertical flue space that restricts air movement through the stored commodity.

**[BG] ATRIUM.** An opening connecting two or more stories other than enclosed *stairways*, elevators, hoistways, escalators, plumbing, electrical, air-conditioning or other equipment, which is closed at the top and not defined as a mall. Stories, as used in this definition, do not include balconies within assembly groups or mezzanines that comply with Section 505 of the *International Building Code*.

**[BG] ATTIC.** The space between the ceiling framing of the top story and the underside of the roof.

**AUDIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of hearing.

**AUTOMATED RACK STORAGE.** Automated rack storage is a stocking method whereby the movement of pallets, products, apparatus or systems are automatically controlled by mechanical or electronic devices.

**AUTOMATIC.** As applied to fire protection devices, a device or system providing an emergency function without the necessity for human intervention and activated as a result of a predetermined temperature rise, rate of temperature rise or combustion products.

**AUTOMATIC FIRE-EXTINGUISHING SYSTEM.** An *approved* system of devices and equipment which automatically detects a fire and discharges an *approved* fire-extinguishing agent onto or in the area of a fire.

**AUTOMATIC SMOKE DETECTION SYSTEM.** A fire alarm system that has initiation devices that utilize smoke detectors for protection of an area such as a room or space with detectors to provide early warning of fire.

**AUTOMATIC SPRINKLER SYSTEM.** An *automatic sprinkler system*, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The system includes a suitable water supply. The portion of the system above the ground is a network of specially sized or hydraulically designed piping installed in a structure or area, generally overhead, and to which automatic sprinklers are connected in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the fire area.

**AUTOMATIC WATER MIST SYSTEM.** A system consisting of a water supply, a pressure source and a distribution piping system with attached nozzles which, at or above a minimum operating pressure, defined by its listing, discharges water in fine droplets meeting the requirements of NFPA 750 for the purpose of the control, suppression or extinguishment of a fire. Such systems include wet-pipe, dry-pipe and pre-action types. The systems are designed as engineered, preengineered, local-application or total flooding systems.

**AUTOMOTIVE MOTOR FUEL-DISPENSING FACILITY.** That portion of property where *flammable* or *combustible liquids* or gases used as motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles.

**AVERAGE AMBIENT SOUND LEVEL.** The root mean square, A-weighted sound pressure level measured over a 24-hour period, or the time any person is present, whichever time period is less.

**[BG] AWNING.** An architectural projection that provides weather protection, identity or decoration and is partially or wholly supported by the building to which it is attached. An awning is comprised of a lightweight frame structure over which a covering is attached.

**[BE] BALANCED DOOR.** A door equipped with double-pivoted hardware so designed as to cause a semicounter balanced swing action when opening.

**BALED COTTON.** See “*Cotton*.”

**BALED COTTON, DENSELY PACKED.** See “*Cotton*.”

**BARRICADE.** A structure that consists of a combination of walls, floor and roof, which is designed to withstand the rapid release of energy in an explosion and which is fully confined, partially vented or fully vented; or other effective method of shielding from *explosive materials* by a natural or artificial barrier.

**Artificial barricade.** An artificial mound or revetment with a minimum thickness of 3 feet (914 mm).

**Natural barricade.** Natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that require protection cannot be seen from the magazine or building containing *explosives* when the trees are bare of leaves.

**BARRICADED.** The effective screening of a building containing *explosive materials* from the magazine or other building, railway or highway by a natural or an artificial barrier. A straight line from the top of any sidewall of the building containing *explosive materials* to the eave line of any magazine or other building or to a point 12 feet (3658 mm) above the center of a railway or highway shall pass through such barrier.

**[BG] BASEMENT.** A story that is not a story above *grade plane*.

**BATTERY SYSTEM, STATIONARY STORAGE.** A rechargeable energy storage system consisting of electrochemical storage batteries, battery chargers, controls and associated electrical equipment designed to provide electrical power to a building. The system is typically used to provide standby or emergency power, an uninterruptable power supply, load shedding, load sharing or similar capabilities.

**BATTERY TYPES.** For the purposes of this code, certain types are defined as follows:

**Flow battery.** A type of storage battery that includes chemical components dissolved in two different liquids. Ion exchange, which provides the flow of electrical current, occurs through the membrane while both liquids circulate in their respective spaces.

**Lead-acid battery.** A storage battery that is comprised of lead electrodes immersed in a solution of water and sulphuric acid electrolyte.

## DEFINITIONS

**Lithium metal polymer battery.** A storage battery that is similar to the lithium ion battery except that it has a lithium metal anode in the place of the traditional carbon or graphite anode.

**Lithium-ion battery.** A storage battery with lithium ions serving as the charge carriers of the battery. The electrolyte is a polymer mixture of carbonates with an inorganic salt and can be in a liquid or a gelled polymer form. Lithiated metal oxide is typically a cathode and forms of carbon or graphite typically form the anode.

**Nickel-cadmium (Ni-Cd) battery.** An alkaline storage battery in which the positive active material is nickel oxide, the negative electrode contains cadmium and the electrolyte is a solution of water and potassium hydroxide.

**Nickel-metal hydride (Ni-MH).** An alkaline storage battery in which the positive active material is nickel oxide, the negative electrode is an intermetallic compound and the electrolyte is usually potassium hydroxide.

**Stationary storage battery.** A group of electrochemical cells interconnected to supply a nominal voltage of DC power to a suitably connected electrical load, designed for service in a permanent location.

**BIN BOX.** A five-sided container with the open side facing an aisle. Bin boxes are self-supporting or supported by a structure designed so that little or no horizontal or vertical space exists around the boxes.

**BIOMASS.** Plant- or animal-based material of biological origin excluding material embedded in geologic formations or transformed into fossils.

**BLAST AREA.** The area including the blast site and the immediate adjacent area within the influence of flying rock, missiles and concussion.

**BLAST SITE.** The area in which *explosive materials* are being or have been loaded and which includes all holes loaded or to be loaded for the same blast and a distance of 50 feet (15 240 mm) in all directions.

**BLASTER.** A person qualified in accordance with Section 5601.4 to be in charge of and responsible for the loading and firing of a blast.

**BLASTING AGENT.** A material or mixture consisting of fuel and oxidizer, intended for blasting provided that the finished product, as mixed for use or shipment, cannot be detonated by means of a No. 8 test detonator when unconfined. Blasting agents are labeled and placarded as Class 1.5 material by US DOTn.

**[BE] BLEACHERS.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a building element (see “*Grandstand*”).

**[BG] BOARDING HOUSE.** A building arranged or used for lodging for compensation, with or without meals, and not occupied as a single-family unit.

**BOILING POINT.** The temperature at which the vapor pressure of a liquid equals the atmospheric pressure of 14.7 pounds per square inch absolute (psia) (101 kPa) or 760 mm of mercury. Where an accurate boiling point is unavailable

for the material in question, or for mixtures which do not have a constant boiling point, for the purposes of this classification, the 20-percent evaporated point of a distillation performed in accordance with ASTM D86 shall be used as the boiling point of the liquid.

**BONFIRE.** An outdoor fire utilized for ceremonial purposes.

**[BE] BREAKOUT.** For revolving doors, a process whereby wings or door panels can be pushed open manually for *means of egress* travel.

**BRITISH THERMAL UNIT (BTU).** The heat necessary to raise the temperature of 1 pound (0.454 kg) of water by 1°F (0.5565°C).

**[A] BUILDING.** Any structure utilized or intended for supporting or sheltering any occupancy.

**BUILDING AREA.** See “*Area, building*.”

**BUILDING HEIGHT.** See “*Height, building*.”

**[A] BUILDING OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of the *International Building Code*, or a duly authorized representative.

**BULK OXYGEN SYSTEM.** An assembly of equipment, such as oxygen storage containers, pressure regulators, safety devices, vaporizers, manifolds and interconnecting piping, that has a storage capacity of more than 20,000 cubic feet (566 m<sup>3</sup>) of oxygen at *normal temperature and pressure (NTP)* including unconnected reserves on hand at the site. The bulk oxygen system terminates at the point where oxygen at service pressure first enters the supply line. The oxygen containers can be stationary or movable, and the oxygen can be stored as a gas or liquid.

**BULK PLANT OR TERMINAL.** That portion of a property where *flammable* or *combustible liquids* are received by tank vessel, pipelines, tank car or tank vehicle and are stored or blended in bulk for the purpose of distributing such liquids by tank vessel, pipeline, tank car, tank vehicle, portable tank or container.

**BULK TRANSFER.** The loading or unloading of *flammable* or *combustible liquids* from or between tank vehicles, tank cars or storage tanks.

**BULLET RESISTANT.** Constructed so as to resist penetration of a bullet of 150-grain M2 ball ammunition having a nominal muzzle velocity of 2,700 feet per second (fps) (824 mps) when fired from a 30-caliber rifle at a distance of 100 feet (30 480 mm), measured perpendicular to the target.

**CANOPY.** A structure or architectural projection of rigid construction over which a covering is attached that provides weather protection, identity or decoration, and may be structurally independent or supported by attachment to a building on one end and by not less than one stanchion on the outer end.

**CAPACITOR ENERGY STORAGE SYSTEM.** A stationary, rechargeable energy storage system consisting of capacitors, chargers, controls and associated electrical equipment designed to provide electrical power to a building or



facility. The system is typically used to provide standby or emergency power, an uninterruptable power supply, load shedding, load sharing or similar capabilities.

**CARBON DIOXIDE ENRICHMENT SYSTEM.** A system where carbon dioxide gas is intentionally introduced into an indoor environment, typically for the purpose of stimulating plant growth.

**CARBON DIOXIDE EXTINGUISHING SYSTEM.** A system supplying carbon dioxide (CO<sub>2</sub>) from a pressurized vessel through fixed pipes and nozzles. The system includes a manual- or automatic-actuating mechanism.

**CARBON MONOXIDE ALARM.** A single- or multiple-station alarm intended to detect carbon monoxide gas and alert occupants by a distinct audible signal. It incorporates a sensor, control components and an alarm notification appliance in a single unit.

**CARBON MONOXIDE DETECTOR.** A device with an integral sensor to detect carbon monoxide gas and transmit an alarm signal to a connected alarm control unit.

**[BG] CARE SUITE.** In Group I-2 occupancies, a group of treatment rooms, care recipient sleeping rooms and the support rooms or spaces and circulation space within the suite where staff are in attendance for supervision of all care recipients within the suite, and the suite is in compliance with the requirements of Section 407.4.4 of the *International Building Code*.

**CARTON.** A cardboard or fiberboard box enclosing a product.

**CEILING LIMIT.** The maximum concentration of an airborne contaminant to which one may be exposed. The ceiling limits utilized are those published in DOL 29 CFR Part 1910.1000. The ceiling Recommended Exposure Limit (REL-C) concentrations published by the US National Institute for Occupational Safety and Health (NIOSH), Threshold Limit Value-Ceiling (TLV-C) concentrations published by the American Conference of Governmental Industrial Hygienists (ACGIH), Ceiling Workplace Environmental Exposure Level (WEEL-Ceiling) Guides published by the American Industrial Hygiene Association (AIHA), and other *approved*, consistent measures are allowed as surrogates for hazardous substances not listed in DOL 29 CFR Part 1910.1000.

**[A] CHANGE OF OCCUPANCY.** Either of the following shall be considered as a change of occupancy where this code requires a greater degree of safety, accessibility, structural strength, fire protection, *means of egress*, ventilation or sanitation than is existing in the current building or structure:

1. Any change in the occupancy classification of a building or structure.
2. Any change in the purpose of, or a change in the level of activity within, a building or structure.

**CHEMICAL.** An element, chemical compound or mixture of elements or compounds or both.

**CHEMICAL FUME HOOD.** A ventilated enclosure designed to contain and exhaust fumes, gases, vapors, mists and particulate matter generated within the hood.

**CHEMICAL NAME.** The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry, the Chemical Abstracts Service rules of nomenclature, or a name which will clearly identify a chemical for the purpose of conducting an evaluation.

**[M] CHIMNEY.** A primarily vertical structure containing one or more flues for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outdoor atmosphere.

**Factory-built chimney.** A *listed* and *labeled* chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

**Masonry chimney.** A field-constructed chimney composed of solid masonry units, bricks, stones, or concrete.

**Metal chimney.** A field-constructed chimney of metal.

**CLEAN AGENT.** Electrically nonconducting, volatile or gaseous fire extinguishant that does not leave a residue upon evaporation.

**[BG] CLINIC, OUTPATIENT.** Buildings or portions thereof used to provide medical care on a less-than-24-hour basis to persons who are not rendered incapable of self-preservation by the services provided.

**CLOSED CONTAINER.** A container sealed by means of a lid or other device such that liquid, vapor or dusts will not escape from it under ordinary conditions of use or handling.

**CLOSED SYSTEM.** The use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of *compressed gases*. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system or piece of equipment.

**COLD DECK.** A pile of unfinished cut logs.

**COMBUSTIBLE DUST.** Finely divided solid material which is 420 microns or less in diameter and which, when dispersed in air in the proper proportions, could be ignited by a flame, spark or other source of ignition. Combustible dust will pass through a US No. 40 standard sieve.

**COMBUSTIBLE FIBERS.** Readily ignitable and free-burning materials in a fibrous or shredded form, such as cocoa fiber, cloth, cotton, excelsior, hay, hemp, henequen,istle, jute, kapok, oakum, rags, sisal, Spanish moss, straw, tow, wastepaper, certain synthetic fibers or other like materials. This definition does not include densely packed baled cotton.

**COMBUSTIBLE GAS DETECTOR.** An instrument that samples the local atmosphere and indicates the presence of ignitable vapors or gases within the flammable or explosive range expressed as a volume percent in air.



## DEFINITIONS

**COMBUSTIBLE LIQUID.** A liquid having a closed cup *flash point* at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

The category of combustible liquids does not include *compressed gases* or *cryogenic fluids* or liquids that do not have a fire point when tested in accordance with ASTM D92.

**Class II.** Liquids having a closed cup *flash point* at or above 100°F (38°C) and below 140°F (60°C).

**Class IIIA.** Liquids having a closed cup *flash point* at or above 140°F (60°C) and below 200°F (93°C).

**Class IIIB.** Liquids having closed cup *flash points* at or above 200°F (93°C).

**[M] COMMERCIAL COOKING APPLIANCES.** Appliances used in a commercial food service establishment for heating or cooking food. For the purpose of this definition, a commercial food service establishment is where food is prepared for sale or is prepared on a scale that is by volume and frequency not representative of domestic household cooking.

**COMMERCIAL MOTOR VEHICLE.** A motor vehicle used to transport passengers or property where the motor vehicle:

1. Has a gross vehicle weight rating of 10,000 pounds (454 kg) or more; or
2. Is designed to transport 16 or more passengers, including the driver.

**COMMODITY.** A combination of products, packing materials and containers.

**[BE] COMMON PATH OF EGRESS TRAVEL.** That portion of *exit access* travel distance measured from the most remote point of each room, area or space to that point where the occupants have separate and distinct access to two *exits* or *exit access* doorways.

**[BE] COMMON USE.** Interior or exterior circulation paths, rooms, spaces or elements that are not for public use and are made available for the shared use of two or more people.

**COMPRESSED GAS.** A material, or mixture of materials that:

1. Is a gas at 68°F (20°C) or less at 14.7 psia (101 kPa) of pressure; and
2. Has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa) which is either liquefied, nonliquefied or in solution, except those gases which have no other health- or physical-hazard properties are not considered to be compressed until the pressure in the packaging exceeds 41 psia (282 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, which are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially liquid at a temperature of 68°F (20°C).

3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.

4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

**COMPRESSED GAS CONTAINER.** A pressure vessel designed to hold *compressed gases* at pressures greater than one atmosphere at 68°F (20°C) and includes cylinders, containers and tanks.

**COMPRESSED GAS SYSTEM.** An assembly of equipment designed to contain, distribute or transport *compressed gases*. It can consist of a *compressed gas* container or containers, reactors and appurtenances, including pumps, compressors and connecting piping and tubing.

**[BG] CONGREGATE LIVING FACILITIES.** A building or part thereof that contains *sleeping units* where residents share bathroom and/or kitchen facilities.

**CONSTANTLY ATTENDED LOCATION.** A designated location at a facility staffed by trained personnel on a continuous basis where alarm or supervisory signals are monitored and facilities are provided for notification of the fire department or other emergency services.

**[A] CONSTRUCTION DOCUMENTS.** The written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of the project necessary for obtaining a permit.

**CONTAINER.** A vessel of 60 gallons (227 L) or less in capacity used for transporting or storing hazardous materials. Pipes, piping systems, engines and engine fuel tanks are not considered to be containers.

**CONTAINMENT SYSTEM.** A gastight recovery system comprised of equipment or devices which can be placed over a leak in a *compressed gas* container, thereby stopping or controlling the escape of gas from the leaking container.

**CONTAINMENT VESSEL.** A gastight recovery vessel designed so that a leaking *compressed gas* container can be placed within its confines thereby encapsulating the leaking container.

**CONTROL AREA.** Spaces within a building where quantities of hazardous materials not exceeding the *maximum allowable quantities per control area* are stored, dispensed, used or handled. See also the definition of “*Outdoor control area*.”

**[BE] CORRIDOR.** An enclosed *exit access* component that defines and provides a path of egress travel.

**CORRIDOR, OPEN-ENDED.** See “*Open-ended corridor*.”

**CORROSIVE.** A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR 173.137, such chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

**COTTON.**

**Baled cotton.** A natural seed fiber wrapped in and secured with industry-accepted materials, usually consisting of burlap, woven polypropylene, polyethylene or cotton or sheet polyethylene, and secured with steel, synthetic or wire bands, or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process).

**Baled cotton, densely packed.** Cotton, made into banded bales, with a packing density of not less than 22 pounds per cubic foot (360 kg/m<sup>3</sup>), and dimensions complying with the following: a length of 55 inches (1397 mm), a width of 21 inches (533.4 mm) and a height of 27.6 to 35.4 inches (701 to 899 mm).

**Seed cotton.** Perishable raw agricultural commodity consisting of cotton fiber (lint) attached to the seed of the cotton plant, which requires ginning to become a commercial product.

**[BG] COURT.** An open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices.

**[BG] COVERED MALL BUILDING.** A single building enclosing a number of tenants and occupants such as retail stores, drinking and dining establishments, entertainment and amusement facilities, passenger transportation terminals, offices, and other similar uses wherein two or more tenants have a main entrance into one or more malls. Anchor buildings shall not be considered as a part of the covered mall building. The term “covered mall building” shall include open mall buildings as defined below.

**Mall.** A roofed or covered common pedestrian area within a covered mall building that serves as access for two or more tenants and not to exceed three levels that are open to each other. The term “mall” shall include open malls as defined below.

**Open mall.** An unroofed common pedestrian way serving a number of tenants not exceeding three levels. Circulation at levels above grade shall be permitted to include open exterior balconies leading to *exits* discharging at grade.

**Open mall building.** Several structures housing a number of tenants such as retail stores, drinking and dining establishments, entertainment and amusement facilities, offices, and other similar uses wherein two or more tenants have a main entrance into one or more open malls. Anchor buildings are not considered as a part of the open mall building.

**CRITICAL AREAS.** Areas that are designated for the highest level of emergency responder radio coverage including but not limited to areas such as exit stairs, *exit passageways*, elevator lobbies, fire protection equipment room and control valve locations, and *fire command centers*.

**CRITICAL CIRCUIT.** A circuit that requires continuous operation to ensure safety of the structure and occupants.

**CRYOGENIC CONTAINER.** A cryogenic vessel of any size used for the transportation, handling or storage of *cryogenic fluids*.

**CRYOGENIC FLUID.** A fluid having a *boiling point* lower than -130°F (-89.9°C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101.3 kPa).

**CRYOGENIC VESSEL.** A pressure vessel, low-pressure tank or atmospheric tank designed to contain a *cryogenic fluid* on which venting, insulation, refrigeration or a combination of these is used in order to maintain the operating pressure within the design pressure and the contents in a liquid phase.

**CURRENT TAP.** An electrical device that, where connected to a permanently installed receptacle outlet, provides multiple receptacle outlet configurations.

**[BG] CUSTODIAL CARE.** Assistance with day-to-day living tasks; such as assistance with cooking, taking medication, bathing, using toilet facilities and other tasks of daily living. Custodial care includes persons receiving care who have the ability to respond to emergency situations and evacuate at a slower rate and/or who have mental and psychiatric complications.

**CYLINDER.** A pressure vessel designed for pressures higher than 40 psia (275.6 kPa) and having a circular cross section. It does not include a portable tank, multiunit tank car tank, cargo tank or tank car.

**DAMPER.** See “*Fire damper*” and “*Smoke damper*.”

**DAY BOX.** A portable magazine designed to hold *explosive materials* and constructed in accordance with the requirements for a Type 3 magazine as defined and classified in Chapter 56.

**DECORATIVE MATERIALS.** All materials applied over the building interior finish for decorative, acoustical or other effect including, but not limited to, curtains, draperies, fabrics, streamers and all other materials utilized for decorative effect including, but not limited to, bulletin boards, artwork, posters, photographs, paintings, batting, cloth, cotton, hay, stalks, straw, vines, leaves, trees, moss and similar items, foam plastics and materials containing foam plastics. Decorative materials do not include wall coverings, ceiling coverings, floor coverings, ordinary window shades, interior finish and materials 0.025 inch (0.64 mm) or less in thickness applied directly to and adhering tightly to a substrate.

**DEFLAGRATION.** An exothermic reaction, such as the extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate less than the velocity of sound. A deflagration can have an explosive effect.

**DELIVERED AUDIO QUALITY (DAQ).** A measure of audio quality over a transmission medium. This metric is often used to quantify the quality of audio heard over a radio system. DAQ levels are defined by the following scale:

DAQ 1 = unusable. Speech is present but not understandable.

DAQ 2 = speech is understandable with considerable effort. Requires frequent repetition due to noise or distortion.

## DEFINITIONS

**DAQ 3** = speech understandable with slight effort. Requires occasional repetition due to noise or distortion.

**DAQ 3.4** = speech understandable without repetition. Some noise or distortion present.

**DAQ 4** = speech easily understandable. Little noise or distortion.

**DAQ 5** = perfect. No distortion or noise discernible.

**DELUGE SYSTEM.** A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same area as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

**DESIGN PRESSURE.** The maximum gauge pressure that a pressure vessel, device, component or system is designed to withstand safely under the temperature and conditions of use expected.

**DESOLVENTIZING.** The act of removing a solvent from a material.

**DETACHED BUILDING.** A separate single-story building, without a *basement* or crawl space, used for the storage or use of hazardous materials and located an *approved* distance from all structures.

**DETEARING.** A process for rapidly removing excess wet coating material from a dipped or coated object or material by passing it through an electrostatic field.

**DETECTOR, HEAT.** A fire detector that senses heat, either abnormally high temperature or rate of rise, or both.

**DETONATING CORD.** A flexible cord containing a center core of high *explosive* used to initiate other *explosives*.

**DETONATION.** An exothermic reaction characterized by the presence of a shock wave in the material which establishes and maintains the reaction. The reaction zone progresses through the material at a rate greater than the velocity of sound. The principal heating mechanism is one of shock compression. *Detonations* have an *explosive* effect.

**DETONATOR.** A device containing any initiating or primary *explosive* that is used for initiating *detonation*. A detonator shall not contain more than 154.32 grains (10 grams) of total *explosives* by weight, excluding ignition or delay charges. The term includes, but is not limited to, electric blasting caps of instantaneous and delay types, blasting caps for use with safety fuses, detonating cord delay connectors, and noninstantaneous and delay blasting caps which use detonating cord, shock tube or any other replacement for electric leg wires. All types of detonators in strengths through No. 8 cap should be rated at 1½ pounds (0.68 kg) of *explosives* per 1,000 caps. For strengths higher than No. 8 cap, consult the manufacturer.

**[BG] DETOXIFICATION FACILITIES.** Facilities that provide treatment for substance abuse serving care recipients who are incapable of self-preservation or who are harmful to themselves or others.

**DIP TANK.** A tank, vat or container of *flammable* or *combustible liquid* in which articles or materials are immersed for the purpose of coating, finishing, treating and similar processes.

**DISCHARGE SITE.** The immediate area surrounding the fireworks mortars used for an outdoor fireworks display.

**DISPENSING.** The pouring or transferring of any material from a container, tank or similar vessel, whereby vapors, dusts, fumes, mists or gases are liberated to the atmosphere.

**DISPENSING DEVICE, OVERHEAD TYPE.** A dispensing device that consists of one or more individual units intended for installation in conjunction with each other, mounted above a dispensing area typically within the motor fuel-dispensing facility canopy structure, and characterized by the use of an overhead hose reel.

**DISPLAY SITE.** The immediate area where a fireworks display is conducted. The display area includes the discharge site, the fallout area and the required separation distance from the mortars to spectator viewing areas. The display area does not include spectator viewing areas or vehicle parking areas.

**DOOR, BALANCED.** See “*Balanced door.*”

**DOOR, DUTCH.** See “*Dutch door.*”

**DOOR, LOW ENERGY POWER-OPERATED.** See “*Low energy power-operated door.*”

**DOOR, POWER-ASSISTED.** See “*Power-assisted door.*”

**DOOR, POWER-OPERATED.** See “*Power-operated door.*”

**DOORWAY, EXIT ACCESS.** See “*Exit access doorway.*”

**[BG] DORMITORY.** A space in a building where group sleeping accommodations are provided in one room, or in a series of closely associated rooms, for persons not members of the same family group, under joint occupancy and single management, as in college dormitories or fraternity houses.

**DRAFT CURTAIN.** A structure arranged to limit the spread of smoke and heat along the underside of the ceiling or roof.

**[BF] DRAFTSTOP.** A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and attics.

**DRY CLEANING.** The process of removing dirt, grease, paints and other stains from such items as wearing apparel, textiles, fabrics and rugs by use of nonaqueous liquids (solvents).

**DRY CLEANING PLANT.** A facility in which dry cleaning and associated operations are conducted, including the office, receiving area and storage rooms.

**DRY CLEANING ROOM.** An occupiable space within a building used for performing dry cleaning operations, the installation of solvent-handling equipment or the storage of dry cleaning solvents.

**DRY CLEANING SYSTEM.** Machinery or equipment in which textiles are immersed or agitated in solvent or in which dry cleaning solvent is extracted from textiles.



**DRY-CHEMICAL EXTINGUISHING AGENT.** A powder composed of small particles, usually of sodium bicarbonate, potassium bicarbonate, urea-potassium-based bicarbonate, potassium chloride or monoammonium phosphate, with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking) and the proper flow capabilities.

**DUST COLLECTION SYSTEM.** A combination of equipment designed to contain, capture and collect airborne *combustible dusts*.

**DUTCH DOOR.** A door divided horizontally so that the top can be operated independently from the bottom.

**[A] DWELLING.** A building that contains one or two *dwelling units* used, intended or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

**[A] DWELLING UNIT.** A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

**EARLY SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER.** A sprinkler *listed* for early suppression fast-response performance.

**[BE] EGRESS COURT.** A *court* or *yard* which provides access to a *public way* for one or more *exits*.

**ELECTROSTATIC FLUIDIZED BED.** A container holding powder coating material that is aerated from below so as to form an air-supported expanded cloud of such material that is electrically charged with a charge opposite to that of the object to be coated. Such object is transported through the container immediately above the charged and aerated materials in order to be coated.

**ELEVATOR GROUP.** A grouping of elevators in a building located adjacent or directly across from one another that respond to a common hall call button(s).

**EMERGENCY ALARM SYSTEM.** A system to provide indication and warning of emergency situations involving hazardous materials.

**EMERGENCY CONTROL STATION.** An *approved* location on the premises where signals from emergency equipment are received and which is staffed by trained personnel.

**[BE] EMERGENCY ESCAPE AND RESCUE OPENING.** An operable exterior window, door or other similar device that provides for a means of escape and access for rescue in the event of an emergency.

**EMERGENCY EVACUATION DRILL.** An exercise performed to train staff and occupants and to evaluate their efficiency and effectiveness in carrying out emergency evacuation procedures.

**EMERGENCY POWER SYSTEM.** A source of automatic electric power of a required capacity and duration to operate required life safety, fire alarm, detection and ventilation systems in the event of a failure of the primary power. Emer-

gency power systems are required for electrical loads where interruption of the primary power could result in loss of human life or serious injuries.

**EMERGENCY SHUTOFF VALVE.** A valve designed to shut off the flow of gases or liquids.

**EMERGENCY SHUTOFF VALVE, AUTOMATIC.** A fail-safe automatic-closing valve designed to shut off the flow of gases or liquids initiated by a control system that is activated by automatic means.

**EMERGENCY SHUTOFF VALVE, MANUAL.** A manually operated valve designed to shut off the flow of gases or liquids.

**EMERGENCY VOICE/ALARM COMMUNICATIONS.** Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building.

**[BE] EMPLOYEE WORK AREA.** All or any portion of a space used only by employees and only for work. *Corridors*, *toilet rooms*, *kitchenettes* and *break rooms* are not employee work areas.

**ENERGY STORAGE MANAGEMENT SYSTEM.** An electronic system that protects energy storage systems from operating outside their safe operating parameters and disconnects electrical power to the ESS or places it in a safe condition if potentially hazardous temperatures or other conditions are detected.

**ENERGY STORAGE SYSTEM (ESS).** One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

**ENERGY STORAGE SYSTEM, ELECTROCHEMICAL.** An energy storage system that stores energy and produces electricity using chemical reactions. It includes, among others, battery ESS and capacitor ESS.

**ENERGY STORAGE SYSTEM, MOBILE.** An energy storage system capable of being moved and utilized for temporary energy storage applications, and not installed as fixed or stationary electrical equipment. The system can include integral wheels for transportation or be loaded on a trailer and unloaded for charging, storage and deployment.

**ENERGY STORAGE SYSTEM, STATIONARY.** An energy storage system installed as fixed or stationary electrical equipment in a permanent location.

**ENERGY STORAGE SYSTEM, WALK-IN UNIT.** A prefabricated building that contains energy storage systems. It includes doors that provide walk-in access for personnel to maintain, test and service the equipment, and is typically used in outdoor and mobile ESS applications.

**ENERGY STORAGE SYSTEM CABINET.** A cabinet containing components of the energy storage system that is included in the UL 9540 listing for the system. Personnel are not able to enter the enclosure other than reaching in to access components for maintenance purposes.



## DEFINITIONS

**ENERGY STORAGE SYSTEM COMMISSIONING.** A systematic process that provides documented confirmation that an energy storage system functions according to the intended design criteria and complies with applicable code requirements.

**ENERGY STORAGE SYSTEM DECOMMISSIONING.** A systematic process that provides documentation and procedures that allow an energy storage system to be safely de-energized, disassembled, readied for shipment or storage, and removed from the premises in accordance with applicable code requirements.

**[BG] EQUIPMENT PLATFORM.** An unoccupied, elevated platform used exclusively for mechanical systems or industrial process equipment, including the associated elevated walkways, stairways, alternating tread devices and ladders necessary to access the platform (see Section 505.3 of the *International Building Code*).

**EXCESS FLOW CONTROL.** A fail-safe system or other approved means designed to shut off flow caused by a rupture in pressurized piping systems.

**EXCESS FLOW VALVE.** A valve inserted into a compressed gas cylinder, portable tank or stationary tank that is designed to positively shut off the flow of gas in the event that its predetermined flow is exceeded.

**EXHAUSTED ENCLOSURE.** An appliance or piece of equipment which consists of a top, a back and two sides providing a means of local exhaust for capturing gases, fumes, vapors and mists. Such enclosures include laboratory hoods, exhaust fume hoods and similar appliances and equipment used to retain and exhaust locally the gases, fumes, vapors and mists that could be released. Rooms or areas provided with general ventilation, in themselves, are not exhausted enclosures.

**EXISTING.** Buildings, facilities or conditions that are already in existence, constructed or officially authorized prior to the adoption of this code.

**[BE] EXIT.** That portion of a means of egress system between the exit access and the exit discharge or public way. Exit components include exterior exit doors at the level of exit discharge, interior exit stairways and ramps, exit passage-ways, exterior exit stairways and ramps and horizontal exits.

**[BE] EXIT ACCESS.** That portion of a means of egress system that leads from any occupied portion of a building or structure to an exit.

**[BE] EXIT ACCESS DOORWAY.** A door or access point along the path of egress travel from an occupied room, area or space where the path of egress enters an intervening room, corridor, exit access stairway or ramp.

**[BE] EXIT ACCESS RAMP.** A ramp within the exit access portion of the means of egress system.

**[BE] EXIT ACCESS STAIRWAY.** A stairway within the exit access portion of the means of egress system.

**[BE] EXIT DISCHARGE.** That portion of a means of egress system between the termination of an exit and a public way.

**[BE] EXIT DISCHARGE, LEVEL OF.** The story at the point at which an exit terminates and an exit discharge begins.

**[BE] EXIT PASSAGEWAY.** An exit component that is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a horizontal direction to the exit discharge.

**EXPANDED PLASTIC.** A foam or cellular plastic material having a reduced density based on the presence of numerous small cavities or cells dispersed throughout the material.

**EXPLOSION.** An effect produced by the sudden violent expansion of gases, which may be accompanied by a shock wave or disruption, or both, of enclosing materials or structures. An explosion could result from any of the following:

1. Chemical changes such as rapid oxidation, deflagration or detonation, decomposition of molecules and runaway polymerization (usually detonations).
2. Physical changes such as pressure tank ruptures.
3. Atomic changes (nuclear fission or fusion).

**EXPLOSIVE.** A chemical compound, mixture or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to, dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord and igniters.

The term “explosive” includes any material determined to be within the scope of USC Title 18: Chapter 40 and also includes any material classified as an explosive by the hazardous materials regulations of DOTn 49 CFR Parts 100–185.

**High explosive.** Explosive material, such as dynamite, which can be caused to detonate by means of a No. 8 test blasting cap where unconfined.

**Low explosive.** Explosive material that will burn or deflagrate when ignited. It is characterized by a rate of reaction that is less than the speed of sound. Examples of low explosives include, but are not limited to, black powder, safety fuse, igniters, igniter cord, fuse lighters, fireworks and propellants, 1.3C.

**Mass-detonating explosives.** Division 1.1, 1.2 and 1.5 explosives alone or in combination, or loaded into various types of ammunition or containers, most of which can be expected to explode virtually instantaneously when a small portion is subjected to fire, severe concussion, impact, the impulse of an initiating agent or the effect of a considerable discharge of energy from without. Materials that react in this manner represent a mass explosion hazard. Such an explosive will normally cause severe structural damage to adjacent objects. Explosive propagation could occur immediately to other items of ammunition and explosives stored sufficiently close to and not adequately protected from the initially exploding pile with a time interval short enough so that two or more quantities must be considered as one for quantity-distance purposes.

**UN/DOtn Class 1 explosives.** The former classification system used by DOtn included the terms “high” and “low” *explosives* as defined herein. The following terms further define *explosives* under the current system applied by DOtn for all *explosive materials* defined as hazard Class 1 materials. Compatibility group letters are used in concert with the division to specify further limitations on each division noted (for example, the letter G identifies the material as a pyrotechnic substance or article containing a pyrotechnic substance and similar materials).

**Division 1.1.** *Explosives* that have a mass explosion hazard. A mass explosion is one which affects almost the entire load instantaneously.

**Division 1.2.** *Explosives* that have a projection hazard but not a mass explosion hazard.

**Division 1.3.** *Explosives* that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

**Division 1.4.** *Explosives* that pose a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

**Division 1.5.** Very insensitive *explosives*. This division is comprised of substances that have a mass explosion hazard but which are so insensitive that there is very little probability of initiation or of transition from burning to *detonation* under normal conditions of transport.

**Division 1.6.** Extremely insensitive articles which do not have a mass explosion hazard. This division is comprised of articles that contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation.

**EXPLOSIVE MATERIAL.** The term “*explosive*” material means *explosives*, blasting agents and detonators.

**[BE] EXTERIOR EXIT RAMP.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to yards, *courts* or *public ways*.

**[BE] EXTERIOR EXIT STAIRWAY.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to yards, *courts* or *public ways*.

**[BF] EXTERIOR WALL.** A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a *fire wall*, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

**EXTRA-HIGH-RACK COMBUSTIBLE STORAGE.** Storage on racks of Class I, II, III or IV commodities that exceed 40 feet (12 192 mm) in height and storage on racks of high-hazard commodities that exceed 30 feet (9144 mm) in height.

**FABRICATION AREA.** An area within a semiconductor fabrication facility and related research and development areas in which there are processes using hazardous production materials. Such areas are allowed to include ancillary rooms or areas such as dressing rooms and offices that are directly related to the fabrication area processes.

**[A] FACILITY.** A building or use in a fixed location including exterior storage areas for flammable and combustible substances and hazardous materials, piers, wharves, tank farms and similar uses. This term includes recreational vehicles, mobile home and manufactured housing parks, sales and storage lots.

**FAIL-SAFE.** A design condition incorporating a feature for automatically counteracting the effect of an anticipated possible source of failure; also, a design condition eliminating or mitigating a hazardous condition by compensating automatically for a failure or malfunction.

**FALLOUT AREA.** The area over which aerial shells are fired. The shells burst over the area, and unsafe debris and malfunctioning aerial shells fall into this area. The fallout area is the location where a typical aerial shell dud falls to the ground, depending on the wind and the angle of mortar placement.

**FALSE ALARM.** The willful and knowing initiation or transmission of a signal, message or other notification of an event of fire when no such danger exists.

**FINES.** Small pieces or splinters of wood byproducts that will pass through a 0.25-inch (6.4 mm) screen.

**FIRE ALARM.** The giving, signaling or transmission to any public fire station, or company or to any officer or employee thereof, whether by telephone, spoken word or otherwise, of information to the effect that there is a fire at or near the place indicated by the person giving, signaling or transmitting such information.

**FIRE ALARM BOX, MANUAL.** See “*Manual fire alarm box.*”

**FIRE ALARM CONTROL UNIT.** A system component that receives inputs from automatic and manual fire alarm devices and may be capable of supplying power to detection devices and transponder(s) or off-premises transmitter(s). The control unit may be capable of providing a transfer of power to the notification appliances and transfer of condition to relays or devices.

**FIRE ALARM SIGNAL.** A signal initiated by a fire alarm-initiating device such as a manual fire alarm box, automatic fire detector, waterflow switch or other device whose activation is indicative of the presence of a fire or fire signature.

**FIRE ALARM SYSTEM.** A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of fire alarm or supervisory signal-initiating devices and to initiate the appropriate response to those signals.

## DEFINITIONS

**FIRE APPARATUS ACCESS ROAD.** A road that provides fire apparatus access from a fire station to a facility, building or portion thereof. This is a general term inclusive of all other terms such as *fire lane*, public street, private street, parking lot lane and access roadway.

**[BF] FIRE AREA.** The aggregate floor area enclosed and bounded by *fire walls*, *fire barriers*, *exterior walls* or *horizontal assemblies* of a building. Areas of the building not provided with surrounding walls shall be included in the fire area if such areas are included within the horizontal projection of the roof or floor next above.

**[BF] FIRE BARRIER.** A *fire-resistance-rated* wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

**FIRE CHIEF.** The chief officer of the fire department serving the jurisdiction, or a duly authorized representative.

**FIRE CODE OFFICIAL.** The *fire chief* or other designated authority charged with the administration and enforcement of the code, or a duly authorized representative.

**FIRE COMMAND CENTER.** The principal attended or unattended location where the status of detection, alarm communications and control systems is displayed, and from which the system(s) can be manually controlled.

**[BF] FIRE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to close automatically upon detection of heat and resist the passage of flame. Fire dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic fire damper is tested and rated for closure under elevated temperature airflow.

**FIRE DEPARTMENT MASTER KEY.** A limited issue key of special or controlled design to be carried by fire department officials in command which will open key boxes on specified properties.

**FIRE DETECTOR, AUTOMATIC.** A device designed to detect the presence of a fire signature and to initiate action.

**[BF] FIRE DOOR.** The door component of a fire door assembly.

**[BF] FIRE DOOR ASSEMBLY.** Any combination of a fire door, frame, hardware and other accessories that together provide a specific degree of fire protection to the opening.

**[BF] FIRE EXIT HARDWARE.** Panic hardware that is *listed* for use on *fire door assemblies*.

**FIRE LANE.** A road or other passageway developed to allow the passage of fire apparatus. A fire lane is not necessarily intended for vehicular traffic other than fire apparatus.

**[BF] FIRE PARTITION.** A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

**FIRE POINT.** The lowest temperature at which a liquid will ignite and achieve sustained burning when exposed to a test flame in accordance with ASTM D92.

**[BF] FIRE PROTECTION RATING.** The period of time that an opening protective assembly will maintain the ability to confine a fire as determined by tests prescribed in Section 716 of the *International Building Code*. Ratings are stated in hours or minutes.

**FIRE PROTECTION SYSTEM.** *Approved* devices, equipment and systems or combinations of systems used to detect a fire, activate an alarm, extinguish or control a fire, control or manage smoke and products of a fire or any combination thereof.

**[BF] FIRE RESISTANCE.** That property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

**FIRE SAFETY FUNCTIONS.** Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire.

**[BF] FIRE SEPARATION DISTANCE.** The distance measured from the building face to one of the following:

1. The closest interior *lot line*.
2. To the centerline of a street, an alley or *public way*.
3. To an imaginary line between two buildings on the lot.

The distance shall be measured at right angles from the face of the wall.

**[BF] FIRE WALL.** A *fire-resistance-rated* wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

**FIRE WATCH.** A temporary measure intended to ensure continuous and systematic surveillance of a building or portion thereof by one or more qualified individuals for the purposes of identifying and controlling fire hazards, detecting early signs of unwanted fire, raising an alarm of fire and notifying the fire department.

**[BF] FIREBLOCKING.** Building materials, or materials *approved* for use as fireblocking, installed to resist the free passage of flame to other areas of the building through concealed spaces.

**[BF] FIRE-RESISTANCE RATING.** The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703 of the *International Building Code*.

**[BF] FIRE-RESISTANT JOINT SYSTEM.** An assemblage of specific materials or products that are designed, tested and *fire-resistance rated* in accordance with either ASTM E1966 or UL 2079 to resist for a prescribed period of time the passage of fire through joints made in or between *fire-resistance-rated* assemblies.



**FIREWORKS.** Any composition or device for the purpose of producing a visible or an audible effect for entertainment purposes by combustion, *deflagration* or *detonation* that meets the definition of 1.3G fireworks or 1.4G fireworks.

**Fireworks, 1.3G.** Large fireworks devices, which are *explosive materials*, intended for use in fireworks displays and designed to produce audible or visible effects by combustion, *deflagration* or *detonation*. Such 1.3G fireworks include, but are not limited to, firecrackers containing more than 130 milligrams (2 grains) of explosive composition, aerial shells containing more than 40 grams of pyrotechnic composition and other display pieces which exceed the limits for classification as 1.4G fireworks. Such 1.3G fireworks are also described as Fireworks, UN 0335 by the DOTn.

**Fireworks, 1.4G.** Small fireworks devices containing restricted amounts of pyrotechnic composition designed primarily to produce visible or audible effects by combustion or *deflagration* that complies with the construction, chemical composition and labeling regulations of the DOTn for Fireworks, UN 0336, and the US Consumer Product Safety Commission as set forth in CPSC 16 CFR Parts 1500 and 1507.

**FIREWORKS DISPLAY.** A presentation of fireworks for a public or private gathering.

**[BG] FIXED BASE OPERATOR (FBO).** A commercial business granted the right by the airport sponsor to operate on an airport and provide aeronautical services such as fueling, hanging, tie-down and parking, aircraft rental, aircraft maintenance and flight instruction.

**[BE] FIXED SEATING.** Furniture or fixtures designed and installed for the use of sitting and secured in place including bench-type seats and seats with or without back or arm rests.

**[BF] FLAME SPREAD.** The propagation of flame over a surface.

**[BF] FLAME SPREAD INDEX.** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84 or UL 723.

**FLAMMABLE CRYOGENIC FLUID.** A *cryogenic fluid* that is flammable in its vapor state.

**FLAMMABLE FINISHES.** Coatings to articles or materials in which the material being applied is a *flammable liquid*, *combustible liquid*, combustible powder, fiberglass resin or flammable or combustible gel coating.

**FLAMMABLE GAS.** A material which is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa)] which:

1. Is ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air; or
2. Has a flammable range at 14.7 psia (101 kPa) with air of not less than 12 percent, regardless of the lower limit.

The limits specified shall be determined at 14.7 psi (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E681.

**FLAMMABLE LIQUEFIED GAS.** A liquefied *compressed gas* which, under a charged pressure, is partially liquid at a temperature of 68°F (20°C) and which is flammable.

**FLAMMABLE LIQUID.** A liquid having a closed cup *flash point* below 100°F (38°C). *Flammable liquids* are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

**Class IA.** Liquids having a *flash point* below 73°F (23°C) and having a *boiling point* below 100°F (38°C).

**Class IB.** Liquids having a *flash point* below 73°F (23°C) and having a *boiling point* at or above 100°F (38°C).

**Class IC.** Liquids having a *flash point* at or above 73°F (23°C) and below 100°F (38°C).

The category of *flammable liquids* does not include *compressed gases* or *cryogenic fluids* or liquids that do not have a *fire point* when tested in accordance with ASTM D92.

**FLAMMABLE MATERIAL.** A material capable of being readily ignited from common sources of heat or at a temperature of 600°F (316°C) or less.

**FLAMMABLE SOLID.** A solid, other than a blasting agent or *explosive*, that is capable of causing fire through friction, absorption of moisture, spontaneous chemical change or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.0866 inch (2.2 mm) per second along its major axis.

**FLAMMABLE VAPOR AREA.** An area in which the concentration of flammable constituents (vapor, gas, fume, mist or dust) in air exceeds 25 percent of their lower flammable limit (LFL) because of the flammable finish processes operation. It shall include:

1. The interior of spray booths.
2. The interior of ducts exhausting from spraying processes.
3. Any area in the direct path of spray or any area containing dangerous quantities of air-suspended powder, combustible residue, dust, deposits, vapor or mists as a result of spraying operations.
4. The area in the vicinity of dip tanks, drain boards or associated drying, conveying or other equipment during operation or shutdown periods.

The *fire code official* is authorized to determine the extent of the flammable vapor area, taking into consideration the material characteristics of the flammable materials, the degree of sustained ventilation and the nature of the operations.



## DEFINITIONS

**FLAMMABLE VAPORS OR FUMES.** The concentration of flammable constituents in air that exceeds 25 percent of their lower flammable limit (LFL).

**FLASH POINT.** The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The *flash point* of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D56, ASTM D93 or ASTM D3278.

**FLEET VEHICLE MOTOR FUEL-DISPENSING FACILITY.** That portion of a commercial, industrial, governmental or manufacturing property where liquids used as fuels are stored and dispensed into the fuel tanks of motor vehicles that are used in connection with such businesses, by persons within the employ of such businesses.

**[BE] FLIGHT.** A continuous run of rectangular treads, *winders* or combination thereof from one landing to another.

**FLOAT.** A floating structure normally used as a point of transfer for passengers and goods, or both, for mooring purposes.

**[BE] FLOOR AREA, GROSS.** The floor area within the inside perimeter of the *exterior walls* of the building under consideration, exclusive of vent shafts and courts, without deduction for *corridors*, *stairways*, *ramps*, closets, the thickness of interior walls, columns or other features. The floor area of a building, or portion thereof, not provided with surrounding *exterior walls* shall be the usable area under the horizontal projection of the roof or floor above. The *gross floor area* shall not include shafts with no openings or interior *courts*.

**[BE] FLOOR AREA, NET.** The actual occupied area not including unoccupied accessory areas such as *corridors*, *stairways*, *ramps*, toilet rooms, mechanical rooms and closets.

### FLUE SPACES.

**Longitudinal flue space.** The flue space between rows of storage perpendicular to the direction of loading.

**Transverse flue space.** The space between rows of storage parallel to the direction of loading.

**FLUIDIZED BED.** A container holding powder coating material that is aerated from below so as to form an air-supported expanded cloud of such material through which the preheated object to be coated is immersed and transported.

**FOAM-EXTINGUISHING SYSTEM.** A special system discharging a foam made from concentrates, either mechanically or chemically, over the area to be protected.

**[BE] FOLDING AND TELESCOPIC SEATING.** Tiered seating having an overall shape and size that is capable of being reduced for purposes of moving or storing and is not a building element.

**[BG] FOSTER CARE FACILITIES.** Facilities that provide care to more than five children, 2½ years of age or less.

**FUEL CELL POWER SYSTEM, STATIONARY.** A stationary energy generation system that converts the chemical energy of a fuel and oxidant to electric energy (DC or AC electricity) by an electrochemical process.

**Field-fabricated fuel cell power system.** A *stationary fuel cell power system* that is assembled at the job site and is not a preengineered or prepackaged factory-assembled fuel cell power system.

**Preengineered fuel cell power system.** A *stationary fuel cell power system* consisting of components and modules that are produced in a factory, and shipped to the job site for assembly.

**Prepackaged fuel cell power system.** A *stationary fuel cell power system* that is factory assembled as a single, complete unit and shipped as a complete unit for installation at the job site.

**FUEL LIMIT SWITCH.** A mechanism, located on a tank vehicle, that limits the quantity of product dispensed at one time.

**FUMIGANT.** A substance which by itself or in combination with any other substance emits or liberates a gas, fume or vapor utilized for the destruction or control of insects, fungi, vermin, germs, rats or other pests, and shall be distinguished from insecticides and disinfectants which are essentially effective in the solid or liquid phases. Examples are methyl bromide, ethylene dibromide, hydrogen cyanide, carbon disulfide and sulfuryl fluoride.

**FUMIGATION.** The utilization within an enclosed space of a fumigant in concentrations that are hazardous or acutely toxic to humans.

**FURNACE CLASS A.** An oven or furnace that has heat utilization equipment operating at approximately atmospheric pressure wherein there is a potential explosion or fire hazard that could be occasioned by the presence of flammable volatiles or combustible materials processed or heated in the furnace.

**Note:** Such flammable volatiles or combustible materials can, for instance, originate from the following:

1. Paints, powders, inks, and adhesives from finishing processes, such as dipped, coated, sprayed and impregnated materials.
2. The substrate material.
3. Wood, paper and plastic pallets, spacers or packaging materials.
4. Polymerization or other molecular rearrangements.

Potentially flammable materials, such as quench oil, waterborne finishes, cooling oil or cooking oils, that present a hazard are ventilated according to Class A standards.

**FURNACE CLASS B.** An oven or furnace that has heat utilization equipment operating at approximately atmospheric pressure wherein there are no flammable volatiles or combustible materials being heated.

**FURNACE CLASS C.** An oven or furnace that has a potential hazard due to a flammable or other special atmosphere being used for treatment of material in process. This type of

furnace can use any type of heating system and includes a special atmosphere supply system. Also included in the Class C classification are integral quench furnaces and molten salt bath furnaces.

**FURNACE CLASS D.** An oven or furnace that operates at temperatures from above ambient to over 5,000°F (2760°C) and at pressures normally below atmospheric using any type of heating system. These furnaces can include the use of special processing atmospheres.

**GAS CABINET.** A fully enclosed, ventilated, noncombustible enclosure used to provide an isolated environment for *compressed gas* cylinders in storage or use. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included.

**GAS DETECTION SYSTEM.** A system or portion of a combination system that utilizes one or more stationary sensors to detect the presence of a specified gas at a specified concentration and initiate one or more responses required by this code, such as notifying a responsible person, activating an alarm signal, or activating or deactivating equipment. A self-contained gas detection and alarm device is not classified as a gas detection system.

**GAS ROOM.** A separately ventilated, fully enclosed room in which only *compressed gases* and associated equipment and supplies are stored or used.

**GAS ROOM, HYDROGEN FUEL.** See “*Hydrogen fuel gas room.*”

**GASEOUS HYDROGEN SYSTEM.** An assembly of piping, devices and apparatus designed to generate, store, contain, distribute or transport a nontoxic, gaseous hydrogen-containing mixture having not less than 95-percent hydrogen gas by volume and not more than 1-percent oxygen by volume. Gaseous hydrogen systems consist of items such as *compressed gas* containers, reactors and appurtenances, including pressure regulators, pressure relief devices, manifolds, pumps, compressors and interconnecting piping and tubing and controls.

**GLOVE BOX.** A sealed enclosure in which items inside the box are handled exclusively using long gloves sealed to ports in the enclosure.

**[BE] GRADE FLOOR EMERGENCY ESCAPE AND RESCUE OPENING.** An emergency escape and rescue opening located such that the bottom of the clear opening is not more than 44 inches (1118 mm) above or below the finished ground level adjacent to the opening.

**[BG] GRADE PLANE.** A reference plane representing the average of finished ground level adjoining the building at exterior walls. Where the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.

**[BE] GRANDSTAND.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a building element (see “*Bleachers*”).

**[BG] GROUP HOME.** A facility for social rehabilitation, substance abuse or mental health problems that contains a group housing arrangement that provides custodial care but does not provide medical care.

**[BE] GUARD.** A building component or a system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.

**[BG] GUESTROOM.** A room used or intended to be used by one or more guests for living or sleeping purposes.

**[BS] GYPSUM BOARD.** Gypsum wallboard, gypsum sheathing, gypsum base for gypsum veneer plaster, exterior gypsum soffit board, predecorated gypsum board or water-resistant gypsum backing board complying with the standards listed in Tables 2506.2 and 2507.2 and Chapter 35 of the *International Building Code*.

**[BG] HABITABLE SPACE.** A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered habitable spaces.

**HALOGENATED EXTINGUISHING SYSTEM.** A fire-extinguishing system using one or more atoms of an element from the halogen chemical series: fluorine, chlorine, bromine and iodine.

**HANDLING.** The deliberate transport by any means to a point of storage or use.

**[BE] HANDRAIL.** A horizontal or sloping rail intended for grasping by the hand for guidance or support.

**HAZARDOUS MATERIALS.** Those chemicals or substances which are *physical hazards* or *health hazards* as defined and classified in this chapter, whether the materials are in usable or waste condition.

**HAZARDOUS PRODUCTION MATERIAL (HPM).** A solid, liquid or gas associated with semiconductor manufacturing that has a degree-of-hazard rating in health, flammability or instability of Class 3 or 4 as ranked by NFPA 704 and which is used directly in research, laboratory or production processes which have, as their end product, materials that are not hazardous.

**HEALTH HAZARD.** A classification of a chemical for which there is statistically significant evidence that acute or chronic health effects are capable of occurring in exposed persons. The term “health hazard” includes chemicals that are toxic, highly toxic and *corrosive*.

**HEAT DETECTOR.** See “*Detector, heat.*”

**[BG] HEIGHT, BUILDING.** The vertical distance from *grade plane* to the average height of the highest roof surface.

**HELIPORT.** An area of land or water or a structural surface that is used, or intended for use, for the landing and taking off of helicopters, and any appurtenant areas which are used, or intended for use, for heliport buildings and other heliport facilities.

**HELISTOP.** The same as “Heliport,” except that fueling, defueling, maintenance, repairs or storage of helicopters is not permitted.

## DEFINITIONS

**HI-BOY.** A cart used to transport hot roofing materials on a roof.

**HIGHER EDUCATION LABORATORY.** Laboratories in Group B occupancies used for educational purposes above the 12th grade. Storage, use and handling of chemicals in such laboratories shall be limited to purposes related to testing, analysis, teaching, research or developmental activities on a nonproduction basis.

**HIGHLY TOXIC.** A material which produces a lethal dose or lethal concentration which falls within any of the following categories:

1. A chemical that has a median lethal dose ( $LD_{50}$ ) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose ( $LD_{50}$ ) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration ( $LC_{50}$ ) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

**HIGHLY VOLATILE LIQUID.** A liquefied *compressed gas* with a *boiling point* of less than 68°F (20°C).

**HIGH-PILED COMBUSTIBLE STORAGE.** Storage of combustible materials in closely packed piles or combustible materials on pallets, in racks or on shelves where the top of storage is greater than 12 feet (3658 mm) in height. Where required by the *fire code official*, *high-piled combustible storage* also includes certain high-hazard commodities, such as rubber tires, Group A plastics, *flammable liquids*, idle pallets and similar commodities, where the top of storage is greater than 6 feet (1829 mm) in height.

**HIGH-PILED STORAGE AREA.** An area within a building which is designated, intended, proposed or actually used for *high-piled combustible storage*, including operating aisles.

**[BG] HIGH-RISE BUILDING.** A building with an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.

**HIGH-VOLTAGE TRANSMISSION LINE.** An electrical power transmission line operating at or above 66 kilovolts.

**HIGHWAY.** A public street, public alley or public road.

**[A] HISTORIC BUILDINGS.** Any building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing by the state historic preservation officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.
2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a national register, state designated or locally designated historic district.

**HOGGED MATERIALS.** Wood waste materials produced from the lumber production process.

**[M] HOOD.** An air-intake device used to capture by entrainment, impingement, adhesion or similar means, grease and similar contaminants before they enter a duct system.

**Type I.** A kitchen hood for collecting and removing grease vapors and smoke.

**Type II.** A general kitchen hood for collecting and removing steam vapor, heat, odors and products of combustion.

**[BF] HORIZONTAL ASSEMBLY.** A *fire-resistance-rated* floor or roof assembly of materials designed to restrict the spread of fire in which continuity is maintained.

**[BE] HORIZONTAL EXIT.** An *exit* component consisting of *fire-resistance-rated* construction and opening protectives intended to compartmentalize portions of a building thereby creating refuge areas that afford safety from fire and smoke from the area of fire origin.

**[BG] HOSPITALS AND PSYCHIATRIC HOSPITALS.** Facilities that provide care or treatment for the medical, psychiatric, obstetrical, or surgical treatment of inpatient care recipients that are incapable of self-preservation.

**HOT WORK.** Operations including cutting, welding, Thermit welding, brazing, soldering, grinding, thermal spraying, thawing pipe, installation of torch-applied roof systems or any other similar activity.

**HOT WORK AREA.** The area exposed to sparks, hot slag, radiant heat, or convective heat as a result of the hot work.

**HOT WORK EQUIPMENT.** Electric or gas welding or cutting equipment used for hot work.

**HOT WORK PERMITS.** Permits issued by the responsible person at the facility under the hot work permit program permitting welding or other hot work to be done in locations referred to in Section 3503.3 and prepermitted by the *fire code official*.

**HOT WORK PROGRAM.** A permitted program, carried out by *approved* facilities-designated personnel, allowing them to oversee and issue permits for hot work conducted by their personnel or at their facility. The intent is to have trained, on-site, responsible personnel ensure that required hot work safety measures are taken to prevent fires and fire spread.

**HPM.** See “*Hazardous Production Material.*”

**HPM FACILITY.** See “*Semiconductor fabrication facility.*”



**HPM ROOM.** A room used in conjunction with or serving a Group H-5 occupancy, where HPM is stored or used and which is classified as a Group H-2, H-3 or H-4 occupancy.

**HYDROGEN FUEL GAS ROOM.** A room or space that is intended exclusively to house a *gaseous hydrogen system*.

**IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH).** The concentration of airborne contaminants that poses a threat of death, immediate or delayed permanent adverse health effects, or effects that could prevent escape from such an environment. This contaminant concentration level is established by the National Institute of Occupational Safety and Health (NIOSH) based on both toxicity and flammability. It generally is expressed in parts per million by volume (ppm v/v) or milligrams per cubic meter (mg/m<sup>3</sup>). Where adequate data do not exist for precise establishment of IDLH concentrations, an independent certified industrial hygienist, industrial toxicologist, appropriate regulatory agency or other source *approved* by the *fire code official* shall make such determination.

**IMPAIRMENT COORDINATOR.** The person responsible for the maintenance of a particular *fire protection system*.

**[BG] INCAPABLE OF SELF-PRESERVATION.** Persons who, because of age, physical limitations, mental limitations, chemical dependency or medical treatment, cannot respond as an individual to an emergency situation.

**INCOMPATIBLE MATERIALS.** Materials that, when mixed, have the potential to react in a manner which generates heat, fumes, gases or byproducts which are hazardous to life or property.

**INERT GAS.** A gas that is capable of reacting with other materials only under abnormal conditions such as high temperatures, pressures and similar extrinsic physical forces. Within the context of the code, inert gases do not exhibit either physical or *health hazard* properties as defined (other than acting as a simple asphyxiant) or hazard properties other than those of a *compressed gas*. Some of the more common inert gases include argon, helium, krypton, neon, nitrogen and xenon.

**INHABITED BUILDING.** A building regularly occupied in whole or in part as a habitation for people, or any place of religious worship, schoolhouse, railroad station, store or other structure where people are accustomed to assemble, except any building or structure occupied in connection with the manufacture, transportation, storage or use of *explosive materials*.

**INITIATING DEVICE.** A system component that originates transmission of a change-of-state condition, such as in a smoke detector, manual fire alarm box, or supervisory switch.

**INSECTICIDAL FOGGING.** The utilization of insecticidal liquids passed through fog-generating units where, by means of pressure and turbulence, with or without the application of heat, such liquids are transformed and discharged in the form of fog or mist blown into an area to be treated.

**INTEGRATED TESTING (FIRE PROTECTION AND LIFE SAFETY SYSTEM).** A testing procedure to establish the operational status, interaction and coordination of two or more fire protection and safety systems.

**[BE] INTERIOR EXIT RAMP.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and provides for a protected path of egress travel to the *exit discharge* or *public way*.

**[BE] INTERIOR EXIT STAIRWAY.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and provides for a protected path of egress travel to the *exit discharge* or *public way*.

**[BG] INTERIOR FINISH.** Interior finish includes interior wall and ceiling finish and interior floor finish.

**[BG] INTERIOR FLOOR-WALL BASE.** Interior floor finish trim used to provide a functional or decorative border at the intersection of walls and floors.

**[BG] INTERIOR WALL AND CEILING FINISH.** The exposed interior surfaces of buildings, including but not limited to: fixed or movable walls and partitions; toilet room privacy partitions; columns; ceilings; and interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural *fire resistance* or similar purposes, but not including trim.

**IRRITANT.** A chemical which is not *corrosive*, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact. A chemical is a skin irritant if, when tested on the intact skin of albino rabbits by the methods of CPSC 16 CFR Part 1500.41 for an exposure of four or more hours or by other appropriate techniques, it results in an empirical score of 5 or more. A chemical is classified as an eye irritant if so determined under the procedure listed in CPSC 16 CFR Part 1500.42 or other *approved* techniques.

**[A] JURISDICTION.** The governmental unit that has adopted this code.

**KEY BOX.** A secure device with a lock operable only by a fire department master key, and containing building entry keys and other keys that may be required for access in an emergency.

**[A] LABELED.** Equipment, materials or products to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, *approved* agency or other organization concerned with product evaluation that maintains periodic inspection of the production of such labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

**LABORATORY SUITE.** A fire-rated enclosed laboratory area that will provide one or more laboratory spaces, within a Group B educational occupancy, that are permitted to include ancillary uses such as offices, bathrooms and corridors that are contiguous with the laboratory area, and are constructed in accordance with Chapter 38.



## DEFINITIONS

**LEVEL OF EXIT DISCHARGE.** See “Exit discharge, level of.”

**LIFE SAFETY SYSTEMS.** Systems, devices and equipment that enhance or facilitate evacuation, smoke control, compartmentation and/or isolation.

**LIMITED SPRAYING SPACE.** An area in which operations for touch-up or spot painting of a surface area of 9 square feet (0.84 m<sup>2</sup>) or less are conducted.

**LIQUEFIED NATURAL GAS (LNG).** A fluid in the liquid state composed predominantly of methane and which may contain minor quantities of ethane, propane, nitrogen or other components normally found in natural gas.

**LIQUEFIED PETROLEUM GAS (LP-gas).** A material which is composed predominantly of the following hydrocarbons or mixtures of them: propane, propylene, butane (normal butane or isobutane) and butylenes.

**LIQUID.** A material having a melting point that is equal to or less than 68°F (20°C) and a *boiling point* which is greater than 68°F (20°C) at 14.7 pounds per square inch absolute (psia) (101 kPa). Where not otherwise identified, the term “liquid” includes both *flammable* and *combustible liquids*.

**LIQUID OXYGEN AMBULATORY CONTAINER.** A container used for liquid oxygen not exceeding 0.396 gallons (1.5 liters) specifically designed for use as a medical device as defined by 21 USC Chapter 9 that is intended for portable therapeutic use and to be filled from its companion base unit, a liquid oxygen home care container.

**LIQUID OXYGEN HOME CARE CONTAINER.** A container used for liquid oxygen not exceeding 15.8 gallons (60 liters) specifically designed for use as a medical device as defined by 21 USC Chapter 9 that is intended to deliver gaseous oxygen for therapeutic use in a home environment.

**LIQUID STORAGE ROOM.** A room classified as a Group H-3 occupancy used for the storage of *flammable* or *combustible liquids* in a closed condition.

**LIQUID STORAGE WAREHOUSE.** A building classified as a Group H-2 or H-3 occupancy used for the storage of *flammable* or *combustible liquids* in a closed condition.

**[A] LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *fire code official* and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

**LOCKDOWN.** An emergency situation, in other than a Group I-3 occupancy, requiring that the occupants be sheltered and secured in place within a building when normal evacuation would put occupants at risk.

**[BG] LODGING HOUSE.** A one-family *dwelling* where one or more occupants are primarily permanent in nature and rent is paid for guestrooms.

**LONGITUDINAL FLUE SPACE.** See “Flue spaces—longitudinal.”

**[A] LOT.** A portion or parcel of land considered as a unit.

**[A] LOT LINE.** A line dividing one lot from another, or from a street or any public place.

**[BE] LOW ENERGY POWER-OPERATED DOOR.** Swinging, sliding or folding door which opens automatically upon an action by a pedestrian such as pressing a push plate or waving a hand in front of a sensor. The door closes automatically, and operates with decreased forces and decreased speeds. See also “Power-assisted door” and “Power-operated door.”

**LOWER EXPLOSIVE LIMIT (LEL).** See “Lower flammable limit.”

**LOWER FLAMMABLE LIMIT (LFL).** The minimum concentration of vapor in air at which propagation of flame will occur in the presence of an ignition source. The LFL is sometimes referred to as LEL or lower explosive limit.

**LOW-PRESSURE TANK.** A storage tank designed to withstand an internal pressure greater than 0.5 pound per square inch gauge (psig) (3.4 kPa) but not greater than 15 psig (103.4 kPa).

**LP-GAS CONTAINER.** Any vessel, including cylinders, tanks, portable tanks and cargo tanks, used for transporting or storing LP-gases.

**MAGAZINE.** A building, structure or container, other than an operating building, *approved* for storage of *explosive materials*.

**Indoor.** A portable structure, such as a box, bin or other container, constructed as required for Type 2, 4 or 5 magazines in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555 so as to be fire resistant and theft resistant.

**Type 1.** A permanent structure, such as a building or igloo, that is bullet resistant, fire resistant, theft resistant, weather resistant and ventilated in accordance with the requirements of NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555.

**Type 2.** A portable or mobile structure, such as a box, skid-magazine, trailer or semitrailer, constructed in accordance with the requirements of NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555 that is fire resistant, theft resistant, weather resistant and ventilated. If used outdoors, a Type 2 magazine is also bullet resistant.

**Type 3.** A fire resistant, theft resistant and weather resistant “day box” or portable structure constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555 used for the temporary storage of *explosive materials*.

**Type 4.** A permanent, portable or mobile structure such as a building, igloo, box, semitrailer or other mobile container that is fire resistant, theft resistant and weather resistant and constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555.

**Type 5.** A permanent, portable or mobile structure such as a building, igloo, box, bin, tank, semitrailer, bulk trailer, tank trailer, bulk truck, tank truck or other mobile container that is theft resistant, which is constructed in accordance with NFPA 495, NFPA 1124 or DOTy 27 CFR Part 555.

**MAGNESIUM.** The pure metal and alloys, of which the major part is magnesium.

**MALL.** See “*Covered mall building.*”

**MANUAL FIRE ALARM BOX.** A manually operated device used to initiate an alarm signal.

**MANUAL STOCKING METHODS.** Stocking methods utilizing ladders or other nonmechanical equipment to move stock.

**MARINA.** Any portion of the ocean or inland water, either naturally or artificially protected, for the mooring, servicing or safety of vessels and shall include artificially protected works, the public or private lands ashore, and structures or facilities provided within the enclosed body of water and ashore for the mooring or servicing of vessels or the servicing of their crews or passengers.

**MARINE MOTOR FUEL-DISPENSING FACILITY.** That portion of property where *flammable* or *combustible liquids* or gases used as fuel for watercraft are stored and dispensed from fixed equipment on shore, piers, wharves, floats or barges into the fuel tanks of watercraft and shall include all other facilities used in connection therewith.

**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA.** The maximum amount of a hazardous material allowed to be stored or used within a *control area* inside a building or an *outdoor control area*. The maximum allowable quantity per *control area* is based on the material state (solid, liquid or gas) and the material storage or use conditions.

**[BE] MEANS OF EGRESS.** A continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a *public way*. A *means of egress* consists of three separate and distinct parts: the *exit access*, the *exit* and the *exit discharge*.

**MECHANICAL STOCKING METHODS.** Stocking methods utilizing motorized vehicles or hydraulic jacks to move stock.

**[BG] MEDICAL CARE.** Care involving medical or surgical procedures, nursing or for psychiatric purposes.

**MEMBRANE STRUCTURE.** An air-inflated, air-supported, cable or frame-covered structure as defined by the *International Building Code* and not otherwise defined as a tent. See Chapter 31 of the *International Building Code*.

**[BF] MEMBRANE-PENETRATION FIRESTOP SYSTEM.** An assemblage consisting of a *fire-resistance-rated* floor-ceiling, roof-ceiling or wall assembly, one or more penetrating items installed into or passing through the breach in one side of the assembly and the materials or devices, or both, installed to resist the spread of fire into the assembly for a prescribed period of time.

**[BE] MERCHANDISE PAD.** A merchandise pad is an area for display of merchandise surrounded by *aisles*, permanent fixtures or walls. Merchandise pads contain elements such as nonfixed and moveable fixtures, cases, racks, counters and partitions as indicated in Section 105.2 of the *International Building Code* from which customers browse or shop.

**METAL HYDRIDE.** A generic name for compounds composed of metallic element(s) and hydrogen.

**METAL HYDRIDE STORAGE SYSTEM.** A *closed system* consisting of a group of components assembled as a package to contain metal-hydrogen compounds for which there exists an equilibrium condition where the hydrogen-absorbing metal alloy(s), hydrogen gas and the metal-hydrogen compound(s) coexist and where only hydrogen gas is released from the system in normal use.

**[BG] MEZZANINE.** An intermediate level or levels between the floor and ceiling of any story and in accordance with Section 505 of the *International Building Code*.

**MISCELLA.** A mixture, in any proportion, of the extracted oil or fat and the extracting solvent.

**MOBILE FOOD PREPARATION VEHICLES.** Vehicles that contain cooking equipment that produce smoke or grease-laden vapors for the purpose of preparing and serving food to the public. Vehicles intended for private recreation shall not be considered mobile food preparation vehicles.

**MOBILE FUELING.** The operation of dispensing liquid fuels from tank vehicles into the fuel tanks of motor vehicles. Mobile fueling may also be known by the terms “Mobile fleet fueling,” “Wet fueling” and “Wet hosing.”

**MORTAR.** A tube from which fireworks shells are fired into the air.

**MULTIPLE-STATION ALARM DEVICE.** Two or more single-station alarm devices that can be interconnected such that actuation of one causes all integral or separate audible alarms to operate. A multiple-station alarm device can consist of one single-station alarm device having connections to other detectors or to a manual fire alarm box.

**MULTIPLE-STATION SMOKE ALARM.** Two or more single-station alarm devices that are capable of interconnection such that actuation of one causes the appropriate alarm signal to operate in all interconnected alarms.

**NESTING.** A method of securing flat-bottomed *compressed gas* cylinders upright in a tight mass using a contiguous three-point contact system whereby all cylinders within a group have not less than three points of contact with other cylinders, walls or bracing.

**NET EXPLOSIVE WEIGHT (net weight).** The weight of *explosive material* expressed in pounds. The net explosive weight is the aggregate amount of *explosive material* contained within buildings, magazines, structures or portions thereof, used to establish quantity-distance relationships.

**NORMAL TEMPERATURE AND PRESSURE (NTP).** A temperature of 70°F (21°C) and a pressure of 1 atmosphere [14.7 psia (101 kPa)].

## DEFINITIONS

**[BE] NOSING.** The leading edge of treads of *stairs* and of landings at the top of *stairway flights*.

**NOTIFICATION ZONE.** See “*Zone, notification*.”

**NUISANCE ALARM.** An alarm caused by mechanical failure, malfunction, improper installation or lack of proper maintenance, or an alarm activated by a cause that cannot be determined.

**[BG] NURSING HOMES.** Facilities that provide care, including both intermediate care facilities and skilled nursing facilities, where any of the persons are incapable of self-preservation.

**OCCUPANCY CLASSIFICATION.** For the purposes of this code, certain occupancies are defined as follows:

**[BG] Group A, Assembly.** Assembly Group A occupancy includes, among others, the use of a building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption; or awaiting transportation.

**[BG] Accessory with places of religious worship.** Accessory religious educational rooms and religious auditoriums with *occupant loads* of less than 100 per room or space are not considered separate occupancies.

**[BG] Assembly Group A-1.** Group A occupancy includes assembly uses, usually with fixed seating, intended for the production and viewing of performing arts or motion pictures including, but not limited to:

- Motion picture theaters
- Symphony and concert halls
- Television and radio studios admitting an audience
- Theaters

**[BG] Assembly Group A-2.** Group A-2 occupancy includes assembly uses intended for food and/or drink consumption including, but not limited to:

- Banquet halls
- Casinos (gaming areas)
- Night clubs
- Restaurants, cafeterias and similar dining facilities (including associated commercial kitchens)
- Taverns and bars

**[BG] Assembly Group A-3.** Group A-3 occupancy includes assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A, including, but not limited to:

- Amusement arcades
- Art galleries
- Bowling alleys
- Community halls
- Courtrooms
- Dance halls (not including food or drink consumption)

Exhibition halls

Funeral parlors

Greenhouses with public access for the conservation and exhibition of plants

Gymnasiums (without spectator seating)

Indoor swimming pools (without spectator seating)

Indoor tennis courts (without spectator seating)

Lecture halls

Libraries

Museums

Places of religious worship

Pool and billiard parlors

Waiting areas in transportation terminals

**[BG] Assembly Group A-4.** Group A-4 occupancy includes assembly uses intended for viewing of indoor sporting events and activities with spectator seating including, but not limited to:

- Arenas
- Skating rinks
- Swimming pools
- Tennis courts

**[BG] Assembly Group A-5.** Group A-5 occupancy includes assembly uses intended for participation in or viewing outdoor activities including, but not limited to:

- Amusement park structures
- Bleachers*
- Grandstands
- Stadiums

**[BG] Associated with Group E occupancies.** A room or space used for assembly purposes that is associated with a Group E occupancy is not considered a separate occupancy.

**[BG] Small assembly spaces.** The following rooms and spaces shall not be classified as assembly occupancies:

1. A room or space used for assembly purposes with an *occupant load* of less than 50 persons classified as a Group B occupancy or as part of that occupancy.
2. A room or space used for assembly purposes that is less than 750 square feet (70 m<sup>2</sup>) in area and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.

**[BG] Small buildings and tenant spaces.** A building or tenant space used for assembly purposes with an *occupant load* of less than 50 persons shall be classified as a Group B occupancy.

## DEFINITIONS

**[BG] Special amusement areas.** Special amusement areas shall comply with Section 411 of the *International Building Code*.

**[BG] Group B, Business.** Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:

- Airport traffic control towers
- Ambulatory care facilities
- Animal hospitals, kennels and pounds
- Banks
- Barber and beauty shops
- Car wash
- Civic administration
- Clinic-outpatient
- Dry cleaning and laundries: pick-up and delivery stations and self-service
- Educational occupancies for students above the 12th grade, including higher education laboratories
- Electronic data processing
- Food processing establishments and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities not more than 2,500 square feet (232 m<sup>2</sup>) in area.
- Laboratories: testing and research
- Motor vehicle showrooms
- Post offices
- Print shops
- Professional services (architects, attorneys, dentists, physicians, engineers, etc.)
- Radio and television stations
- Telephone exchanges
- Training and skill development not in a school or academic program (This shall include, but not be limited to, tutoring centers, martial arts studios, gymnastics and similar uses regardless of the ages served, and where not classified as a Group A occupancy).

**[BG] Airport traffic control towers.** Airport traffic control towers shall comply with Section 412.2 of the *International Building Code*.

**[BG] Ambulatory care facilities.** Ambulatory care facilities shall comply with Section 422 of the *International Building Code*.

**[BG] Higher education laboratories.** Higher education laboratories shall comply with Section 428 of the *International Building Code*.

**[BG] Group E, Educational.** Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade. Rooms normally occupied by preschool, kindergarten or first grade students shall be located on a level of exit discharge. Rooms normally occupied by second grade students shall not be located more than one level above the level of exit discharge unless provided with a dedicated and independent means of egress.

**[BG] Accessory to places of religious worship.** Religious educational rooms and religious auditoriums, which are accessory to places of religious worship in accordance with Section 303.1.4 of the *Arkansas Fire Prevention Code*, Volume II and have *occupant loads* of less than 100 per room or space shall be classified as Group A-3 occupancies.

**[BG] Group E, day care facilities.** This group includes buildings and structures or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or *personal care services* for less than 24 hours per day.

**[BG] Five or fewer children.** A facility having five or fewer children receiving such care shall be classified as part of the primary occupancy.

**[BG] Five or fewer children in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer children receiving such care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

**[BG] Within places of worship.** Rooms and spaces within places of worship providing such care during religious functions shall be classified as part of the primary occupancy.

**[BG] Storm shelters in Group E occupancies.** Storm shelters shall be provided for Group E occupancies where required by Section 423.4 of the *International Building Code*.

**[BG] Group F, Factory Industrial.** Factory Industrial Group F occupancy includes, among others, the use of a building or structure, or a portion thereof, for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as a Group H high-hazard or Group S storage occupancy.

**[BG] Factory Industrial F-1 Moderate-hazard occupancy.** Factory industrial uses that are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moderate Hazard and shall include, but not be limited to, the following:

- Aircraft (manufacturing, not to include repair)
- Appliances
- Athletic equipment
- Automobiles and other motor vehicles



## DEFINITIONS

Bakeries  
 Beverages; over 16-percent alcohol content  
 Bicycles  
 Boats  
 Brooms or brushes  
 Business machines  
 Cameras and photo equipment  
 Canvas or similar fabric  
 Carpets and rugs (includes cleaning)  
 Clothing  
 Construction and agricultural machinery  
 Disinfectants  
 Dry cleaning and dyeing  
 Electric generation plants  
 Electronics  
 Energy storage systems (ESS) in dedicated-use buildings  
 Engines (including rebuilding)  
 Food processing and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities more than 2,500 square feet (232 m<sup>2</sup>) in area.  
 Furniture  
 Hemp products  
 Jute products  
 Laundries  
 Leather products  
 Machinery  
 Metals  
 Millwork (sash and door)  
 Motion pictures and television filming (without spectators)  
 Musical instruments  
 Optical goods  
 Paper mills or products  
 Photographic film  
 Plastic products  
 Printing or publishing  
 Refuse incineration  
 Shoes  
 Soaps and detergents  
 Textiles  
 Tobacco  
 Trailers  
 Upholstering  
 Water/sewer treatment facilities  
 Wood; distillation  
 Woodworking (cabinet)

**[BG] Aircraft manufacturing facilities.** Aircraft manufacturing facilities shall comply with Section 412.6 of the *International Building Code*.

**[BG] Factory Industrial F-2 Low-hazard Occupancy.** Factory industrial uses involving the fabrication or manufacturing of noncombustible materials that, during finishing, packaging or processing do not involve a significant fire hazard, shall be classified as Group F-2 occupancies and shall include, but not be limited to, the following:

Beverages; up to and including 16-percent alcohol content  
 Brick and masonry  
 Ceramic products  
 Foundries  
 Glass products  
 Gypsum  
 Ice  
 Metal products (fabrication and assembly)

**Group H, High-hazard.** High-hazard Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or *health hazard* in quantities in excess of those allowed in *control areas* complying with Section 5003.8.3, based on the maximum allowable quantity limits for *control areas* set forth in Tables 5003.1.1(1) and 5003.1.1(2). Hazardous occupancies are classified in Groups H-1, H-2, H-3, H-4 and H-5 and shall be in accordance with this code and the requirements of Section 415 of the *International Building Code*. Hazardous materials stored or used on top of roofs or canopies shall be classified as outdoor storage or use and shall comply with this code.

**High-hazard Group H-1.** Buildings and structures containing materials that pose a *detonation* hazard shall be classified as Group H-1. Such materials shall include, but not be limited to, the following:

Detonable pyrophoric materials  
 Explosives:  
     Division 1.1  
     Division 1.2  
     Division 1.3  
     Division 1.4  
     Division 1.5  
     Division 1.6  
 Organic peroxides, unclassified detonable  
 Oxidizers, Class 4  
 Unstable (reactive) materials, Class 3 detonable, and Class 4

**High-hazard Group H-2.** Buildings and structures containing materials that pose a *deflagration* hazard or a hazard from accelerated burning shall be classified as

## DEFINITIONS

Group H-2. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA flammable or *combustible liquids* that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa)

*Combustible dusts* where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3 of the *International Building Code*

*Cryogenic fluids*, flammable

Flammable gases

Organic peroxides, Class I

Oxidizers, Class 3, that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa)

Pyrophoric liquids, solids and gases, nondetonable

Unstable (reactive) materials, Class 3, nondetonable

Water-reactive materials, Class 3

**High-hazard Group H-3.** Buildings and structures containing materials that readily support combustion or that pose a *physical hazard* shall be classified as Group H-3. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA flammable or *combustible liquids* that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103.4 kPa) or less

Combustible fibers, other than densely packed baled cotton, where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3 of the *International Building Code*

Consumer fireworks, 1.4G (Class C, Common)

*Cryogenic fluids*, oxidizing

Flammable solids

Organic peroxides, Class II and III

Oxidizers, Class 2

Oxidizers, Class 3, that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103 kPa) or less

Oxidizing gases

Unstable (reactive) materials, Class 2

Water-reactive materials, Class 2

**High-hazard Group H-4.** Buildings and structures containing materials that are *health hazards* shall be classified as Group H-4. Such materials shall include, but not be limited to, the following:

*Corrosives*

Highly toxic materials

Toxic materials

**High-hazard Group H-5.** Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials (HPM) are used and the aggregate quantity of materials is in excess of those listed in Tables 5003.1.1(1) and 5003.1.1(2) shall be classified as Group H-5. Such facilities and areas shall be designed and constructed in accordance with Section 415.11 of the *International Building Code*.

**Multiple hazards.** Buildings and structures containing a material or materials representing hazards that are classified in one or more of Groups H-1, H-2, H-3 and H-4 shall conform to the code requirements for each of the occupancies so classified.

**Occupancies containing explosives not classified as H-1.** The following occupancies containing *explosive materials* shall be classified as follows:

1. Division 1.3 *explosive materials* that are used and maintained in a form where either confinement or configuration will not elevate the hazard from a mass fire hazard to mass explosion hazard shall be allowed in Group H-2 occupancies.
2. Articles, including articles packaged for shipment, that are not regulated as a Division 1.4 explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpackaged articles used in process operations that do not propagate a *detonation* or deflagration between articles shall be allowed in H-3 occupancies.

**Uses other than Group H.** The storage, use or handling of hazardous materials as described in one or more of the following items shall not cause the occupancy to be classified as Group H, but it shall be classified as the occupancy that it most nearly resembles:

1. Buildings and structures occupied for the application of flammable finishes, provided that such buildings or areas conform to the requirements of Chapter 24 of this code and Section 416 of the *International Building Code*.
2. Wholesale and retail sales and storage of *flammable* and *combustible liquids* in mercantile occupancies conforming to Chapter 57.
3. Closed piping system containing *flammable* or *combustible liquids* or gases utilized for the operation of machinery or equipment.

## DEFINITIONS

4. Cleaning establishments that utilize *combustible liquid* solvents having a *flash point* of 140°F (60°C) or higher in *closed systems* employing equipment *listed* by an *approved* testing agency, provided that this occupancy is separated from all other areas of the building by 1-hour *fire barriers* in accordance with Section 707 of the *International Building Code* or 1-hour *horizontal assemblies* in accordance with Section 711 of the *International Building Code*, or both.
5. Cleaning establishments that utilize a liquid solvent having a *flash point* at or above 200°F (93°C).
6. Liquor stores and distributors without bulk storage.
7. Refrigeration systems.
8. The storage or utilization of materials for agricultural purposes on the premises.
9. Stationary storage battery systems installed in accordance with Section 1207.
10. *Corrosive* personal or household products in their original packaging used in retail display.
11. Commonly used *corrosive* building materials.
12. Buildings and structures occupied for aerosol product storage, aerosol cooking spray products or plastic aerosol 3 products shall be classified as Group S-1, provided that such buildings conform to the requirements of Chapter 51.
13. Display and storage of nonflammable solid and nonflammable or noncombustible liquid hazardous materials in quantities not exceeding the *maximum allowable quantity per control area* in Group M or S occupancies complying with Section 5003.8.3.5.1.
14. The storage of black powder, smokeless propellant and small arms primers in Groups M and R-3 and special industrial explosive devices in Groups B, F, M and S, provided that such storage conforms to the quantity limits and requirements of this code.
15. Stationary fuel cell power systems installed in accordance with this code.
16. *Capacitor energy storage systems* in accordance with this code.
17. Group B higher education laboratory occupancies complying with Section 428 of the *International Building Code* and Chapter 38 of this code.
18. Distilling or brewing of beverages conforming to the requirements of this code.
19. The storage of beer, distilled spirits and wines in barrels and casks conforming to the requirements of this code.

**[BG] Group I, Institutional.** Institutional Group I occupancy includes, among others, the use of a building or structure, or a portion thereof, in which care or supervision is provided to persons who are or are not capable of self-preservation without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted. Institutional occupancies shall be classified as Group I-1, I-2, I-3 or I-4.

**[BG] Institutional Group I-1.** Institutional Group I-1 occupancy shall include buildings, structures or portions thereof for more than 16 persons, excluding staff, who reside on a 24-hour basis in a supervised environment and receive custodial care. Buildings of Group I-1 shall be classified as one of the occupancy conditions indicated below and shall comply with Section 420 of the *International Building Code*. This group shall include, but not be limited to, the following:

- Alcohol and drug centers
- Assisted living facilities
- Congregate care facilities
- Group homes
- Halfway houses
- Residential board and care facilities
- Residential board and custodial care facilities
- Social rehabilitation facilities

**[BG] Condition 1.** This occupancy condition shall include buildings in which all persons receiving custodial care who, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

**[BG] Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving custodial care who require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation.

**[BG] Five or fewer persons receiving custodial care.** A facility with five or fewer persons receiving custodial care shall be classified as Group R-3 or shall comply with the *International Residential Code* provided that an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or with Section P2904 of the *International Residential Code*.

**[BG] Six to 16 persons receiving custodial care.** A facility housing not fewer than six and not more than 16 persons receiving custodial care shall be classified as Group R-4.

**[BG] Institutional Group I-2.** Institutional Group I-2 occupancy shall include buildings and structures used for medical care on a 24-hour basis for more than five persons who are not capable of self-preservation. This group shall include, but not be limited to, the following:

- Foster care facilities
- Detoxification facilities

## DEFINITIONS

Hospitals  
Nursing homes  
Psychiatric hospitals

**[BG] Occupancy Conditions.** Buildings of Group I-2 shall be classified as one of the following occupancy conditions and shall comply with Section 407 of the *International Building Code*:

**[BG] Condition 1.** This occupancy condition shall include facilities that provide nursing and medical care but do not provide emergency care, surgery, obstetrics, or in-patient stabilization units for psychiatric or detoxification, including, but not limited to, nursing homes and foster care facilities.

**[BG] Condition 2.** This occupancy condition shall include facilities that provide nursing and medical care and could provide emergency care, surgery, obstetrics, or inpatient stabilization units for psychiatric or detoxification, including, but not limited to, hospitals.

**[BG] Five or fewer persons receiving medical care.** A facility with five or fewer persons receiving medical care shall be classified as Group R-3 or shall comply with the *International Residential Code* provided that an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or with Section P2904 of the *International Residential Code*.

**[BG] Institutional Group I-3.** Institutional Group I-3 occupancy shall include buildings and structures which are inhabited by more than five persons who are under restraint or security. A Group I-3 facility is occupied by persons who are generally incapable of self-preservation due to security measures not under the occupants' control. This group shall include, but not be limited to, the following:

Correctional centers  
Detention centers  
Jails  
Prerelease centers  
Prisons  
Reformatories

Buildings of Group I-3 shall be classified as one of the following occupancy conditions and shall comply with Section 408 of the *International Building Code*:

**[BG] Condition 1.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas and other spaces where access or occupancy is permitted to the exterior via *means of egress* without restraint. A Condition 1 facility is permitted to be constructed as Group R.

**[BG] Condition 2.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas and any other occupied

*smoke compartment* to one or more other *smoke compartments*. Egress to the exterior is impeded by locked *exits*.

**[BG] Condition 3.** This occupancy condition shall include buildings in which free movement is allowed within individual *smoke compartments*, such as within a residential unit comprised of individual *sleeping units* and group activity spaces, where egress is impeded by remote-controlled release of *means of egress* from such *smoke compartment* to another *smoke compartment*.

**[BG] Condition 4.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Remote-controlled release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the *smoke compartment* to other *smoke compartments*.

**[BG] Condition 5.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Staff-controlled manual release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the *smoke compartment* to other *smoke compartments*.

**[BG] Institutional Group I-4, day care facilities.** Institutional Group I-4 shall include buildings and structures occupied by more than five persons of any age who receive custodial care for less than 24 hours by persons other than parents or guardians; relatives by blood, marriage, or adoption; and in a place other than the home of the person cared for. Rooms normally occupied by preschool, kindergarten or first grade students shall be located on a level of exit discharge. Rooms normally occupied by second grade students shall not be located more than one level above the level of exit discharge unless provided with a dedicated and independent means of egress. This group shall include, but not be limited to, the following:

Adult day care  
Child day care

**[BG] Classification as Group E.** A child day care facility that provides care for more than five but not more than 100 children 2½ years or less of age, where the rooms in which the children are cared for are located on a *level of exit discharge* serving such rooms and each of these child care rooms has an *exit* door directly to the exterior, shall be classified as Group E.

**[BG] Five or fewer occupants receiving care in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer persons receiving custodial care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

•  
•  
•  
•  
•  
•  
•  
•



## DEFINITIONS

**[BG] Five or fewer occupants receiving care.** A facility having five or fewer persons receiving custodial care shall be classified as part of the primary occupancy.

**[BG] Within a place of religious worship.** Rooms and spaces within places of religious worship providing such care during religious functions shall be classified as part of the primary occupancy.

**[BG] Group M, Mercantile.** Mercantile Group M occupancy includes, among others, the use of a building or structure or a portion thereof, for the display and sale of merchandise, and involves stocks of goods, wares or merchandise incidental to such purposes and accessible to the public. Mercantile occupancies shall include, but not be limited to, the following:

- Department stores
- Drug stores
- Greenhouses with public access that maintain plants for display and sale
- Markets
- Motor fuel-dispensing facilities
- Retail or wholesale stores
- Sales rooms

**[BG] Motor fuel-dispensing facilities.** Motor fuel-dispensing facilities shall comply with Section 406.7 of the *International Building Code*.

**[BG] Quantity of hazardous materials.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored or displayed in a single control area of a Group M occupancy shall not exceed the quantities in Table 5704.3.4.1.

**[BG] Group R, Residential.** Residential Group R includes, among others, the use of a building or structure, or a portion thereof, for sleeping purposes when not classified as an Institutional Group I or when not regulated by the *International Residential Code* in accordance with Section 101.2 of the *International Building Code*. Group R occupancies not constructed in accordance with the *International Residential Code* as permitted by Sections 310.4.1 and 310.4.2 of the *International Building Code* shall comply with Section 420 of the *International Building Code*.

**[BG] Residential Group R-1.** Residential Group R-1 occupancies containing *sleeping units* where the occupants are primarily transient in nature, including:

- Boarding houses* (transient) with more than 10 occupants
- Congregate living facilities (transient) with more than 10 occupants
- Hotels (transient)
- Motels (transient)

**[BG] Residential Group R-2.** Residential Group R-2 occupancies containing *sleeping units* or more than

two *dwelling units* where the occupants are primarily permanent in nature, including:

- Apartment houses
- Congregate living facilities* (nontransient) with more than 16 occupants
- Boarding houses (nontransient)
- Convents
- Dormitories*
- Fraternities and sororities
- Monasteries
- Hotels (nontransient)
- Live/work units*
- Motels (nontransient)
- Vacation timeshare properties

**[BG] Residential Group R-3.** Residential Group R-3 occupancies where the occupants are primarily permanent in nature and not classified as Group R-1, R-2, R-4 or I, including:

- Buildings that do not contain more than two *dwelling units*
- Care facilities that provide accommodations for five or fewer persons receiving care
- Congregate living facilities* (nontransient) with 16 or fewer occupants
- Boarding houses (nontransient)
- Convents
- Dormitories*
- Fraternities and sororities
- Monasteries
- Congregate living facilities* (transient) with 10 or fewer occupants
- Boarding houses* (transient)
- Lodging houses* (transient) with five or fewer *guestrooms* and 10 or fewer occupants

**[BG] Care facilities within a dwelling.** Care facilities for five or fewer persons receiving care that are within a single-family dwelling are permitted to comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**[BG] Lodging houses.** Owner-occupied *lodging houses* with five or fewer guestrooms and 10 or fewer total occupants shall be permitted to be constructed in accordance with the *International Residential Code* provided that an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**[BG] Residential Group R-4.** Residential Group R-4 shall include buildings, structures or portions thereof for more than five but not more than 16 persons, excluding staff, who reside on a 24-hour basis in a

## DEFINITIONS

supervised residential environment and receive custodial care. Buildings of Group R-4 shall be classified as one of the occupancy conditions indicated below. This group shall include, but not be limited to, the following:

- Alcohol and drug centers
- Assisted living facilities
- Congregate care facilities
- Group homes
- Halfway houses
- Residential board and care facilities
- Social rehabilitation facilities

Group R-4 occupancies shall meet the requirements for construction as defined for Group R-3, except as otherwise provided for in the *International Building Code*.

**[BG] Condition 1.** This occupancy condition shall include buildings in which all persons receiving custodial care, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

**[BG] Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving custodial care who require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation.

**[BG] Group S, Storage.** Storage Group S occupancy includes, among others, the use of a building or structure, or a portion thereof, for storage that is not classified as a hazardous occupancy.

**[BG] Group S-1 moderate-hazard storage.** Storage Group S-1 occupancies are buildings occupied for storage uses that are not classified as Group S-2, including, but not limited to, storage of the following:

- Aerosols, Levels 2 and 3
- Aircraft hangar (storage and repair)
- Bags: cloth, burlap and paper
- Bamboos and rattan
- Baskets
- Belting: canvas and leather
- Beverages over 16-percent alcohol content
- Books and paper in rolls or packs
- Boots and shoes
- Buttons, including cloth covered, pearl or bone
- Cardboard and cardboard boxes
- Clothing, woolen wearing apparel
- Cordage
- Dry boat storage (indoor)
- Furniture
- Furs
- Glues, mucilage, pastes and size

Grains

Horns and combs, other than celluloid

Leather

Linoleum

Lumber

Motor vehicle repair garages complying with the maximum allowable quantities of hazardous materials listed in Table 5003.1.1(1) (see Section 406.8 of the *International Building Code*)

Photo engravings

Resilient flooring

Self-service storage facility (mini-storage)

Silks

Soaps

Sugar

Tires, bulk storage of Tobacco, cigars, cigarettes and snuff

Upholstery and mattresses

Wax candles

**[BG] Aircraft hangars.** Aircraft hangars used for storage or repair shall comply with Section 412.3 of the *International Building Code*.

**[BG] Motor vehicle repair garages.** Motor vehicle repair garages shall comply with Section 406.8 of the *International Building Code*.

**[BG] Group S-2 low-hazard storage.** Storage Group S-2 occupancies include, among others, buildings used for the storage of noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic trim, such as knobs, handles or film wrapping. Storage uses shall include, but not be limited to, storage of the following:

- Asbestos
- Beverages up to and including 16-percent alcohol
- Cement in bags
- Chalk and crayons
- Dairy products in nonwaxed coated paper containers
- Dry cell batteries
- Electrical coils
- Electrical motors
- Empty cans
- Food products
- Foods in noncombustible containers
- Fresh fruits and vegetables in nonplastic trays or containers
- Frozen foods
- Glass

## DEFINITIONS

Glass bottles, empty or filled with noncombustible liquids  
 Gypsum board  
 Inert pigments  
 Ivory  
 Meats  
 Metal cabinets  
 Metal desks with plastic tops and trim  
 Metal parts  
 Metals  
 Mirrors  
 Oil-filled and other types of distribution transformers  
 Porcelain and pottery  
 Public parking garages, open or enclosed  
 Stoves  
 Talc and soapstones  
 Washers and dryers

**[BG] Public parking garages.** Public parking garages shall comply with Section 406.4 of the *International Building Code* and the additional requirements of Section 406.5 of the *International Building Code* for open parking garages or Section 406.6 of the *International Building Code* for enclosed parking garages.

**[BG] Combustible storage.** High-piled stock or rack storage, or attic, under-floor and concealed spaces used for storage of combustible materials, shall be in accordance with Section 413 of the *International Building Code*.

**[BG] Accessory storage spaces.** A room or space used for storage purposes that is accessory to another occupancy shall be classified as part of that occupancy.

**[BG] Group U, Miscellaneous.** Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy. Group U shall include, but not be limited to, the following:

Agricultural buildings  
 Aircraft hangar, accessory to a one- or two-family residence (see Section 412.4 of the *International Building Code*)  
 Barns  
 Carports  
 Communication equipment structures with a gross floor area of less than 1,500 square feet (139 m<sup>2</sup>)  
 Fences more than 7 feet (2134 mm) in height  
 Grain silos, accessory to a residential occupancy  
 Livestock shelters

Private garages  
 Retaining walls  
 Sheds  
 Stables  
 Tanks  
 Towers

**[BG] Private garages and carports.** Private garages and carports shall comply with Section 406.3 of the *International Building Code*.

**[BG] Residential aircraft hangars.** Aircraft hangars accessory to a one- or two-family residence shall comply with Section 412.4 of the *International Building Code*.

**[BG] Greenhouses.** Greenhouses not classified as another occupancy shall be classified as Use Group U.

**[BG] OCCUPANT LOAD.** The number of persons for which the *means of egress* of a building or portion thereof is designed.

**OPEN BURNING.** The burning of materials wherein products of combustion are emitted directly into the ambient air without passing through a stack or chimney from an enclosed chamber. Open burning does not include road flares, smudge-pots and similar devices associated with safety or occupational uses typically considered open flames, *recreational fires* or use of portable outdoor fireplaces. For the purpose of this definition, a chamber shall be regarded as enclosed when, during the time combustion occurs, only apertures, ducts, stacks, flues or chimneys necessary to provide combustion air and permit the escape of exhaust gas are open.

**OPEN MALL.** See “*Covered mall building*.”

**OPEN MALL BUILDING.** See “*Covered mall building*.”

**[BG] OPEN PARKING GARAGE.** A structure or portion of a structure with the openings as described in Section 406.5.2 of the *International Building Code* on two or more sides that is used for the parking or storage of private motor vehicles as described in Section 406.5 of the *International Building Code*.

**OPEN SYSTEM.** The use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.

**OPEN-AIR ASSEMBLY SEATING.** Seating served by *means of egress* that is not subject to smoke accumulation within or under a structure and is open to the atmosphere.

**[BE] OPEN-ENDED CORRIDOR.** An interior *corridor* that is open on each end and connects to an exterior *stairway* or *ramp* at each end with no intervening doors or separation from the *corridor*.

**[BF] OPENING PROTECTIVE.** A fire door assembly, fire shutter assembly, fire window assembly or glass-block assembly in a fire-resistance-rated wall or partition.

**OPERATING BUILDING.** A building occupied in conjunction with the manufacture, transportation or use of explosive materials. Operating buildings are separated from one another with the use of intraplant or intraline distances.

**OPERATING LINE.** A group of buildings, facilities or workstations so arranged as to permit performance of the steps in the manufacture of an explosive or in the loading, assembly, modification and maintenance of ammunition or devices containing explosive materials.

**OPERATING PRESSURE.** The pressure at which a system operates.

**ORGANIC COATING.** A liquid mixture of binders such as alkyd, nitrocellulose, acrylic or oil, and flammable and combustible solvents such as hydrocarbon, ester, ketone or alcohol, which, when spread in a thin film, convert to a durable protective and decorative finish.

**ORGANIC PEROXIDE.** An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can present an explosion hazard (*detonation* or *deflagration*) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

**Class I.** Describes those formulations that are capable of *deflagration* but not *detonation*.

**Class II.** Describes those formulations that burn very rapidly and that pose a moderate reactivity hazard.

**Class III.** Describes those formulations that burn rapidly and that pose a moderate reactivity hazard.

**Class IV.** Describes those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.

**Class V.** Describes those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.

**Unclassified detonable.** Organic peroxides that are capable of *detonation*. These peroxides pose an extremely high-explosion hazard through rapid explosive decomposition.

**OUTDOOR ASSEMBLY EVENT.** An outdoor gathering of persons for any purpose.

**OUTDOOR CONTROL AREA.** An outdoor area that contains hazardous materials in amounts not exceeding the maximum allowable quantities of Table 5003.1.1(3) or Table 5003.1.1(4).

**OUTPATIENT CLINIC.** See “Clinic, outpatient.”

**OVERCROWDING.** A condition that exists when either there are more people in a building, structure or portion thereof than have been authorized or posted by the fire code official, or when the fire code official determines that a threat exists to the safety of the occupants due to persons sitting

and/or standing in locations that may obstruct or impede the use of aisles, passages, corridors, stairways, exits or other components of the means of egress.

**[A] OWNER.** Any person, agent, operator, entity, firm or corporation having any legal or equitable interest in the property; or recorded in the official records of the state, county or municipality as holding an interest or title to the property; or otherwise having possession or control of the property, including the guardian of the estate of any such person, and the executor or administrator of the estate of such person if ordered to take possession of real property by a court.

**OXIDIZER.** A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials and, if heated or contaminated, can result in vigorous self-sustained decomposition.

**Class 4.** An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning rate of combustible materials with which it comes into contact. Additionally, the oxidizer causes a severe increase in the burning rate and can cause spontaneous ignition of combustibles.

**Class 3.** An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes in contact.

**Class 2.** An oxidizer that will cause a moderate increase in the burning rate of combustible materials with which it comes in contact.

**Class 1.** An oxidizer that does not moderately increase the burning rate of combustible materials.

**OXIDIZING CRYOGENIC FLUID.** An oxidizing gas in the cryogenic state.

**OXIDIZING GAS.** A gas that can support and accelerate combustion of other materials more than air does.

**OZONE-GAS GENERATOR.** Equipment which causes the production of ozone.

**[BE] PANIC HARDWARE.** A door-latching assembly incorporating a device that releases the latch upon the application of a force in the direction of egress travel. See also “Fire exit hardware.”

**PASSIVE RF EMITTING DEVICE.** A device that does not require an external AC or DC source of power for its operation, and does not provide amplification of the RF signal, including but not limited to coax, couplers, splitters and passive antennas.

**PASS-THROUGH.** An enclosure installed in a wall with a door on each side that allows chemicals, HPM, equipment, and parts to be transferred from one side of the wall to the other.

**[BG] PENTHOUSE.** An enclosed, unoccupied rooftop structure used for sheltering mechanical and electrical equipment, tanks, elevators and related machinery, and vertical shaft openings.



## DEFINITIONS

**PERMISSIBLE EXPOSURE LIMIT (PEL).** The maximum permitted 8-hour time-weighted-average concentration of an airborne contaminant. The exposure limits to be utilized are those published in DOL 29 CFR Part 1910.1000. The Recommended Exposure Limit (REL) concentrations published by the US National Institute for Occupational Safety and Health (NIOSH), Threshold Limit Value-Time Weighted Average (TLV-TWA) concentrations published by the American Conference of Governmental Industrial Hygienists (ACGIH), Workplace Environmental Exposure Level (WEEL) Guides published by the American Industrial Hygiene Association (AIHA), and other *approved*, consistent measures are allowed as surrogates for hazardous substances not listed in DOL 29 CFR Part 1910.1000.

**[A] PERMIT.** An official document or certificate issued by the *fire code official* that authorizes performance of a specified activity.

**[A] PERSON.** An individual, heirs, executors, administrators or assigns, and also includes a firm, partnership or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

**[BG] PERSONAL CARE SERVICE.** The care of persons who do not require medical care. Personal care involves responsibility for the safety of the persons while inside the building.

**PESTICIDE.** A substance or mixture of substances, including fungicides, intended for preventing, destroying, repelling or mitigating pests and substances or a mixture of substances intended for use as a plant regulator, defoliant or desiccant. Products defined as drugs in the Federal Food, Drug and Cosmetic Act are not pesticides.

**[BE] PHOTOLUMINESCENT.** Having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed.

**PHYSICAL HAZARD.** A chemical for which there is evidence that it is a *combustible liquid*, *cryogenic fluid*, *explosive*, flammable (solid, liquid or gas), organic peroxide (solid or liquid), oxidizer (solid or liquid), oxidizing gas, pyrophoric (solid, liquid or gas), unstable (reactive) material (solid, liquid or gas) or water-reactive material (solid or liquid).

**PHYSIOLOGICAL WARNING THRESHOLD.** A concentration of airborne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter (mg/m<sup>3</sup>), that represents the concentration at which persons can sense the presence of the contaminant due to odor, irritation or other quick-acting physiological responses. When used in conjunction with the permissible exposure limit (PEL), the physiological warning threshold levels are those consistent with the classification system used to establish the PEL. See the definition of “*Permissible exposure limit (PEL)*.”

**PIER.** A structure built over the water, supported by pillars or piles, and used as a landing place, pleasure pavilion or similar purpose.

**PLACE OF RELIGIOUS WORSHIP.** See “*Religious worship, place of*.”

**[M] PLENUM.** An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement and thereby serve as part of an air distribution system.

**PLOSOPHORIC MATERIAL.** Two or more unmixed, commercially manufactured, prepackaged chemical substances including oxidizers, *flammable liquids* or solids, or similar substances that are not independently classified as *explosives* but which, when mixed or combined, form an *explosive* that is intended for blasting.

**PLYWOOD AND VENEER MILLS.** Facilities where raw wood products are processed into finished wood products, including waferboard, oriented strandboard, fiberboard, composite wood panels and plywood.

**PORTABLE GENERATOR.** A mobile internal combustion engine-driven device that provides temporary electrical power. This includes hand portable, wheeled, trailer mounted, and motor vehicle-mounted generator sets. It does not include generators in permanent, fixed installations.

**PORTABLE OUTDOOR FIREPLACE.** A portable, outdoor, solid-fuel-burning fireplace that may be constructed of steel, concrete, clay or other noncombustible material. A portable outdoor fireplace may be open in design, or may be equipped with a small hearth opening and a short chimney or chimney opening in the top.

**[BE] POWER-ASSISTED DOOR.** Swinging door that opens by reduced pushing or pulling force on the door-operating hardware. The door closes automatically after the pushing or pulling force is released, and functions with decreased forces. See also “*Low energy power-operated door*” and “*Power-operated door*.”

**POWERED INDUSTRIAL TRUCK.** A forklift, tractor, platform lift truck or motorized hand truck powered by an electrical motor or internal combustion engine. Powered industrial trucks do not include farm vehicles or automotive vehicles for highway use.

**[BE] POWER-OPERATED DOOR.** Swinging, sliding, or folding door that opens automatically when approached by a pedestrian or opens automatically upon an action by a pedestrian. The door closes automatically and includes provisions such as presence sensors to prevent entrapment. See also “*Low energy power-operated door*” and “*Power-assisted door*.”

**PRESSURE VESSEL.** A closed vessel designed to operate at pressures above 15 psig (103 kPa).

**PRIMARY CONTAINMENT.** The first level of containment, consisting of the inside portion of that container which comes into immediate contact on its inner surface with the material being contained.

**[BG] PRIVATE GARAGE.** A building or portion of a building in which motor vehicles used by the *owner* or tenants of the building or buildings on the premises are stored or kept, without provisions for repairing or servicing such vehicles for profit.

**PROCESS TRANSFER.** The transfer of *flammable* or *combustible liquids* between tank vehicles or tank cars and process operations. Process operations may include containers, tanks, piping and equipment.

**PROPELLANT.** The liquefied or *compressed gas* in an aerosol container that expels the contents from an aerosol container when the valve is actuated. A propellant is considered flammable if it forms a flammable mixture with air, or if a flame is self-propagating in a mixture with air.

**PROXIMATE AUDIENCE.** An audience closer to pyrotechnic devices than allowed by NFPA 1123.

**[B] PSYCHIATRIC HOSPITALS.** See “*Hospitals and psychiatric hospitals.*”

**PUBLIC TRAFFIC ROUTE (PTR).** Any public street, road, highway, navigable stream or passenger railroad that is used for through traffic by the general public.

**[A] PUBLIC WAY.** A street, alley or other parcel of land open to the outside air leading to a street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet (3048 mm).

**[BE] PUBLIC-USE AREAS.** Interior or exterior rooms or spaces that are made available to the general public.

**PYROPHORIC.** A chemical with an autoignition temperature in air, at or below a temperature of 130°F (54°C).

**PYROTECHNIC ARTICLE.** A pyrotechnic device for use in the entertainment industry, which is not classified as fireworks.

**PYROTECHNIC COMPOSITION.** A chemical mixture that produces visible light displays or sounds through a self-propagating, heat-releasing chemical reaction which is initiated by ignition.

**PYROTECHNIC SPECIAL EFFECT.** A visible or audible effect for entertainment created through the use of pyrotechnic materials and devices.

**PYROTECHNIC SPECIAL-EFFECT MATERIAL.** A chemical mixture used in the entertainment industry to produce visible or audible effects by combustion, *deflagration* or *detonation*. Such a chemical mixture predominantly consists of solids capable of producing a controlled, self-sustaining and self-contained exothermic chemical reaction that results in heat, gas sound, light or a combination of these effects. The chemical reaction functions without external oxygen.

**PYROTECHNICS.** Controlled exothermic chemical reactions timed to create the effects of heat, hot gas, sound, dispersion of aerosols, emission of visible light or a combination of such effects to achieve the maximum effect from the least volume of pyrotechnic composition.

**QUANTITY-DISTANCE (Q-D).** The quantity of *explosive material* and separation distance relationships providing protection. These relationships are based on levels of risk considered acceptable for the stipulated exposures and are tabulated in the appropriate Q-D tables. The separation distances specified afford less than absolute safety:

**Inhabited building distance (IBD).** The minimum separation distance between an operating building or magazine containing *explosive materials* and an inhabited building or site boundary.

**Intermagazine distance (IMD).** The minimum separation distance between magazines.

**Intraline distance (ILD) or Intraplant distance (IPD).** The distance to be maintained between any two operating buildings on an *explosives* manufacturing site when at least one contains or is designed to contain *explosives*, or the distance between a magazine and an operating building.

**RADIO FREQUENCY (RF).** A measurement representing the oscillation rate of the electromagnetic radiation spectrum, or electromagnetic radio waves, from public safety frequency bands as specified by the *fire code official*.

**RAILWAY.** A steam, electric or other railroad or railway that carries passengers for hire.

**[BE] RAMP.** A walking surface that has a running slope steeper than 1 unit vertical in 20 units horizontal (5-percent slope).

**RAMP, EXIT ACCESS.** See “*Exit access ramp.*”

**RAMP, EXTERIOR EXIT.** See “*Exterior exit ramp.*”

**RAMP, INTERIOR EXIT.** See “*Interior exit ramp.*”

**RAW PRODUCT.** A mixture of natural materials such as tree, brush trimmings, or waste logs and stumps.

**[M] READY ACCESS (TO).** That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel or similar obstruction [see “*Access (to)*”].

**READY BOX.** A weather-resistant container with a self-closing or automatic-closing cover that protects fireworks shells from burning debris. Tarpaulins shall not be considered as ready boxes.

**[A] RECORD DRAWINGS.** Drawings (“as built”) that document the location of all devices, appliances, wiring, sequences, wiring methods and connections of the components of a fire alarm system as installed.

**RECREATIONAL FIRE.** An outdoor fire burning materials other than rubbish where the fuel being burned is not contained in an incinerator, outdoor fireplace, portable outdoor fireplace, barbecue grill or barbecue pit and has a total fuel area of 3 feet (914 mm) or less in diameter and 2 feet (610 mm) or less in height for pleasure, religious, ceremonial, cooking, warmth or similar purposes.

**REDUCED FLOW VALVE.** A valve equipped with a restricted flow orifice and inserted into a *compressed gas* cylinder, portable tank or stationary tank that is designed to reduce the maximum flow from the valve under full-flow

## DEFINITIONS

conditions. The maximum flow rate from the valve is determined with the valve allowed to flow to atmosphere with no other piping or fittings attached.

**REFINERY.** A plant in which *flammable* or *combustible liquids* are produced on a commercial scale from crude petroleum, natural gasoline or other hydrocarbon sources.

**REFRIGERANT.** The fluid used for heat transfer in a refrigeration system; the refrigerant absorbs heat and transfers it at a higher temperature and a higher pressure, usually with a change of state.

**[M] REFRIGERATING (REFRIGERATION) SYSTEM.** A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

**[A] REGISTERED DESIGN PROFESSIONAL.** An architect or engineer, registered or licensed to practice professional architecture or engineering, as defined by the statutory requirements of the professional registration laws of the state in which the project is to be constructed.

**[BG] RELIGIOUS WORSHIP, PLACE OF.** A building or portion thereof intended for the performance of religious services.

**RELOCATABLE POWER TAP.** A relocatable electrical enclosure that provides one or more receptacle outlets and that is provided with an attached power supply cord and attachment plug for connection to a permanently installed receptacle outlet (also called a “multiplug adaptor”).

**REMOTE EMERGENCY SHUTOFF DEVICE.** The combination of an operator-carried signaling device and a mechanism on the tank vehicle. Activation of the remote emergency shutoff device sends a signal to the tanker-mounted mechanism and causes fuel flow to cease.

**REMOTE SOLVENT RESERVOIR.** A liquid solvent container enclosed against evaporative losses to the atmosphere during periods when the container is not being utilized, except for a solvent return opening not larger than 16 square inches (10 322 mm<sup>2</sup>). Such return allows pump-cycled used solvent to drain back into the reservoir from a separate solvent sink or work area.

**REMOTELY LOCATED, MANUALLY ACTIVATED SHUTDOWN CONTROL.** A control system that is designed to initiate shutdown of the flow of gases or liquids that is manually activated from a point located some distance from the delivery system.

**REPAIR GARAGE.** A building, structure or portion thereof used for servicing or repairing motor vehicles.

**RESIN APPLICATION AREA.** An area where reinforced plastics are used to manufacture products by hand lay-up or spray-fabrication methods.

**RESPONSIBLE PERSON.** A person trained in the safety and fire safety considerations concerned with hot work. Responsible for reviewing the sites prior to issuing permits as part of the hot work permit program and following up as the job progresses.

**RETAIL DISPLAY AREA.** The area of a Group M occupancy open for the purpose of viewing or purchasing merchandise offered for sale. Individuals in such establishments are free to circulate among the items offered for sale which are typically displayed on shelves, racks or the floor.

**ROLL COATING.** The process of coating, spreading and impregnating fabrics, paper or other materials as they are passed directly through a tank or trough containing *flammable* or *combustible liquids*, or over the surface of a roller revolving partially submerged in a *flammable* or *combustible liquid*.

**RUBBISH (TRASH).** Combustible and noncombustible waste materials, including residue from the burning of coal, wood, coke or other combustible material, paper, rags, cartons, tin cans, metals, mineral matter, glass crockery, dust and discarded refrigerators, and heating, cooking or incinerator-type appliances.

**SAFETY CAN.** An *approved* container of not more than 5-gallon (19 L) capacity having a spring-closing lid and spout cover so designed that it will relieve internal pressure when subjected to fire exposure.

**SAFETY DATA SHEET (SDS).** Information concerning a hazardous material which is prepared in accordance with the provisions of DOL 29 CFR Part 1910.1200 or in accordance with the provisions of a federally *approved* state OSHA plan. A document titled as a Material Safety Data Sheet (MSDS) is equivalent to an SDS for the purposes of this code.

**[BE] SCISSOR STAIRWAY.** Two interlocking *stairways* providing two separate paths of egress located within one *exit* enclosure.

**SECONDARY CONTAINMENT.** That level of containment that is external to and separate from primary containment.

**SEED COTTON.** See “*Cotton*.”

**SEGREGATED.** Storage in the same room or inside area, but physically separated by distance from *incompatible materials*.

**[BF] SELF-CLOSING.** As applied to a fire door or other opening, means equipped with an *approved* device that will ensure closing after having been opened.

**[BE] SELF-LUMINOUS.** Illuminated by a self-contained power source, other than batteries, and operated independently of external power sources.

**SELF-PRESERVATION, INCAPABLE OF.** See “*Incapable of self-preservation*.”

**SELF-SERVICE MOTOR FUEL-DISPENSING FACILITY.** That portion of motor fuel-dispensing facility where liquid motor fuels are dispensed from fixed *approved* dispensing equipment into the fuel tanks of motor vehicles by persons other than a motor fuel-dispensing facility attendant.

**SEMICONDUCTOR FABRICATION FACILITY.** A building or a portion of a building in which electrical circuits or devices are created on solid crystalline substances having



electrical conductivity greater than insulators but less than conductors. These circuits or devices are commonly known as semiconductors.

**SERVICE CORRIDOR.** A fully enclosed passage used for transporting HPM and purposes other than required *means of egress*.

**SHELF STORAGE.** Storage on shelves less than 30 inches (762 mm) deep with the distance between shelves not exceeding 3 feet (914 mm) vertically. For other shelving arrangements, see the requirements for rack storage.

**SINGLE-STATION SMOKE ALARM.** An assembly incorporating the detector, the control equipment and the alarm-sounding device in one unit, operated from a power supply either in the unit or obtained at the point of installation.

**[BG] SITE.** A parcel of land bounded by a *lot line* or a designated portion of a public right-of-way.

**SITE SAFETY PLAN.** A plan developed to establish a fire prevention program at a construction site.

**[BG] SITE-FABRICATED STRETCH SYSTEM.** A system, fabricated on site and intended for acoustical, tackable or aesthetic purposes, that is composed of three elements:

1. A frame constructed of plastic, wood, metal or other material used to hold fabric in place.
2. A core material (infill, with the correct properties for the application).
3. An outside layer, comprised of a textile, fabric or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame.

**SKY LANTERN.** An unmanned device with a fuel source that incorporates an open flame in order to make the device airborne.

**[BG] SLEEPING UNIT.** A single unit providing rooms or spaces for one or more persons that includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not *sleeping units*.

**SMALL ARMS AMMUNITION.** A shotgun, rifle or pistol cartridge and any cartridge for propellant-actuated devices. This definition does not include military ammunition containing bursting charges or incendiary, trace, spotting or pyrotechnic projectiles.

**SMALL ARMS PRIMERS.** Small percussion-sensitive *explosive* charges, encased in a cap, used to ignite propellant powder.

**SMOKE ALARM.** A single- or multiple-station alarm responsive to smoke. See also “*Single-station smoke alarm*” and “*Multiple-station smoke alarm*.”

**[BF] SMOKE BARRIER.** A continuous membrane, either vertical or horizontal, such as a wall, floor, or ceiling assembly, that is designed and constructed to restrict the movement of smoke.

**[BG] SMOKE COMPARTMENT.** A space within a building enclosed by *smoke barriers* on all sides, including the top and bottom.

**[BF] SMOKE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to resist the passage of smoke. The device is installed to operate automatically, controlled by a smoke detection system, and where required, is capable of being positioned from a *fire command center*.

**SMOKE DETECTOR.** A *listed* device that senses visible or invisible particles of combustion.

**SMOKE PARTITION.** A wall assembly that extends from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.

**[BG] SMOKE-DEVELOPED INDEX.** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E84.

**SMOKELESS PROPELLANTS.** Solid propellants, commonly referred to as smokeless powders, used in small arms ammunition, cannons, rockets, propellant-actuated devices and similar articles.

**[BF] SMOKEPROOF ENCLOSURE.** An *interior exit stairway* designed and constructed so that the movement of the products of combustion produced by a fire occurring in any part of the building into the enclosure is limited.

**[BE] SMOKE-PROTECTED ASSEMBLY SEATING.** Seating served by means of egress that is not subject to smoke accumulation within or under a structure for a specified design time by means of passive design or by mechanical ventilation.

**SOLID.** A material that has a melting point and decomposes or sublimates at a temperature greater than 68°F (20°C).

**SOLID BIOFUEL.** Densified biomass made in the form of cubiform, polyhedral, polyhydric or cylindrical units, produced by compressing milled biomass.

**SOLID BIOMASS FEEDSTOCK.** The basic materials of which solid biofuel is composed, manufactured or made.

**SOLID SHELVING.** Shelving that is solid, slatted or of other construction located in racks and which obstructs sprinkler discharge down into the racks.

**SOLVENT DISTILLATION UNIT.** An appliance that receives contaminated *flammable* or *combustible liquids* and which distills the contents to remove contaminants and recover the solvents.

**SOLVENT OR LIQUID CLASSIFICATIONS.** A method for classifying solvents or liquids according to the following classes:

**Class I solvents.** Liquids having a *flash point* below 100°F (38°C).

**Class II solvents.** Liquids having a *flash point* at or above 100°F (38°C) and below 140°F (60°C).



## DEFINITIONS

**Class IIIA solvents.** Liquids having a *flash point* at or above 140°F (60°C) and below 200°F (93°C).

**Class IIIB solvents.** Liquids having a *flash point* at or above 200°F (93°C).

**Class IV solvents.** Liquids classified as nonflammable.

**SPECIAL AMUSEMENT BUILDING.** A building that is temporary, permanent or mobile that contains a device or system that conveys passengers or provides a walkway along, around or over a course in any direction as a form of amusement arranged so that the egress path is not readily apparent due to visual or audio distractions or an intentionally confounded egress path, or is not readily available because of the mode of conveyance through the building or structure.

**[A] SPECIAL EXPERT.** An individual who has demonstrated qualifications in a specific area, outside the practice of architecture or engineering, through education, training and experience.

**SPECIAL INDUSTRIAL EXPLOSIVE DEVICE.** An *explosive* power pack containing an *explosive* charge in the form of a cartridge or construction device. The term includes but is not limited to *explosive* rivets, *explosive* bolts, *explosive* charges for driving pins or studs, cartridges for *explosive*-actuated power tools and charges of *explosives* used in automotive air bag inflators, jet tapping of open hearth furnaces and jet perforation of oil well casings.

**SPRAY BOOTH.** A mechanically ventilated appliance of varying dimensions and construction provided to enclose or accommodate a spraying operation and to confine and limit the escape of spray vapor and residue and to exhaust it safely.

**SPRAY ROOM.** A room designed to accommodate spraying operations, constructed in accordance with the *International Building Code*.

**SPRAYING SPACE.** An area in which dangerous quantities of flammable vapors or combustible residues, dusts or deposits are present due to the operation of spraying processes. The *fire code official* is authorized to define the limits of the spraying space in any specific case.

**[BE] STAIR.** A change in elevation, consisting of one or more risers.

**[BE] STAIRWAY.** One or more *flights* of *stairs*, either exterior or interior, with the necessary landings and platforms connecting them, to form a continuous and uninterrupted passage from one level to another.

**STAIRWAY, EXIT ACCESS.** See “*Exit access stairway*.”

**STAIRWAY, EXTERIOR EXIT.** See “*Exterior exit stairway*.”

**STAIRWAY, INTERIOR EXIT.** See “*Interior exit stairway*.”

**STAIRWAY, SCISSOR.** See “*Scissor stairway*.”

**[BE] STAIRWAY, SPIRAL.** A *stairway* having a closed circular form in its plan view with uniform section-shaped treads attached to and radiating from a minimum-diameter supporting column.

**STANDBY POWER SYSTEM.** A source of automatic electric power of a required capacity and duration to operate required building, hazardous materials or ventilation systems in the event of a failure of the primary power. Standby power systems are required for electrical loads where interruption of the primary power could create hazards or hamper rescue or fire-fighting operations.

**STANDPIPE, TYPES OF.** Standpipe types are as follows:

**Automatic dry.** A dry standpipe system, normally filled with pressurized air, that is arranged through the use of a device, such as a dry pipe valve, to admit water into the system piping automatically upon the opening of a hose valve. The water supply for an automatic dry standpipe system shall be capable of supplying the system demand.

**Automatic wet.** A wet standpipe system that has a water supply that is capable of supplying the system demand automatically.

**Manual dry.** A dry standpipe system that does not have a permanent water supply attached to the system. Manual dry standpipe systems require water from a fire department pumper to be pumped into the system through the fire department connection in order to supply the system demand.

**Manual wet.** A wet standpipe system connected to a water supply for the purpose of maintaining water within the system but which does not have a water supply capable of delivering the system demand attached to the system. Manual wet standpipe systems require water from a fire department pumper (or the like) to be pumped into the system in order to supply the system demand.

**Semiautomatic dry.** A dry standpipe system that is arranged through the use of a device, such as a deluge valve, to admit water into the system piping upon activation of a remote control device located at a hose connection. A remote control activation device shall be provided at each hose connection. The water supply for a semiautomatic dry standpipe system shall be capable of supplying the system demand.

**STANDPIPE SYSTEM, CLASSES OF.** Standpipe system classes are as follows:

**Class I system.** A system providing 2½-inch (64 mm) hose connections to supply water for use by fire departments and those trained in handling heavy fire streams.

**Class II system.** A system providing 1½-inch (38 mm) hose stations to supply water for use primarily by the building occupants or by the fire department during initial response.

**Class III system.** A system providing 1½-inch (38 mm) hose stations to supply water for use by building occupants and 2½-inch (64 mm) hose connections to supply a larger volume of water for use by fire departments and those trained in handling heavy fire streams.

**STATIC PILES.** Piles in which processed wood product or solid biomass feedstock is mounded and is not being turned or moved.

**STEEL.** Hot- or cold-rolled as defined by the *International Building Code*.

**STORAGE, HAZARDOUS MATERIALS.** The keeping, retention or leaving of hazardous materials in closed containers, tanks, cylinders, or similar vessels; or vessels supplying operations through closed connections to the vessel.

**[BG] STORY.** That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above (see “*Basement*,” “*Building height*,” “*Grade plane*” and “*Mezzanine*”). A story is measured as the vertical distance from top to top of two successive tiers of beams or finished floor surfaces and, for the topmost story, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

**[BG] STORY ABOVE GRADE PLANE.** Any story having its finished floor surface entirely above *grade plane*, or in which the finished surface of the floor next above is:

1. More than 6 feet (1829 mm) above *grade plane*; or
2. More than 12 feet (3658 mm) above the finished ground level at any point.

**SUBORDINATE (FIRE PROTECTION AND LIFE SAFETY SYSTEM).** A system that is activated by another fire protection or life safety system. For example, where a fire alarm system activates a smoke removal or elevator recall system, the smoke removal or elevator recall system is considered to be “subordinate” to the fire alarm system.

**SUPERVISING STATION.** A facility that receives signals and at which personnel are in attendance at all times to respond to these signals.

**SUPERVISORY SERVICE.** The service required to monitor performance of guard tours and the operative condition of fire protection systems or other systems for the protection of life and property.

**SUPERVISORY SIGNAL.** A signal indicating the need of action in connection with the supervision of guard tours, the fire protection systems or equipment, or the maintenance features of related systems.

**SUPERVISORY SIGNAL-INITIATING DEVICE.** An initiating device such as a valve supervisory switch, water level indicator, or low-air pressure switch on a dry-pipe sprinkler system whose change of state signals an off-normal condition and its restoration to normal of a *fire protection* or life safety system; or a need for action in connection with guard tours, fire protection systems or equipment, or maintenance features of related systems.

**SYSTEM.** An assembly of equipment consisting of a tank, container or containers, appurtenances, pumps, compressors and connecting piping.

**TANK.** A vessel containing more than 60 gallons (227 L).

**TANK, ATMOSPHERIC.** A storage tank designed to operate at pressures from atmospheric through 1.0 pound per square inch gauge (760 mm Hg through 812 mm Hg) measured at the top of the tank.

**TANK, MOTOR VEHICLE FUEL.** A tank permanently mounted on a motor vehicle to store a gas or liquid fuel that is used for propulsion.

**TANK, PORTABLE.** A packaging of more than 60-gallon (227 L) capacity and designed primarily to be loaded into or on or temporarily attached to a transport vehicle or ship and equipped with skids, mountings or accessories to facilitate handling of the tank by mechanical means. It does not include any cylinder having less than a 1,000-pound (454 kg) water capacity, cargo tank, tank car tank or trailers carrying cylinders of more than 1,000-pound (454 kg) water capacity.

**TANK, PRIMARY.** A *listed* atmospheric tank used to store liquid. See “*Primary containment*.”

**TANK, PROTECTED ABOVE GROUND.** A tank *listed* in accordance with UL 2085 consisting of a primary tank provided with protection from physical damage and fire-resistive protection from a high-intensity liquid pool fire exposure. The tank may provide protection elements as a unit or may be an assembly of components, or a combination thereof.

**TANK, STATIONARY.** Packaging designed primarily for stationary installations not intended for loading, unloading or attachment to a transport vehicle as part of its normal operation in the process of use. It does not include cylinders having less than a 1,000-pound (454 kg) water capacity.

**TANK VEHICLE.** A vehicle other than a railroad tank car or boat, with a cargo tank mounted thereon or built as an integral part thereof, used for the transportation of *flammable* or *combustible liquids*, LP-gas or hazardous chemicals. Tank vehicles include self-propelled vehicles and full trailers and semitrailers, with or without motive power, and carrying part or all of the load.

**TEMPORARY SPECIAL EVENT STRUCTURE.** Any temporary ground-supported structure, platform, stage, stage scaffolding or rigging, canopy, tower supporting audio or visual effects equipment or similar structures not regulated within the scope of the *International Building Code*.

**TENT.** A structure, enclosure, umbrella structure or shelter, with or without sidewalls or drops, constructed of fabric or pliable material supported in any manner except by air or the contents it protects (see “*Umbrella structure*”).

**THEFT RESISTANT.** Construction designed to deter illegal entry into facilities for the storage of *explosive materials*.

**[BF] THROUGH-PENETRATION FIRESTOP SYSTEM.** An assemblage consisting of a *fire-resistance-rated* floor, floor-ceiling or wall assembly, one or more penetrating items passing through the breaches in both sides of the assembly and the materials or devices, or both, installed to resist the spread of fire through the assembly for a prescribed period of time.

**TIMBER AND LUMBER PRODUCTION FACILITIES.** Facilities where raw wood products are processed into finished wood products.

**TIRES, BULK STORAGE OF.** Storage of tires where the area available for storage exceeds 20,000 cubic feet (566 m<sup>3</sup>).

## DEFINITIONS

**TOOL.** A device, storage container, workstation or process machine used in a *fabrication area*.

**TORCH-APPLIED ROOF SYSTEM.** Bituminous roofing systems using membranes that are adhered by heating with a torch and melting asphalt back coating instead of mopping hot asphalt for adhesion.

**[A] TOWNHOUSE.** A single-family *dwelling unit* constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on not less than two sides.

**TOXIC.** A chemical falling within any of the following categories:

1. A chemical that has a median lethal dose ( $LD_{50}$ ) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose ( $LD_{50}$ ) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration ( $LC_{50}$ ) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

**TRAFFIC CALMING DEVICES.** Traffic calming devices are design elements of fire apparatus access roads such as street alignment, installation of barriers, and other physical measures intended to reduce traffic and cut-through volumes, and slow vehicle speeds.

**[BG] TRANSIENT.** Occupancy of a *dwelling unit* or *sleeping unit* for not more than 30 days.

**[BG] TRANSIENT AIRCRAFT.** Aircraft based at another location and that is at the transient location for not more than 90 days.

**TRANSVERSE FLUE SPACE.** See “*Flue spaces—Transverse*.”

**TRASH.** See “*Rubbish (trash)*.”

**TROUBLE SIGNAL.** A signal initiated by the fire alarm system or device indicative of a fault in a monitored circuit or component.

**TUBE TRAILER.** A semitrailer on which a number of tubular gas cylinders have been mounted. A manifold is typically provided that connects the cylinder valves enabling gas to be discharged from one or more tubes or cylinders through a piping and control system.

**TWENTY-FOUR-HOUR BASIS.** See “*24-hour basis*” before the “A” entries.

**UMBRELLA STRUCTURE.** A structure, enclosure or shelter with or without sidewalls or drops, constructed of fabric or pliable material supported by a central pole or poles (see “*Tent*”).

**UNAUTHORIZED DISCHARGE.** A release or emission of materials in a manner which does not conform to the provisions of this code or applicable public health and safety regulations.

**UNSTABLE (REACTIVE) MATERIAL.** A material, other than an *explosive*, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with *incompatible materials*. Unstable (reactive) materials are subdivided as follows:

**Class 4.** Materials that in themselves are readily capable of *detonation* or *explosive* decomposition or *explosive* reaction at *normal temperature and pressure*. This class includes materials that are sensitive to mechanical or localized thermal shock at *normal temperature and pressure*.

**Class 3.** Materials that in themselves are capable of *detonation* or of *explosive* decomposition or *explosive* reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**Class 2.** Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at *normal temperature and pressure*, and that can undergo violent chemical change at elevated temperature and pressure.

**Class 1.** Materials that in themselves are normally stable but which can become unstable at elevated temperature and pressure.

**UNWANTED FIRE.** A fire not used for cooking, heating or recreational purposes or one not incidental to the normal operations of the property.

**USE (MATERIAL).** Placing a material into action, including solids, liquids and gases.

**VAPOR PRESSURE.** The pressure exerted by a volatile fluid as determined in accordance with ASTM D323.

**[M] VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

**VESSEL.** A motorized watercraft, other than a seaplane on the water, used or capable of being used as a means of transportation. Nontransportation vessels, such as houseboats and boathouses, are included in this definition.

## DEFINITIONS

**VISIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of sight.

**WATER MIST SYSTEM, AUTOMATIC.** See “*Automatic water mist system.*”

**WATER-REACTIVE MATERIAL.** A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause auto-ignition or ignition of combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

**Class 3.** Materials that react explosively with water without requiring heat or confinement.

**Class 2.** Materials that react violently with water or have the ability to boil water. Materials that produce flammable, toxic or other hazardous gases, or evolve enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture.

**Class 1.** Materials that react with water with some release of energy, but not violently.

**WET FUELING.** See “*Mobile fueling.*”

**WET HOSING.** See “*Mobile fueling.*”

**WET-CHEMICAL EXTINGUISHING AGENT.** A solution of water and potassium-carbonate-based chemical, potassium-acetate-based chemical or a combination thereof, forming an extinguishing agent.

**WHARF.** A structure or bulkhead constructed of wood, stone, concrete or similar material built at the shore of a harbor, lake or river for vessels to lie alongside of, and to anchor piers or floats.

**WILDFIRE RISK AREA.** Land that is covered with grass, grain, brush or forest, whether privately or publicly owned, which is so situated or is of such inaccessible location that a fire originating upon it would present an abnormally difficult job of suppression or would result in great or unusual damage through fire or such areas designated by the *fire code official*.

**[BE] WINDER.** A tread with nonparallel edges.

**WIRELESS PROTECTION SYSTEM.** A system or a part of a system that can transmit and receive signals without the aid of wire.

**WORKSTATION.** A defined space or an independent principal piece of equipment using HPM within a *fabrication area* where a specific function, laboratory procedure or research activity occurs. *Approved* or *listed* hazardous materials storage cabinets, *flammable liquid* storage cabinets or gas cabinets serving a workstation are included as part of the workstation. A workstation is allowed to contain ventilation equipment, fire protection devices, detection devices, electrical devices and other processing and scientific equipment.

**[BG] YARD.** An open space, other than a *court*, unobstructed from the ground to the sky, except where specifically provided by the *International Building Code*, on the lot on which a building is situated.

**ZONE.** A defined area within the protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent or an area in which a form of control can be executed.

**ZONE, NOTIFICATION.** An area within a building or facility covered by notification appliances which are activated simultaneously.





# Part II—General Safety Provisions

## CHAPTER 3 GENERAL REQUIREMENTS

### User note:

**About this chapter:** Chapter 3 provides general requirements for asphalt kettles, combustible waste material, ignition sources, motion picture projection rooms and film, open burning, recreational fires, portable outdoor fireplaces, open flames, powered industrial trucks and equipment, smoking, vacant premises, vehicle impact protection, fueled equipment, indoor displays, general storage, outdoor pallet storage, hazards to fire fighters, landscaped roofs, laundry carts, mobile food preparation vehicles, additive manufacturing (3D printing) and artificial combustible vegetation. These are intended to improve premises safety for everyone, including construction workers, tenants, operations and maintenance personnel, and emergency response personnel.

### SECTION 301 GENERAL

**301.1 Scope.** The provisions of this chapter shall govern the occupancy and maintenance of all structures and premises for precautions against fire and the spread of fire and general requirements of fire safety.

**301.2 Permits.** Permits shall be required as set forth in Section 105.5 for the activities or uses regulated by Sections 306, 307, 308, 315 and 320.

### SECTION 302 DEFINITIONS

**302.1 Definitions.** The following terms are defined in Chapter 2:

**3D PRINTER.**

**ADDITIVE MANUFACTURING.**

**BONFIRE.**

**HI-BOY.**

**HIGH-VOLTAGE TRANSMISSION LINE.**

**OPEN BURNING.**

**PORTABLE OUTDOOR FIREPLACE.**

**POWERED INDUSTRIAL TRUCK.**

**RECREATIONAL FIRE.**

**SKY LANTERN.**

### SECTION 303 ASPHALT KETTLES

**303.1 Transporting.** Asphalt (tar) kettles shall not be transported over any highway, road or street when the heat source for the kettle is operating.

**Exception:** Asphalt (tar) kettles in the process of patching road surfaces.

**303.2 Location.** Asphalt (tar) kettles shall not be located within 20 feet (6096 mm) of any combustible material, combustible building surface or any building opening and within a controlled area identified by the use of traffic cones,

barriers or other *approved* means. Asphalt (tar) kettles and pots shall not be utilized inside or on the roof of a building or structure. Roofing kettles and operating asphalt (tar) kettles shall not block *means of egress*, gates, roadways or entrances.

**303.3 Location of fuel containers.** Fuel containers shall be located not less than 10 feet (3048 mm) from the burner.

**Exception:** Containers properly insulated from heat or flame are allowed to be within 2 feet (610 mm) of the burner.

**303.4 Attendant.** An operating kettle shall be attended by not less than one employee knowledgeable of the operations and hazards. The employee shall be within 100 feet (30 480 mm) of the kettle and have the kettle within sight. Ladders or similar obstacles shall not form a part of the route between the attendant and the kettle.

**303.5 Fire extinguishers.** There shall be a portable fire extinguisher complying with Section 906 and with a minimum 40-B:C rating within 25 feet (7620 mm) of each asphalt (tar) kettle during the period such kettle is being utilized. Additionally, there shall be one portable fire extinguisher with a minimum 3-A:40-B:C rating on the roof being covered.

**303.6 Lids.** Asphalt (tar) kettles shall be equipped with tight-fitting lids.

**303.7 Hi-boys.** Hi-boys shall be constructed of noncombustible materials. Hi-boys shall be limited to a capacity of 55 gallons (208 L). Fuel sources or heating elements shall not be allowed as part of a hi-boy.

**303.8 Roofing kettles.** Roofing kettles shall be constructed of noncombustible materials.

**303.9 Fuel containers under air pressure.** Fuel containers that operate under air pressure shall not exceed 20 gallons (76 L) in capacity and shall be *approved*.

**303.10 Scan roof for hot spots.** At the end of day or work period, the roof work shall be scanned (checked) with a heat source meter or electronic scanner to determine any hot spots on wood curbs, cants or roof projections on the completed roof which could smolder or combust after workers leave the job. An acceptable alternative to scanning the roof is to monitor the roof for a minimum of 3 hours before workers leave the job site.



## GENERAL REQUIREMENTS

## SECTION 304 COMBUSTIBLE WASTE MATERIAL

**304.1 Waste accumulation prohibited.** Combustible waste material creating a fire hazard shall not be allowed to accumulate in buildings or structures or upon premises.

**304.1.1 Waste material.** Accumulations of wastepaper, wood, hay, straw, weeds, litter or combustible or flammable waste or rubbish of any type shall not be permitted to remain on a roof or in any *court*, yard, vacant lot, alley, parking lot, open space, or beneath a grandstand, *bleacher*, pier, wharf, manufactured home, recreational vehicle or other similar structure.

**304.1.2 Vegetation.** Weeds, grass, vines or other growth that is capable of being ignited and endangering property, shall be cut down and removed by the *owner* or occupant of the premises. Vegetation clearance requirements in wildland-urban interface areas shall be in accordance with the *International Wildland-Urban Interface Code*.

**304.1.3 Space underneath seats.** Spaces underneath grandstand and bleacher seats shall be kept free from combustible and flammable materials. Except where enclosed in not less than 1-hour *fire-resistance-rated* construction in accordance with the *International Building Code*.

**304.1.3.1 Spaces underneath grandstands and bleachers.** Spaces underneath grandstands and bleachers shall not be occupied or utilized for purposes other than *means of egress* except where equipped with an *automatic sprinkler system* in accordance with Section 903.2.1.5.1, or separated with fire barriers and *horizontal assemblies* in accordance with Section 1030.1.1.1.

**304.2 Storage.** Storage of combustible rubbish shall not produce conditions that will create a nuisance or a hazard to the public health, safety or welfare.

**304.3 Containers.** Combustible rubbish and waste material kept within or near a structure shall be stored in accordance with Sections 304.3.1 through 304.3.4.

**304.3.1 Spontaneous ignition.** Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a *listed* disposal container. Contents of such containers shall be removed and disposed of daily.

**304.3.2 Capacity exceeding 5.33 cubic feet.** Containers with a capacity exceeding 5.33 cubic feet (40 gallons) (0.15 m<sup>3</sup>) shall be provided with lids. Containers and lids shall be constructed of noncombustible materials or of combustible materials with a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

**Exception:** Wastebaskets complying with Section 808.

**304.3.3 Capacity exceeding 1.5 cubic yards.** Dumpsters and containers with an individual capacity of 1.5 cubic yards [40.5 cubic feet (1.15 m<sup>3</sup>)] or more shall not be stored

in buildings or placed within 5 feet (1524 mm) of combustible walls, openings or combustible roof eave lines.

### Exceptions:

1. Dumpsters or containers that are placed inside buildings in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
2. Storage in a structure shall not be prohibited where the structure is of Type I or IIA construction, located not less than 10 feet (3048 mm) from other buildings and used exclusively for dumpster or container storage.
3. Dumpsters or containers that are located adjacent to buildings where the exterior area is protected by an *approved automatic sprinkler system*.

**304.3.4 Capacity of 1 cubic yard or more.** Dumpsters with an individual capacity of 1.0 cubic yard [200 gallons (0.76 m<sup>3</sup>)] or more shall not be stored in buildings or placed within 5 feet (1524 mm) of combustible walls, openings or combustible roof eave lines unless the dumpsters are constructed of noncombustible materials or of combustible materials with a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

### Exceptions:

1. Dumpsters in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
2. Storage in a structure shall not be prohibited where the structure is of Type I or IIA construction, located not less than 10 feet (3048 mm) from other buildings and used exclusively for dumpster or container storage.

## SECTION 305 IGNITION SOURCES

**305.1 Clearance from ignition sources.** Clearance between ignition sources, such as luminaires, heaters, flame-producing devices and combustible materials, shall be maintained in an *approved* manner.

**305.2 Hot ashes and spontaneous ignition sources.** Hot ashes, cinders, smoldering coals or greasy or oily materials subject to spontaneous ignition shall not be deposited in a combustible receptacle, within 10 feet (3048 mm) of other combustible material including combustible walls and partitions or within 2 feet (610 mm) of openings to buildings.

**Exception:** The minimum required separation distance to other combustible materials shall be 2 feet (610 mm) where the material is deposited in a covered, noncombustible receptacle placed on a noncombustible floor, ground surface or stand.

## GENERAL REQUIREMENTS

**305.3 Open-flame warning devices.** Open-flame warning devices shall not be used along an excavation, road, or any place where the dislodgment of such device might permit the device to roll, fall or slide on to any area or land containing combustible material.

**305.4 Deliberate or negligent burning.** It shall be unlawful to deliberately or through negligence set fire to or cause the burning of combustible material in such a manner as to endanger the safety of persons or property.

**305.5 Unwanted fire ignitions.** Acts or processes that have caused repeated ignition of unwanted fires shall be modified to prevent future ignition.

### SECTION 306 MOTION PICTURE PROJECTION ROOMS AND FILM

**306.1 Motion picture projection rooms.** Electric arc, xenon or other light source projection equipment that develops hazardous gases, dust or radiation and the projection of ribbon-type cellulose nitrate film, regardless of the light source used in projection, shall be operated within a motion picture projection room complying with Section 409 of the *International Building Code*.

**306.2 Cellulose nitrate film storage.** Storage of cellulose nitrate film shall be in accordance with NFPA 40.

### SECTION 307 OPEN BURNING, RECREATIONAL FIRES AND PORTABLE OUTDOOR FIREPLACES

**307.1 General.** A person shall not kindle or maintain or authorize to be kindled or maintained any *open burning* unless conducted and *approved* in accordance with Sections 307.1.1 through 307.5.

**307.1.1 Prohibited open burning.** *Open burning* shall be prohibited when atmospheric conditions or local circumstances make such fires hazardous.

**Exception:** Prescribed burning for the purpose of reducing the impact of wildland fire when authorized by the *fire code official*.

**307.2 Permit required.** A permit shall be obtained from the *fire code official* in accordance with Section 105.5 prior to kindling a fire for recognized silvicultural or range or wildlife management practices, prevention or control of disease or pests, or a bonfire. Application for such approval shall only be presented by and permits issued to the *owner* of the land on which the fire is to be kindled.

**307.2.1 Authorization.** Where required by state or local law or regulations, *open burning* shall only be permitted with prior approval from the state or local air and water quality management authority, provided that all conditions specified in the authorization are followed.

**307.3 Extinguishment authority.** Where *open burning* creates or adds to a hazardous situation, or a required permit for *open burning* has not been obtained, the *fire code official* is authorized to order the extinguishment of the *open burning* operation.

**307.4 Location.** The location for *open burning* shall be not less than 50 feet (15 240 mm) from any structure, and provisions shall be made to prevent the fire from spreading to within 50 feet (15 240 mm) of any structure.

#### Exceptions:

1. Fires in *approved* containers that are not less than 15 feet (4572 mm) from a structure.
2. The minimum required distance from a structure shall be 25 feet (7620 mm) where the pile size is 3 feet (914 mm) or less in diameter and 2 feet (610 mm) or less in height.

**307.4.1 Bonfires.** A bonfire shall not be conducted within 50 feet (15 240 mm) of a structure or combustible material unless the fire is contained in a barbecue pit. Conditions that could cause a fire to spread within 50 feet (15 240 mm) of a structure shall be eliminated prior to ignition.

**307.4.2 Recreational fires.** *Recreational fires* shall not be conducted within 25 feet (7620 mm) of a structure or combustible material. Conditions that could cause a fire to spread within 25 feet (7620 mm) of a structure shall be eliminated prior to ignition.

**307.4.3 Portable outdoor fireplaces.** Portable outdoor fireplaces shall be used in accordance with the manufacturer's instructions and shall not be operated within 15 feet (3048 mm) of a structure or combustible material.

**Exception:** Portable outdoor fireplaces used at one- and two-family *dwellings*.

**307.4.4 Construction warming fires.** Unless prohibited by local or county ordinance or by local burn ban, warming fires shall be allowed when temperatures are below 32°F (0°C). Warming fires must be contained in a noncombustible container with a spark arrestor. Warming fires shall not be located within 25 feet (7620 mm) of any combustible structure or within 10 (3048 mm) feet of a roadway. Only vegetation and nontreated lumber will be allowed to be used for fuel.

**307.5 Attendance.** *Open burning*, bonfires, *recreational fires* and use of portable outdoor fireplaces shall be constantly attended until the fire is extinguished. Not fewer than one portable fire extinguisher complying with Section 906 with a minimum 4-A rating or other *approved* on-site fire-extinguishing equipment, such as dirt, sand, water barrel, garden hose or water truck, shall be available for immediate utilization.

### SECTION 308 OPEN FLAMES

**308.1 General.** Open flame, fire and burning on all premises shall be in accordance with Sections 308.1.1 through 308.4.1 and with other applicable sections of this code.

**308.1.1 Where prohibited.** A person shall not take or utilize an open flame or light in a structure, vessel, boat or other place where highly flammable, combustible or explosive material is utilized or stored. Lighting appliances shall be well-secured in a glass globe and wire mesh cage or a similar *approved* device.



## GENERAL REQUIREMENTS

**308.1.2 Throwing or placing sources of ignition.** A person shall not throw or place, or cause to be thrown or placed, a lighted match, cigar, cigarette, matches, or other flaming or glowing substance or object on any surface or article where it can cause an unwanted fire.

**308.1.3 Torches for removing paint.** A person utilizing a torch or other flame-producing device for removing paint from a structure shall provide not less than one portable fire extinguisher complying with Section 906 and with a minimum 4-A rating, two portable fire extinguishers, each with a minimum 2-A rating, or a water hose connected to the water supply on the premises where such burning is done. The person doing the burning shall remain on the premises 1 hour after the torch or flame-producing device is utilized.

**308.1.4 Open-flame cooking devices.** Charcoal burners and other open-flame cooking devices shall not be operated on combustible balconies or within 10 feet (3048 mm) of combustible construction.

### Exceptions:

1. One- and two-family *dwelling*s.
2. Where buildings, balconies and decks are protected by an *automatic sprinkler system*.
3. LP-gas cooking devices having LP-gas container with a water capacity not greater than 2½ pounds [nominal 1 pound (0.454 kg) LP-gas capacity].

**308.1.5 Location near combustibles.** Open flames such as from candles, lanterns, kerosene heaters and gas-fired heaters shall not be located on or near decorative material or similar combustible materials.

**308.1.6 Open-flame devices.** Torches and other devices, machines or processes liable to start or cause fire shall not be operated or used in or on wildfire risk areas, except by a permit in accordance with Section 105.5 secured from the *fire code official*.

**Exception:** Use within inhabited premises or designated campsites that are not less than 30 feet (9144 mm) from grass-, grain-, brush- or forest-covered areas.

**308.1.6.1 Signals and markers.** Flame-employing devices, such as lanterns or kerosene road flares, shall not be operated or used as a signal or marker in or on wildfire risk areas.

**Exception:** The proper use of fusees at the scenes of emergencies or as required by standard railroad operating procedures.

**308.1.6.2 Portable fueled open-flame devices.** Portable open-flame devices fueled by flammable or combustible gases or liquids shall be enclosed or installed in such a manner as to prevent the flame from contacting combustible material.

### Exceptions:

1. LP-gas-fueled devices used for sweating pipe joints or removing paint in accordance with Chapter 61.
2. Cutting and welding operations in accordance with Chapter 35.

3. Torches or flame-producing devices in accordance with Section 308.4.

4. Candles and open-flame decorative devices in accordance with Section 308.3.

**308.1.6.3 Sky lanterns.** A person shall not release or cause to be released an untethered sky lantern.

**308.1.7 Religious ceremonies.** Where, in the opinion of the *fire code official*, adequate safeguards have been taken, participants in religious ceremonies are allowed to carry hand-held candles. Hand-held candles shall not be passed from one person to another while lighted.

**308.1.7.1 Aisles and exits.** Candles shall be prohibited in areas where occupants stand, or in an *aisle* or *exit*.

**308.1.8 Flaming food and beverage preparation.** The preparation of flaming foods or beverages in places of assembly and drinking or dining establishments shall be in accordance with Sections 308.1.8.1 through 308.1.8.5.

**308.1.8.1 Dispensing.** *Flammable* or *combustible liquids* used in the preparation of flaming foods or beverages shall be dispensed from one of the following:

1. A 1-ounce (29.6 ml) container.
2. A container not exceeding 1-quart (946.5 ml) capacity with a controlled pouring device that will limit the flow to a 1-ounce (29.6 ml) serving.

**308.1.8.2 Containers not in use.** Containers shall be secured to prevent spillage when not in use.

**308.1.8.3 Serving of flaming food.** The serving of flaming foods or beverages shall be done in a safe manner and shall not create high flames. The pouring, ladling or spooning of liquids is restricted to a maximum height of 8 inches (203 mm) above the receiving receptacle.

**308.1.8.4 Location.** Flaming foods or beverages shall be prepared only in the immediate vicinity of the table being serviced. They shall not be transported or carried while burning.

**308.1.8.5 Fire protection.** The person preparing the flaming foods or beverages shall have a wet cloth towel immediately available for use in smothering the flames in the event of an emergency.

**308.2 Permits required.** Permits shall be obtained from the *fire code official* in accordance with Section 105.5 prior to engaging in the following activities involving open flame, fire and burning:

1. Use of a torch or flame-producing device to remove paint from a structure.
2. Use of open flame, fire or burning in connection with Group A or E occupancies.
3. Use or operation of torches and other devices, machines or processes liable to start or cause fire in or on wildfire risk areas.

**308.3 Group A occupancies.** Open-flame devices shall not be used in a Group A occupancy.

### Exceptions:

1. Open-flame devices are allowed to be used in the following situations, provided that *approved*

## GENERAL REQUIREMENTS

precautions are taken to prevent ignition of a combustible material or injury to occupants:

- 1.1. Where necessary for ceremonial or religious purposes in accordance with Section 308.1.7.
- 1.2. On stages and platforms as a necessary part of a performance in accordance with Section 308.3.2.
- 1.3. Where candles on tables are securely supported on substantial noncombustible bases and the candle flames are protected.
2. Heat-producing equipment complying with Chapter 6 and the *International Mechanical Code*.
3. Gas lights are allowed to be used provided that adequate precautions satisfactory to the *fire code official* are taken to prevent ignition of combustible materials.

**308.3.1 Open-flame decorative devices.** Open-flame decorative devices shall comply with all of the following restrictions:

1. Class I and Class II liquids and LP-gas shall not be used.
2. Liquid- or solid-fueled lighting devices containing more than 8 ounces (237 ml) of fuel must self-extinguish and not leak fuel at a rate of more than 0.25 teaspoon per minute (1.26 ml per minute) if tipped over.
3. The device or holder shall be constructed to prevent the spillage of liquid fuel or wax at the rate of more than 0.25 teaspoon per minute (1.26 ml per minute) when the device or holder is not in an upright position.
4. The device or holder shall be designed so that it will return to the upright position after being tilted to an angle of 45 degrees (0.79 rad) from vertical.

**Exception:** Devices that self-extinguish if tipped over and do not spill fuel or wax at the rate of more than 0.25 teaspoon per minute (1.26 ml per minute) if tipped over.

5. The flame shall be enclosed except where openings on the side are not more than 0.375-inch (9.5 mm) diameter or where openings are on the top and the distance to the top is such that a piece of tissue paper placed on the top will not ignite in 10 seconds.
6. Chimneys shall be made of noncombustible materials and securely attached to the open-flame device.

**Exception:** A chimney is not required to be attached to any open-flame device that will self-extinguish if the device is tipped over.

7. Fuel canisters shall be safely sealed for storage.
8. Storage and handling of *combustible liquids* shall be in accordance with Chapter 57.

9. Shades, where used, shall be made of noncombustible materials and securely attached to the open-flame device holder or chimney.

10. Candelabras with flame-lighted candles shall be securely fastened in place to prevent overturning, and shall be located away from occupants using the area and away from possible contact with drapes, curtains or other combustibles.

**308.3.2 Theatrical performances.** Where *approved*, open-flame devices used in conjunction with theatrical performances are allowed to be used where adequate safety precautions have been taken in accordance with NFPA 160.

**308.4 Group R occupancies.** Open flame, fire and burning in Group R occupancies shall comply with the requirements of Sections 308.1 through 308.1.6.3 and Section 308.4.1.

**308.4.1 Group R-2 dormitories.** Candles, incense and similar open-flame-producing items shall not be allowed in *sleeping units* in Group R-2 dormitory occupancies.

## SECTION 309 POWERED INDUSTRIAL TRUCKS AND EQUIPMENT

**309.1 General.** Powered industrial trucks and similar equipment including, but not limited to, floor scrubbers and floor buffers, shall be operated and maintained in accordance with Sections 309.2 through 309.7.

**309.2 Use in hazardous (classified) locations.** Powered industrial trucks used in areas designated as hazardous (classified) locations in accordance with NFPA 70 shall be *listed* and *labeled* for use in the environment intended in accordance with NFPA 505.

**309.3 Battery chargers.** Battery chargers shall be of an *approved* type. Combustible storage shall be kept not less than 3 feet (915 mm) from battery chargers. Battery charging shall not be conducted in areas open to the public.

**309.4 Ventilation.** Ventilation shall be provided in an *approved* manner in battery-charging areas to prevent a dangerous accumulation of flammable gases.

**309.5 Fire extinguishers.** Battery-charging areas shall be provided with a fire extinguisher complying with Section 906 having a minimum 4-A:20-B:C rating within 20 feet (6096 mm) of the battery charger.

**309.6 Refueling.** Powered industrial trucks using liquid fuel, LP-gas or hydrogen shall be refueled outside of buildings or in areas specifically *approved* for that purpose. Fixed fuel-dispensing equipment and associated fueling operations shall be in accordance with Chapter 23. Other fuel-dispensing equipment and operations, including cylinder exchange for LP-gas-fueled vehicles, shall be in accordance with Chapter 57 for *flammable* and *combustible liquids* or Chapter 61 for LP-gas.

**309.7 Repairs.** Repairs to fuel systems, electrical systems and repairs utilizing open flame or welding shall be done in *approved* locations outside of buildings or in areas specifically *approved* for that purpose.

## GENERAL REQUIREMENTS

SECTION 310  
SMOKING

**310.1 General.** The smoking or carrying of a lighted pipe, cigar, cigarette or any other type of smoking paraphernalia or material is prohibited in the areas indicated in Sections 310.2 through 310.8.

**310.2 Prohibited areas.** Smoking shall be prohibited where conditions are such as to make smoking a hazard, and in spaces where flammable or combustible materials are stored or handled.

**Exception:** In Group I-2 occupancies, patients shall be permitted to smoke in designated patient care areas based on the clinical needs of the patient.

**310.2.1 Group I-2.** In Group I-2 occupancies, smoking shall be prohibited in patient care areas or where oxygen is used, stored or handled.

**310.3 “No Smoking” signs.** The *fire code official* is authorized to order the posting of “No Smoking” signs or the international symbol for no smoking in a conspicuous location in each structure or location in which smoking is prohibited. The content, lettering, size, color and location of required “No Smoking” signs shall be *approved*.

**Exception:** “No Smoking” signs are not required in interior locations of the facility where signs are displayed at all major entrances into the facility.

**310.4 Removal of signs prohibited.** A posted “No Smoking” sign shall not be obscured, removed, defaced, mutilated or destroyed.

**310.5 Compliance with “No Smoking” signs.** Smoking shall not be permitted nor shall a person smoke, throw or deposit any lighted or smoldering substance in any place where “No Smoking” signs are posted.

**310.6 Ash trays.** Where smoking is permitted, suitable noncombustible ash trays or match receivers shall be provided on each table and at other appropriate locations. In Group I-2 occupancies, noncombustible metal containers with self-closing covers shall be provided in areas where smoking is permitted.

**310.7 Burning objects.** Lighted matches, cigarettes, cigars or other burning object shall not be discarded in such a manner that could cause ignition of other combustible material.

**310.8 Hazardous environmental conditions.** Where the *fire code official* determines that hazardous environmental conditions necessitate controlled use of smoking materials, the ignition or use of such materials in mountainous, brush-covered or forest-covered areas or other designated areas is prohibited except in *approved* designated smoking areas.

SECTION 311  
VACANT PREMISES

**311.1 General.** Temporarily unoccupied buildings, structures, premises or portions thereof, including tenant spaces, shall be safeguarded and maintained in accordance with Sections 311.1.1 through 311.6.

**311.1.1 Abandoned premises.** Buildings, structures and premises for which an *owner* cannot be identified or located by dispatch of a certificate of mailing to the last known or registered address, which persistently or repeatedly become unprotected or unsecured, which have been occupied by unauthorized persons or for illegal purposes, or which present a danger of structural collapse or fire spread to adjacent properties shall be considered to be abandoned, declared unsafe and abated by demolition or rehabilitation in accordance with the *International Property Maintenance Code* and the *International Building Code*.

**311.1.2 Tenant spaces.** Storage and lease plans required by this code shall be revised and updated to reflect temporary or partial vacancies.

**311.2 Safeguarding vacant premises.** Temporarily unoccupied buildings, structures, premises or portions thereof shall be secured and protected in accordance with Sections 311.2.1 through 311.2.3.

**311.2.1 Security.** Exterior and interior openings open to other tenants or unauthorized persons shall be boarded, locked, blocked or otherwise protected to prevent entry by unauthorized individuals. The *fire code official* is authorized to placard, post signs, erect barrier tape or take similar measures as necessary to secure public safety.

**311.2.2 Fire protection.** Fire protection systems shall be maintained in an operable condition at all times.

**Exceptions:**

1. Where the premises have been cleared of all combustible materials and debris and, in the opinion of the *fire code official*, the type of construction, *fire separation distance* and security of the premises do not create a fire hazard.
2. Where *approved* by the *fire code official*, buildings that will not be heated and where *fire protection systems* will be exposed to freezing temperatures, fire alarm and *automatic sprinkler systems* are permitted to be placed out of service and standpipes are permitted to be maintained as dry systems (without an automatic water supply), provided that the building does not have contents or storage, and windows, doors and other openings are secured to prohibit entry by unauthorized persons.
3. Where *approved* by the *fire code official*, fire alarm and *automatic sprinkler systems* are permitted to be placed out of service in seasonally occupied buildings: that will not be heated; where fire protection systems will be exposed to freezing temperatures; where *fire areas* do not exceed 12,000 square feet (1115 m<sup>2</sup>); and that do not store motor vehicles or hazardous materials.

**311.2.3 Fire separation.** *Fire-resistance-rated* partitions, *fire barriers* and *fire walls* separating vacant tenant spaces from the remainder of the building shall be maintained. Openings, joints and penetrations in *fire-*

## GENERAL REQUIREMENTS

*resistance-rated* assemblies shall be protected in accordance with Chapter 7.

**311.3 Removal of combustibles.** Persons owning, or in charge or control of, a vacant building or portion thereof, shall remove therefrom all accumulations of combustible materials, flammable or combustible waste or rubbish and shall securely lock or otherwise secure doors, windows and other openings to prevent entry by unauthorized persons. The premises shall be maintained clear of waste or hazardous materials.

**Exceptions:**

1. Buildings or portions of buildings undergoing additions, *alterations*, repairs or change of occupancy in accordance with the *International Building Code*, where waste is controlled and removed as required by Section 304.
2. Seasonally occupied buildings.

**311.4 Removal of hazardous materials.** Persons owning or having charge or control of a vacant building containing hazardous materials regulated by Chapter 50 shall comply with the facility closure requirements of Section 5001.6.




**311.5 Placards.** Any vacant or abandoned buildings or structures determined to be unsafe pursuant to Section 114 relating to structural or interior hazards shall be marked as required by Sections 311.5.1 through 311.5.5.

**311.5.1 Placard location.** Placards shall be applied on the front of the structure and be visible from the street. Additional placards shall be applied to the side of each entrance to the structure and on penthouses.

**311.5.2 Placard size and color.** Placards shall be 24 inches by 24 inches (610 mm by 610 mm) minimum in size with a red background, white reflective stripes and a white reflective border. The stripes and border shall have a 2-inch (51 mm) minimum stroke.

**311.5.3 Placard date.** Placards shall bear the date of their application to the building and the date of the most recent inspection.

**311.5.4 Placard symbols.** The design of the placards shall use the following symbols:

1.  This symbol shall mean that the structure had normal structural conditions at the time of marking.
2.  This symbol shall mean that structural or interior hazards exist and interior fire-fighting or rescue operations should be conducted with extreme caution.
3.  This symbol shall mean that structural or interior hazards exist to a degree that consideration should be given to limit fire fighting to exterior operations only, with entry only occurring for known life hazards.
4. Vacant marker hazard identification symbols: The following symbols shall be used to designate

known hazards on the vacant building marker. They shall be placed directly above the symbol.

- 4.1. R/O—Roof open.
- 4.2. S/M—Stairs, steps and landing missing.
- 4.3. F/E—Avoid fire escapes.
- 4.4. H/F—Holes in floor.

**311.5.5 Informational use.** The use of these symbols shall be informational only and shall not in any way limit the discretion of the on-scene incident commander.

**311.6 Unoccupied tenant spaces in mall buildings.** Unoccupied tenant spaces in covered and open mall buildings shall be:

1. Kept free from the storage of any materials.
2. Separated from the remainder of the building by partitions of not less than 0.5-inch-thick (12.7 mm) gypsum board or an *approved* equivalent to the underside of the ceiling of the adjoining tenant spaces.
3. Without doors or other access openings other than one door that shall be kept key locked in the closed position except during that time when opened for inspection.
4. Kept free from combustible waste and be broomswept clean.

## SECTION 312 VEHICLE IMPACT PROTECTION

**312.1 General.** Vehicle impact protection required by this code shall be provided by posts that comply with Section 312.2 or by other *approved* physical barriers that comply with Section 312.3.

**312.2 Posts.** Guard posts shall comply with all of the following requirements:

1. Constructed of steel not less than 4 inches (102 mm) in diameter and concrete filled.
2. Spaced not more than 4 feet (1219 mm) between posts on center.
3. Set not less than 3 feet (914 mm) deep in a concrete footing of not less than a 15-inch (381 mm) diameter.
4. Set with the top of the posts not less than 3 feet (914 mm) above ground.
5. Located not less than 3 feet (914 mm) from the protected object.

**312.3 Other barriers.** Barriers, other than posts specified in Section 312.2, that are designed to resist, deflect or visually deter vehicular impact commensurate with an anticipated impact scenario shall be permitted where *approved*.



## GENERAL REQUIREMENTS

SECTION 313  
FUELED EQUIPMENT

**313.1 General.** Fueled equipment including, but not limited to, motorcycles, mopeds, lawn-care equipment, portable generators and portable cooking equipment, shall not be stored, operated or repaired within a building.

**Exceptions:**

1. Buildings or rooms constructed for such use in accordance with the *International Building Code*.
2. Where allowed by Section 314.
3. Storage of equipment utilized for maintenance purposes is allowed in *approved* locations where the aggregate fuel capacity of the stored equipment does not exceed 10 gallons (38 L) and the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**313.1.1 Removal.** The *fire code official* is authorized to require removal of fueled equipment from locations where the presence of such equipment is determined by the *fire code official* to be hazardous.

**313.2 Group R occupancies.** Vehicles powered by *flammable liquids*, Class II *combustible liquids* or compressed flammable gases shall not be stored within the living space of Group R buildings.

SECTION 314  
INDOOR DISPLAYS

**314.1 General.** Indoor displays constructed within any occupancy shall comply with Sections 314.2 through 314.4.

**314.2 Fixtures and displays.** Fixtures and displays of goods for sale to the public shall be arranged so as to maintain free, immediate and unobstructed access to exits as required by Chapter 10.

**314.3 Highly combustible goods.** The display of highly combustible goods, including but not limited to fireworks, *flammable* or *combustible liquids*, liquefied flammable gases, oxidizing materials, pyroxylin plastics and agricultural goods, in main *exit access aisles*, *corridors*, covered and open malls, or within 5 feet (1524 mm) of entrances to *exits* and exterior exit doors is prohibited where a fire involving such goods would rapidly prevent or obstruct egress.

**314.4 Vehicles.** Liquid-fueled or gaseous-fueled vehicles, aircraft, boats or other motorcraft shall not be located indoors except as follows:

1. The engine starting system is made inoperable or batteries are disconnected except where the *fire code official* requires that the batteries remain connected to maintain safety features.
2. Fuel in fuel tanks does not exceed one-quarter tank or 5 gallons (19 L) (whichever is least).
3. Fuel tanks and fill openings are closed and sealed to prevent tampering.

4. Vehicles, aircraft, boats or other motorcraft equipment are not fueled or defueled within the building.

SECTION 315  
GENERAL STORAGE

**315.1 General.** Storage shall be in accordance with Sections 315.2 through 315.6. Outdoor pallet storage shall be in accordance with Sections 315.2 and 315.7.

**Exception:** Wood and wood composite pallets stored outdoors at pallet manufacturing and recycling facilities and complying with Section 2810.

**315.2 Permit required.** A permit for miscellaneous combustible storage shall be required as set forth in Section 105.5.

**315.3 Storage in buildings.** Storage of materials in buildings shall be orderly and stacks shall be stable. Storage of combustible materials shall be separated from heaters or heating devices by distance or shielding so that ignition cannot occur.

**315.3.1 Ceiling clearance.** Storage shall be maintained 2 feet (610 mm) or more below the ceiling in nonsprinklered areas of buildings or not less than 18 inches (457 mm) below sprinkler head deflectors in sprinklered areas of buildings.

**Exceptions:**

1. The 2-foot (610 mm) ceiling clearance is not required for storage along walls in nonsprinklered areas of buildings.
2. The 18-inch (457 mm) ceiling clearance is not required for storage along walls in areas of buildings equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.

**315.3.2 Means of egress.** Combustible materials shall not be stored in *exits* or enclosures for *stairways* and *ramps*. Combustible materials in the *means of egress* during construction, demolition, remodeling or *alterations* shall comply with Section 3312.3.

**315.3.3 Equipment rooms.** Combustible material shall not be stored in boiler rooms, mechanical rooms, elevator machine rooms, electrical equipment rooms or in *fire command centers* as specified in Section 508.1.5.

**315.3.4 Attic, under-floor and concealed spaces.** Attic, under-floor and concealed spaces used for storage of combustible materials shall be protected on the storage side as required for 1-hour *fire-resistance-rated* construction. Openings shall be protected by assemblies that are self-closing and are of noncombustible construction or solid wood core not less than 1<sup>3</sup>/<sub>4</sub> inches (44.5 mm) in thickness. Storage shall not be placed on exposed joists.

**Exceptions:**

1. Areas protected by *approved automatic sprinkler systems*.
2. Group R-3 and Group U occupancies.

**315.4 Outside storage.** Outside storage of combustible materials shall not be located within 10 feet (3048 mm) of a *lot line*.

**Exceptions:**

1. The separation distance is allowed to be reduced to 3 feet (914 mm) for storage not exceeding 6 feet (1829 mm) in height.
2. The separation distance is allowed to be reduced where the *fire code official* determines that hazard to the adjoining property does not exist.

**315.4.1 Storage beneath overhead projections from buildings.** Where buildings are protected by an *automatic sprinkler system*, the outdoor storage, display and handling of combustible materials under eaves, canopies or other projections or overhangs are prohibited except where automatic sprinklers are installed under such eaves, canopies or other projections or overhangs.

**315.4.2 Height.** Storage in the open shall not exceed 20 feet (6096 mm) in height.

**315.5 Storage underneath high-voltage transmission lines.** Storage located underneath high-voltage transmission lines shall be in accordance with Section 316.6.2.

**315.6 Storage in plenums.** Storage is prohibited in plenums. Abandoned material in plenums shall be deemed to be storage and shall be removed. Where located in plenums, the portion of abandoned cables that are able to be accessed without causing damage, or requiring demolition to the building shall be identified for future use with a tag or shall be deemed storage and shall be removed.

**315.7 Outdoor pallet storage.** Pallets stored outdoors shall comply with Sections 315.7 through 315.7.7. Pallets stored within a building shall be protected in accordance with Chapter 32.

**315.7.1 Storage beneath overhead projections from buildings.** Where buildings are equipped throughout with an *automatic sprinkler system*, the outdoor storage of

pallets under eaves, canopies or other projections or overhangs are prohibited except where automatic sprinklers are installed under such eaves, canopies or other projections or overhangs.

**315.7.2 Distance to lot line.** Pallet storage shall not be located within 10 feet (3048 mm) of a *lot line*.

**315.7.3 Storage height.** Pallet storage shall not exceed 20 feet (6096 mm) in height.

**315.7.4 Pallet pile stability and size.** Pallet stacks shall be arranged to form stable piles. Individual pallet piles shall cover an area not greater than 400 square feet (37 m<sup>2</sup>).

**315.7.5 Pallet types.** Pallets shall be all wood, with slatted or solid top or bottom, with metal fasteners, or shall be plastic or composite pallets, *listed* and *labeled* in accordance with UL 2335 or FM 4996. Plastic pallets shall be both solid and gridded deck, independent of the pallet manufacturing process, type of resin used in fabrication or geometry of the pallet.

**315.7.6 Pile separation distances.** In addition to the other requirements of this section, pallet stacks and piles shall be separated in accordance with Sections 315.7.6.1 and 315.7.6.2.

**315.7.6.1 Building separation.** Pallet stacks and piles shall be separated from buildings in accordance with Table 315.7.6(1) for wood pallets and Table 315.7.6(2) for plastic pallets.

**315.7.6.2 Separation from other pallets and on-site storage.** Pallets shall be separated from other pallet piles and other storage in accordance with Table 315.7.6(3) for wood pallets and Table 315.7.6(4) for plastic pallets.

**315.7.7 Prohibited locations.** Pallets shall not be stored underneath high-voltage transmission lines, elevated roadways or elevated railways.

**TABLE 315.7.6(1)**  
**SEPARATION DISTANCE BETWEEN WOOD PALLET STACKS AND BUILDINGS**

WALL CONSTRUCTION	OPENING TYPE	WOOD PALLET SEPARATION DISTANCE (feet)		
		≤ 50 Pallets	51 to 200 Pallets	> 200 Pallets
Masonry	None	2	2	2
Masonry	Fire-rated glazing with open sprinklers	2	5	20
Masonry	Fire-rated glazing	5	10	20
Masonry	Plain glass with open sprinklers	5	10	20
Noncombustible	None	5	10	20
Wood with open sprinklers	—	5	10	20
Wood	None	15	30	90
Any	Plain glass	15	30	90

For SI: 1 foot = 304.8 mm.

## GENERAL REQUIREMENTS

**TABLE 315.7.6(2)**  
**SEPARATION DISTANCE BETWEEN PLASTIC PALLET STACKS AND BUILDINGS**

WALL CONSTRUCTION	OPENING TYPE	PLASTIC PALLET SEPARATION DISTANCE (feet)		
		≤ 50 Pallets	51 to 200 Pallets	> 200 Pallets
Masonry	None	2	2	2
Masonry	Fire-rated glazing with open sprinklers	10	20	50
Masonry	Fire-rated glazing	15	40	100
Masonry	Plain glass with open sprinklers	15	40	100
Noncombustible	None	15	40	100
Wood with open sprinklers	—	15	40	100
Wood	None	30	80	150
Any	Plain glass	30	80	150

For SI: 1 foot = 304.8 mm.

**TABLE 315.7.6(3)**  
**SEPARATION FROM OTHER PALLET PILES AND ON-SITE STORAGE (WOOD PALLETS)**

	WOOD PALLET SEPARATION DISTANCE (feet)		
	≤ 50 Pallets	51 to 200 Pallets	> 200 Pallets
Between pallet piles	7.5	15	45
Other on-site storage	7.5	15	45

For SI: 1 foot = 304.8 mm.

**TABLE 315.7.6(4)**  
**SEPARATION FROM OTHER PALLET PILES AND ON-SITE STORAGE (PLASTIC PALLETS)**

	PLASTIC PALLET SEPARATION DISTANCE (feet)		
	≤ 50 Pallets	51 to 200 Pallets	> 200 Pallets
Between pallet piles	15	40	75
Other on-site storage	15	40	75

For SI: 1 foot = 304.8 mm.

## SECTION 316 HAZARDS TO FIRE FIGHTERS

**316.1 Trapdoors to be closed.** Trapdoors and scuttle covers, other than those that are within a *dwelling unit* or automatically operated, shall be kept closed at all times except when in use.

**316.2 Shaftway markings.** Vertical shafts shall be identified as required by this section.

**316.2.1 Exterior access to shaftways.** Outside openings that can be reached by the fire department and that open directly on a hoistway or shaftway communicating between two or more floors in a building shall be plainly marked with the word “SHAFTWAY” in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible from the outside of the building.

**316.2.2 Interior access to shaftways.** Door or window openings to a hoistway or shaftway from the interior of the building shall be plainly marked with the word

“SHAFTWAY” in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible.

**Exception:** Marking shall not be required on shaftway openings that are readily discernible as openings onto a shaftway by the construction or arrangement.

**316.3 Pitfalls.** The intentional design or *alteration* of buildings to disable, injure, maim or kill intruders is prohibited. A person shall not install and use firearms, sharp or pointed objects, razor wire, *explosives*, *flammable* or *combustible liquid* containers, or dispensers containing highly toxic, toxic, irritant or other hazardous materials in a manner that could passively or actively disable, injure, maim or kill a fire fighter who forcibly enters a building for the purpose of controlling or extinguishing a fire, rescuing trapped occupants or rendering other emergency assistance.

**316.4 Obstructions on roofs.** Wires, cables, ropes, antennas, or other suspended obstructions installed on the roof of a building having a roof slope of less than 30 degrees (0.52

## GENERAL REQUIREMENTS

rad) shall not create an obstruction that is less than 7 feet (2133 mm) high above the surface of the roof.

**Exceptions:**

1. Such obstruction shall be permitted where the wire, cable, rope, antenna or suspended obstruction is encased in a white, 2-inch (51 mm) minimum diameter plastic pipe or an *approved* equivalent.
2. Such obstruction shall be permitted where there is a solid obstruction below such that accidentally walking into the wire, cable, rope, antenna or suspended obstruction is not possible.

**316.5 Security device.** Any security device or system that emits any medium that could obscure a *means of egress* in any building, structure or premise shall be prohibited.

**316.6 Structures and outdoor storage underneath high-voltage transmission lines.** Structures and outdoor storage underneath high-voltage transmission lines shall comply with Sections 316.6.1 and 316.6.2, respectively.

**316.6.1 Structures.** Structures shall not be constructed within the utility easement beneath high-voltage transmission lines.

**Exception:** Restrooms and unoccupied telecommunication structures of noncombustible construction less than 15 feet (4572 mm) in height.

**316.6.2 Outdoor storage.** Outdoor storage within the utility easement underneath high-voltage transmission lines shall be limited to noncombustible material. Storage of hazardous materials including, but not limited to, *flammable* and *combustible liquids* is prohibited.

**Exception:** Combustible storage, including vehicles and fuel storage for backup power equipment serving public utility equipment, is allowed, provided that a plan indicating the storage configuration is submitted and *approved*.

## SECTION 317 LANDSCAPED ROOFS

**317.1 General.** Landscaped roofs shall be installed and maintained in accordance with Sections 317.2 through 317.5 and Sections 1505 and 1507.15 of the *International Building Code*.

**317.2 Landscaped roof size.** Landscaped roof areas shall not exceed 15,625 square feet (1450 m<sup>2</sup>) in size for any single area with a maximum dimension of 125 feet (39 m) in length or width. A minimum 6-foot-wide (1.8 m) clearance consisting of a *listed* Class A roof assembly tested in accordance with ASTM E108 or UL 790 shall be provided between adjacent landscaped roof areas.

**317.3 Rooftop structure and equipment clearance.** For all vegetative roofs abutting combustible vertical surfaces, a Class A-rated roof system complying with ASTM E108 or UL 790 shall be achieved for a minimum 6-foot-wide (1829 mm) continuous border placed around rooftop structures and all rooftop equipment including, but not limited to, mechanical and machine rooms, penthouses, skylights, roof vents, solar panels, antenna supports and building service equipment.

cal and machine rooms, penthouses, skylights, roof vents, solar panels, antenna supports and building service equipment.

**317.4 Vegetation.** Vegetation shall be maintained in accordance with Sections 317.4.1 and 317.4.2.

**317.4.1 Irrigation.** Supplemental irrigation shall be provided to maintain levels of hydration necessary to keep green roof plants alive and to keep dry foliage to a minimum.

**317.4.2 Dead foliage.** Excess biomass, such as overgrown vegetation, leaves and other dead and decaying material, shall be removed at regular intervals not less than two times per year.

**317.4.3 Maintenance plan.** The *fire code official* is authorized to require a maintenance plan for vegetation placed on roofs due to the size of a landscaped roof, materials used or where a fire hazard exists to the building or exposures due to the lack of maintenance.

**317.5 Maintenance equipment.** Fueled equipment stored on roofs and used for the care and maintenance of vegetation on roofs shall be stored in accordance with Section 313.

## SECTION 318 LAUNDRY CARTS

**318.1 Laundry carts with a capacity of 1 cubic yard or more.** Laundry carts with an individual capacity of 1 cubic yard [200 gallons (0.76 m<sup>3</sup>)] or more, used in laundries within Group B, E, F-1, I, M and R-1 occupancies, shall be constructed of noncombustible materials or materials having a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> at a flux of 50 kW/m<sup>2</sup> where tested in a horizontal orientation in accordance with ASTM E1354.

**Exceptions:**

1. Laundry carts in areas protected by an *approved automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1.
2. Laundry carts in coin-operated laundries.

## SECTION 319 MOBILE FOOD PREPARATION VEHICLES \*\*\*\*\*LEAVE FOR LOCAL ADOPTION\*\*\*\*\*

**319.1 General.** Mobile food preparation vehicles that are equipped with appliances that produce smoke or grease-laden vapors shall comply with this section.

**319.2 Permit required.** Permits shall be required as set forth in Section 105.5.

**319.3 Exhaust hood.** Cooking equipment that produces grease-laden vapors shall be provided with a kitchen exhaust hood in accordance with Section 606.

**319.4 Fire protection.** Fire protection shall be provided in accordance with Sections 319.4.1 and 319.4.2.

**319.4.1 Fire protection for cooking equipment.** Cooking equipment shall be protected by automatic fire-extinguishing systems in accordance with Section 904.13.



## GENERAL REQUIREMENTS

**319.4.2 Fire extinguisher.** Portable fire extinguishers shall be provided in accordance with Section 906.4.

**319.5 Appliance connection to fuel supply piping.** Gas cooking appliances shall be secured in place and connected to fuel-supply piping with an appliance connector complying with ANSI Z21.69/CSA 6.16. The connector installation shall be configured in accordance with the manufacturer's installation instructions. Movement of appliances shall be limited by restraining devices installed in accordance with the connector and appliance manufacturer's instructions.

**319.6 Cooking oil storage containers.** Cooking oil storage containers within mobile food preparation vehicles shall have a maximum aggregate volume not more than 120 gallons (454 L), and shall be stored in such a way as to not be toppled or damaged during transport.

**319.7 Cooking oil storage tanks.** Cooking oil storage tanks within mobile food preparation vehicles shall comply with Sections 319.7.1 through 319.7.5.2.

**319.7.1 Metallic storage tanks.** Metallic cooking oil storage tanks shall be *listed* in accordance with UL 80 or UL 142, and shall be installed in accordance with the tank manufacturer's instructions.

**319.7.2 Nonmetallic storage tanks.** Nonmetallic cooking oil storage tanks shall be installed in accordance with the tank manufacturer's instructions and shall comply with both of the following:

1. Tanks shall be *listed* for use with cooking oil, including maximum temperature to which the tank will be exposed during use.
2. Tank capacity shall not exceed 200 gallons (757 L) per tank.

**319.7.3 Cooking oil storage system components.** Metallic and nonmetallic cooking oil storage system components shall include, but are not limited to, piping, connections, fittings, valves, tubing, hose, pumps, vents and other related components used for the transfer of cooking oil.

**319.7.4 Design criteria.** The design, fabrication and assembly of system components shall be suitable for the working pressures, temperatures and structural stresses to be encountered by the components.

**319.7.5 Tank venting.** Normal and emergency venting shall be provided for cooking oil storage tanks.

**319.7.5.1 Normal vents.** Normal vents shall be located above the maximum normal liquid line, and shall have a minimum effective area not smaller than the largest filling or withdrawal connection. Normal vents are not required to vent to the exterior.

**319.7.5.2 Emergency vents.** Emergency relief vents shall be located above the maximum normal liquid line, and shall be in the form of a device or devices that will relieve excessive internal pressure caused by an exposure fire. For nonmetallic tanks, the emergency relief vent shall be allowed to be in the form of construction. Emergency vents are not required to discharge to the exterior.

**319.8 LP-gas systems.** Where LP-gas systems provide fuel for cooking appliances, such systems shall comply with Chapter 61 and Sections 319.8.1 through 319.8.5.

**319.8.1 Maximum aggregate volume.** The maximum aggregate capacity of LP-gas containers transported on the vehicle and used to fuel cooking appliances only shall not exceed 200 pounds (91 kg) propane capacity.

**319.8.2 Protection of container.** LP-gas containers installed on the vehicle shall be securely mounted and restrained to prevent movement.

**319.8.3 LP-gas container construction.** LP-gas containers shall be manufactured in compliance with the requirements of NFPA 58.

**319.8.4 Protection of system piping.** LP-gas system piping, including valves and fittings, shall be adequately protected to prevent tampering, impact damage, and damage from vibration.

**319.8.5 LP-gas alarms.** A *listed* LP-gas alarm shall be installed within the vehicle in the vicinity of LP-gas system components, in accordance with the manufacturer's instructions.

**319.9 CNG systems.** Where CNG systems provide fuel for cooking appliances, such systems shall comply with Sections 319.9.1 through 319.9.4.

**319.9.1 CNG containers supplying only cooking fuel.** CNG containers installed solely to provide fuel for cooking purposes shall be in accordance with Sections 319.9.1.1 through 319.9.1.3.

**319.9.1.1 Maximum aggregate volume.** The maximum aggregate capacity of CNG containers transported on the vehicle shall not exceed 1,300 pounds (590 kg) water capacity.

**319.9.1.2 Protection of container.** CNG containers shall be securely mounted and restrained to prevent movement. Containers shall not be installed in locations subject to a direct vehicle impact.

**319.9.1.3 CNG container construction.** CNG containers shall be an NGV-2 cylinder.

**319.9.2 CNG containers supplying transportation and cooking fuel.** Where CNG containers and systems are used to supply fuel for cooking purposes in addition to being used for transportation fuel, the installation shall be in accordance with NFPA 52.

**319.9.3 Protection of system piping.** CNG system piping, including valves and fittings, shall be adequately protected to prevent tampering, impact damage and damage from vibration.

**319.9.4 Methane alarms.** A *listed* methane gas alarm shall be installed within the vehicle in accordance with manufacturer's instructions.

**319.10 Maintenance.** Maintenance of systems on mobile food preparation vehicles shall be in accordance with Sections 319.10.1 through 319.10.3.

**319.10.1 Exhaust system.** The exhaust system, including hood, grease-removal devices, fans, ducts and other

appurtenances, shall be inspected and cleaned in accordance with Section 606.3.

**319.10.2 Fire protection systems and devices.** *Fire protection systems* and devices shall be maintained in accordance with Section 901.6.

**319.10.3 Fuel gas systems.** LP-gas containers installed on the vehicle and fuel-gas piping systems shall be inspected annually by an *approved* inspection agency or a company that is registered with the US Department of Transportation to requalify LP-gas cylinders, to ensure that system components are free from damage, suitable for the intended service and not subject to leaking. CNG containers shall be inspected every 3 years in a qualified service facility. CNG containers shall not be used past their expiration date as listed on the manufacturer's container label. Upon satisfactory inspection, the *approved* inspection agency shall affix a tag on the fuel gas system or within the vehicle indicating the name of the inspection agency and the date of satisfactory inspection.

## SECTION 320 ADDITIVE MANUFACTURING (3D PRINTING)

**320.1 General.** Additive manufacturing equipment and operations shall comply with Section 320.

**320.1.1 Scope.** Additive manufacturing shall comply with one of the following:

1. Nonindustrial additive manufacturing shall comply with Section 320.2.
2. Industrial additive manufacturing shall comply with Section 320.3.

**320.1.2 Installation, operation and maintenance.** 3D printers and associated additive manufacturing equipment shall be installed, operated and maintained in accordance with this code, the listing and the manufacturer's instructions.

**320.1.3 Production materials.** Only the production materials *listed* for use with the equipment and included in the manufacturer's instructions shall be used.

**320.2 Nonindustrial additive manufacturing.** Nonindustrial additive manufacturing equipment and operations shall comply with Sections 320.2.1 and 320.2.2. Additive manufacturing equipment and operations that do not comply with Section 320.2 shall comply with Section 320.3.

**320.2.1 Listing.** 3D printers used in nonindustrial additive manufacturing shall be *listed* and *labeled* in accordance with UL 2011, UL 60950-1 or UL 62368-1. The listing shall also verify:

1. The 3D printers are self-contained and utilize maximum 30-liter prepackaged production materials.
2. The operation of the 3D printers shall not create a hazardous (classified) electrical area or zone outside the unit.

3. If any hazardous (classified) electrical area or zone exists inside the unit's outer enclosure, the area shall be protected by intrinsically safe electrical construction or other acceptable protection methods.

4. The 3D printers shall not utilize inert gas or an external combustible dust collection system.

**320.2.2 Occupancies.** Nonindustrial additive manufacturing shall be permitted in all occupancy groups.

**320.3 Industrial additive manufacturing.** Industrial additive manufacturing equipment and operations shall comply with Sections 320.3.1 through 320.3.12.

**320.3.1 Permits required.** Permits shall be obtained from the *fire code official* in accordance with Section 105.5 prior to engaging in industrial additive manufacturing operations.

**320.3.2 Listing.** 3D printers used in industrial additive manufacturing shall be *listed* and *labeled* in accordance with UL 2011 or *approved* for the application based on a field evaluation conducted by an *approved* agency.

**320.3.3 Combustible dusts and metals.** Industrial additive manufacturing operations that store, use or produce combustible dust, combustible particulate solids or combustible metals shall comply with Chapter 22 and this section.

**320.3.4 Powder evaluation.** Printing powders used in industrial additive manufacturing operations shall be tested for combustibility in accordance with NFPA 484 or NFPA 652 as applicable. A copy of test reports shall be provided to the *fire code official* upon request.

**320.3.5 Combustible (nonmetallic) dusts.** Industrial additive manufacturing operations that store, use or produce combustible (nonmetallic) dusts shall comply with NFPA 654.

**320.3.6 Combustible metals.** Industrial additive manufacturing operations that store or use combustible metals shall comply with NFPA 484.

**320.3.7 Ancillary equipment.** Ancillary equipment provided for recycling, sieving, vacuuming or handling combustible powders shall be designed and *approved* for such use.

**320.3.8 Hazardous materials.** Industrial additive manufacturing operations that store or use hazardous materials exceeding the maximum allowable quantity limits shall comply with Chapter 50.

**320.3.9 Inert gas.** Additive manufacturing processes that utilize inert gases shall comply with Chapter 53. Ventilation or gas detection shall be provided in accordance with Section 5307.

**320.3.10 Technical assistance.** Where required by the *fire code official*, a report evaluating the acceptability of technologies, processes, products, facilities, materials and uses associated with the operation shall be provided in accordance with Section 104.8.2 and *approved*.

## GENERAL REQUIREMENTS

**320.3.11 Performance-based design alternative.** Where *approved* by the *fire code official*, buildings and facilities where industrial additive manufacturing is performed shall be permitted to comply with the performance-based design options in Section 5001.3 as an alternative to compliance with the other requirements set forth in this section.

**320.3.12 Occupancies.** Industrial additive manufacturing shall be conducted only in the occupancy groups associated with manufacturing operation and permitted by the Chapter 50 maximum allowable quantity tables. Where *approved*, the requirements in Section 320.3.6 shall be permitted to provide the technical basis for determining compliance with Table 5003.1.1(1), Note q.

### SECTION 321 ARTIFICIAL COMBUSTIBLE VEGETATION

**321.1 Artificial combustible vegetation on roofs and near buildings.** Artificial combustible vegetation exceeding 6 feet (1829 mm) in height and permanently installed outdoors within 5 feet (1524 mm) of a building or on the roof of a building shall comply with Section 807.4.1. The placement of artificial combustible vegetation shall also comply with Sections 806.3 and 807.4.2.

**Exception:** Artificial decorative vegetation located more than 30 feet (9144 mm) from the exterior wall of a building.

## CHAPTER 4

# EMERGENCY PLANNING AND PREPAREDNESS

### User note:

**About this chapter:** Chapter 4 addresses the human contribution to life safety in buildings when a fire or other emergency occurs. The requirements for continuous training and scheduled fire, evacuation and lockdown drills can be as important as the required periodic inspections and maintenance of built-in fire protection features. The level of preparation by the occupants also improves the emergency responders' abilities during an emergency. The International Building Code® focuses on built-in fire protection features, such as automatic sprinkler systems, fire-resistance-rated construction and properly designed egress systems, whereas this chapter fully addresses the human element.

### SECTION 401 GENERAL

**401.1 Scope.** Reporting of emergencies, coordination with emergency response forces, emergency plans and procedures for managing or responding to emergencies shall comply with the provisions of this section.

**Exception:** Firms that have *approved* on-premises fire-fighting organizations and that are in compliance with *approved* procedures for fire reporting.

**401.2 Approval.** Where required by this code, fire safety plans, emergency procedures and employee training programs shall be *approved* by the *fire code official*.

**401.3 Emergency responder notification.** Notification of emergency responders shall be in accordance with Sections 401.3.1 through 401.3.3.

**401.3.1 Fire events.** In the event an unwanted fire occurs on a property, the *owner* or occupant shall immediately report such condition to the fire department.

**401.3.2 Alarm activations.** Upon activation of a fire alarm signal, employees or staff shall immediately notify the fire department.

**401.3.3 Delayed notification.** A person shall not, by verbal or written directive, require any delay in the reporting of a fire to the fire department.

**401.4 Required plan implementation.** In the event an unwanted fire is detected in a building or a fire alarm activates, the emergency plan shall be implemented.

**401.5 Making false report.** A person shall not give, signal or transmit a false alarm.

**401.6 Emergency evacuation drills.** The sounding of a fire alarm signal and the carrying out of an emergency evacuation drill in accordance with the provisions of Section 405 shall be allowed.

**401.7 Unplanned evacuation.** Evacuations made necessary by the unplanned activation of a fire alarm system or by any other emergency shall not be substituted for a required evacuation drill.

**401.8 Interference with fire department operations.** It shall be unlawful to interfere with, attempt to interfere with,

conspire to interfere with, obstruct or restrict the mobility of or block the path of travel of a fire department emergency vehicle in any way, or to interfere with, attempt to interfere with, conspire to interfere with, obstruct or hamper any fire department operation.

### SECTION 402 DEFINITIONS

**402.1 Definitions.** The following terms are defined in Chapter 2:

**EMERGENCY EVACUATION DRILL.**  
**LOCKDOWN.**

### SECTION 403 EMERGENCY PREPAREDNESS REQUIREMENTS

**403.1 General.** In addition to the requirements of Section 401, occupancies, uses and outdoor locations shall comply with the emergency preparedness requirements set forth in Sections 403.2 through 403.11.3.3. Where a fire safety and evacuation plan is required by Sections 403.2 through 403.10.5, evacuation drills shall be in accordance with Section 405 and employee training shall be in accordance with Section 406.

**403.2 Group A occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group A *occupancies*, other than those occupancies used exclusively for purposes of religious worship with an *occupant load* less than 2,000, and for buildings containing both a Group A occupancy and an atrium. Group A occupancies shall comply with Sections 403.2.1 through 403.2.4.

**403.2.1 Seating plan.** In addition to the requirements of Section 404.2, the fire safety and evacuation plans for assembly occupancies shall include a detailed seating plan, *occupant load* and *occupant load* limit. Deviations from the *approved* plans shall be allowed provided that the *occupant load* limit for the occupancy is not exceeded and the aisles and *exit* accessways remain unobstructed.



## EMERGENCY PLANNING AND PREPAREDNESS

**403.2.2 Announcements.** In theaters, motion picture theaters, auditoriums and similar assembly occupancies in Group A used for noncontinuous programs, an audible announcement shall be made not more than 10 minutes prior to the start of each program to notify the occupants of the location of the exits to be used in the event of a fire or other emergency.

**Exception:** In motion picture theaters, the announcement is allowed to be projected on the screen in a manner *approved* by the *fire code official*.

**403.2.3 Fire watch personnel.** Fire watch personnel shall be provided where required by Section 403.11.1.

**403.2.4 Crowd managers.** Crowd managers shall be provided where required by Section 403.11.3.

**403.3 Group B occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group B occupancy where the Group B occupancy has an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge* and for buildings having an ambulatory care facility.

**403.3.1 Ambulatory care facilities.** Ambulatory care facilities shall comply with the requirements of Sections 401, 403.3.1.1 through 403.3.1.2 and 404 through 406.

**403.3.1.1 Fire safety and evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include a description of special staff actions. This shall include procedures for stabilizing care recipients in a defend-in-place response, staged evacuation, or full evacuation in conjunction with the entire building if part of a multitenant facility.

**403.3.1.1.1 Fire safety plan.** A copy of the fire safety plan shall be maintained at the facility at all times. The plan shall include all of the following in addition to the requirements of Section 404:

1. Locations of care recipients who are rendered incapable of self-preservation.
2. Maximum number of care recipients rendered incapable of self-preservation.
3. Area and extent of each ambulatory care facility.
4. Location of any special locking arrangements.

**403.3.1.2 Staff training.** Staff shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by the staff at intervals not exceeding three months. Training of new staff shall be provided promptly on entrance to duty.

Staff shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

**403.4 Group E occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group E occupancies and for buildings containing both a Group E occupancy and an atrium. Group E occupancies shall comply with Sections 403.4.1 through 403.4.3.

**403.4.1 First emergency evacuation drill.** The first emergency evacuation drill of each school year shall be conducted within 10 days of the beginning of classes.

**403.4.2 Time of day.** Emergency evacuation drills shall be conducted at different hours of the day or evening, during the changing of classes, when the school is at assembly, during the recess or gymnastic periods, or during other times to avoid distinction between drills and actual fires.

**403.4.3 Assembly points.** Outdoor assembly areas shall be designated and shall be located a safe distance from the building being evacuated so as to avoid interference with fire department operations. The assembly areas shall be arranged to keep each class separate to provide accountability of all individuals.

**403.5 Group F occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group F occupancy where any of the following conditions apply:

1. The Group F occupancy has an *occupant load* of 500 or more persons.
2. The Group F occupancy has an *occupant load* of more than 100 persons above or below the lowest *level of exit discharge*.
3. Group F pallet manufacturing and recycling facilities as required by Section 2810.

**403.6 Group H occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group H occupancies.

**403.6.1 Group H-5 occupancies.** Group H-5 occupancies shall comply with Sections 403.6.1.1 through 403.6.1.4.

**403.6.1.1 Plans and diagrams.** In addition to the requirements of Section 404 and Section 407.6, plans and diagrams shall be maintained in *approved* locations indicating the approximate plan for each area; the amount and type of HPM stored, handled and used; locations of shutoff valves for HPM supply piping; emergency telephone locations and locations of *exits*.

**403.6.1.2 Plan updating.** The plans and diagrams required by Sections 404, 403.6.1.1 and 407.6 shall be maintained up-to-date and the *fire code official* and fire department shall be informed of major changes.

**403.6.1.3 Emergency response team.** Responsible persons shall be designated as an on-site emergency response team and trained to be liaison personnel for the fire department. These persons shall aid the fire department in preplanning emergency responses, iden-

tifying locations where HPM is stored, handled and used, and be familiar with the chemical nature of such material. An adequate number of personnel for each work shift shall be designated.

**403.6.1.4 Emergency drills.** Emergency drills of the on-site emergency response team shall be conducted on a regular basis but not less than once every three months. Records of drills conducted shall be maintained.

**403.7 Group I occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group I occupancies. Group I occupancies shall comply with Sections 403.7.1 through 403.7.3.6.

**403.7.1 Group I-1 occupancies.** Group I-1 occupancies shall comply with Sections 403.7.1.1 through 403.7.1.7.

**403.7.1.1 Fire safety and evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include a description of special staff actions. Plans shall include all of the following in addition to the requirements of Section 404:

1. Procedures for full evacuation of care recipients.
2. In Group I-1, Condition 2, procedures for staged evacuation of care recipients through a refuge area in an adjacent *smoke compartment* and then to an exterior assembly point.
3. Shall be amended or revised upon admission of any resident care recipient with unusual needs.

**403.7.1.1.1 Fire safety plan.** A copy of the fire safety plan shall be maintained at the facility at all times. The plan shall include the following in addition to the requirements of Section 404.2.2:

1. Location and number of care recipient sleeping rooms.
2. Location of special locking arrangements.

**403.7.1.2 Staff training.** Staff shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by staff at intervals not exceeding three months. Training of new staff shall be provided promptly upon entrance to duty.

Staff shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

**403.7.1.3 Resident training.** Residents capable of assisting in their own evacuation shall be trained in the proper actions to take in the event of a fire. In Group I-1, Condition 2 occupancies, training shall include evacuation through an adjacent *smoke compartment* and then to an exterior assembly point. The training shall include actions to take if the primary escape route is blocked. Residents shall be trained to assist each

other in case of fire to the extent their physical and mental abilities permit them to do so without additional personal risk.

**403.7.1.4 Drill frequency.** In addition to the evacuation drills required in Section 405.3, staff shall participate in drills an additional two times a year on each shift. Twelve drills with all occupants shall be conducted in the first year of operation.

**403.7.2 Group I-2 occupancies.** Group I-2 occupancies shall comply with Sections 403.7.2.1 through 403.7.2.4.

**403.7.2.1 Fire safety and evacuation plan.** The fire safety and evacuation plans required by Section 404 shall include a description of special staff *actions*. Plans shall include all of the following in addition to the requirements of Section 404:

1. Procedures for evacuation for care recipients with needs for containment or restraint and post-evacuation containment, where present.
2. A written plan for maintenance of the *means of egress*.
3. Procedure for a defend-in-place strategy.
4. Procedures for a full-floor or building evacuation, where necessary.
5. In Group I-2, Condition 2, amendments or revisions upon admission of any care recipients with unusual needs.

**403.7.2.2 Fire safety plan.** A copy of the fire safety plan shall be maintained at the facility at all times. The plan shall include all of the following in addition to the requirements of Section 404.2.2:

1. Location and number of care recipient sleeping rooms and operating rooms.
2. Location of special locking arrangements.

**403.7.2.3 Staff training.** Staff shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by staff at intervals not exceeding three months. Training of new staff shall be provided promptly upon entrance to duty.

Staff shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

**403.7.2.4 Emergency evacuation drills.** Emergency evacuation drills shall comply with Section 405.

**403.7.2.5 Fire loss prevention in operating rooms.** Fire protection features and procedures for fire loss prevention in surgical operating rooms shall comply with NFPA 99, Section 16.13.

**403.7.3 Group I-3 occupancies.** Group I-3 occupancies shall comply with Sections 403.7.3.1 through 403.7.3.6.

## EMERGENCY PLANNING AND PREPAREDNESS

**403.7.3.1 Fire safety and evacuation plans.** The fire safety and evacuation plans required by Section 404 shall include a description of special staff actions. Plans shall include all of the following in addition to the requirements of Section 404:

1. Procedures for evacuation of detainees with needs for containment or restraint and post-evacuation containment, where present.
2. Procedures for a defend-in-place strategy.
3. Procedures for a full-floor or building evacuation, where necessary.

**403.7.3.2 Fire safety plan.** A copy of the fire safety plan shall be maintained at the facility at all times. The plan shall include both of the following in addition to the requirements of Section 404.2.2:

1. Location and number of cells.
2. Location of special locking arrangements.

**403.7.3.3 Staff training.** Staff shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by staff at intervals not exceeding three months. Training of new staff shall be provided promptly upon entrance to duty.

Staff shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

**403.7.3.4 Staffing.** Group I-3 occupancies shall be provided with 24-hour staffing. A staff person shall be within three floors or 300 feet (91 440 mm) horizontal distance of the access door of each resident housing area. In Group I-3 Conditions 3, 4 and 5, as defined in Chapter 2, the arrangement shall be such that the staff involved can start release of locks necessary for emergency evacuation or rescue and initiate other necessary emergency actions within 2 minutes of an alarm.

**Exception:** A staff person shall not be required to be within three floors or 300 feet (91 440 mm) horizontal distance of the access door of each resident housing area in areas in which all locks are unlocked remotely and automatically in accordance with Section 408.4 of the *International Building Code*.

**403.7.3.5 Notification.** Provisions shall be made for residents in Group I-3 Conditions 3, 4 and 5, as defined in Chapter 2, to readily notify staff of an emergency.

**403.7.3.6 Keys.** Keys necessary for unlocking doors installed in a *means of egress* shall be individually identifiable by both touch and sight.

**403.8 Group M occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for buildings containing a Group M occupancy where the Group M occupancy has an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge* and for buildings containing both a Group M occupancy and an atrium.

**403.9 Group R occupancies.** Group R occupancies shall comply with Sections 403.9.1 through 403.9.3.4.

**403.9.1 Group R-1 occupancies.** An approved fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-1 occupancies. Group R-1 occupancies shall comply with Sections 403.9.1.1 through 403.9.1.3.

**403.9.1.1 Evacuation diagrams.** A diagram depicting two evacuation routes shall be posted on or immediately adjacent to every required egress door from each hotel or motel *sleeping unit*.

**403.9.1.2 Emergency duties.** Upon discovery of a fire or suspected fire, hotel and motel employees shall perform the following duties:

1. Activate the fire alarm system, where provided.
2. Notify the public fire department.
3. Take other action as previously instructed.

**403.9.1.3 Fire safety and evacuation instructions.** Information shall be provided in the fire safety and evacuation plan required by Section 404 to allow guests to decide whether to evacuate to the outside, evacuate to an *area of refuge*, remain in place, or any combination of the three.

**403.9.2 Group R-2 occupancies.** Group R-2 occupancies shall comply with Sections 403.9.2.1 through 403.9.2.3.

**403.9.2.1 College and university buildings.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-2 college and university buildings. Group R-2 college and university buildings shall comply with Sections 403.9.2.1.1 and 403.9.2.1.2.

**403.9.2.1.1 First emergency evacuation drill.** The first emergency evacuation drill of each school year shall be conducted within 10 days of the beginning of classes.

**403.9.2.1.2 Time of day.** Emergency evacuation drills shall be conducted at different hours of the day or evening, during the changing of classes, when school is at assembly, during recess or gymnastic periods or during other times to avoid distinction between drills and actual fires. One required drill shall be held during hours after sunset or before sunrise.

**403.9.2.2 Emergency guide.** Fire emergency guides shall be provided for Group R-2 occupancies. Guide contents, maintenance and distribution shall comply with Sections 403.9.2.2.1 through 403.9.2.2.3.

**403.9.2.2.1 Guide contents.** A fire emergency guide shall describe the location, function and use of fire protection equipment and appliances available for use by residents, including fire alarm systems, smoke alarms and portable fire extinguishers. Guides shall include an emergency evacuation plan for each *dwelling unit*.

**403.9.2.2.2 Emergency guide maintenance.** Emergency guides shall be reviewed and *approved* by the *fire code official*.

**403.9.2.2.3 Emergency guide distribution.** A copy of the emergency guide shall be given to each tenant prior to initial occupancy.

**403.9.2.3 Evacuation diagrams for dormitories.** A diagram depicting two evacuation routes shall be posted on or immediately adjacent to every required egress door from each dormitory *sleeping unit* or *dwelling unit*. Evacuation diagrams shall be reviewed and updated as needed to maintain accuracy.

**403.9.3 Group R-4 occupancies.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for Group R-4 occupancies. Group R-4 occupancies shall comply with Sections 403.9.3.1 through 403.9.3.4.

**403.9.3.1 Fire safety and evacuation plan.** The fire safety and evacuation plan required by Section 404 shall include a description of special staff actions. Plans shall include procedures necessary for full evacuation of care recipients, and shall be amended or revised upon admission of care recipients with unusual needs.

**403.9.3.1.1 Fire safety plan.** A copy of the fire safety plan shall be maintained at the facility at all times. The plan shall include the following in addition to the requirements of Section 404.2.2:

1. Location and number of care recipient sleeping rooms.
2. Location of special locking arrangements.

**403.9.3.2 Staff training.** Staff shall be periodically instructed and kept informed of their duties and responsibilities under the plan. Records of instruction shall be maintained. Such instruction shall be reviewed by staff at intervals not exceeding three months. Training of new staff shall be provided promptly upon entrance to duty.

Staff shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

**403.9.3.3 Resident training.** Residents capable of assisting in their own evacuation shall be trained in the proper actions to take in the event of a fire. The training shall include actions to take if the primary escape route is blocked. Residents shall be trained to assist each other in case of fire to the extent their physical and mental abilities permit them to do so without additional personal risk.

**403.9.3.4 Drill frequency.** In addition to the evacuation drills required in Section 405.3, staff shall participate in drills an additional two times a year on each shift. Twelve drills with all occupants shall be conducted in the first year of operation.

**403.10 Special uses.** Special uses shall be in accordance with Sections 403.10.1 through 403.10.5.

**403.10.1 Covered and open mall buildings.** Covered and open mall buildings shall comply with the requirements of Sections 403.10.1.1 through 403.10.1.6.

**403.10.1.1 Malls and mall buildings exceeding 50,000 square feet.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for covered malls exceeding 50,000 square feet (4645 m<sup>2</sup>) in aggregate floor area and for open mall buildings exceeding 50,000 square feet (4645 m<sup>2</sup>) in aggregate area within the perimeter line.

**403.10.1.2 Lease plan.** In addition to the requirements of Section 404.2.2, a lease plan that includes the following information shall be prepared for each covered and open mall building:

1. Each occupancy, including identification of tenant.
2. Exits from each tenant space.
3. Fire protection features, including the following:
  - 3.1. Fire department connections.
  - 3.2. Fire command center.
  - 3.3. Smoke management system controls.
  - 3.4. Elevators, elevator machine rooms and controls.
  - 3.5. Hose valve outlets.
  - 3.6. Sprinkler and standpipe control valves.
  - 3.7. Areas protected with automatic sprinkler systems and automatic fire-extinguishing systems.
  - 3.8. Automatic fire detector zones.
  - 3.9. Fire barriers.

**403.10.1.3 Lease plan approval.** The lease plan shall be submitted to the *fire code official* for approval, and shall be maintained on-site for immediate reference by responding fire service personnel.

**403.10.1.4 Lease plan revisions.** The lease plans shall be revised annually or as often as necessary to keep them current. Modifications or changes in tenants or occupancies shall not be made without prior approval of the *fire code official* and building official.

**403.10.1.5 Tenant identification.** Tenant identification shall be provided for secondary *exits* from occupied tenant spaces that lead to an *exit corridor* or directly to the exterior of the building. Tenant identification shall be posted on the exterior side of the *exit* or *exit access* door and shall identify the business name and address using plainly legible letters and numbers that contrast with their background.

**Exception:** Tenant identification is not required for anchor stores.



## EMERGENCY PLANNING AND PREPAREDNESS

**403.10.1.6 Unoccupied tenant spaces.** The fire safety and evacuation plan shall provide for compliance with the requirements for unoccupied tenant spaces in Section 311.

**403.10.2 High-rise buildings.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for high-rise buildings.

**403.10.3 Underground buildings.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared and maintained for underground buildings.

**403.10.4 Buildings using occupant evacuation elevators.** In buildings using occupant evacuation elevators in accordance with Section 3008 of the *International Building Code*, the fire safety and evacuation plan and the training required by Sections 404 and 406, respectively, shall incorporate specific procedures for the occupants using such elevators.

**403.10.5 Buildings with high-piled storage.** An *approved* fire safety and evacuation plan in accordance with Section 404 shall be prepared for buildings with *high-piled combustible storage* in any of the following situations:

1. The *high-piled storage area* exceeds 500,000 square feet (46 450 m<sup>2</sup>) for Class I-IV commodities.
2. The *high-piled storage area* exceeds 300,000 square feet (27 870 m<sup>2</sup>) for high-hazard commodities.
3. The *high-piled storage* is located in a Group H occupancy.
4. The *high-piled storage* is located in a Group F occupancy with an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge*.
5. The *high-piled storage* is located in a Group M occupancy with an *occupant load* of 500 or more persons or more than 100 persons above or below the lowest *level of exit discharge*.
6. Where required by the *fire code official* for other *high-piled storage areas*.

**403.11 Special requirements for public safety.** Special requirements for public safety shall be in accordance with Sections 403.11.1 through 403.11.3.3.

**403.11.1 Fire watch personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety in a place of assembly or any other place where people congregate, because of the number of persons, or the nature of the performance, exhibition, display, contest or activity, the *owner*, agent or lessee shall provide one or more fire watch personnel, as required and *approved*. Fire watch personnel shall comply with Sections 403.11.1.1 and 403.11.1.2.

**403.11.1.1 Duty times.** Fire watch personnel shall remain on duty while places requiring a fire watch are

open to the public, or when an activity requiring a fire watch is being conducted.

**403.11.1.2 Duties.** On-duty fire watch personnel shall have the following responsibilities:

1. Keep diligent watch for fires, obstructions to *means of egress* and other hazards.
2. Take prompt measures for remediation of hazards and extinguishment of fires that occur.
3. Take prompt measures to assist in the evacuation of the public from the structures.

**403.11.2 Public safety plan for gatherings.** Where the *fire code official* determines that an indoor or outdoor gathering of persons has an adverse impact on public safety through diminished access to buildings, structures, fire hydrants and fire apparatus access roads or where such gatherings adversely affect public safety services of any kind, the *fire code official* shall have the authority to order the development of or prescribe a public safety plan that provides an *approved* level of public safety and addresses the following items:

1. Emergency vehicle ingress and egress.
2. Fire protection.
3. Emergency egress or escape routes.
4. Emergency medical services.
5. Public assembly areas.
6. The directing of both attendees and vehicles, including the parking of vehicles.
7. Vendor and food concession distribution.
8. The need for the presence of law enforcement.
9. The need for fire and emergency medical services personnel.
10. The need for a weather monitoring person.

**403.11.3 Crowd managers.** Where facilities or events involve a gathering of more than 500 people, crowd managers shall be provided in accordance with Sections 403.11.3.1 through 403.11.3.3.

**403.11.3.1 Number of crowd managers.** Not fewer than two trained crowd managers, and not fewer than one trained crowd manager for each 250 persons or portion thereof, shall be provided for the gathering.

### Exceptions:

1. Outdoor events with fewer than 1,000 persons in attendance shall not require crowd managers.
2. Assembly occupancies used exclusively for religious worship with an *occupant load* not exceeding 1,000 shall not require crowd managers.
3. The number of crowd managers shall be reduced where, in the opinion of the *fire code official*, the fire protection provided by the facility and the nature of the event warrant a reduction.

## EMERGENCY PLANNING AND PREPAREDNESS

**403.11.3.2 Training.** Training for crowd managers shall be *approved*.

**403.11.3.3 Duties.** The duties of crowd managers shall include, but not be limited to:

1. Conduct an inspection of the area of responsibility and identify and address any egress barriers.
2. Conduct an inspection of the area of responsibility to identify and mitigate any fire hazards.
3. Verify compliance with all permit conditions, including those governing pyrotechnics and other special effects.
4. Direct and assist the event attendees in evacuation during an emergency.
5. Assist emergency response personnel where requested.
6. Other duties required by the *fire code official*.
7. Other duties as specified in the fire safety plan.

## SECTION 404 FIRE SAFETY, EVACUATION AND LOCKDOWN PLANS

**404.1 General.** Where required by Section 403, fire safety, evacuation and lockdown plans shall comply with Sections 404.2 through 404.4.1.

**404.2 Contents.** Fire safety, evacuation and lockdown plan contents shall be in accordance with Sections 404.2.1 through 404.2.3.2.

**404.2.1 Fire evacuation plans.** Fire evacuation plans shall include the following:

1. Emergency egress or escape routes and whether evacuation of the building is to be complete by selected floors or areas only or with a defend-in-place response.
2. Procedures for employees who must remain to operate critical equipment before evacuating.
3. Procedures for the use of elevators to evacuate the building where occupant evacuation elevators complying with Section 3008 of the *International Building Code* are provided.
4. Procedures for assisted rescue for persons unable to use the general *means of egress* unassisted.
5. Procedures for accounting for employees and occupants after evacuation has been completed.
6. Identification and assignment of personnel responsible for rescue or emergency medical aid.
7. The preferred and any alternative means of notifying occupants of a fire or emergency.
8. The preferred and any alternative means of reporting fires and other emergencies to the fire department or designated emergency response organization.

9. Identification and assignment of personnel who can be contacted for further information or explanation of duties under the plan.
10. A description of the emergency voice/alarm communication system alert tone and preprogrammed voice messages, where provided.

**404.2.2 Fire safety plans.** Fire safety plans shall include the following:

1. The procedure for reporting a fire or other emergency.
2. The life safety strategy including the following:
  - 2.1. Procedures for notifying occupants, including areas with a private mode alarm system.
  - 2.2. Procedures for occupants under a defend-in-place response.
  - 2.3. Procedures for evacuating occupants, including those who need evacuation assistance.
3. Site plans indicating the following:
  - 3.1. The occupancy assembly point.
  - 3.2. The locations of fire hydrants.
  - 3.3. The normal routes of fire department vehicle access.
4. Floor plans identifying the locations of the following:
  - 4.1. *Exits*.
  - 4.2. Primary evacuation routes.
  - 4.3. Secondary evacuation routes.
  - 4.4. Accessible egress routes.
    - 4.4.1. Areas of refuge.
    - 4.4.2. Exterior areas for assisted rescue.
  - 4.5. Refuge areas associated with *smoke barriers* and *horizontal exits*.
  - 4.6. Manual fire alarm boxes.
  - 4.7. Portable fire extinguishers.
  - 4.8. Occupant-use hose stations.
  - 4.9. Fire alarm annunciators and controls.
5. A list of major fire hazards associated with the normal use and occupancy of the premises, including maintenance and housekeeping procedures.
6. Identification and assignment of personnel responsible for maintenance of systems and equipment installed to prevent or control fires.
7. Identification and assignment of personnel responsible for maintenance, housekeeping and controlling fuel hazard sources.

**404.2.3 Lockdown plans.** Lockdown plans shall only be permitted where such plans are approved by the *fire code official* and are in compliance with Sections 404.2.3.1 and 404.2.3.2.

## EMERGENCY PLANNING AND PREPAREDNESS

**404.2.3.1 Lockdown plan contents.** Lockdown plans shall include the following:

1. Identification of individuals authorized to issue a lockdown order.
2. Security measures used during normal operations, when the building is occupied, that could adversely affect egress or fire department operations.
3. A description of identified emergency and security threats addressed by the plan, including specific lockdown procedures to be implemented for each threat condition.
4. Means and methods of initiating a lockdown plan for each threat, including:
  - 4.1. The means of notifying occupants of a lockdown event, which shall be distinct from the fire alarm signal.
  - 4.2. Identification of each door or other access point that will be secured.
  - 4.3. A description of the means or methods used to secure doors and other access points.
  - 4.4. A description of how locking means and methods are in compliance with the requirements of this code for egress and accessibility.
5. Procedures for reporting to the fire department any lockdown condition affecting egress or fire department operations.
6. Procedures for determining and reporting the presence or absence of occupants to emergency response agencies during a lockdown.
7. Means for providing two-way communication between a central location and each area subject to being secured during a lockdown.
8. Identification of the prearranged signal for terminating the lockdown.
9. Identification of individuals authorized to issue a lockdown termination order.
10. Procedures for unlocking doors and verifying that the *means of egress* has been returned to normal operations upon termination of the lockdown.
11. Training procedures and frequency of lockdown plan drills.

**404.2.3.2 Drills.** Lockdown plan drills shall be conducted in accordance with the approved plan. Such drills shall not be substituted for fire and evacuation drills required by Section 405.3.

**404.3 Maintenance.** Fire safety, evacuation and lockdown plans shall be reviewed or updated annually or as necessitated by changes in staff assignments, occupancy or the physical arrangement of the building.

**404.4 Availability.** Fire safety, evacuation and lockdown plans shall be available in the workplace for reference and review by employees, and copies shall be furnished to the *fire code official* for review on request.

**404.4.1 Distribution.** The fire safety, evacuation and lockdown plans shall be distributed to the tenants and building service employees by the *owner* or *owner's* agent. Tenants shall distribute to their employees applicable parts of the fire safety plan and lockdown plan affecting the employees' actions in the event of a fire or other emergency.

## SECTION 405 EMERGENCY EVACUATION DRILLS

**405.1 General.** Emergency fire and evacuation drills complying with Sections 405.3 through 405.10 shall be conducted not less than annually where fire safety and evacuation plans are required by Section 403 or where required by the *fire code official*. Lockdown plan drills shall be conducted in accordance with the *approved* plan. Such drills shall not be substituted for fire and evacuation drills required by Section 405.3. Drills shall be designed in cooperation with the local authorities.

**405.2 Occupant participation.** Emergency fire and evacuation drills shall involve the actual evacuation of occupants to a selected assembly point and shall provide occupants with experience in exiting through required exits.

### Exceptions:

1. In ambulatory care facilities and Group I-2, the movement of care recipients to a safe area or to the exterior of the building is not required.
2. In Group I-1, Condition 2, the assembly point for residents is permitted to be within an adjacent *smoke compartment*.
3. In Group R-4, actual exiting from emergency escape and rescue openings shall not be required. Opening the emergency escape and rescue openings and signaling for help shall be an acceptable alternative.
4. In Group I-3, Conditions 2 through 5 where a defend-in-place response is permitted, the assembly point for detainees is permitted to be within an adjacent *smoke compartment*.
5. In Group I-3, Conditions 2 through 5, movement of detainees is not required to an assembly point where there are security concerns.

**405.3 Frequency.** Required emergency evacuation drills shall be held at the intervals specified in Table 405.3 or more frequently where necessary to familiarize all occupants with the drill procedure.

## EMERGENCY PLANNING AND PREPAREDNESS

**TABLE 405.3**  
**FIRE AND EVACUATION DRILL**  
**FREQUENCY AND PARTICIPATION**

GROUP OR OCCUPANCY	FREQUENCY	PARTICIPATION
Group A	Quarterly	Staff
Group B <sup>a</sup>	Annually	All occupants
Group B (Ambulatory care facilities)	Quarterly on each shift	Staff
Group B <sup>a</sup> (Clinic, outpatient)	Annually	Staff
Group E	Monthly	All occupants
Group F	Annually	Employees
Group I-1 <sup>c</sup>	Semiannually on each shift	All occupants
Group I-2	Quarterly on each shift	Staff
Group I-3	Quarterly on each shift	Staff
Group I-4	Monthly on each shift	All occupants
Group R-1	Quarterly on each shift	Employees
Group R-2 <sup>b</sup>	Four annually	All occupants
Group R-4 <sup>c</sup>	Semiannually on each shift	All occupants

- a. Emergency evacuation drills are required in Group B buildings having an occupant load of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge.
- b. Emergency evacuation drills in Group R-2 college and university buildings shall be in accordance with Section 403.9.2.1. Other Group R-2 occupancies shall be in accordance with Section 403.9.2.2.
- c. In groups I-1 and R-4, see Sections 403.7.1.4 and 403.9.3.4 for additional drills for staff.

**405.4 Leadership.** Responsibility for the planning and conduct of drills shall be assigned to competent persons designated to exercise leadership.

**405.5 Time.** Drills shall be held at unexpected times and under varying conditions to simulate the unusual conditions that occur in case of fire.

**Exceptions:**

1. In severe climates, the *fire code official* shall have the authority to modify the emergency evacuation drill termination points and frequency.
2. In Groups I-1, I-2, I-3 and R-4, where staff-only emergency evacuation drills are conducted after visiting hours or where care recipients are expected to be asleep, a coded announcement shall be an acceptable alternative to audible alarms.

**405.6 Recordkeeping.** Records shall be maintained of required emergency evacuation drills and include the following information:

1. Identity of the person conducting the drill.
2. Date and time of the drill.
3. Notification method used.

4. Employees on duty and participating.
5. Number of occupants evacuated.
6. Special conditions simulated.
7. Problems encountered.
8. Weather conditions when occupants were evacuated.
9. Time required to accomplish complete evacuation.

**405.7 Notification.** Where required by the *fire code official*, prior notification of emergency evacuation drills shall be given to the *fire code official*.

**405.8 Initiation.** Where a fire alarm system is provided, emergency evacuation drills shall be initiated by activating the fire alarm system.

**405.9 Accountability.** As building occupants arrive at the assembly point, efforts shall be made to determine if all occupants have been successfully evacuated or have been accounted for.

**Exception:** In Group I-2 and ambulatory care facilities, the movement of care recipients to safe areas or to the exterior of the building is not required.

**405.10 Recall and reentry.** An electrically or mechanically operated signal used to recall occupants after an evacuation shall be separate and distinct from the signal used to initiate the evacuation. The recall signal initiation means shall be manually operated and under the control of the person in charge of the premises or the official in charge of the incident. Persons shall not reenter the premises until authorized to do so by the official in charge.

## SECTION 406

### EMPLOYEE TRAINING AND RESPONSE PROCEDURES

**406.1 General.** Where fire safety and evacuation plans are required by Section 403, employees shall be trained in fire emergency procedures based on plans prepared in accordance with Section 404.

**406.2 Frequency.** Employees shall receive training in the contents of fire safety and evacuation plans and their duties as part of new employee orientation and not less than annually thereafter. Records of training shall be maintained.

**406.3 Employee training program.** Employees shall be trained in fire prevention, evacuation and fire safety in accordance with Sections 406.3.1 through 406.3.4.

**406.3.1 Fire prevention training.** Employees shall be apprised of the fire hazards of the materials and processes to which they are exposed. Each employee shall be instructed in the proper procedures for preventing fires in the conduct of their assigned duties.

**406.3.2 Evacuation training.** Employees shall be familiarized with the fire alarm and evacuation signals, their assigned duties in the event of an alarm or emergency, evacuation routes, areas of refuge, exterior assembly areas and procedures for evacuation.



## EMERGENCY PLANNING AND PREPAREDNESS

**406.3.3 Fire safety training.** Employees assigned fire-fighting duties shall be trained to know the locations and proper use of portable fire extinguishers or other manual fire-fighting equipment and the protective clothing or equipment required for its safe and proper use.

**406.3.4 Emergency lockdown training.** Where a facility has a lockdown plan, employees shall be trained on their assigned duties and procedures in the event of an emergency lockdown.

## SECTION 407 HAZARD COMMUNICATION

**407.1 General.** The provisions of Sections 407.2 through 407.7 shall be applicable where hazardous materials subject to permits under Section 5001.5 are located on the premises or where required by the *fire code official*.

**407.2 Safety Data Sheets.** Safety Data Sheets (SDS) for all hazardous materials shall be either readily available on the premises as a paper copy, or where *approved*, shall be permitted to be readily retrievable by electronic access.

**407.3 Identification.** Individual containers of hazardous materials, cartons or packages shall be marked or labeled in accordance with applicable federal regulations. Buildings, rooms and spaces containing hazardous materials shall be identified by hazard warning signs in accordance with Section 5003.5.

**407.4 Training.** Persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used shall be familiar with the chemical nature of the materials and the appropriate mitigating actions necessary in the event of a fire, leak or spill. Responsible persons shall be designated and trained to be liaison personnel for the fire department. These persons shall aid the fire department in preplanning emergency responses and identification of where hazardous materials are located, and shall have access to Safety Data Sheets and be knowledgeable in the site emergency response procedures.

**407.5 Hazardous Materials Inventory Statement.** Where required by the *fire code official*, each application for a permit shall include a Hazardous Materials Inventory Statement (HMIS) in accordance with Section 5001.5.2.

**407.6 Hazardous Materials Management Plan.** Where required by the *fire code official*, each application for a permit shall include a Hazardous Materials Management Plan (HMMP) in accordance with Section 5001.5.1. The *fire code official* is authorized to accept a similar plan required by other regulations.

**407.7 Facility closure plans.** The permit holder or applicant shall submit to the *fire code official* a facility closure plan in accordance with Section 5001.6.3 to terminate storage, dispensing, handling or use of hazardous materials.

# Part III—Building and Equipment Design Features

## CHAPTER 5 FIRE SERVICE FEATURES

### User note:

**About this chapter:** Chapter 5 provides requirements that apply to all buildings and occupancies and pertain to access roads, access to building openings and roofs, premises identification, key boxes, fire protection water supplies, fire command centers, fire department access to equipment and emergency responder radio coverage in buildings. Although many safety features are part of the building design, features such as proper fire department access roads and radio coverage are necessary in case of emergency and are important tools for emergency responders for public safety and their own safety.

### SECTION 501 GENERAL

**501.1 Scope.** Fire service features for buildings, structures and premises shall comply with this chapter.

**501.2 Permits.** A permit shall be required as set forth in Sections 105.5 and 105.6.

**501.3 Construction documents.** *Construction documents* for proposed fire apparatus access, location of *fire lanes*, security gates across fire apparatus access roads and *construction documents* and hydraulic calculations for fire hydrant systems shall be submitted to the fire department for review and approval prior to construction.

**501.3.1 Site safety plan.** The *owner* or *owner's* authorized agent shall be responsible for the development, implementation and maintenance of an *approved* written *site safety plan* in accordance with Section 3303.

**501.4 Timing of installation.** Where fire apparatus access roads or a water supply for fire protection are required to be installed, such protection shall be installed and made serviceable prior to and during the time of construction except where *approved* alternative methods of protection are provided. Temporary street signs shall be installed at each street intersection where construction of new roadways allows passage by vehicles in accordance with Section 505.2.

### SECTION 502 DEFINITIONS

**502.1 Definitions.** The following terms are defined in Chapter 2:

AGENCY.

FIRE APPARATUS ACCESS ROAD.

FIRE COMMAND CENTER.

FIRE DEPARTMENT MASTER KEY.

FIRE LANE.

KEY BOX.

TRAFFIC CALMING DEVICES.

### SECTION 503 FIRE APPARATUS ACCESS ROADS

**503.1 Where required.** Fire apparatus access roads shall be provided and maintained in accordance with Sections 503.1.1 through 503.1.3.

**503.1.1 Buildings and facilities.** *Approved* fire apparatus access roads shall be provided for every facility, building or portion of a building hereafter constructed or moved into or within the jurisdiction. The fire apparatus access road shall comply with the requirements of this section and shall extend to within 150 feet (45 720 mm) of all portions of the facility and all portions of the *exterior walls* of the first story of the building as measured by an *approved* route around the exterior of the building or facility.

#### Exceptions:

1. The *fire code official* is authorized to increase the dimension of 150 feet (45 720 mm) where any of the following conditions occur:
  - 1.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3.
  - 1.2. Fire apparatus access roads cannot be installed because of location on property, topography, waterways, nonnegotiable grades or other similar conditions, and an *approved* alternative means of fire protection is provided.
  - 1.3. There are not more than two Group R-3 or Group U occupancies.
2. Where *approved* by the *fire code official*, fire apparatus access roads shall be permitted to be exempted or modified for solar photovoltaic power generation facilities.

**503.1.2 Additional access.** The *fire code official* is authorized to require more than one fire apparatus access road based on the potential for impairment of a single road by vehicle congestion, condition of terrain, climatic conditions or other factors that could limit access.

## FIRE SERVICE FEATURES

**503.1.3 High-piled storage.** Fire department vehicle access to buildings used for *high-piled combustible storage* shall comply with the applicable provisions of Chapter 32.

**503.2 Specifications.** Fire apparatus access roads shall be installed and arranged in accordance with Sections 503.2.1 through 503.2.8.

**503.2.1 Dimensions.** Fire apparatus access roads shall have an unobstructed width of not less than 20 feet (6096 mm), exclusive of shoulders and curbs, except for *approved* security gates in accordance with Section 503.6, and an unobstructed vertical clearance of not less than 13 feet 6 inches (4115 mm).

**503.2.1.1 Divided entrance.** When guard houses, security stations, medians or other similar obstructions are so located as to create a divided entrance or fire lane, each individual lane shall be a minimum of 15 feet (4572 mm) clear width on each side of the obstruction. Such divisions are not permitted adjacent to fire hydrants or fire department connections, or at any location where a fire apparatus vehicle is expected to be positioned for the duration of a fire event.

**503.2.2 Authority.** The *fire code official* shall have the authority to require or permit modifications to the required access widths where they are inadequate for fire or rescue operations or where necessary to meet the public safety objectives of the jurisdiction.

**503.2.3 Surface.** Fire apparatus access roads shall be designed and maintained to support the imposed loads of fire apparatus and shall be surfaced so as to provide all-weather driving capabilities.

**503.2.4 Turning radius.** The required turning radius of a fire apparatus access road shall be determined by the *fire code official*.

**503.2.5 Dead ends.** Dead-end fire apparatus access roads in excess of 150 feet (45 720 mm) in length shall be provided with an *approved* area for turning around fire apparatus.

**503.2.6 Bridges and elevated surfaces.** Where a bridge or an elevated surface is part of a fire apparatus access road, the bridge shall be constructed and maintained in accordance with AASHTO HB-17. Bridges and elevated surfaces shall be designed for a live load sufficient to carry the imposed loads of fire apparatus. Vehicle load limits shall be posted at both entrances to bridges where required by the *fire code official*. Where elevated surfaces designed for emergency vehicle use are adjacent to surfaces that are not designed for such use, *approved* barriers, *approved* signs or both shall be installed and maintained where required by the *fire code official*.

**503.2.7 Grade.** The grade of the fire apparatus access road shall be within the limits established by the *fire code official* based on the fire department's apparatus.

**503.2.8 Angles of approach and departure.** The angles of approach and departure for fire apparatus access roads shall be within the limits established by the *fire code official* based on the fire department's apparatus.

**503.3 Marking.** Where required by the *fire code official*, *approved* signs or other *approved* notices or markings that include the words "NO PARKING—FIRE LANE" shall be provided for fire apparatus access roads to identify such roads or prohibit the obstruction thereof. The means by which *fire lanes* are designated shall be maintained in a clean and legible condition at all times and be replaced or repaired when necessary to provide adequate visibility. Signs shall be located at each end of a painted curb, and additionally in between so that the maximum separation between the signs is 100 feet (30 480 mm) as measured along the centerline of the fire apparatus road or as approved by the *fire code official* or local authority having jurisdiction.

**503.4 Obstruction of fire apparatus access roads.** Fire apparatus access roads shall not be obstructed in any manner, including the parking of vehicles. The minimum widths and clearances established in Sections 503.2.1 and 503.2.2 shall be maintained at all times.

**503.4.1 Traffic calming devices.** Traffic calming devices shall be prohibited unless *approved* by the *fire code official*.

**503.5 Required gates or barricades.** The *fire code official* is authorized to require the installation and maintenance of gates or other *approved* barricades across fire apparatus access roads, trails or other accessways, not including public streets, alleys or highways. Electric gate operators, where provided, shall be *listed* in accordance with UL 325. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

**503.5.1 Secured gates and barricades.** Where required, gates and barricades shall be secured in an *approved* manner. Roads, trails and other accessways that have been closed and obstructed in the manner prescribed by Section 503.5 shall not be trespassed on or used unless authorized by the *owner* and the *fire code official*.

**Exception:** The restriction on use shall not apply to public officers acting within the scope of duty.

**503.6 Security gates.** The installation of security gates across a fire apparatus access road shall be *approved* by the *fire code official*. Where security gates are installed, they shall have an *approved* means of emergency operation. The security gates and the emergency operation shall be maintained operational at all times. Electric gate operators, where provided, shall be *listed* in accordance with UL 325. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

## SECTION 504

### ACCESS TO BUILDING OPENINGS AND ROOFS

**504.1 Required access.** Exterior doors and openings required by this code or the *International Building Code* shall be maintained readily accessible for emergency access by the fire department. An *approved* access walkway leading from fire apparatus access roads to exterior openings shall be provided where required by the *fire code official*.

**504.2 Maintenance of exterior doors and openings.** Exterior doors and their function shall not be eliminated without prior approval. Exterior doors that have been rendered nonfunctional

and that retain a functional door exterior appearance shall have a sign affixed to the exterior side of the door with the words "THIS DOOR BLOCKED." The sign shall consist of letters having a principal stroke of not less than  $\frac{3}{4}$  inch (19.1 mm) wide and not less than 6 inches (152 mm) high on a contrasting background. Required fire department access doors shall not be obstructed or eliminated. *Exit* and exit access doors shall comply with Chapter 10. Access doors for *high-piled combustible storage* shall comply with Section 3206.7.

**504.3 Stairway access to roof.** New buildings four or more stories above grade plane, except those with a roof slope greater than four units vertical in 12 units horizontal (33.3-percent slope), shall be provided with a *stairway* to the roof. *Stairway* access to the roof shall be in accordance with Section 1011.12. Such *stairway* shall be marked at street and floor levels with a sign indicating that the *stairway* continues to the roof. Where roofs are used for landscaped roofs or for other purposes, stairways shall be provided as required for such occupancy classification.

## SECTION 505 PREMISES IDENTIFICATION

**505.1 Address identification.** New and existing buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 4 inches (102 mm) high with a minimum stroke width of  $\frac{1}{2}$  inch (12.7 mm). Where required by the *fire code official*, address identification shall be provided in additional *approved* locations to facilitate emergency response. Where access is by means of a private road and the building cannot be viewed from the *public way*, a monument, pole or other sign or means shall be used to identify the structure. Address identification shall be maintained.

**505.2 Street or road signs.** Streets and roads shall be identified with *approved* signs. Temporary signs shall be installed at each street intersection when construction of new roadways allows passage by vehicles. Signs shall be of an *approved* size, weather resistant and be maintained until replaced by permanent signs.

## SECTION 506 KEY BOXES

**506.1 Where required.** Where access to or within a structure or an area is restricted because of secured openings or where immediate access is necessary for life-saving or fire-fighting purposes, the *fire code official* is authorized to require a key box to be installed in an *approved* location. The key box shall be of an *approved* type *listed* in accordance with UL 1037, and shall contain keys to gain necessary access as required by the *fire code official*.

- **Exception:** Occupancies requiring restricted access by specific state statutes or rule.

**506.1.1 Locks.** An *approved* lock shall be installed on gates or similar barriers where required by the *fire code official*.

**506.1.2 Key boxes for nonstandardized fire service elevator keys.** Key boxes provided for nonstandardized fire service elevator keys shall comply with Section 506.1 and all of the following:

1. The key box shall be compatible with an existing rapid entry key box system in use in the jurisdiction and *approved* by the *fire code official*.
2. The front cover shall be permanently labeled with the words "FIRE DEPARTMENT USE ONLY—ELEVATOR KEYS."
3. The key box shall be mounted at each elevator bank at the lobby nearest to the lowest level of fire department access.
4. The key box shall be mounted 5 feet 6 inches (1676 mm) above the finished floor to the right side of the elevator bank.
5. Contents of the key box are limited to fire service elevator keys. Additional elevator access tools, keys and information pertinent to emergency planning or elevator access shall be permitted where authorized by the *fire code official*.
6. In buildings with two or more elevator banks, a single key box shall be permitted to be used where such elevator banks are separated by not more than 30 feet (9144 mm). Additional key boxes shall be provided for each individual elevator or elevator bank separated by more than 30 feet (9144 mm).

**Exception:** A single key box shall be permitted to be located adjacent to a *fire command center* or the nonstandard fire service elevator key shall be permitted to be secured in a key box used for other purposes and located in accordance with Section 506.1.

**506.2 Key box maintenance.** The operator of the building shall immediately notify the *fire code official* and provide the new key where a lock is changed or rekeyed. The key to such lock shall be secured in the key box.

## SECTION 507 FIRE PROTECTION WATER SUPPLIES

**507.1 Required water supply.** An *approved* water supply capable of supplying the required fire flow for fire protection shall be provided to premises on which facilities, buildings or portions of buildings are hereafter constructed or moved into or within the jurisdiction.

**507.2 Type of water supply.** A water supply shall consist of reservoirs, pressure tanks, elevated tanks, water mains or other fixed systems capable of providing the required fire flow.

**507.2.1 Private fire service mains.** Private fire service mains and appurtenances shall be installed in accordance with NFPA 24.

**507.2.2 Water tanks.** Water tanks for private fire protection shall be installed in accordance with NFPA 22.

**507.3 Fire flow.** Fire-flow requirements for buildings or portions of buildings and facilities shall be determined by an *approved* method.



## FIRE SERVICE FEATURES

**507.4 Water supply test.** The *fire code official* shall be notified prior to the water supply test. Water supply tests shall be witnessed by the *fire code official* or *approved* documentation of the test shall be provided to the *fire code official* prior to final approval of the water supply system. Water supply tests shall be conducted within 6 months of hydraulic calculation submittal.

**507.5 Fire hydrant systems.** Fire hydrant systems shall comply with Sections 507.5.1 through 507.5.6.

**507.5.1 Where required.** Where a portion of the facility or building hereafter constructed or moved into or within the jurisdiction is more than 400 feet (122 m) from a hydrant on a fire apparatus access road, as measured by an *approved* route around the exterior of the facility or building, on-site fire hydrants and mains shall be provided where required by the *fire code official*.

### Exceptions:

1. For Group R-3 and Group U occupancies, the distance requirement shall be 600 feet (183 m).
2. For buildings equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the distance requirement shall be 600 feet (183 m).

**507.5.1.1 Hydrant for standpipe systems.** Buildings equipped with a standpipe system installed in accordance with Section 905 shall have a fire hydrant within 100 feet (30 480 mm) of the fire department connections.

**Exception:** The distance shall be permitted to exceed 100 feet (30 480 mm) where *approved* by the *fire code official*.

**507.5.2 Inspection, testing and maintenance.** Fire hydrant systems shall be subject to periodic tests as required by the *fire code official*. Fire hydrant systems shall be maintained in an operative condition at all times and shall be repaired where defective. Additions, repairs, alterations and servicing shall comply with *approved* standards. Records of tests and required maintenance shall be maintained.

**507.5.3 Private fire service mains and water tanks.** Private fire service mains and water tanks shall be periodically inspected, tested and maintained in accordance with NFPA 25 at the following intervals:

1. Private fire hydrants of all types: Inspection annually and after each operation; flow test and maintenance annually.
2. Fire service main piping: Inspection of exposed, annually; flow test every 5 years.
3. Fire service main piping strainers: Inspection and maintenance after each use.

Records of inspections, testing and maintenance shall be maintained.

**507.5.4 Obstruction.** Unobstructed access to fire hydrants shall be maintained at all times. The fire department shall not be deterred or hindered from gaining immediate access to fire protection equipment or fire hydrants.

**507.5.5 Clear space around hydrants.** A 3-foot (914 mm) clear space shall be maintained around the circumference of fire hydrants, except as otherwise required or *approved*.

**507.5.6 Physical protection.** Where fire hydrants are subject to impact by a motor vehicle, guard posts or other *approved* means shall comply with Section 312.

## SECTION 508 FIRE COMMAND CENTER

**508.1 General.** Where required by other sections of this code and in all buildings classified as high-rise buildings by the *International Building Code* and in all F-1 and S-1 occupancies with a building footprint greater than 500,000 square feet (46 452 m<sup>2</sup>), a *fire command center* for fire department operations shall be provided and shall comply with Sections 508.1.1 through 508.1.7.

**508.1.1 Location and access.** The location and access to the *fire command center* shall be *approved* by the *fire code official*.

**508.1.2 Separation.** The *fire command center* shall be separated from the remainder of the building by not less than a 1-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assembly* constructed in accordance with Section 711 of the *International Building Code*, or both.

**508.1.3 Size.** The *fire command center* shall be not less than 0.015 percent of the total building area of the facility served or 200 square feet (19 m<sup>2</sup>) in area, whichever is greater, with a minimum dimension of 0.7 times the square root of the room area or 10 feet (3048 mm), whichever is greater.

Where a *fire command center* is required for Group F-1 and S-1 occupancies with a building footprint greater than 500,000 square feet (46 452 m<sup>2</sup>), the *fire command center* shall have a minimum size of 96 square feet (9 m<sup>2</sup>) with a minimum dimension of 8 feet (2438 mm) where *approved* by the *fire code official*.

**508.1.4 Layout approval.** A layout of the *fire command center* and all features required by this section to be contained therein shall be submitted for approval prior to installation.

**508.1.5 Storage.** Storage unrelated to operation of the *fire command center* shall be prohibited.

**508.1.6 Required features.** The *fire command center* shall comply with NFPA 72 and shall contain the following features:

1. The emergency voice/alarm communication system control unit.
2. The fire department communications system.
3. Fire detection and alarm system annunciator.
4. Annunciator unit visually indicating the location of the elevators and whether they are operational.
5. Status indicators and controls for air distribution systems.
6. The fire fighter's control panel required by Section 909.16 for smoke control systems installed in the building.

7. Controls for unlocking *interior exit stairway* doors simultaneously.
  8. Sprinkler valve and water-flow detector display panels.
  9. Emergency and standby power status indicators.
  10. A telephone for fire department use with controlled access to the public telephone system.
  11. Fire pump status indicators.
  12. Schematic building plans indicating the typical floor plan and detailing the building core, *means of egress*, *fire protection systems*, fire-fighter air-replenishment systems, fire-fighting equipment and fire department access, and the location of *fire walls*, *fire barriers*, *fire partitions*, *smoke barriers* and smoke partitions.
  13. An *approved* Building Information Card that includes, but is not limited to, all of the following information:
    - 13.1. General building information that includes: property name, address, the number of floors in the building above and below grade, use and occupancy classification (for mixed uses, identify the different types of occupancies on each floor) and the estimated building population during the day, night and weekend.
    - 13.2. Building emergency contact information that includes: a list of the building's emergency contacts including but not limited to building manager, building engineer and their respective work phone number, cell phone number and email address.
    - 13.3. Building construction information that includes: the type of building construction including but not limited to floors, walls, columns and roof assembly.
    - 13.4. *Exit access stairway* and *exit stairway* information that includes: number of *exit access stairways* and *exit stairways* in building; each *exit access stairway* and *exit stairway* designation and floors served; location where each *exit access stairway* and *exit stairway* discharges, *interior exit stairways* that are pressurized; *exit stairways* provided with emergency lighting; each *exit stairway* that allows reentry; *exit stairways* providing roof access; elevator information that includes: number of elevator banks, elevator bank designation, elevator car numbers and respective floors that they serve; location of elevator machine rooms, control rooms and control spaces; location of sky lobby; and location of freight elevator banks.
    - 13.5. Building services and system information that includes: location of mechanical rooms, location of building management system, location and capacity of all fuel oil tanks, location of emergency generator and location of natural gas service.
    - 13.6. *Fire protection system* information that includes: location of standpipes, location of fire pump room, location of fire department connections, floors protected by automatic sprinklers and location of different types of *automatic sprinkler systems* installed including but not limited to dry, wet and pre-action.
    - 13.7. Hazardous material information that includes: location and quantity of hazardous material.
  14. Work table.
  15. Generator supervision devices, manual start and transfer features.
  16. Public address system, where specifically required by other sections of this code.
  17. Elevator fire recall switch in accordance with ASME A17.1/CSA B44.
  18. Elevator emergency or standby power selector switch(es), where emergency or standby power is provided.
- 508.1.7 Fire command center identification.** The *fire command center* shall be identified by a permanent, easily visible sign stating "FIRE COMMAND CENTER" located on the door to the *fire command center*.

## SECTION 509 FIRE PROTECTION AND UTILITY EQUIPMENT IDENTIFICATION AND ACCESS

**509.1 Identification.** Fire protection equipment shall be identified in an *approved* manner. Rooms containing controls for air-conditioning systems or *fire protection systems* shall be identified for the use of the fire department. *Approved* signs required to identify *fire protection system* equipment and equipment location shall be constructed of durable materials, permanently installed and readily visible.

**509.1.1 Utility identification.** Where required by the *fire code official*, gas shutoff valves, electric meters, service switches and other utility equipment shall be clearly and legibly marked to identify the unit or space that it serves. Identification shall be made in an *approved* manner, readily visible and shall be maintained.

**509.2 Equipment access.** *Approved* access shall be provided and maintained for all *fire protection system* equipment to permit immediate safe operation and maintenance of such equipment. Storage, trash and other materials or objects shall not be placed or kept in such a manner that would prevent such equipment from being readily accessible.

## SECTION 510 EMERGENCY RESPONDER COMMUNICATION COVERAGE

**510.1 Emergency responder communication coverage in new buildings.** *Approved* in-building, two-way emergency responder communication coverage for emergency responders shall be provided in all new buildings. In-building, two-way emergency responder communication coverage within the building shall be based on the existing coverage levels of the public safety communication systems utilized by the jurisdiction, measured at the exterior of the building. This section shall not require improvement of the existing public safety communication systems.

### Exceptions:

1. Where *approved* by the building official and the *fire code official*, a wired communication system in accordance with Section 907.2.13.2 shall be permitted to be installed or maintained instead of an *approved* radio coverage system.
2. Where it is determined by the *fire code official* that the radio coverage system is not needed.
3. In facilities where emergency responder radio coverage is required and such systems, components or equipment required could have a negative impact on the normal operations of that facility, the *fire code official* shall have the authority to accept an automatically activated emergency responder radio coverage system.

**510.2 Emergency responder communication coverage in existing buildings.** Existing buildings shall be provided with *approved* in-building, two-way emergency responder communication coverage for emergency responders as required in Chapter 11.

**510.3 Permit required.** A construction permit for the installation of or modification to in-building, two-way emergency responder communication coverage systems and related equipment is required as specified in Section 105.6.4. Maintenance performed in accordance with this code is not considered a modification and does not require a permit.

**510.4 Technical requirements.** Equipment required to provide in-building, two-way emergency responder communication coverage shall be *listed* in accordance with UL 2524. Systems, components and equipment required to provide the in-building, two-way emergency responder communication coverage system shall comply with Sections 510.4.1 through 510.4.2.8.

**510.4.1 Emergency responder communication coverage system signal strength.** The building shall be considered to have acceptable in-building, two-way emergency responder communication system coverage where signal strength measurements in 95 percent of all areas and 99 percent of areas designated as *critical areas* by the *fire code official* on each floor of the building meet the signal strength requirements in Sections 510.4.1.1 through 510.4.1.3.

**510.4.1.1 Minimum signal strength into the building.** The minimum inbound signal strength shall be

sufficient to provide usable voice communications throughout the coverage area as specified by the *fire code official*. The inbound signal level shall be a minimum of -95dBm throughout the coverage area and sufficient to provide not less than a Delivered Audio Quality (DAQ) of 3.0 or an equivalent Signal-to-Interference-Plus-Noise Ratio (SINR) applicable to the technology for either analog or digital signals.

**510.4.1.2 Minimum signal strength out of the building.** The minimum outbound signal strength shall be sufficient to provide usable voice communications throughout the coverage area as specified by the *fire code official*. The outbound signal level shall be sufficient to provide not less than a DAQ of 3.0 or an equivalent SINR applicable to the technology for either analog or digital signals.

**510.4.1.3 System performance.** Signal strength shall be sufficient to meet the requirements of the applications being utilized by public safety for emergency operations through the coverage area as specified by the *fire code official* in Section 510.4.2.2.

**510.4.2 System design.** The in-building, two-way emergency responder communication coverage system shall be designed in accordance with Sections 510.4.2.1 through 510.4.2.8 and NFPA 1221.

**510.4.2.1 Amplification systems and components.** Buildings and structures that cannot support the required level of in-building, two-way emergency responder communication coverage shall be equipped with systems and components to enhance the radio signals and achieve the required level of in-building, two-way emergency responder communication coverage specified in Sections 510.4.1 through 510.4.1.3. In-building, two-way emergency responder communication systems utilizing radio-frequency-emitting devices and cabling shall be *approved* by the *fire code official*. Prior to installation, all RF-emitting devices shall have the certification of the radio licensing authority and be suitable for public safety use.

**510.4.2.2 Technical criteria.** The *fire code official* shall maintain a document providing the specific technical information and requirements for the in-building, two-way emergency responder communication coverage system. This document shall contain, but not be limited to, the various frequencies required, the location of radio sites, the effective radiated power of radio sites, the maximum propagation delay in microseconds, the applications being used and other supporting technical information necessary for system design.

**510.4.2.3 Standby power.** In-building, two-way emergency responder communication radio coverage systems shall be provided with dedicated standby batteries or provided with 2-hour standby batteries and connected to the facility generator power system in accordance with Section 1203. The standby power supply shall be capable of operating the in-building, two-way emergency responder communication coverage system at 100-percent system capacity for a duration of not less than 12 hours.



**510.4.2.4 Signal booster requirements.** If used, signal boosters shall meet the following requirements:

1. All signal booster components shall be contained in a National Electrical Manufacturer's Association (NEMA) 4-type waterproof cabinet.
2. Battery systems used for the emergency power source shall be contained in a NEMA 3R or higher-rated cabinet.
3. Equipment shall have FCC or other radio licensing authority certification and be suitable for public safety use prior to installation.
4. Where a donor antenna exists, isolation shall be maintained between the donor antenna and all inside antennas to not less than 20dB greater than the system gain under all operating conditions.
5. Active RF-emitting devices used for in-building, two-way emergency responder communication coverage systems shall have built-in oscillation detection and control circuitry.
6. The installation of amplification systems or systems that operate on or provide the means to cause interference on any in-building, two-way emergency responder communication coverage network shall be coordinated and *approved* by the *fire code official*.

**510.4.2.5 System monitoring.** The in-building, two-way emergency responder communication coverage system shall be monitored by a *listed fire alarm control unit*, or where *approved* by the *fire code official*, shall sound an audible signal at a constantly attended on-site location. Automatic supervisory signals shall include the following:

1. Loss of normal AC power supply.
2. System battery charger(s) failure.
3. Malfunction of the donor antenna(s).
4. Failure of active RF-emitting device(s).
5. Low-battery capacity at 70-percent reduction of operating capacity.
6. Failure of critical system components.
7. The communications link between the *fire alarm system* and the in-building, two-way emergency responder communication coverage system.
8. Oscillation of active RF-emitting device(s).

**510.4.2.6 Additional frequencies and change of frequencies.** The in-building, two-way emergency responder communication coverage system shall be capable of modification or expansion in the event frequency changes are required by the FCC or other radio licensing authority, or additional frequencies are made available by the FCC or other radio licensing authority.

**510.4.2.7 Design documents.** The *fire code official* shall have the authority to require “as-built” design documents and specifications for in-building, two-way emergency responder communication coverage systems. The documents shall be in a format acceptable to the *fire code official*.

**510.4.2.8 Radio communication antenna density.** Systems shall be engineered to minimize the near-far effect. In-building, two-way emergency responder communication coverage system designs shall include sufficient antenna density to address reduced gain conditions.

**Exception:** Systems where all portable devices within the same band use active power control features.

**510.5 Installation requirements.** The installation of the in-building, two-way emergency responder communication coverage system shall be in accordance with NFPA 1221 and Sections 510.5.2 through 510.5.5.

**510.5.1 Mounting of the donor antenna(s).** To maintain proper alignment with the system designed donor site, donor antennas shall be permanently affixed on the building or where *approved*, mounted on a movable sled with a clearly visible sign stating “MOVEMENT OR REPOSITIONING OF THIS ANTENNA IS PROHIBITED WITHOUT APPROVAL FROM THE FIRE CODE OFFICIAL.” The antenna installation shall be in accordance with the applicable requirements in the *International Building Code* for weather protection of the building envelope.

**510.5.2 Approval prior to installation.** Amplification systems capable of operating on frequencies licensed to any public safety *agency* by the FCC or other radio licensing authority shall not be installed without prior coordination and approval of the *fire code official*.

**510.5.3 Minimum qualifications of personnel.** The minimum qualifications of the system designer and lead installation personnel shall include both of the following:

1. A valid FCC-issued general radio operators license.
2. Certification of in-building system training issued by an *approved* organization or *approved* school, or a certificate issued by the manufacturer of the equipment being installed.

These qualifications shall not be required where demonstration of adequate skills and experience satisfactory to the *fire code official* is provided.

**510.5.4 Acceptance test procedure.** Where an in-building, two-way emergency responder communication coverage system is required, and upon completion of installation, the building *owner* shall have the radio system tested to verify that two-way coverage on each floor of the building is not less than 95 percent. The test procedure shall be conducted as follows:

1. Each floor of the building shall be divided into a grid of 20 approximately equal test areas.



## FIRE SERVICE FEATURES

2. The test shall be conducted using a calibrated portable radio of the latest brand and model used by the *agency* talking through the *agency's* radio communications system or equipment *approved* by the *fire code official*.
3. Failure of more than one test area shall result in failure of the test.
4. In the event that two of the test areas fail the test, in order to be more statistically accurate, the floor shall be permitted to be divided into 40 equal test areas. Failure of not more than two nonadjacent test areas shall not result in failure of the test. If the system fails the 40-area test, the system shall be altered to meet the 95-percent coverage requirement.
5. A test location approximately in the center of each test area shall be selected for the test, with the radio enabled to verify two-way communications to and from the outside of the building through the public *agency's* radio communications system. Once the test location has been selected, that location shall represent the entire test area. Failure in the selected test location shall be considered to be a failure of that test area. Additional test locations shall not be permitted.
6. The gain values of all amplifiers shall be measured and the test measurement results shall be kept on file with the building *owner* so that the measurements can be verified during annual tests. In the event that the measurement results become lost, the building *owner* shall be required to rerun the acceptance test to reestablish the gain values.
7. As part of the installation, a spectrum analyzer or other suitable test equipment shall be utilized to ensure spurious oscillations are not being generated by the subject signal booster. This test shall be conducted at the time of installation and at subsequent annual inspections.
8. Systems shall be tested using two portable radios simultaneously conducting subjective voice quality checks. One portable radio shall be positioned not greater than 10 feet (3048 mm) from the indoor antenna. The second portable radio shall be positioned at a distance that represents the farthest distance from any indoor antenna. With both portable radios simultaneously keyed up on different frequencies within the same band, subjective audio testing shall be conducted and comply with DAQ levels as specified in Sections 510.4.1.1 and 510.4.1.2.

**510.5.5 FCC compliance.** The in-building, two-way emergency responder communication coverage system installation and components shall comply with all applicable federal regulations including, but not limited to, FCC 47 CFR Part 90.219.

**510.6 Maintenance.** The in-building, two-way emergency responder communication coverage system shall be main-

tained operational at all times in accordance with Sections 510.6.1 through 510.6.4.

**510.6.1 Testing and proof of compliance.** The *owner* of the building or *owner's* authorized agent shall have the in-building, two-way emergency responder communication coverage system inspected and tested annually or where structural changes occur, including additions or remodels that could materially change the original field performance tests. Testing shall consist of the following:

1. In-building coverage test as described in Section 510.5.4.
2. Signal boosters shall be tested to verify that the gain is the same as it was upon initial installation and acceptance or set to optimize the performance of the system.
3. Backup batteries and power supplies shall be tested under load of a period of 1 hour to verify that they will properly operate during an actual power outage. If within the 1-hour test period the battery exhibits symptoms of failure, the test shall be extended for additional 1-hour periods until the integrity of the battery can be determined.
4. All active components shall be checked to verify operation within the manufacturer's specifications.

At the conclusion of the testing, a report, which shall verify compliance with Section 510.5.4, shall be submitted to the *fire code official*.

**510.6.2 Additional frequencies.** The building *owner* shall modify or expand the in-building, two-way emergency responder communication coverage system at his or her expense in the event frequency changes are required by the FCC or other radio licensing authority, or additional frequencies are made available by the FCC or other radio licensing authority. Prior approval of an in-building, two-way emergency responder communication coverage system on previous frequencies does not exempt this section.

**510.6.3 Nonpublic safety system.** Where other nonpublic safety amplification systems installed in buildings reduce the performance or cause interference with the in-building, two-way emergency responder communication coverage system, the nonpublic safety amplification system shall be corrected or removed.

**510.6.4 Field testing.** *Agency* personnel shall have the right to enter onto the property at any reasonable time to conduct field testing to verify the required level of radio coverage.

## CHAPTER 6

# BUILDING SERVICES AND SYSTEMS

### User note:

**About this chapter:** Chapter 6 focuses on building systems and services as they relate to potential safety hazards and when and how they should be installed. This chapter brings together all building system- and service-related issues for convenience and provides a more systematic view of buildings. The following building services and systems are addressed: electrical equipment wiring and hazards, elevator operation, maintenance and fire service keys, fuel-fired appliances, commercial cooking equipment and systems, commercial cooking oil storage, mechanical refrigeration, hyperbaric facilities and clothes dryer exhaust systems. Note that building systems focused on energy systems and components are addressed by Chapter 12. Portions of this chapter were extensively reorganized for the 2021 edition. For clarity, the relocation marginal markings have not been included. For complete information, see the relocations table in the preface information of this code.

### SECTION 601 GENERAL

**601.1 Scope.** The provisions of this chapter shall apply to the installation, operation and maintenance of the following building services and systems:

1. Electrical systems, equipment and wiring.
2. Information technology server rooms.
3. Elevator systems, emergency operation and recall.
4. Fuel-fired appliances, heating systems, chimneys and fuel oil storage.
5. Commercial cooking equipment and systems.
6. Commercial cooking oil storage.
7. Mechanical refrigeration systems.
8. Hyperbaric facilities.
9. Clothes dryer exhaust systems.

**601.2 Hazard abatement.** Operations or conditions deemed unsafe or hazardous by the *fire code official* shall be abated. Equipment, appliances, materials and systems that are modified or damaged and constitute an electrical shock or fire hazard shall not be used.

**601.2.1 Correction of unsafe conditions.** The *fire code official* shall be authorized to require the *owner*, the *owner's* authorized agent, operator or occupant of a building or premises to abate or cause to be abated or corrected such unsafe operations or conditions either by repair, rehabilitation, demolition or other *approved* corrective action in compliance with this code.

### SECTION 602 DEFINITIONS

**602.1 Definitions.** The following terms are defined in Chapter 2:

**COMMERCIAL COOKING APPLIANCES.**

**HOOD.**

**Type I.**

**REFRIGERANT.**

**REFRIGERATING (REFRIGERATION) SYSTEM.**

### SECTION 603 ELECTRICAL EQUIPMENT, WIRING AND HAZARDS

**603.1 General.** Electrical equipment, wiring and systems required by this code or the *International Building Code* shall be installed, used and maintained in accordance with NFPA 70 and Sections 603.2 through 603.10.

**603.1.1 Equipment and wiring.** All electrical equipment, wiring, devices and appliances shall be tested; *listed* and *labeled*; and installed, used and maintained in accordance with NFPA 70 and all instructions included as part of such listing.

**603.1.2 Healthcare facilities.** In Group I-2 facilities, ambulatory care facilities and outpatient clinics, the electrical systems and equipment shall be maintained and tested in accordance with NFPA 99.

**603.2 Abatement of unsafe conditions and electrical hazards.** Conditions that constitute an electrical shock or fire hazard shall be abated.

**603.2.1 Modified or damaged.** Electrical wiring, devices, equipment and appliances that are modified or damaged, and constitute an electrical shock or fire hazard, shall not be used until repaired or replaced in accordance with this code and NFPA 70.

**603.2.2 Open electrical terminations.** Open junction boxes and open-wiring splices shall be prohibited. *Approved* covers shall be provided for all switch and electrical outlet boxes.

**603.3 Illumination.** Illumination shall be provided for service equipment areas, motor control centers and electrical panelboards.

**603.4 Working space and clearances.** Working space around electrical equipment shall be provided in accordance with Section 110.26 of NFPA 70 for electrical equipment rated 1,000 volts or less, and Section 110.32 of NFPA 70 for electrical equipment rated over 1,000 volts. The minimum required working space shall be not less than 30 inches (762 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height in front of electrical service equipment. Where the electrical service equipment is wider than 30

## BUILDING SERVICES AND SYSTEMS

inches (762 mm), the minimum working space shall be not less than the width of the equipment. Storage of materials shall not be located within the designated working space.

**603.4.1 Labeling.** Doors into electrical control panel rooms shall be marked with a plainly visible and legible sign stating “ELECTRICAL ROOM” or similar *approved* wording. The disconnecting means for each service, feeder or branch circuit originating on a switchboard or panelboard shall be legibly and durably marked to indicate its purpose unless such purpose is clearly evident. Where buildings or structures are supplied by more than one power source, markings shall be provided at each service equipment location and at all interconnected electric power production sources identifying all electric power sources at the premises in accordance with NFPA 70.

**603.5 Relocatable power taps and current taps.** The construction and use of current taps and relocatable power taps shall be in accordance with NFPA 70 and this code.

**603.5.1 Listing.** Relocatable power taps shall be *listed* in accordance with UL 1363. Current taps shall be *listed* and *labeled* in accordance with UL 498A.

**603.5.1.1 Listing in Group I-2 occupancies and ambulatory care facilities.** In Group I-2 occupancies and ambulatory care facilities, relocatable power taps shall be listed in accordance with UL 1363 except under the following conditions:

1. In Group I-2, Condition 2 occupancies, relocatable power taps providing power to patient care-related electrical equipment in the patient care vicinity, as defined by NFPA 99, shall be listed in accordance with UL 1363A or UL 60601-1.
2. In Group I-2, Condition 1 facilities, in care recipient rooms using line-operated patient care-related electrical equipment, relocatable power taps in the patient care vicinity, as defined by NFPA 99, shall be listed in accordance with UL 1363A or UL 60601-1.
3. In ambulatory care facilities, relocatable power taps providing power to patient care-related electrical equipment in the patient care vicinity, as defined by NFPA 99, shall be listed in accordance with UL 1363A or UL 60601-1.

**603.5.2 Application and use.** Relocatable power taps and current taps shall be directly connected to a permanently installed receptacle.

**Exceptions:**

1. Where *approved* for use in a Group A occupancy or in a meeting room in a Group B occupancy, not more than five relocatable power taps shall be permitted to be connected together or connected to an extension cord for temporary use to supply power to electronic equipment.

2. Current taps and relocatable power taps shall not be required to connect directly to a permanently installed receptacle outlet where used for 90 days or less for the purpose of testing the performance of such devices.

**603.5.3 Installation.** Relocatable power tap cords shall not extend through walls, ceilings, floors, under doors or floor coverings, or be subject to environmental or physical damage.

**603.6 Extension cords.** Extension cords shall not be a substitute for permanent wiring and shall be *listed* and *labeled* in accordance with UL 817. Extension cords shall not be affixed to structures, extended through walls, ceilings or floors, or under doors or floor coverings, nor shall such cords be subject to environmental damage or physical impact. Extension cords shall be used only with portable appliances. Extension cords marked for indoor use shall not be used outdoors.

**603.6.1 Application and use.** Extension cords shall be plugged directly into an *approved* receptacle, relocatable power tap or current tap and, except for *approved* multi-plug extension cords, shall serve only one portable appliance.

**603.6.2 Ampacity.** The ampacity of the extension cords shall be not less than the rated capacity of the portable appliance supplied by the cord.

**603.6.3 Maintenance.** Extension cords shall be maintained in good condition without splices, deterioration or damage.

**603.6.4 Grounding.** Extension cords shall be grounded where serving grounded portable appliances.

**603.7 Electrical motors.** Electrical motors shall be maintained free from excessive accumulations of oil, dirt, waste and debris.

**603.8 Temporary wiring.** The use of temporary wiring for electrical power and lighting installations shall not exceed a period of 90 days. Temporary wiring methods shall meet the applicable provisions of NFPA 70.

**Exception:** Temporary wiring for electrical power and lighting installations complying with the applicable provisions of NFPA 70 is permitted during periods of construction, remodeling, repair or demolition of buildings, structures, equipment or similar activities.

**603.8.1 Attachment to structures.** Temporary wiring attached to a structure shall be protected from physical damage and supported on insulators spaced not more than 10 feet (3048 mm) apart.

**603.9 Portable, electric space heaters.** Where not prohibited by other sections of this code, portable, electric space heaters shall be permitted to be used in all occupancies in accordance with Sections 603.9.1 through 603.9.5.

**603.9.1 Listed and labeled.** Only *listed* and *labeled* portable, electric space heaters shall be used.

**603.9.2 Power supply.** Portable, electric space heaters shall be plugged directly into an *approved* receptacle.

**603.9.3 Extension cords.** Portable, electric space heaters shall not be plugged into extension cords.

**603.9.4 Prohibited areas.** Portable, electric space heaters shall not be operated within 3 feet (914 mm) of any combustible materials. Portable, electric space heaters shall be operated only in locations for which they are *listed*.

**603.9.5 Group I-2 occupancies and ambulatory care facilities.** Where used in Group I-2 and ambulatory care facilities, portable, electric space heaters shall be limited to those having a heating element that cannot exceed a temperature of 212°F (100°C), and such heaters shall only be used in nonsleeping staff and employee areas.

**603.10 Abandoned wiring in plenums.** Abandoned cables in plenums that are able to be accessed without causing damage, or requiring demolition to the building, shall be tagged for future use or shall be removed.

## SECTION 604 ELEVATOR OPERATION, MAINTENANCE AND FIRE SERVICE KEYS

**604.1 General.** Where elevators and conveying systems are installed, they shall comply with Chapter 30 of the *International Building Code* and Sections 604.2 through 604.7 of this code.

**604.2 Emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more shall comply with the requirements in Chapter 11. New elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with ASME A17.1/CSA B44.

**604.3 Standby power.** In buildings and structures where standby power is required or furnished to operate an elevator, standby power shall be provided in accordance with Section 1203. Operation of the system shall be in accordance with Sections 604.3.1 through 604.3.4.

**604.3.1 Manual transfer.** Standby power shall be manually transferable to all elevators in each bank.

**604.3.2 One elevator.** Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

**604.3.3 Two or more elevators.** Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, not

less than one elevator shall remain operable from the standby power source.

**604.3.4 Machine room ventilation.** Where standby power is connected to elevators, the machine room ventilation or air conditioning shall be connected to the standby power source.

**[BE] 604.4 Emergency signs.** An *approved* pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit *stairways* and not to use the elevators in case of fire. The sign shall read: "IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRS."

### Exceptions:

1. The emergency sign shall not be required for elevators that are part of an accessible *means of egress* complying with Section 1009.4.
2. The emergency sign shall not be required for elevators that are used for occupant self-evacuation in accordance with Section 3008 of the *International Building Code*.

**604.5 Maintenance of elevators.** Elevator features and lobbies required by Section 3006 of the *International Building Code* shall be maintained in accordance with Sections 604.5.1 through 604.5.4.

**604.5.1 Fire service access elevators and lobbies.** Where fire service access elevators are required by Section 3007 of the *International Building Code*, fire service access elevator fire protection and safety features and lobbies required by Section 3007 of the *International Building Code* shall be maintained free of storage and furniture.

**604.5.2 Occupant evacuation elevators and lobbies.** Where occupant evacuation elevators are provided in accordance with Section 3008 of the *International Building Code*, occupant evacuation elevator fire protection and safety features and lobbies required by Section 3008 of the *International Building Code* shall be maintained free of storage and furniture.

**604.5.3 Storage within elevator lobbies.** Where hoistway opening protection is required by Section 3006.2 of the *International Building Code*, elevator lobbies shall be maintained free of storage.

**604.5.4 Water protection of hoistway enclosures.** Methods to prevent water from infiltrating into a hoistway enclosure required by Sections 3007.3 and 3008.3 of the *International Building Code* shall be maintained.

**604.6 Elevator keys.** All elevators shall be provided with elevator car door and fire-fighter service keys in accordance with Sections 604.6.1 through 604.6.2.4.

**604.6.1 Elevator key location.** Keys for the elevator car doors and fire-fighter service keys shall be kept in an *approved* location for immediate use by the fire department.

**604.6.2 Standardized fire service elevator keys.** Buildings with elevators equipped with Phase I emergency recall, Phase II emergency in-car operation, or a fire



## BUILDING SERVICES AND SYSTEMS

service access elevator shall be equipped to operate with a standardized fire service elevator key *approved* by the *fire code official* or a standardized key in accordance with ASME A17.1/CSA B44.

**Exception:** The *owner* shall be permitted to place the building's nonstandardized fire service elevator keys in a key box installed in accordance with Section 506.1.2.

**604.6.2.1 Requirements for standardized fire service elevator keys.** Standardized fire service elevator keys shall comply with all of the following:

1. All fire service elevator keys within the jurisdiction shall be uniform and *approved* in accordance with Section 604.6.2. Keys shall be cut to a uniform key code.
2. Fire service elevator keys shall be of a patent-protected design to prevent unauthorized duplication.
3. Fire service elevator keys shall be factory restricted by the manufacturer to prevent the unauthorized distribution of key blanks. Uncut key blanks shall not be permitted to leave the factory.
4. Fire service elevator keys subject to these rules shall be engraved with the words "DO NOT DUPLICATE."

**604.6.2.2 Access to standardized fire service keys.** Access to standardized fire service elevator keys shall be restricted to the following:

1. Elevator owners or their authorized agents.
2. Elevator contractors.
3. Elevator inspectors of the jurisdiction.
4. *Fire code officials* of the jurisdiction.
5. The fire department and other emergency response agencies designated by the *fire code official*.

**604.6.2.3 Duplication or distribution of keys.** A person shall not duplicate a standardized fire service elevator key or issue, give, or sell a duplicated key unless in accordance with this code.

**604.6.2.4 Responsibility to provide keys.** The building *owner* shall provide up to three standardized fire service elevator keys where required by the *fire code official*, upon installation of a standardized fire service key switch or switches in the building.

**604.7 Storage.** Storage is prohibited in elevator cars or elevator machine rooms.

**Exceptions:**

1. Blankets used for protection of elevator cab walls during construction or renovation.
2. Materials necessary for the operation and maintenance of the elevator equipment.

## SECTION 605 FUEL-FIRED APPLIANCES

**605.1 General.** The design, construction, installation, operation, alteration, repair and maintenance of nonportable gas-fired appliances and systems shall comply with the provisions of this section and the *International Fuel Gas Code*. The design, construction, installation, operation, alteration, repair and maintenance of nonportable solid fuel-fired and oil-fired appliances and systems shall comply with the provisions of this section and the *International Mechanical Code*. The construction and use of portable fuel-fired appliances not connected to a fixed fuel piping system, such as blow torches, melting pots and weed burners, shall comply with this section.

**605.1.1 Installation of nonportable fuel-fired appliances.** The installation of nonportable fuel-fired appliances shall be made in accordance with the manufacturer's installation instructions and applicable federal, state and local rules and regulations.

**605.1.2 Electrical wiring and equipment.** Electrical wiring and equipment used in connection with fuel-fired appliances and equipment shall be installed and maintained in accordance with Section 603 and NFPA 70.

**605.1.3 Fuel oil.** The grade of fuel oil used in an oil burner shall be that for which the oil burner is *approved* and as stipulated by the oil burner manufacturer's instructions. Oil containing gasoline shall not be used. Waste crankcase oil shall be an acceptable fuel in Group F, M and S occupancies where utilized in equipment *listed* and *labeled* for use with waste oil and where such equipment is installed in accordance with the manufacturer's instructions and the terms of its listing.

**605.1.4 Access.** The installation of fuel-fired equipment shall be provided with access to equipment for cleaning hot surfaces; removing burners; replacing motors, controls, air filters, chimney and vent connectors, draft regulators and other working parts; and for adjusting, cleaning and lubricating parts.

**605.1.5 Testing, diagrams and instructions.** After installation of the fuel-fired equipment, operation and combustion performance tests shall be conducted to determine that the equipment is in proper operating condition and that all accessory equipment, controls, and safety devices function properly.

**605.1.5.1 Diagrams.** Contractors installing industrial oil-burning systems shall furnish not less than two copies of diagrams showing the main oil lines and controlling valves, one copy of which shall be posted at the oil-burning equipment and another at an *approved* location that will be available in case of emergency.

**605.1.5.2 Operating instructions.** After completing the installation, the installer shall instruct the *owner* or operator in the proper operation of the equipment. The installer shall furnish the *owner* or operator with the manufacturer's operating instructions.

**605.1.6 Clearances.** Working clearances between fuel-fired appliances and electrical panelboards and equipment shall be in accordance with NFPA 70. Clearances between oil-fired equipment and oil supply tanks shall be in accordance with NFPA 31.

**605.2 Abatement of unsafe conditions.** The *fire code official* is authorized to order that measures be taken to prevent the operation of any existing stove, oven, furnace, incinerator, boiler or any other heat-producing device or appliance found to be defective or in violation of code requirements for existing appliances after giving notice to this effect to any person, *owner*, firm or agent or operator in charge of the same. The *fire code official* is authorized to take measures to prevent the operation of any device or appliance without notice when inspection shows the existence of an immediate fire hazard or when imperiling human life. The defective device shall remain withdrawn from service until all necessary repairs or *alterations* have been made or replaced in accordance with Section 605.1.

**605.2.1 Chimneys and appliances.** Chimneys, vents, incinerators, smokestacks or similar devices for conveying smoke or hot gases to the outer air and the appliances such as stoves, furnaces, fireboxes or boilers to which such devices are connected, shall be maintained so as not to create a fire hazard.

**605.2.1.1 Masonry chimneys.** Masonry chimneys that, upon inspection, are found to be without a flue liner and that have open mortar joints which will permit smoke or gases to be discharged into the building, or which are cracked as to be dangerous, shall be repaired or relined with a *listed* chimney liner system installed in accordance with the manufacturer's instructions and the *International Mechanical Code* or a flue lining system installed in accordance with the requirements of the *International Building Code* and appropriate for the intended class of chimney service.

**605.2.1.2 Metal chimneys.** Metal chimneys that are corroded or improperly supported shall be repaired or replaced in accordance with the *International Mechanical Code*.

**605.2.1.3 Decorative shrouds.** Decorative shrouds installed at the termination of factory-built chimneys or vents shall be removed except where such shrouds are *listed* and *labeled* for use with the specific factory-built chimney system and are installed in accordance with the chimney or vent manufacturer's instructions and the *International Mechanical Code* or *International Fuel Gas Code*.

**605.2.1.4 Factory-built chimney and vent systems.** Existing factory-built chimneys and vent systems that are damaged, corroded or improperly supported shall be repaired or replaced in accordance with the *International Mechanical Code*.

**605.2.1.5 Connectors.** Existing chimney and vent connectors that are damaged, corroded or improperly supported shall be repaired or replaced in accordance with the *International Mechanical Code*.

**605.3 Chimneys and vents.** Masonry chimneys shall be constructed in accordance with the *International Building Code*. Factory-built chimneys and vent systems serving solid-fuel-fired appliances or oil-fired appliances shall be installed in accordance with the *International Mechanical Code*. Metal chimneys shall be constructed and installed in accordance with the *International Mechanical Code*. Factory-built chimneys and vent systems serving gas-fired appliances shall be installed in accordance with the *International Fuel Gas Code*.

**605.4 Fuel oil storage systems.** Fuel oil storage systems for building heating systems shall be installed and maintained in accordance with this code. Tanks and fuel-oil piping systems shall be installed in accordance with Chapter 13 of the *International Mechanical Code*.

**605.4.1 Fuel oil storage in outside, above-ground tanks.** Where connected to a fuel-oil piping system, the maximum amount of fuel oil storage allowed outside above ground without additional protection shall be 660 gallons (2498 L). The storage of fuel oil above ground in quantities exceeding 660 gallons (2498 L) shall comply with NFPA 31.

**605.4.1.1 Approval.** Outdoor fuel oil storage tanks shall be in accordance with UL 80, UL 142 or UL 2085.

**605.4.2 Fuel oil storage inside buildings.** Fuel oil storage inside buildings shall comply with Sections 605.4.2.2 through 605.4.2.8 or Chapter 57.

**605.4.2.1 Approval.** Indoor fuel oil storage tanks shall be in accordance with UL 80, UL 142 or UL 2085.

**605.4.2.2 Quantity limits.** One or more fuel oil storage tanks containing Class II or III *combustible liquid* shall be permitted in a building. The aggregate capacity of all tanks shall not exceed the following:

1. 660 gallons (2498 L) in unsprinklered buildings, where stored in a tank complying with UL 80, UL 142 or UL 2085.
2. 1,320 gallons (4996 L) in buildings equipped with an *automatic sprinkler* system in accordance with Section 903.3.1.1, where stored in a tank complying with UL 142. The tank shall be *listed* as a secondary containment tank, and the secondary containment shall be monitored visually or automatically.
3. 3,000 gallons (11 356 L) in buildings equipped with an automatic sprinkler system in accordance with Section 903.3.1.1, where stored in protected above-ground tanks complying with UL 2085 and Section 5704.2.9.7. The tank shall be *listed* as a secondary containment tank, as required by UL 2085, and the secondary containment shall be monitored visually or automatically.

**605.4.2.3 Restricted use and connection.** Tanks installed in accordance with Section 605.4.2 shall be used only to supply fuel oil to fuel-burning equipment, generators or fire pumps installed in accordance with

Section 605.4.2.5. Connections between tanks and equipment supplied by such tanks shall be made using closed piping systems in accordance with the *International Mechanical Code*.

**605.4.2.4 Applicability of maximum allowable quantity and control area requirements.** The quantity of *combustible liquid* stored in tanks complying with Section 605.4.2 shall not be counted towards the maximum allowable quantity set forth in Table 5003.1.1(1), and such tanks shall not be required to be located in a *control area*.

**605.4.2.5 Installation.** Tanks and piping systems shall be installed in accordance with Section 915 and Chapter 13, both of the *International Mechanical Code*, as applicable.

**605.4.2.6 Separation.** Rooms containing fuel oil tanks for internal combustion engines shall be separated from the remainder of the building by *fire barriers*, *horizontal assemblies*, or both, with a minimum 1-hour *fire-resistance rating* with 1-hour fire-protection-rated *opening protectives* constructed in accordance with the *International Building Code*.

**Exception:** Rooms containing protected above-ground tanks complying with Section 5704.2.9.7 shall not be required to be separated from surrounding areas.

**605.4.2.7 Spill containment.** Tanks exceeding 60-gallon (227 L) capacity or an aggregate capacity of 1,000 gallons (3785 L) that are not provided with integral secondary containment shall be provided with spill containment sized to contain a release from the largest tank.

**605.4.2.8 Tanks in basements.** Tanks in *basements* shall be located not more than two stories below *grade plane*.

**605.4.3 Underground storage of fuel oil.** The storage of fuel oil in underground storage tanks shall comply with UL 58 or UL 1316 and be installed in accordance with NFPA 31.

**605.5 Portable unvented heaters.** Portable unvented fuel-fired heating equipment shall be prohibited in occupancies in Groups A, E, I, R-1, R-2, R-3 and R-4 and ambulatory care facilities.

**Exceptions:**

1. Portable unvented fuel-fired heaters *listed* in accordance with UL 647 are permitted to be used in one- and two-family dwellings, where operated and maintained in accordance with the manufacturer's instructions.
2. Portable outdoor gas-fired heating appliances in accordance with Section 605.5.2.

**605.5.1 Prohibited locations.** Unvented fuel-fired heating equipment shall not be located in, or obtain combustion air from, any of the following rooms or spaces: sleeping rooms, bathrooms, toilet rooms or storage closets.

**605.5.2 Portable outdoor gas-fired heating appliances.**

Portable gas-fired heating appliances located outdoors shall be in accordance with Sections 605.5.2.1 through 605.5.2.3.4.

**605.5.2.1 Location.** Portable outdoor gas-fired heating appliances shall be used and located in accordance with Sections 605.5.2.1.1 through 605.5.2.1.4.

**605.5.2.1.1 Prohibited locations.** The storage or use of portable outdoor gas-fired heating appliances is prohibited in any of the following locations:

1. Inside of any occupancy where connected to the fuel gas container.
2. Inside of tents, canopies and membrane structures.
3. On exterior balconies.

**Exception:** As permitted in Chapter 61.

**605.5.2.1.2 Clearance to buildings.** Portable outdoor gas-fired heating appliances shall be located not less than 5 feet (1524 mm) from buildings.

**605.5.2.1.3 Clearance to combustible materials.** Portable outdoor gas-fired heating appliances shall not be located beneath, or closer than 5 feet (1524 mm) to combustible decorations and combustible overhangs, awnings, sunshades or similar combustible attachments to buildings.

**605.5.2.1.4 Proximity to exits.** Portable outdoor gas-fired heating appliances shall not be located within 5 feet (1524 mm) of *exits* or *exit discharges*.

**605.5.2.2 Use and operation.** Portable outdoor gas-fired heating appliances shall be used and operated in accordance with Sections 605.5.2.2.1 through 605.5.2.2.4.

**605.5.2.2.1 Listing and approval.** Only *listed* and *approved* portable outdoor gas-fired heating appliances utilizing a fuel gas container that is integral to the appliance shall be used. Portable outdoor gas-fired heating appliances shall be *listed* and *labeled* in accordance with ANSI Z83.26/CSA 2.37.

**605.5.2.2.2 Use and maintenance.** Portable outdoor gas-fired heating appliances shall be used and maintained in accordance with the manufacturer's instructions.

**605.5.2.2.3 Tip-over switch.** Portable outdoor gas-fired heating appliances shall be equipped with a tilt or tip-over switch that automatically shuts off the flow of gas if the appliance is tilted more than 15 degrees (0.26 rad) from the vertical.

**605.5.2.2.4 Guard against contact.** The heating element or combustion chamber of portable outdoor gas-fired heating appliances shall be permanently guarded so as to prevent accidental contact by persons or material.

**605.5.2.3 Gas containers.** Fuel gas containers for portable outdoor gas-fired heating appliances shall comply with Sections 605.5.2.3.1 through 605.5.2.3.4.



**605.5.2.3.1 Approved containers.** Only *approved* DOTn or ASME gas containers shall be used.

**605.5.2.3.2 Container replacement.** Replacement of fuel gas containers in portable outdoor gas-fired heating appliances shall not be conducted while the public is present.

**605.5.2.3.3 Container capacity.** The maximum individual capacity of gas containers used in connection with portable outdoor gas-fired heating appliances shall not exceed 20 pounds (9 kg).

**605.5.2.3.4 Indoor storage prohibited.** Gas containers shall not be stored inside of buildings except in accordance with Section 6109.9.

**605.6 Heating appliances.** Heating appliances shall be *listed* and shall comply with Sections 605.6.1 and 605.6.2.

**605.6.1 Guard against contact.** The heating element or combustion chamber shall be permanently guarded so as to prevent accidental contact by persons or material.

**605.6.2 Heating appliance installation and maintenance.** Heating appliances shall be installed and maintained in accordance with the manufacturer's instructions, the *International Building Code*, the *International Fuel Gas Code*, the *International Mechanical Code* and NFPA 70.

**605.7 Unauthorized operation.** It shall be a violation of this code for any person, user, firm or agent to continue the utilization of any device or appliance (the operation of which has been discontinued or ordered discontinued in accordance with Section 605.2) unless written authority to resume operation is given by the *fire code official*. Removing or breaking the means by which operation of the device is prevented shall be a violation of this code.

**605.8 Incinerators.** Commercial, industrial and residential-type incinerators and chimneys shall be constructed in accordance with the *International Building Code*, the *International Fuel Gas Code* and the *International Mechanical Code*.

**605.8.1 Residential incinerators.** Residential incinerators shall be *listed* and *labeled* in accordance with UL 791.

**605.8.2 Spark arrestor.** Incinerators shall be equipped with an effective means for arresting sparks.

**605.8.3 Restrictions.** Where the *fire code official* determines that burning in incinerators located within 500 feet (152 m) of mountainous, brush or grass-covered areas will create an undue fire hazard because of atmospheric conditions, such burning shall be prohibited.

**605.8.4 Time of burning.** Burning shall take place only during *approved* hours.

**605.8.5 Discontinuance.** The *fire code official* is authorized to require incinerator use to be discontinued immediately if the *fire code official* determines that smoke emissions are offensive to occupants of surrounding property or if the use of incinerators is determined by the *fire code official* to constitute a hazardous condition.

**605.8.6 Flue-fed incinerators in Group I-2.** In Group I-2 occupancies, the continued use of existing flue-fed incinerators is prohibited.

**605.8.7 Incinerator inspections in Group I-2.** Incinerators in Group I-2 occupancies shall be inspected not less than annually in accordance with the manufacturer's instructions. Inspection records shall be maintained on the premises and made available to the *fire code official* upon request.

**605.9 Gas meters.** Above-ground gas meters, regulators and piping subject to damage shall be protected by a barrier complying with Section 312 or otherwise protected in an *approved* manner.

## SECTION 606 COMMERCIAL COOKING EQUIPMENT AND SYSTEMS

**[M] 606.1 General.** Commercial kitchen exhaust hoods shall comply with the requirements of the *International Mechanical Code*.

**[M] 606.2 Where required.** A Type I hood shall be installed at or above all commercial cooking appliances and domestic cooking appliances used for commercial purposes that produce grease vapors. A residential hood is allowed for protection of domestic cooking appliances in day care facilities that meet requirements of Section 904.14, *Arkansas Fire Prevention Code*, Volume I.

### Exceptions:

1. Factory-built commercial exhaust hoods that are *listed* and *labeled* in accordance with UL 710, and installed in accordance with Section 304.1 of the *International Mechanical Code*, shall not be required to comply with Sections 507.1.5, 507.2.3, 507.2.5, 507.2.8, 507.3.1, 507.3.3, 507.4 and 507.5 of the *International Mechanical Code*.
2. Factory-built commercial cooking recirculating systems that are *listed* and *labeled* in accordance with UL 710B, and installed in accordance with Section 304.1 of the *International Mechanical Code*, shall not be required to comply with Sections 507.1.5, 507.2.3, 507.2.5, 507.2.8, 507.3.1, 507.3.3, 507.4 and 507.5 of the *International Mechanical Code*. Spaces in which such systems are located shall be considered to be kitchens and shall be ventilated in accordance with Table 403.3.1.1 of the *International Mechanical Code*. For the purpose of determining the floor area required to be ventilated, each individual appliance shall be considered as occupying not less than 100 square feet (9.3 m<sup>2</sup>).
3. Where cooking appliances are equipped with integral down-draft exhaust systems and such appliances and exhaust systems are *listed* and *labeled* for the application in accordance with NFPA 96, a hood shall not be required at or above them.
4. A Type I hood shall not be required for an electric cooking appliance where an *approved* testing agency provides documentation that the appliance effluent contains 5 mg/m<sup>3</sup> or less of grease when



## BUILDING SERVICES AND SYSTEMS

tested at an exhaust flow rate of 500 cfm (0.236 m<sup>3</sup>/s) in accordance with UL 710B.

- **606.2.1 Where required: retroactive in existing buildings or structures.** A residential hood shall be installed in all day care and I-4 Occupancies serving 16 or more persons.

- **606.3 Operations and maintenance.** Commercial cooking systems shall be operated and maintained in accordance with Sections 606.3.1 through 606.3.4.

**606.3.1 Ventilation system.** The ventilation system in connection with hoods shall be operated at the required rate of air movement, and grease filters *listed* and *labeled* in accordance with UL 1046 shall be in place where equipment under a kitchen grease hood is used.

**606.3.2 Grease extractors.** Where grease extractors are installed, they shall be operated when the commercial-type cooking equipment is used.

**606.3.3 Cleaning.** Hoods, grease-removal devices, fans, ducts and other appurtenances shall be cleaned at intervals as required by Sections 606.3.3.1 through 606.3.3.3.

**606.3.3.1 Inspection.** Hoods, grease-removal devices, fans, ducts and other appurtenances shall be inspected at intervals specified in Table 606.3.3.1 or as *approved* by the *fire code official*. Inspections shall be completed by qualified individuals.

**TABLE 606.3.3.1  
COMMERCIAL COOKING SYSTEM INSPECTION FREQUENCY**

TYPE OF COOKING OPERATIONS	FREQUENCY OF INSPECTION
High-volume cooking operations such as 24-hour cooking, charbroiling or wok cooking	3 months
Low-volume cooking operations such as places of religious worship, seasonal businesses and senior centers	12 months
Cooking operations utilizing solid fuel-burning cooking appliances	1 month
All other cooking operations	6 months

**606.3.3.2 Grease accumulation.** If during the inspection it is found that hoods, grease-removal devices, fans, ducts or other appurtenances have an accumulation of grease, such components shall be cleaned in accordance with ANSI/IKECA C10.

**606.3.3.3 Records.** Records for inspections shall state the individual and company performing the inspection, a description of the inspection and when the inspection took place. Records for cleanings shall state the individual and company performing the cleaning and when the cleaning took place. Such records shall be completed after each inspection or cleaning and maintained.

**606.3.3.3.1 Tags.** When a commercial kitchen hood or duct system is inspected, a tag containing the service provider name, address, telephone number and date of service shall be provided in a conspicuous location. Prior tags shall be covered or removed.

**606.3.4 Extinguishing system service.** Automatic fire-extinguishing systems protecting commercial cooking systems shall be serviced as required in Section 904.13.5.

**606.4 Appliance connection to building piping.** Gas-fired commercial cooking appliances installed on casters and appliances that are moved for cleaning and sanitation purposes shall be connected to the piping system with an appliance connector *listed* as complying with ANSI Z21.69/CSA 6.16. The commercial cooking appliance connector installation shall be configured in accordance with the manufacturer's installation instructions. Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer's instructions.

## SECTION 607 COMMERCIAL COOKING OIL STORAGE

**607.1 General.** Storage of cooking oil (grease) in commercial cooking operations utilizing above-ground tanks with a capacity greater than 60 gal (227 L) installed within a building shall comply with Sections 607.2 through 607.7 and NFPA 30. For purposes of this section, cooking oil shall be classified as a Class IIIB liquid unless otherwise determined by testing.

**607.2 Metallic storage tanks.** Metallic cooking oil storage tanks shall be *listed* in accordance with UL 80 or UL 142, and shall be installed in accordance with the tank manufacturer's instructions.

**607.3 Nonmetallic storage tanks.** Nonmetallic cooking oil storage tanks shall be *listed* in accordance with UL 2152 and shall be installed in accordance with the tank manufacturer's instructions. Tank capacity shall not exceed 200 gallons (757 L) per tank.

**607.4 Cooking oil storage system components.** Cooking oil storage system components shall include but are not limited to piping, connections, fittings, valves, tubing, hose, pumps, vents and other related components used for the transfer of cooking oil, and are permitted to be of either metallic or nonmetallic construction.

**607.4.1 Design standards.** The design, fabrication and assembly of system components shall be suitable for the working pressures, temperatures and structural stresses to be encountered by the components.

**607.4.2 Components in contact with heated oil.** System components that come in contact with heated cooking oil shall be rated for the maximum operating temperatures expected in the system.

**607.5 Tank venting.** Normal and emergency venting shall be provided for cooking oil storage tanks.

**607.5.1 Normal vents.** Normal vents shall be located above the maximum normal liquid line, and shall have a minimum effective area not smaller than the largest filling or withdrawal connection. Normal vents shall be permitted to vent inside the building.

**607.5.2 Emergency vents.** Emergency relief vents shall be located above the maximum normal liquid line, and shall be in the form of a device or devices that will relieve excessive internal pressure caused by an exposure fire. For nonmetallic tanks, the emergency relief vent shall be

allowed to be in the form of construction. Emergency vents shall be permitted to vent inside the building.

**607.6 Heating of cooking oil.** Electrical equipment used for heating cooking oil in cooking oil storage systems shall be *listed* to UL 499 and shall comply with NFPA 70. Use of electrical immersion heaters shall be prohibited in nonmetallic tanks.

**607.7 Electrical equipment.** Electrical equipment used for the operation of cooking oil storage systems shall comply with NFPA 70.

## SECTION 608 MECHANICAL REFRIGERATION

**[M] 608.1 Scope.** Refrigeration systems shall be installed in accordance with the *International Mechanical Code*.

**608.1.1 Refrigerants other than ammonia.** Where a refrigerant other than ammonia is used, refrigeration systems and the buildings in which such systems are installed shall be in accordance with ASHRAE 15.

**608.1.2 Ammonia refrigeration.** Refrigeration systems using ammonia refrigerant and the buildings in which such systems are installed shall comply with IIAR 2 for system design; IIAR 6 for inspection, testing and maintenance; and IIAR 7 for operating procedures. Decommissioning of ammonia refrigeration systems shall comply with IIAR 8, and engineering practices for existing ammonia refrigeration systems shall be in accordance with IIAR 9.

**608.2 Permits.** Permits shall be obtained for refrigeration systems in accordance with Sections 105.5 and 105.6.

**[M] 608.3 Refrigerants.** The use and purity of new, recovered and reclaimed refrigerants shall be in accordance with the *International Mechanical Code*.

**[M] 608.4 Refrigerant classification.** Refrigerants shall be classified in accordance with the *International Mechanical Code*.

**[M] 608.5 Change in refrigerant type.** A change in the type of refrigerant in a refrigeration system shall be in accordance with the *International Mechanical Code*.

**608.6 Access.** Access to refrigeration systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be provided for the fire department at all times as required by the *fire code official*.

**608.7 Testing of equipment.** Refrigeration equipment and systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be subject to periodic testing in accordance with Section 608.7.1. Records of tests shall be maintained. Tests of emergency devices or systems required by this chapter shall be conducted by persons trained and qualified in refrigeration systems.

**608.7.1 Periodic testing.** The following emergency devices or systems shall be periodically tested in accordance

with the manufacturer's instructions and as required by the *fire code official*.

1. Treatment and flaring systems.
2. Valves and appurtenances necessary to the operation of emergency refrigeration control boxes.
3. Fans and associated equipment intended to operate emergency ventilation systems.
4. Detection and alarm systems.

**608.8 Emergency signs.** Refrigeration units or systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant shall be provided with *approved* emergency signs, charts and labels in accordance with NFPA 704. Hazard signs shall be in accordance with the *International Mechanical Code* for the classification of refrigerants listed therein.

**608.9 Refrigerant detection.** Machinery rooms shall be provided with a refrigerant detector with an audible and visible alarm. Where ammonia is used as the refrigerant, detection shall comply with IIAR 2. For refrigerants other than ammonia, refrigerant detection shall comply with Section 608.9.1.

**608.9.1 Refrigerants other than ammonia.** A detector, or a sampling tube that draws air to a detector, shall be provided at an *approved* location where refrigerant from a leak is expected to accumulate. The system shall be designed to initiate audible and visible alarms inside of and outside each entrance to the refrigerating machinery room and transmit a signal to an *approved* location where the concentration of refrigerant detected exceeds the lesser of the following:

1. The corresponding TLV-TWA values shown in the *International Mechanical Code* for the refrigerant classification.
2. Twenty-five percent of the lower flammable limit (LFL).

Detection of a refrigerant concentration exceeding the upper detection limit or 25 percent of the lower flammable limit (LFL), whichever is lower, shall stop refrigerant equipment in the machinery room in accordance with Section 608.10.1.

**608.10 Remote controls.** Where flammable refrigerants are used and compliance with Section 1106 of the *International Mechanical Code* is required, remote control of the mechanical equipment and appliances located in the machinery room as required by Sections 608.10.1 and 608.10.2 shall be provided at an *approved* location immediately outside the machinery room and adjacent to its principal entrance.

**608.10.1 Refrigeration system emergency shutoff.** A clearly identified switch of the break-glass type or with an *approved* tamper-resistant cover shall provide off-only control of refrigerant compressors, refrigerant pumps and normally closed automatic refrigerant valves located in the machinery room. Additionally, this equipment shall be automatically shut off when the refrigerant vapor concentration in the machinery room exceeds the vapor

## BUILDING SERVICES AND SYSTEMS

detector's upper detection limit or 25 percent of the LEL, whichever is lower.

**608.10.2 Ventilation system.** A clearly identified switch of the break-glass type or with an *approved* tamper-resistant cover shall provide on-only control of the machinery room ventilation fans.

**608.11 Emergency pressure control system.** Permanently installed refrigeration systems in machinery rooms containing more than 6.6 pounds (3 kg) of flammable, toxic or highly toxic refrigerant or ammonia shall be provided with an emergency pressure control system in accordance with Sections 608.11.1 and 608.11.2.

**608.11.1 Automatic crossover valves.** Each high- and intermediate-pressure zone in a refrigeration system shall be provided with a single automatic valve providing a crossover connection to a lower pressure zone. Automatic crossover valves shall comply with Sections 608.11.1.1 through 608.11.1.3.

**608.11.1.1 Overpressure limit set point.** Automatic crossover valves shall be arranged to automatically relieve excess system pressure to a lower pressure zone if the pressure in a high- or intermediate-pressure zone rises to within 90 percent of the set point for emergency pressure relief devices.

**608.11.1.2 Manual operation.** Where required by the *fire code official*, automatic crossover valves shall be capable of manual operation.

**608.11.1.3 System design pressure.** Refrigeration system zones that are connected to a higher pressure zone by an automatic crossover valve shall be designed to safely contain the maximum pressure that can be achieved by interconnection of the two zones.

**608.11.2 Automatic emergency stop.** An automatic emergency stop feature shall be provided in accordance with Sections 608.11.2.1 and 608.11.2.2.

**608.11.2.1 Operation of an automatic crossover valve.** Operation of an automatic crossover valve shall cause all compressors on the affected system to immediately stop. Dedicated pressure-sensing devices located immediately adjacent to crossover valves shall be permitted as a means for determining operation of a valve. To ensure that the automatic crossover valve system provides a redundant means of stopping compressors in an overpressure condition, high-pressure cutout sensors associated with compressors shall not be used as a basis for determining operation of a crossover valve.

**608.11.2.2 Overpressure in low-pressure zone.** The lowest pressure zone in a refrigeration system shall be provided with a dedicated means of determining a rise in system pressure to within 90 percent of the set point for emergency pressure relief devices. Activation of the overpressure sensing device shall cause all compressors on the affected system to immediately stop.

**608.12 Storage, use and handling.** Flammable and combustible materials shall not be stored in machinery rooms for refrigeration systems having a refrigerant circuit containing more than 220 pounds (100 kg) of Group A1 or 30 pounds (14 kg) of any other group refrigerant. Storage, use or handling of extra refrigerant or refrigerant oils shall be as required by Chapters 50, 53, 55 and 57.

**Exception:** This provision shall not apply to spare parts, tools and incidental materials necessary for the safe and proper operation and maintenance of the system.

**608.13 Discharge and termination of pressure relief and purge systems.** Pressure relief devices, fusible plugs and purge systems discharging to the atmosphere from refrigeration systems containing flammable, toxic or highly toxic refrigerants or ammonia shall comply with Sections 608.13.2 through 608.13.4.

**608.13.1 Fusible plugs and rupture members.** Discharge piping and devices connected to the discharge side of a fusible plug or rupture member shall have provisions to prevent plugging the pipe in the event the fusible plug or rupture member functions.

**608.13.2 Flammable refrigerants.** Systems containing more than 6.6 pounds (3 kg) of flammable refrigerants having a density equal to or greater than the density of air shall discharge vapor to the atmosphere only through an *approved* treatment system in accordance with Section 608.13.5 or a flaring system in accordance with Section 608.13.6. Systems containing more than 6.6 pounds (3 kg) of flammable refrigerants having a density less than the density of air shall be permitted to discharge vapor to the atmosphere provided that the point of discharge is located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or *exit*.

**608.13.3 Toxic and highly toxic refrigerants.** Systems containing more than 6.6 pounds (3 kg) of toxic or highly toxic refrigerants shall discharge vapor to the atmosphere only through an *approved* treatment system in accordance with Section 608.13.5 or a flaring system in accordance with Section 608.13.6.

**608.13.4 Ammonia refrigerant.** Systems containing more than 6.6 pounds (3 kg) of ammonia refrigerant shall discharge vapor to the atmosphere in accordance with one of the following methods:

1. Directly to atmosphere where the *fire code official* determines, on review of an analysis prepared in accordance with Section 104.8.2, that a health hazard would not result from atmospheric discharge of ammonia.
2. Through an *approved* treatment system in accordance with Section 608.13.5.
3. Through a flaring system in accordance with Section 608.13.6.



4. Through an *approved* ammonia diffusion system in accordance with Section 608.13.7.
5. By other *approved* means.

**Exception:** Ammonia/water absorption systems containing less than 22 pounds (10 kg) of ammonia and for which the ammonia circuit is located entirely outdoors.

**608.13.5 Treatment systems.** Treatment systems shall be designed to reduce the allowable discharge concentration of the refrigerant gas to not more than 50 percent of the IDLH at the point of exhaust. Treatment systems shall be in accordance with Chapter 60.

**608.13.6 Flaring systems.** Flaring systems for incineration of flammable refrigerants shall be designed to incinerate the entire discharge. The products of refrigerant incineration shall not pose health or environmental hazards. Incineration shall be automatic upon initiation of discharge, shall be designed to prevent blowback and shall not expose structures or materials to threat of fire. Standby fuel, such as LP-gas, and standby power shall have the capacity to operate for one and one-half the required time for complete incineration of refrigerant in the system. Standby electrical power, where required to complete the incineration process, shall be in accordance with Section 1203.

**608.13.7 Ammonia diffusion systems.** Ammonia diffusion systems shall include a tank containing 1 gallon of water for each pound of ammonia (8.3 L of water for each 1 kg of ammonia) that will be released in 1 hour from the largest relief device connected to the discharge pipe. The water shall be prevented from freezing. The discharge pipe from the pressure relief device shall distribute ammonia in the bottom of the tank, but not lower than 33 feet (10 058 mm) below the maximum liquid level. The tank shall contain the volume of water and ammonia without overflowing.

**608.14 Mechanical ventilation exhaust.** Exhaust from mechanical ventilation systems serving refrigeration machinery rooms containing flammable, toxic or highly toxic refrigerants, other than ammonia, capable of exceeding 25 percent of the LFL or 50 percent of the IDLH shall be equipped with *approved* treatment systems to reduce the discharge concentrations to those values or lower.

**Exception:** Refrigeration systems containing Group A2L complying with Section 608.18.

**608.15 Notification of refrigerant discharges.** The *fire code official* shall be notified immediately when a discharge becomes reportable under state, federal or local regulations in accordance with Section 5003.3.1.

**608.16 Records.** A record of refrigerant quantities brought into and removed from the premises shall be maintained.

**[M] 608.17 Electrical equipment.** Where refrigerant of Groups A2, A3, B2 and B3, as defined in the *International Mechanical Code*, are used, refrigeration machinery rooms

shall conform to the Class I, Division 2, hazardous location classification requirements of NFPA 70.

**Exceptions:**

1. Ammonia machinery rooms that are provided with ventilation in accordance with Section 1101.1.2, Exception 1 of the *International Mechanical Code*.
2. Machinery rooms for systems containing Group A2L refrigerants that are provided with ventilation in accordance with Section 608.18.

**[M] 608.18 Special requirements for Group A2L refrigerant machinery rooms.** Machinery rooms with systems containing Group A2L refrigerants that do not comply with the Class I, Division 2, hazardous location electrical requirements of NFPA 70, as permitted by Section 608.17, Exception 2, shall comply with Sections 608.18.1 through 608.18.2.

**608.18.1 Ventilation system activation.** Ventilation shall be activated by the refrigerant detection system in the machinery room. Refrigerant detection shall be in accordance with Section 608.9 and all of the following:

1. The detectors shall activate at or below a refrigerant concentration of 25 percent of the LFL.
2. Upon activation, the detection system shall activate the emergency ventilation system in Section 608.18.2.
3. The detection, signaling and control circuits shall be supervised.

**[M] 608.18.2 Emergency ventilation system.** An emergency ventilation system shall be provided at the minimum exhaust rate specified in ASHRAE 15 or Table 608.18.2. Shut down of the emergency ventilation system shall be by manual means.

**[M] TABLE 608.18.2  
MINIMUM EXHAUST RATE**

REFRIGERANT	Q (m <sup>3</sup> /sec)	Q (cfm)
R32	15.4	32,600
R143a	13.6	28,700
R444A	6.46	13,700
R444B	10.6	22,400
R445A	7.83	16,600
R446A	23.9	50,700
R447A	23.8	50,400
R451A	7.04	15,000
R451B	7.05	15,000
R1234yf	7.80	16,600
R1234ze(E)	5.92	12,600

**[M] 608.18.3 Emergency ventilation system discharge.** The point of discharge to the atmosphere shall be located outside of the structure at not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or *exit*.



## BUILDING SERVICES AND SYSTEMS

## SECTION 609 HYPERBARIC FACILITIES

**609.1 General.** Hyperbaric facilities shall be inspected, tested and maintained in accordance with NFPA 99.

**609.2 Records.** Records shall be maintained of all testing and repair conducted on the hyperbaric chamber and associated devices and equipment. Records shall be available to the *fire code official*.

## SECTION 610 CLOTHES DRYER EXHAUST SYSTEMS

**610.1 Clothes dryer exhaust duct systems.** Clothes dryer exhaust duct systems shall be in accordance with Sections 610.1.1 and 610.1.2.

**610.1.1 Installation.** Clothes dryer exhaust duct systems shall be installed in accordance with the *International Mechanical Code* or the *International Fuel Gas Code*, and the manufacturer's installation instructions.

**610.1.2 Maintenance.** The lint trap, mechanical and heating components, and the exhaust duct system of a clothes dryer shall be maintained in accordance with the manufacturer's operating instructions to prevent the accumulation of lint or debris that prevents the exhaust of air and products of combustion.

## CHAPTER 7

# FIRE AND SMOKE PROTECTION FEATURES

### User note:

**About this chapter:** Chapter 7 provides requirements to maintain the fire-resistance ratings of building elements and to limit fire spread. Section 701 addresses the maintenance of and owner's responsibility for construction elements such as fire barriers and smoke barriers. The rest of the chapter deals with various aspects that also must be maintained to achieve overall fire resistance of the main fire- and smoke-resistive features. These include penetrations, joint protection, door and window openings, and duct and air transfer opening protection.

### SECTION 701 GENERAL

**701.1 Scope.** The provisions of this chapter shall govern the inspection and maintenance of the materials, systems and assemblies used for structural *fire resistance*, *fire-resistance-rated* construction separation of adjacent spaces and construction installed to resist the passage of smoke to safeguard against the spread of fire and smoke within a building and the spread of fire to or from buildings. New buildings shall comply with the *International Building Code*.

**701.2 Fire-resistance-rated construction.** The *fire-resistance rating* of the following *fire-resistance-rated* construction shall be maintained:

1. Structural members.
2. *Exterior walls*.
3. *Fire walls, fire barriers, fire partitions*.
4. *Horizontal assemblies*.
5. Shaft enclosures.

**701.2.1 Hanging displays.** The hanging and displaying of salable goods and other decorative materials from acoustical ceiling systems that are part of a *fire-resistance-rated horizontal assembly* shall be prohibited.

**701.2.2 Permanent marking and notification in new construction.** All fire walls, fire barriers, fire partitions and smoke partitions shall be effectively and permanently identified with signs or stenciling in a manner acceptable to the authority having jurisdiction. Such identification shall be above any decorative or finished ceiling and in concealed spaces, attics and crawl spaces.

**701.3 Smoke barriers.** The *fire-resistance rating* and smoke-resistant characteristics of *smoke barriers* shall be maintained.

**701.4 Smoke partitions.** The smoke-resistant characteristics of smoke partitions shall be maintained.

**701.5 Maintaining protection.** Materials, systems and devices used to repair or protect breaches and openings in *fire-resistance-rated* construction and construction installed to resist the passage of smoke shall be maintained in accordance with Sections 703 through 707.

**701.6 Owner's responsibility.** The *owner* shall maintain an inventory of all required *fire-resistance-rated* construction, construction installed to resist the passage of smoke and the

construction included in Sections 703 through 707 and Sections 602.4.1 and 602.4.2 of the *International Building Code*. Such construction shall be visually inspected by the *owner* annually and properly repaired, restored or replaced where damaged, altered, breached or penetrated. Records of inspections and repairs shall be maintained. Where concealed, such elements shall not be required to be visually inspected by the *owner* unless the concealed space is accessible by the removal or movement of a panel, access door, ceiling tile or similar movable entry to the space.

**701.7 Unsafe conditions.** Where any components in this chapter are not maintained and do not function as intended or do not have the *fire resistance* or the resistance to the passage of smoke required by the code under which the building was constructed, remodeled or altered, such component(s) or portion thereof shall be deemed an unsafe condition, in accordance with Section 114.1.1. Components or portions thereof determined to be unsafe shall be repaired or replaced to conform to that code under which the building was constructed, remodeled or altered or this chapter, as deemed appropriate by the *fire code official*.

Where the condition of components is such that any building, structure or portion thereof presents an imminent danger to the occupants of the building, structure or portion thereof, the *fire code official* shall act in accordance with Section 114.2.

### SECTION 702 DEFINITIONS

**702.1 Definitions.** The following terms are defined in Chapter 2:

**DRAFTSTOP.**

**FIREBLOCKING.**

**MEMBRANE-PENETRATION FIRESTOP SYSTEM.  
OPENING PROTECTIVE.**

**SMOKE BARRIER.**

**SMOKE PARTITION.**

**THROUGH-PENETRATION FIRESTOP SYSTEM.**

## FIRE AND SMOKE PROTECTION FEATURES

SECTION 703  
PENETRATIONS

**703.1 Maintaining protection.** Materials and firestop systems used to protect membrane and through penetrations in *fire-resistance-rated* construction and construction installed to resist the passage of smoke shall be maintained. The materials and firestop systems shall be securely attached to or bonded to the construction being penetrated with no openings visible through or into the cavity of the construction. Where the system design number is known, the system shall be inspected to the listing criteria and manufacturer's installation instructions.

**703.2 Repair of penetrations.** Where damaged, materials used to protect membrane- and through-penetrations shall be replaced or restored with materials or systems that meet or exceed the code requirements applicable at the time when the assembly was constructed, remodeled or altered.

SECTION 704  
JOINTS AND VOIDS

**704.1 Maintaining protection.** Where required when the building was originally constructed, materials and systems used to protect joints and voids in the following locations shall be maintained. The materials and systems shall be securely attached to or bonded to the adjacent construction, without openings visible through the construction.

1. Joints in or between *fire-resistance-rated* walls, floors or floor/ceiling assemblies and roof or roof/ceiling assemblies.
2. Joints in *smoke barriers*.
3. Voids at the intersection of a horizontal floor assembly and an exterior curtain wall.
4. Voids at the intersection of a horizontal *smoke barrier* and an exterior curtain wall.
5. Voids at the intersection of a nonfire-resistance-rated floor assembly and an exterior curtain wall.
6. Voids at the intersection of a vertical *fire barrier* and an exterior curtain wall.
7. Voids at the intersection of a vertical *fire barrier* and a nonfire-resistance-rated roof assembly.

Unprotected joints and voids do not need to be protected where such joints and voids were not required to be protected when the building was originally constructed. Where the system design number is known, the system shall be inspected to the listing criteria and manufacturer's installation instructions.

**704.2 Repair of joints and voids.** Where damaged, materials used to protect joints and voids shall be replaced or restored with materials or systems that meet or exceed the code requirements applicable at the time when the assembly was constructed, remodeled or altered.

**704.3 Opening protectives.** Where openings are required to be protected, opening protectives shall be maintained self-closing or automatic-closing by smoke detection. Existing

fusible-link-type automatic door-closing devices are permitted if the fusible link rating does not exceed 135°F (57°C).

SECTION 705  
DOOR AND WINDOW OPENINGS

**705.1 General.** Where required when the building was originally constructed, opening protectives installed in *fire-resistance-rated* assemblies, *smoke barriers* and *smoke partitions* shall be inspected and maintained in accordance with this section.

**705.2 Inspection and maintenance.** *Opening protectives* in *fire-resistance-rated* assemblies shall be inspected and maintained in accordance with NFPA 80. *Opening protectives* in *smoke barriers* shall be inspected and maintained in accordance with NFPA 80 and NFPA 105. Openings in smoke partitions shall be inspected and maintained in accordance with NFPA 105. Fire doors and smoke and draft control doors shall not be blocked, obstructed, or otherwise made inoperable. Fusible links shall be replaced promptly whenever fused or damaged. *Opening protectives* and smoke and draft control doors shall not be modified.

**705.2.1 Labeling requirements.** Where *approved* by the *fire code official*, the application of field-applied labels associated with the maintenance of *opening protectives* shall follow the requirements of the *approved* third-party certification organization accredited for *listing* the opening protective.

**705.2.2 Signs.** Where required by the *fire code official*, a sign shall be permanently displayed on or near each *fire door* in letters not less than 1 inch (25 mm) high to read as follows:

1. For doors designed to be kept normally open: "FIRE DOOR—DO NOT BLOCK."
2. For doors designed to be kept normally closed: "FIRE DOOR—KEEP CLOSED."

**705.2.3 Hold-open devices and closers.** Hold-open devices and automatic door closers, where provided, shall be maintained. During the period that such device is out of service for repairs, the door it operates shall remain in the closed position.

**705.2.4 Door operation.** Swinging *fire doors* shall close from the full-open position and latch automatically.

**705.2.5 Smoke- and heat-activated doors.** Smoke-activated doors shall be maintained to self-close or automatically close upon detection of smoke. Existing fusible-link-type automatic door-closing devices are permitted if the fusible link rating does not exceed 135°F (57°C).

**705.2.6 Testing.** Horizontal and vertical sliding and rolling *fire doors* shall be inspected and tested annually to confirm proper operation and full closure. Records of inspections and testing shall be maintained.

## SECTION 706 DUCT AND AIR TRANSFER OPENINGS

**706.1 Maintaining protection.** Dampers protecting ducts and air transfer openings shall be inspected and maintained in accordance with NFPA 80 and NFPA 105. Other products or materials used to protect the openings for ducts and air transfer openings shall be securely attached to or bonded to the construction containing the duct or air transfer opening, without visible openings through or into the cavity of the construction. Any damaged products or materials protecting duct and air transfer openings shall be repaired, restored or replaced.

**706.2 Unprotected openings.** Unprotected duct and air transfer openings in *fire-resistance-rated* construction and construction installed to resist the passage of smoke shall be protected so as to comply with requirements that were in effect when the building was constructed.

## SECTION 707 CONCEALED SPACES

**707.1 Fireblocking and draftstopping.** Required *fireblocking* and draftstopping in combustible concealed spaces shall be maintained to provide continuity and integrity of the construction.

## SECTION 708 SPRAY FIRE-RESISTANT MATERIALS AND INTUMESCENT FIRE-RESISTANT MATERIALS

**708.1 Maintaining protection.** Where required when the building was originally permitted and constructed, spray fire-resistant materials and intumescent fire-resistant materials shall be visually inspected to verify that the materials do not exhibit exposure to the substrate.





## CHAPTER 8

# INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

### User note:

**About this chapter:** Chapter 8 provides requirements for interior finishes, decorative materials and furnishings in new and existing buildings so that they do not significantly add to or create fire hazards in buildings. The provisions tend to focus on occupancies with specific risk characteristics, such as vulnerability of occupants, density of occupants, lack of familiarity with the building and societal expectations of importance. This chapter is consistent with Chapter 8 of the International Building Code®, which regulates the interior finishes and decorative materials of new buildings.

### SECTION 801 GENERAL

**801.1 Scope.** The provisions of this chapter shall govern interior finish, interior trim, furniture, furnishings, decorative materials and decorative vegetation in buildings. Existing buildings shall comply with Sections 803 through 808. New buildings shall comply with Sections 804 through 808, and Section 803 of the *International Building Code*.

### SECTION 802 DEFINITIONS

**802.1 Definitions.** The following terms are defined in Chapter 2:

**FLAME SPREAD.**

**FLAME SPREAD INDEX.**

**INTERIOR FLOOR-WALL BASE.**

**SITE-FABRICATED STRETCH SYSTEM.**

**SMOKE-DEVELOPED INDEX.**

### SECTION 803 INTERIOR WALL AND CEILING FINISH IN EXISTING BUILDINGS

**803.1 General.** The provisions of this section shall limit the allowable fire performance and smoke development of interior wall and ceiling finishes in existing buildings based on location and occupancy classification. Interior wall and ceiling finishes shall be classified in accordance with Section 803 of the *International Building Code*. Such materials shall be classified in accordance with NFPA 286, as indicated in Section 803.1.1, or in accordance with ASTM E84 or UL 723, as indicated in Section 803.1.2.

Materials tested in accordance with Section 803.1.1 shall not be required to be tested in accordance with Section 803.1.2.

**803.1.1 Interior wall and ceiling finish materials tested in accordance with NFPA 286.** Interior wall and ceiling finish materials shall be classified in accordance with NFPA 286 and tested in accordance with Section 803.1.1.1. Materials complying with Section 803.1.1.1 shall be considered to comply with the requirements of Class A specified in Section 803.1.2.

**803.1.1.1 Acceptance criteria for NFPA 286.** The interior finish shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
3. Flashover, as defined in NFPA 286, shall not occur.
4. The peak heat release rate throughout the test shall not exceed 800 kW.
5. The total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

**803.1.2 Interior wall and ceiling finish materials tested in accordance with ASTM E84 or UL 723.** Interior wall and ceiling finishes shall be classified in accordance with ASTM E84 or UL 723. Such interior finish materials shall be grouped in the following classes in accordance with their flame spread and smoke-developed indices:

Class A: Flame spread index 0–25; smoke-developed index 0–450.

Class B: Flame spread index 26–75; smoke-developed index 0–450.

Class C: Flame spread index 76–200; smoke-developed index 0–450.

**Exception:** Materials tested in accordance with Section 803.1.1 and as indicated in Sections 803.1.3 through 803.15.

**803.1.3 Interior wall and ceiling finish materials with specific requirements.** The materials indicated in Sections 803.4 through 803.15 shall be tested as indicated in the corresponding sections.

**803.2 Stability.** Interior finish materials regulated by this chapter shall be applied or otherwise fastened in such a manner that such materials will not readily become detached where subjected to room temperatures of 200°F (93°C) for not less than 30 minutes.

**803.3 Interior finish requirements based on occupancy.** Interior wall and ceiling finish shall have a flame spread index not greater than that specified in Table 803.3 for the group and location designated. Interior wall and ceiling finish materials tested in accordance with NFPA 286, and meeting the acceptance criteria of Section 803.1.1.1, shall be used where a Class A classification in accordance with ASTM E84 or UL 723 is required.

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

**TABLE 803.3**  
**INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY<sup>k</sup>**

GROUP	SPRINKLERED <sup>i</sup>			NONSPRINKLERED		
	Interior exit stairways and interior exit ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>c</sup>	Interior exit stairways and interior exit ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and exit access ramps	Rooms and enclosed spaces <sup>c</sup>
A-1 and A-2	B	B	C	A	A <sup>d</sup>	B <sup>e</sup>
A-3 <sup>f</sup> , A-4, A-5	B	B	C	A	A <sup>d</sup>	C
B, E, M, R-1, R-4	B	C <sup>m</sup>	C	A	B <sup>m</sup>	C
F	C	C	C	B	C	C
H	B	B	C <sup>g</sup>	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B <sup>h, i</sup>	A	A	B
I-3	A	A <sup>j</sup>	C	A	A	B
I-4	B	B	B <sup>h, i</sup>	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No Restrictions			No Restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Class C interior finish materials shall be allowed for wainscoting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.11 of the *International Building Code*.
- b. In exit enclosures of buildings less than three stories in height of other than Group I-3, Class B interior finish for nonsprinklered buildings and Class C for sprinklered buildings shall be permitted.
- c. Requirements for rooms and enclosed spaces shall be based on spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered as enclosing spaces and the rooms or spaces on both sides shall be considered as one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor, regardless of the group classification of the building or structure.
- d. Lobby areas in Group A-1, A-2 and A-3 occupancies shall be not less than Class B materials.
- e. Class C interior finish materials shall be allowed in Group A occupancies with an occupant load of 300 persons or less.
- f. In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be allowed.
- g. Class B material is required where the building exceeds two stories.
- h. Class C interior finish materials shall be allowed in administrative spaces.
- i. Class C interior finish materials shall be allowed in rooms with a capacity of four persons or less.
- j. Class B materials shall be allowed as wainscoting extending not more than 48 inches above the finished floor in corridors.
- k. Finish materials as provided for in other sections of this code.
- l. Applies where the vertical exits, exit passageways, corridors or rooms and spaces are protected by an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.

- **803.3.1 Interior finish requirements—day care occupancies.** Interior finish requirements shall apply to all areas used for day care that are part of the means of egress in day care facilities serving 10 or fewer clients, located in the caregiver's home.

**803.4 Fire-retardant coatings.** The required flame spread or smoke-developed index of surfaces in existing buildings shall be allowed to be achieved by application of *approved* fire-retardant coatings, paints or solutions to surfaces having a flame spread index exceeding that allowed. Such applications shall comply with NFPA 703 and the required fire-retardant properties shall be maintained or renewed in accordance with the manufacturer's instructions. The fire-retardant paint, coating or solution shall have been assessed by testing over the same substrate to be used in the application.

**803.5 Textile wall coverings.** Where used as interior wall finish materials, textile wall coverings, including materials

having a woven, nonwoven, napped, tufted, looped or similar surface, shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1, 803.5.1 or 803.5.2.

**803.5.1 Room corner test for textile wall coverings and expanded vinyl wall coverings.** Textile wall coverings and expanded vinyl wall coverings shall meet the criteria of Section 803.5.1.1 when tested in the manner intended for use in accordance with the Method B protocol of NFPA 265 using the product mounting system, including adhesive. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

**803.5.1.1 Acceptance criteria for NFPA 265 Method B test protocol.** Where testing to NFPA 265, the interior finish shall comply with the following:

1. During the 40-kW exposure, flames shall not spread to the ceiling.

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

2. The flame shall not spread to the outer extremities of the samples on the 8-foot by 12-foot (203 by 305 mm) walls.
3. Flashover, as defined in NFPA 265, shall not occur.
4. For newly introduced wall coverings, the total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

**803.5.2 Acceptance criteria for wall and ceiling coverings.** Textile wall and ceiling coverings shall have a Class A flame spread index in accordance with ASTM E84 or UL 723, and be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

**803.6 Textile ceiling coverings.** Where used as interior ceiling finish materials, textile ceiling coverings, including materials having a woven, nonwoven, napped, tufted, looped or similar surface and carpet or similar textile materials, shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1 or 803.5.2.

**803.7 Expanded vinyl wall coverings.** Where used as interior wall finish materials, expanded vinyl wall coverings shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1, 803.5.1 or 803.5.2.

**803.8 Expanded vinyl ceiling coverings.** Where used as interior ceiling finish materials, expanded vinyl ceiling coverings shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1 or 803.5.2.

**[BF] 803.9 High-density polyethylene (HDPE) and polypropylene (PP).** Where high-density polyethylene or polypropylene is used as an interior finish, it shall comply with Section 803.1.1.

**[BF] 803.10 Site-fabricated stretch systems.** Where used as newly installed interior wall or interior ceiling finish materials, site-fabricated stretch systems containing all three components described in the definition in Chapter 2 shall be tested in the manner intended for use, and shall comply with the requirements of Section 803.1.1 or 803.1.2. If the materials are tested in accordance with ASTM E84 or UL 723, specimen preparation and mounting shall be in accordance with ASTM E2573.

**803.11 Foam plastic materials.** Foam plastic materials shall not be used as interior wall and ceiling finish unless specifically allowed by Section 803.11.1 or 803.11.2. Foam plastic materials shall not be used as interior trim unless specifically allowed by Section 804.2.

**803.11.1 Foam plastic combustibility characteristics.** Foam plastic materials shall be allowed on the basis of fire tests that substantiate their combustibility characteristics for the use intended under actual fire conditions, as indicated in Section 2603.9 of the *International Building Code*. This section shall apply both to exposed foam plastics and to foam plastics used in conjunction with a textile or vinyl facing or cover.

**803.11.2 Thermal barrier for foam plastics.** Foam plastic material shall be allowed if it is separated from the interior of the building by a thermal barrier in accordance with Section 2603.4 of the *International Building Code*.

**803.12 Facings or wood veneers intended to be applied on site over a wood substrate.** Facings or veneers intended to be applied on site over a wood substrate shall comply with one of the following:

1. The facing or veneer shall meet the criteria of Section 803.1.1 when tested in accordance with NFPA 286 using the product mounting system, including adhesive, described in Section 5.8.9 of NFPA 286.
2. The facing or veneer shall have a Class A, B or C flame spread index and smoke-developed index based on the requirements of Table 803.3, in accordance with ASTM E84 or UL 723. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

**803.13 Laminated products factory produced with an attached wood substrate.** Laminated products factory produced with an attached wood substrate shall comply with one of the following:

1. The laminated product shall meet the criteria of Section 803.1.1 when tested in accordance with NFPA 286 using the product mounting system, including adhesive, of actual use.
2. The laminated product shall have a Class A, B or C flame spread index and smoke-developed index based on the requirements of Table 803.3, in accordance with ASTM E84 or UL 723. Test specimen preparation and mounting shall be in accordance with ASTM E2579.

**803.14 Thickness exemption.** Materials having a thickness less than 0.036 inch (0.9 mm) applied directly to the surface of walls or ceilings shall not be required to be tested.

**803.15 Heavy timber exemption.** Exposed portions of building elements complying with the requirements of Type IV construction in accordance with the *International Building Code* shall not be subject to interior finish requirements.

## SECTION 804 INTERIOR WALL AND CEILING TRIM AND INTERIOR FLOOR FINISH IN NEW AND EXISTING BUILDINGS

**804.1 Interior trim.** Combustible trim in new and existing buildings, excluding *handrails* and guards, shall not exceed 10 percent of the specific wall or ceiling areas to which it is attached. Other than foam plastic, material used as interior trim shall comply with Section 804.1.1 or 804.1.2. Foam plastic used as interior trim shall comply with Section 804.2.

**804.1.1 Testing in accordance with NFPA 286.** Interior trim material shall be tested in accordance with NFPA 286 and comply with the acceptance criteria in Section 803.1.1.1. Where the interior trim material has been



## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

tested as an interior finish in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.1.1, it shall not be required to be tested for flame spread index and smoke-developed index in accordance with ASTM E84 or UL 723.

**804.1.2 Testing in accordance with ASTM E84 or UL 723.** Material, other than foam plastic, used as interior trim shall have minimum Class C flame spread and smoke-developed indices, when tested in accordance with ASTM E84 or UL 723, as described in Section 803.1.2.

**804.2 Foam plastic interior trim.** Foam plastic used as interior trim shall comply with Sections 804.2.1 through 804.2.4.

**804.2.1 Density.** The minimum density of the interior trim shall be 20 pounds per cubic foot (320 kg/m<sup>3</sup>).

**804.2.2 Thickness.** The maximum thickness of the interior trim shall be 1/2 inch (12.7 mm) and the maximum width shall be 8 inches (203 mm).

**804.2.3 Area limitation.** The interior trim shall not constitute more than 10 percent of the specific wall or ceiling area to which it is attached.

**804.2.4 Flame spread.** The flame spread index shall not exceed 75 where tested in accordance with ASTM E84 or UL 723. The smoke-developed index shall not be limited.

**Exception:** Where the interior trim material has been tested as an interior finish in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.1.1, it is not required to be tested for flame spread index in accordance with ASTM E84 or UL 723.

**804.3 New interior floor finish.** New interior floor finish and floor covering materials in new and existing buildings shall comply with Sections 804.3.1 through 804.3.3.2.

**Exception:** Floor finishes and coverings of a traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials that are not composed of fibers.

**804.3.1 Classification.** Interior floor finish and floor covering materials required by Section 804.3.3.2 to be of Class I or II materials shall be classified in accordance with ASTM E648 or NFPA 253. The classification referred to herein corresponds to the classifications determined by ASTM E648 or NFPA 253 as follows: Class I, 0.45 watts/cm<sup>2</sup> or greater; Class II, 0.22 watts/cm<sup>2</sup> or greater.

**804.3.2 Testing and identification.** Interior floor finish and floor covering materials shall be tested by an *approved* agency in accordance with ASTM E648 or NFPA 253 and identified by a hang tag or other suitable method so as to identify the manufacturer or supplier and style, and shall indicate the interior floor finish or floor covering classification in accordance with Section 804.3.1. Carpet-type floor coverings shall be tested as proposed for use, including underlayment. Test reports confirming the information provided in the manufac-

turer's product identification shall be furnished to the *fire code official* upon request.

**804.3.3 Interior floor finish requirements.** New interior floor covering materials shall comply with Sections 804.3.3.1 and 804.3.3.2, and interior floor finish materials shall comply with Section 804.3.1.

**804.3.3.1 Pill test.** In all occupancies, new floor covering materials shall comply with the requirements of the DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or of ASTM D2859.

**804.3.3.2 Minimum critical radiant flux.** In all occupancies, new interior floor finish and floor covering materials in enclosures for *stairways* and *ramps*, *exit passageways*, *corridors* and rooms or spaces not separated from *corridors* by full-height partitions extending from the floor to the underside of the ceiling shall withstand a minimum critical radiant flux. The minimum critical radiant flux shall be not less than Class I in Groups I-1, I-2 and I-3 and not less than Class II in Groups A, B, E, H, I-4, M, R-1, R-2 and S.

**Exception:** Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, Class II materials shall be permitted in any area where Class I materials are required and materials complying with DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or with ASTM D2859 shall be permitted in any area where Class II materials are required.

**804.4 Interior floor-wall base.** Interior floor-wall base that is 6 inches (152 mm) or less in height shall be tested in accordance with ASTM E648 or NFPA 253 and shall be not less than Class II. Where a Class I floor finish is required, the floor-wall base shall be Class I. The classification referred to herein corresponds to the classifications determined by ASTM E648 or NFPA 253 as follows: Class I, 0.45 watt/cm<sup>2</sup> or greater; Class II, 0.22 watts/cm<sup>2</sup> or greater.

**Exception:** Interior trim materials that comply with Section 804.1.

## SECTION 805 UPHOLSTERED FURNITURE AND MATTRESSES IN NEW AND EXISTING BUILDINGS

**805.1 Group I-1, Condition 2.** The requirements in Sections 805.1.1 through 805.1.2 shall apply to facilities in Group I-1, Condition 2.

**805.1.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.1.1.1 through 805.1.1.3.

**805.1.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

1.5 inches (38 mm) when tested in accordance with NFPA 261.

2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

**805.1.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total heat released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 megajoules (MJ).

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.1.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.1.1.1 and 805.1.1.2.

**805.1.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.1.2.1 through 805.1.2.3.

**805.1.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

**805.1.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total heat released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.1.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance

with the requirements of Sections 805.2.2.1 and 805.2.2.2.

**805.2 Group I-2 and Group B ambulatory care facilities.** The requirements in Sections 805.2.1 through 805.2.2 shall apply to Group I-2 occupancies and Group B ambulatory care facilities.

**805.2.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.2.1.1 through 805.2.1.3.

**805.2.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following: (a) mocked-up composites of the upholstered furniture shall have a char length not exceeding 1.5 inches (38 mm) when tested in accordance with NFPA 261 or (b) the components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

**Exception:** Upholstered furniture belonging to the patients in sleeping rooms of Group I-2, Condition 1 occupancies, provided that a smoke detector is installed in such rooms. Battery-powered, single-station smoke alarms shall be allowed.

**805.2.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total heat released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.2.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.2.1.1 and 805.2.1.2.

**805.2.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.2.2.1 through 805.2.2.3.

**805.2.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

**805.2.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. The total heat released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.2.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.2.2.1 and 805.2.2.2.

**805.3 Group I-3, detention and correction facilities.** The requirements in Sections 805.3.1 through 805.3.2 shall apply to detention and correction facilities classified in Group I-3.

**805.3.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.3.1.1 through 805.3.1.3

**805.3.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1.5 inches (38 mm) when tested in accordance with NFPA 261.
2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

**805.3.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.
2. The total heat released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

**805.3.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.3.1.1 and 805.3.1.2.

**805.3.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.3.2.1 through 805.3.2.3.

**805.3.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

**805.3.2.2 Fire performance tests.** Newly introduced mattresses shall be tested in accordance with Section 805.3.2.2.1 or 805.3.2.2.2.

**805.3.2.2.1 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

1. The peak rate of heat release for the single mattress shall not exceed 100 kW.
2. The total heat released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**805.3.2.2.2 Mass loss test.** Newly introduced mattresses shall have a mass loss not exceeding 15 percent of the initial mass of the mattress where tested in accordance with the test in Annex A3 of ASTM F1085.

**805.3.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.3.2.1 and 805.3.2.2.

**805.4 Group R-2 college and university dormitories.** The requirements of Sections 805.4.1 through 805.4.2.3 shall apply to college and university dormitories classified in Group R-2, including decks, porches and balconies.

**805.4.1 Upholstered furniture.** Newly introduced upholstered furniture shall meet the requirements of Sections 805.4.1.1 through 805.4.1.3.

**805.4.1.1 Ignition by cigarettes.** Newly introduced upholstered furniture shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with one of the following:

1. Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1½ inches (38 mm) when tested in accordance with NFPA 261.
2. The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260.

**805.4.1.2 Heat release rate.** Newly introduced upholstered furniture shall have limited rates of heat release when tested in accordance with ASTM E1537 or California Technical Bulletin 133, as follows:

1. The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

- The total heat released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Upholstered furniture in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.4.1.3 Identification.** Upholstered furniture shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.4.1.1 and 805.4.1.2.

**805.4.2 Mattresses.** Newly introduced mattresses shall meet the requirements of Sections 805.4.2.1 through 805.4.2.3.

**805.4.2.1 Ignition by cigarettes.** Newly introduced mattresses shall be shown to resist ignition by cigarettes as determined by tests conducted in accordance with DOC 16 CFR Part 1632 and shall have a char length not exceeding 2 inches (51 mm).

**805.4.2.2 Heat release rate.** Newly introduced mattresses shall have limited rates of heat release when tested in accordance with ASTM E1590 or California Technical Bulletin 129, as follows:

- The peak rate of heat release for the single mattress shall not exceed 100 kW.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

- The total heat released by the single mattress during the first 10 minutes of the test shall not exceed 25 MJ.

**Exception:** Mattresses in rooms or spaces protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**805.4.2.3 Identification.** Mattresses shall bear the label of an *approved* agency, confirming compliance with the requirements of Sections 805.4.2.1 and 805.4.2.2.

### SECTION 806 NATURAL DECORATIVE VEGETATION IN NEW AND EXISTING BUILDINGS

**806.1 Natural cut trees.** Natural cut trees, where allowed by this section, shall have the trunk bottoms cut off not less than 0.5 inch (12.7 mm) above the original cut and shall be placed in a support device complying with Section 806.1.2.

**806.1.1 Restricted occupancies.** Natural cut trees shall be prohibited within ambulatory care facilities and Group A, E, I-1, I-2, I-3, I-4, M, R-1, R-2 and R-4 occupancies.

#### Exceptions:

- Trees located in areas protected by an *approved automatic sprinkler system* installed

in accordance with Section 903.3.1.1 or 903.3.1.2 shall not be prohibited in Groups A, E, M, R-1 and R-2.

- Trees shall be allowed within *dwelling units* in Group R-2 occupancies.

**806.1.2 Support devices.** The support device that holds the tree in an upright position shall be of a type that is stable and that meets all of the following criteria:

- The device shall hold the tree securely and be of adequate size to avoid tipping over of the tree.
- The device shall be capable of containing a minimum two-day supply of water.
- The water level, when full, shall cover the tree stem not less than 2 inches (51 mm). The water level shall be maintained above the fresh cut and checked not less than once daily.

**806.1.3 Dryness.** The tree shall be removed from the building whenever the needles or leaves fall off readily when a tree branch is shaken or if the needles are brittle and break when bent between the thumb and index finger. The tree shall be checked daily for dryness.

**806.1.4 Fire-retardant treatments for natural cut trees.** Where fire-retardant treatments are applied to natural cut trees, the fire-retardant treatment shall be tested by an *approved* agency and shall comply with both Test Method 1 and Test Method 2 of ASTM E3082.

**806.2 Obstruction of means of egress.** The required width of any portion of a *means of egress* shall not be obstructed by decorative vegetation. Natural cut trees shall not be located within an *exit*, *corridor*, or a lobby or vestibule.

**806.3 Open flame.** Candles and open flames shall not be used on or near decorative vegetation. Natural cut trees shall be kept a distance from heat vents and any open flame or heat-producing devices not less than the height of the tree.

**806.4 Electrical fixtures and wiring.** The use of unlisted electrical wiring and lighting on natural vegetation, including natural cut trees, shall be prohibited.

### SECTION 807 DECORATIVE MATERIALS AND ARTIFICIAL DECORATIVE VEGETATION IN NEW AND EXISTING BUILDINGS

**807.1 General.** The following requirements shall apply to all occupancies:

- Furnishings or decorative materials of an explosive or highly flammable character shall not be used.
- Fire-retardant coatings in existing buildings shall be maintained so as to retain the effectiveness of the treatment under service conditions encountered in actual use.
- Furnishings or other objects shall not be placed to obstruct *exits*, access thereto, egress therefrom or visibility thereof.



## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

4. The permissible amount of noncombustible decorative materials shall not be limited.

**807.2 Combustible decorative materials.** In Groups A, B, E, I, M and R-1 and in dormitories in Group R-2, curtains, draperies, fabric hangings and other similar combustible decorative materials suspended from walls or ceilings shall comply with Section 807.3 and shall not exceed 10 percent of the specific wall or ceiling area to which such materials are attached.

Fixed or movable walls and partitions, paneling, wall pads and crash pads applied structurally or for decoration, acoustical correction, surface insulation or other purposes shall be considered to be *interior finish*, shall comply with Section 803 and shall not be considered *decorative materials* or furnishings.

### Exceptions:

1. In auditoriums in Group A, the permissible amount of curtains, draperies, fabric hangings and similar combustible decorative material suspended from walls or ceilings shall not exceed 75 percent of the aggregate wall area where the building is equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, and where the material is installed in accordance with Section 803.15 of the *International Building Code*.
2. In Group R-2 dormitories, within *sleeping units* and *dwelling units*, the permissible amount of curtains, draperies, fabric hangings and similar decorative materials suspended from walls or ceilings shall not exceed 50 percent of the aggregate wall areas where the building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.
3. In Group B and M occupancies, the amount of combustible fabric partitions suspended from the ceiling and not supported by the floor shall comply with Section 807.3 and shall not be limited.
4. The 10-percent limit shall not apply to curtains, draperies, fabric hangings and similar combustible decorative materials used as window coverings.

**807.3 Acceptance criteria and reports.** Where required to exhibit improved fire performance, curtains, draperies, fabric hangings and other similar combustible decorative materials suspended from walls or ceilings shall be tested by an *approved agency* and meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 or exhibit a maximum rate of heat release of 100 kW when tested in accordance with NFPA 289, using the 20 kW ignition source. Reports of test results shall be prepared in accordance with the test method used and furnished to the *fire code official* upon request.

**807.4 Artificial decorative vegetation.** Artificial decorative vegetation shall comply with this section and the require-

ments of Sections 806.2 and 806.3. Natural decorative vegetation shall comply with Section 806.

**Exception:** Testing of artificial vegetation is not required in Group I-1; Group I-2, Condition 1; Group R-2; Group R-3; or Group R-4 occupancies equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1, where such artificial vegetation complies with the following:

1. Wreaths and other decorative items on doors shall not obstruct the door operation and shall not exceed 50 percent of the surface area of the door.
2. Decorative artificial vegetation shall be limited to not more than 30 percent of the wall area to which it is attached.
3. Decorative artificial vegetation not on doors or walls shall not exceed 3 feet (914 mm) in any dimension.

**807.4.1 Flammability.** Artificial decorative vegetation shall meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701. Meeting such criteria shall be documented and certified by the manufacturer in an *approved* manner. Alternatively, the artificial decorative vegetation shall be tested in accordance with NFPA 289, using the 20 kW ignition source, and shall have a maximum heat release rate of 100 kW.

**807.4.2 Electrical fixtures and wiring on artificial vegetation.** The use of unlisted electrical wiring and lighting on artificial decorative vegetation shall be prohibited. The use of electrical wiring and lighting on artificial trees constructed entirely of metal shall be prohibited.

**807.5 Occupancy-based requirements.** Occupancies shall comply with Sections 807.5.1 through 807.5.6.

**807.5.1 Group A.** In Group A occupancies, the requirements in Sections 807.5.1.1 through 807.5.1.4 shall apply.

**807.5.1.1 Foam plastics.** Exposed foam plastic materials and unprotected materials containing foam plastic used for decorative purposes or stage scenery or exhibit booths shall have a maximum heat release rate of 100 kW when tested in accordance with UL 1975, or when tested in accordance with NFPA 289 using the 20 kW ignition source.

### Exceptions:

1. Individual foam plastic items or items containing foam plastic where the foam plastic does not exceed 1 pound (0.45 kg) in weight.
2. Cellular or foam plastic shall be allowed for trim in accordance with Section 804.2.

**807.5.1.2 Motion picture screens.** The screens on which motion pictures are projected in new and existing buildings of Group A shall either meet the flame propagation performance criteria of Test Method 1 or

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

Test Method 2, as appropriate, of NFPA 701 or shall comply with the requirements for a Class B interior finish in accordance with Section 803 of the *International Building Code*.

### 807.5.1.3 Wood use in places of religious worship.

In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall not be limited.

**807.5.1.4 Pyroxylin plastic.** Imitation leather or other material consisting of or coated with a pyroxylin or similarly hazardous base shall not be used.

**807.5.2 Group E.** Group E occupancies shall comply with Sections 807.5.2.1 through 807.5.2.3.

**807.5.2.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

#### Exceptions:

1. *Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. *Corridors* protected by an *approved* fire alarm system installed in accordance with Section 907.
3. Storage in metal lockers, provided the minimum required egress width is maintained.

**807.5.2.2 Artwork in corridors.** Artwork and teaching materials shall be limited on the walls of *corridors* to not more than 20 percent of the wall area.

**807.5.2.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of classrooms to not more than 50 percent of the specific wall area to which they are attached.

**807.5.3 Groups I-1 and I-2.** In Group I-1 and I-2 occupancies, combustible *decorative materials* shall comply with Sections 807.5.3.1 through 807.5.3.4.

**807.5.3.1 Group I-1 and I-2 Condition 1 within units.** In Group I-1 and Group I-2, Condition 1 occupancies, equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, within *sleeping units* and *dwelling units*, combustible decorative materials placed on walls shall be limited to not more than 50 percent of the wall area to which they are attached.

**807.5.3.2 In Group I-1 and I-2, Condition 1 for areas other than within units.** In Group I-1 and Group I-2, Condition 1 occupancies, equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, combustible decorative materials placed on walls in areas other than within *dwelling* and *sleeping units* shall be limited to not more than 30 percent of the wall area to which they are attached.

**807.5.3.3 In Group I-2, Condition 2.** In Group I-2, Condition 2 occupancies, equipped throughout with an

*approved automatic sprinkler system* installed in accordance with Section 903.3.1.1, combustible decorative materials placed on walls shall be limited to not more than 30 percent of the wall area to which they are attached.

**807.5.3.4 Other areas in Groups I-1 and I-2.** In Group I-1 and I-2 occupancies, in areas not equipped throughout with an *approved automatic sprinkler system*, combustible *decorative materials* shall be of such limited quantities that a hazard of fire development or spread is not present.

**807.5.4 Group I-3.** In Group I-3, combustible *decorative materials* are prohibited.

**807.5.5 Group I-4.** Group I-4 occupancies shall comply with the requirements in Sections 807.5.5.1 through 807.5.5.3.

**807.5.5.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

#### Exceptions:

1. *Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. *Corridors* protected by an *approved* fire alarm system installed in accordance with Section 907.
3. Storage in metal lockers, provided that the minimum required egress width is maintained.

**807.5.5.2 Artwork in corridors.** Artwork and teaching materials shall be limited on walls of *corridors* to not more than 20 percent of the wall area.

**807.5.5.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of classrooms to not more than 50 percent of the specific wall area to which they are attached.

**807.5.6 Dormitories in Group R-2.** In Group R-2 dormitories, within *sleeping units* and *dwelling units*, the combustible decorative materials shall be of limited quantities such that a hazard of fire development or spread is not present.

## SECTION 808

### FURNISHINGS OTHER THAN UPHOLSTERED FURNITURE AND MATTRESSES OR DECORATIVE MATERIALS IN NEW AND EXISTING BUILDINGS

**808.1 Wastebaskets and linen containers in Group I-1, I-2 and I-3 occupancies and Group B ambulatory care facilities.** Wastebaskets, linen containers and other waste containers, including their lids, located in Group I-1, I-2 and I-3 occupancies and Group B ambulatory care facilities shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

## INTERIOR FINISH, DECORATIVE MATERIALS AND FURNISHINGS

Metal wastebaskets and other metal waste containers with a capacity of 20 gallons (75.7 L) or more shall be *listed* in accordance with UL 1315 and shall be provided with a noncombustible lid. Portable containers exceeding 32 gallons (121 L) shall be stored in an area classified as a waste and linen collection room and constructed in accordance with Table 509.1 of the *International Building Code*.

**Exception:** Recycling containers complying with Section 808.1.2 are not required to be stored in waste and linen collection rooms.

**808.1.1 Capacity density.** The average capacity density of containers located in an individual room or space, other than waste and linen collection rooms, shall not be greater than 0.5 gal/ft<sup>2</sup> (20.4 L/m<sup>2</sup>).

**808.1.2 Recycling clean waste containers.** Recycling clean waste containers, including their lids, shall not exceed an individual capacity of 96 gallons (363 L).

### **808.2 Waste containers with a capacity of 20 gallons or more in Group R-2 college and university dormitories.**

Waste containers, including their lids, located in Group R-2 college and university dormitories, and with a capacity of 20 gallons (75.7 L) or more, shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation. Metal wastebaskets and other metal waste containers with a capacity of 20 gallons (75.7 L) or more shall be *listed* in accordance with UL 1315 and shall be provided with a noncombustible lid. Portable containers exceeding 32 gallons (121 L) shall be stored in an area classified as a waste and linen collection room constructed in accordance with Table 509.1 of the *International Building Code*.

**808.3 Signs.** Foam plastic signs that are not affixed to interior building surfaces shall have a maximum heat release rate of 150 kW when tested in accordance with UL 1975, or when tested in accordance with NFPA 289 using the 20-kW ignition source.

**Exception:** Where the aggregate area of foam plastic signs is less than 10 percent of the floor area or wall area of the room or space in which the signs are located, whichever is less, subject to the approval of the *fire code official*.

**808.4 Combustible lockers.** Where lockers constructed of combustible materials are used, the lockers shall be considered to be interior finish and shall comply with Section 803.

**Exception:** Lockers constructed entirely of wood and noncombustible materials shall be permitted to be used wherever interior finish materials are required to meet a Class C classification in accordance with Section 803.1.2.

**808.5 Play structures added to existing buildings.** Where play structures that exceed 10 feet (3048 mm) in height or 150 square feet (14 m<sup>2</sup>) in area are added inside an existing building, they shall comply with Section 424 of the *International Building Code*.

## CHAPTER 9

# FIRE PROTECTION AND LIFE SAFETY SYSTEMS

### User note:

**About this chapter:** Chapter 9 prescribes the minimum requirements for active fire protection equipment systems to perform the functions of detecting a fire, alerting the occupants or fire department of a fire emergency, mass notification, gas detection, controlling smoke and controlling or extinguishing the fire. Generally, the requirements are based on the occupancy, the height and the area of the building because these are the factors that most affect fire-fighting capabilities and the relative hazard of a specific building or portion thereof. This chapter parallels and is substantially duplicated in Chapter 9 of the International Building Code®; however, this chapter also contains periodic testing criteria that are not contained in the International Building Code. In addition, the special fire protection system requirements based on use and occupancy found in Chapter 4 of the International Building Code are duplicated in this chapter as a user convenience.

### SECTION 901 GENERAL

**901.1 Scope.** The provisions of this chapter shall specify where *fire protection* and *life safety systems* are required and shall apply to the design, installation, inspection, operation, testing and maintenance of all *fire protection* and *life safety systems*.

**901.2 Construction documents.** The *fire code official* shall have the authority to require *construction documents* and calculations for all *fire protection* and *life safety systems* and to require permits be issued for the installation, rehabilitation or modification of any *fire protection* and *life safety systems*. *Construction documents* for *fire protection* and *life safety systems* shall be submitted for review and approval prior to system installation.

**901.2.1 Statement of compliance.** Before requesting final approval of the installation, where required by the *fire code official*, the installing contractor shall furnish a written statement to the *fire code official* that the subject *fire protection* or *life safety system* has been installed in accordance with *approved plans* and has been tested in accordance with the manufacturer's specifications and the appropriate installation standard. Any deviations from the design standards shall be noted and copies of the approvals for such deviations shall be attached to the written statement.

**901.3 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

**901.4 Fire protection and life safety systems.** *Fire protection* and *life safety systems* shall be installed, repaired, operated and maintained in accordance with this code and the *International Building Code*.

**901.4.1 Required fire protection and life safety systems.** *Fire protection* and *life safety systems* required by this code or the *International Building Code* shall be installed, repaired, operated, tested and maintained in accordance with this code. A *fire protection* or *life safety system* for which a design option, exception or reduction to the provisions of this code or the *International Building Code* has been granted shall be considered to be a required system.

**901.4.2 Nonrequired fire protection and life safety systems.** *Fire protection* and *life safety systems* or portion thereof not required by this code or the *International Building Code* shall be allowed to be furnished for partial or complete protection provided that such installed systems meet the applicable requirements of this code and the *International Building Code*.

**901.4.3 Alterations in buildings and structures.** For any *alteration* within a building or structure, the *fire protection* and *life safety systems* shall be extended, altered or augmented to maintain and continue protection within the building or structure. Persons shall not remove or modify any *fire protection* or *life safety system* installed or maintained under the provisions of this code or the *International Building Code* without approval from the *fire code official*.

**901.4.4 Fire areas.** Where buildings, or portions thereof, are divided into *fire areas* so as not to exceed the limits established for requiring a *fire protection system* in accordance with this chapter, such *fire areas* shall be separated by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, having a *fire-resistance rating* of not less than that determined in accordance with Section 707.3.10 of the *International Building Code*.

**901.4.5 Additional fire protection systems.** In occupancies of a hazardous nature, where special hazards exist in addition to the normal hazards of the occupancy, or where the *fire code official* determines that access for fire apparatus is unduly difficult, the *fire code official* shall have the authority to require additional safeguards and *fire protection systems*. *Fire protection* and *life safety systems* required under this section shall be installed in accordance with this code and the applicable referenced standards.

**901.4.6 Appearance of equipment.** Any device that has the physical appearance of *life safety* or *fire protection* equipment but that does not perform that *life safety* or *fire protection* function shall be prohibited.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**901.4.7 Pump and riser room size.** Where provided, fire pump rooms and *automatic sprinkler system* riser rooms shall be designed with adequate space for all equipment necessary for the installation, as defined by the manufacturer, with sufficient working space around the stationary equipment. Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required *fire-resistance-rated* assembly. Fire pump and *automatic sprinkler system* riser rooms shall be provided with doors and unobstructed passageways large enough to allow removal of the largest piece of equipment.

**901.4.7.1 Access.** Automatic sprinkler system risers, fire pumps and controllers shall be provided with *ready access*. Where located in a fire pump room or automatic sprinkler system riser room, the door shall be permitted to be locked provided that the key is available at all times.

**901.4.7.2 Marking on access doors.** Access doors for automatic sprinkler system riser rooms and fire pump rooms shall be labeled with an *approved* sign. The lettering shall be in contrasting color to the background. Letters shall have a minimum height of 2 inches (51 mm) with a minimum stroke of  $\frac{3}{8}$  inch (10 mm).

**901.4.7.3 Environment.** Automatic sprinkler system riser rooms and fire pump rooms shall be maintained at a temperature of not less than 40°F (4°C). Heating units shall be permanently installed.

**901.4.7.4 Lighting.** Permanently installed artificial illumination shall be provided in the automatic sprinkler system riser rooms and fire pump rooms.

**901.5 Installation acceptance testing.** *Fire protection* and *life safety systems* and appurtenances thereto shall be subject to acceptance tests as contained in the installation standards and as *approved* by the *fire code official*. The *fire code official* shall be notified before any required acceptance testing.

**901.5.1 Occupancy.** It shall be unlawful to occupy any portion of a building or structure until the required *fire protection* and *life safety systems* have been tested and *approved*.

**901.6 Inspection, testing and maintenance.** *Fire protection* and *life safety systems* shall be maintained in an operative condition at all times, and shall be replaced or repaired where defective. Nonrequired *fire protection* and *life safety systems* and equipment shall be inspected, tested and maintained or removed in accordance with Section 901.8.

**901.6.1 Standards.** *Fire protection systems* shall be inspected, tested and maintained in accordance with the referenced standards *listed* in Table 901.6.1.

**TABLE 901.6.1  
FIRE PROTECTION SYSTEM MAINTENANCE STANDARDS**

SYSTEM	STANDARD
Portable fire extinguishers	NFPA 10
Carbon dioxide fire-extinguishing systems	NFPA 12
Halon 1301 fire-extinguishing systems	NFPA 12A
Dry-chemical extinguishing systems	NFPA 17
Wet-chemical extinguishing systems	NFPA 17A
Water-based fire protection systems	NFPA 25
Fire alarm systems	NFPA 72
Smoke and heat vents	NFPA 204
Water-mist systems	NFPA 750
Clean-agent extinguishing systems	NFPA 2001
Aerosol fire-extinguishing systems	NFPA 2010

**901.6.2 Integrated testing.** Where two or more *fire protection* or *life safety systems* are interconnected, the intended response of subordinate *fire protection* and *life safety systems* shall be verified when required testing of the initiating system is conducted. In addition, integrated testing shall be performed in accordance with Sections 901.6.2.1 and 901.6.2.2.

**901.6.2.1 High-rise buildings.** For high-rise buildings, integrated testing shall comply with NFPA 4, with an integrated test performed prior to issuance of the certificate of occupancy and at intervals not exceeding 10 years, unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4. If an equipment failure is detected during integrated testing, a repeat of the integrated test shall not be required, except as necessary to verify operation of fire protection or life safety functions that are initiated by equipment that was repaired or replaced.

**901.6.2.2 Smoke control systems.** Where a fire alarm system is integrated with a smoke control system as outlined in Section 909, integrated testing shall comply with NFPA 4, with an integrated test performed prior to issuance of the certificate of occupancy and at intervals not exceeding 10 years, unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4. If an equipment failure is detected during integrated testing, a repeat of the integrated test shall not be required, except as necessary to verify operation of fire protection or life safety functions that are initiated by equipment that was repaired or replaced.

**901.6.3 Records.** Records of all system inspections, tests and maintenance required by the referenced standards shall be maintained.

**901.6.3.1 Records information.** Initial records shall include the name of the installation contractor, type of components installed, manufacturer of the components, location and number of components installed

per floor. Records shall include the manufacturers' operation and maintenance instruction manuals. Such records shall be maintained for the life of the installation.

**901.7 Systems out of service.** Where a required *fire protection system* is out of service, the fire department and the *fire code official* shall be notified immediately and, where required by the *fire code official*, the building shall be either evacuated or an *approved* fire watch shall be provided for all occupants left unprotected by the shutdown until the *fire protection system* has been returned to service.

Where utilized, fire watches shall be provided with not less than one *approved* means for notification of the fire department and their only duty shall be to perform constant patrols of the protected premises and keep watch for fires.

**Exception:** Facilities with an *approved* notification and impairment management program. The notification and impairment program for water-based *fire protection systems* shall comply with NFPA 25.

**901.7.1 Impairment coordinator.** The building owner shall assign an impairment coordinator to comply with the requirements of this section. In the absence of a specific designee, the owner shall be considered to be the impairment coordinator.

**901.7.2 Tag required.** A tag shall be used to indicate that a system, or portion thereof, has been removed from service.

**901.7.3 Placement of tag.** The tag shall be posted at each fire department connection, system control valve, fire alarm control unit, fire alarm annunciator and *fire command center*, indicating which system, or part thereof, has been removed from service. The *fire code official* shall specify where the tag is to be placed.

**901.7.4 Preplanned impairment programs.** Preplanned impairments shall be authorized by the impairment coordinator. Before authorization is given, a designated individual shall be responsible for verifying that all of the following procedures have been implemented:

1. The extent and expected duration of the impairment have been determined.
2. The areas or buildings involved have been inspected and the increased risks determined.
3. Recommendations have been submitted to management or the building owner/manager.
4. The fire department has been notified.
5. The insurance carrier, the alarm company, the building owner/manager and other authorities having jurisdiction have been notified.
6. The supervisors in the areas to be affected have been notified.
7. A tag impairment system has been implemented.
8. Necessary tools and materials have been assembled on the impairment site.

**901.7.5 Emergency impairments.** Where unplanned impairments occur, appropriate emergency action shall be taken to minimize potential injury and damage. The impairment coordinator shall implement the steps outlined in Section 901.7.4.

**901.7.6 Restoring systems to service.** Where impaired equipment is restored to normal working order, the impairment coordinator shall verify that all of the following procedures have been implemented:

1. Necessary inspections and tests have been conducted to verify that affected systems are operational.
2. Supervisors have been advised that protection is restored.
3. The fire department has been advised that protection is restored.
4. The building owner/manager, insurance carrier, alarm company and other involved parties have been advised that protection is restored.
5. The impairment tag has been removed.

**901.8 Removal of or tampering with equipment.** It shall be unlawful for any person to remove, tamper with or otherwise disturb any *fire protection* or *life safety system* required by this code except for the purposes of extinguishing fire, training, recharging or making necessary repairs or where *approved* by the *fire code official*.

**901.8.1 Removal of or tampering with appurtenances.** Locks, gates, doors, barricades, chains, enclosures, signs, tags or seals that have been installed by or at the direction of the *fire code official* shall not be removed, unlocked, destroyed, tampered with or otherwise vandalized in any manner.

**901.8.2 Removal of existing occupant-use hose lines.** The *fire code official* is authorized to permit the removal of existing occupant-use hose lines where both of the following conditions exist:

1. The hose line would not be utilized by trained personnel or the fire department.
2. The remaining outlets are compatible with local fire department fittings.

**901.9 Termination of monitoring service.** For fire alarm systems required to be monitored by this code, notice shall be made to the *fire code official* whenever alarm monitoring services are terminated. Notice shall be made in writing by the provider of the monitoring service being terminated.

**901.10 Recall of fire protection components.** Any *fire protection system* component regulated by this code that is the subject of a voluntary or mandatory recall under federal law shall be replaced with *approved*, *listed* components in compliance with the referenced standards of this code. The *fire code official* shall be notified in writing by the building owner when the recalled component parts have been replaced.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**SECTION 902  
DEFINITIONS**

**902.1 Definitions.** The following terms are defined in Chapter 2:

**ALARM NOTIFICATION APPLIANCE.**  
**ALARM SIGNAL.**  
**ALARM VERIFICATION FEATURE.**  
**ANNUNCIATOR.**  
**AUDIBLE ALARM NOTIFICATION APPLIANCE.**  
**AUTOMATIC.**  
**AUTOMATIC FIRE-EXTINGUISHING SYSTEM.**  
**AUTOMATIC SMOKE DETECTION SYSTEM.**  
**AUTOMATIC SPRINKLER SYSTEM.**  
**AUTOMATIC WATER MIST SYSTEM.**  
**AVERAGE AMBIENT SOUND LEVEL.**  
**CARBON DIOXIDE EXTINGUISHING SYSTEM.**  
**CLEAN AGENT.**  
**COMMERCIAL MOTOR VEHICLE.**  
**CONSTANTLY ATTENDED LOCATION.**  
**DELUGE SYSTEM.**  
**DETECTOR, HEAT.**  
**DRY-CHEMICAL EXTINGUISHING AGENT.**  
**ELEVATOR GROUP.**  
**EMERGENCY ALARM SYSTEM.**  
**EMERGENCY VOICE/ALARM COMMUNICATIONS.**  
**FIRE ALARM BOX, MANUAL.**  
**FIRE ALARM CONTROL UNIT.**  
**FIRE ALARM SIGNAL.**  
**FIRE ALARM SYSTEM.**  
**FIRE AREA.**  
**FIRE DETECTOR, AUTOMATIC.**  
**FIRE PROTECTION SYSTEM.**  
**FIRE SAFETY FUNCTIONS.**  
**FIXED BASE OPERATOR (FBO).**  
**FOAM-EXTINGUISHING SYSTEM.**  
**GAS DETECTION SYSTEM.**  
**HALOGENATED EXTINGUISHING SYSTEM.**  
**IMPAIRMENT COORDINATOR.**  
**INITIATING DEVICE.**  
**LIFE SAFETY SYSTEMS.**  
**MANUAL FIRE ALARM BOX.**  
**MULTIPLE-STATION ALARM DEVICE.**  
**MULTIPLE-STATION SMOKE ALARM.**  
**NOTIFICATION ZONE.**

**NUISANCE ALARM.**  
**PRIVATE GARAGE.**  
**RECORD DRAWINGS.**  
**SINGLE-STATION SMOKE ALARM.**  
**SLEEPING UNIT.**  
**SMOKE ALARM.**  
**SMOKE DETECTOR.**  
**STANDPIPE, TYPES OF.**  
     **Automatic dry.**  
     **Automatic wet.**  
     **Manual dry.**  
     **Manual wet.**  
     **Semiautomatic dry.**  
**STANDPIPE SYSTEM, CLASSES OF.**  
     **Class I system.**  
     **Class II system.**  
     **Class III system.**  
**SUPERVISING STATION.**  
**SUPERVISORY SERVICE.**  
**SUPERVISORY SIGNAL.**  
**SUPERVISORY SIGNAL-INITIATING DEVICE.**  
**TIRES, BULK STORAGE OF.**  
**TRANSIENT AIRCRAFT.**  
**TROUBLE SIGNAL.**  
**VISIBLE ALARM NOTIFICATION APPLIANCE.**  
**WET-CHEMICAL EXTINGUISHING AGENT.**  
**WIRELESS PROTECTION SYSTEM.**  
**ZONE.**  
**ZONE, NOTIFICATION.**

**SECTION 903  
AUTOMATIC SPRINKLER SYSTEMS**

**903.1 General.** *Automatic sprinkler systems* shall comply with this section.

**903.1.1 Alternative protection.** Alternative automatic fire-extinguishing systems complying with Section 904 shall be permitted instead of automatic sprinkler system protection where recognized by the applicable standard and *approved by the fire code official*.

**903.2 Where required.** *Approved automatic sprinkler systems* in new buildings and structures shall be provided in the locations described in Sections 903.2.1 through 903.2.12.

**Exception:** Spaces or areas in telecommunications buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided that those spaces or areas are equipped throughout with an automatic smoke detection system in accordance with Section 907.2 and

are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**903.2.1 Group A.** An *automatic sprinkler system* shall be provided throughout buildings and portions thereof used as Group A occupancies as provided in this section.

**903.2.1.1 Group A-1.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-1 occupancies and throughout all stories from the Group A-1 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.
4. The *fire area* contains a multiple-theater complex.

**903.2.1.2 Group A-2.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-2 occupancies and throughout all stories from the Group A-2 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 100 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**903.2.1.3 Group A-3.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-3 occupancies and throughout all stories from the Group A-3 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**903.2.1.4 Group A-4.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-4 occupancies and throughout all stories from the Group A-4 occupancy to and including the *levels of*

*exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**903.2.1.5 Group A-5.** An *automatic sprinkler system* shall be provided for all enclosed Group A-5 accessory use areas in excess of 1,000 square feet (93 m<sup>2</sup>).

**903.2.1.5.1 Spaces under grandstands or bleachers.** Enclosed spaces under *grandstands* or *bleachers* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where either of the following exist:

1. The enclosed area is 1,000 square feet (93 m<sup>2</sup>) or less and is not constructed in accordance with Section 1030.1.1.1.
2. The enclosed area exceeds 1,000 square feet (93 m<sup>2</sup>).

**903.2.1.6 Assembly occupancies on roofs.** Where an occupied roof has an assembly occupancy with an *occupant load* exceeding 100 for Group A-2 and 300 for other Group A occupancies, all floors between the occupied roof and the *level of exit discharge* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.

**Exception:** Open parking garages of Type I or Type II construction.

**903.2.1.7 Multiple fire areas.** An *automatic sprinkler system* shall be provided where multiple *fire areas* of Group A-1, A-2, A-3 or A-4 occupancies share *exit* or *exit access* components and the combined *occupant load* of these *fire areas* is 300 or more.

**903.2.2 Ambulatory care facilities.** An *automatic sprinkler system* shall be installed throughout the entire floor containing an ambulatory care facility where either of the following conditions exist at any time:

1. Four or more care recipients are incapable of self-preservation.
2. One or more care recipients that are incapable of self-preservation are located at other than the *level of exit discharge* serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor as well as all floors below where such care is provided, and all floors between the level of ambulatory care and the nearest *level of exit discharge*, the *level of exit discharge*, and all floors below the *level of exit discharge*.

**Exception:** Floors classified as an open parking garage are not required to be sprinklered.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**903.2.3 Group E.** An *automatic sprinkler system* shall be provided for Group E occupancies as follows:

1. Throughout all Group E *fire areas* greater than 12,000 square feet (1115 m<sup>2</sup>) in area.
2. The Group E *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**Exception:** In buildings where every classroom has not fewer than one exterior exit door at ground level, an *automatic sprinkler system* is not required in any area below the lowest *level of exit discharge* serving that area.

3. The Group E *fire area* has an *occupant load* of 300 or more.

**903.2.4 Group F-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exists:

1. A Group F-1 *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group F-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group F-1 *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).

**903.2.4.1 Woodworking operations.** An *automatic sprinkler system* shall be provided throughout all Group F-1 occupancy *fire areas* that contain woodworking operations in excess of 2,500 square feet (232 m<sup>2</sup>) in area that generate finely divided combustible waste or use finely divided combustible materials.

**903.2.4.2 Group F-1 distilled spirits.** An *automatic sprinkler system* shall be provided throughout a Group F-1 *fire area* used for the manufacture of distilled spirits.

**903.2.4.3 Group F-1 upholstered furniture or mattresses.** An *automatic sprinkler system* shall be provided throughout a Group F-1 *fire area* that exceeds 2,500 square feet (232 m<sup>2</sup>) used for the manufacture of upholstered furniture or mattresses.

**903.2.5 Group H.** *Automatic sprinkler systems* shall be provided in high-hazard occupancies as required in Sections 903.2.5.1 through 903.2.5.3.

**903.2.5.1 General.** An *automatic sprinkler system* shall be installed in Group H occupancies.

**903.2.5.2 Group H-5 occupancies.** An *automatic sprinkler system* shall be installed throughout buildings containing Group H-5 occupancies. The design of the sprinkler system shall be not less than that required under the *International Building Code* for the occupancy hazard classifications in accordance with Table 903.2.5.2.

Where the design area of the sprinkler system consists of a *corridor* protected by one row of sprin-

klers, the maximum number of sprinklers required to be calculated is 13.

**TABLE 903.2.5.2  
GROUP H-5 SPRINKLER DESIGN CRITERIA**

LOCATION	OCCUPANCY HAZARD CLASSIFICATION
Fabrication areas	Ordinary Hazard Group 2
Service corridors	Ordinary Hazard Group 2
Storage rooms without dispensing	Ordinary Hazard Group 2
Storage rooms with dispensing	Extra Hazard Group 2
Corridors	Ordinary Hazard Group 2

**903.2.5.3 Pyroxylin plastics.** An *automatic sprinkler system* shall be provided in buildings, or portions thereof, where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds (45 kg).

**903.2.6 Group I.** An *automatic sprinkler system* shall be provided throughout buildings with a Group I *fire area*.

**Exceptions:**

1. An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group I-1, Condition 1 facilities.
2. An *automatic sprinkler system* is not required where Group I-4 day care facilities are at the *level of exit discharge* and where every room where care is provided has not fewer than one exterior *exit door*.
3. In buildings where Group I-4 day care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be installed on the entire floor where care is provided, all floors between the level of care and the *level of exit discharge* and all floors below the *level of exit discharge* other than areas classified as an open parking garage.

**903.2.7 Group M.** An *automatic sprinkler system* shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

1. A Group M *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group M *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group M *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).

**903.2.7.1 High-piled storage.** An *automatic sprinkler system* shall be provided as required in Chapter 32 in all buildings of Group M where storage of merchandise is in high-piled or rack storage arrays.

**903.2.7.2 Group M upholstered furniture or mattresses.** An *automatic sprinkler system* shall be provided throughout a Group M *fire area* where the

area used for the display and sale of upholstered furniture or mattresses exceeds 5,000 square feet (464 m<sup>2</sup>).

**903.2.8 Group R.** An *automatic sprinkler system* installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R *fire area*.

**Exception:** Group R-2 live/work units and Group R-3 lodging houses with five or fewer guestrooms.

**903.2.8.1 Group R-3.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-3 occupancies.

**903.2.8.2 Group R-4, Condition 1.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-4, Condition 1 occupancies.

**903.2.8.3 Group R-4, Condition 2.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group R-4, Condition 2 occupancies.

**903.2.8.4 Care facilities.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in care facilities with five or fewer individuals in a single-family *dwelling*.

**903.2.9 Group S-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. A Group S-1 *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group S-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group S-1 *fire areas* on all floors, including any mezzanines, exceeds 24,000 square feet (2230 m<sup>2</sup>).
4. A Group S-1 *fire area* used for the storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**903.2.9.1 Repair garages.** An *automatic sprinkler system* shall be provided throughout all buildings used as repair garages in accordance with Section 406.8 of the *International Building Code*, as shown:

1. Buildings having two or more stories above *grade plane*, including *basements*, with a *fire area* containing a repair garage exceeding 10,000 square feet (929 m<sup>2</sup>).
2. Buildings not more than one story above *grade plane*, with a *fire area* containing a repair garage exceeding 12,000 square feet (1115 m<sup>2</sup>).
3. Buildings with repair garages servicing vehicles parked in *basements*.
4. A Group S-1 *fire area* used for the repair of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**903.2.9.2 Bulk storage of tires.** Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet (566 m<sup>3</sup>) shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**903.2.9.3 Group S-1 distilled spirits or wine.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* used for the bulk storage of distilled spirits or wine.

**903.2.9.4 Group S-1 upholstered furniture and mattresses.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* where the area used for the storage of upholstered furniture or mattresses exceeds 2,500 square feet (232 m<sup>2</sup>).

**Exception:** Self-service storage facilities not greater than one story above grade plane where all storage spaces can be accessed directly from the exterior. Self-service storage facilities with interior-only access not greater than 5,000 square feet (464 m<sup>2</sup>).

**903.2.10 Group S-2 parking garages.** An *automatic sprinkler system* shall be provided throughout buildings classified as parking garages where any of the following conditions exist:

1. Where the *fire area* of the enclosed parking garage, in accordance with Section 406.6 of the *International Building Code*, exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. Where the enclosed parking garage, in accordance with Section 406.6 of the *International Building Code*, is located beneath other groups.

**Exception:** Enclosed parking garages located beneath Group R-3 occupancies.

3. Where the *fire area* of the open parking garage, in accordance with Section 406.5 of the *International Building Code*, exceeds 48,000 square feet (4460 m<sup>2</sup>).

**903.2.10.1 Commercial parking garages.** An *automatic sprinkler system* shall be provided throughout buildings used for storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**903.2.10.2 Mechanical-access enclosed parking garages.** An *approved automatic sprinkler system* shall be provided throughout buildings used for the storage of motor vehicles in a mechanical-access enclosed parking garage. The portion of the building that contains the mechanical-access enclosed parking garage shall be protected with a specially engineered *automatic sprinkler system*.

**903.2.11 Specific buildings areas and hazards.** In all occupancies other than Group U, an *automatic sprinkler system* shall be installed for building design or hazards in the locations set forth in Sections 903.2.11.1 through 903.2.11.6.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**903.2.11.1 Stories without openings.** An *automatic sprinkler system* shall be installed throughout all *stories*, including *basements*, of all buildings where the floor area exceeds 1,500 square feet (139 m<sup>2</sup>) and where the story does not comply with the following criteria for exterior wall openings:

1. Openings below grade that lead directly to ground level by an exterior *stairway* complying with Section 1011 or an outside *ramp* complying with Section 1012. Openings shall be located in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the story on not fewer than one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm).
2. Openings entirely above the adjoining ground level totaling not less than 20 square feet (1.86 m<sup>2</sup>) in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the story on not fewer than one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). The height of the bottom of the clear opening shall not exceed 44 inches (1118 mm) measured from the floor.

**903.2.11.1.1 Opening dimensions and access.** Openings shall have a minimum dimension of not less than 30 inches (762 mm). *Access* to such openings shall be provided for the fire department from the exterior and shall not be obstructed in a manner such that fire fighting or rescue cannot be accomplished from the exterior.

**903.2.11.1.2 Openings on one side only.** Where openings in a story are provided on only one side and the opposite wall of such story is more than 75 feet (22 860 mm) from such openings, the story shall be equipped throughout with an *approved automatic sprinkler system*, or openings shall be provided on not fewer than two sides of the story.

**903.2.11.1.3 Basements.** Where any portion of a *basement* is located more than 75 feet (22 860 mm) from openings required by Section 903.2.11.1, or where walls, partitions or other obstructions are installed that restrict the application of water from hose streams, the *basement* shall be equipped throughout with an *approved automatic sprinkler system*.

**903.2.11.2 Rubbish and linen chutes.** An *automatic sprinkler system* shall be installed at the top of rubbish and linen chutes and in their terminal rooms. Chutes shall have additional sprinkler heads installed at alternate floors and at the lowest intake. Where a rubbish chute extends through a building more than one floor below the lowest intake, the extension shall have sprinklers installed that are recessed from the drop area of the chute and protected from freezing in accordance with Section 903.3.1.1. Such sprinklers shall be

installed at alternate floors, beginning with the second level below the last intake and ending with the floor above the discharge. *Access* to sprinklers in chutes shall be provided for servicing.

**903.2.11.3 Buildings 55 feet or more in height.** An *automatic sprinkler system* shall be installed throughout buildings that have one or more stories with an *occupant load* of 30 or more located 55 feet (16 764 mm) or more above the lowest level of fire department vehicle access, measured to the finished floor.

**Exception:** Occupancies in Group F-2.

**903.2.11.4 Ducts conveying hazardous exhausts.** Where required by the *International Mechanical Code*, automatic sprinklers shall be provided in ducts conveying hazardous exhaust or flammable or combustible materials.

**Exception:** Ducts where the largest cross-sectional diameter of the duct is less than 10 inches (254 mm).

**903.2.11.5 Commercial cooking operations.** An *automatic sprinkler system* shall be installed in commercial kitchen exhaust hood and duct systems where an *automatic sprinkler system* is used to comply with Section 904.

**903.2.11.6 Other required fire protection systems.** In addition to the requirements of Section 903.2, the provisions indicated in Table 903.2.11.6 require the installation of a fire protection system for certain buildings and areas.

**903.2.12 During construction.** *Automatic sprinkler systems* required during construction, *alteration* and demolition operations shall be provided in accordance with Section 3314.

**903.3 Installation requirements.** *Automatic sprinkler systems* shall be designed and installed in accordance with Sections 903.3.1 through 903.3.8.

**903.3.1 Standards.** Sprinkler systems shall be designed and installed in accordance with Section 903.3.1.1, unless otherwise permitted by Sections 903.3.1.2 and 903.3.1.3 and other chapters of this code, as applicable. A minimum of 5 psi (34.5 kPa) safety factor shall be provided between the hydraulic calculated system demand and the available water supply.

**903.3.1.1 NFPA 13 sprinkler systems.** Where the provisions of this code require that a building or portion thereof be equipped throughout with an *automatic sprinkler system* in accordance with this section, sprinklers shall be installed throughout in accordance with NFPA 13 except as provided in Sections 903.3.1.1.1 and 903.3.1.1.2.

**903.3.1.1.1 Exempt locations.** Automatic sprinklers shall not be required in the following rooms or areas where such rooms or areas are protected with an *approved* automatic fire detection system in accordance with Section 907.2 that will respond to visible or invisible particles of combustion. Sprinklers shall not be omitted from a room merely

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**TABLE 903.2.11.6**  
**ADDITIONAL REQUIRED FIRE PROTECTION SYSTEMS**

SECTION	SUBJECT
903.2.10.2	Mechanical-access enclosed parking garages
914.2.1	Covered and open mall buildings
914.3.1	High-rise buildings
914.4.1	Atriums
914.5.1	Underground structures
914.6.1	Stages
914.7.1	Special amusement buildings
914.8.2	Airport traffic control towers
914.8.3, 914.8.6	Aircraft hangars
914.9	Flammable finishes
914.10	Drying rooms
914.11.1	Ambulatory care facilities
1030.6.2.3	Smoke-protected assembly seating
1103.5.1	Existing Group A occupancies
1103.5.2	Pyroxylin plastic storage in existing buildings
1103.5.3	Existing Group I-2 occupancies
1103.5.5	Existing Group I-2, Condition 2 occupancies
1103.5.5	Pyroxylin plastics
Table 1207.7, Table 1207.8, Table 1206.9, Table 1206.10	Stationary and mobile energy storage systems
2108.2	Dry cleaning plants
2108.3	Dry cleaning machines
2309.3.1.5.2	Hydrogen motor fuel-dispensing area canopies
2404.2	Spray finishing in Group A, E, I or R
2404.4	Spray booths and spray rooms
2405.2	Dip-tank rooms in Group A, I or R
2405.4.1	Dip tanks
2405.9.4	Hardening and tempering tanks
2703.10	HPM facilities
2703.10.1.1	HPM work station exhaust
2703.10.2	HPM gas cabinets and exhausted enclosures
2703.10.3	HPM exit access corridor
2703.10.4	HPM exhaust ducts
2703.10.4.1	HPM noncombustible ducts
2703.10.4.2	HPM combustible ducts
2807.3	Lumber production conveyor enclosures
2808.7	Recycling facility conveyor enclosures
3006.1	Class A and B ovens
3006.2	Class C and D ovens
Table 3206.2	Storage fire protection
3206.4	Storage
3210.1.1	Record storage over 12 feet

(continued)

**TABLE 903.2.11.6—continued**  
**ADDITIONAL REQUIRED FIRE PROTECTION SYSTEMS**

SECTION	SUBJECT
3704.5	Storage of more than 1,000 cubic feet of loose combustible fibers
5003.8.4.1	Gas rooms
5003.8.5.3	Exhausted enclosures
5004.5	Indoor storage of hazardous materials
5005.1.8	Indoor dispensing of hazardous materials
5104.4.1	Aerosol product warehouses
5106.3.2	Aerosol display and merchandising areas
5306.2.1	Exterior medical gas storage room
5306.2.2	Interior medical gas storage room
5306.2.3	Medical gas storage cabinet
5606.5.2.1	Storage of smokeless propellant
5606.5.2.3	Storage of small arms primers
5704.3.7.5.1	Flammable and combustible liquid storage rooms
5704.3.8.4	Flammable and combustible liquid storage warehouses
5705.3.7.3	Flammable and combustible liquid Group H-2 or H-3 areas
6004.1.2	Gas cabinets for highly toxic and toxic gas
6004.1.3	Exhausted enclosures for highly toxic and toxic gas
6004.2.2.6	Gas rooms for highly toxic and toxic gas
6004.3.3	Outdoor storage for highly toxic and toxic gas
6504.1.1	Pyroxylin plastic storage cabinets
6504.1.3	Pyroxylin plastic storage vaults
6504.2	Pyroxylin plastic storage and manufacturing

For SI: 1 cubic foot = 0.023 m<sup>3</sup>.

because it is damp, of *fire-resistance-rated* construction or contains electrical equipment.

1. A room where the application of water, or flame and water, constitutes a serious life or fire hazard.
2. A room or space where sprinklers are considered undesirable because of the nature of the contents, where *approved* by the *fire code official*.
3. Generator and transformer rooms separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a *fire-resistance rating* of not less than 2 hours.
4. Rooms or areas that are of noncombustible construction with wholly noncombustible contents.
5. Fire service access elevator machine rooms and machinery spaces.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

- Machine rooms, machinery spaces, control rooms and control spaces associated with occupant evacuation elevators designed in accordance with Section 3008 of the *International Building Code*.

**903.3.1.1.2 Bathrooms.** In Group R occupancies, sprinklers shall not be required in bathrooms that do not exceed 55 square feet (5 m<sup>2</sup>) in area and are located within individual *dwelling units* or *sleeping units*, provided that walls and ceilings, including the walls and ceilings behind a shower enclosure or tub, are of noncombustible or limited-combustible materials with a 15-minute thermal barrier rating.

**903.3.1.2 NFPA 13R sprinkler systems.** *Automatic sprinkler systems* in Group R occupancies shall be permitted to be installed throughout in accordance with NFPA 13R where the Group R occupancy meets all of the following conditions:

- Four stories or less above grade plane.
- The floor level of the highest story is 30 feet (9144 mm) or less above the lowest level of fire department vehicle access.
- The floor level of the lowest story is 30 feet (9144 mm) or less below the lowest level of fire department vehicle access.

The number of stories of Group R occupancies constructed in accordance with Sections 510.2 and 510.4 of the *International Building Code* shall be measured from *grade plane*.

**903.3.1.2.1 Balconies and decks.** Sprinkler protection shall be provided for exterior balconies, decks and ground floor patios of *dwelling units* and *sleeping units* where either of the following conditions exists:

- The building is of Type V construction, provided that there is a roof or deck above.
- Exterior balconies, decks and ground floor patios of *dwelling units* and *sleeping units* are constructed in accordance with Section 705.2.3.1, Exception 3 of the *International Building Code*.

Sidewall sprinklers that are used to protect such areas shall be permitted to be located such that their deflectors are within 1 inch (25 mm) to 6 inches (152 mm) below the structural members and a maximum distance of 14 inches (356 mm) below the deck of the exterior balconies and decks that are constructed of open wood joist construction.

**903.3.1.2.2 Corridors and balconies in the means of egress.** Sprinkler protection shall be provided in *corridors* and for balconies in the *means of egress* where any of the following conditions apply:

- Corridors* with combustible floor or walls.
- Corridors* with an interior change of direction exceeding 45 degrees (0.79 rad).

- Corridors* that are less than 50 percent open to the outside atmosphere at the ends.
- Open-ended *corridors* and associated exterior *stairways* and ramps as specified in Section 1027.6, Exception 3.
- Egress balconies not complying with Sections 1021.2 and 1021.3.

**903.3.1.2.3 Attics.** Attic protection shall be provided as follows:

- Attics that are used or intended for living purposes or storage shall be protected by an *automatic sprinkler system*.
- Where fuel-fired equipment is installed in an unsprinklered attic, not fewer than one quick-response intermediate temperature sprinkler shall be installed above the equipment.
- Where located in a building of Type III, Type IV or Type V construction designed in accordance with Section 510.2 or 510.4 of the *International Building Code*, attics not required by Item 1 to have sprinklers shall comply with one of the following if the roof assembly is located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access needed to meet the provisions in Section 503:
  - Provide *automatic sprinkler system* protection.
  - Construct the attic using noncombustible materials.
  - Construct the attic using fire-retardant-treated wood complying with Section 2303.2 of the *International Building Code*.
  - Fill the attic with noncombustible insulation.

The height of the roof assembly shall be determined by measuring the distance from the lowest required fire vehicle access road surface adjacent to the building to the eave of the highest pitched roof, the intersection of the highest roof to the exterior wall, or the top of the highest parapet, whichever yields the greatest distance. For the purpose of this measurement, required fire vehicle access roads shall include only those roads that are necessary for compliance with Section 503.

- Group R-4, Condition 2 occupancy attics not required by Item 1 to have sprinklers shall comply with one of the following:
  - Provide *automatic sprinkler system* protection.

- 4.2. Provide a heat detection system throughout the attic that is arranged to activate the building fire alarm system.
- 4.3. Construct the attic using noncombustible materials.
- 4.4. Construct the attic using fire-retardant-treated wood complying with Section 2303.2 of the *International Building Code*.
- 4.5. Fill the attic with noncombustible insulation.

**903.3.1.3 NFPA 13D sprinkler systems.** *Automatic sprinkler systems* installed in one- and two-family dwellings; Group R-3; Group R-4, Condition 1; and townhouses shall be permitted to be installed throughout in accordance with NFPA 13D.

**903.3.2 Quick-response and residential sprinklers.** Where *automatic sprinkler systems* are required by this code, quick-response or residential automatic sprinklers shall be installed in all of the following areas in accordance with Section 903.3.1 and their listings:

1. Throughout all spaces within a *smoke compartment* containing care recipient *sleeping units* in Group I-2 in accordance with the *International Building Code*.
2. Throughout all spaces within a *smoke compartment* containing gas fireplace appliances and decorative gas appliances in Group I-2 in accordance with the *International Building Code*.
3. Throughout all spaces within a *smoke compartment* containing treatment rooms in ambulatory care facilities.
4. *Dwelling units* and *sleeping units* in Group I-1 and R occupancies.
5. Light-hazard occupancies as defined in NFPA 13.

**903.3.3 Obstructed locations.** Automatic sprinklers shall be installed with regard to obstructions that will delay activation or obstruct the water distribution pattern and shall be in accordance with the applicable *automatic sprinkler system* standard that is being used. Automatic sprinklers shall be installed in or under covered kiosks, displays, booths, concession stands or equipment that exceeds 4 feet (1219 mm) in width. Not less than a 3-foot (914 mm) clearance shall be maintained between automatic sprinklers and the top of piles of *combustible fibers*.

**Exception:** Kitchen equipment under exhaust hoods protected with a fire-extinguishing system in accordance with Section 904.

**903.3.4 Actuation.** *Automatic sprinkler systems* shall be automatically actuated unless specifically provided for in this code.

**903.3.5 Water supplies.** Water supplies for *automatic sprinkler systems* shall comply with this section and the standards referenced in Section 903.3.1. The potable

water supply shall be protected against backflow in accordance with the requirements of this section and the *International Plumbing Code*. For connections to public waterworks systems, the water supply test used for design of *fire protection systems* shall be adjusted to account for seasonal and daily pressure fluctuations based on information from the water supply authority and as *approved* by the *fire code official*.

**903.3.5.1 Domestic services.** Where the domestic service provides the water supply for the *automatic sprinkler system*, the supply shall be in accordance with this section.

**903.3.5.2 Residential combination services.** A single combination water supply shall be allowed provided that the domestic demand is added to the sprinkler demand as required by NFPA 13R.

**903.3.6 Hose threads.** Fire hose threads and fittings used in connection with *automatic sprinkler systems* shall be as prescribed by the *fire code official*.

**903.3.7 Fire department connections.** Fire department connections for *automatic sprinkler systems* shall be installed in accordance with Section 912.

**903.3.8 Limited area sprinkler systems.** Limited area sprinkler systems shall be in accordance with the standards listed in Section 903.3.1 except as provided in Sections 903.3.8.1 through 903.3.8.5.

**903.3.8.1 Number of sprinklers.** Limited area sprinkler systems shall not exceed six sprinklers in any single *fire area*.

**903.3.8.2 Occupancy hazard classification.** Only areas classified by NFPA 13 as Light Hazard or Ordinary Hazard Group 1 shall be permitted to be protected by limited area sprinkler systems.

**903.3.8.3 Piping arrangement.** Where a limited area sprinkler system is installed in a building with an automatic wet standpipe system, sprinklers shall be supplied by the standpipe system. Where a limited area sprinkler system is installed in a building without an automatic wet standpipe system, water shall be permitted to be supplied by the plumbing system provided that the plumbing system is capable of simultaneously supplying domestic and sprinkler demands.

**903.3.8.4 Supervision.** Control valves shall not be installed between the water supply and sprinklers unless the valves are of an *approved* indicating type that are supervised or secured in the open position.

**903.3.8.5 Calculations.** Hydraulic calculations in accordance with NFPA 13 shall be provided to demonstrate that the available water flow and pressure are adequate to supply all sprinklers installed in any single *fire area* with discharge densities corresponding to the hazard classification.

**903.4 Sprinkler system supervision and alarms.** Valves controlling the water supply for *automatic sprinkler systems*, pumps, tanks, water levels and temperatures, critical air

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

pressures and waterflow switches on all sprinkler systems shall be electrically supervised by a *listed* fire alarm control unit.

### Exceptions:

1. *Automatic sprinkler systems* protecting one- and two-family *dwellings*.
2. Limited area sprinkler systems in accordance with Section 903.3.8.
3. *Automatic sprinkler systems* installed in accordance with NFPA 13R where a common supply main is used to supply both domestic water and the *automatic sprinkler system*, and a separate shutoff valve for the *automatic sprinkler system* is not provided.
4. Jockey pump control valves that are sealed or locked in the open position.
5. Control valves to commercial kitchen hoods, paint spray booths or dip tanks that are sealed or locked in the open position.
6. Valves controlling the fuel supply to fire pump engines that are sealed or locked in the open position.
7. Trim valves to pressure switches in dry, preaction and deluge sprinkler systems that are sealed or locked in the open position.
8. Underground key or hub gate valves in roadway boxes.

**903.4.1 Monitoring.** Alarm, supervisory and trouble signals shall be distinctly different and shall be automatically transmitted to an *approved* supervising station or, where *approved* by the *fire code official*, shall sound an audible signal at a constantly attended location.

**Exception:** Backflow prevention device test valves located in limited area sprinkler system supply piping shall be locked in the open position. In occupancies required to be equipped with a fire alarm system, the backflow preventer valves shall be electrically supervised by a tamper switch installed in accordance with NFPA 72 and separately annunciated.

**903.4.2 Alarms.** An *approved* audible device, located on the exterior of the building in an *approved* location, shall be connected to each *automatic sprinkler system*. Such sprinkler waterflow alarm devices shall be activated by water flow equivalent to the flow of a single sprinkler of the smallest orifice size installed in the system. Where a fire alarm system is installed, actuation of the *automatic sprinkler system* shall actuate the building fire alarm system.

**903.4.3 Floor control valves.** *Approved* supervised indicating control valves shall be provided at the point of connection to the riser on each floor in high-rise buildings.

**903.5 Testing and maintenance.** Automatic sprinkler systems shall be tested and maintained in accordance with Section 901.

**903.6 Where required in existing buildings and structures.** An *automatic sprinkler system* shall be provided in existing buildings and structures where required in Chapter 11.

## SECTION 904 ALTERNATIVE AUTOMATIC FIRE-EXTINGUISHING SYSTEMS

**904.1 General.** Automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall be designed, installed, inspected, tested and maintained in accordance with the provisions of this section and the applicable referenced standards.

**904.1.1 Certification of service personnel for fire-extinguishing equipment.** Service personnel providing or conducting maintenance on automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall possess a valid certificate issued by an *approved* governmental agency, or other *approved* organization for the type of system and work performed.

**904.2 Where permitted.** Automatic fire-extinguishing systems installed as an alternative to the required *automatic sprinkler systems* of Section 903 shall be *approved* by the *fire code official*.

**904.2.1 Restriction on using automatic sprinkler system exceptions or reductions.** Automatic fire-extinguishing systems shall not be considered alternatives for the purposes of exceptions or reductions allowed for *automatic sprinkler systems* or by other requirements of this code.

**904.2.2 Commercial hood and duct systems.** Each required commercial kitchen exhaust hood and duct system required by Section 606 to have a Type I hood shall be protected with an *approved* automatic fire-extinguishing system installed in accordance with this code.

**904.3 Installation.** Automatic fire-extinguishing systems shall be installed in accordance with this section.

**904.3.1 Electrical wiring.** Electrical wiring shall be in accordance with NFPA 70.

**904.3.2 Actuation.** Automatic fire-extinguishing systems shall be automatically actuated and provided with a manual means of actuation in accordance with Section 904.13.1. Where more than one hazard could be simultaneously involved in fire due to their proximity, all hazards shall be protected by a single system designed to protect all hazards that could become involved.

**Exception:** Multiple systems shall be permitted to be installed if they are designed to operate simultaneously.

**904.3.3 System interlocking.** Automatic equipment interlocks with fuel shutoffs, ventilation controls, door closers, window shutters, conveyor openings, smoke and heat vents and other features necessary for proper operation of the fire-extinguishing system shall be provided as required by the design and installation standard utilized for the hazard.



**904.3.4 Alarms and warning signs.** Where alarms are required to indicate the operation of automatic fire-extinguishing systems, distinctive audible, visible alarms and warning signs shall be provided to warn of pending agent discharge. Where exposure to automatic-extinguishing agents poses a hazard to persons and a delay is required to ensure the evacuation of occupants before agent discharge, a separate warning signal shall be provided to alert occupants once agent discharge has begun. Audible signals shall be in accordance with Section 907.5.2.

**904.3.5 Monitoring.** Where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the building fire alarm system in accordance with NFPA 72.

**904.4 Inspection and testing.** Automatic fire-extinguishing systems shall be inspected and tested in accordance with the provisions of this section prior to acceptance.

**904.4.1 Inspection.** Prior to conducting final acceptance tests, all of the following items shall be inspected:

1. Hazard specification for consistency with design hazard.
2. Type, location and spacing of automatic- and manual-initiating devices.
3. Size, placement and position of nozzles or discharge orifices.
4. Location and identification of audible and visible alarm devices.
5. Identification of devices with proper designations.
6. Operating instructions.

**904.4.2 Alarm testing.** Notification appliances, connections to fire alarm systems and connections to *approved* supervising stations shall be tested in accordance with this section and Section 907 to verify proper operation.

**904.4.2.1 Audible and visible signals.** The audibility and visibility of notification appliances signaling agent discharge or system operation, where required, shall be verified.

**904.4.3 Monitor testing.** Connections to protected premises and supervising station fire alarm systems shall be tested to verify proper identification and retransmission of alarms from automatic fire-extinguishing systems.

**904.5 Wet-chemical systems.** Wet-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17A and their listing. Records of inspections and testing shall be maintained.

**904.5.1 System test.** Systems shall be inspected and tested for proper operation at six-month intervals. Tests shall include a check of the detection system, alarms and releasing devices, including manual stations and other associated equipment. Extinguishing system units shall be weighed and the required amount of agent verified. Stored pressure-type units shall be checked for the required pressure. The cartridge of cartridge-operated units shall be weighed and replaced at intervals indicated by the manufacturer.

**904.5.2 Fusible link maintenance.** Fixed temperature-sensing elements shall be maintained to ensure proper operation of the system.

**904.6 Dry-chemical systems.** Dry-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17 and their listing. Records of inspections and testing shall be maintained.

**904.6.1 System test.** Systems shall be inspected and tested for proper operation at six-month intervals. Tests shall include a check of the detection system, alarms and releasing devices, including manual stations and other associated equipment. Extinguishing system units shall be weighed, and the required amount of agent verified. Stored pressure-type units shall be checked for the required pressure. The cartridge of cartridge-operated units shall be weighed and replaced at intervals indicated by the manufacturer.

**904.6.2 Fusible link maintenance.** Fixed temperature-sensing elements shall be maintained to ensure proper operation of the system.

**904.7 Foam systems.** Foam-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 11 and NFPA 16 and their listing. Records of inspections and testing shall be maintained.

**904.7.1 System test.** Foam-extinguishing systems shall be inspected and tested at intervals in accordance with NFPA 25.

**904.8 Carbon dioxide systems.** Carbon dioxide extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12 and their listing. Records of inspections and testing shall be maintained.

**904.8.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

**904.8.2 High-pressure cylinders.** High-pressure cylinders shall be weighed and the date of the last hydrostatic test shall be verified at six-month intervals. Where a container shows a loss in original content of more than 10 percent, the cylinder shall be refilled or replaced.

**904.8.3 Low-pressure containers.** The liquid-level gauges of low-pressure containers shall be observed at one-week intervals. Where a container shows a content loss of more than 10 percent, the container shall be refilled to maintain the minimum gas requirements.

**904.8.4 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. At five-year intervals, all hoses shall be tested.

**904.8.4.1 Test procedure.** Hoses shall be tested at not less than 2,500 pounds per square inch (psi) (17 238 kPa) for high-pressure systems and at not less than 900 psi (6206 kPa) for low-pressure systems.

**904.8.5 Auxiliary equipment.** Auxiliary and supplementary components, such as switches, door and window releases, interconnected valves, damper releases and supplementary alarms, shall be manually operated at 12-



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

month intervals to ensure that such components are in proper operating condition.

**904.9 Halon systems.** Halogenated extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12A and their listing. Records of inspections and testing shall be maintained.

**904.9.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

**904.9.2 Containers.** The extinguishing agent quantity and pressure of containers shall be checked at six-month intervals. Where a container shows a loss in original weight of more than 5 percent or a loss in original pressure (adjusted for temperature) of more than 10 percent, the container shall be refilled or replaced. The weight and pressure of the container shall be recorded on a tag attached to the container.

**904.9.3 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. At five-year intervals, all hoses shall be tested.

**904.9.3.1 Test procedure.** For Halon 1301 systems, hoses shall be tested at not less than 1,500 psi (10 343 kPa) for 600 psi (4137 kPa) charging pressure systems and not less than 900 psi (6206 kPa) for 360 psi (2482 kPa) charging pressure systems. For Halon 1211 hand-hose line systems, hoses shall be tested at 2,500 psi (17 238 kPa) for high-pressure systems and 900 psi (6206 kPa) for low-pressure systems.

**904.9.4 Auxiliary equipment.** Auxiliary and supplementary components, such as switches, door and window releases, interconnected valves, damper releases and supplementary alarms, shall be manually operated at 12-month intervals to ensure such components are in proper operating condition.

**904.10 Clean-agent systems.** Clean-agent fire-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 2001 and their listing. Records of inspections and testing shall be maintained.

**904.10.1 System test.** Systems shall be inspected and tested for proper operation at 12-month intervals.

**904.10.2 Containers.** The extinguishing agent quantity and pressure of the containers shall be checked at six-month intervals. Where a container shows a loss in original weight of more than 5 percent or a loss in original pressure, adjusted for temperature, of more than 10 percent, the container shall be refilled or replaced. The weight and pressure of the container shall be recorded on a tag attached to the container.

**904.10.3 System hoses.** System hoses shall be examined at 12-month intervals for damage. Damaged hoses shall be replaced or tested. All hoses shall be tested at five-year intervals.

**904.11 Automatic water mist systems.** *Automatic water mist systems* shall be permitted in applications that are

consistent with the applicable listing or approvals and shall comply with Sections 904.11.1 through 904.11.3.

**904.11.1 Design and installation requirements.** *Automatic water mist systems* shall be designed and installed in accordance with Sections 904.11.1.1 through 904.11.1.4.

**904.11.1.1 General.** *Automatic water mist systems* shall be designed and installed in accordance with NFPA 750 and the manufacturer's instructions.

**904.11.1.2 Actuation.** *Automatic water mist systems* shall be automatically actuated.

**904.11.1.3 Water supply protection.** Connections to a potable water supply shall be protected against back-flow in accordance with the *International Plumbing Code*.

**904.11.1.4 Secondary water supply.** Where a secondary water supply is required for an *automatic sprinkler system*, an *automatic water mist system* shall be provided with an *approved* secondary water supply.

**904.11.2 Water mist system supervision and alarms.** Supervision and alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.

**904.11.2.1 Monitoring.** Monitoring shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.1.

**904.11.2.2 Alarms.** Alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.2.

**904.11.2.3 Floor control valves.** Floor control valves shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.3.

**904.11.3 Testing and maintenance.** *Automatic water mist systems* shall be tested and maintained in accordance with Section 901.6.

**904.12 Aerosol fire-extinguishing systems.** Aerosol fire-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 2010 and their listing.

Such devices and appurtenances shall be *listed* and installed in compliance with manufacturer's instructions.

**904.12.1 Maintenance.** Not less than semiannually, an inspection shall be conducted by a trained person to assess whether the system is in working order. Not less than annually, a certified fire suppression contractor having knowledge of and training in the installation, operation and maintenance of the specific fire-extinguishing system shall inspect, test, service and maintain such system in accordance with this section and the manufacturer's specifications and servicing manuals. Records of inspections and testing shall be maintained.

**904.13 Commercial cooking systems.** The automatic fire-extinguishing system for commercial cooking systems shall be of a type recognized for protection of commercial cook-

ing equipment and exhaust systems of the type and arrangement protected. Preengineered automatic dry- and wet-chemical extinguishing systems shall be tested in accordance with UL 300 and *listed* and *labeled* for the intended application. Other types of automatic fire-extinguishing systems shall be *listed* and *labeled* for specific use as protection for commercial cooking operations. The system shall be installed in accordance with this code, NFPA 96, its listing and the manufacturer's installation instructions. Automatic fire-extinguishing systems of the following types shall be installed in accordance with the referenced standard indicated, as follows:

1. Carbon dioxide extinguishing systems, NFPA 12.
2. *Automatic sprinkler systems*, NFPA 13.
3. Automatic water mist systems, NFPA 750.
4. Foam-water sprinkler system or foam-water spray systems, NFPA 16.
5. Dry-chemical extinguishing systems, NFPA 17.
6. Wet-chemical extinguishing systems, NFPA 17A.

**Exception:** Factory-built commercial cooking recirculating systems that are tested in accordance with UL 710B and *listed*, *labeled* and installed in accordance with Section 304.1 of the *International Mechanical Code*.

**904.13.1 Manual system operation.** A manual actuation device shall be located at or near a *means of egress* from the cooking area not less than 10 feet (3048 mm) and not more than 20 feet (6096 mm) from the kitchen exhaust system. The manual actuation device shall be installed not more than 48 inches (1200 mm) nor less than 42 inches (1067 mm) above the floor and shall clearly identify the hazard protected. The manual actuation shall require a maximum force of 40 pounds (178 N) and a maximum movement of 14 inches (356 mm) to actuate the fire suppression system.

**Exception:** *Automatic sprinkler systems* shall not be required to be equipped with manual actuation means.

**904.13.2 System interconnection.** The actuation of the fire extinguishing system shall automatically shut down the fuel or electrical power supply to the cooking equipment. The fuel and electrical supply reset shall be manual.

**904.13.3 Carbon dioxide systems.** Where carbon dioxide systems are used, there shall be a nozzle at the top of the ventilating duct. Additional nozzles that are symmetrically arranged to give uniform distribution shall be installed within vertical ducts exceeding 20 feet (6096 mm) and horizontal ducts exceeding 50 feet (15 240 mm). Dampers shall be installed at either the top or the bottom of the duct and shall be arranged to operate automatically upon activation of the fire-extinguishing system. Where the damper is installed at the top of the duct, the top nozzle shall be immediately below the damper. Automatic carbon dioxide fire-extinguishing systems shall be sufficiently sized to protect all hazards venting through a common duct simultaneously.

**904.13.3.1 Ventilation system.** Commercial-type cooking equipment protected by an automatic carbon dioxide extinguishing system shall be arranged to shut off the ventilation system upon activation.

**904.13.4 Special provisions for automatic sprinkler systems.** *Automatic sprinkler systems* protecting commercial-type cooking equipment shall be supplied from a separate, indicating-type control valve that is identified. Access to the control valve shall be provided.

**904.13.4.1 Listed sprinklers.** Sprinklers used for the protection of fryers shall be tested in accordance with UL 199E, *listed* for that application and installed in accordance with their listing.

**904.13.5 Operations and maintenance.** Automatic fire-extinguishing systems protecting commercial cooking systems shall be maintained in accordance with Sections 904.13.5.1 through 904.13.5.3.

**904.13.5.1 Existing automatic fire-extinguishing systems.** Where changes in the cooking media, positioning of cooking equipment or replacement of cooking equipment occur in existing commercial cooking systems, the automatic fire-extinguishing system shall be required to comply with the applicable provisions of Sections 904.13 through 904.13.4.

**904.13.5.2 Extinguishing system service.** Automatic fire-extinguishing systems shall be serviced not less frequently than every six months and after activation of the system. Inspection shall be by qualified individuals, and a certificate of inspection shall be forwarded to the *fire code official* upon completion.

**904.13.5.3 Fusible link and sprinkler head replacement.** Fusible links and automatic sprinkler heads shall be replaced annually, and other protection devices shall be serviced or replaced in accordance with the manufacturer's instructions.

**Exception:** Frangible bulbs are not required to be replaced annually.

**904.14 Domestic cooking facilities.** Cooktops and ranges installed in the following occupancies shall be protected in accordance with Section 904.14.1:

1. In Group I-1 occupancies where domestic cooking facilities are installed in accordance with Section 420.9 of the *International Building Code*.
2. In Group I-2 occupancies where domestic cooking facilities are installed in accordance with Section 407.2.7 of the *International Building Code*.
3. In Group R-2 college dormitories where domestic cooking facilities are installed in accordance with Section 420.11 of the *International Building Code*.
4. New and existing day care facilities shall be provided with automatic fire-extinguishing systems for cooking appliances utilizing a cooking surface. Automatic fire-extinguishing systems designed for residential use are allowed for protection of domestic cooking appliances.

**Exception:** In-home day care licensed for 16 or fewer children and all of the following requirements are met:

1. The license holder resides in the home.
2. The licensed caregiver resides in the home.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

3. A signed agreement to not conduct cooking that produces grease-laden vapors during the hours of day care operation is provided.

**904.14.1 Protection from fire.** Cooktops and ranges shall be protected in accordance with Section 904.14.1.1 or 904.14.1.2.

**904.14.1.1 Automatic fire-extinguishing system.** The domestic recirculating or exterior vented cooking hood provided over the cooktop or range shall be equipped with an *approved* automatic fire-extinguishing system complying with the following:

1. The automatic fire-extinguishing system shall be of a type recognized for protection of domestic cooking equipment. Preengineered automatic fire-extinguishing systems shall be *listed and labeled* in accordance with UL 300A and installed in accordance with the manufacturer's instructions.
2. Manual actuation of the fire-extinguishing system shall be provided in accordance with Section 904.13.1.
3. Interconnection of the fuel and electric power supply shall be in accordance with Section 904.13.2.

**904.14.1.2 Ignition prevention.** Cooktops and ranges shall include burners that have been tested and *listed* to prevent ignition of cooking oil with burners turned on to their maximum heat settings and allowed to operate for 30 minutes.

### SECTION 905 STANDPIPE SYSTEMS

**905.1 General.** Standpipe systems shall be provided in new buildings and structures in accordance with Sections 905.2 through 905.11. In buildings used for *high-piled combustible storage*, fire protection shall be in accordance with Chapter 32.

**905.2 Installation standard.** Standpipe systems shall be installed in accordance with this section and NFPA 14. Fire department connections for standpipe systems shall be in accordance with Section 912.

**905.3 Required installations.** Standpipe systems shall be installed where required by Sections 905.3.1 through 905.3.8. Standpipe systems are allowed to be combined with *automatic sprinkler systems*.

**Exception:** Standpipe systems are not required in Group R-3 occupancies.

**905.3.1 Height.** Class III standpipe systems shall be installed throughout buildings where any of the following conditions exist:

1. Four or more stories are above or below *grade plane*.
2. The floor level of the highest story is located more than 30 feet (9144 mm) above the lowest level of the fire department vehicle access.

3. The floor level of the lowest story is located more than 30 feet (9144 mm) below the highest level of fire department vehicle access.

#### Exceptions:

1. Class I standpipes are allowed in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Class I standpipes are allowed in Group B and E occupancies.
3. Class I standpipes are allowed in parking garages.
4. Class I standpipes are allowed in *basements* equipped throughout with an *automatic sprinkler system*.
5. Class I standpipes are allowed in buildings where occupant-use hose lines will not be utilized by trained personnel or the fire department.
6. In determining the lowest level of fire department vehicle access, it shall not be required to consider either of the following:
  - 6.1. Recessed loading docks for four vehicles or less.
  - 6.2. Conditions where topography makes access from the fire department vehicle to the building impractical or impossible.

**905.3.2 Group A.** Class I automatic wet standpipes shall be provided in nonsprinklered Group A buildings having an *occupant load* exceeding 1,000 persons.

#### Exceptions:

1. Open-air-seating spaces without enclosed spaces.
2. Class I automatic dry and semiautomatic dry standpipes or manual wet standpipes are allowed in buildings that are not high-rise buildings.

**905.3.3 Covered and open mall buildings.** Covered mall and open mall buildings shall be equipped throughout with a standpipe system where required by Section 905.3.1. Mall buildings not required to be equipped with a standpipe system by Section 905.3.1 shall be equipped with Class I hose connections connected to the *automatic sprinkler system* sized to deliver water at 250 gallons per minute (946.4 L/min) at the hydraulically most remote hose connection while concurrently supplying the *automatic sprinkler system* demand. The standpipe system shall be designed not to exceed a 50 pounds per square inch (psi) (345 kPa) residual pressure loss with a flow of 250 gallons per minute (946.4 L/min) from the fire department connection to the hydraulically most remote hose connection. Hose connections shall be provided at each of the following locations:

1. Within the mall at the entrance to each *exit passageway* or *corridor*.
2. At each floor-level landing within *interior exit stairways* opening directly on the mall.
3. At exterior public entrances to the mall of a covered mall building.



4. At public entrances at the perimeter line of an open mall building.
5. At other locations as necessary so that the distance to reach all portions of a tenant space does not exceed 200 feet (60 960 mm) from a hose connection.

**905.3.4 Stages.** Stages greater than 1,000 square feet (93 m<sup>2</sup>) in area shall be equipped with a Class III wet standpipe system with 1½-inch and 2½-inch (38 mm and 64 mm) hose connections on each side of the stage.

**Exception:** Where the building or area is equipped throughout with an *automatic sprinkler system*, a 1½-inch (38 mm) hose connection shall be installed in accordance with NFPA 13 or in accordance with NFPA 14 for Class II or III standpipes.

**905.3.4.1 Hose and cabinet.** The 1½-inch (38 mm) hose connections shall be equipped with sufficient lengths of 1½-inch (38 mm) hose to provide fire protection for the stage area. Hose connections shall be equipped with an *approved* adjustable fog nozzle and be mounted in a cabinet or on a rack.

**905.3.5 Underground buildings.** Underground buildings shall be equipped throughout with a Class I automatic wet or manual wet standpipe system.

**905.3.6 Helistops and heliports.** Buildings with a roof-top *helistop* or *heliport* shall be equipped with a Class I or III standpipe system extended to the roof level on which the *helistop* or *heliport* is located in accordance with Section 2007.5.

**905.3.7 Marinas and boatyards.** Standpipes in marinas and boatyards shall comply with Chapter 36.

**905.3.8 Landscaped roofs.** Buildings or structures that have landscaped roofs and that are equipped with a standpipe system shall have the standpipe system extended to the roof level on which the landscaped roof is located.

**905.4 Location of Class I standpipe hose connections.** Class I standpipe hose connections shall be provided in all of the following locations:

1. In every required *interior exit stairway*, a hose connection shall be provided for each story above and below *grade plane*. Hose connections shall be located at the main floor landing unless otherwise *approved* by the *fire code official*.

**Exception:** A single hose connection shall be permitted to be installed in the open *corridor* or open breezeway between open *stairs* that are not greater than 75 feet (22 860 mm) apart.

2. On each side of the wall adjacent to the *exit* opening of a horizontal *exit*.

**Exception:** Where floor areas adjacent to a horizontal *exit* are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the horizontal *exit*.

3. In every *exit passageway*, at the entrance from the *exit passageway* to other areas of a building.

**Exception:** Where floor areas adjacent to an *exit passageway* are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the entrance from the *exit passageway* to other areas of the building.

4. In covered mall buildings, adjacent to each exterior public entrance to the mall and adjacent to each entrance from an *exit passageway* or *exit corridor* to the mall. In open mall buildings, adjacent to each public entrance to the mall at the perimeter line and adjacent to each entrance from an *exit passageway* or *exit corridor* to the mall.
5. Where the roof has a slope less than 4 units vertical in 12 units horizontal (33.3-percent slope), a hose connection shall be located to serve the roof or at the highest landing of an *interior exit stairway* with access to the roof provided in accordance with Section 1011.12.
6. Where the most remote portion of a nonsprinklered floor or story is more than 150 feet (45 720 mm) from a hose connection or the most remote portion of a sprinklered floor or story is more than 200 feet (60 960 mm) from a hose connection, the *fire code official* is authorized to require that additional hose connections be provided in *approved* locations.

**905.4.1 Protection.** Risers and laterals of Class I standpipe systems not located within an *interior exit stairway* shall be protected by a degree of *fire resistance* equal to that required for vertical enclosures in the building in which they are located.

**Exception:** In buildings equipped throughout with an *approved automatic sprinkler system*, laterals that are not located within an *interior exit stairway* are not required to be enclosed within fire-resistance-rated construction.

**905.4.2 Interconnection.** In buildings where more than one standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

**905.5 Location of Class II standpipe hose connections.** Class II standpipe hose connections shall be located so that all portions of the building are within 30 feet (9144 mm) of a nozzle attached to 100 feet (30 480 mm) of hose. Class II standpipe hose connections shall be located where they will have *ready access*.

**905.5.1 Groups A-1 and A-2.** In Group A-1 and A-2 occupancies with *occupant loads* of more than 1,000, hose connections shall be located on each side of any stage, on each side of the rear of the auditorium, on each side of the balcony and on each tier of dressing rooms.

**905.5.2 Protection.** *Fire-resistance-rated* protection of risers and laterals of Class II standpipe systems is not required.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**905.5.3 Class II system 1-inch hose.** A minimum 1-inch (25 mm) hose shall be allowed to be used for hose stations in light-hazard occupancies where investigated and *listed* for this service and where *approved* by the *fire code official*.

**905.6 Location of Class III standpipe hose connections.** Class III standpipe systems shall have hose connections located as required for Class I standpipes in Section 905.4 and shall have Class II hose connections as required in Section 905.5.

**905.6.1 Protection.** Risers and laterals of Class III standpipe systems shall be protected as required for Class I systems in accordance with Section 905.4.1.

**905.6.2 Interconnection.** In buildings where more than one Class III standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

**905.7 Cabinets.** Cabinets containing fire-fighting equipment, such as standpipes, fire hose, fire extinguishers or fire department valves, shall not be blocked from use or obscured from view.

**905.7.1 Cabinet equipment identification.** Cabinets shall be identified in an *approved* manner by a permanently attached sign with letters not less than 2 inches (51 mm) high in a color that contrasts with the background color, indicating the equipment contained therein.

### Exceptions:

1. Doors not large enough to accommodate a written sign shall be marked with a permanently attached pictogram of the equipment contained therein.
2. Doors that have either an *approved* visual identification clear glass panel or a complete glass door panel are not required to be marked.

**905.7.2 Locking cabinet doors.** Cabinets shall be unlocked.

### Exceptions:

1. Visual identification panels of glass or other *approved* transparent frangible material that is easily broken and allows access.
2. *Approved* locking arrangements.
3. Group I-3 occupancies.

**905.8 Dry standpipes.** Dry standpipes shall not be installed.

**Exception:** Where subject to freezing and in accordance with NFPA 14.

**905.9 Valve supervision.** Valves controlling water supplies shall be supervised in the open position so that a change in the normal position of the valve will generate a supervisory signal at the supervising station required by Section 903.4. Where a fire alarm system is provided, a signal shall be transmitted to the control unit.

### Exceptions:

1. Valves to underground key or hub valves in roadway boxes do not require supervision.

2. Valves locked in the normal position and inspected as provided in this code in buildings not equipped with a fire alarm system.

**905.10 During construction.** Standpipe systems required during construction and demolition operations shall be provided in accordance with Section 3313.

**905.11 Locking standpipe outlet caps.** The *fire code official* is authorized to require locking caps on the outlets on standpipes where the responding fire department carries key wrenches for the removal that are compatible with locking FDC connection caps.

**905.12 Existing buildings.** Where required in Chapter 11, existing structures shall be equipped with standpipes installed in accordance with Section 905.

## SECTION 906 PORTABLE FIRE EXTINGUISHERS

**906.1 Where required.** Portable fire extinguishers shall be installed in all of the following locations:

1. In new and existing Group A, B, E, F, H, I, M, R-1, R-2, R-4 and S occupancies.

### Exceptions:

1. In Group R-2 occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each dwelling unit is provided with a portable fire extinguisher having a minimum rating of 1-A:10-B:C.
2. In Group E occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each classroom is provided with a portable fire extinguisher having a minimum rating of 2-A:20-B:C.
3. In storage areas of Group S occupancies where forklift, powered industrial truck or powered cart operators are the primary occupants, fixed extinguishers, as specified in NFPA 10, shall not be required where in accordance with all of the following:
  - 3.1. Use of vehicle-mounted extinguishers shall be *approved* by the *fire code official*.
  - 3.2. Each vehicle shall be equipped with a 10-pound, 40A:80B:C extinguisher affixed to the vehicle using a mounting bracket *approved* by the extinguisher manufacturer or the *fire code official* for vehicular use.
  - 3.3. Not less than two spare extinguishers of equal or greater rating shall be available on-site to replace a discharged extinguisher.

- 3.4. Vehicle operators shall be trained in the proper operation, use and inspection of extinguishers.
- 3.5. Inspections of vehicle-mounted extinguishers shall be performed daily.
2. Within 30 feet (9144 mm) distance of travel from commercial cooking equipment and from domestic cooking equipment in Group I-1; I-2, Condition 1; and R-2 college dormitory occupancies.
3. In areas where *flammable* or *combustible liquids* are stored, used or dispensed.
4. On each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3316.1.
5. Where required by the sections indicated in Table 906.1.
6. Special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the *fire code official*.

**Exception:** Portable fire extinguishers are not required at normally unmanned Group U occupancy buildings or structures where a portable fire extinguisher suitable to the hazard of the location is provided on the vehicle of visiting personnel.

**TABLE 906.1**  
**ADDITIONAL REQUIRED PORTABLE FIRE EXTINGUISHERS**

SECTION	SUBJECT
303.5	Asphalt kettles
307.5	Open burning
308.1.3	Open flames—torches
309.4	Powered industrial trucks
1204.10	Portable generators
2005.2	Aircraft towing vehicles
2005.3	Aircraft welding apparatus
2005.4	Aircraft fuel-servicing tank vehicles
2005.5	Aircraft hydrant fuel-servicing vehicles
2005.6	Aircraft fuel-dispensing stations
2007.7	Heliports and helistops
2108.4	Dry cleaning plants
2305.5	Motor fuel-dispensing facilities
2310.6.4	Marine motor fuel-dispensing facilities
2311.6	Repair garages
2404.4.1	Spray-finishing operations
2405.4.2	Dip-tank operations
2406.4.2	Powder-coating areas
2804.3	Lumberyards/woodworking facilities
2808.8	Recycling facilities
2809.5	Exterior lumber storage
2903.5	Organic-coating areas

(continued)

**TABLE 906.1—continued**  
**ADDITIONAL REQUIRED PORTABLE FIRE EXTINGUISHERS**

SECTION	SUBJECT
3006.3	Industrial ovens
3107.9	Tents and membrane structures
3206.10	High-piled storage
3316.1	Buildings under construction or demolition
3318.3	Roofing operations
3408.2	Tire rebuilding/storage
3504.2.6	Welding and other hot work
3604.4	Marinas
3703.6	Combustible fibers
5703.2.1	Flammable and combustible liquids, general
5704.3.3.1	Indoor storage of flammable and combustible liquids
5704.3.7.5.2	Liquid storage rooms for flammable and combustible liquids
5705.4.9	Solvent distillation units
5706.2.7	Farms and construction sites—flammable and combustible liquids storage
5706.4.10.1	Bulk plants and terminals for flammable and combustible liquids
5706.5.4.5	Commercial, industrial, governmental or manufacturing establishments—fuel dispensing
5706.6.4	Tank vehicles for flammable and combustible liquids
5906.5.7	Flammable solids
6108.2	LP-gas

**906.2 General requirements.** Portable fire extinguishers shall be selected, installed and maintained in accordance with this section and NFPA 10.

**Exceptions:**

1. The distance of travel to reach an extinguisher shall not apply to the spectator seating portions of Group A-5 occupancies.
2. Thirty-day inspections shall not be required and maintenance shall be allowed to be once every 3 years for dry-chemical or halogenated agent portable fire extinguishers that are supervised by a *listed* and *approved* electronic monitoring device, provided that all of the following conditions are met:
  - 2.1. Electronic monitoring shall confirm that extinguishers are properly positioned, properly charged and unobstructed.
  - 2.2. Loss of power or circuit continuity to the electronic monitoring device shall initiate a trouble signal.
  - 2.3. The extinguishers shall be installed inside of a building or cabinet in a noncorrosive environment.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

- 2.4. Electronic monitoring devices and supervisory circuits shall be tested every 3 years when extinguisher maintenance is performed.
- 2.5. A written log of required hydrostatic test dates for extinguishers shall be maintained by the *owner* to verify that hydrostatic tests are conducted at the frequency required by NFPA 10.

3. In Group I-3, portable fire extinguishers shall be permitted to be located at staff locations.

**906.2.1 Certification of service personnel for portable fire extinguishers.** Service personnel providing or conducting maintenance on portable fire extinguishers shall possess a valid certificate issued by an *approved* governmental agency, or other *approved* organization for the type of work performed.

**906.3 Size and distribution.** The size and distribution of portable fire extinguishers shall be in accordance with Sections 906.3.1 through 906.3.4.

**TABLE 906.3(1)**  
**FIRE EXTINGUISHERS FOR CLASS A FIRE HAZARDS**

	LIGHT (Low) HAZARD OCCUPANCY	ORDINARY (Moderate) HAZARD OCCUPANCY	EXTRA (High) HAZARD OCCUPANCY
Minimum-rated single extinguisher	2-A <sup>c</sup>	2-A	4-A <sup>a</sup>
Maximum floor area per unit of A	3,000 square feet	1,500 square feet	1,000 square feet
Maximum floor area for extinguisher <sup>b</sup>	11,250 square feet	11,250 square feet	11,250 square feet
Maximum distance of travel to extinguisher	75 feet	75 feet	75 feet

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon = 3.785 L.

- a. Two 2½-gallon water-type extinguishers shall be deemed the equivalent of one 4-A rated extinguisher.
- b. Annex E.3.3 of NFPA 10 provides more details concerning application of the maximum floor area criteria.
- c. Two water-type extinguishers, each with a 1-A rating, shall be deemed the equivalent of one 2-A rated extinguisher for Light (Low) Hazard Occupancies.

**TABLE 906.3(2)**  
**FIRE EXTINGUISHERS FOR FLAMMABLE OR COMBUSTIBLE LIQUIDS WITH DEPTHS OF LESS THAN OR EQUAL TO 0.25 INCH<sup>a</sup>**

TYPE OF HAZARD	BASIC MINIMUM EXTINGUISHER RATING	MAXIMUM DISTANCE OF TRAVEL TO EXTINGUISHERS (feet)
Light (Low)	5-B	30
	10-B	50
Ordinary (Moderate)	10-B	30
	20-B	50
Extra (High)	40-B	30
	80-B	50

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. For requirements on water-soluble flammable liquids and alternative sizing criteria, see Section 5.5 of NFPA 10.

**906.3.1 Class A fire hazards.** The minimum sizes and distribution of portable fire extinguishers for occupancies that involve primarily Class A fire hazards shall comply with Table 906.3(1).

**906.3.2 Class B fire hazards.** Portable fire extinguishers for occupancies involving *flammable* or *combustible liquids* with depths less than or equal to 0.25 inch (6.4 mm) shall be selected and placed in accordance with Table 906.3(2).

Portable fire extinguishers for occupancies involving *flammable* or *combustible liquids* with a depth of greater than 0.25 inch (6.4 mm) shall be selected and placed in accordance with NFPA 10.

**906.3.3 Class C fire hazards.** Portable fire extinguishers for Class C fire hazards shall be selected and placed on the basis of the anticipated Class A or B hazard.

**906.3.4 Class D fire hazards.** Portable fire extinguishers for occupancies involving combustible metals shall be selected and placed in accordance with NFPA 10.

**906.4 Cooking equipment fires.** Fire extinguishers provided for the protection of cooking equipment shall be of an *approved* type compatible with the automatic fire-extinguishing system agent. Cooking equipment involving solid fuels or vegetable or animal oils and fats shall be protected by a Class K-rated portable extinguisher in accordance with Sections 906.1, Item 2, 906.4.1 and 906.4.2 as applicable.

**906.4.1 Portable fire extinguishers for solid fuel cooking appliances.** Solid fuel cooking appliances, whether or not under a hood, with fireboxes 5 cubic feet (0.14 m<sup>3</sup>) or less in volume shall have a minimum 2.5-gallon (9 L) or two 1.5-gallon (6 L) Class K wet-chemical portable fire extinguishers located in accordance with Section 906.1.

**906.4.2 Class K portable fire extinguishers for deep fat fryers.** Where hazard areas include deep fat fryers, *listed* Class K portable fire extinguishers shall be provided as follows:

1. For up to four fryers having a maximum cooking medium capacity of 80 pounds (36.3 kg) each: one Class K portable fire extinguisher of a minimum 1.5-gallon (6 L) capacity.
2. For every additional group of four fryers having a maximum cooking medium capacity of 80 pounds (36.3 kg) each: one additional Class K portable fire extinguisher of a minimum 1.5-gallon (6 L) capacity shall be provided.
3. For individual fryers exceeding 6 square feet (0.55 m<sup>2</sup>) in surface area: Class K portable fire extinguishers shall be installed in accordance with the extinguisher manufacturer's recommendations.

**906.5 Conspicuous location.** Portable fire extinguishers shall be located in conspicuous locations where they will have *ready access* and be immediately available for use. These locations shall be along normal paths of travel, unless the *fire code official* determines that the hazard posed indicates the need for placement away from normal paths of travel.

**906.6 Unobstructed and unobscured.** Portable fire extinguishers shall not be obstructed or obscured from view. In rooms or areas in which visual obstruction cannot be completely avoided, means shall be provided to indicate the locations of extinguishers.

**906.7 Hangers and brackets.** Hand-held portable fire extinguishers, not housed in cabinets, shall be installed on the hangers or brackets supplied. Hangers or brackets shall be securely anchored to the mounting surface in accordance with the manufacturer's installation instructions.

**906.8 Cabinets.** Cabinets used to house portable fire extinguishers shall not be locked.

**Exceptions:**

1. Where portable fire extinguishers subject to malicious use or damage are provided with a means of *ready access*.
2. In Group I-3 occupancies and in mental health areas in Group I-2 occupancies, access to portable fire extinguishers shall be permitted to be locked or to be located in staff locations provided that the staff has keys.

**906.9 Extinguisher installation.** The installation of portable fire extinguishers shall be in accordance with Sections 906.9.1 through 906.9.3.

**906.9.1 Extinguishers weighing 40 pounds or less.** Portable fire extinguishers having a gross weight not exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 5 feet (1524 mm) above the floor.

**906.9.2 Extinguishers weighing more than 40 pounds.** Hand-held portable fire extinguishers having a gross weight exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 3.5 feet (1067 mm) above the floor.

**906.9.3 Floor clearance.** The clearance between the floor and the bottom of installed hand-held portable fire extinguishers shall be not less than 4 inches (102 mm).

**906.10 Wheeled units.** Wheeled fire extinguishers shall be conspicuously located in a designated location.

## SECTION 907

### FIRE ALARM AND DETECTION SYSTEMS

**907.1 General.** This section covers the application, installation, performance and maintenance of fire alarm systems and their components in new and existing buildings and structures. The requirements of Section 907.2 are applicable to new buildings and structures. The requirements of Section 907.9 are applicable to existing buildings and structures.

**907.1.1 Construction documents.** *Construction documents* for fire alarm systems shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code; the *International Building Code*; and relevant laws, ordinances, rules and regulations, as determined by the *fire code official*.

**907.1.2 Fire alarm shop drawings.** Shop drawings for fire alarm systems shall be prepared in accordance with NFPA 72 and submitted for review and approval prior to system installation. Final as-built drawings shall be submitted as required by the authority having jurisdiction. Shop drawings shall include, but not be limited to, all of the following:

1. Project name and address. Owner's name, address and phone number.
2. Contractor name, address, phone number, license number, license classification and license limit.
3. Occupancy classification for building and each area, including occupant load.
4. Fire alarm circuit classification (power-limited),
5. Class/style designation of all initiating device circuit (IDC), signaling circuits (SLC) and notification appliance circuits (NAC).
6. Conductor type and size.
7. Sequence of operation input/output matrix, as required by NFPA 72.
8. Symbol legend with equipment description (manufacturer's name and model number) and mounting description (surface, semi-flush, flush and exterior).
9. When required by the fire code official, symbols used on the shop drawings shall follow NFPA 170.
10. Site plan.
11. Floor plan drawn to an indicated scale ( $\frac{1}{8}$  inch (3.2 mm) minimum) on sheets of a uniform size showing:
  - a. Point of compass (north arrow).
  - b. Key plans.
  - c. Walls, doors, windows, stairs, elevators, high-piled storage racks, etc., as needed to indicate all conditions and requirements.
  - d. Room use identification labels.
  - e. Alarm-initiating device, notification appliance, and auxiliary controlled or monitored equipment and systems, control and annunciation equipment location(s).
  - f. Conductor/conduit routing and size.
  - g. Location of end-of-line resistors.
  - h. Device address.
  - i. Notification appliance numbering by circuit and device corresponding to the riser and/or one-line diagrams.
  - j. Power panels and circuits connections.
  - k. Ceiling heights and construction (i.e., beam, joist, soffit or projection extending below the ceiling when a ceiling-mounted device and/or appliance is used).
12. Mounting height detail for wall-mounted device and/or appliance.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

13. Riser diagram including the following information:
  - a. General arrangement of the system, in building cross section.
  - b. Wall/shaft/stairwell and/or cable ratings when survivability or class A requirements apply.
  - c. Type and number of circuits in each riser.
  - d. Type and number of fire alarm system components/devices on each circuit, on each floor or level.
14. Standardized calculations:
  - a. Battery (all panels).
  - b. Load (all notification appliance and auxiliary circuits).
  - c. Voltage drop (all notification appliance circuits, including remote annunciators and auxiliary appliances).
15. Project data submittal, including a cover index sheet listing products used by make and model number, manufacturer data sheets and listing information for all equipment, devices, materials, wire and cable.
16. Design number and detail of penetration fire stop system where required.
17. Any additional information determined necessary by the Fire Code Official.

**907.1.3 Equipment.** Systems and components shall be listed and approved for the purpose for which they are installed.

**907.2 Where required—new buildings and structures.** An approved fire alarm system installed in accordance with the provisions of this code and NFPA 72 shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.5, unless other requirements are provided by another section of this code.

Not fewer than one manual fire alarm box shall be provided in an approved location to initiate a fire alarm signal for fire alarm systems employing automatic fire detectors or waterflow detection devices. Where other sections of this code allow elimination of fire alarm boxes due to sprinklers, a single fire alarm box shall be installed.

**Exceptions:**

1. The manual fire alarm box is not required for fire alarm systems dedicated to elevator recall control and supervisory service.
2. The manual fire alarm box is not required for Group R-2 occupancies unless required by the fire code official to provide a means for fire watch personnel to initiate an alarm during a sprinkler system impairment event. Where provided, the manual fire alarm box shall not be located in an area that is open to the public.

**907.2.1 Group A.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group A occupancies where the occupant load due to the assembly occupancy is

300 or more, or where the Group A occupant load is more than 100 persons above or below the lowest level of exit discharge. Group A occupancies not separated from one another in accordance with Section 707.3.10 of the *International Building Code* shall be considered as a single occupancy for the purposes of applying this section. Portions of Group E occupancies occupied for assembly purposes shall be provided with a fire alarm system as required for the Group E occupancy.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**907.2.1.1 System initiation in Group A occupancies with an occupant load of 1,000 or more.** Activation of the fire alarm in Group A occupancies with an occupant load of 1,000 or more shall initiate a signal using an emergency voice/alarm communications system in accordance with Section 907.5.2.2.

**Exception:** Where approved, the prerecorded announcement is allowed to be manually deactivated for a period of time, not to exceed 3 minutes, for the sole purpose of allowing a live voice announcement from an approved, constantly attended location.

**907.2.1.2 Emergency voice/alarm communication system captions.** Stadiums, arenas and grandstands required to caption audible public announcements shall be in accordance with Section 907.5.2.2.4.

**907.2.2 Group B.** A manual fire alarm system, which activates the occupant notification system in accordance with Section 907.5, shall be installed in Group B occupancies where one of the following conditions exists:

1. The combined Group B occupant load of all floors is 500 or more.
2. The Group B occupant load is more than 100 persons above or below the lowest level of exit discharge.
3. The fire area contains an ambulatory care facility.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**907.2.2.1 Ambulatory care facilities.** Fire areas containing ambulatory care facilities shall be provided with an electronically supervised automatic smoke detection system installed within the ambulatory care facility and in public use areas outside of tenant spaces, including public corridors and elevator lobbies.

**Exception:** Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 provided that the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**907.2.3 Group E.** A manual fire alarm system that initiates the occupant notification signal utilizing an emergency voice/alarm communication system meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall be installed in Group E occupancies. Where *automatic sprinkler systems* or smoke detectors are installed, such systems or detectors shall be connected to the building fire alarm system. The provisions of Section 907.2.3.1 through 907.2.3.3 shall apply in rooms normally occupied by preschool or kindergarten students when used for sleeping.

**Exceptions:**

1. A manual fire alarm system shall not be required in Group E occupancies with an *occupant load* of 50 or less.
2. Emergency voice/alarm communication systems meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall not be required in Group E occupancies with occupant loads of 100 or less, provided that activation of the manual fire alarm system initiates an *approved* occupant notification signal in accordance with Section 907.5.
3. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:
  - 3.1. Interior *corridors* are protected by smoke detectors.
  - 3.2. Auditoriums, cafeterias, gymnasiums and similar areas are protected by *heat detectors* or other *approved* detection devices.
  - 3.3. Shops and laboratories involving dusts or vapors are protected by *heat detectors* or other *approved* detection devices.
  - 3.4. Manual activation is provided from a normally occupied location.
4. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:
  - 4.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
  - 4.2. The emergency voice/alarm communication system will activate on sprinkler water flow.
  - 4.3. Manual activation is provided from a normally occupied location.

**907.2.3.1 Day care facilities.** Day care facilities with an occupant load of 30 or less shall be protected with single- or multiple-station smoke alarms in the following places:

1. On the ceiling or wall outside of each room used for sleeping (in the immediate vicinity of the room).
2. In each day care room used for sleeping.

**907.2.3.2 Interconnection.** Where more than one smoke alarm is required to be installed, the smoke detectors shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

**907.2.3.3 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system.

**907.2.4 Group F.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group F occupancies where both of the following conditions exist:

1. The Group F occupancy is two or more stories in height.
2. The Group F occupancy has a combined *occupant load* of 500 or more above or below the lowest *level of exit discharge*.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**907.2.5 Group H.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group H-5 occupancies and in occupancies used for the manufacture of organic coatings. An automatic smoke detection system shall be installed for highly toxic gases, organic peroxides and oxidizers in accordance with Chapters 60, 62 and 63, respectively.

**907.2.6 Group I.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group I occupancies. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in accordance with Sections 907.2.6.1, 907.2.6.2 and 907.2.6.3.3.

**Exceptions:**

1. Manual fire alarm boxes in *sleeping units* of Group I-1 and I-2 occupancies shall not be required at *exits* if located at all care providers' control stations or other constantly attended

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

staff locations, provided that such manual fire alarm boxes are visible and provided with *ready access*, and the distances of travel required in Section 907.4.2.1 are not exceeded.

2. Occupant notification systems are not required to be activated where private mode signaling installed in accordance with NFPA 72 is *approved* by the *fire code official* and staff evacuation responsibilities are included in the fire safety and evacuation plan required by Section 404.

**907.2.6.1 Group I-1.** An automatic smoke detection system shall be installed in *corridors*, waiting areas open to *corridors* and *habitable spaces* other than *sleeping units* and kitchens. The system shall be activated in accordance with Section 907.5.

### Exceptions:

1. For Group I-1, Condition 1 occupancies, smoke detection in *habitable spaces* is not required where the facility is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. Smoke detection is not required for exterior balconies.

**907.2.6.1.1 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

**907.2.6.2 Group I-2.** An automatic smoke detection system shall be installed in *corridors* in Group I-2, Condition 1 facilities and spaces permitted to be open to the *corridors* by Section 407.2 of the *International Building Code*. The system shall be activated in accordance with Section 907.4. Group I-2, Condition 2 occupancies shall be equipped with an automatic smoke detection system as required in Section 407 of the *International Building Code*.

### Exceptions:

1. *Corridor* smoke detection is not required in *smoke compartments* that contain *sleeping units* where such units are provided with smoke detectors that comply with UL 268. Such detectors shall provide a visual display on the *corridor* side of each *sleeping unit* and shall provide an audible and visual alarm at the care providers' station attending each unit.
2. *Corridor* smoke detection is not required in *smoke compartments* that contain *sleeping units* where *sleeping unit* doors are equipped with automatic door-closing devices with integral smoke detectors on the unit sides installed in accordance with their listing, provided that the integral detectors perform the required alerting function.

**907.2.6.3 Group I-3 occupancies.** Group I-3 occupancies shall be equipped with a manual fire alarm system and automatic smoke detection system installed for alerting staff.

**907.2.6.3.1 System initiation.** Actuation of an automatic fire-extinguishing system, *automatic sprinkler system*, a manual fire alarm box or a fire detector shall initiate an *approved* fire alarm signal that automatically notifies staff.

**907.2.6.3.2 Manual fire alarm boxes.** Manual fire alarm boxes are not required to be located in accordance with Section 907.4.2 where the fire alarm boxes are provided at staff-attended locations having direct supervision over areas where manual fire alarm boxes have been omitted.

**907.2.6.3.2.1 Manual fire alarms boxes in detainee areas.** Manual fire alarm boxes are allowed to be locked in areas occupied by detainees, provided that staff members are present within the subject area and have keys readily available to operate the manual fire alarm boxes.

**907.2.6.3.3 Automatic smoke detection system.** An automatic smoke detection system shall be installed throughout resident housing areas, including *sleeping units* and contiguous day rooms, group activity spaces and other common spaces normally open to residents.

### Exceptions:

1. Other *approved* smoke detection arrangements providing equivalent protection, including, but not limited to, placing detectors in exhaust ducts from cells or behind protective guards *listed* for the purpose, are allowed where necessary to prevent damage or tampering.
2. *Sleeping units* in Use Conditions 2 and 3 as described in Section 308 of the *International Building Code*.
3. Smoke detectors are not required in *sleeping units* with four or fewer occupants in *smoke compartments* that are equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**907.2.7 Group M.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group M occupancies where one of the following conditions exists:

1. The combined Group M *occupant load* of all floors is 500 or more persons.
2. The Group M *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.

### Exceptions:

1. A manual fire alarm system is not required in covered or open mall buildings complying with



Section 402 of the *International Building Code*.

2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will automatically activate throughout the notification zones upon sprinkler water flow.

**907.2.7.1 Occupant notification.** During times that the building is occupied, the initiation of a signal from a manual fire alarm box or from a waterflow switch shall not be required to activate the alarm notification appliances when an alarm signal is activated at a constantly attended location from which evacuation instructions shall be initiated over an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

**907.2.8 Group R-1.** Fire alarm systems and smoke alarms shall be installed in Group R-1 occupancies as required in Sections 907.2.8.1 through 907.2.8.3.

**907.2.8.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-1 occupancies.

**Exceptions:**

1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual *sleeping units* and contiguous attic and crawl spaces to those units are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *egress court* or yard.
2. Manual fire alarm boxes are not required throughout the building where all of the following conditions are met:
  - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
  - 2.2. The notification appliances will activate upon sprinkler water flow.
  - 2.3. Not fewer than one manual fire alarm box is installed at an *approved* location.

**907.2.8.2 Automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed throughout all interior *corridors* serving *sleeping units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior

*corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

**907.2.8.3 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

**907.2.9 Group R-2.** Fire alarm systems and smoke alarms shall be installed in Group R-2 occupancies as required in Sections 907.2.9.1 and 907.2.9.3.

**907.2.9.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies where any of the following conditions apply:

1. Any *dwelling unit* or *sleeping unit* is located three or more stories above the lowest *level of exit discharge*.
2. Any *dwelling unit* or *sleeping unit* is located more than one story below the highest *level of exit discharge* of *exits* serving the *dwelling unit* or *sleeping unit*.
3. The building contains more than 16 *dwelling units* or *sleeping units*.

**Exceptions:**

1. A fire alarm system is not required in buildings not more than two stories in height where all *dwelling units* or *sleeping units* and contiguous attic and crawl spaces are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each *dwelling unit* or *sleeping unit* has an *exit* directly to a *public way*, *egress court* or yard.
2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and the occupant notification appliances will automatically activate throughout the notification zones upon a sprinkler water flow.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1027.6, Exception 3.

**907.2.9.2 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**907.2.9.3 Group R-2 college and university buildings.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies operated by a college or university for student or staff housing in all of the following locations:

1. Common spaces outside of *dwelling units* and *sleeping units*.
2. Laundry rooms, mechanical equipment rooms and storage rooms.
3. All interior *corridors* serving *sleeping units* or *dwelling units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* or *dwelling units* and where each *sleeping unit* or *dwelling unit* either has a *means of egress* door opening directly to an exterior *exit access* that leads directly to an *exit* or a *means of egress* door opening directly to an *exit*.

Required smoke alarms in *dwelling units* and *sleeping units* in Group R-2 occupancies operated by a college or university for student or staff housing shall be interconnected with the fire alarm system in accordance with NFPA 72.

**907.2.10 Group S.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group S public- and self-storage occupancies three stories or greater in height for interior *corridors* and interior common areas. Visible notification appliances are not required within storage units.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1, and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**907.2.11 Single- and multiple-station smoke alarms.** Listed single- and multiple-station smoke alarms complying with UL 217 shall be installed in accordance with Sections 907.2.11.1 through 907.2.11.7 and NFPA 72. Every new and existing dwelling, including one- and two-family dwellings, and every new and existing dwelling unit within an apartment house, condominium or townhouse, and every guest and sleeping room in a motel, hotel or dormitory shall be provided with an approved listed smoke alarm.

**907.2.11.1 Group R-1.** Single- or multiple-station smoke alarms shall be installed in all of the following locations in Group R-1:

1. In sleeping areas.
2. In every room in the path of the *means of egress* from the sleeping area to the door leading from the *sleeping unit*.

3. In each story within the *sleeping unit*, including *basements*. For *sleeping units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

**907.2.11.2 Groups R-2, R-3, R-4 and I-1.** Single- or multiple-station smoke alarms shall be installed and maintained in Groups R-2, R-3, R-4 and I-1 regardless of *occupant load* at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.
3. In each story within a *dwelling unit*, including *basements* but not including crawl spaces and uninhabitable attics. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

**907.2.11.3 Installation near cooking appliances.** Smoke alarms shall not be installed in the following locations unless this would prevent placement of a smoke alarm in a location required by Section 907.2.11.1 or 907.2.11.2:

1. Ionization smoke alarms shall not be installed less than 20 feet (6096 mm) horizontally from a permanently installed cooking appliance.
2. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet (3048 mm) horizontally from a permanently installed cooking appliance.
3. Photoelectric smoke alarms shall not be installed less than 6 feet (1829 mm) horizontally from a permanently installed cooking appliance.

**907.2.11.4 Installation near bathrooms.** Smoke alarms shall be installed not less than 3 feet (914 mm) horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by Section 907.2.11.1 or 907.2.11.2.

**907.2.11.5 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling unit* or *sleeping unit* in Group R or I-1 occupancies, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. Physical interconnection of smoke alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

**907.2.11.6 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system in accordance with Section 1203. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system that complies with Section 603.

**907.2.11.7 Smoke detection system.** Smoke detectors listed in accordance with UL 268 and provided as part of the building fire alarm system shall be an acceptable alternative to single- and multiple-station *smoke alarms* and shall comply with the following:

1. The fire alarm system shall comply with all applicable requirements in Section 907.
2. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall initiate alarm notification in the *dwelling unit* or *sleeping unit* in accordance with Section 907.5.2.
3. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall not activate alarm notification appliances outside of the *dwelling unit* or *sleeping unit*, provided that a supervisory signal is generated and monitored in accordance with Section 907.6.6.

**907.2.12 Special amusement buildings.** An automatic smoke detection system shall be provided in special amusement buildings in accordance with Sections 907.2.12.1 through 907.2.12.3.

**907.2.12.1 Alarm.** Activation of any single smoke detector, the *automatic sprinkler system* or any other automatic fire detection device shall immediately activate an audible and visible alarm at the building at a constantly attended location from which emergency action can be initiated, including the capability of manual initiation of requirements in Section 907.2.12.2.

**907.2.12.2 System response.** The activation of two or more smoke detectors, a single smoke detector equipped with an alarm verification feature, the *automatic sprinkler system* or other *approved* fire detection device shall automatically do all of the following:

1. Cause illumination of the *means of egress* with light of not less than 1 footcandle (11 lux) at the walking surface level.
2. Stop any conflicting or confusing sounds and visual distractions.
3. Activate an *approved* directional *exit* marking that will become apparent in an emergency.

4. Activate a prerecorded message, audible throughout the special amusement building, instructing patrons to proceed to the nearest *exit*. Alarm signals used in conjunction with the prerecorded message shall produce a sound that is distinctive from other sounds used during normal operation.

**907.2.12.3 Emergency voice/alarm communication system.** An emergency voice/alarm communication system, which is allowed to serve as a public address system, shall be installed in accordance with Section 907.5.2.2 and be audible throughout the entire special amusement building.

**907.2.13 High-rise buildings.** High-rise buildings shall be provided with an automatic smoke detection system in accordance with Section 907.2.13.1, a fire department communication system in accordance with Section 907.2.13.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.

**Exceptions:**

1. Airport traffic control towers in accordance with Section 907.2.22 of this code and Section 412 of the *International Building Code*.
2. Open parking garages in accordance with Section 406.5 of the *International Building Code*.
3. Buildings with an occupancy in Group A-5 in accordance with Section 303.1 of the *International Building Code*.
4. Low-hazard special occupancies in accordance with Section 503.1.1 of the *International Building Code*.
5. Buildings with an occupancy in Group H-1, H-2 or H-3 in accordance with Section 415 of the *International Building Code*.
6. In Group I-1 and I-2 occupancies, the alarm shall sound at a constantly attended location and occupant notification shall be broadcast by the emergency voice/alarm communication system.

**907.2.13.1 Automatic smoke detection.** Automatic smoke detection in high-rise buildings shall be in accordance with Sections 907.2.13.1.1 and 907.2.13.1.2.

**907.2.13.1.1 Area smoke detection.** Area smoke detectors shall be provided in accordance with this section. Smoke detectors shall be connected to an automatic fire alarm system. The activation of any detector required by this section shall activate the emergency voice/alarm communication system in accordance with Section 907.5.2.2. In addition to smoke detectors required by Sections 907.2.1 through 907.2.9, smoke detectors shall be located as follows:

1. In each mechanical equipment, electrical, transformer, telephone equipment or similar room that is not provided with sprinkler protection.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

2. In each elevator machine room, machinery space, control room and control space and in elevator lobbies.

**907.2.13.1.2 Duct smoke detection.** Duct smoke detectors complying with Section 907.3.1 shall be located as follows:

1. In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 2,000 cubic feet per minute (cfm) (0.94 m<sup>3</sup>/s). Such detectors shall be located in a serviceable area downstream of the last duct inlet.
2. At each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air-conditioning system. In Group R-1 and R-2 occupancies, a smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cfm (2.4 m<sup>3</sup>/s) and serving not more than 10 air-inlet openings.

### **907.2.13.2 Fire department communication system.**

Where a wired communication system is *approved* in lieu of an in-building, two-way emergency responder communication coverage system in accordance with Section 510, the wired fire department communication system shall be designed and installed in accordance with NFPA 72 and shall operate between a *fire command center* complying with Section 508, elevators, elevator lobbies, emergency and standby power rooms, fire pump rooms, areas of refuge and inside *interior exit stairways*. The fire department communication device shall be provided at each floor level within the *interior exit stairway*.

**907.2.13.3 Multiple-channel voice evacuation.** In buildings with an occupied floor more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, voice evacuation systems for high-rise buildings shall be multiple-channel systems.

**907.2.14 Atriums connecting more than two stories.** A fire alarm system shall be installed in occupancies with an atrium that connects more than two stories, with smoke detection in locations required by a rational analysis in Section 909.4 and in accordance with the system operation requirements in Section 909.17. The system shall be activated in accordance with Section 907.5. Such occupancies in Group A, E or M shall be provided with an emergency voice/alarm communication system complying with the requirements of Section 907.5.2.2.

**907.2.15 High-piled combustible storage areas.** An automatic smoke detection system shall be installed throughout *high-piled combustible storage* areas where required by Section 3206.5.

**907.2.16 Aerosol storage uses.** Aerosol product rooms and general-purpose warehouses containing aerosol products shall be provided with an *approved* manual fire alarm system where required by this code.

**907.2.17 Lumber, wood structural panel and veneer mills.** Lumber, wood structural panel and veneer mills shall be provided with a manual fire alarm system.

**907.2.18 Underground buildings with smoke control systems.** Where a smoke control system is installed in an underground building in accordance with the *International Building Code*, automatic smoke detectors shall be provided in accordance with Section 907.2.18.1.

**907.2.18.1 Smoke detectors.** Not fewer than one smoke detector *listed* for the intended purpose shall be installed in all of the following areas:

1. Mechanical equipment, electrical, transformer, telephone equipment, elevator machine or similar rooms.
2. Elevator lobbies.
3. The main return and exhaust air plenum of each air-conditioning system serving more than one story and located in a serviceable area downstream of the last duct inlet.
4. Each connection to a vertical duct or riser serving two or more floors from return air ducts or plenums of heating, ventilating and air-conditioning systems, except that in Group R occupancies, a *listed* smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cfm (2.4 m<sup>3</sup>/s) and serving not more than 10 air inlet openings.

**907.2.18.2 Alarm required.** Activation of the smoke control system shall activate an audible alarm at a constantly attended location.

**907.2.19 Deep underground buildings.** Where the lowest level of a structure is more than 60 feet (18 288 mm) below the finished floor of the lowest *level of exit discharge*, the structure shall be equipped throughout with a manual fire alarm system, including an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

**907.2.20 Covered and open mall buildings.** Where the total floor area exceeds 50,000 square feet (4645 m<sup>2</sup>) within either a covered mall building or within the perimeter line of an open mall building, an emergency voice/alarm communication system shall be provided. Access to emergency voice/alarm communication systems serving a mall, required or otherwise, shall be provided for the fire department. The system shall be provided in accordance with Section 907.5.2.2.

**907.2.21 Residential aircraft hangars.** Not fewer than one single-station smoke alarm shall be installed within a residential aircraft hangar as defined in Chapter 2 of the *International Building Code* and shall be interconnected into the residential smoke alarm or other sounding device to provide an alarm that will be audible in all sleeping areas of the *dwelling*.

**907.2.22 Airport traffic control towers.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be



provided in airport control towers in accordance with Sections 907.2.22.1 and 907.2.22.2.

**Exception:** Audible appliances shall not be installed within the control tower cab.

**907.2.22.1 Airport traffic control towers with multiple exits and automatic sprinklers.** Airport traffic control towers with multiple *exits* and equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Outside each opening into *interior exit stairways*.
5. Along the single *means of egress* permitted from observation levels.
6. Outside each opening into the single *means of egress* permitted from observation levels.

**907.2.22.2 Other airport traffic control towers.** Airport traffic control towers with a single *exit* or where sprinklers are not installed throughout shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Office spaces incidental to the tower operation.
5. Lounges for employees, including sanitary facilities.
6. *Means of egress*.
7. Utility shafts where *access* to smoke detectors can be provided.

**907.2.23 Energy storage systems.** An automatic smoke detection system or radiant-energy detection system shall be installed in rooms, areas and walk-in units containing energy storage systems as required in Section 1207.5.4.

**907.3 Fire safety functions.** Automatic fire detectors utilized for the purpose of performing fire safety functions shall be connected to the building's fire alarm control unit where a fire alarm system is required by Section 907.2. Detectors shall, upon actuation, perform the intended function and activate the alarm notification appliances or activate a visible and audible supervisory signal at a constantly attended location. In buildings not equipped with a fire alarm system, the automatic fire detector shall be powered by normal electrical service and, upon actuation, perform the intended function. The detectors shall be located in accordance with NFPA 72.

**907.3.1 Duct smoke detectors.** Smoke detectors installed in ducts shall be *listed* for the air velocity, temperature and humidity present in the duct. Duct smoke detectors shall be connected to the building's fire alarm control unit where a fire alarm system is required by Section 907.2. Activation of a duct smoke detector shall initiate a visible

and audible supervisory signal at a *constantly attended location* and shall perform the intended fire safety function in accordance with this code and the *International Mechanical Code*. In facilities that are required to be monitored by a supervising station, duct smoke detectors shall report only as a supervisory signal and not as a fire alarm. They shall not be used as a substitute for required open area detection.

**Exceptions:**

1. The supervisory signal at a *constantly attended location* is not required where duct smoke detectors activate the building's alarm notification appliances.
2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an *approved* location. Smoke detector trouble conditions shall activate a visible or audible signal in an *approved* location and shall be identified as air duct detector trouble.

**907.3.2 Special locking systems.** Where special locking systems are installed on *means of egress* doors in accordance with Section 1010.2.14 or 1010.2.13, an automatic detection system shall be installed as required by that section.

**907.3.3 Elevator emergency operation.** Automatic fire detectors installed for elevator emergency operation shall be installed in accordance with the provisions of ASME A17.1/CSA B44 and NFPA 72.

**907.3.4 Wiring.** The wiring to the auxiliary devices and equipment used to accomplish the fire safety functions shall be monitored for integrity in accordance with NFPA 72.

**907.4 Initiating devices.** Where a fire alarm system is required by another section of this code, occupant notification in accordance with Section 907.5 shall be initiated by one or more of the following. Initiating devices shall be installed in accordance with Sections 907.4.1 through 907.4.3.1.

1. Manual fire alarm boxes.
2. Automatic fire detectors.
3. *Automatic sprinkler system* waterflow devices.
4. Automatic fire-extinguishing systems.

**907.4.1 Protection of fire alarm control unit.** In areas that are not continuously occupied, a single smoke detector shall be provided at the location of each fire alarm control unit, notification appliance circuit power extenders and supervising station transmitting equipment.

**Exception:** Where ambient conditions prohibit installation of a smoke detector, a *heat detector* shall be permitted.

**907.4.2 Manual fire alarm boxes.** Where a manual fire alarm system is required by another section of this code, it shall be activated by fire alarm boxes installed in accordance with Sections 907.4.2.1 through 907.4.2.6.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**907.4.2.1 Location.** Manual fire alarm boxes shall be located not more than 5 feet (1524 mm) from the entrance to each *exit*. In buildings not protected by an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, additional manual fire alarm boxes shall be located so that the distance of travel to the nearest box does not exceed 200 feet (60 960 mm).

**907.4.2.2 Height.** The height of the manual fire alarm boxes shall be not less than 42 inches (1067 mm) and not more than 48 inches (1372 mm) measured vertically, from the floor level to the activating handle or lever of the box.

**907.4.2.3 Color.** Manual fire alarm boxes shall be red in color.

**907.4.2.4 Signs.** Where fire alarm systems are not monitored by an *approved* supervising station in accordance with Section 907.6.6, an *approved* permanent sign shall be installed adjacent to each manual fire alarm box that reads: "WHEN ALARM SOUNDS—CALL FIRE DEPARTMENT."

**Exception:** Where the manufacturer has permanently provided this information on the manual fire alarm box.

**907.4.2.5 Protective covers.** The *fire code official* is authorized to require the installation of *listed* manual fire alarm box protective covers to prevent malicious false alarms or to provide the manual fire alarm box with protection from physical damage. The protective cover shall be transparent or red in color with a transparent face to permit visibility of the manual fire alarm box. Each cover shall include proper operating instructions. A protective cover that emits a local alarm signal shall not be installed unless *approved*. Protective covers shall not project more than that permitted by Section 1003.3.3.

**907.4.2.6 Unobstructed and unobscured.** Manual fire alarm boxes shall be provided with *ready access*, unobstructed, unobscured and visible at all times.

**907.4.3 Automatic smoke detection.** Where an automatic smoke detection system is required, it shall utilize smoke detectors unless ambient conditions prohibit such an installation. In spaces where smoke detectors cannot be utilized due to ambient conditions, *approved* automatic *heat detectors* shall be permitted.

**907.4.3.1 Automatic sprinkler system.** For conditions other than specific fire safety functions noted in Section 907.3, in areas where ambient conditions prohibit the installation of smoke detectors, an *automatic sprinkler system* installed in such areas in accordance with Section 903.3.1.1 or 903.3.1.2 and that is connected to the fire alarm system shall be *approved* as automatic heat detection.

**907.5 Occupant notification.** Occupant notification by fire alarms shall be in accordance with Sections 907.5.1 through 907.5.2.3.3. Occupant notification by smoke alarms in Group R-1 and R-2 occupancies shall comply with Section 907.5.2.1.3.2.

**907.5.1 Alarm activation and annunciation.** Upon activation, fire alarm systems shall initiate occupant notification and shall annunciate at the fire alarm control unit, or where allowed elsewhere by Section 907, at a *constantly attended location*.

**907.5.1.1 Presignal feature.** A presignal feature shall only be provided where *approved*. The presignal shall be annunciated at an *approved, constantly attended location*, having the capability to activate the occupant notification system in the event of fire or other emergency.

**907.5.2 Alarm notification appliances.** Alarm notification appliances shall be provided and shall be *listed* for their purpose.

**907.5.2.1 Audible alarms.** Audible alarm notification appliances shall be provided and emit a distinctive sound that is not to be used for any purpose other than that of a fire alarm.

#### Exceptions:

1. Audible alarm notification appliances are not required in critical care areas of Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
2. A visible alarm notification appliance installed in a nurses' control station or other continuously attended staff location in a Group I-2, Condition 2 suite shall be an acceptable alternative to the installation of audible alarm notification appliances throughout a suite or unit in Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
3. Where provided, audible notification appliances located in each enclosed occupant evacuation elevator lobby in accordance with Section 3008.9.1 of the *International Building Code* shall be connected to a separate notification zone for manual paging only.

**907.5.2.1.1 Average sound pressure.** The audible alarm notification appliances shall provide a sound pressure level of 15 decibels (dBA) above the average ambient sound level or 5 dBA above the maximum sound level having a duration of not less than 60 seconds, whichever is greater, in every occupiable space within the building.

**907.5.2.1.2 Maximum sound pressure.** The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance from the audible appliance. Where the average ambient noise is greater than 105 dBA, visible alarm notification appliances shall be provided in accordance with NFPA 72 and audible alarm notification appliances shall not be required.

**907.5.2.1.3 Audible signal frequency in Group R-1 and R-2 sleeping rooms.** Audible signal frequency in Group R-1 and R-2 occupancies shall be in accordance with Sections 907.5.2.1.3.1 and 907.5.2.1.3.2.

**907.5.2.1.3.1 Fire alarm system signal.** In sleeping rooms of Group R-1 and R-2 occupancies, the audible alarm activated by a fire alarm system shall be a 520-Hz low-frequency signal complying with NFPA 72.

**907.5.2.1.3.2 Smoke alarm signal in sleeping rooms.** In sleeping rooms of Group R-1 and R-2 occupancies that are required by Section 907.2.8 or 907.2.9 to have a fire alarm system, the audible alarm signal activated by single- or multiple-station smoke alarms in the *dwelling unit* or *sleeping unit* shall be a 520-Hz signal complying NFPA 72.

Where a sleeping room smoke alarm is unable to produce a 520-Hz signal, the 520-Hz alarm signal shall be provided by a *listed* notification appliance or a smoke detector with an integral 520-Hz sounder.

**907.5.2.2 Emergency voice/alarm communication systems.** Emergency voice/alarm communication systems required by this code shall be designed and installed in accordance with NFPA 72. The operation of any automatic fire detector, sprinkler waterflow device or manual fire alarm box shall automatically sound an alert tone followed by voice instructions giving *approved* information and directions for a general or staged evacuation in accordance with the building's fire safety and evacuation plans required by Section 404. In high-rise buildings, the system shall operate on at least the alarming floor, the floor above and the floor below. Speakers shall be provided throughout the building by paging zones. At a minimum, paging zones shall be provided as follows:

1. Elevator groups.
2. *Interior exit stairways*.
3. Each floor.
4. *Areas of refuge* as defined in Chapter 2.

**Exception:** In Group I-1 and I-2 occupancies, the alarm shall sound in a constantly attended area and a general occupant notification shall be broadcast over the overhead page.

**907.5.2.2.1 Manual override.** A manual override for emergency voice communication shall be provided on a selective and all-call basis for all paging zones.

**907.5.2.2.2 Live voice messages.** The emergency voice/alarm communication system shall have the capability to broadcast live voice messages by paging zones on a selective and all-call basis.

**907.5.2.2.3 Alternative uses.** The emergency voice/alarm communication system shall be allowed

to be used for other announcements, provided that the manual fire alarm use takes precedence over any other use.

**907.5.2.2.4 Emergency voice/alarm communication captions.** Where stadiums, arenas and *grandstands* have 15,000 fixed seats or more and provide audible public announcements, the emergency/voice alarm communication system shall provide prerecorded or real-time captions. Prerecorded or live emergency captions shall be from an *approved* location constantly attended by personnel trained to respond to an emergency.

**907.5.2.2.5 Standby power.** Emergency voice/alarm communications systems shall be provided with standby power in accordance with Section 1203.

**907.5.2.3 Visible alarms.** Visible alarm notification appliances shall be provided in accordance with Sections 907.5.2.3.1 through 907.5.2.3.3.

#### Exceptions:

1. Visible alarm notification appliances are not required in *alterations*, except where an existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed.
2. Visible alarm notification appliances shall not be required in *exits* as defined in Chapter 2.
3. Visible alarm notification appliances shall not be required in elevator cars.
4. Visual alarm notification appliances are not required in critical care areas of Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
5. A visible alarm notification appliance installed in a nurses' control station or other continuously attended staff location in a Group I-2, Condition 2 suite shall be an acceptable alternative to the installation of visible alarm notification appliances throughout the suite or unit in Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.

**907.5.2.3.1 Public use areas and common use areas.** Visible alarm notification appliances shall be provided in *public use areas* and *common use areas*. Areas considered public and common by the NFPA, ADAAG and *The Arkansas School Facilities Manual* shall be included.

**Exception:** Where employee work areas have audible alarm coverage, the notification appliance circuits serving the employee work areas shall be initially designed with not less than 20-percent spare capacity to account for the potential of adding visible notification appliances in

the future to accommodate hearing-impaired employee(s).

**907.5.2.3.2 Groups I-1 and R-1.** *Habitable spaces in dwelling units and sleeping units* in Group I-1 and R-1 occupancies in accordance with Table 907.5.2.3.2 shall be provided with visible alarm notification. Visible alarms shall be activated by the in-room smoke alarm and the building fire alarm system.

TABLE 907.5.2.3.2  
VISIBLE ALARMS

NUMBER OF SLEEPING UNITS	SLEEPING ACCOMMODATIONS WITH VISIBLE ALARMS
6 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000

**907.5.2.3.3 Group R-2.** In Group R-2 occupancies required by Section 907 to have a fire alarm system, each *story* that contains *dwelling units* and *sleeping units* shall be provided with the capability to support future visible alarm notification appliances in accordance with Chapter 11 of ICC A117.1. Such capability shall accommodate wired or wireless equipment.

**907.5.2.3.3.1 Wired equipment.** Where wired equipment is used to comply with the future capability required by Section 907.5.2.3.3, the system shall include one of the following capabilities:

1. The replacement of audible appliances with combination audible/visible appliances or additional visible notification appliances.
2. The future extension of the existing wiring from the unit smoke alarm locations to required locations for visible appliances.
3. For wired equipment, the fire alarm power supply and circuits shall have not less than 5-percent excess capacity to accommodate the future addition of visible alarm notification appliances, and a single access point to such circuits shall be available on every story. Such circuits shall not be required to be extended beyond a single access point on a story.

The fire alarm system shop drawings required by Section 907.1.2 shall include the power supply and circuit documentation to accommodate the future addition of visible notification appliances.

**907.6 Installation and monitoring.** A fire alarm system shall be installed and monitored in accordance with Sections 907.6.1 through 907.6.6.3 and NFPA 72.

**907.6.1 Wiring.** Wiring shall comply with the requirements of NFPA 70 and NFPA 72. Wireless protection systems utilizing radio-frequency transmitting devices shall comply with the special requirements for supervision of low-power wireless systems in NFPA 72.

**907.6.2 Power supply.** The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.

**Exception:** Backup power for single-station and multiple-station smoke alarms as required in Section 907.2.11.6.

**907.6.3 Initiating device identification.** The fire alarm system shall identify the specific initiating device address, location, device type, floor level where applicable and status including indication of normal, alarm, trouble and supervisory status, as appropriate.

**Exceptions:**

1. Fire alarm systems in single-story buildings less than 22,500 square feet (2090 m<sup>2</sup>) in area.
2. Fire alarm systems that only include manual fire alarm boxes, waterflow initiating devices and not more than 10 additional alarm-initiating devices.
3. Special initiating devices that do not support individual device identification.
4. Fire alarm systems or devices that are replacing existing equipment.

**907.6.3.1 Annunciation.** The initiating device status shall be annunciated at an *approved* on-site location.

**907.6.4 Zones.** Each floor shall be zoned separately and a zone shall not exceed 22,500 square feet (2090 m<sup>2</sup>). The length of any zone shall not exceed 300 feet (91 440 mm) in any direction.

**Exception:** *Automatic sprinkler system* zones shall not exceed the area permitted by NFPA 13.

**907.6.4.1 Zoning indicator panel.** A zoning indicator panel and the associated controls shall be provided in an *approved* location. The visual zone indication shall lock in until the system is reset and shall not be canceled by the operation of an audible alarm-silencing switch.

**907.6.4.2 High-rise buildings.** In high-rise buildings, a separate zone by floor shall be provided for each of the following types of alarm-initiating devices where provided:

1. Smoke detectors.

2. Sprinkler waterflow devices.
3. Manual fire alarm boxes.
4. Other *approved* types of automatic fire protection systems.

**907.6.5 Access.** Access shall be provided to each fire alarm device and notification appliance for periodic inspection, maintenance and testing.

**907.6.6 Monitoring.** Fire alarm systems required by this chapter or by the *Arkansas Fire Prevention Code*, Volume II shall be monitored by an *approved* supervising station in accordance with NFPA 72.

**Exception:** Monitoring by a supervising station is not required for:

1. Single- and multiple-station smoke alarms required by Section 907.2.11.
2. Smoke detectors in Group I-3 occupancies.
3. *Automatic sprinkler systems* in one- and two-family dwellings.
4. Manual fire alarm systems.

**907.6.6.1 Transmission of alarm signals.** Transmission of alarm signals to a supervising station shall be in accordance with NFPA 72.

**907.6.6.2 MIY monitoring.** Direct transmission of alarms associated with monitor it yourself (MIY) transmitters to a public safety answering point (PSAP) shall not be permitted unless *approved* by the *fire code official*.

**907.6.6.3 Termination of monitoring service.** Termination of fire alarm monitoring services shall be in accordance with Section 901.9.

**907.7 Acceptance tests and completion.** Upon completion of the installation, the fire alarm system and all fire alarm components shall be tested in accordance with NFPA 72.

**907.7.1 Single- and multiple-station alarm devices.** When the installation of the alarm devices is complete, each device and interconnecting wiring for multiple-station alarm devices shall be tested in accordance with the smoke alarm provisions of NFPA 72.

**907.7.2 Record of completion.** A record of completion in accordance with NFPA 72 verifying that the system has been installed and tested in accordance with the *approved* plans and specifications shall be provided.

**907.7.3 Instructions.** Operating, testing and maintenance instructions and record drawings (“as built”) and equipment specifications shall be provided at an *approved* location.

**907.8 Inspection, testing and maintenance.** The maintenance and testing schedules and procedures for fire alarm and fire detection systems shall be in accordance with Sections 907.8.1 through 907.8.4 and NFPA 72. Records of inspection, testing and maintenance shall be maintained.

**907.8.1 Maintenance required.** Where required for compliance with the provisions of this code, devices, equipment, systems, conditions, arrangements, levels of

protection or other features shall thereafter be continuously maintained in accordance with applicable NFPA requirements or as directed by the *fire code official*.

**907.8.2 Testing.** Testing shall be performed in accordance with the schedules in NFPA 72 or more frequently where required by the *fire code official*. Records of testing shall be maintained.

**Exception:** Devices or equipment that are inaccessible because of safety considerations shall be tested during scheduled shutdowns where *approved* by the *fire code official*, but not less than every 18 months.

**907.8.3 Smoke detector sensitivity.** Smoke detector sensitivity shall be checked within one year after installation and every alternate year thereafter. After the second calibration test, where sensitivity tests indicate that the detector has remained within its *listed* and marked sensitivity range (or 4-percent obscuration light gray smoke, if not marked), the length of time between calibration tests shall be permitted to be extended to not more than 5 years. Where the frequency is extended, records of detector-caused nuisance alarms and subsequent trends of these alarms shall be maintained. In zones or areas where nuisance alarms show any increase over the previous year, calibration tests shall be performed.

**907.8.4 Inspection, testing and maintenance.** The building owner shall be responsible to maintain the fire and life safety systems in an operable condition at all times. Service personnel shall meet the qualification requirements of NFPA 72 for inspection, testing and maintenance of such systems. Records of inspection, testing and maintenance shall be maintained.

**907.9 Where required in existing buildings and structures.** An *approved* fire alarm system shall be provided in existing buildings and structures where required in Chapter 11.

**907.10 Smoke alarm maintenance.** Smoke alarms shall be tested and maintained in accordance with the manufacturer’s instructions. Smoke alarms shall be replaced when they fail to respond to operability tests, or when they exceed 10 years from the date of manufacture, unless an earlier replacement is specified in the manufacturer’s published instructions.

## SECTION 908 EMERGENCY ALARM SYSTEMS

**908.1 Group H occupancies.** Emergency alarms for the detection and notification of an emergency condition in Group H occupancies shall be provided as required in Chapter 50.

**908.2 Group H-5 occupancy.** Emergency alarms for notification of an emergency condition in an HPM facility shall be provided as required in Section 2703.12.

**908.3 Fire alarm system interface.** Where an emergency alarm system is interfaced with a building’s fire alarm system, the signal produced at the fire alarm control unit shall be a supervisory signal.



## SECTION 909 SMOKE CONTROL SYSTEMS

**909.1 Scope and purpose.** This section applies to mechanical or passive smoke control systems where they are required for new buildings or portions thereof by provisions of the *International Building Code* or this code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-removal provisions found in Section 910. Mechanical smoke control systems shall not be considered exhaust systems under Chapter 5 of the *International Mechanical Code*.

**909.2 General design requirements.** Buildings, structures, or parts thereof required by the *International Building Code* or this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design. The *construction documents* shall include sufficient information and detail to describe adequately the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied with sufficient information and analysis to demonstrate compliance with these provisions.

**909.3 Special inspection and test requirements.** In addition to the ordinary inspection and test requirements that buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 shall undergo special inspections and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the *construction documents* shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The special inspections and tests required by this section shall be conducted under the same terms as in Section 1704 of the *International Building Code*.

**909.4 Analysis.** A rational analysis supporting the types of smoke control systems to be employed, the methods of their operations, the systems supporting them and the methods of construction to be utilized shall accompany the *construction documents* submission and include, but not be limited to, the items indicated in Sections 909.4.1 through 909.4.7.

**909.4.1 Stack effect.** The system shall be designed such that the maximum probable normal or reverse stack effect will not adversely interfere with the system's capabilities. In determining the maximum probable stack effect, altitude, elevation, weather history and interior temperatures shall be used.

**909.4.2 Temperature effect of fire.** Buoyancy and expansion caused by the design fire in accordance with Section 909.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with the system's capabilities.

**909.4.3 Wind effect.** The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of the *International Building Code*.

**909.4.4 Systems.** The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems status. The design shall consider the effects of the fire on the heating, ventilating and air-conditioning systems.

**909.4.5 Climate.** The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

**909.4.6 Duration of operation.** All portions of active or engineered smoke control systems shall be capable of continued operation after detection of the fire event for a period of not less than either 20 minutes or 1.5 times the calculated egress time, whichever is greater.

**909.4.7 Smoke control system interaction.** The design shall consider the interaction effects of the operation of multiple smoke control systems for all design scenarios.

**909.5 Smoke barrier construction.** *Smoke barriers* required for passive smoke control and a smoke control system using the pressurization method shall comply with Section 709 of the *International Building Code*. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls:  $A/A_w = 0.00100$
2. Interior *exit stairways* and *ramps* and *exit passageways*:  $A/A_w = 0.00035$
3. Enclosed *exit access stairways* and *ramps* and all other shafts:  $A/A_w = 0.00150$
4. Floors and roofs:  $A/A_F = 0.00050$

where:

$A$  = Total leakage area, square feet ( $m^2$ ).

$A_F$  = Unit floor or roof area of barrier, square feet ( $m^2$ ).

$A_w$  = Unit wall area of barrier, square feet ( $m^2$ ).

The leakage area ratios shown do not include openings due to gaps around doors and operable windows. The total leakage area of the *smoke barrier* shall be determined in accordance with Section 909.5.1 and tested in accordance with Section 909.5.2.

**909.5.1 Total leakage area.** Total leakage area of the barrier is the product of the *smoke barrier* gross area multiplied by the allowable leakage area ratio, plus the area of other openings such as gaps around doors and operable windows.

**909.5.2 Testing of leakage area.** Compliance with the maximum total leakage area shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems utilizing the pressurization method. Compliance with the maximum total leakage area of passive smoke control systems shall be verified through methods such as door fan testing or other methods, as *approved by the fire code official*.

**909.5.3 Opening protection.** Openings in *smoke barriers* shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by fire door assemblies complying with Section 716 of the *International Building Code*.

**Exceptions:**

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors *listed* for releasing service installed in accordance with Section 907.3.
2. Fixed openings between smoke zones that are protected utilizing the airflow method.
3. In Group I-1, Condition 2; Group I-2; and ambulatory care facilities, where a pair of opposite-swinging doors are installed across a *corridor* in accordance with Section 909.5.3.1, the doors shall not be required to be protected in accordance with Section 716 of the *International Building Code*. The doors shall be close-fitting within operational tolerances and shall not have a center mullion or undercuts in excess of  $\frac{3}{4}$ -inch (19.1 mm) louvers or grilles. The doors shall have head and jamb stops and astragals or rabbets at meeting edges and, where permitted by the door manufacturer's listing, positive-latching devices are not required.
4. In Group I-2 and ambulatory care facilities, where such doors are special-purpose horizontal sliding, accordion or folding door assemblies installed in accordance with Section 1010.3.3 and are automatic closing by smoke detection in accordance with Section 716.2.6.6 of the *International Building Code*.
5. Group I-3.
6. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank-down capacity of greater than 20 minutes as determined by the design fire size.

**909.5.3.1 Group I-1, Condition 2; Group I-2; and ambulatory care facilities.** In Group I-1, Condition 2; Group I-2; and *ambulatory care facilities*, where doors are installed across a *corridor*, the doors shall be automatic closing by smoke detection in accordance with Section 716.2.6.6 of the *International Building Code* and shall have a vision panel with fire-protection-rated

glazing materials in fire-protection-rated frames, the area of which shall not exceed that tested.

**909.5.3.2 Ducts and air transfer openings.** Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) smoke damper complying with Section 717 of the *International Building Code*.

**909.6 Pressurization method.** The primary mechanical means of controlling smoke shall be by pressure differences across *smoke barriers*. Maintenance of a tenable environment is not required in the smoke-control zone of fire origin.

**909.6.1 Minimum pressure difference.** The pressure difference across a *smoke barrier* used to separate smoke zones shall be not less than 0.05-inch water gage (0.0124 kPa) in fully sprinklered buildings.

In buildings permitted to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure differences not less than two times the maximum calculated pressure difference produced by the design fire.

**909.6.2 Maximum pressure difference.** The maximum air pressure difference across a *smoke barrier* shall be determined by required door-opening or closing forces. The actual force required to open *exit* doors when the system is in the smoke control mode shall be in accordance with Section 1010.1.3. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(W\Delta P)/2(W - d) \quad \text{(Equation 9-1)}$$

where:

$A$  = Door area, square feet ( $m^2$ ).

$d$  = Distance from door handle to latch edge of door, feet (m).

$F$  = Total door opening force, pounds (N).

$F_{dc}$  = Force required to overcome closing device, pounds (N).

$K$  = Coefficient 5.2 (1.0).

$W$  = Door width, feet (m).

$\Delta P$  = Design pressure difference, inches of water (Pa).

**909.6.3 Pressurized stairways and elevator hoistways.** Where *stairways* or elevator hoistways are pressurized, such pressurization systems shall comply with Section 909 as smoke control systems, in addition to the requirements of Sections 909.20 and 909.21.

**909.7 Airflow design method.** Where *approved by the fire code official*, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflow shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be considered to prevent flow reversal from turbulent effects.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

Smoke control systems using the airflow method shall be designed in accordance with NFPA 92.

**909.7.1 Prohibited conditions.** This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. Airflow toward the fire shall not exceed 200 feet per minute (1.02 m/s). Where the calculated airflow exceeds this limit, the airflow method shall not be used.

**909.8 Exhaust method.** Where *approved* by the *fire code official*, mechanical smoke control for large enclosed volumes, such as in atriums or malls, shall be permitted to utilize the exhaust method. Smoke control systems using the exhaust method shall be designed in accordance with NFPA 92.

**909.8.1 Smoke layer.** The height of the lowest horizontal surface of the smoke layer interface shall be maintained not less than 6 feet (1829 mm) above a walking surface that forms a portion of a required egress system within the smoke zone.

**909.9 Design fire.** The design fire shall be based on a rational analysis performed by the *registered design professional* and *approved* by the *fire code official*. The design fire shall be based on the analysis in accordance with Section 909.4 and this section.

**909.9.1 Factors considered.** The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire and whether the fire is likely to be steady or unsteady.

**909.9.2 Design fire fuel.** Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration.

**909.9.3 Heat-release assumptions.** The analysis shall make use of best available data from *approved* sources and shall not be based on excessively stringent limitations of combustible material.

**909.9.4 Sprinkler effectiveness assumptions.** A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

**909.10 Equipment.** Equipment including, but not limited to, fans, ducts, automatic dampers and balance dampers shall be suitable for their intended use, suitable for the probable exposure temperatures that the rational analysis indicates, and as *approved* by the *fire code official*.

**909.10.1 Exhaust fans.** Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad \text{(Equation 9-2)}$$

where:

$c$  = Specific heat of smoke at smoke layer temperature, Btu/lb°F (kJ/kg × K).

$m$  = Exhaust rate, pounds per second (kg/s).

$Q_c$  = Convective heat output of fire, Btu/s (kW).

$T_a$  = Ambient temperature, °F (K).

$T_s$  = Smoke temperature, °F (K).

**Exception:** Reduced  $T_s$  as calculated based on the assurance of adequate dilution air.

**909.10.2 Ducts.** Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 909.10.1. Ducts shall be constructed and supported in accordance with the *International Mechanical Code*. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from *fire-resistance-rated* structural elements of the building by substantial, noncombustible supports.

**Exception:** Flexible connections, for the purpose of vibration isolation, complying with the *International Mechanical Code* and that are constructed of *approved fire-resistance-rated* materials.

**909.10.3 Equipment, inlets and outlets.** Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outside air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

**909.10.4 Automatic dampers.** Automatic dampers, regardless of the purpose for which they are installed within the smoke control system, shall be *listed* and conform to the requirements of *approved* recognized standards.

**909.10.5 Fans.** In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the structural design requirements of Chapter 16 of the *International Building Code*.

Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts) as determined from measurement of actual current draw and shall have a minimum service factor of 1.15.

**909.11 Standby power.** Smoke control systems shall be provided with standby power in accordance with Section 1203.

**909.11.1 Equipment room.** The standby power source and its transfer switches shall be in a room separate from the normal power transformers and switch gears and



ventilated directly to and from the exterior. The room shall be enclosed with not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**909.11.2 Power sources and power surges.** Elements of the smoke control system relying on volatile memories or the like shall be supplied with uninterruptable power sources of sufficient duration to span 15-minute primary power interruption. Elements of the smoke control system susceptible to power surges shall be suitably protected by conditioners, suppressors or other *approved* means.

**909.12 Detection and control systems.** Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907. Such systems shall be equipped with a control unit complying with UL 864 and *listed* as smoke control equipment.

**909.12.1 Verification.** Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override and the presence of power downstream of all disconnects. A preprogrammed weekly test sequence shall report abnormal conditions audibly, visually and by printed report. The preprogrammed weekly test shall operate all devices, equipment and components used for smoke control.

**Exception:** Where verification of individual components tested through the preprogrammed weekly testing sequence will interfere with, and produce unwanted effects to, normal building operation, such individual components are permitted to be bypassed from the preprogrammed weekly testing, where *approved* by the *fire code official* and in accordance with both of the following:

1. Where the operation of components is bypassed from the preprogrammed weekly test, presence of power downstream of all disconnects shall be verified weekly by a *listed* control unit.
2. Testing of all components bypassed from the preprogrammed weekly test shall be in accordance with Section 909.20.6.

**909.12.2 Wiring.** In addition to meeting requirements of NFPA 70, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

**909.12.3 Activation.** Smoke control systems shall be activated in accordance with this section.

**909.12.3.1 Pressurization, airflow or exhaust method.** Mechanical smoke control systems using the pressurization, airflow or exhaust method shall have completely automatic control.

**909.12.3.2 Passive method.** Passive smoke control systems actuated by *approved* spot-type detectors *listed* for releasing service shall be permitted.

**909.12.4 Automatic control.** Where completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned *automatic sprinkler system* complying with Section 903.3.1.1, manual controls provided with *ready access* for the fire department and any smoke detectors required by the engineering analysis.

**909.13 Control air tubing.** Control air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections and shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

**909.13.1 Materials.** Control air tubing shall be hard drawn copper, Type L, ACR in accordance with ASTM B42, ASTM B43, ASTM B68/B68M, ASTM B88, ASTM B251 and ASTM B280. Fittings shall be wrought copper or brass, solder type, in accordance with ASME B16.18 or ASME B16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP5 brazing alloy with solidus above 1,100°F (593°C) and liquidus below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

**Exception:** Nonmetallic tubing used within control panels and at the final connection to devices, provided that all of the following conditions are met:

1. Tubing shall comply with the requirements of Section 602.2.1.3 of the *International Mechanical Code*.
2. Tubing and the connected device shall be completely enclosed within a galvanized or paint-grade steel enclosure having a minimum thickness of 0.0296 inch (0.7534 mm) (No. 22 gage). Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or Teflon or by suitable brass compression to male-barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or moveable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing connected to devices on doors shall be fastened along hinges.

**909.13.2 Isolation from other functions.** Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

**909.13.3 Testing.** Control air tubing shall be tested at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**909.14 Marking and identification.** The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

**909.15 Control diagrams.** Identical control diagrams showing all devices in the system and identifying their location and function shall be maintained current and kept on file with the *fire code official*, the fire department and in the *fire command center* in a format and manner *approved* by the *fire code official*.

**909.16 Fire fighter's smoke control panel.** A fire fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be located in a *fire command center* complying with Section 508 in high-rise buildings or buildings with smoke-protected assembly seating. In all other buildings, the fire fighter's smoke control panel shall be installed in an *approved* location adjacent to the fire alarm control panel. The fire fighter's smoke control panel shall comply with Sections 909.16.1 through 909.16.3.

**909.16.1 Smoke control systems.** Fans within the building shall be shown on the fire fighter's control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone and by pilot-lamp-type indicators as follows:

1. Fans, dampers and other operating equipment in their normal status—WHITE.
2. Fans, dampers and other operating equipment in their off or closed status—RED.
3. Fans, dampers and other operating equipment in their on or open status—GREEN.
4. Fans, dampers and other operating equipment in a fault status—YELLOW/AMBER.

**909.16.2 Smoke control panel.** The fire fighter's control panel shall provide control capability over the complete smoke control system equipment within the building as follows:

1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can be controlled from other sources within the building. This includes *stairway* pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator shaft fans; and other operating equipment used or intended for smoke control purposes.
2. OPEN-AUTO-CLOSE control over individual dampers relating to smoke control and that are controlled from other sources within the building.
3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the fire fighter's control panel.

### Exceptions:

1. Complex systems, where *approved*, where the controls and indicators are combined to control

and indicate all elements of a single smoke zone as a unit.

2. Complex systems, where *approved*, where the control is accomplished by computer interface using *approved*, plain English commands.

**909.16.3 Control action and priorities.** The fire fighter's control panel actions shall be as follows:

1. ON-OFF and OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the fire fighter's control panel, automatic or manual control from any other control point within the building shall not contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment including, but not limited to, duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices, such means shall be capable of being overridden by the fire fighter's control panel. The last control action as indicated by each fire fighter's control panel switch position shall prevail. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

**Exception:** Power disconnects required by NFPA 70.

2. Only the AUTO position of each three-position firefighter's control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, nonemergency, building control position. Where a fire fighter's control panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described in Section 909.16.1. Where directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

**909.17 System response time.** Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as dampers and fans) in the sequence necessary to prevent physical damage to the fans, dampers, ducts and other equipment. For purposes of smoke control, the fire fighter's control panel response time shall be the same for automatic or manual smoke control action initiated from any other building control point. The total response time, including that necessary for detection, shutdown of operating equipment and smoke control system startup, shall allow for full operational mode to be achieved before the conditions in the space exceed the design smoke condition. Upon receipt

of an alarm condition at the fire alarm control panel, fans, dampers and automatic doors shall have achieved their proper operating state and the final status shall be indicated at the smoke control panel within 90 seconds. The system response time for each component and their sequential relationships shall be detailed in the required rational analysis and verification of their installed condition reported in the required final report.

**909.18 Acceptance testing.** Devices, equipment, components and sequences shall be individually tested. These tests, in addition to those required by other provisions of this code, shall consist of determination of function, sequence and, where applicable, capacity of their installed condition.

**909.18.1 Detection devices.** Smoke or fire detectors that are a part of a smoke control system shall be tested in accordance with Chapter 9 in their installed condition. Where applicable, this testing shall include verification of airflow in both minimum and maximum conditions.

**909.18.2 Ducts.** Ducts that are part of a smoke control system shall be traversed using generally accepted practices to determine actual air quantities.

**909.18.3 Dampers.** Dampers shall be tested for function in their installed condition.

**909.18.4 Inlets and outlets.** Inlets and outlets shall be read using generally accepted practices to determine air quantities.

**909.18.5 Fans.** Fans shall be examined for correct rotation. Measurements of voltage, amperage, revolutions per minute and belt tension shall be made.

**909.18.6 Smoke barriers.** Measurements using inclined manometers or other *approved* calibrated measuring devices shall be made of the pressure differences across *smoke barriers*. Such measurements shall be conducted for each possible smoke control condition.

**909.18.7 Controls.** Each smoke zone equipped with an automatic-initiation device shall be put into operation by the actuation of one such device. Each additional device within the zone shall be verified to cause the same sequence without requiring the operation of fan motors in order to prevent damage. Control sequences shall be verified throughout the system, including verification of override from the fire fighter's control panel and simulation of standby power conditions.

**909.18.8 Testing for smoke control.** Smoke control systems shall be tested by a special inspector in accordance with Section 1705.19 of the *International Building Code*.

**909.18.8.1 Scope of testing.** Testing shall be conducted in accordance with the following:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure-difference testing, flow measurements, and detection and control verification.

**909.18.8.2 Qualifications.** *Approved* agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

**909.18.8.3 Reports.** A complete report of testing shall be prepared by the *approved* agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or mark. The report shall be reviewed by the responsible *registered design professional* and, when satisfied that the design intent has been achieved, the responsible *registered design professional* shall sign, seal and date the report.

**909.18.8.3.1 Report filing.** A copy of the final report shall be filed with the *fire code official* and an identical copy shall be maintained in an *approved* location at the building.

**909.18.9 Identification and documentation.** Charts, drawings and other documents identifying and locating each component of the smoke control system, and describing their proper function and maintenance requirements, shall be maintained on file at the building as an attachment to the report required by Section 909.18.8.3. Devices shall have an *approved* identifying tag or mark on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

**909.19 System acceptance.** Buildings, or portions thereof, required by this code to comply with this section shall not be issued a certificate of occupancy until such time that the *fire code official* determines that the provisions of this section have been fully complied with and that the fire department has received satisfactory instruction on the operation, both automatic and manual, of the system and a written maintenance program complying with the requirements of Section 909.22.1 has been submitted and *approved* by the *fire code official*.

**Exception:** In buildings of phased construction, a temporary certificate of occupancy, as *approved* by the *fire code official*, shall be allowed, provided that those portions of the building to be occupied meet the requirements of this section and that the remainder does not pose a significant hazard to the safety of the proposed occupants or adjacent buildings.

**[BF] 909.20 Smokeproof enclosures.** Where required by Section 1023.12, a *smokeproof enclosure* shall be constructed in accordance with this section. A smokeproof enclosure shall consist of an *interior exit stairway* or *ramp* that is enclosed in accordance with the applicable provisions of Section 1023 and an open exterior balcony or ventilated vestibule meeting the requirements of this section. Where access to the roof is required, such access shall be from the smokeproof enclosure where a *smokeproof enclosure* is required.

**[BF] 909.20.1 Access.** Access to the *stairway* or *ramp* shall be by way of a vestibule or an open exterior balcony. The minimum dimension of the vestibule shall be not less than the required width of the *corridor* leading to the

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

vestibule but shall not have a width of less than 44 inches (1118 mm) and shall not have a length of less than 72 inches (1829 mm) in the direction of egress travel.

**[BF] 909.20.2 Construction.** The *smokeproof enclosure* shall be separated from the remainder of the building by not less than 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both. Openings are not permitted other than the required *means of egress doors*. The vestibule shall be separated from the *stairway* or *ramp* by not less than 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both. The open exterior balcony shall be constructed in accordance with the *fire-resistance-rating* requirements for floor assemblies.

**[BF] 909.20.2.1 Door closers.** Doors in a *smokeproof enclosure* shall be self-closing or automatic closing by actuation of a smoke detector in accordance with Section 716.2.6.6 of the *International Building Code* and shall be installed at the floor-side entrance to the *smokeproof enclosure*. The actuation of the smoke detector on any door shall activate the closing devices on all doors in the *smokeproof enclosure* at all levels. Smoke detectors shall be installed in accordance with Section 907.3.

**[BF] 909.20.3 Natural ventilation alternative.** The provisions of Sections 909.20.3.1 through 909.20.3.3 shall apply to ventilation of *smokeproof enclosures* by natural means.

**[BF] 909.20.3.1 Balcony doors.** Where access to the *stairway* or *ramp* is by way of an open exterior balcony, the door assembly into the enclosure shall be a fire door assembly in accordance with Section 716 of the *International Building Code*.

**[BF] 909.20.3.2 Vestibule doors.** Where access to the *stairway* or *ramp* is by way of a vestibule, the door assembly into the vestibule shall be a fire door assembly complying with Section 716 of the *International Building Code*. The door assembly from the vestibule to the *stairway* shall have not less than a 20-minute *fire protection rating* complying with Section 716 of the *International Building Code*.

**[BF] 909.20.3.3 Vestibule ventilation.** Each vestibule shall have a minimum net area of 16 square feet (1.5 m<sup>2</sup>) of opening in a wall facing an outer *court*, *yard* or *public way* that is not less than 20 feet (6096 mm) in width.

**[BF] 909.20.4 Mechanical ventilation alternative.** The provisions of Sections 909.20.4.1 through 909.20.4.4 shall apply to ventilation of *smokeproof enclosures* by mechanical means.

**[BF] 909.20.4.1 Vestibule doors.** The door assembly from the building into the vestibule shall be a fire door assembly complying with Section 716.2.2.1 of the

*International Building Code*. The door assembly from the vestibule to the *stairway* or *ramp* shall have not less than a 20-minute *fire protection rating* and shall meet the requirements for a smoke door assembly in accordance with Section 716.2.2.1 of the *International Building Code*. The door shall be installed in accordance with NFPA 105.

**[BF] 909.20.4.2 Vestibule ventilation.** The vestibule shall be supplied with not less than one air change per minute and the exhaust shall be not less than 150 percent of supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 6 inches (152 mm) of the floor level. The top of the exhaust register shall be located at the top of the smoke trap but not more than 6 inches (152 mm) down from the top of the trap, and shall be entirely within the smoke trap area. Doors in the open position shall not obstruct duct openings. Duct openings with controlling dampers are permitted where necessary to meet the design requirements, but dampers are not otherwise required.

**[BF] 909.20.4.2.1 Engineered ventilation system.**

Where a specially engineered system is used, the system shall exhaust a quantity of air equal to not less than 90 air changes per hour from any vestibule when in emergency operation mode and shall be sized to handle three vestibules simultaneously. Smoke detectors shall be located at the floor-side entrance to each vestibule and shall activate the system for the affected vestibule. Smoke detectors shall be installed in accordance with Section 907.3.

**[BF] 909.20.4.3 Smoke trap.** The vestibule ceiling shall be not less than 20 inches (508 mm) higher than the door opening into the vestibule to serve as a smoke and heat trap and to provide an upward-moving air column. The height shall not be decreased unless approved and justified by design and test.

**[BF] 909.20.4.4 Stairway or ramp shaft air movement system.** The *stairway* or *ramp* shaft shall be provided with a dampered relief opening and supplied with sufficient air to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) in the shaft relative to the vestibule with all doors closed.

**[BF] 909.20.5 Stairway and ramp pressurization alternative.** Where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the vestibule is not required, provided that each *interior exit stairway* or *ramp* is pressurized to not less than 0.10 inch of water (25 Pa) and not more than 0.35 inch of water (87 Pa) in the shaft relative to the building measured with all *interior exit stairway* and *ramp* doors closed under maximum anticipated conditions of stack effect and wind effect.

**[BF] 909.20.6 Ventilating equipment.** The activation of ventilating equipment required by the alternatives in Sections 909.20.4 and 909.20.5 shall be by smoke detectors installed at each floor level at an *approved* location at



the entrance to the *smokeproof enclosure*. When the closing device for the stairway and ramp shaft and vestibule doors is activated by smoke detection or power failure, the mechanical equipment shall activate and operate at the required performance levels. Smoke detectors shall be installed in accordance with Section 907.3.

**[BF] 909.20.6.1 Ventilation systems.** *Smokeproof enclosure* ventilation systems shall be independent of other building ventilation systems. The equipment, control wiring, power wiring and ductwork shall comply with one of the following:

1. Equipment, control wiring, power wiring and ductwork shall be located exterior to the building and directly connected to the *smokeproof enclosure* or connected to the *smokeproof enclosure* by ductwork enclosed by not less than 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.
2. Equipment, control wiring, power wiring and ductwork shall be located within the *smokeproof enclosure* with intake or exhaust directly from and to the outside or through ductwork enclosed by not less than 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.
3. Equipment, control wiring, power wiring and ductwork shall be located within the building if separated from the remainder of the building, including other mechanical equipment, by not less than 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**Exception:** Control wiring and power wiring located outside of a 2-hour fire barrier construction shall be protected using any one of the following methods:

1. Cables used for survivability of required *critical circuits* shall be *listed* in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 2 hours.
2. Where encased with not less than 2 inches (51 mm) of concrete.
3. Electrical circuit protective systems shall have a *fire-resistance rating* of not less than 2 hours. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

**[BF] 909.20.6.2 Standby power.** Mechanical vestibule and *stairway* and *ramp* shaft ventilation systems

and automatic fire detection systems shall be provided with standby power in accordance with Section 603.

**[BF] 909.20.6.3 Acceptance and testing.** Before the mechanical equipment is *approved*, the system shall be tested in the presence of the building official to confirm that the system is operating in compliance with these requirements.

**[BF] 909.21 Elevator hoistway pressurization alternative.** Where elevator hoistway pressurization is provided in lieu of required enclosed elevator lobbies, the pressurization system shall comply with Sections 909.21.1 through 909.21.11.

**[BF] 909.21.1 Pressurization requirements.** Elevator hoistways shall be pressurized to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to adjacent occupied space on all floors. This pressure shall be measured at the midpoint of each hoistway door, with all elevator cars at the floor of recall and all hoistway doors on the floor of recall open and all other hoistway doors closed. The pressure differentials shall be measured between the hoistway and the adjacent elevator landing. The opening and closing of hoistway doors at each level must be demonstrated during this test. The supply air intake shall be from an outside, uncontaminated source located a minimum distance of 20 feet (6096 mm) from any air exhaust system or outlet.

#### Exceptions:

1. On floors containing only Group R occupancies, the pressure differential is permitted to be measured between the hoistway and a *dwelling unit* or *sleeping unit*.
2. Where an elevator opens into a lobby enclosed in accordance with Section 3007.6 or 3008.6 of the *International Building Code*, the pressure differential is permitted to be measured between the hoistway and the space immediately outside the door(s) from the floor to the enclosed lobby.
3. The pressure differential is permitted to be measured relative to the outdoor atmosphere on floors other than the following:
  - 3.1. The fire floor.
  - 3.2. The two floors immediately below the fire floor.
  - 3.3. The floor immediately above the fire floor.
4. The minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to occupied floors is not required at the floor of recall with the doors open.

**[BF] 909.21.1.1 Use of ventilation systems.** Ventilation systems, other than hoistway supply air systems, are permitted to be used to exhaust air from adjacent spaces on the fire floor, two floors immediately below and one floor immediately above the fire floor to the



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

building's exterior where necessary to maintain positive pressure relationships as required in Section 909.21.1 during operation of the elevator shaft pressurization system.

**[BF] 909.21.2 Rational analysis.** A rational analysis complying with Section 909.4 shall be submitted with the *construction documents*.

**[BF] 909.21.3 Ducts for system.** Any duct system that is part of the pressurization system shall be protected with the same *fire-resistance rating* as required for the elevator shaft enclosure.

**[BF] 909.21.4 Fan system.** The fan system provided for the pressurization system shall be as required by Sections 909.21.4.1 through 909.21.4.4.

**[BF] 909.21.4.1 Fire resistance.** Where located within the building, the fan system that provides the pressurization shall be protected with the same *fire-resistance rating* required for the elevator shaft enclosure.

**[BF] 909.21.4.2 Smoke detection.** The fan system shall be equipped with a smoke detector that will automatically shut down the fan system when smoke is detected within the system.

**[BF] 909.21.4.3 Separate systems.** A separate fan system shall be used for each elevator hoistway.

**[BF] 909.21.4.4 Fan capacity.** The supply fan shall be either adjustable with a capacity of not less than 1,000 cfm (0.4719 m<sup>3</sup>/s) per door, or that specified by a *registered design professional* to meet the requirements of a designed pressurization system.

**[BF] 909.21.5 Standby power.** The pressurization system shall be provided with standby power in accordance with Section 1203.

**[BF] 909.21.6 Activation of pressurization system.** The elevator pressurization system shall be activated upon activation of either the building fire alarm system or the elevator lobby smoke detectors. Where both a building fire alarm system and elevator lobby smoke detectors are present, each shall be independently capable of activating the pressurization system.

**[BF] 909.21.7 Testing.** Testing for performance shall be required in accordance with Section 909.18.8. System acceptance shall be in accordance with Section 909.19.

**[BF] 909.21.8 Marking and identification.** Detection and control systems shall be marked in accordance with Section 909.14.

**[BF] 909.21.9 Control diagrams.** Control diagrams shall be provided in accordance with Section 909.15.

**[BF] 909.21.10 Control panel.** A control panel complying with Section 909.16 shall be provided.

**[BF] 909.21.11 System response time.** Hoistway pressurization systems shall comply with the requirements for smoke control system response time in Section 909.17.

**909.22 Maintenance.** Smoke control systems shall be maintained to ensure to a reasonable degree that the system is capable of controlling smoke for the duration required. The

system shall be maintained in accordance with the manufacturer's instructions and Sections 909.22.1 through 909.22.6.

**909.22.1 Schedule.** A routine maintenance and operational testing program shall be initiated immediately after the smoke control system has passed the acceptance tests. A written schedule for routine maintenance and operational testing shall be established.

**909.22.2 Records.** Records of smoke control system testing and maintenance shall be maintained. The record shall include the date of the maintenance, identification of the servicing personnel and notification of any unsatisfactory condition and the corrective action taken, including parts replaced.

**909.22.3 Testing.** Operational testing of the smoke control system shall include all equipment such as initiating devices, fans, dampers, controls, doors and windows.

**909.22.4 Dedicated smoke control systems.** Dedicated smoke control systems shall be operated for each control sequence semiannually. The system shall be tested under standby power conditions.

**909.22.5 Nondedicated smoke control systems.** Nondedicated smoke control systems shall be operated for each control sequence annually. The system shall be tested under standby power conditions.

**909.22.6 Components bypassing weekly test.** Where components of the smoke control system are bypassed by the preprogrammed weekly test required by Section 909.12.1, such components shall be tested semiannually. The system shall be tested under standby power conditions.

## SECTION 910 SMOKE AND HEAT REMOVAL

**910.1 General.** Where required by this code, smoke and heat vents or mechanical smoke removal systems shall conform to the requirements of this section.

**910.2 Where required.** Smoke and heat vents or a mechanical smoke removal system shall be installed as required by Sections 910.2.1 and 910.2.2.

### Exceptions:

1. Frozen food warehouses used solely for storage of Class I and II commodities where protected by an *approved automatic sprinkler system*.
2. Smoke and heat removal shall not be required in areas of buildings equipped with early suppression fast-response (ESFR) sprinklers.
3. Smoke and heat removal shall not be required in areas of buildings equipped with control mode special application sprinklers with a response time index of  $50(m \times s)^{1/2}$  or less that are *listed* to control a fire in stored commodities with 12 or fewer sprinklers.

**910.2.1 Group F-1 or S-1.** Smoke and heat vents installed in accordance with Section 910.3 or a mechanical smoke removal system installed in accordance with Section 910.4 shall be installed in buildings and portions

thereof used as a Group F-1 or S-1 occupancy having more than 50,000 square feet (4645 m<sup>2</sup>) of undivided area. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the upper surface of the story is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

**Exception:** Group S-1 aircraft repair hangars.

**910.2.2 High-piled combustibile storage.** Smoke and heat removal required by Table 3206.2 for buildings and portions thereof containing *high-piled combustibile storage* shall be installed in accordance with Section 910.3 in unsprinklered buildings. In buildings and portions thereof containing *high-piled combustibile storage* equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, a smoke and heat removal system shall be installed in accordance with Section 910.3 or 910.4. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where the upper surface of the story is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

**910.3 Smoke and heat vents.** The design and installation of smoke and heat vents shall be in accordance with Sections 910.3.1 through 910.3.3.

**910.3.1 Listing and labeling.** Smoke and heat vents shall be *listed* and *labeled* to indicate compliance with UL 793 or FM 4430.

**910.3.2 Smoke and heat vent locations.** Smoke and heat vents shall be located 20 feet (6096 mm) or more from adjacent *lot lines* and *fire walls* and 10 feet (3048 mm) or more from *fire barriers*. Vents shall be uniformly located within the roof in the areas of the building where the vents are required to be installed by Section 910.2, with consideration given to roof pitch, sprinkler location and structural members.

**910.3.3 Smoke and heat vents area.** The required aggregate area of smoke and heat vents shall be calculated as follows:

For buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1:

$$A_{VR} = V/9000 \quad (\text{Equation 9-3})$$

where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$V$  = Volume (ft<sup>3</sup>) of the area that requires smoke removal.

For unsprinklered buildings:

$$A_{VR} = A_{FA}/50 \quad (\text{Equation 9-4})$$

where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$A_{FA}$  = The area of the floor in the area that requires smoke removal.

**910.3.4 Vent operation.** Smoke and heat vents shall be capable of being operated by *approved* automatic and manual means.

**910.3.5 Fusible link temperature rating.** Where vents are installed in areas provided with automatic fire sprinklers and the vents operate by fusible link, the fusible link shall have a temperature rating of 360°F (182°C).

**910.4 Mechanical smoke removal systems.** Mechanical smoke removal systems shall be designed and installed in accordance with Sections 910.4.1 through 910.4.7.

**910.4.1 Automatic sprinklers required.** The building shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**910.4.2 Exhaust fan construction.** Exhaust fans that are part of a mechanical smoke removal system shall be rated for operation at 221°F (105°C). Exhaust fan motors shall be located outside of the exhaust fan airstream.

**910.4.3 System design criteria.** The mechanical smoke removal system shall be sized to exhaust the building at a minimum rate of two air changes per hour based on the volume of the building or portion thereof without contents. The capacity of each exhaust fan shall not exceed 30,000 cubic feet per minute (14.2 m<sup>3</sup>/s).

**910.4.3.1 Makeup air.** Makeup air openings shall be provided within 6 feet (1829 mm) of the floor level. Operation of makeup air openings shall be manual or automatic. The minimum gross area of makeup air inlets shall be 8 square feet per 1,000 cubic feet per minute (0.74 m<sup>2</sup> per 0.4719 m<sup>3</sup>/s) of smoke exhaust.

**910.4.4 Activation.** The mechanical smoke removal system shall be activated by manual controls only.

**910.4.5 Manual control location.** Manual controls shall be located where they are able to be accessed by the fire service from an exterior door of the building and separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**910.4.6 Control wiring.** Wiring for operation and control of mechanical smoke removal systems shall be connected ahead of the main disconnect in accordance with Section 701.12E of NFPA 70 and be protected against interior fire exposure to temperatures in excess of 1,000°F (538°C) for a period of not less than 15 minutes.

**910.4.7 Controls.** Where building air-handling and mechanical smoke removal systems are combined or where independent building air-handling systems are provided, fans shall automatically shut down in accordance with the *International Mechanical Code*. The manual controls provided for the smoke removal system shall have the capability to override the automatic shut-down of fans that are part of the smoke removal system.

**910.5 Maintenance and testing.** Maintenance and testing of smoke and heat vents and mechanical smoke removal systems shall be in accordance with Sections 910.5.1 and

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

910.5.2. A written record of inspection, testing and maintenance that includes the date, identification of personnel involved, any unsatisfactory result, corrective action taken and replaced parts shall be maintained on the premises.

**910.5.1 Smoke and heat vents.** Smoke and heat vents shall be maintained in an operative condition. Inspection, testing and maintenance shall be in accordance with NFPA 204 except as follows:

1. Mechanically operated smoke and heat vents shall be inspected annually and operationally tested not less than every 5 years.
2. Gravity dropout smoke and heat vents shall be inspected annually.
3. Fused, damaged or painted fusible links shall be replaced.

**910.5.2 Mechanical smoke removal systems.** Mechanical smoke removal systems shall be maintained in accordance with NFPA 204 and the equipment manufacturer's instructions except as follows:

1. Systems shall be inspected and operationally tested annually.
2. Testing shall include the operation of all system components, controls and ancillary equipment, such as makeup air openings.
3. A written schedule for routine maintenance and operational testing shall be established and testing shall be conducted in accordance with the schedule.

## SECTION 911 EXPLOSION CONTROL

**911.1 General.** Explosion control shall be provided in the following locations:

1. Where a structure, room or space is occupied for purposes involving explosion hazards as identified in Table 911.1.
2. Where quantities of hazardous materials specified in Table 911.1 exceed the maximum allowable quantities in Table 5003.1.1(1).

Such areas shall be provided with explosion (*deflagration*) venting, explosion (*deflagration*) prevention systems or *barricades* in accordance with this section and NFPA 68, NFPA 69 or NFPA 495 as applicable. *Deflagration* venting shall not be utilized as a means to protect buildings from *detonation* hazards.

**911.2 Required deflagration venting.** Areas that are required to be provided with *deflagration* venting shall comply with the following:

1. Walls, ceilings and roofs exposing surrounding areas shall be designed to resist a minimum internal pressure of 100 pounds per square foot (psf) (4788 Pa). The minimum internal design pressure shall be not less than five times the maximum internal relief pressure specified in Item 5 of this section.

2. *Deflagration* venting shall be provided only in exterior walls and roofs.

**Exception:** Where sufficient *exterior wall* and roof venting cannot be provided because of inadequate exterior wall or roof area, *deflagration* venting shall be allowed by specially designed shafts vented to the exterior of the building.

3. *Deflagration* venting shall be designed to prevent unacceptable structural damage. Where relieving a *deflagration*, vent closures shall not produce projectiles of sufficient velocity and mass to cause life threatening injuries to the occupants or other persons on the property or adjacent *public ways*.
4. The aggregate clear area of vents and venting devices shall be governed by the pressure resistance of the construction assemblies specified in Item 1 of this section and the maximum internal pressure allowed by Item 5 of this section.
5. Vents shall be designed to withstand loads in accordance with the *International Building Code*. Vents shall consist of any one or any combination of the following to relieve at a maximum internal pressure of 20 pounds per square foot (958 Pa), but not less than the loads required by the *International Building Code*:
  - 5.1. *Exterior walls* designed to release outward.
  - 5.2. Hatch covers.
  - 5.3. Outward swinging doors.
  - 5.4. Roofs designed to uplift.
  - 5.5. Venting devices *listed* for the purpose.
6. Vents designed to release from the *exterior walls* or roofs of the building when venting a *deflagration* shall discharge directly to the exterior of the building where an unoccupied space not less than 50 feet (15 240 mm) in width is provided between the *exterior walls* of the building and the *lot line*.

**Exception:** Vents complying with Item 7 of this section.

7. Vents designed to remain attached to the building when venting a *deflagration* shall be so located that the discharge opening shall be not less than 10 feet (3048 mm) vertically from window openings and *exits* in the building and 20 feet (6096 mm) horizontally from *exits* in the building, from window openings and *exits* in adjacent buildings on the same lot and from the *lot line*.
8. Discharge from vents shall not be into the interior of the building.

**911.3 Explosion prevention systems.** Explosion prevention systems shall be of an *approved* type and installed in accordance with the provisions of this code and NFPA 69.

**911.4 Deflagration venting.** *Deflagration* venting shall be of an *approved* type and installed in accordance with the provisions of this code and NFPA 68.

**911.5 Barricades.** *Barricades* shall be designed and installed in accordance with NFPA 495.

**TABLE 911.1  
EXPLOSION CONTROL REQUIREMENTS<sup>f</sup>**

MATERIAL	CLASS	EXPLOSION CONTROL METHODS	
		Barricade construction	Explosion (deflagration) venting or explosion (deflagration) prevention systems
Hazard Category			
Combustible dusts <sup>a</sup>	—	Not required	Required
Cryogenic fluids	Flammable	Not required	Required
Explosives	Division 1.1	Required	Not required
	Division 1.2	Required	Not required
	Division 1.3	Not required	Required
	Division 1.4	Not required	Required
	Division 1.5	Required	Not required
	Division 1.6	Required	Not required
Flammable gas	Gaseous	Not required	Required
	Liquefied	Not required	Required
Flammable liquids	IA <sup>b</sup>	Not required	Required
	IB <sup>c</sup>	Not required	Required
Organic peroxides	Unclassified detonable	Required	Not permitted
	I	Required	Not permitted
Oxidizer liquids and solids	4	Required	Not permitted
Pyrophoric	Gases	Not required	Required
Unstable (reactive)	4	Required	Not permitted
	3 detonable	Required	Not permitted
	3 nondetonable	Not required	Required
Water-reactive liquids and solids	3	Not required	Required
	2 <sup>e</sup>	Not required	Required
Special Uses			
Acetylene generator rooms	—	Not required	Required
Electrochemical energy storage systems <sup>g</sup>	—	Not required	Required
Energy storage systems <sup>g</sup>	—	Not required	Required
Grain processing	—	Not required	Required
Liquefied petroleum gas distribution facilities	—	Not required	Required
Where explosion hazards exist <sup>d</sup>	Detonation	Required	Not permitted
	Deflagration	Not required	Required

a. Combustible dusts where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.8.2. See definition of “Combustible dust” in Chapter 2.

b. Storage or use.

c. In open use or dispensing.

d. Rooms containing dispensing and use of hazardous materials where an explosive environment can occur because of the characteristics or nature of the hazardous materials or as a result of the dispensing or use process.

e. A method of explosion control shall be provided where Class 2 water-reactive materials can form potentially explosive mixtures.

f. Explosion venting is not required for Group H-5 Fabrication Areas complying with Chapter 27 and the *International Building Code*.

g. Where explosion control is required in Section 1207.6.3.

## SECTION 912 FIRE DEPARTMENT CONNECTIONS

**912.1 Installation.** Fire department connections shall be installed in accordance with the NFPA standard applicable to the system design and shall comply with Sections 912.2 through 912.7.

**912.2 Location.** With respect to hydrants, driveways, buildings and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the buildings for other fire apparatus. The location of fire department connections shall be *approved by the fire code official*.

**912.2.1 Visible location.** Fire department connections shall be located on the street side of buildings or facing



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

*approved* fire apparatus access roads, fully visible and recognizable from the street, fire apparatus access road or nearest point of fire department vehicle access or as otherwise *approved* by the *fire code official*.

**912.2.2 Existing buildings.** On existing buildings, whenever the fire department connection is not visible to approaching fire apparatus, the fire department connection shall be indicated by an *approved* sign mounted on the street front or on the side of the building. Such sign shall have the letters “FDC” not less than 6 inches (152 mm) high and words in letters not less than 2 inches (51 mm) high or an arrow to indicate the location. Such signs shall be subject to the approval of the *fire code official*.

**912.3 Fire hose threads.** Fire hose threads used in connection with standpipe systems shall be *approved* and shall be compatible with fire department hose threads.

**912.4 Access.** Immediate access to fire department connections shall be maintained at all times and without obstruction by fences, bushes, trees, walls or any other fixed or moveable object. Access to fire department connections shall be *approved* by the *fire code official*.

**Exception:** Fences, where provided with an access gate equipped with a sign complying with the legend requirements of Section 912.5 and a means of emergency operation. The gate and the means of emergency operation shall be *approved* by the *fire code official* and maintained operational at all times.

**912.4.1 Locking fire department connection caps.** The *fire code official* is authorized to require locking caps on fire department connections for water-based *fire protection systems* where the responding fire department carries appropriate key wrenches for removal.

**912.4.2 Clear space around connections.** A working space of not less than 36 inches (914 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided and maintained in front of and to the sides of wall-mounted fire department connections and around the circumference of free-standing fire department connections, except as otherwise required or *approved* by the *fire code official*.

**912.4.3 Physical protection.** Where fire department connections are subject to impact by a motor vehicle, vehicle impact protection shall be provided in accordance with Section 312.

**912.5 Signs.** A metal sign with raised letters not less than 1 inch (25 mm) in size shall be mounted on all fire department connections serving automatic sprinklers, standpipes or fire pump connections. Such signs shall read: “AUTOMATIC SPRINKLERS” or “STANDPIPES” or “TEST CONNECTION” or a combination thereof as applicable. Where the fire department connection does not serve the entire building, a sign shall be provided indicating the portions of the building served.

**912.6 Backflow protection.** The potable water supply to automatic sprinkler and standpipe systems shall be protected against backflow as required by the *International Plumbing Code*.

**912.7 Inspection, testing and maintenance.** Fire department connections shall be periodically inspected, tested and maintained in accordance with NFPA 25. Records of inspection, testing and maintenance shall be maintained.

## SECTION 913 FIRE PUMPS

**913.1 General.** Where provided, fire pumps for *fire protection systems* shall be installed in accordance with this section and NFPA 20.

**Exception:** Pumps for *automatic sprinkler systems* installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**913.2 Protection against interruption of service.** The fire pump, driver and controller shall be protected in accordance with NFPA 20 against possible interruption of service through damage caused by explosion, fire, flood, earthquake, rodents, insects, windstorm, freezing, vandalism and other adverse conditions.

**913.2.1 Protection of fire pump rooms.** Rooms where fire pumps are located shall be separated from all other areas of the building in accordance with Section 913.2.1 of the *International Building Code*.

**913.2.2 Circuits supplying fire pumps.** Cables used for survivability of circuits supplying fire pumps shall be protected using one of the following methods:

1. Cables used for survivability of required *critical circuits* shall be *listed* in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 1 hour.
2. Electrical circuit protective systems shall have a *fire-resistance rating* of not less than 1 hour. Electrical circuit protective systems shall be installed in accordance with their listing requirements.
3. Construction having a *fire-resistance rating* of not less than 1 hour.
4. The cable or raceway is encased in a minimum of 2 inches (51 mm) of concrete.

**Exception:** This section shall not apply to cables, or portions of cables, located within a fire pump room or generator room that is separated from the remainder of the occupancy with *fire-resistance-rated* construction.

**913.3 Temperature of pump room.** Suitable means shall be provided for maintaining the temperature of a pump room or pump house, where required, above 40°F (5°C).

**913.3.1 Engine manufacturer’s recommendation.** Temperature of the pump room, pump house or area where engines are installed shall never be less than the minimum recommended by the engine manufacturer. The engine manufacturer’s recommendations for oil heaters shall be followed.

**913.4 Valve supervision.** Where provided, the fire pump suction, discharge and bypass valves, and isolation valves on the backflow prevention device or assembly shall be supervised open by one of the following methods:

1. Central-station, proprietary or remote-station signaling service.
2. Local signaling service that will cause the sounding of an audible signal at a *constantly attended location*.
3. Locking valves open.
4. Sealing of valves and *approved* weekly recorded inspection where valves are located within fenced enclosures under the control of the *owner*.

**913.4.1 Test outlet valve supervision.** Fire pump test outlet valves shall be supervised in the closed position.

**913.5 Testing and maintenance.** Fire pumps shall be inspected, tested and maintained in accordance with the requirements of this section and NFPA 25. Records of inspection, testing and maintenance shall be maintained.

**913.5.1 Acceptance test.** Acceptance testing shall be done in accordance with the requirements of NFPA 20.

**913.5.2 Generator sets.** Engine generator sets supplying emergency or standby power to fire pump assemblies shall be periodically tested in accordance with NFPA 110. Records of testing shall be maintained.

**913.5.3 Transfer switches.** Automatic transfer switches shall be periodically tested in accordance with NFPA 110. Records of testing shall be maintained.

**913.5.4 Pump room environmental conditions.** Tests of pump room environmental conditions, including heating, ventilation and illumination, shall be made to ensure proper manual or automatic operation of the associated equipment.

**913.6 Supervisory conditions.** The following conditions shall be supervised by the fire alarm system as appropriate for the type of pump supervised:

1. Pump room temperature;
2. Phase loss;
3. Phase reversal;
4. Pump in manual mode.

## SECTION 914

### FIRE PROTECTION BASED ON SPECIAL DETAILED REQUIREMENTS OF USE AND OCCUPANCY

**914.1 General.** This section shall specify where *fire protection systems* are required based on the detailed requirements of use and occupancy of the *International Building Code*.

**914.2 Covered and open mall buildings.** Covered and open mall buildings shall comply with Sections 914.2.1 through 914.2.4.

**914.2.1 Automatic sprinkler system.** Covered and open mall buildings and buildings connected shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, which shall comply with the all of the following:

1. The *automatic sprinkler system* shall be complete and operative throughout occupied space in the mall building prior to occupancy of any of the tenant spaces. Unoccupied tenant spaces shall be similarly protected unless provided with *approved* alternative protection.
2. Sprinkler protection for the mall of a covered mall building shall be independent from that provided for tenant spaces or anchor buildings.
3. Sprinkler protection for the tenant spaces of an open mall building shall be independent from that provided for anchor buildings.
4. Sprinkler protection shall be provided beneath exterior circulation balconies located adjacent to an open mall.
5. Where tenant spaces are supplied by the same system, they shall be independently controlled.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of open parking garages separated from the covered or open mall in accordance with Section 402.4.2.3 of the *International Building Code* and constructed in accordance with Section 406.5 of the *International Building Code*.

**914.2.2 Standpipe system.** The covered and open mall building shall be equipped throughout with a standpipe system as required by Section 905.3.3.

**914.2.3 Emergency voice/alarm communication system.** Where the total floor area exceeds 50,000 square feet (4645 m<sup>2</sup>) within either a covered mall building or within the perimeter line of an open mall building, an emergency voice/alarm communication system shall be provided. *Access* to emergency voice/alarm communication systems serving a mall, required or otherwise, shall be provided for the fire department. The system shall be provided in accordance with Section 907.5.2.2.

**914.2.4 Fire department access to equipment.** Rooms or areas containing controls for air-conditioning systems or *fire protection systems* shall be identified for use by the fire department.

**914.3 High-rise buildings.** High-rise buildings shall comply with Sections 914.3.1 through 914.3.7.

**914.3.1 Automatic sprinkler system.** Buildings and structures shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and a secondary water supply where required by Section 914.3.2.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of telecommunications equipment buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided that those spaces or areas are equipped throughout with an automatic fire detection system in accordance with Section 907.2 and are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or not less than 2-hour

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

*horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**914.3.1.1 Number of sprinkler risers and system design.** Each sprinkler system zone in buildings that are more than 420 feet (128 m) in height shall be supplied by not fewer than two risers. Each riser shall supply sprinklers on alternate floors. If more than two risers are provided for a zone, sprinklers on adjacent floors shall not be supplied from the same riser.

**914.3.1.1.1 Riser location.** Sprinkler risers shall be placed in *interior exit stairways* and *ramps* that are remotely located in accordance with Section 1007.

**914.3.1.2 Water supply to required fire pumps.** In all buildings that are more than 420 feet (128 m) in *building height*, and buildings of Type IVA and IVB construction that are more than 120 feet (36.6 m) in *building height*, required fire pumps shall be supplied by connections to not fewer than two water mains located in different streets. Separate supply piping shall be provided between each connection to the water main and the pumps. Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

**Exception:** Two connections to the same main shall be permitted provided that the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through not fewer than one of the connections.

**914.3.2 Secondary water supply.** An automatic secondary on-site water supply having a capacity not less than the hydraulically calculated sprinkler demand, including the hose stream requirement, shall be provided for high-rise buildings assigned to Seismic Design Category C, D, E or F as determined by the *International Building Code*. An additional fire pump shall not be required for the secondary water supply unless needed to provide the minimum design intake pressure at the suction side of the fire pump supplying the *automatic sprinkler system*. The secondary water supply shall have a duration of not less than 30 minutes as determined by the occupancy hazard classification in accordance with NFPA 13.

**914.3.3 Fire alarm system.** A fire alarm system shall be provided in accordance with Section 907.2.13.

**914.3.4 Automatic smoke detection.** Smoke detection shall be provided in accordance with Section 907.2.13.1.

**914.3.5 Emergency voice/alarm communication system.** An emergency voice/alarm communication system shall be provided in accordance with Section 907.5.2.2.

**914.3.6 Emergency responder communication coverage.** In-building, two-way emergency responder communication coverage shall be provided in accordance with Section 510.

**914.3.7 Fire command.** A *fire command center* complying with Section 508 shall be provided in a location *approved* by the fire department.

**914.4 Atriums.** Atriums shall comply with Sections 914.4.1 and 914.4.2.

**914.4.1 Automatic sprinkler system.** An *approved automatic sprinkler system* shall be installed throughout the entire building.

**Exceptions:**

1. That area of a building adjacent to or above the atrium need not be sprinklered, provided that portion of the building is separated from the atrium portion by not less than a 2-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.
2. Where the ceiling of the atrium is more than 55 feet (16 764 mm) above the floor, sprinkler protection at the ceiling of the atrium is not required.

**914.4.2 Fire alarm system.** A fire alarm system shall be provided where required by Section 907.2.14.

**914.5 Underground buildings.** Underground buildings shall comply with Sections 914.5.1 through 914.5.5.

**914.5.1 Automatic sprinkler system.** The highest *level of exit discharge* serving the underground portions of the building and all levels below shall be equipped with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1. Waterflow switches and control valves shall be supervised in accordance with Section 903.4.

**914.5.2 Smoke control system.** A smoke control system is required to control the migration of products of combustion in accordance with Section 909 and provisions of this section. Smoke control shall restrict movement of smoke to the general area of fire origin and maintain *means of egress* in a usable condition.

**914.5.3 Compartment smoke control system.** Where compartmentation is required by Section 405.4 of the *International Building Code*, each compartment shall have an independent smoke control system. The system shall be automatically activated and capable of manual operation in accordance with Section 907.2.18.

**914.5.4 Fire alarm system.** A fire alarm system shall be provided where required by Sections 907.2.18 and 907.2.19.

**914.5.5 Standpipe system.** The underground building shall be provided throughout with a standpipe system in accordance with Section 905.

**914.6 Stages.** Stages shall comply with Sections 914.6.1 and 914.6.2.

**914.6.1 Automatic sprinkler system.** Stages shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Sprinklers shall be installed under the roof and gridiron and under all catwalks and galleries over the stage. Sprinklers shall be installed in dressing rooms, performer lounges, shops and storerooms accessory to such stages.

**Exceptions:**

1. Sprinklers are not required under stage areas less than 4 feet (1219 mm) in clear height



utilized exclusively for storage of tables and chairs, provided that the concealed space is separated from the adjacent spaces by Type X gypsum board not less than  $\frac{5}{8}$  inch (15.9 mm) in thickness.

2. Sprinklers are not required for stages 1,000 square feet (93 m<sup>2</sup>) or less in area and 50 feet (15 240 mm) or less in height where curtains, scenery or other combustible hangings are not retractable vertically. Combustible hangings shall be limited to a single main curtain, borders, legs and a single backdrop.
3. Sprinklers are not required within portable orchestra enclosures on stages.

**914.6.2 Standpipe system.** Standpipe systems shall be provided in accordance with Section 905.

**914.7 Special amusement areas.** Special amusement areas shall comply with Sections 914.7.1 and 914.7.2.

**914.7.1 Automatic sprinkler system.** Buildings containing special amusement areas shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Where the special amusement area is temporary, the sprinkler water supply shall be of an *approved* temporary means.

**Exception:** Automatic sprinklers are not required where the total floor area of a temporary special amusement area is less than 1,000 square feet (93 m<sup>2</sup>) and the *exit access* travel distance from any point in the special amusement area to an *exit* is less than 50 feet (15 240 mm).

**914.7.2 Automatic smoke detection.** Special amusement areas shall be equipped with an automatic smoke detection system in accordance with Section 907.2.12.

**914.8 Aircraft-related occupancies.** Aircraft-related occupancies shall comply with Sections 914.8.1 through 914.8.6.

**914.8.1 Automatic smoke detection systems.** Airport traffic control towers shall be provided with an automatic

smoke detection system installed in accordance with Section 907.2.22.

**914.8.2 Automatic sprinkler system for new airport traffic control towers.** Where an occupied floor is located more than 35 feet (10 668 mm) above the lowest level of fire department vehicle access, new airport traffic control towers shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**914.8.3 Fire suppression for aircraft hangars.** Aircraft hangars shall be provided with a fire suppression system designed in accordance with NFPA 409, based on the classification for the hangar given in Table 914.8.3.

**Exception:** Where a fixed base operator has separate repair facilities on-site, Group II hangars operated by a fixed base operator used for storage of transient aircraft only shall have a fire suppression system, but the system shall be exempt from foam requirements.

**914.8.3.1 Hazardous operations.** Any Group III aircraft hangar in accordance with Table 914.8.3 that contains hazardous operations including, but not limited to, the following shall be provided with a Group I or II fire suppression system in accordance with NFPA 409 as applicable:

1. Doping.
2. *Hot work* including, but not limited to, welding, torch cutting and torch soldering.
3. Fuel transfer.
4. Fuel tank repair or maintenance not including defueled tanks in accordance with NFPA 409, inerted tanks or tanks that have never been fueled.
5. Spray finishing operations.
6. Total fuel capacity of all aircraft within the unsprinklered single *fire area* in excess of 1,600 gallons (6057 L).
7. Total fuel capacity of all aircraft within the maximum single *fire area* in excess of 7,500

**TABLE 914.8.3**  
**HANGAR FIRE SUPPRESSION REQUIREMENTS<sup>a, b, c</sup>**

MAXIMUM SINGLE FIRE AREA (square feet)	INTERNATIONAL BUILDING CODE TYPE OF CONSTRUCTION								
	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
≥ 40,001	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I
40,000	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
30,000	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
20,000	Group III	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II
15,000	Group III	Group III	Group III	Group II	Group III	Group II	Group III	Group II	Group II
12,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II	Group II
8,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II
5,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 foot = 304.8 mm.

a. Aircraft hangars with a door height greater than 28 feet shall be provided with fire suppression for a Group I hangar regardless of maximum fire area.

b. Groups shall be as classified in accordance with NFPA 409.

c. Membrane structures complying with Section 3102 of the *International Building Code* shall be classified as a Group IV hangar.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

gallons (28 390 L) for a hangar equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

### 914.8.3.2 Separation of maximum single fire areas.

Maximum single *fire areas* established in accordance with hangar classification and construction type in Table 914.8.3 shall be separated by 2-hour *fire walls* constructed in accordance with Section 706 of the *International Building Code*. In determining the maximum single *fire area* as set forth in Table 914.8.3, ancillary uses that are separated from aircraft servicing areas by not less than a 1-hour *fire barrier* constructed in accordance with Section 707 of the *International Building Code* shall not be included in the area.

**914.8.4 Finishing.** The process of “doping,” involving the use of a volatile flammable solvent, or of painting shall be carried on in a separate detached building equipped with automatic fire-extinguishing equipment in accordance with Section 903.

**914.8.5 Residential aircraft hangar smoke alarms.** Smoke alarms shall be provided within residential aircraft hangars in accordance with Section 907.2.2.1.

**914.8.6 Aircraft paint hangar fire suppression.** Aircraft paint hangars shall be provided with fire suppression as required by NFPA 409.

**914.9 Application of flammable finishes.** An *automatic sprinkler system* or fire-extinguishing system shall be provided in all spray rooms and spray booths, and shall be installed in accordance with Chapter 9.

**914.10 Drying rooms.** Drying rooms designed for high-hazard materials and processes, including special occupancies as provided for in Chapter 4 of the *International Building Code*, shall be protected by an *approved* automatic fire-extinguishing system complying with the provisions of Chapter 9.

**914.11 Ambulatory care facilities.** Occupancies classified as ambulatory care facilities shall comply with Sections 914.11.1 through 914.11.3.

**914.11.1 Automatic sprinkler systems.** An *automatic sprinkler system* shall be provided for ambulatory care facilities in accordance with Section 903.2.2.

**914.11.2 Manual fire alarm systems.** A manual fire alarm system shall be provided for ambulatory care facilities in accordance with Section 907.2.2.

**914.11.3 Fire alarm systems.** An automatic smoke detection system shall be provided for ambulatory care facilities in accordance with Section 907.2.2.1.

## SECTION 915 CARBON MONOXIDE DETECTION

**915.1 General.** Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Section 1103.9.

**915.1.1 Where required.** Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

**915.1.2 Fuel-burning appliances and fuel-burning fireplaces.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms that contain a fuel-burning appliance or a fuel-burning fireplace.

**915.1.3 Fuel-burning forced-air furnaces.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms served by a fuel-burning, forced-air furnace.

**Exception:** Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in the first room or area served by each main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an *approved* location.

**915.1.4 Fuel-burning appliances outside of dwelling units, sleeping units and classrooms.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms located in buildings that contain fuel-burning appliances or fuel-burning fireplaces.

### Exceptions:

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in one of the following locations:
  - 2.1. In an *approved* location between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
  - 2.2. On the ceiling of the room containing the fuel-burning appliance or fuel-burning fireplace.

**915.1.5 Private garages.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms in buildings with attached private garages.

### Exceptions:

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the private garage and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms located more than one story above or below a private garage.

3. Carbon monoxide detection shall not be required where the private garage connects to the building through an *open-ended corridor*.
4. Where a carbon monoxide detector is provided in an *approved* location between openings to a private garage and *dwelling units, sleeping units* or classrooms.

**915.1.6 Exempt garages.** For determining compliance with Section 915.1.5, an open parking garage complying with Section 406.5 of the *International Building Code* or an enclosed parking garage complying with Section 406.6 of the *International Building Code* shall not be considered a private garage.

**915.2 Locations.** Where required by Section 915.1.1, carbon monoxide detection shall be installed in the locations specified in Sections 915.2.1 through 915.2.3.

**915.2.1 Dwelling units.** Carbon monoxide detection shall be installed in *dwelling units* outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

**915.2.2 Sleeping units.** Carbon monoxide detection shall be installed in *sleeping units*.

**Exception:** Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the *sleeping unit* where the *sleeping unit* or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced-air furnace.

**915.2.3 Group E occupancies.** Carbon monoxide detectors shall be installed in classrooms in Group E occupancies. Carbon monoxide alarm signals shall be automatically transmitted to an on-site location that is staffed by school personnel.

**Exception:** Carbon monoxide alarm signals shall not be required to be automatically transmitted to an on-site location that is staffed by school personnel in Group E occupancies with an *occupant load* of 30 or less.

**915.3 Carbon monoxide detection.** Carbon monoxide detection required by Sections 915.1 through 915.2.3 shall be provided by carbon monoxide alarms complying with Section 915.4 or carbon monoxide detection systems complying with Section 915.5.

**915.4 Carbon monoxide alarms.** Carbon monoxide alarms shall comply with Sections 915.4.1 through 915.4.4.

**915.4.1 Power source.** Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than that required for overcurrent protection.

**Exception:** Where installed in buildings without commercial power, battery-powered carbon monoxide alarms shall be an acceptable alternative.

**915.4.2 Listings.** Carbon monoxide alarms shall be *listed* in accordance with UL 2034.

**915.4.3 Locations.** Carbon monoxide alarms shall only be installed in *dwelling units* and in *sleeping units*. They shall not be installed in locations where the code requires carbon monoxide detectors to be used.

**915.4.4 Combination alarms.** Combination carbon monoxide/smoke alarms shall be an acceptable alternative to carbon monoxide alarms. Combination carbon monoxide/smoke alarms shall be *listed* in accordance with UL 217 and UL 2034.

**915.5 Carbon monoxide detection systems.** Carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide alarms and shall comply with Sections 915.5.1 through 915.5.3.

**915.5.1 General.** Carbon monoxide detection systems shall comply with NFPA 720. Carbon monoxide detectors shall be *listed* in accordance with UL 2075.

**915.5.2 Locations.** Carbon monoxide detectors shall be installed in the locations specified in Section 915.2. These locations supersede the locations specified in NFPA 720.

**915.5.3 Combination detectors.** Combination carbon monoxide/smoke detectors installed in carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide detectors, provided that they are *listed* in accordance with UL 268 and UL 2075.

**915.6 Maintenance.** Carbon monoxide alarms and carbon monoxide detection systems shall be maintained in accordance with NFPA 720. Carbon monoxide alarms and carbon monoxide detectors that become inoperable or begin producing end-of-life signals shall be replaced.

**915.6.1 Enclosed parking garages.** Carbon monoxide and nitrogen dioxide detectors installed in enclosed parking garages in accordance with Section 404.1 of the *International Mechanical Code* shall be maintained in accordance with the manufacturer's instructions and their listing. Detectors that become inoperable or begin producing end-of-life signals shall be replaced.

## SECTION 916 GAS DETECTION SYSTEMS

**916.1 Gas detection systems.** Gas detection systems required by this code shall comply with Sections 916.2 through 916.11.

**916.2 Permits.** Permits shall be required as set forth in Section 105.6.10.

**916.2.1 Construction documents.** Documentation of the gas detection system design and equipment to be used that demonstrates compliance with the requirements of this code shall be provided with the application for permit.

**916.3 Equipment.** Gas detection system equipment shall be designed for use with the gases being detected and shall be installed in accordance with manufacturer's instructions.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**916.4 Power connections.** Gas detection systems shall be permanently connected to the building electrical power supply or shall be permitted to be cord connected to an unswitched receptacle using an *approved* restraining means that secures the plug to the receptacle.

**916.5 Emergency and standby power.** Standby or emergency power shall be provided or the gas detection system shall initiate a trouble signal at an *approved* location if the power supply is interrupted.

**916.6 Sensor locations.** Sensors shall be installed in *approved* locations where leaking gases are expected to accumulate.

**916.7 Gas sampling.** Gas sampling shall be performed continuously. Sample analysis shall be processed immediately after sampling, except as follows:

1. For HPM gases, sample analysis shall be performed at intervals not exceeding 30 minutes.
2. For toxic gases that are not HPM, sample analysis shall be performed at intervals not exceeding 5 minutes, in accordance with Section 6004.2.2.7.
3. Where a less frequent or delayed sampling interval is *approved*.

**916.8 System activation.** A gas detection alarm shall be initiated where any sensor detects a concentration of gas exceeding the following thresholds:

1. For flammable gases, a gas concentration exceeding 25 percent of the lower flammability limit (LFL).
2. For nonflammable gases, a gas concentration exceeding one-half of the IDLH, unless a different threshold is specified by the section of this code requiring a gas detection system.

Upon activation of a gas detection alarm, alarm signals or other required responses shall be as specified by the section of this code requiring a gas detection system. Audible and visible alarm signals associated with a gas detection alarm shall be distinct from fire alarm and carbon monoxide alarm signals.

**916.9 Signage.** Signs shall be provided adjacent to gas detection system alarm signaling devices that advise occupants of the nature of the signals and actions to take in response to the signal.

**916.10 Fire alarm system connections.** Gas sensors and gas detection systems shall not be connected to fire alarm systems unless *approved* and connected in accordance with the fire alarm equipment manufacturer's instructions.

**916.11 Inspection, testing and sensor calibration.** Inspection and testing of gas detection systems shall be conducted not less than annually. Sensor calibration shall be confirmed at the time of sensor installation and calibration shall be performed at the frequency specified by the sensor manufacturer.

## SECTION 917 MASS NOTIFICATION SYSTEMS

**917.1 College and university campuses.** Prior to construction of a new building requiring a fire alarm system on a multiple-building college or university campus having a cumulative building *occupant load* of 1,000 or more, a mass notification risk analysis shall be conducted in accordance with NFPA 72. Where the risk analysis determines a need for mass notification, an *approved* mass notification system shall be provided in accordance with the findings of the risk analysis.

## CHAPTER 10

# MEANS OF EGRESS

### User note:

**About this chapter:** Chapter 10 provides the general criteria for designing the means of egress established as the primary method for protection of people in buildings by allowing timely relocation or evacuation of building occupants. Both prescriptive and performance language is utilized in this chapter to provide for a basic approach in the determination of a safe exiting system for all occupancies. This chapter addresses all portions of the egress system (exit access, exits and exit discharge) and includes design requirements as well as provisions regulating individual components. The requirements detail the size, arrangement, number and protection of means of egress components. Functional and operational characteristics that will permit the safe use of components without special knowledge or effort are specified.

The means of egress protection requirements work in coordination with other sections of the code, such as protection of vertical openings (see Chapter 7), interior finish (see Chapter 8), fire suppression and detection systems (see Chapter 9) and numerous others, all having an impact on life safety. Sections 1003 through 1031 are duplicated text from Chapter 10 of the International Building Code®; however, the International Fire Code® contains an additional Section 1032 on maintenance of the means of egress system in existing buildings. Retroactive minimum means of egress requirements for existing buildings are found in Chapter 11. Section 1010 was extensively reorganized for the 2021 edition. For complete information, see the relocations table in the preface information for the International Building Code.

### SECTION 1001 ADMINISTRATION

**1001.1 General.** Buildings or portions thereof shall be provided with a *means of egress* system as required by this chapter. The provisions of this chapter shall control the design, construction and arrangement of *means of egress* components required to provide an *approved means of egress* from structures and portions thereof. Sections 1003 through 1031 shall apply to new construction. Section 1032 shall apply to existing buildings.

**Exception:** Detached one- and two-family *dwelling*s and multiple single-family *dwelling*s (*townhouses*) not more than three stories above *grade plane* in height with a separate means of egress and their accessory structures shall comply with the *International Residential Code*.

**[BE] 1001.2 Minimum requirements.** It shall be unlawful to alter a building or structure in a manner that will reduce the number of *exits* or the capacity of the *means of egress* to less than required by this code.

### SECTION 1002 DEFINITIONS

**[BE] 1002.1 Definitions.** The following terms are defined in Chapter 2:

ACCESSIBLE MEANS OF EGRESS.

AISLE.

AISLE ACCESSWAY.

ALTERNATING TREAD DEVICE.

AREA OF REFUGE.

BLEACHERS.

BREAKOUT.

COMMON PATH OF EGRESS TRAVEL.

CORRIDOR.

DOOR, BALANCED.

EGRESS COURT.

EMERGENCY ESCAPE AND RESCUE OPENING.

EXIT.

EXIT ACCESS.

EXIT ACCESS DOORWAY.

EXIT ACCESS RAMP.

EXIT ACCESS STAIRWAY.

EXIT DISCHARGE.

EXIT DISCHARGE, LEVEL OF.

EXIT PASSAGEWAY.

EXTERIOR EXIT RAMP.

EXTERIOR EXIT STAIRWAY.

FIRE EXIT HARDWARE.

FIXED SEATING.

FLIGHT.

FLOOR AREA, GROSS.

FLOOR AREA, NET.

FOLDING AND TELESCOPIC SEATING.

GRADE FLOOR EMERGENCY ESCAPE AND RESCUE OPENINGS.

GRANDSTAND.

GUARD.

HANDRAIL.

HORIZONTAL EXIT.

INTERIOR EXIT RAMP.

INTERIOR EXIT STAIRWAY.

LOW ENERGY POWER-OPERATED DOOR.

MEANS OF EGRESS.



## MEANS OF EGRESS

MERCHANDISE PAD.  
 NOSING.  
 OCCUPANT LOAD.  
 OPEN-AIR ASSEMBLY SEATING.  
 OPEN-ENDED CORRIDOR.  
 PANIC HARDWARE.  
 PHOTOLUMINESCENT.  
 POWER-ASSISTED DOOR.  
 POWER-OPERATED DOOR.  
 PUBLIC WAY.  
 RAMP.  
 SCISSOR STAIRWAY.  
 SELF-LUMINOUS.  
 SMOKE-PROTECTED ASSEMBLY SEATING.  
 STAIR.  
 STAIRWAY.  
 STAIRWAY, INTERIOR EXIT.  
 STAIRWAY, SPIRAL.  
 WINDER.

### SECTION 1003 GENERAL MEANS OF EGRESS

**[BE] 1003.1 Applicability.** The general requirements specified in Sections 1003 through 1015 shall apply to all three elements of the *means of egress* system, in addition to those specific requirements for the *exit access*, the *exit* and the *exit discharge* detailed elsewhere in this chapter.

**[BE] 1003.2 Ceiling height.** The *means of egress* shall have a ceiling height of not less than 7 feet 6 inches (2286 mm) above the finished floor.

#### Exceptions:

1. Sloped ceilings in accordance with Section 1207.2 of the *International Building Code*.
2. Ceilings of *dwelling units* and *sleeping units* within residential occupancies in accordance with Section 1207.2 of the *International Building Code*.
3. Allowable projections in accordance with Section 1003.3.
4. *Stair* headroom in accordance with Section 1011.3.
5. Door height in accordance with Section 1010.1.1.
6. *Ramp* headroom in accordance with Section 1012.5.2.
7. The clear height of floor levels in vehicular and pedestrian traffic areas of public and private park-

ing garages in accordance with Section 406.2.2 of the *International Building Code*.

8. Areas above and below *mezzanine* floors in accordance with Section 505.2 of the *International Building Code*.

**[BE] 1003.3 Protruding objects.** Protruding objects on circulation paths shall comply with the requirements of Sections 1003.3.1 through 1003.3.4.

**[BE] 1003.3.1 Headroom.** Protruding objects are permitted to extend below the minimum ceiling height required by Section 1003.2 where a minimum headroom of 80 inches (2032 mm) is provided over any circulation paths, including walks, *corridors*, *aisles* and passageways. Not more than 50 percent of the ceiling area of a *means of egress* shall be reduced in height by protruding objects.

**Exception:** Door closers and stops shall not reduce headroom to less than 78 inches (1981 mm).

A barrier shall be provided where the vertical clearance above a circulation path is less than 80 inches (2032 mm) high above the finished floor. The leading edge of such a barrier shall be located 27 inches (686 mm) maximum above the finished floor.

**[BE] 1003.3.2 Post-mounted objects.** A free-standing object mounted on a post or pylon shall not overhang that post or pylon more than 4 inches (102 mm) where the lowest point of the leading edge is more than 27 inches (686 mm) and less than 80 inches (2032 mm) above the finished floor. Where a sign or other obstruction is mounted between posts or pylons and the clear distance between the posts or pylons is greater than 12 inches (305 mm), the lowest edge of such sign or obstruction shall be 27 inches (686 mm) maximum or 80 inches (2032 mm) minimum above the finished floor or ground.

**Exception:** These requirements shall not apply to sloping portions of *handrails* between the top and bottom riser of *stairs* and above the *ramp* run.

**[BE] 1003.3.3 Horizontal projections.** Objects with leading edges more than 27 inches (685 mm) and not more than 80 inches (2030 mm) above the finished floor shall not project horizontally more than 4 inches (102 mm) into the circulation path.

**Exception:** *Handrails* are permitted to protrude 4½ inches (114 mm) from the wall or guard.

**[BE] 1003.3.4 Clear width.** Protruding objects shall not reduce the minimum clear width of *accessible routes*.

**[BE] 1003.4 Slip-resistant surface.** Circulation paths of the *means of egress* shall have a slip-resistant surface and be securely attached.

**[BE] 1003.5 Elevation change.** Where changes in elevation of less than 12 inches (305 mm) exist in the *means of egress*, sloped surfaces shall be used. Where the slope is greater than 1 unit vertical in 20 units horizontal (5-percent slope), *ramps* complying with Section 1012 shall be used. Where the

difference in elevation is 6 inches (152 mm) or less, the *ramp* shall be equipped with either *handrails* or floor finish materials that contrast with adjacent floor finish materials.

#### Exceptions:

1. Steps at exterior doors complying with Section 1010.1.4.
2. A *stair* with a single riser or with two risers and a tread is permitted at locations not required to be *accessible* by Chapter 11 of the *International Building Code*, where the risers and treads comply with Section 1011.5, the minimum depth of the tread is 13 inches (330 mm) and not less than one *handrail* complying with Section 1014 is provided within 30 inches (762 mm) of the centerline of the normal path of egress travel on the *stair*.
3. A step is permitted in *aisles* serving seating that has a difference in elevation less than 12 inches (305 mm) at locations not required to be *accessible* by Chapter 11 of the *International Building Code*, provided that the risers and treads comply with Section 1030.14 and the *aisle* is provided with a *handrail* complying with Section 1030.16.

Throughout a story in a Group I-2 occupancy, any change in elevation in portions of the *means of egress* that serve nonambulatory persons shall be by means of a *ramp* or sloped walkway.

**[BE] 1003.6 Means of egress continuity.** The path of egress travel along a *means of egress* shall not be interrupted by a building element other than a *means of egress* component as specified in this chapter. Obstructions shall not be placed in the minimum width or required capacity of a *means of egress* component except projections permitted by this chapter. The minimum width or required capacity of a *means of egress* system shall not be diminished along the path of egress travel.

**[BE] 1003.7 Elevators, escalators and moving walks.** Elevators, escalators and moving walks shall not be used as a component of a required *means of egress* from any other part of the building.

**Exception:** Elevators used as an *accessible means of egress* in accordance with Section 1009.4.

## SECTION 1004 OCCUPANT LOAD

**[BE] 1004.1 Design occupant load.** In determining *means of egress* requirements, the number of occupants for whom *means of egress* facilities are provided shall be determined in accordance with this section.

**[BE] 1004.2 Cumulative occupant loads.** Where the path of egress travel includes intervening rooms, areas or spaces, cumulative *occupant loads* shall be determined in accordance with this section.

**[BE] 1004.2.1 Intervening spaces or accessory areas.** Where occupants egress from one or more rooms, areas or spaces through others, the design *occupant load* shall be

the combined *occupant load* of interconnected accessory or intervening spaces. Design of egress path capacity shall be based on the cumulative portion of *occupant loads* of all rooms, areas or spaces to that point along the path of egress travel.

**[BE] 1004.2.2 Adjacent levels for mezzanines.** That portion of the *occupant load* of a *mezzanine* with required egress through a room, area or space on an adjacent level shall be added to the *occupant load* of that room, area or space.

**[BE] 1004.2.3 Adjacent stories.** Other than for the egress components designed for convergence in accordance with Section 1005.6, the *occupant load* from separate stories shall not be added.

**[BE] 1004.3 Multiple-function occupant load.** Where an area under consideration contains multiple functions having different *occupant load* factors, the design *occupant load* for such area shall be based on the floor area of each function calculated independently.

**[BE] 1004.4 Multiple occupancies.** Where a building contains two or more occupancies, the *means of egress* requirements shall apply to each portion of the building based on the occupancy of that space. Where two or more occupancies utilize portions of the same *means of egress* system, those egress components shall meet the more stringent requirements of all occupancies that are served.

**[BE] 1004.5 Areas without fixed seating.** The number of occupants shall be computed at the rate of one occupant per unit of area as prescribed in Table 1004.5. For areas without *fixed seating*, the *occupant load* shall be not less than that number determined by dividing the floor area under consideration by the *occupant load* factor assigned to the function of the space as set forth in Table 1004.5. Where an intended function is not listed in Table 1004.5, the *fire code official* shall establish a function based on a listed function that most nearly resembles the intended function.

**Exception:** Where *approved* by the *fire code official*, the actual number of occupants for whom each occupied space, floor or building is designed, although less than those determined by calculation, shall be permitted to be used in the determination of the design *occupant load*.

**[BE] TABLE 1004.5  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR <sup>a</sup>
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross

(continued)

## MEANS OF EGRESS

[BE] TABLE 1004.5—continued  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR <sup>a</sup>
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.6
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	150 gross
Concentrated business use areas	See Section 1004.8
Courtrooms—other than fixed seating areas	40 net
Day care	35 net
Dormitories	50 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
Exercise rooms	50 gross
Group H-5 fabrication and manufacturing areas	200 gross
Industrial areas	100 gross
Institutional areas	
Inpatient treatment areas	240 gross
Outpatient areas	100 gross
Sleeping areas	120 gross
Kitchens, commercial	200 gross
Library	
Reading rooms	50 net
Stack area	100 gross
Locker rooms	50 gross
Mall buildings—covered and open	See Section 402.8.2 of the <i>International Building Code</i>
Mercantile	60 gross
Storage, stock, shipping areas	300 gross
Parking garages	200 gross
Residential	200 gross
Skating rinks, swimming pools	
Rink and pool	50 gross
Decks	15 gross
Stages and platforms	15 net
Warehouses	500 gross

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 foot = 304.8 mm.

a. Floor area in square feet per occupant.

[BE] **1004.5.1 Increased occupant load.** The *occupant load* permitted in any building, or portion thereof, is permitted to be increased from that number established for the occupancies in Table 1004.5, provided that all other requirements of the code are met based on such modified number and the *occupant load* does not exceed one occupant per 7 square feet (0.65 m<sup>2</sup>) of occupiable floor space. Where required by the *fire code official*, an *approved aisle*, seating or fixed equipment diagram substantiating any increase in *occupant load* shall be submitted. Where required by the *fire code official*, such diagram shall be posted.

[BE] **1004.6 Fixed seating.** For areas having fixed seats and *aisles*, the *occupant load* shall be determined by the number of fixed seats installed therein. The *occupant load* for areas in which *fixed seating* is not installed, such as waiting spaces, shall be determined in accordance with Section 1004.5 and added to the number of fixed seats.

The *occupant load* of wheelchair spaces and the associated companion seat shall be based on one occupant for each wheelchair space and one occupant for the associated companion seat provided in accordance with Section 1109.2.3 of the *International Building Code*.

For areas having fixed seating without dividing arms, the *occupant load* shall be not less than the number of seats based on one person for each 18 inches (457 mm) of seating length.

The *occupant load* of seating booths shall be based on one person for each 24 inches (610 mm) of booth seat length measured at the backrest of the seating booth.

[BE] **1004.7 Outdoor areas.** *Yards*, patios, occupied roofs *courts* and similar outdoor areas accessible to and usable by the building occupants shall be provided with *means of egress* as required by this chapter. The *occupant load* of such outdoor areas shall be assigned by the *fire code official* in accordance with the anticipated use. Where outdoor areas are to be used by persons in addition to the occupants of the building, and the path of egress travel from the outdoor areas passes through the building, *means of egress* requirements for the building shall be based on the sum of the *occupant loads* of the building plus the outdoor areas.

**Exceptions:**

1. Outdoor areas used exclusively for service of the building need only have one *means of egress*.
2. Both outdoor areas associated with Group R-3 and individual *dwelling units* of Group R-2.

[BE] **1004.8 Concentrated business use areas.** The *occupant load* factor for concentrated business use shall be applied to telephone call centers, trading floors, electronic data processing centers and similar business use areas with a higher density of occupants than would normally be expected in a typical business occupancy environment. Where *approved* by the code official, the *occupant load* for concentrated business use areas shall be the actual *occupant load*, but not less than one occupant per 50 square feet (4.65 m<sup>2</sup>) of gross occupiable floor space.

**[BE] 1004.9 Posting of occupant load.** Every room or space that is an assembly occupancy shall have the *occupant load* of the room or space posted in a conspicuous place, near the main *exit* or *exit access* doorway from the room or space, for the intended configurations. Posted signs shall be of an *approved* legible permanent design and shall be maintained by the *owner* or the *owner's* authorized agent.

## SECTION 1005 MEANS OF EGRESS SIZING

**[BE] 1005.1 General.** All portions of the *means of egress* system shall be sized in accordance with this section.

**Exception:** *Aisles* and *aisle accessways* in rooms or spaces used for assembly purposes complying with Section 1030.

**[BE] 1005.2 Minimum width based on component.** The minimum width, in inches (mm), of any *means of egress* components shall be not less than that specified for such component, elsewhere in this code.

**[BE] 1005.3 Required capacity based on occupant load.** The required capacity, in inches (mm), of the *means of egress* for any room, area, space or story shall be not less than that determined in accordance with Sections 1005.3.1 and 1005.3.2.

**[BE] 1005.3.1 Stairways.** The capacity, in inches, of *means of egress stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a *means of egress* capacity factor of 0.3 inch (7.6 mm) per occupant. Where *stairways* serve more than one story, only the *occupant load* of each story considered individually shall be used in calculating the required capacity of the *stairways* serving that story.

### Exceptions:

1. For other than Group H and I-2 occupancies, the capacity, in inches, of *means of egress stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a *means of egress* capacity factor of 0.2 inch (5.1 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.
2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1030.6.2 indicated for stepped *aisles* for *exit access* or *exit stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
3. Facilities with *open-air assembly seating* shall be permitted to the capacity factors in Section 1030.6.3 indicated for stepped *aisles* for *exit access* or *exit stairways* where the entire path

for *means of egress* from the seating to the *exit discharge* is open to the outdoors.

**[BE] 1005.3.2 Other egress components.** The capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a *means of egress* capacity factor of 0.2 inch (5.1 mm) per occupant.

### Exceptions:

1. For other than Group H and I-2 occupancies, the capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a *means of egress* capacity factor of 0.15 inch (3.8 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.
2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1030.6.2 indicated for level or ramped *aisles* for *means of egress* components other than *stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
3. Facilities with *open-air assembly seating* shall be permitted to the capacity factors in Section 1030.6.3 indicated for level or ramped *aisles* for *means of egress* components other than *stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is open to the outdoors.

**[BE] 1005.4 Continuity.** The minimum width or required capacity of the *means of egress* required from any story of a building shall not be reduced along the path of egress travel until arrival at the *public way*.

**[BE] 1005.5 Distribution of minimum width and required capacity.** Where more than one *exit*, or access to more than one *exit*, is required, the *means of egress* shall be configured such that the loss of any one *exit*, or access to one *exit*, shall not reduce the available capacity or width to less than 50 percent of the required capacity or width.

**[BE] 1005.6 Egress convergence.** Where the *means of egress* from stories above and below converge at an intermediate level, the capacity of the *means of egress* from the point of convergence shall be not less than the largest minimum width or the sum of the required capacities for the *stairways* or *ramps* serving the two adjacent stories, whichever is larger.

**[BE] 1005.7 Encroachment.** Encroachments into the required *means of egress* width shall be in accordance with the provisions of this section.

**[BE] 1005.7.1 Doors.** Doors, when fully opened, shall not reduce the required width by more than 7 inches (178



## MEANS OF EGRESS

mm). Doors in any position shall not reduce the required width by more than one-half.

### Exceptions:

1. Surface-mounted latch release hardware shall be exempt from inclusion in the 7-inch maximum (178 mm) encroachment where both of the following conditions exists:
  - 1.1. The hardware is mounted to the side of the door facing away from the adjacent wall where the door is in the open position.
  - 1.2. The hardware is mounted not less than 34 inches (865 mm) nor more than 48 inches (1219 mm) above the finished floor.
2. The restrictions on door swing shall not apply to doors within individual *dwelling units* and *sleeping units* of Group R-2 occupancies and *dwelling units* of Group R-3 occupancies.

**[BE] 1005.7.2 Other projections.** *Handrail* projections shall be in accordance with the provisions of Section 1014.8. Other nonstructural projections such as trim and similar decorative features shall be permitted to project into the required width not more than 1½ inches (38 mm) on each side.

**Exception:** Projections are permitted in *corridors* within Group I-2, Condition 1 in accordance with Section 407.4.3 of the *International Building Code*.

**[BE] 1005.7.3 Protruding objects.** Protruding objects shall comply with the applicable requirements of Section 1003.3.

## SECTION 1006 NUMBERS OF EXITS AND EXIT ACCESS DOORWAYS

**[BE] 1006.1 General.** The number of *exits* or *exit access doorways* required within the *means of egress* system shall comply with the provisions of Section 1006.2 for spaces, including *mezzanines*, and Section 1006.3 for *stories* or occupied roofs.

**[BE] 1006.2 Egress from spaces.** Rooms, areas or spaces, including *mezzanines*, within a story or *basement* shall be provided with the number of *exits* or access to *exits* in accordance with this section.

**[BE] 1006.2.1 Egress based on occupant load and common path of egress travel distance.** Two *exits* or *exit access doorways* from any space shall be provided where the design *occupant load* or the *common path of egress travel* distance exceeds the values listed in Table 1006.2.1. The cumulative *occupant load* from adjacent rooms, areas or spaces shall be determined in accordance with Section 1004.2.

### Exceptions:

1. The number of *exits* from foyers, lobbies, vestibules or similar spaces need not be based on

cumulative occupant loads for areas discharging through such spaces, but the capacity of the *exits* from such spaces shall be based on applicable cumulative occupant loads.

2. Care suites in Group I-2 occupancies complying with Section 407.4 of the *International Building Code*.
3. Unoccupied mechanical rooms and penthouses are not required to comply with the *common path of egress travel* distance measurement.

**[BE] 1006.2.1.1 Three or more exits or exit access doorways.** Three *exits* or *exit access doorways* shall be provided from any space with an *occupant load* of 501 to 1,000. Four *exits* or *exit access doorways* shall be provided from any space with an *occupant load* greater than 1,000.

**[BE] 1006.2.2 Egress based on use.** The numbers, configuration and types of components of *exits* or access to *exits* shall be provided in the uses described in Sections 1006.2.2.1 through 1006.2.2.6.

**[BE] 1006.2.2.1 Boiler, incinerator and furnace rooms.** Two *exit access doorways* are required in boiler, incinerator and furnace rooms where the area is over 500 square feet (46 m²) and any fuel-fired equipment exceeds 400,000 British thermal units (Btu) (422 000 KJ) input capacity. Where two *exit access doorways* are required, one is permitted to be a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the length of the maximum overall diagonal dimension of the room.

**[BE] 1006.2.2.2 Refrigeration machinery rooms.** Machinery rooms larger than 1,000 square feet (93 m²) shall have not less than two *exits* or *exit access doorways*. Where two *exit access doorways* are required, one such doorway is permitted to be served by a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the maximum horizontal dimension of the room.

All portions of machinery rooms shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway*. An increase in *exit access* travel distance is permitted in accordance with Section 1017.1.

*Exit* and *exit access doorways* shall swing in the direction of egress travel and shall be equipped with panic hardware, regardless of the *occupant load* served. *Exit* and *exit access doorways* shall be tight fitting and self-closing.

**[BE] 1006.2.2.3 Refrigerated rooms or spaces.** Rooms or spaces having a floor area larger than 1,000 square feet (93 m²), containing a refrigerant evaporator and maintained at a temperature below 68°F (20°C), shall have access to not less than two *exits* or *exit access doorways*.

*Exit access* travel distance shall be determined as specified in Section 1017.1, but all portions of a refrigerated room shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway*.

**[BE] TABLE 1006.2.1  
SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY**

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)		With Sprinkler System (feet)
		Occupant Load		
		OL ≤ 30	OL > 30	
A <sup>c</sup> , E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	3	NP	NP	25 <sup>b</sup>
H-4, H-5	10	NP	NP	75 <sup>b</sup>
I-1, I-2 <sup>d</sup> , I-4	10	NP	NP	75 <sup>a</sup>
I-3	10	NP	NP	100 <sup>a</sup>
R-1	10	NP	NP	75 <sup>a</sup>
R-2	20	NP	NP	125 <sup>a</sup>
R-3 <sup>e</sup>	20	NP	NP	125 <sup>a, g</sup>
R-4 <sup>e</sup>	20	NP	NP	125 <sup>a, g</sup>
S <sup>f</sup>	29	100	75	100 <sup>a</sup>
U	49	100	75	75 <sup>a</sup>

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

- Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.
- Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.
- For a room or space used for assembly purposes having fixed seating, see Section 1030.8.
- For the travel distance limitations in Group I-2, see Section 407.4 of the *International Building Code*.
- The common path of egress travel distance shall apply only in a Group R-3 occupancy located in a mixed occupancy building.
- The length of common path of egress travel distance in a Group S-2 open parking garage shall be not more than 100 feet.
- For the travel distance limitations in Groups R-3 and R-4 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3, see Section 1006.2.2.6.

erated room or space shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway* where such rooms are not protected by an *approved automatic sprinkler system*. Egress is allowed through adjoining refrigerated rooms or spaces.

**Exception:** Where using refrigerants in quantities limited to the amounts based on the volume set forth in the *International Mechanical Code*.

**[BE] 1006.2.2.4 Electrical rooms.** The location and number of *exit* or *exit access doorways* shall be provided for electrical rooms in accordance with Section 110.26 of NFPA 70 for electrical equipment rated 1,000 volts or less, and Section 110.33 of NFPA 70 for electrical equipment rated over 1,000 volts. Panic hardware shall be provided where required in accordance with Section 1010.2.9.2.

**[BE] 1006.2.2.5 Vehicular ramps.** Vehicular *ramps* shall not be considered as an *exit access ramp* unless pedestrian facilities are provided.

**[BE] 1006.2.2.6 Groups R-3 and R-4.** Where Group R-3 occupancies are permitted by Section 903.2.8 to be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.3, the *exit access* travel distance for Group R-3 shall be not more than 125 feet (38 100 mm). Where Group R-4 occupancies

are permitted by Section 903.2.8 to be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.3, the *exit access* travel distance for Group R-4 shall be not more than 75 feet (22 860 mm).

**[BE] 1006.3 Egress from stories or occupied roofs.** The *means of egress* system serving any *story* or occupied roof shall be provided with the number of separate and distinct *exits* or access to *exits* based on the aggregate *occupant load* served in accordance with this section.

**[BE] 1006.3.1 Occupant load.** Where *stairways* serve more than one *story*, or more than one *story* and an occupied roof, only the *occupant load* of each *story* or occupied roof, considered individually, shall be used when calculating the required number of *exits* or access to *exits* serving that *story*.

**[BE] 1006.3.2 Path of egress travel.** The path of egress travel to an *exit* shall not pass through more than one adjacent *story*.

**Exception:** The path of egress travel to an *exit* shall be permitted to pass through more than one adjacent *story* in any of the following:

- In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four

## MEANS OF EGRESS

stories or fewer serving and contained within an individual dwelling unit or *sleeping unit* or live/work unit.

2. *Exit access stairways* serving and contained within a Group R-3 congregate residence or a Group R-4 facility.
3. *Exit access stairways* and *ramps* within an atrium complying with Section 404 of the *International Building Code*.
4. *Exit access stairways* and *ramps* in open parking garages that serve only the parking garage.
5. *Exit access stairways* and *ramps* serving open-air assembly seating complying with the *exit access* travel distance requirements of Section 1030.7.
6. *Exit access stairways* and *ramps* between the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, places of religious worship, auditoriums and sports facilities.
7. Exterior *exit access stairways* and *ramps* between occupied roofs.

**[BE] 1006.3.3 Egress based on occupant load.** Each story and occupied roof shall have the minimum number of separate and distinct *exits*, or access to *exits*, as specified in Table 1006.3.3. A single *exit* or access to a single *exit* shall be permitted in accordance with Section 1006.3.4. The required number of *exits*, or *exit access stairways* or *ramps* providing access to *exits*, from any story or occupied roof shall be maintained until arrival at the *exit discharge* or *public way*.

**[BE] TABLE 1006.3.3  
MINIMUM NUMBER OF EXITS OR  
ACCESS TO EXITS PER STORY**

OCCUPANT LOAD PER STORY	MINIMUM NUMBER OF EXITS OR ACCESS TO EXITS FROM STORY
1–500	2
501–1,000	3
More than 1,000	4

**[BE] 1006.3.4 Single exits.** A single *exit* or access to a single *exit* shall be permitted from any story or occupied roof, where one of the following conditions exists:

1. The *occupant load*, number of *dwelling units* and *exit access* travel distance do not exceed the values in Table 1006.3.4(1) or 1006.3.4(2).
2. Rooms, areas and spaces complying with Section 1006.2.1 with *exits* that discharge directly to the exterior at the *level of exit discharge*, are permitted to have one *exit* or access to a single *exit*.
3. Parking garages where vehicles are mechanically parked shall be permitted to have one *exit* or access to a single *exit*.
4. Group R-3 and R-4 occupancies shall be permitted to have one *exit* or access to a single *exit*.
5. Individual single-story or multistory *dwelling units* shall be permitted to have a single *exit* or access to a single *exit* from the *dwelling unit* provided that both of the following criteria are met:
  - 5.1. The *dwelling unit* complies with Section 1006.2.1 as a space with one means of egress.
  - 5.2. Either the *exit* from the *dwelling unit* discharges directly to the exterior at the *level of exit discharge*, or the *exit* access outside the *dwelling unit's* entrance door provides access to not less than two *approved independent exits*.

**[BE] 1006.3.4.1 Mixed occupancies.** Where one *exit*, or *exit access stairway* or *ramp* providing access to *exits* at other stories, is permitted to serve individual stories, mixed occupancies shall be permitted to be served by single *exits* provided that each individual occupancy complies with the applicable requirements of Table 1006.3.4(1) or 1006.3.4(2) for that occupancy. Where applicable, cumulative *occupant loads* from adjacent occupancies shall be considered to be in accordance with the provisions of Section 1004.1. In each story of a mixed occupancy building, the maximum number of occupants served by a single *exit* shall

**[BE] TABLE 1006.3.4(1)  
STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR R-2 OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM NUMBER OF DWELLING UNITS	MAXIMUM EXIT ACCESS TRAVEL DISTANCE
Basement, first, second or third story above grade plane	R-2 <sup>a, b</sup>	4 dwelling units	125 feet
Fourth story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

a. Buildings classified as Group R-2 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with emergency escape and rescue openings in accordance with Section 1031.

b. This table is used for R-2 occupancies consisting of dwelling units. For R-2 occupancies consisting of sleeping units, use Table 1006.3.4(2).

**[BE] TABLE 1006.3.4(2)**  
**STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR OTHER OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM OCCUPANT LOAD PER STORY	MAXIMUM EXIT ACCESS TRAVEL DISTANCE (feet)
First story above or below grade plane	A, B <sup>b</sup> , E, F <sup>b</sup> , M, U	49	75
	H-2, H-3	3	25
	H-4, H-5, I, R-1, R-2 <sup>a, c</sup>	10	75
	S <sup>b, d</sup>	29	75
Second story above grade plane	B, F, M, S <sup>d</sup>	29	75
Third story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

- Buildings classified as Group R-2 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with emergency escape and rescue openings in accordance with Section 1031.
- Group B, F and S occupancies in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 shall have a maximum exit access travel distance of 100 feet.
- This table is used for R-2 occupancies consisting of sleeping units. For R-2 occupancies consisting of dwelling units, use Table 1006.3.4(1).
- The length of exit access travel distance in a Group S-2 open parking garage shall be not more than 100 feet.

be such that the sum of the ratios of the calculated number of occupants of the space divided by the allowable number of occupants indicated in Table 1006.3.4(2) for each occupancy does not exceed one. Where *dwelling units* are located on a story with other occupancies, the actual number of *dwelling units* divided by four plus the ratio from the other occupancy does not exceed one.

## SECTION 1007 EXIT AND EXIT ACCESS DOORWAY CONFIGURATION

**[BE] 1007.1 General.** *Exits, exit access doorways, and exit access stairways and ramps* serving spaces, including individual building stories, shall be separated in accordance with the provisions of this section.

**[BE] 1007.1.1 Two exits or exit access doorways.** Where two *exits, exit access doorways, exit access stairways or ramps*, or any combination thereof, are required from any portion of the *exit access*, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between them. Interlocking or *scissor stairways* shall be counted as one *exit stairway*.

### Exceptions:

- Where *interior exit stairways or ramps* are interconnected by a 1-hour *fire-resistance-rated corridor* conforming to the requirements of Section 1020, the required exit separation shall be measured along the shortest direct line of travel within the *corridor*.

- Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, the separation distance shall be not less than one-third of the length of the maximum overall diagonal dimension of the area served.

**[BE] 1007.1.1.1 Measurement point.** The separation distance required in Section 1007.1.1 shall be measured in accordance with the following:

- The separation distance to *exit* or *exit access doorways* shall be measured to any point along the width of the doorway.
- The separation distance to *exit access stairways* shall be measured to the closest riser.
- The separation distance to *exit access ramps* shall be measured to the start of the *ramp* run.

**[BE] 1007.1.2 Three or more exits or exit access doorways.** Where access to three or more *exits* is required, not less than two *exit* or *exit access doorways* shall be arranged in accordance with the provisions of Section 1007.1.1. Additional required *exit* or *exit access doorways* shall be arranged a reasonable distance apart so that if one becomes blocked, the others will be available.

**[BE] 1007.1.3 Remoteness of exit access stairways or ramps.** Where two *exit access stairways or ramps* provide the required *means of egress* to *exits* at another story, the required separation distance shall be maintained for all portions of such *exit access stairways or ramps*.

**[BE] 1007.1.3.1 Three or more exit access stairways or ramps.** Where more than two *exit access stairways or ramps* provide the required *means of egress*, not less than two shall be arranged in accordance with Section 1007.1.3.



## MEANS OF EGRESS

## SECTION 1008

### MEANS OF EGRESS ILLUMINATION

**[BE] 1008.1 Means of egress illumination.** Illumination shall be provided in the *means of egress* in accordance with Section 1008.2. Under emergency power, *means of egress* illumination shall comply with Section 1008.3.

**[BE] 1008.2 Illumination required.** The *means of egress* serving a room or space shall be illuminated at all times that the room or space is occupied.

#### Exceptions:

1. Occupancies in Group U.
2. *Aisle accessways* in Group A.
3. *Dwelling units* and *sleeping units* in Groups R-1, R-2 and R-3.
4. *Sleeping units* of Group I occupancies.

**[BE] 1008.2.1 Illumination level under normal power.** The *means of egress* illumination level shall be not less than 1 footcandle (11 lux) at the walking surface. Along *exit access stairways*, *exit stairways* and at their required landings, the illumination level shall be not less than 10 footcandles (108 lux) at the walking surface when the *stairway* is in use.

**Exception:** For auditoriums, theaters, concert or opera halls and similar assembly occupancies, the illumination at the walking surface is permitted to be reduced during performances by one of the following methods provided that the required illumination is automatically restored upon activation of a premises' fire alarm system:

1. Externally illuminated walking surfaces shall be permitted to be illuminated to not less than 0.2 footcandle (2.15 lux).
2. Steps, landings and the sides of *ramps* shall be permitted to be marked with self-luminous materials in accordance with Sections 1025.2.1, 1025.2.2 and 1025.2.4 by systems listed in accordance with UL 1994.

**[BE] 1008.2.2 Group I-2.** In Group I-2 occupancies where two or more *exits* are required, on the exterior landings required by Section 1010.1.5, *means of egress* illumination levels for the *exit discharge* shall be provided such that failure of a single lamp in a luminaire shall not reduce the illumination level on that landing to less than 1 footcandle (11 lux).

**[BE] 1008.2.3 Exit discharge.** Illumination shall be provided along the path of travel for the *exit discharge* from each *exit* to the *public way*.

**Exception:** Illumination shall not be required where the path of the *exit discharge* meets both of the following requirements:

1. The path of *exit discharge* is illuminated from the exit to a safe dispersal area complying with Section 1028.5.

2. A dispersal area shall be illuminated to a level not less than 1 footcandle (11 lux) at the walking surface.

**[BE] 1008.3 Emergency power for illumination.** The power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply.

**[BE] 1008.3.1 General.** In the event of power supply failure in rooms and spaces that require two or more *exits* or *access to exits*, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Aisles*.
2. *Corridors*.
3. *Exit access stairways* and *ramps*.

**[BE] 1008.3.2 Buildings.** In the event of power supply failure, in buildings that require two or more *exits* or *access to exits*, an emergency electrical system shall automatically illuminate all of the following areas:

1. Interior *exit access stairways* and *ramps*.
2. Interior and exterior *exit stairways* and *ramps*.
3. *Exit passageways*.
4. Vestibules and areas on the *level of discharge* used for *exit discharge* in accordance with Section 1028.2.
5. Exterior landings as required by Section 1010.1.5 for exit doorways that lead directly to the *exit discharge*.

**[BE] 1008.3.3 Rooms and spaces.** In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:

1. Electrical equipment rooms.
2. *Fire command centers*.
3. Fire pump rooms.
4. Generator rooms.
5. Public restrooms with an area greater than 300 square feet (27.87 m<sup>2</sup>).

**[BE] 1008.3.4 Duration.** The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Section 2702 of the *International Building Code*.

**[BE] 1008.3.5 Illumination level under emergency power.** Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 footcandle (11 lux) and a minimum at any point of 0.1 footcandle (1 lux) measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle (6 lux) average and a minimum at any point of 0.06 footcandle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded. In Group I-2 occupancies, failure of a single lamp in a luminaire shall not reduce the illumination level to less than 0.2 footcandle (2.2 lux).

## SECTION 1009 ACCESSIBLE MEANS OF EGRESS

**[BE] 1009.1 Accessible means of egress required.** *Accessible means of egress* shall comply with this section. Accessible spaces shall be provided with not less than one *accessible means of egress*. Where more than one *means of egress* is required by Section 1006.2 or 1006.3 from any accessible space, each accessible portion of the space shall be served by not less than two *accessible means of egress*.

### Exceptions:

1. One *accessible means of egress* is required from an accessible *mezzanine* level in accordance with Section 1009.3, 1009.4 or 1009.5.
2. In assembly areas with ramped *aisles* or stepped *aisles*, one *accessible means of egress* is permitted where the common path of travel is accessible and meets the requirements in Section 1030.8.

**[BE] 1009.2 Continuity and components.** Each required *accessible means of egress* shall be continuous to a *public way* and shall consist of one or more of the following components:

1. *Accessible routes* complying with Section 1104 of the *International Building Code*.
2. *Interior exit stairways* complying with Sections 1009.3 and 1023.
3. *Exit access stairways* complying with Sections 1009.3 and 1019.3 or 1019.4.
4. *Exterior exit stairways* complying with Sections 1009.3 and 1027 and serving levels other than the *level of exit discharge*.
5. Elevators complying with Section 1009.4.
6. Platform lifts complying with Section 1009.5.
7. *Horizontal exits* complying with Section 1026.
8. *Ramps* complying with Section 1012.
9. *Areas of refuge* complying with Section 1009.6.
10. Exterior areas for assisted rescue complying with Section 1009.7 serving *exits* at the *level of exit discharge*.

**[BE] 1009.2.1 Elevators required.** In buildings where a required accessible floor or occupied roof is four or more stories above or below a *level of exit discharge*, not less than one required *accessible means of egress* shall be an elevator complying with Section 1009.4.

### Exceptions:

1. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be required on floors provided with a *horizontal exit* and located at or above the *levels of exit discharge*.
2. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance

with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be required on floors provided with a *ramp* conforming to the provisions of Section 1012.

**[BE] 1009.3 Stairways.** In order to be considered part of an *accessible means of egress*, a *stairway* between stories shall comply with Sections 1009.3.1 through 1009.3.3.

**[BE] 1009.3.1 Exit access stairways.** *Exit access stairways* that connect levels in the same *story* are not permitted as part of an *accessible means of egress*.

**Exception:** *Exit access stairways* providing *means of egress* from mezzanines are permitted as part of an *accessible means of egress*.

**[BE] 1009.3.2 Stairway width.** *Stairways* shall have a clear width of 48 inches (1219 mm) minimum between *handrails*.

### Exceptions:

1. The clear width of 48 inches (1219 mm) between *handrails* is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
2. The clear width of 48 inches (1219 mm) between *handrails* is not required for *stairways* accessed from a refuge area in conjunction with a *horizontal exit*.

**[BE] 1009.3.3 Area of refuge.** *Stairways* shall either incorporate an *area of refuge* within an enlarged floor-level landing or shall be accessed from an *area of refuge* complying with Section 1009.6.

### Exceptions:

1. *Areas of refuge* are not required at *exit access stairways* where two-way communication is provided at the elevator landing in accordance with Section 1009.8.
2. *Areas of refuge* are not required at *stairways* in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. *Areas of refuge* are not required at *stairways* serving *open parking garages*.
4. *Areas of refuge* are not required for *smoke-protected* or *open-air assembly seating* areas complying with Sections 1030.6.2 and 1030.6.3.
5. *Areas of refuge* are not required at *stairways* in Group R-2 occupancies.
6. *Areas of refuge* are not required for *stairways* accessed from a refuge area in conjunction with a *horizontal exit*.

**[BE] 1009.4 Elevators.** In order to be considered part of an *accessible means of egress*, an elevator shall comply with Sections 1009.4.1 and 1009.4.2.

## MEANS OF EGRESS

**[BE] 1009.4.1 Standby power.** The elevator shall meet the emergency operation and signaling device requirements of Section 2.27 of ASME A17.1/CSA B44. Standby power shall be provided in accordance with Chapter 27 and Section 3003 of the *International Building Code*.

**[BE] 1009.4.2 Area of refuge.** The elevator shall be accessed from an *area of refuge* complying with Section 1009.6.

### Exceptions:

1. *Areas of refuge* are not required at the elevator in open parking garages.
2. *Areas of refuge* are not required in buildings and facilities equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. *Areas of refuge* are not required at elevators not required to be located in a shaft in accordance with Section 712 of the *International Building Code*.
4. *Areas of refuge* are not required at elevators serving *smoke protected or open-air assembly seating areas* complying with Sections 1030.6.2 and 1030.6.3.
5. *Areas of refuge* are not required for elevators accessed from a refuge area in conjunction with a *horizontal exit*.

**[BE] 1009.5 Platform lifts.** Platform lifts shall be permitted to serve as part of an *accessible means of egress* where allowed as part of a required *accessible route* in Section 1110.9 of the *International Building Code* except for Item 10. Standby power for the platform lift shall be provided in accordance with Chapter 27 of the *International Building Code*.

**[BE] 1009.6 Areas of refuge.** Every required *area of refuge* shall be accessible from the space it serves by an *accessible means of egress*.

**[BE] 1009.6.1 Travel distance.** The maximum travel distance from any accessible space to an *area of refuge* shall not exceed the *exit access* travel distance permitted for the occupancy in accordance with Section 1017.1.

**[BE] 1009.6.2 Stairway or elevator access.** Every required *area of refuge* shall have direct access to a *stairway* complying with Sections 1009.3 and 1023 or an elevator complying with Section 1009.4.

**Exception:** An interior *area of refuge* at the *level of exit discharge* that provides direct access to an exterior exit door.

**[BE] 1009.6.3 Size.** Each *area of refuge* shall be sized to accommodate one wheelchair space of 30 inches by 52 inches (762 mm by 1321 mm) for each 200 occupants or portion thereof, based on the *occupant load* of the *area of refuge* and areas served by the *area of refuge*. Such wheelchair spaces shall not reduce the *means of egress*

minimum width or required capacity. Access to any of the required wheelchair spaces in an *area of refuge* shall not be obstructed by more than one adjoining wheelchair space.

**[BE] 1009.6.4 Separation.** Each *area of refuge* shall be separated from the remainder of the story by a *smoke barrier* complying with Section 709 of the *International Building Code* or a *horizontal exit* complying with Section 1026. Each *area of refuge* shall be designed to minimize the intrusion of smoke.

### Exceptions:

1. *Areas of refuge* located within an enclosure for *interior exit stairways* complying with Section 1023.
2. *Areas of refuge* in outdoor facilities where *exit access* is essentially open to the outside.

**[BE] 1009.6.5 Two-way communication.** *Areas of refuge* shall be provided with a two-way communication system complying with Sections 1009.8.1 and 1009.8.2.

**[BE] 1009.7 Exterior areas for assisted rescue.** Exterior areas for assisted rescue shall be accessed by an *accessible route* from the area served.

Where the *exit discharge* does not include an *accessible route* from an *exit* located on the *level of exit discharge* to a *public way*, an exterior area of assisted rescue shall be provided on the exterior landing in accordance with Sections 1009.7.1 through 1009.7.4.

**[BE] 1009.7.1 Size.** Each exterior area for assisted rescue shall be sized to accommodate wheelchair spaces in accordance with Section 1009.6.3.

**[BE] 1009.7.2 Separation.** *Exterior walls* separating the exterior area of assisted rescue from the interior of the building shall have a minimum *fire-resistance rating* of 1 hour, rated for exposure to fire from the inside. The *fire-resistance-rated exterior wall* construction shall extend horizontally not less than 10 feet (3048 mm) beyond the landing on either side of the landing or equivalent *fire-resistance-rated* construction is permitted to extend out perpendicular to the *exterior wall* not less than 4 feet (1219 mm) on the side of the landing. The *fire-resistance-rated* construction shall extend vertically from the ground to a point not less than 10 feet (3048 mm) above the floor level of the area for assisted rescue or to the roof line, whichever is lower. Openings within such *fire-resistance-rated exterior walls* shall be protected in accordance with Section 716 of the *International Building Code*.

**Exception:** The *fire-resistance rating* and opening protectives are not required in the exterior wall where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**[BE] 1009.7.3 Openness.** The exterior area for assisted rescue shall be open to the outside air. The sides other than the separation walls shall be not less than 50 percent



open, and the open area shall be distributed so as to minimize the accumulation of smoke or toxic gases.

**[BE] 1009.7.4 Stairways.** *Stairways* that are part of the *means of egress* for the exterior area for assisted rescue shall provide a minimum clear width of 48 inches (1219 mm) between *handrails*.

**Exception:** The minimum clear width of 48 inches (1219 mm) between *handrails* is not required at *stairways* serving buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**[BE] 1009.8 Two-way communication.** A two-way communication system complying with Sections 1009.8.1 and 1009.8.2 shall be provided at the landing serving each elevator or bank of elevators on each accessible floor that is one or more stories above or below the *level of exit discharge*.

**Exceptions:**

1. Two-way communication systems are not required at the landing serving each elevator or bank of elevators where the two-way communication system is provided within *areas of refuge* in accordance with Section 1009.6.5.
2. Two-way communication systems are not required on floors provided with *ramps* conforming to the provisions of Section 1012.
3. Two-way communication systems are not required at the landings serving only service elevators that are not designated as part of the *accessible means of egress* or serve as part of the required *accessible route* into a facility.
4. Two-way communication systems are not required at the landings serving only freight elevators.
5. Two-way communication systems are not required at the landing serving a private residence elevator.
6. Two-way communication systems are not required in Group I-2 or I-3 facilities.

**[BE] 1009.8.1 System requirements.** Two-way communication systems shall provide communication between each required location and the *fire command center* or a central control point location *approved* by the fire department. Where the central control point is not a constantly attended location, the two-way communication system shall have a timed automatic telephone dial-out capability that provides two-way communication with an *approved* supervising station or 9-1-1. The two-way communication system shall include both audible and visible signals.

**[BE] 1009.8.2 Directions.** Directions for the use of the two-way communication system, instructions for summoning assistance via the two-way communication system and written identification of the location shall be posted adjacent to the two-way communication system. Signage shall comply with the ICC A117.1 requirements for visual characters.

**[BE] 1009.9 Signage.** Signage indicating special accessibility provisions shall be provided as shown:

1. Each door providing access to an *area of refuge* from an adjacent floor area shall be identified by a sign stating: "AREA OF REFUGE."
2. Each door providing access to an exterior area for assisted rescue shall be identified by a sign stating: "EXTERIOR AREA FOR ASSISTED RESCUE."

Signage shall comply with the ICC A117.1 requirements for visual characters and include the International Symbol of Accessibility. Where exit sign illumination is required by Section 1013.3, the signs shall be illuminated. Additionally, visual characters, raised character and braille signage complying with ICC A117.1 shall be located at each door to an *area of refuge* and exterior area for assisted rescue in accordance with Section 1013.4.

**[BE] 1009.10 Directional signage.** Directional signage indicating the location of all other *means of egress* and which of those are *accessible means of egress* shall be provided at the following:

1. At *exits* serving a required accessible space but not providing an *approved accessible means of egress*.
2. At elevator landings.
3. Within *areas of refuge*.

**[BE] 1009.11 Instructions.** In *areas of refuge* and exterior areas for assisted rescue, instructions on the use of the area under emergency conditions shall be posted. Signage shall comply with the ICC A117.1 requirements for visual characters. The instructions shall include all of the following:

1. Persons able to use the *exit stairway* do so as soon as possible, unless they are assisting others.
2. Information on planned availability of assistance in the use of *stairs* or supervised operation of elevators and how to summon such assistance.
3. Directions for use of the two-way communication system where provided.

## SECTION 1010 DOORS, GATES AND TURNSTILES

**[BE] 1010.1 Doors.** Doors in the *means of egress* shall comply with the requirements of Sections 1010.1.1 through 1010.3.4. Exterior exit doors shall also comply with the requirements of Section 1022.2. Gates in the *means of egress* shall comply with the requirements of Sections 1010.4 and 1010.4.1. Turnstiles in the *means of egress* shall comply with the requirements of Sections 1010.5 through 1010.5.4.

Doors, gates and turnstiles provided for egress purposes in numbers greater than required by this code shall comply with the requirements of this section.

Doors in the *means of egress* shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Mirrors or similar reflecting materials shall not be used on *means of egress* doors. *Means of egress* doors shall not be concealed by curtains, drapes, decorations or similar materials.



## MEANS OF EGRESS

**[BE] 1010.1.1 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear opening width of 32 inches (813 mm). The clear opening width of doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). Where this section requires a minimum clear opening width of 32 inches (813 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a minimum clear opening width of 32 inches (813 mm). In Group I-2, doors serving as *means of egress* doors where used for the movement of beds shall provide a minimum clear opening width of 41½ inches (1054 mm). The minimum clear opening height of doors shall be not less than 80 inches (2032 mm).

**Exceptions:**

1. In Group R-2 and R-3 *dwelling* and *sleeping units* that are not required to be an Accessible unit, Type A unit or Type B unit, the minimum width shall not apply to door openings that are not part of the required *means of egress*.
2. Group I-3 door openings to resident *sleeping units* that are not required to be an Accessible unit shall have a minimum clear opening width of 28 inches (711 mm).
3. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum clear opening width.
4. The maximum width of door leaves in revolving doors that comply with Section 1010.3.1 shall not be limited.
5. The maximum width of door leaves in power-operated doors that comply with Section 1010.3.2 shall not be limited.
6. Door openings within a *dwelling unit* or *sleeping unit* shall have a minimum clear opening height of 78 inches (1981 mm).
7. In *dwelling* and *sleeping units* that are not required to be Accessible, Type A or Type B units, exterior door openings, other than the required *exit* door, shall have a minimum clear opening height of 76 inches (1930 mm).
8. In Groups I-1, R-2, R-3 and R-4, in *dwelling* and *sleeping units* that are not required to be Accessible, Type A or Type B units, the minimum clear opening widths shall not apply to interior egress doors.
9. Door openings required to be *accessible* within Type B units intended for user passage shall have a minimum clear opening width of 31.75 inches (806 mm).
10. Doors to walk-in freezers and coolers less than 1,000 square feet (93 m<sup>2</sup>) in area shall have a maximum width of 60 inches (1524 mm) nominal.

11. Doors serving nonaccessible single-user shower or sauna compartments; toilet stalls; or dressing, fitting or changing rooms shall have a minimum clear opening width of 20 inches (508 mm).

**[BE] 1010.1.1.1 Projections into clear opening.**

There shall not be projections into the required clear opening width lower than 34 inches (864 mm) above the floor or ground. Projections into the clear opening width between 34 inches (864 mm) and 80 inches (2032 mm) above the floor or ground shall not exceed 4 inches (102 mm).

**Exception:** Door closers, overhead door stops, power door operators, and electromagnetic door locks shall be permitted to be 78 inches (1980 mm) minimum above the floor.

**[BE] 1010.1.2 Egress door types.** Egress doors shall be of the side-hinged swinging door, pivoted door or balanced door types.

**Exceptions:**

1. Private garages, office areas, factory and storage areas with an *occupant load* of 10 or less.
2. Group I-3 occupancies used as a place of detention.
3. Critical or intensive care patient rooms within suites of health care facilities.
4. Doors within or serving a single *dwelling unit* in Groups R-2 and R-3.
5. In other than Group H occupancies, revolving doors complying with Section 1010.3.1.
6. In other than Group H occupancies, special-purpose horizontal sliding, accordion or folding door assemblies complying with Section 1010.3.3.
7. Power-operated doors in accordance with Section 1010.3.2.
8. Doors serving a bathroom within an individual *sleeping unit* in Group R-1.
9. In other than Group H occupancies, manually operated horizontal sliding doors are permitted in a *means of egress* from spaces with an *occupant load* of 10 or less.

**[BE] 1010.1.2.1 Direction of swing.** Side-hinged swinging doors, pivoted doors and balanced doors shall swing in the direction of egress travel where serving a room or area containing an *occupant load* of 50 or more persons or a Group H occupancy.

**[BE] 1010.1.3 Forces to unlatch and open doors.** The forces to unlatch doors shall comply with the following:

1. Where door hardware operates by push or pull, the operational force to unlatch the door shall not exceed 15 pounds (66.7 N).
2. Where door hardware operates by rotation, the operational force to unlatch the door shall not exceed 28 inch-pounds (315 N-cm).

The force to open doors shall comply with the following:

1. For interior swinging egress doors that are manually operated, other than doors required to be fire rated, the force for pushing or pulling open the door shall not exceed 5 pounds (22 N).
2. For other swinging doors, sliding doors or folding doors, and doors required to be fire rated, the door shall require not more than a 30-pound (133 N) force to be set in motion and shall move to a full-open position when subjected to not more than a 15-pound (67 N) force.

**[BE] 1010.1.3.1 Location of applied forces.** Forces shall be applied to the latch side of the door.

**[BE] 1010.1.3.2 Manual horizontal sliding doors.** Where a manual horizontal sliding door is required to latch, the latch or other mechanism shall prevent the door from rebounding into a partially open position when the door is closed.

**[BE] 1010.1.4 Floor elevation.** There shall be a floor or landing on each side of a door. Such floor or landing shall be at the same elevation on each side of the door. Landings shall be level except for exterior landings, which are permitted to have a slope not to exceed 0.25 unit vertical in 12 units horizontal (2-percent slope).

**Exceptions:**

1. At doors serving individual *dwelling units* or *sleeping units* in Groups R-2 and R-3, a door is permitted to open at the top step of an interior flight of stairs, provided that the door does not swing over the top step.
2. At exterior doors serving Groups F, H, R-2 and S and where such doors are not part of an accessible route, the landing at an exterior door shall be not more than 7 inches (178 mm) below the landing on the egress side of the door, provided that the door, other than an exterior storm or screen door, does not swing over the landing.
3. At exterior doors serving Group U and individual *dwelling units* and *sleeping units* in Groups R-2 and R-3, and where such units are not required to be Accessible units, Type A units or Type B units, the landing at an exterior doorway shall be not more than 7<sup>3</sup>/<sub>4</sub> inches (197 mm) below the landing on the egress side of the door. Such doors, including storm or screen doors, shall be permitted to swing over either landing.
4. Variations in elevation due to differences in finish materials, but not more than 1/2 inch (12.7 mm).
5. Exterior decks, patios or balconies that are part of Type B *dwelling units* or *sleeping units*, that have impervious surfaces and that are not more than 4 inches (102 mm) below the finished

floor level of the adjacent interior space of the *dwelling unit* or *sleeping unit*.

6. Doors serving equipment spaces not required to be accessible in accordance with Section 1103.2.9 of the *International Building Code* and serving an *occupant load* of five or less shall be permitted to have a landing on one side to be not more than 7 inches (178 mm) above or below the landing on the egress side of the door.

**[BE] 1010.1.5 Landings at doors.** Landings shall have a width not less than the width of the *stairway* or the door, whichever is greater. Doors in the fully open position shall not reduce a required dimension by more than 7 inches (178 mm). Where a landing serves an *occupant load* of 50 or more, doors in any position shall not reduce the landing to less than one-half its required width. Landings shall have a length measured in the direction of travel of not less than 44 inches (1118 mm).

**Exception:** Landing length in the direction of travel in Groups R-3 and U and within individual units of Group R-2 need not exceed 36 inches (914 mm).

**[BE] 1010.1.6 Thresholds.** Thresholds at doorways shall not exceed 3/4 inch (19.1 mm) in height above the finished floor or landing for sliding doors serving *dwelling units* or 1/2 inch (12.7 mm) above the finished floor or landing for other doors. Raised thresholds and floor level changes greater than 1/4 inch (6.4 mm) at doorways shall be beveled with a slope not greater than 1 unit vertical in 2 units horizontal (50-percent slope).

**Exceptions:**

1. In occupancy Group R-2 or R-3, threshold heights for sliding and side-hinged exterior doors shall be permitted to be up to 7<sup>3</sup>/<sub>4</sub> inches (197 mm) in height if all of the following apply:
  - 1.1. The door is not part of the required *means of egress*.
  - 1.2. The door is not part of an *accessible route* as required by Chapter 11 of the *International Building Code*.
  - 1.3. The door is not part of an accessible unit, Type A unit or Type B unit.
2. In Type B units, where Exception 5 to Section 1010.1.4 permits a 4-inch (102 mm) elevation change at the door, the threshold height on the exterior side of the door shall not exceed 4<sup>3</sup>/<sub>4</sub> inches (120 mm) in height above the exterior deck, patio or balcony for sliding doors or 4<sup>1</sup>/<sub>2</sub> inches (114 mm) above the exterior deck, patio or balcony for other doors.

**[BE] 1010.1.7 Door arrangement.** Space between two doors in a series shall be 48 inches (1219 mm) minimum plus the width of a door swinging into the space. Doors in

## MEANS OF EGRESS

a series shall swing either in the same direction or away from the space between the doors.

### Exceptions:

1. The minimum distance between horizontal sliding power-operated doors in a series shall be 48 inches (1219 mm).
2. Storm and screen doors serving individual *dwelling units* in Groups R-2 and R-3 need not be spaced 48 inches (1219 mm) from the other door.
3. Doors within individual *dwelling units* in Groups R-2 and R-3 other than within Type A *dwelling units*.

**[BE] 1010.2 Door operations.** Except as specifically permitted by this section, egress doors shall be readily openable from the egress side without the use of a key or special knowledge or effort.

**[BE] 1010.2.1 Unlatching.** The unlatching of any door or leaf for egress shall require not more than one motion in a single linear or rotational direction to release all latching and all locking devices.

### Exceptions:

1. Places of detention or restraint.
2. Where manually operated bolt locks are permitted by Section 1010.2.5.
3. Doors with automatic flush bolts as permitted by Section 1010.2.4, Item 4.
4. Doors from individual *dwelling units* and *sleeping units* of Group R occupancies as permitted by Section 1010.2.4, Item 5.

**[BE] 1010.2.2 Hardware.** Door handles, pulls, latches, locks and other operating devices on doors required to be accessible by Chapter 11 of the *International Building Code* shall not require tight grasping, tight pinching or twisting of the wrist to operate.

**[BE] 1010.2.3 Hardware height.** Door handles, pulls, latches, locks and other operating devices shall be installed 34 inches (864 mm) minimum and 48 inches (1219 mm) maximum above the finished floor. Locks used only for security purposes and not used for normal operation are permitted at any height.

**Exception:** Access doors or gates in barrier walls and fences protecting pools, spas and hot tubs shall be permitted to have operable parts of the latch release on self-latching devices at 54 inches (1370 mm) maximum above the finished floor or ground, provided that the self-latching devices are not also self-locking devices operated by means of a key, electronic opener or integral combination lock.

**[BE] 1010.2.4 Locks and latches.** Locks and latches shall be permitted to prevent operation of doors where any of the following exist:

1. Places of detention or restraint.
2. In Group I-1, Condition 2 and Group I-2 occupancies where the clinical needs of persons receiving

care require containment or where persons receiving care pose a security threat, provided that all clinical staff can readily unlock doors at all times, and all such locks are keyed to keys carried by all clinical staff at all times or all clinical staff have the codes or other means necessary to operate the locks at all times.

3. In buildings in occupancy Group A having an *occupant load* of 300 or less, Groups B, F, M and S, and in places of religious worship, the main door or doors are permitted to be equipped with key-operated locking devices from the egress side provided:
  - 3.1. The locking device is readily distinguishable as locked.
  - 3.2. A readily visible durable sign is posted on the egress side on or adjacent to the door stating: "THIS DOOR TO REMAIN UNLOCKED WHEN THIS SPACE IS OCCUPIED." The sign shall be in letters 1 inch (25 mm) high on a contrasting background.
  - 3.3. The use of the key-operated locking device is revocable by the *fire code official* for due cause.

4. Where egress doors are used in pairs, *approved* automatic flush bolts shall be permitted to be used, provided that the door leaf having the automatic flush bolts does not have a doorknob or surface-mounted hardware.
5. Doors from individual *dwelling* or *sleeping units* of Group R occupancies having an *occupant load* of 10 or less are permitted to be equipped with a night latch, dead bolt or security chain, provided such devices are openable from the inside without the use of a key or tool.
6. Fire doors after the minimum elevated temperature has disabled the unlatching mechanism in accordance with *listed* fire door test procedures.
7. Doors serving roofs not intended to be occupied shall be permitted to be locked, preventing entry to the building from the roof.
8. Other than *egress courts*, where occupants must egress from an exterior space through the building for *means of egress*, *exit access* doors shall be permitted to be equipped with an *approved* locking device where installed and operated in accordance with all of the following:
  - 8.1. The maximum *occupant load* shall be posted where required by Section 1004.9. Such sign shall be permanently affixed inside the building and shall be posted in a conspicuous space near all the *exit access doorways*.
  - 8.2. A weatherproof telephone or two-way communication system installed in accordance with Sections 1009.8.1 and 1009.8.2

shall be located adjacent to not less than one required *exit access* door on the exterior side.

- 8.3. The egress door locking device is readily distinguishable as locked and shall be a key-operated locking device.
- 8.4. A clear window or glazed door opening, not less than 5 square feet (0.46 m<sup>2</sup>) in area, shall be provided at each *exit access* door to determine if there are occupants using the outdoor area.
- 8.5. A readily visible durable sign shall be posted on the interior side on or adjacent to each locked required *exit access* door serving the exterior area stating: "THIS DOOR TO REMAIN UNLOCKED WHEN THE OUTDOOR AREA IS OCCUPIED." The letters on the sign shall be not less than 1 inch (25.4 mm) high on a contrasting background.
- 8.6. The *occupant load* of the occupied exterior area shall not exceed 300 occupants in accordance with Section 1004.
9. Locking devices are permitted on doors to balconies, decks or other exterior spaces serving individual *dwelling* or *sleeping units*.
10. Locking devices are permitted on doors to balconies, decks or other exterior spaces of 250 square feet (23.23 m<sup>2</sup>) or less, serving a private office space.

**[BE] 1010.2.5 Bolt locks.** Manually operated flush bolts or surface bolts are not permitted.

**Exceptions:**

1. On doors not required for egress in individual *dwelling units* or *sleeping units*.
2. Where a pair of doors serves a storage or equipment room, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf.
3. Where a pair of doors serves an *occupant load* of less than 50 persons in a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf. The inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.
4. Where a pair of doors serves a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf provided that such inactive leaf is not needed to meet egress capacity requirements and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. The inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.

5. Where a pair of doors serves patient care rooms in Group I-2 occupancies, self-latching edge- or surface-mounted bolts are permitted on the inactive leaf provided that the inactive leaf is not needed to meet egress capacity requirements and the inactive leaf shall not contain doorknobs, panic bars or similar operating hardware.

**[BE] 1010.2.6 Closet doors.** Closet doors that latch in the closed position shall be openable from inside the closet.

**[BE] 1010.2.7 Stairway doors.** Interior *stairway means of egress* doors shall be openable from both sides without the use of a key or special knowledge or effort.

**Exceptions:**

1. *Stairway* discharge doors shall be openable from the egress side and shall only be locked from the opposite side.
2. This section shall not apply to doors arranged in accordance with Section 403.5.3 of the *International Building Code*.
3. *Stairway* exit doors are permitted to be locked from the side opposite the egress side, provided that they are openable from the egress side and capable of being unlocked simultaneously without unlatching upon a signal from the *fire command center*, if present, or a signal by emergency personnel from a single location inside the main entrance to the building.
4. *Stairway exit* doors shall be openable from the egress side and shall only be locked from the opposite side in Group B, F, M and S occupancies where the only interior access to the tenant space is from a single *exit stairway* where permitted in Section 1006.3.4.
5. *Stairway exit* doors shall be openable from the egress side and shall only be locked from the opposite side in Group R-2 occupancies where the only interior access to the *dwelling unit* is from a single exit stairway where permitted in Section 1006.3.4.

**[BE] 1010.2.8 Locking arrangements in educational occupancies.** In Group E occupancies, Group B educational occupancies and Group I-4 occupancies, egress doors from classrooms, offices and other occupied rooms with locking arrangements designed to keep intruders from entering the room shall comply with all of the following conditions:

1. The door shall be capable of being unlocked from outside the room with a key or other *approved* means.
2. The door shall be openable from within the room in accordance with Section 1010.2.
3. Modifications shall not be made to *listed* panic hardware, fire door hardware or door closers.
4. Modifications to fire door assemblies shall be in accordance with NFPA 80.



## MEANS OF EGRESS

Remote locking or unlocking of doors from an *approved* location shall be permitted in addition to the unlocking operation in Item 1.

**[BE] 1010.2.9 Panic and fire exit hardware.** Swinging doors serving a Group H occupancy and swinging doors serving rooms or spaces with an *occupant load* of 50 or more in a Group A or E occupancy shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*.

**Exceptions:**

1. A main *exit* of a Group A occupancy shall be permitted to have locking devices in accordance with Section 1010.2.4, Item 3.
2. Doors provided with *panic hardware* or *fire exit hardware* and serving a Group A or E occupancy shall be permitted to be electrically locked in accordance with Section 1010.2.12 or 1010.2.11.
3. *Exit access* doors serving occupied exterior areas shall be permitted to be locked in accordance with Section 1010.2.4, Item 8.
4. Courtrooms shall be permitted to be locked in accordance with Section 1010.2.13, Item 3.

**[BE] 1010.2.9.1 Refrigeration machinery room.** Refrigeration machinery rooms larger than 1,000 square feet (93 m<sup>2</sup>) shall have not less than two *exit* or *exit access doorways* that swing in the direction of egress travel and shall be equipped with *panic hardware* or *fire exit hardware*.

**[BE] 1010.2.9.2 Rooms with electrical equipment.** *Exit* or *exit access* doors serving transformer vaults, rooms designated for batteries or energy storage systems, or modular data centers shall be equipped with *panic hardware* or *fire exit hardware*. Rooms containing electrical equipment rated 800 amperes or more that contain overcurrent devices, switching devices or control devices and where the *exit* or *exit access* door is less than 25 feet (7620 mm) from the equipment working space as required by NFPA 70, such doors shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*. The doors shall swing in the direction of egress travel.

**[BE] 1010.2.9.3 Installation.** Where *panic* or *fire exit hardware* is installed, it shall comply with the following:

1. *Panic hardware* shall be *listed* in accordance with UL 305.
2. *Fire exit hardware* shall be *listed* in accordance with UL 10C and UL 305.
3. The actuating portion of the releasing device shall extend not less than one-half of the door leaf width.
4. The maximum unlatching force shall not exceed 15 pounds (67 N).

**[BE] 1010.2.9.4 Balanced doors.** If *balanced doors* are used and *panic hardware* is required, the *panic hardware* shall be the push-pad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

**[BE] 1010.2.10 Monitored or recorded egress.** Where electrical systems that monitor or record egress activity are incorporated, the locking system shall comply with Section 1010.2.11, 1010.2.12, 1010.2.13, 1010.2.14 or 1010.2.15, or shall be readily openable from the egress side without the use of a key or special knowledge or effort.

**[BE] 1010.2.11 Door hardware release of electrically locked egress doors.** Door hardware release of electric locking systems shall be permitted on doors in the *means of egress* in any occupancy except Group H where installed and operated in accordance with all of the following:

1. The door hardware that is affixed to the door leaf has an obvious method of operation that is readily operated under all lighting conditions.
2. The door hardware is capable of being operated with one hand and shall comply with Section 1010.2.1.
3. Operation of the door hardware directly interrupts the power to the electric lock and unlocks the door immediately.
4. Loss of power to the electric locking system automatically unlocks the door.
5. Where *panic* or *fire exit hardware* is required by Section 1010.2.9, operation of the *panic* or *fire exit hardware* also releases the electric lock.
6. The locking system units shall be *listed* in accordance with UL 294.

**[BE] 1010.2.12 Sensor release of electrically locked egress doors.** Sensor release of electric locking systems shall be permitted on doors located in the *means of egress* in any occupancy except Group H where installed and operated in accordance with all of the following criteria:

1. The sensor shall be installed on the egress side, arranged to detect an occupant approaching the doors and shall cause the electric locking system to unlock.
2. The electric locks shall be arranged to unlock by a signal from or loss of power to the sensor.
3. Loss of power to the lock or locking system shall automatically unlock the electric locks.
4. The doors shall be arranged to unlock from a manual unlocking device located 40 inches to 48 inches (1016 mm to 1219 mm) vertically above the floor and within 5 feet (1524 mm) of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign that reads "PUSH

TO EXIT.” When operated, the manual unlocking device shall result in direct interruption of power to the electric lock—*independent of other electronics*—and the electric lock shall remain unlocked for not less than 30 seconds.

5. Activation of the building fire alarm system, where provided, shall automatically unlock the electric lock, and the electric lock shall remain unlocked until the fire alarm system has been reset.
6. Activation of the building *automatic sprinkler system* or fire detection system, where provided, shall automatically unlock the electric lock. The electric lock shall remain unlocked until the fire alarm system has been reset.
7. Emergency lighting shall be provided on the egress side of the door.
8. The door locking system units shall be *listed* in accordance with UL 294.

**[BE] 1010.2.13 Delayed egress.** Delayed egress locking systems shall be permitted to be installed on doors serving the following occupancies in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved* automatic smoke or heat detection system installed in accordance with Section 907:

1. Group B, F, I, M, R, S and U occupancies.
2. Group E classrooms with an *occupant load* of less than 50.
3. In courtrooms in Group A-3 and B occupancies, delayed egress locking systems shall be permitted to be installed on *exit* or *exit access* doors, other than the main *exit* or *exit access* door, in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[BE] 1010.2.13.1 Delayed egress locking system.** The delayed egress locking system shall be installed and operated in accordance with all of the following:

1. The delay electronics of the delayed egress locking system shall deactivate upon actuation of the *automatic sprinkler system* or automatic fire detection system, allowing immediate, free egress.
2. The delay electronics of the delayed egress locking system shall deactivate upon loss of power controlling the lock or lock mechanism, allowing immediate free egress.
3. The delayed egress locking system shall have the capability of being deactivated at the *fire command center* and other *approved* locations.
4. An attempt to egress shall initiate an irreversible process that shall allow such egress in not more than 15 seconds when a physical effort to exit is applied to the egress side door hardware

for not more than 3 seconds. Initiation of the irreversible process shall activate an audible signal in the vicinity of the door. Once the delay electronics have been deactivated, rearming the delay electronics shall be by manual means only.

**Exception:** Where *approved*, a delay of not more than 30 seconds is permitted on a delayed egress door.

5. The egress path from any point shall not pass through more than one delayed egress locking system.

**Exceptions:**

1. In Group I-1, Condition 2, Group I-2 or I-3 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided that the combined delay does not exceed 30 seconds.
2. In Group I-1, Condition 1 or Group I-4 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided that the combined delay does not exceed 30 seconds and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
6. A sign shall be provided on the door and shall be located above and within 12 inches (305 mm) of the door exit hardware:

**Exception:** Where *approved*, in Group I occupancies, the installation of a sign is not required where care recipients who, because of clinical needs, require restraint or containment as part of the function of the treatment area.

- 6.1. For doors that swing in the direction of egress, the sign shall read: “PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS.”
- 6.2. For doors that swing in the opposite direction of egress, the sign shall read: “PULL UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS.”
- 6.3. The sign shall comply with the visual character requirements in ICC A117.1.

## MEANS OF EGRESS

7. Emergency lighting shall be provided on the egress side of the door.
8. The delayed egress locking system units shall be *listed* in accordance with UL 294.

**[BE] 1010.2.14 Controlled egress doors in Groups I-1 and I-2.** Electric locking systems, including electro-mechanical locking systems and electromagnetic locking systems, shall be permitted to be locked in the means of egress in Group I-1 or I-2 occupancies where the clinical needs of persons receiving care require their containment. Controlled egress doors shall be permitted in such occupancies where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved* automatic smoke detection system installed in accordance with Section 907, provided that the doors are installed and operate in accordance with all of the following:

1. The door locks shall unlock on actuation of the *automatic sprinkler system* or automatic smoke detection system.
2. The door locks shall unlock on loss of power controlling the lock or lock mechanism.
3. The door locking system shall be installed to have the capability of being unlocked by a switch located at the *fire command center*, a nursing station or other *approved* location. The switch shall directly break power to the lock.
4. A building occupant shall not be required to pass through more than one door equipped with a controlled egress locking system before entering an *exit*.
5. The procedures for unlocking the doors shall be described and *approved* as part of the emergency planning and preparedness required by Chapter 4.
6. All clinical staff shall have the keys, codes or other means necessary to operate the locking systems.
7. Emergency lighting shall be provided at the door.
8. The door locking system units shall be *listed* in accordance with UL 294.

### Exceptions:

1. Items 1 through 4 shall not apply to doors to areas occupied by persons who, because of clinical needs, require restraint or containment as part of the function of a psychiatric or cognitive treatment area.
2. Items 1 through 4 shall not apply to doors to areas where a *listed* egress control system is utilized to reduce the risk of child abduction from nursery and obstetric areas of a Group I-2 hospital.

**[BE] 1010.2.15 Locking arrangements in buildings within correctional facilities.** In buildings within correctional and detention facilities, doors in *means of egress* serving rooms or spaces occupied by persons whose movements are controlled for security reasons shall be

permitted to be locked where equipped with egress control devices that shall unlock manually and by not less than one of the following means:

1. Activation of an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. Activation of an *approved* manual fire alarm box.
3. A signal from a constantly attended location.

**[BE] 1010.3 Special doors.** Special doors and security grilles shall comply with the requirements of Sections 1010.3.1 through 1010.3.4.

**[BE] 1010.3.1 Revolving doors.** Revolving doors shall comply with the following:

1. Revolving doors shall comply with BHMA A156.27 and shall be installed in accordance with the manufacturer's instructions.
2. Each revolving door shall be capable of *breakout* in accordance with BHMA A156.27 and shall provide an aggregate width of not less than 36 inches (914 mm).
3. A revolving door shall not be located within 10 feet (3048 mm) of the foot or top of *stairways* or escalators. A dispersal area shall be provided between the *stairways* or escalators and the revolving doors.
4. The revolutions per minute (rpm) for a revolving door shall not exceed the maximum rpm as specified in BHMA A156.27. Manual revolving doors shall comply with Table 1010.3.1(1). Automatic or power-operated revolving doors shall comply with Table 1010.3.1(2).
5. An emergency stop switch shall be provided near each entry point of power or automatic operated revolving doors within 48 inches (1219 mm) of the door and between 34 inches (864 mm) and 48 inches (1219 mm) above the floor. The activation area of the emergency stop switch button shall be not less than 1 inch (25 mm) in diameter and shall be red.
6. Each revolving door shall have a side-hinged swinging door that complies with Section 1010.1 in the same wall and within 10 feet (3048 mm) of the revolving door.
7. Revolving doors shall not be part of an *accessible route* required by Section 1009 of this code and Chapter 11 of the *International Building Code*.

**[BE] TABLE 1010.3.1(1)  
MAXIMUM DOOR SPEED MANUAL REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
6-0	12
7-0	11
8-0	10
9-0	9
10-0	8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**[BE] TABLE 1010.3.1(2)**  
**MAXIMUM DOOR SPEED AUTOMATIC OR**  
**POWER-OPERATED REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
8-0	7.2
9-0	6.4
10-0	5.7
11-0	5.2
12-0	4.8
12-6	4.6
14-0	4.1
16-0	3.6
17-0	3.4
18-0	3.2
20-0	2.9
24-0	2.4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**[BE] 1010.3.1.1 Egress component.** A revolving door used as a component of a *means of egress* shall comply with Section 1010.3.1 and the following three conditions:

1. Revolving doors shall not be given credit for more than 50 percent of the minimum width or required capacity.
2. Each revolving door shall be credited with a capacity based on not more than a 50-person *occupant load*.
3. Each revolving door shall provide for egress in accordance with BHMA A156.27 with a *breakout* force of not more than 130 pounds (578 N).

**[BE] 1010.3.1.2 Other than egress component.** A revolving door used as other than a component of a *means of egress* shall comply with Section 1010.3.1. The *breakout* force of a revolving door not used as a component of a *means of egress* shall not be more than 180 pounds (801 N).

**Exception:** A *breakout* force in excess of 180 pounds (801 N) is permitted if the breakout force is reduced to not more than 130 pounds (578 N) when not less than one of the following conditions is satisfied:

1. There is a power failure or power is removed to the device holding the door wings in position.
2. There is an actuation of the *automatic sprinkler system* where such system is provided.
3. There is an actuation of a smoke detection system that is installed in accordance with Section 907 to provide coverage in areas within the building that are within 75 feet (22 860 mm) of the revolving doors.

4. There is an actuation of a manual control switch, in an *approved* location and clearly identified, that reduces the *breakout* force to not more than 130 pounds (578 N).

**[BE] 1010.3.2 Power-operated doors.** Where *means of egress* doors are operated or assisted by power, the design shall be such that in the event of power failure, the door is capable of being opened manually to permit *means of egress* travel or closed where necessary to safeguard *means of egress*. The forces required to open these doors manually shall not exceed those specified in Section 1010.1.3, except that the force to set the door in motion shall not exceed 50 pounds (220 N). The door shall be capable of opening from any position to the full width of the opening in which such door is installed when a force is applied to the door on the side from which egress is made. Power-operated swinging doors, power-operated sliding doors and power-operated folding doors shall comply with BHMA A156.10. Power-assisted swinging doors and low energy power-operated swinging doors shall comply with BHMA A156.19. Low-energy power-operated sliding doors and low-energy power-operated folding doors shall comply with BHMA A156.38.

#### Exceptions:

1. Occupancies in Group I-3.
2. Special-purpose horizontal sliding, accordion or folding doors complying with Section 1010.3.3.
3. For a biparting door in the emergency *breakout* mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 32-inch (813 mm) single-leaf requirement of Section 1010.1.1, provided that a minimum 32-inch (813 mm) clear opening is provided when the two biparting leaves meeting in the center are broken out.

**[BE] 1010.3.3 Special-purpose horizontal sliding, accordion or folding doors.** In other than Group H occupancies, special-purpose horizontal sliding, accordion, or folding door assemblies permitted to be a component of a *means of egress* in accordance with Exception 6 to Section 1010.1.2 shall comply with all of the following criteria:

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure.
2. The doors shall be openable by a simple method without special knowledge or effort from the egress side or sides.
3. The force required to operate the door shall not exceed 30 pounds (133 N) to set the door in motion and 15 pounds (67 N) to close the door or open it to the minimum required width.
4. The door shall be openable with a force not to exceed 15 pounds (67 N) when a force of 250 pounds (1100 N) is applied perpendicular to the door adjacent to the operating device.



## MEANS OF EGRESS

5. The door assembly shall comply with the applicable *fire protection rating* and, where rated, shall be self-closing or automatic closing by smoke detection in accordance with Section 716.2.6.6 of the *International Building Code*, shall be installed in accordance with NFPA 80 and shall comply with Section 716 of the *International Building Code*.
6. The door assembly shall have an integrated standby power supply.
7. The door assembly power supply shall be electrically supervised.
8. The door shall open to the minimum required width within 10 seconds after activation of the operating device.

**[BE] 1010.3.4 Security grilles.** In Groups B, F, M and S, horizontal sliding or vertical security grilles are permitted at the main *exit* and shall be openable from the inside without the use of a key or special knowledge or effort during periods that the space is occupied. The grilles shall remain secured in the full-open position during the period of occupancy by the general public. Where two or more *exits* or *access to exits* are required, not more than one-half of the *exits* or *exit access doorways* shall be equipped with horizontal sliding or vertical security grilles.

**[BE] 1010.4 Gates.** Gates serving the *means of egress* system shall comply with the requirements of this section. Gates used as a component in a *means of egress* shall conform to the applicable requirements for doors.

**Exception:** Horizontal sliding or swinging gates exceeding the 4-foot (1219 mm) maximum leaf width limitation are permitted in fences and walls surrounding a stadium.

**[BE] 1010.4.1 Stadiums.** *Panic hardware* is not required on gates surrounding stadiums where such gates are under constant immediate supervision while the public is present, and where safe dispersal areas based on 3 square feet (0.28 m<sup>2</sup>) per occupant are located between the fence and enclosed space. Such required safe dispersal areas shall not be located less than 50 feet (15 240 mm) from the enclosed space. See Section 1028.5 for *means of egress* from safe dispersal areas.

**[BE] 1010.5 Turnstiles and similar devices.** Turnstiles or similar devices that restrict travel to one direction shall not be placed so as to obstruct any required *means of egress*, except where permitted in accordance with Sections 1010.5.1, 1010.5.2 and 1010.5.3.

**[BE] 1010.5.1 Capacity.** Each turnstile or similar device shall be credited with a capacity based on not more than a 50-person *occupant load* where all of the following provisions are met:

1. Each device shall turn free in the direction of egress travel when primary power is lost and on the manual release by an employee in the area.
2. Such devices are not given credit for more than 50 percent of the required egress capacity or width.

3. Each device is not more than 39 inches (991 mm) high.
4. Each device has not less than 16½ inches (419 mm) clear width at and below a height of 39 inches (991 mm) and not less than 22 inches (559 mm) clear width at heights above 39 inches (991 mm).

**[BE] 1010.5.1.1 Clear width.** Where located as part of an *accessible route*, turnstiles shall have not less than 36 inches (914 mm) clear width at and below a height of 34 inches (864 mm), not less than 32 inches (813 mm) clear width between 34 inches (864 mm) and 80 inches (2032 mm) and shall consist of a mechanism other than a revolving device.

**[BE] 1010.5.2 Security access turnstiles.** Security access turnstiles that inhibit travel in the direction of egress utilizing a physical barrier shall be permitted to be considered as a component of the *means of egress*, provided that all of the following criteria are met:

1. The building is protected throughout by an *approved*, supervised *automatic sprinkler system* in accordance with Section 903.3.1.1.
2. Each security access turnstile lane configuration has a minimum clear passage width of 22 inches (559 mm).
3. Any security access turnstile lane configuration providing a clear passage width of less than 32 inches (810 mm) shall be credited with a maximum egress capacity of 50 persons.
4. Any security access turnstile lane configuration providing a clear passage width of 32 inches (810 mm) or more shall be credited with a maximum egress capacity as calculated in accordance with Section 1005.
5. Each secured physical barrier shall automatically retract or swing to an unobstructed open position in the direction of egress, under each of the following conditions:
  - 5.1. Upon loss of power to the turnstile or any part of the access control system that secures the physical barrier.
  - 5.2. Upon actuation of a clearly identified manual release device with ready access that results in direct interruption of power to each secured physical barrier, after which such barriers remain in the open position for not less than 30 seconds. The manual release device shall be positioned at one of the following locations:
    - 5.2.1. On the egress side of each security access turnstile lane.
    - 5.2.2. At an *approved* location where it can be actuated by an employee assigned to the area at all times that the building is occupied.

- 5.3. Upon actuation of the building fire alarm system, if provided, after which the physical barrier remains in the open position until the fire alarm system is manually reset.

**Exception:** Actuation of a manual fire alarm box.

- 5.4. Upon actuation of the building *automatic sprinkler system* or fire detection system, after which the physical barrier remains in the open position until the fire alarm system is manually reset.

**[BE] 1010.5.3 High turnstile.** Turnstiles more than 39 inches (991 mm) high shall meet the requirements for revolving doors or the requirements of Section 1010.5.2 for security access turnstiles.

**[BE] 1010.5.4 Additional door.** Where serving an *occupant load* greater than 300, each turnstile that is not portable shall have a side-hinged swinging door that conforms to Section 1010.1 within 50 feet (15 240 mm).

**Exception:** A side-hinged swinging door is not required at security access turnstiles that comply with Section 1010.5.2.

## SECTION 1011 STAIRWAYS

**[BE] 1011.1 General.** *Stairways* serving occupied portions of a building shall comply with the requirements of Sections 1011.2 through 1011.13. *Alternating tread devices* shall comply with Section 1011.14. Ship's ladders shall comply with Section 1011.15. Ladders shall comply with Section 1011.16.

**Exception:** Within rooms or spaces used for assembly purposes, stepped *aisles* shall comply with Section 1030.

**[BE] 1011.2 Width and capacity.** The required capacity of *stairways* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm). See Section 1009.3 for *accessible means of egress stairways*.

### Exceptions:

1. *Stairways* serving an *occupant load* of less than 50 shall have a width of not less than 36 inches (914 mm).
2. *Spiral stairways* as provided for in Section 1011.10.
3. Where an incline platform lift or *stairway chairlift* is installed on *stairways* serving occupancies in Group R-3, or within *dwelling units* in occupancies in Group R-2, a clear passage width not less than 20 inches (508 mm) shall be provided. Where the seat and platform can be folded when not in use, the distance shall be measured from the folded position.

**[BE] 1011.3 Headroom.** *Stairways* shall have a headroom clearance of not less than 80 inches (2032 mm) measured

vertically from a line connecting the edge of the *nosings*. Such headroom shall be continuous above the *stairway* to the point where the line intersects the landing below, one tread depth beyond the bottom riser. The minimum clearance shall be maintained the full width of the *stairway* and landing.

### Exceptions:

1. *Spiral stairways* complying with Section 1011.10 are permitted a 78-inch (1981 mm) headroom clearance.
2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; where the *nosings* of treads at the side of a *flight* extend under the edge of a floor opening through which the *stair* passes, the floor opening shall be allowed to project horizontally into the required headroom not more than 4<sup>3</sup>/<sub>4</sub> inches (121 mm).

**[BE] 1011.4 Walkline.** The walkline across *winder* treads shall be concentric to the direction of travel through the turn and located 12 inches (305 mm) from the side where the *winders* are narrower. The 12-inch (305 mm) dimension shall be measured from the widest point of the clear *stair* width at the walking surface of the *winder*. Where *winders* are adjacent within the *flight*, the point of the widest clear *stair* width of the adjacent *winders* shall be used.

**[BE] 1011.5 Stair treads and risers.** *Stair* treads and risers shall comply with Sections 1011.5.1 through 1011.5.5.3.

**[BE] 1011.5.1 Dimension reference surfaces.** For the purpose of this section, all dimensions are exclusive of carpets, rugs or runners.

**[BE] 1011.5.2 Riser height and tread depth.** *Stair* riser heights shall be 7 inches (178 mm) maximum and 4 inches (102 mm) minimum. The riser height shall be measured vertically between the *nosings* of adjacent treads or between the *stairway* landing and the adjacent tread. Rectangular tread depths shall be 11 inches (279 mm) minimum measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's *nosing*. *Winder* treads shall have a minimum tread depth of 11 inches (279 mm) between the vertical planes of the foremost projection of adjacent treads at the intersections with the walkline and a minimum tread depth of 10 inches (254 mm) within the clear width of the *stair*.

### Exceptions:

1. *Spiral stairways* in accordance with Section 1011.10.
2. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to use the riser/tread dimension in Section 1030.14.2.
3. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling*

## MEANS OF EGRESS

*ing units* in Group R-2 occupancies; the maximum riser height shall be  $7\frac{3}{4}$  inches (197 mm); the minimum tread depth shall be 10 inches (254 mm); the minimum *winder* tread depth at the walkline shall be 10 inches (254 mm); and the minimum *winder* tread depth shall be 6 inches (152 mm). A *nosing* projection not less than  $\frac{3}{4}$  inch (19.1 mm) but not more than  $1\frac{1}{4}$  inches (32 mm) shall be provided on *stairways* with solid risers where the tread depth is less than 11 inches (279 mm).

4. See Section 503.1 of the *International Existing Building Code* for the replacement of existing *stairways*.
5. In Group I-3 facilities, *stairways* providing access to guard towers, observation stations and control rooms, not more than 250 square feet (23 m<sup>2</sup>) in area, shall be permitted to have a maximum riser height of 8 inches (203 mm) and a minimum tread depth of 9 inches (229 mm).

**[BE] 1011.5.3 Winder treads.** *Winder* treads are not permitted in *means of egress stairways* except within a *dwelling unit*.

**Exceptions:**

1. Curved *stairways* in accordance with Section 1011.9.
2. *Spiral stairways* in accordance with Section 1011.10.

**[BE] 1011.5.4 Dimensional uniformity.** *Stair* treads and risers shall be of uniform size and shape. The tolerance between the largest and smallest riser height or between the largest and smallest tread depth shall not exceed  $\frac{3}{8}$  inch (9.5 mm) in any *flight* of *stairs*. The greatest *winder* tread depth at the walkline within any *flight* of *stairs* shall not exceed the smallest by more than  $\frac{3}{8}$  inch (9.5 mm).

**Exceptions:**

1. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to comply with the dimensional nonuniformity in Section 1030.14.2.
2. Consistently shaped *winders*, complying with Section 1011.5, differing from rectangular treads in the same *flight* of *stairs*.
3. Nonuniform riser dimension complying with Section 1011.5.4.1.

**[BE] 1011.5.4.1 Nonuniform height risers.** Where the bottom or top riser adjoins a sloping *public way*, walkway or driveway having an established grade and serving as a landing, the bottom or top riser is permitted to be reduced along the slope to less than 4 inches (102 mm) in height, with the variation in height of the bottom or top riser not to exceed 1 unit vertical in 12 units horizontal (8-percent slope) of *stair* width. The nosings or leading edges of treads at such nonuniform height risers shall have a distinctive marking stripe,

different from any other *nosing* marking provided on the *stair flight*. The distinctive marking stripe shall be visible in descent of the *stair* and shall have a slip-resistant surface. Marking stripes shall have a width of not less than 1 inch (25 mm) but not more than 2 inches (51 mm).

**[BE] 1011.5.5 Nosing and riser profile.** *Nosings* shall have a curvature or bevel of not less than  $\frac{1}{16}$  inch (1.6 mm) but not more than  $\frac{9}{16}$  inch (14.3 mm) from the foremost projection of the tread. Risers shall be solid and vertical or sloped under the tread above from the underside of the *nosing* above at an angle not more than 30 degrees (0.52 rad) from the vertical.

**[BE] 1011.5.5.1 Nosing projection size.** The leading edge (*nosings*) of treads shall project not more than  $1\frac{1}{4}$  inches (32 mm) beyond the tread below.

**[BE] 1011.5.5.2 Nosing projection uniformity.** *Nosing* projections of the leading edges shall be of uniform size, including the projections of the *nosing's* leading edge of the floor at the top of a *flight*.

**[BE] 1011.5.5.3 Solid risers.** Risers shall be solid.

**Exceptions:**

1. Solid risers are not required for *stairways* that are not required to comply with Section 1009.3, provided that the opening between treads does not permit the passage of a sphere with a diameter of 4 inches (102 mm).
2. Solid risers are not required for occupancies in Group I-3 or in Group F, H and S occupancies other than areas accessible to the public. The size of the opening in the riser is not restricted.
3. Solid risers are not required for *spiral stairways* constructed in accordance with Section 1011.10.

**[BE] 1011.6 Stairway landings.** There shall be a floor or landing at the top and bottom of each *stairway*. The width of landings, measured perpendicularly to the direction of travel, shall be not less than the width of *stairways* served. Every landing shall have a minimum depth, measured parallel to the direction of travel, equal to the width of the *stairway* or 48 inches (1219 mm), whichever is less. Doors opening onto a landing shall not reduce the landing to less than one-half the required width. When fully open, the door shall not project more than 7 inches (178 mm) into the required width of a landing. Where wheelchair spaces are required on the stairway landing in accordance with Section 1009.6.3, the wheelchair space shall not be located in the required width of the landing and doors shall not swing over the wheelchair spaces.

**Exceptions:**

1. Where *stairways* connect stepped *aisles* to cross *aisles* or concourses, *stairway* landings are not required at the transition between *stairways* and



stepped *aisles* constructed in accordance with Section 1030.

2. Where curved *stairways* of constant radius have intermediate landings, the landing depth shall be measured horizontally between the intersection of the walkline of the lower flight at the landing *nosing* and the intersection of the walkline of the upper flight at the *nosing* of the lowest tread of the upper flight.
3. Where a landing turns 90 degrees (1.57 rad) or more, the minimum landing depth in accordance with this section shall not be required where the landing provided is not less than that described by an arc with a radius equal to the width of the flight served.

**[BE] 1011.7 Stairway construction.** *Stairways* shall be built of materials consistent with the types permitted for the type of construction of the building.

**Exceptions:**

1. Wood *handrails* shall be permitted in all types of construction.
2. Interior *exit stairway* in accordance with Section 510.2 of the *International Building Code*.

**[BE] 1011.7.1 Stairway walking surface.** The walking surface of treads and landings of a *stairway* shall not be sloped steeper than 1 unit vertical in 48 units horizontal (2-percent slope) in any direction. *Stairway* treads and landings shall have a solid surface. Finish floor surfaces shall be securely attached.

**Exceptions:**

1. Openings in *stair* walking surfaces shall be a size that does not permit the passage of 1/2-inch-diameter (12.7 mm) sphere. Elongated openings shall be placed so that the long dimension is perpendicular to the direction of travel.
2. In Group F, H and S occupancies, other than areas of parking structures accessible to the public, openings in treads and landings shall not be prohibited provided that a sphere with a diameter of 1 1/8 inches (29 mm) cannot pass through the opening.

**[BE] 1011.7.2 Outdoor conditions.** Outdoor *stairways* and outdoor approaches to *stairways* shall be designed so that water will not accumulate on walking surfaces.

**[BE] 1011.7.3 Enclosures under interior stairways.** The walls and soffits within enclosed usable spaces under enclosed and unenclosed *stairways* shall be protected by 1-hour fire-resistance-rated construction or the *fire-resistance rating* of the *stairway* enclosure, whichever is greater. Access to the enclosed space shall not be directly from within the *stairway* enclosure.

**Exception:** Spaces under *stairways* serving and contained within a single residential *dwelling unit* in Group R-2 or R-3 shall be permitted to be protected on

the enclosed side with 1/2-inch (12.7 mm) gypsum board.

**[BE] 1011.7.4 Enclosures under exterior stairways.** There shall not be enclosed usable space under *exterior exit stairways* unless the space is completely enclosed in 1-hour *fire-resistance-rated* construction. The open space under *exterior stairways* shall not be used for any purpose.

**[BE] 1011.8 Vertical rise.** A *flight of stairs* shall not have a vertical rise greater than 12 feet (3658 mm) between floor levels or landings.

**Exception:** *Spiral stairways* used as a *means of egress* from technical production areas.

**[BE] 1011.9 Curved stairways.** Curved *stairways* with *winder* treads shall have treads and risers in accordance with Section 1011.5 and the smallest radius shall be not less than twice the minimum width or required capacity of the *stairway*.

**Exception:** The radius restriction shall not apply to curved *stairways* in Group R-3 and within individual *dwelling units* in Group R-2.

**[BE] 1011.10 Spiral stairways.** *Spiral stairways* are permitted to be used as a component in the *means of egress* only within *dwelling units* or from a space not more than 250 square feet (23 m<sup>2</sup>) in area and serving not more than five occupants, or from technical production areas in accordance with Section 410.5 of the *International Building Code*.

A *spiral stairway* shall have a 6 3/4-inch (171 mm) minimum clear tread depth at a point 12 inches (305 mm) from the narrow edge. The risers shall be sufficient to provide a headroom of 78 inches (1981 mm) minimum, but riser height shall not be more than 9 1/2 inches (241 mm). The minimum *stairway* clear width at and below the *handrail* shall be 26 inches (660 mm).

**[BE] 1011.11 Handrails.** *Flights of stairways* shall have *handrails* on each side and shall comply with Section 1014. Where glass is used to provide the *handrail*, the *handrail* shall comply with Section 2407 of the *International Building Code*.

**Exceptions:**

1. *Flights of stairways* within *dwelling units*, and flights of *spiral stairways* are permitted to have a *handrail* on one side only.
2. Decks, patios and walkways that have a single change in elevation where the landing depth on each side of the change of elevation is greater than what is required for a landing do not require *handrails*.
3. In Group R-3 occupancies, a change in elevation consisting of a single riser at an entrance or egress door does not require *handrails*.
4. Changes in room elevations of three or fewer risers within *dwelling units* and *sleeping units* in Group R-2 and R-3 do not require *handrails*.



## MEANS OF EGRESS

5. Where a platform lift is in a stationary position and the floor of the platform lift serves as the upper landing of a *stairway*, *handrails* shall not be required on the *stairway*, provided that all of the following criteria are met:

- 5.1. The *stairway* contains not more than two risers.
- 5.2. A handhold, positioned horizontally or vertically, is located on one side of the *stairway* adjacent to the top landing.
- 5.3. The handhold is located not less than 34 inches (864 mm) and not more than 42 inches (1067 mm) above the bottom landing of the *stairway*.
- 5.4. The handhold gripping surface complies with Section 1014.3 and is not less than 4.5 inches (114 mm) in length.

**[BE] 1011.12 Stairway to roof.** In buildings four or more stories above *grade plane*, one *stairway* shall extend to the roof surface, unless the roof has a slope steeper than 4 units vertical in 12 units horizontal (33-percent slope).

**Exception:** Other than where required by Section 1011.12.1, in buildings without an occupied roof, access to the roof from the top story shall be permitted to be by an *alternating tread device*, a ship's ladder or a permanent ladder.

**[BE] 1011.12.1 Stairway to elevator equipment.** Roofs and penthouses containing elevator equipment that must be accessed for maintenance are required to be accessed by a *stairway*.

**[BE] 1011.12.2 Roof access.** Where a *stairway* is provided to a roof, access to the roof shall be provided through a penthouse complying with Section 1511.2 of the *International Building Code*.

**Exception:** In buildings without an occupied roof, access to the roof shall be permitted to be a roof hatch or trap door not less than 16 square feet (1.5 m<sup>2</sup>) in area and having a minimum dimension of 2 feet (610 mm).

**[BE] 1011.13 Guards.** *Guards* shall be provided along *stairways* and landings where required by Section 1015 and shall be constructed in accordance with Section 1015. Where the roof hatch opening providing the required access is located within 10 feet (3049 mm) of the roof edge, such roof access or roof edge shall be protected by *guards* installed in accordance with Section 1015.

**[BE] 1011.14 Alternating tread devices.** *Alternating tread devices* are limited to an element of a *means of egress* in buildings of Groups F, H and S from a *mezzanine* not more than 250 square feet (23 m<sup>2</sup>) in area and that serves not more than five occupants; in buildings of Group I-3 from a guard tower, observation station or control room not more than 250 square feet (23 m<sup>2</sup>) in area and for access to unoccupied roofs. *Alternating tread devices* used as a *means of egress* shall not have a rise greater than 20 feet (6096 mm) between floor levels or landings.

**[BE] 1011.14.1 Handrails of alternating tread devices.** *Handrails* shall be provided on both sides of *alternating tread devices* and shall comply with Section 1014.

**[BE] 1011.14.2 Treads of alternating tread devices.** *Alternating tread devices* shall have a minimum tread depth of 5 inches (127 mm), a minimum projected tread depth of 8<sup>1</sup>/<sub>2</sub> inches (216 mm), a minimum tread width of 7 inches (178 mm) and a maximum riser height of 9<sup>1</sup>/<sub>2</sub> inches (241 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projections of adjacent treads. The riser height shall be measured vertically between the leading edges of adjacent treads. The riser height and tread depth provided shall result in an angle of ascent from the horizontal of between 50 and 70 degrees (0.87 and 1.22 rad). The initial tread of the device shall begin at the same elevation as the platform, landing or floor surface.

**Exception:** *Alternating tread devices* used as an element of a *means of egress* in buildings from a *mezzanine* area not more than 250 square feet (23 m<sup>2</sup>) in area that serves not more than five occupants shall have a minimum tread depth of 3 inches (76 mm) with a minimum projected tread depth of 10<sup>1</sup>/<sub>2</sub> inches (267 mm). The rise to the next alternating tread surface shall not exceed 8 inches (203 mm).

**[BE] 1011.15 Ship's ladders.** Ship's ladders are permitted to be used in Group I-3 as a component of a *means of egress* to and from control rooms or elevated facility observation stations not more than 250 square feet (23 m<sup>2</sup>) with not more than three occupants and for access to unoccupied roofs. The minimum clear width at and below the *handrails* shall be 20 inches (508 mm). Ship's ladders shall be designed for the live loads indicated in Section 1607.17 of the *International Building Code*.

**[BE] 1011.15.1 Handrails of ship's ladders.** *Handrails* shall be provided on both sides of ship's ladders.

**[BE] 1011.15.2 Treads of ship's ladders.** Ship's ladders shall have a minimum tread depth of 5 inches (127 mm). The tread shall be projected such that the total of the tread depth plus the *nosings* projection is not less than 8<sup>1</sup>/<sub>2</sub> inches (216 mm). The maximum riser height shall be 9<sup>1</sup>/<sub>2</sub> inches (241 mm).

**[BE] 1011.16 Ladders.** Permanent ladders shall not serve as a part of the *means of egress* from occupied spaces within a building. Permanent ladders shall be constructed in accordance with Section 306.5 of the *International Mechanical Code* and designed for the live loads indicated in Section 1607.17 of the *International Building Code*. Permanent ladders shall be permitted to provide access to the following areas:

1. Spaces frequented only by personnel for maintenance, repair or monitoring of equipment.
2. Nonoccupiable spaces accessed only by catwalks, crawl spaces, freight elevators or very narrow passageways.
3. Raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to,

observation galleries, prison guard towers, fire towers or lifeguard stands.

4. Elevated levels in Group U not open to the general public.
5. Nonoccupied roofs that are not required to have *stairway* access in accordance with Section 1011.12.1.
6. Where permitted to access equipment and appliances in accordance with Section 306.5 of the *International Mechanical Code*.

## SECTION 1012 RAMPS

**[BE] 1012.1 Scope.** The provisions of this section shall apply to *ramps* used as a component of a *means of egress*.

### Exceptions:

1. Ramped *aisles* within assembly rooms or spaces shall comply with the provisions in Section 1030.
2. Curb *ramps* shall comply with ICC A117.1.
3. Vehicle *ramps* in parking garages for pedestrian *exit access* shall not be required to comply with Sections 1012.3 through 1012.10 where they are not an *accessible route* serving accessible parking spaces, other required accessible elements or part of an *accessible means of egress*.

**[BE] 1012.2 Slope.** *Ramps* used as part of a *means of egress* shall have a running slope not steeper than 1 unit vertical in 12 units horizontal (8-percent slope). The slope of other pedestrian *ramps* shall not be steeper than 1 unit vertical in 8 units horizontal (12.5-percent slope).

**[BE] 1012.3 Cross slope.** The slope measured perpendicular to the direction of travel of a *ramp* shall not be steeper than 1 unit vertical in 48 units horizontal (2-percent slope).

**[BE] 1012.4 Vertical rise.** The rise for any *ramp* run shall be 30 inches (762 mm) maximum.

**[BE] 1012.5 Minimum dimensions.** The minimum dimensions of *means of egress ramps* shall comply with Sections 1012.5.1 through 1012.5.3.

**[BE] 1012.5.1 Width and capacity.** The minimum width and required capacity of a *means of egress ramp* shall be not less than that required for *corridors* by Section 1020.3. The clear width of a *ramp* between *handrails*, if provided, or other permissible projections shall be 36 inches (914 mm) minimum.

**[BE] 1012.5.2 Headroom.** The minimum headroom in all parts of the *means of egress ramp* shall be not less than 80 inches (2032 mm) above the finished floor of the *ramp* run and any intermediate landings. The minimum clearance shall be maintained for the full width of the ramp and landing.

**[BE] 1012.5.3 Restrictions.** *Means of egress ramps* shall not reduce in width in the direction of egress travel.

Projections into the required *ramp* and landing width are prohibited. Doors opening onto a landing shall not reduce the clear width to less than 42 inches (1067 mm).

**[BE] 1012.6 Landings.** *Ramps* shall have landings at the bottom and top of each *ramp*, points of turning, entrance, *exits* and at doors. Landings shall comply with Sections 1012.6.1 through 1012.6.5.

**[BE] 1012.6.1 Slope.** Landings shall have a slope not steeper than 1 unit vertical in 48 units horizontal (2-percent slope) in any direction. Changes in level are not permitted.

**[BE] 1012.6.2 Width.** The landing width shall be not less than the width of the widest *ramp* run adjoining the landing.

**[BE] 1012.6.3 Length.** The landing length shall be 60 inches (1525 mm) minimum.

### Exceptions:

1. In Group R-2 and R-3 individual *dwelling* and *sleeping units* that are not required to be Accessible units, Type A units or Type B units in accordance with Section 1108 of the *International Building Code*, landings are permitted to be 36 inches (914 mm) minimum.
2. Where the *ramp* is not a part of an *accessible route*, the length of the landing shall not be required to be more than 48 inches (1219 mm) in the direction of travel.

**[BE] 1012.6.4 Change in direction.** Where changes in direction of travel occur at landings provided between *ramp* runs, the landing shall be 60 inches by 60 inches (1524 mm by 1524 mm) minimum.

**Exception:** In Group R-2 and R-3 individual *dwelling* or *sleeping units* that are not required to be Accessible units, Type A units or Type B units in accordance with Section 1108 of the *International Building Code*, landings are permitted to be 36 inches by 36 inches (914 mm by 914 mm) minimum.

**[BE] 1012.6.5 Doorways.** Where doorways are located adjacent to a *ramp* landing, maneuvering clearances required by ICC A117.1 are permitted to overlap the required landing area.

**[BE] 1012.7 Ramp construction.** *Ramps* shall be built of materials consistent with the types permitted for the type of construction of the building, except that wood *handrails* shall be permitted for all types of construction.

**[BE] 1012.7.1 Ramp surface.** The surface of *ramps* shall be of slip-resistant materials that are securely attached.

**[BE] 1012.7.2 Outdoor conditions.** Outdoor *ramps* and outdoor approaches to *ramps* shall be designed so that water will not accumulate on walking surfaces.

**[BE] 1012.8 Handrails.** *Ramps* with a rise greater than 6 inches (152 mm) shall have *handrails* on both sides. *Handrails* shall comply with Section 1014.

## MEANS OF EGRESS

**[BE] 1012.9 Guards.** *Guards* shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015.

**[BE] 1012.10 Edge protection.** Edge protection complying with Section 1012.10.1 or 1012.10.2 shall be provided on each side of *ramp* runs and at each side of *ramp* landings.

### Exceptions:

1. Edge protection is not required on *ramps* that are not required to have *handrails*, provided that they have flared sides that comply with the ICC A117.1 curb *ramp* provisions.
2. Edge protection is not required on the sides of *ramp* landings serving an adjoining *ramp* run or *stairway*.
3. Edge protection is not required on the sides of *ramp* landings having a vertical dropoff of not more than  $\frac{1}{2}$  inch (12.7 mm) within 10 inches (254 mm) horizontally of the required landing area.

**[BE] 1012.10.1 Curb, rail, wall or barrier.** A curb, rail, wall or barrier shall be provided to serve as edge protection. A curb shall be not less than 4 inches (102 mm) in height. Barriers shall be constructed so that the barrier prevents the passage of a 4-inch-diameter (102 mm) sphere, where any portion of the sphere is within 4 inches (102 mm) of the floor or ground surface.

**[BE] 1012.10.2 Extended floor or ground surface.** The floor or ground surface of the *ramp* run or landing shall extend 12 inches (305 mm) minimum beyond the inside face of a *handrail* complying with Section 1014.

## SECTION 1013 EXIT SIGNS

**[BE] 1013.1 Where required.** *Exits* and *exit access* doors shall be marked by an *approved* exit sign readily visible from any direction of egress travel. The path of egress travel to *exits* and within *exits* shall be marked by readily visible exit signs to clearly indicate the direction of egress travel in cases where the *exit* or the path of egress travel is not immediately visible to the occupants. Intervening *means of egress* doors within *exits* shall be marked by exit signs. Exit sign placement shall be such that any point in an *exit access corridor* or *exit passageway* is within 100 feet (30 480 mm) or the *listed* viewing distance of the sign, whichever is less, from the nearest visible exit sign.

### Exceptions:

1. Exit signs are not required in rooms or areas that require only one *exit* or *exit access*.
2. Main exterior *exit* doors or gates that are obviously and clearly identifiable as *exits* need not have *exit* signs where *approved* by the *fire code official*.
3. Exit signs are not required in occupancies in Group U and individual *sleeping units* or *dwelling units* in Group R-1, R-2 or R-3.

4. Exit signs are not required in dayrooms, sleeping rooms or dormitories in occupancies in Group I-3.
5. In occupancies in Groups A-4 and A-5, exit signs are not required on the seating side of vomitories or openings into seating areas where exit signs are provided in the concourse that are readily apparent from the vomitories. Egress lighting is provided to identify each vomitory or opening within the seating area in an emergency.

**[BE] 1013.2 Low-level exit signs in Group R-1.** Where exit signs are required in Group R-1 occupancies by Section 1013.1, additional low-level exit signs shall be provided in all areas serving guestrooms in Group R-1 occupancies and shall comply with Section 1013.5.

The bottom of the sign shall be not less than 10 inches (254 mm) nor more than 18 inches (455 mm) above the floor level. The sign shall be flush mounted to the door or wall. Where mounted on the wall, the edge of the sign shall be within 4 inches (102 mm) of the door frame on the latch side.

**[BE] 1013.3 Illumination.** Exit signs shall be internally or externally illuminated.

**Exception:** Tactile signs required by Section 1013.4 need not be provided with illumination.

**[BE] 1013.4 Raised character and braille exit signs.** Where exit signs are provided at an *area of refuge* with direct access to a *stairway*, an exterior area for assisted rescue, an *exit stairway* or ramp, an *exit passageway*, a *horizontal exit* and the *exit discharge*, a sign stating “EXIT” in visual characters, raised characters and braille and complying with ICC A117.1 shall be provided.

**[BE] 1013.5 Internally illuminated exit signs.** Electrically powered, *self-luminous* and *photoluminescent exit* signs shall be *listed* and *labeled* in accordance with UL 924 and shall be installed in accordance with the manufacturer’s instructions and Section 1203. Exit signs shall be illuminated at all times.

**[BE] 1013.6 Externally illuminated exit signs.** Externally illuminated exit signs shall comply with Sections 1013.6.1 through 1013.6.3.

**[BE] 1013.6.1 Graphics.** Every exit sign and directional exit sign shall have plainly legible letters not less than 6 inches (152 mm) high with the principal strokes of the letters not less than  $\frac{3}{4}$  inch (19.1 mm) wide. The word “EXIT” shall have letters having a width not less than 2 inches (51 mm) wide, except the letter “I,” and the minimum spacing between letters shall be not less than  $\frac{3}{8}$  inch (9.5 mm). Signs larger than the minimum established in this section shall have letter widths, strokes and spacing in proportion to their height.

The word “EXIT” shall be in high contrast with the background and shall be clearly discernible when the means of exit sign illumination is or is not energized. If a chevron directional indicator is provided as part of the exit sign, the construction shall be such that the direction of the chevron directional indicator cannot be readily changed.



**[BE] 1013.6.2 Exit sign illumination.** The face of an exit sign illuminated from an external source shall have an intensity of not less than 5 footcandles (54 lux).

**[BE] 1013.6.3 Power source.** Exit signs shall be illuminated at all times. To ensure continued illumination for a duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Section 1203. Group I-2, Condition 2 exit sign illumination shall not be provided by unit equipment batteries only.

**Exception:** *Approved* exit sign illumination types that provide continuous illumination independent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.

## SECTION 1014 HANDRAILS

**[BE] 1014.1 Where required.** *Handrails* serving *flights of stairways*, *ramps*, *stepped aisles* and *ramped aisles* shall be adequate in strength and attachment in accordance with Section 1607.8 of the *International Building Code*. *Handrails* required for *flights of stairways* by Section 1011.11 shall comply with Sections 1014.2 through 1014.9. *Handrails* required for *ramps* by Section 1012.8 shall comply with Sections 1014.2 through 1014.8. *Handrails* for *stepped aisles* and *ramped aisles* required by Section 1030.16 shall comply with Sections 1014.2 through 1014.8.

**[BE] 1014.2 Height.** Handrail height, measured above *stair tread nosings*, or finish surface of *ramp* slope, shall be uniform, not less than 34 inches (864 mm) and not more than 38 inches (965 mm). Handrail height of *alternating tread devices* and ship's ladders, measured above tread *nosings*, shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

### Exceptions:

1. Where handrail fittings or bendings are used to provide continuous transition between *flights*, the fittings or bendings shall be permitted to exceed the maximum height.
2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are associated with a Group R-3 occupancy or associated with individual *dwelling units* in Group R-2 occupancies; where handrail fittings or bendings are used to provide continuous transition between *flights*, transition at *winder* treads, transition from *handrail* to *guard*, or where used at the start of a *flight*, the *handrail* height at the fittings or bendings shall be permitted to exceed the maximum height.

3. *Handrails* on top of a *guard* where permitted along *stepped aisles* and *ramped aisles* in accordance with Section 1030.16.

**[BE] 1014.3 Handrail graspability.** Required *handrails* shall comply with Section 1014.3.1 or shall provide equivalent graspability.

**Exception:** In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; *handrails* shall be Type I in accordance with Section 1014.3.1, Type II in accordance with Section 1014.3.2 or shall provide equivalent graspability.

**[BE] 1014.3.1 Type I.** *Handrails* with a circular cross section shall have an outside diameter of not less than 1 1/4 inches (32 mm) and not greater than 2 inches (51 mm). Where the *handrail* is not circular, it shall have a perimeter dimension of not less than 4 inches (102 mm) and not greater than 6 1/4 inches (160 mm) with a maximum cross-sectional dimension of 2 1/4 inches (57 mm) and minimum cross-sectional dimension of 1 inch (25 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

**[BE] 1014.3.2 Type II.** *Handrails* with a perimeter greater than 6 1/4 inches (160 mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of 3/4 inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of not less than 5/16 inch (8 mm) within 7/8 inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than 3/8 inch (10 mm) to a level that is not less than 1 3/4 inches (45 mm) below the tallest portion of the profile. The width of the *handrail* above the recess shall be not less than 1 1/4 inches (32 mm) to not greater than 2 3/4 inches (70 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

**[BE] 1014.4 Continuity.** Handrail gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

### Exceptions:

1. *Handrails* within *dwelling units* are permitted to be interrupted by a newel post at a turn or landing.
2. Within a *dwelling unit*, the use of a volute, turn-out, starting easing or starting newel is allowed over the lowest tread.
3. Handrail brackets or balusters attached to the bottom surface of the *handrail* that do not project horizontally beyond the sides of the *handrail* within 1 1/2 inches (38 mm) of the bottom of the *handrail* shall not be considered obstructions. For each 1/2 inch (12.7 mm) of additional *handrail* perimeter dimension above 4 inches (102 mm), the vertical clearance dimension of 1 1/2 inches (38 mm) shall be permitted to be reduced by 1/8 inch (3.2 mm).
4. Where *handrails* are provided along walking surfaces with slopes not steeper than 1:20, the



## MEANS OF EGRESS

bottoms of the handrail gripping surfaces shall be permitted to be obstructed along their entire length where they are integral to crash rails or bumper guards.

5. *Handrails* serving stepped *aisles* or ramped *aisles* are permitted to be discontinuous in accordance with Section 1030.16.1.

**[BE] 1014.5 Fittings.** *Handrails* shall not rotate within their fittings.

**[BE] 1014.6 Handrail extensions.** *Handrails* shall return to a wall, *guard* or the walking surface or shall be continuous to the *handrail* of an adjacent *flight* of *stairs* or *ramp* run. Where *handrails* are not continuous between *flights* the *handrails* shall extend horizontally not less than 12 inches (305 mm) beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At *ramps* where *handrails* are not continuous between runs, the *handrails* shall extend horizontally above the landing 12 inches (305 mm) minimum beyond the top and bottom of *ramp* runs. The extensions of *handrails* shall be in the same direction of the *flights* of *stairs* at *stairways* and the *ramp* runs at *ramps*.

### Exceptions:

1. *Handrails* within a *dwelling unit* that is not required to be accessible need extend only from the top riser to the bottom riser.
2. *Handrails* serving *aisles* in rooms or spaces used for assembly purposes are permitted to comply with the handrail extensions in accordance with Section 1030.16.
3. *Handrails* for *alternating tread devices* and ship's ladders are permitted to terminate at a location vertically above the top and bottom risers. *Handrails* for *alternating tread devices* are not required to be continuous between *flights* or to extend beyond the top or bottom risers.

**[BE] 1014.7 Clearance.** Clear space between a *handrail* and a wall or other surface shall be not less than 1½ inches (38 mm). A *handrail* and a wall or other surface adjacent to the *handrail* shall be free of any sharp or abrasive elements.

**[BE] 1014.8 Projections.** On *ramps* and on ramped *aisles* that are part of an *accessible route*, the clear width between *handrails* shall be 36 inches (914 mm) minimum. Projections into the required width of *aisles*, *stairways* and *ramps* at each side shall not exceed 4½ inches (114 mm) at or below the *handrail* height. Projections into the required width shall not be limited above the minimum headroom height required in Section 1011.3. Projections due to intermediate *handrails* shall not constitute a reduction in the egress width. Where a pair of intermediate *handrails* are provided within the *stairway* width without a walking surface between the pair of intermediate *handrails* and the distance between the pair of intermediate *handrails* is greater than 6 inches (152 mm), the available egress width shall be reduced by the distance between the closest edges of each such intermediate pair of *handrails* that is greater than 6 inches (152 mm).

**[BE] 1014.9 Intermediate handrails.** *Stairways* shall have intermediate *handrails* located in such a manner that all portions of the *stairway* minimum width or required capacity are within 30 inches (762 mm) of a *handrail*. On monumental *stairs*, *handrails* shall be located along the most direct path of egress travel.

## SECTION 1015 GUARDS

**[BE] 1015.1 General.** *Guards* shall comply with the provisions of Sections 1015.2 through 1015.7. Operable windows with sills located more than 72 inches (1829 mm) above finished grade or other surface below shall comply with Section 1015.8.

**[BE] 1015.2 Where required.** *Guards* shall be located along open-sided walking surfaces, including *mezzanines*, equipment platforms, *aisles*, *stairs*, *ramps* and landings that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) horizontally to the edge of the open side. *Guards* shall be adequate in strength and attachment in accordance with Section 1607.8 of the *International Building Code*.

**Exception:** *Guards* are not required for the following locations:

1. On the loading side of loading docks or piers.
2. On the audience side of stages and raised platforms, including *stairs* leading up to the stage and raised platforms.
3. On raised stage and platform floor areas, such as runways, *ramps* and side stages used for entertainment or presentations.
4. At vertical openings in the performance area of stages and platforms.
5. At elevated walking surfaces appurtenant to stages and platforms for access to and utilization of special lighting or equipment.
6. Along vehicle service pits not accessible to the public.
7. In assembly seating areas at cross *aisles* in accordance with Section 1030.17.2.
8. On the loading side of station platforms on fixed guideway transit or passenger rail systems.

**[BE] 1015.2.1 Glazing.** Where glass is used to provide a *guard* or as a portion of the *guard* system, the *guard* shall comply with Section 2407 of the *International Building Code*. Where the glazing provided does not meet the strength and attachment requirements of Section 1607.8 of the *International Building Code*, complying *guards* shall be located along glazed sides of open-sided walking surfaces.

**[BE] 1015.3 Height.** Required *guards* shall be not less than 42 inches (1067 mm) high, measured vertically as follows:

1. From the adjacent walking surfaces.

2. On *stairways* and stepped *aisles*, from the line connecting the leading edges of the tread *nosings*.
3. On *ramps* and ramped *aisles*, from the *ramp* surface at the *guard*.

**Exceptions:**

1. For occupancies in Group R-3 not more than three stories above grade in height and within individual *dwelling units* in occupancies in Group R-2 not more than three stories above grade in height with separate *means of egress*, required *guards* shall be not less than 36 inches (914 mm) in height measured vertically above the adjacent walking surfaces.
2. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, *guards* on the open sides of *stairs* shall have a height not less than 34 inches (864 mm) measured vertically from a line connecting the leading edges of the treads.
3. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, where the top of the *guard* serves as a *handrail* on the open sides of *stairs*, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) measured vertically from a line connecting the leading edges of the treads.
4. The *guard* height in assembly seating areas shall comply with Section 1030.17 as applicable.
5. Along *alternating tread devices* and ship's ladders, *guards* where the top rail serves as a *handrail* shall have height not less than 30 inches (762 mm) and not more than 34 inches (864 mm), measured vertically from the leading edge of the device tread *nosing*.
6. In Group F occupancies where *exit access stairways* serve fewer than three stories and such *stairways* are not open to the public, and where the top of the *guard* also serves as a *handrail*, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) measured vertically from a line connecting the leading edges of the treads.

**[BE] 1015.4 Opening limitations.** Required *guards* shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter from the walking surface to the required *guard* height.

**Exceptions:**

1. From a height of 36 inches (914 mm) to 42 inches (1067 mm), *guards* shall not have openings that allow passage of a sphere  $4\frac{3}{8}$  inches (111 mm) in diameter.
2. The triangular openings at the open sides of a *stair*, formed by the riser, tread and bottom rail shall not allow passage of a sphere 6 inches (152 mm) in diameter.

3. At elevated walking surfaces for access to and use of electrical, mechanical or plumbing systems or equipment, *guards* shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.
4. In areas that are not open to the public within occupancies in Group I-3, F, H or S, and for *alternating tread devices* and ship's ladders, *guards* shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.
5. In assembly seating areas, *guards* required at the end of *aisles* in accordance with Section 1030.17.4 shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter up to a height of 26 inches (660 mm). From a height of 26 inches (660 mm) to 42 inches (1067 mm) above the adjacent walking surfaces, *guards* shall not have openings that allow passage of a sphere 8 inches (203 mm) in diameter.
6. Within individual *dwelling units* and *sleeping units* in Group R-2 and R-3 occupancies, *guards* on the open sides of *stairs* shall not have openings that allow passage of a sphere  $4\frac{3}{8}$  (111 mm) inches in diameter.

**[BE] 1015.5 Screen porches.** Porches and decks that are enclosed with insect screening shall be provided with *guards* where the walking surface is located more than 30 inches (762 mm) above the floor or grade below.

**[BE] 1015.6 Mechanical equipment, systems and devices.** *Guards* shall be provided where various components that require service are located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall extend not less than 30 inches (762 mm) beyond each end of such components. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where personal fall arrest anchorage connector devices that comply with ANSI/ASSE Z359.1 are installed.

**[BE] 1015.7 Roof access.** *Guards* shall be provided where the roof hatch opening is located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall extend not less than 30 inches (762 mm) beyond each end of the hatch parallel to the roof edge. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where personal fall arrest anchorage connector devices that comply with ANSI/ASSE Z359.1 are installed.

**[BE] 1015.8 Window openings.** Windows in Group R-2 and R-3 buildings including *dwelling units*, where the bottom of the clear opening of an operable window is located less than

## MEANS OF EGRESS

36 inches (914 mm) above the finished floor and more than 72 inches (1829 mm) above the finished grade or other surface below on the exterior of the building, shall comply with one of the following:

1. Operable windows where the top of the sill of the opening is located more than 75 feet (22 860 mm) above the finished grade or other surface below and that are provided with window fall prevention devices that comply with ASTM F2006.
2. Operable windows where the openings will not allow a 4-inch-diameter (102 mm) sphere to pass through the opening when the window is in its largest opened position.
3. Operable windows where the openings are provided with window fall prevention devices that comply with ASTM F2090.
4. Operable windows that are provided with window opening control devices that comply with Section 1015.8.1.

**[BE] 1015.8.1 Window opening control devices.** Window opening control devices shall comply with ASTM F2090. The window opening control device, after operation to release the control device allowing the window to fully open, shall not reduce the minimum net clear opening area of the window unit to less than the area required by Section 1031.3.1.

## SECTION 1016 EXIT ACCESS

**[BE] 1016.1 General.** The *exit access* shall comply with the applicable provisions of Sections 1003 through 1015. *Exit access* arrangement shall comply with Sections 1016 through 1021.

**[BE] 1016.2 Egress through intervening spaces.** Egress through intervening spaces shall comply with this section.

1. *Exit access* through an enclosed elevator lobby is permitted. Where access to two or more *exits* or *exit access doorways* is required in Section 1006.2.1, access to not less than one of the required *exits* shall be provided without travel through the enclosed elevator lobbies required by Section 3006 of the *International Building Code*. Where the path of *exit access* travel passes through an enclosed elevator lobby the level of protection required for the enclosed elevator lobby is not required to be extended to the *exit* unless direct access to an *exit* is required by other sections of this code.
2. Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, are not a Group H occupancy and provide a discernible path of egress travel to an *exit*.

**Exception:** *Means of egress* are not prohibited through adjoining or intervening rooms or spaces in a Group H, S or F occupancy where the

adjoining or intervening rooms or spaces are the same or a lesser hazard occupancy group.

3. An *exit access* shall not pass through a room that can be locked to prevent egress.
4. *Means of egress* from *dwelling units* or sleeping areas shall not lead through other sleeping areas, toilet rooms or bathrooms.
5. Egress shall not pass through kitchens, storage rooms, closets or spaces used for similar purposes.

### Exceptions:

1. *Means of egress* are not prohibited through a kitchen area serving adjoining rooms constituting part of the same *dwelling unit* or *sleeping unit*.
2. *Means of egress* are not prohibited through stockrooms in Group M occupancies where all of the following are met:
  - 2.1. The stock is of the same hazard classification as that found in the main retail area.
  - 2.2. Not more than 50 percent of the *exit access* is through the stockroom.
  - 2.3. The stockroom is not subject to locking from the egress side.
  - 2.4. There is a demarcated, minimum 44-inch-wide (1118 mm) *aisle* defined by full- or partial-height fixed walls or similar construction that will maintain the required width and lead directly from the retail area to the *exit* without obstructions.

**[BE] 1016.2.1 Multiple tenants.** Where more than one tenant occupies any one floor of a building or structure, each tenant space, *dwelling unit* and *sleeping unit* shall be provided with access to the required *exits* without passing through adjacent tenant spaces, *dwelling units* and *sleeping units*.

**Exception:** The *means of egress* from a smaller tenant space shall not be prohibited from passing through a larger adjoining tenant space where such rooms or spaces of the smaller tenant occupy less than 10 percent of the area of the larger tenant space through which they pass; are the same or similar occupancy group; a discernable path of egress travel to an *exit* is provided; and the *means of egress* into the adjoining space is not subject to locking from the egress side. A required *means of egress* serving the larger tenant space shall not pass through the smaller tenant space or spaces.



## SECTION 1017 EXIT ACCESS TRAVEL DISTANCE

**[BE] 1017.1 General.** Travel distance within the *exit access* portion of the *means of egress* system shall be in accordance with this section.

**[BE] 1017.2 Limitations.** *Exit access* travel distance shall not exceed the values given in Table 1017.2.

**[BE] TABLE 1017.2  
EXIT ACCESS TRAVEL DISTANCE<sup>a</sup>**

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200	250 <sup>b, c</sup>
I-1	Not Permitted	250 <sup>b</sup>
B	200	300 <sup>c</sup>
F-2, S-2, U	300	400 <sup>c</sup>
H-1	Not Permitted	75 <sup>d</sup>
H-2	Not Permitted	100 <sup>d</sup>
H-3	Not Permitted	150 <sup>d</sup>
H-4	Not Permitted	175 <sup>d</sup>
H-5	Not Permitted	200 <sup>c</sup>
I-2, I-3	Not Permitted	200 <sup>c</sup>
I-4	150	200 <sup>c</sup>

For SI: 1 foot = 304.8 mm.

a. See the following sections for modifications to exit access travel distance requirements:

Section 402.8 of the *International Building Code*: For the distance limitation in malls.

Section 407.4 of the *International Building Code*: For the distance limitation in Group I-2.

Sections 408.6.1 and 408.8.1 of the *International Building Code*: For the distance limitations in Group I-3.

Section 411.2 of the *International Building Code*: For the distance limitation in special amusement areas.

Section 412.6 of the *International Building Code*: For the distance limitations in aircraft manufacturing facilities.

Section 1006.2.2.2: For the distance limitation in refrigeration machinery rooms.

Section 1006.2.2.3: For the distance limitation in refrigerated rooms and spaces.

Section 1006.3.4: For buildings with one exit.

Section 1017.2.2: For increased distance limitation in Groups F-1 and S-1.

Section 1030.7: For increased limitation in assembly seating.

Section 3103.4 of the *International Building Code*: For temporary structures.

Section 3104.9 of the *International Building Code*: For pedestrian walkways.

b. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.

c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

d. Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.1.

e. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

**[BE] 1017.2.1 Exterior egress balcony increase.** *Exit access* travel distances specified in Table 1017.2 shall be increased up to an additional 100 feet (30 480 mm) provided that the last portion of the *exit access* leading to the *exit* occurs on an exterior egress balcony constructed in accordance with Section 1021. The length of such balcony shall be not less than the amount of the increase taken.

**[BE] 1017.2.2 Groups F-1 and S-1 increase.** The maximum *exit access* travel distance shall be 400 feet (122 m) in Group F-1 or S-1 occupancies where all of the following conditions are met:

1. The portion of the building classified as Group F-1 or S-1 is limited to one story in height.
2. The minimum height from the finished floor to the bottom of the ceiling or roof slab or deck is 24 feet (7315 mm).
3. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[BE] 1017.3 Measurement.** *Exit access* travel distance shall be measured from the most remote point of each room, area or space along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an *exit*. Where more than one *exit* is required, *exit access* travel distance shall be measured to the nearest *exit*.

### Exceptions:

1. In open parking garages, *exit access* travel distance is permitted to be measured to the closest riser of an *exit access stairway* or the closest slope of an *exit access ramp*.
2. In smoke-protected seating and open-air assembly seating, *exit access* travel distance shall be measured in accordance with Section 1030.7.

**[BE] 1017.3.1 Exit access stairways and ramps.** Travel distance on *exit access stairways* or *ramps* shall be included in the *exit access* travel distance measurement. The measurement along *stairways* shall be made on a plane parallel and tangent to the *stair tread nosings* in the center of the *stair* and landings. The measurement along *ramps* shall be made on the walking surface in the center of the *ramp* and landings.

**1017.3.2 Atriums.** *Exit access* travel distance for areas open to an atrium shall comply with the requirements of Sections 1017.3.2.1 through 1017.3.2.3.

**1017.3.2.1 Egress not through the atrium.** Where required access to the *exits* is not through the atrium, *exit access* travel distance shall comply with Section 1017.2.

**1017.3.2.2 Exit access travel distance at the level of exit discharge.** Where the path of egress travel is through an atrium space, *exit access* travel distance at the *level of exit discharge* shall be determined in accordance with Section 1017.2.

**1017.3.2.3 Exit access travel distance at other than the level of exit discharge.** Where the path of egress



## MEANS OF EGRESS

travel is not at the *level of exit discharge* from the atrium, that portion of the total permitted *exit access* travel distance that occurs within the atrium shall be not greater than 200 feet (60 960 mm).

SECTION 1018  
AISLES

**[BE] 1018.1 General.** *Aisles* and *aisle accessways* serving as a portion of the *exit access* in the *means of egress* system shall comply with the requirements of this section. *Aisles* or *aisle accessways* shall be provided from all occupied portions of the *exit access* that contain seats, tables, furnishings, displays and similar fixtures or equipment. The minimum width or required capacity of *aisles* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**[BE] 1018.2 Aisles in assembly spaces.** *Aisles* and *aisle accessways* serving a room or space used for assembly purposes shall comply with Section 1030.

**[BE] 1018.3 Aisles in Groups B and M.** In Group B and M occupancies, the minimum clear *aisle* width shall be determined by Section 1005.1 for the *occupant load* served, but shall be not less than that required for *corridors* by Section 1020.3.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be accessible by Chapter 11 of the *International Building Code* need not exceed 28 inches (711 mm) in width.

**[BE] 1018.4 Aisle accessways in Group M.** An *aisle accessway* shall be provided on not less than one side of each element within the *merchandise pad*. The minimum clear width for an *aisle accessway* not required to be accessible shall be 30 inches (762 mm). The required clear width of the *aisle accessway* shall be measured perpendicular to the elements and merchandise within the *merchandise pad*. The 30-inch (762 mm) minimum clear width shall be maintained to provide a path to an adjacent *aisle* or *aisle accessway*. The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any point in the *merchandise pad*.

**Exception:** For areas serving not more than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).

**[BE] 1018.5 Aisles in other than assembly spaces and Groups B and M.** In other than rooms or spaces used for assembly purposes and Group B and M occupancies, the minimum clear *aisle* capacity shall be determined by Section 1005.1 for the *occupant load* served, but the width shall be not less than that required for *corridors* by Section 1020.3.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be accessible by Chapter 11 of the *International Building Code* need not exceed 28 inches (711 mm) in width.

SECTION 1019  
EXIT ACCESS STAIRWAYS AND RAMPS

**[BE] 1019.1 General.** *Exit access stairways* and *ramps* serving as an *exit access* component in a *means of egress* system shall comply with the requirements of this section. The number of stories connected by *exit access stairways* and *ramps* shall include *basements*, but not *mezzanines*.

**[BE] 1019.2 All occupancies.** *Exit access stairways* and *ramps* that serve floor levels within a single story are not required to be enclosed.

**[BE] 1019.3 Occupancies other than Groups I-2 and I-3.** In other than Group I-2 and I-3 occupancies, floor openings containing *exit access stairways* or *ramps* shall be enclosed with a shaft enclosure constructed in accordance with Section 713 of the *International Building Code*.

**Exceptions:**

1. *Exit access stairways* and *ramps* that serve or atmospherically communicate between only two adjacent stories. Such interconnected stories shall not be open to other stories.
2. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual *dwelling unit* or *sleeping unit* or live/work unit.
3. *Exit access stairways* serving and contained within a Group R-3 congregate residence or a Group R-4 facility are not required to be enclosed.
4. *Exit access stairways* and *ramps* in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the *stairway* or *ramp* and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.
5. *Exit access stairways* and *ramps* within an atrium complying with the provisions of Section 404 of the *International Building Code*.
6. *Exit access stairways* and *ramps* in open parking garages that serve only the parking garage.
7. *Exit access stairways* and *ramps* serving smoke-protected or open-air assembly seating complying with the *exit access* travel distance requirements of Section 1030.7.
8. *Exit access stairways* and *ramps* between the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, places of religious worship, auditoriums and sports facilities.
9. Exterior *exit access stairways* or *ramps* between occupied roofs.

**[BE] 1019.4 Group I-2 and I-3 occupancies.** In Group I-2 and I-3 occupancies, floor openings between stories contain-

ing *exit access stairways* or *ramps* are required to be enclosed with a shaft enclosure constructed in accordance with Section 713 of the *International Building Code*.

**Exception:** In Group I-3 occupancies, *exit access stairways* or *ramps* constructed in accordance with Section 408 of the *International Building Code* are not required to be enclosed.

## SECTION 1020 CORRIDORS

**[BE] 1020.1 General.** *Corridors* serving as an *exit access* component in a *means of egress* system shall comply with the requirements of Sections 1020.2 and 1020.7.

**[BE] 1020.2 Construction.** *Corridors* shall be *fire-resistance rated* in accordance with Table 1020.2. The *corridor* walls required to be *fire-resistance rated* shall comply with Section 708 of the *International Building Code* for *fire partitions*.

### Exceptions:

1. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group E where each room that is used for instruction has not less than one door opening directly to the exterior and rooms for assembly purposes have not less than one-half of the required *means of egress* doors opening directly to the exterior. Exterior doors specified in this exception are required to be at ground level.
2. A *fire-resistance rating* is not required for *corridors* contained within a *dwelling unit* or *sleeping unit* in an occupancy in Groups I-1 and R.
3. A *fire-resistance rating* is not required for *corridors* in open parking garages.
4. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group B that is a space requiring only a single *means of egress* complying with Section 1006.2.
5. *Corridors* adjacent to the *exterior walls* of buildings shall be permitted to have unprotected openings on unrated *exterior walls* where unrated walls are permitted by Table 705.5 of the *International Building Code* and unprotected openings are permitted by Table 705.8 of the *International Building Code*.

**[BE] 1020.2.1 Hoistway opening protection.** Elevator hoistway openings shall be protected in accordance with Section 3006.2.1 of the *International Building Code*.

**[BE] 1020.3 Width and capacity.** The required capacity of *corridors* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than that specified in Table 1020.3.

**Exception:** In Group I-2 occupancies, *corridors* are not required to have a clear width of 96 inches (2438 mm) in areas where there will not be stretcher or bed movement for access to care or as part of the defend-in-place strategy.

**[BE] TABLE 1020.2  
CORRIDOR FIRE-RESISTANCE RATING**

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system
H-1, H-2, H-3	All	Not Permitted	1 <sup>c</sup>
H-4, H-5	Greater than 30	Not Permitted	1 <sup>c</sup>
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5 <sup>c</sup> /1 <sup>d</sup>
I-2 <sup>a</sup>	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 <sup>b, c</sup>
I-4	All	1	0

- a. For requirements for occupancies in Group I-2, see Sections 407.2 and 407.3 of the *International Building Code*.
- b. For a reduction in the fire-resistance rating for occupancies in Group I-3, see Section 408.8 of the *International Building Code*.
- c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 where allowed.
- d. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

**[BE] TABLE 1020.3  
MINIMUM CORRIDOR WIDTH**

OCCUPANCY	MINIMUM WIDTH (inches)
Any facility not listed below	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36
Within a dwelling unit	36
In Group E with a corridor having a occupant load of 100 or more	72
In corridors and areas serving stretcher traffic in ambulatory care facilities	72
Group I-2 in areas where required for bed movement	96

For SI: 1 inch = 25.4 mm.

**[BE] 1020.4 Obstruction.** The minimum width or required capacity of *corridors* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**[BE] 1020.5 Dead ends.** Where more than one *exit* or *exit access doorway* is required, the *exit access* shall be arranged such that dead-end *corridors* do not exceed 20 feet (6096 mm) in length.

### Exceptions:

1. In Group I-3, Condition 2, 3 or 4 occupancies, the dead end in a *corridor* shall not exceed 50 feet (15 240 mm).
2. In occupancies in Groups B, E, F, I-1, M, R-1, R-2, S and U, where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the length of the dead-end *corridors* shall not exceed 50 feet (15 240 mm).

## MEANS OF EGRESS

3. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.
4. In Group I-2, Condition 2 occupancies, the length of dead-end *corridors* that do not serve patient rooms or patient treatment spaces shall not exceed 30 feet (9144 mm).

**[BE] 1020.6 Air movement in corridors.** *Corridors* shall not serve as supply, return, exhaust, relief or ventilation air ducts.

### Exceptions:

1. Use of a *corridor* as a source of makeup air for exhaust systems in rooms that open directly onto such *corridors*, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall be permitted, provided that each such *corridor* is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the *corridor*.
2. Where located within a *dwelling unit*, the use of *corridors* for conveying return air shall not be prohibited.
3. Where located within tenant spaces of 1,000 square feet (93 m<sup>2</sup>) or less in area, utilization of *corridors* for conveying return air is permitted.
4. Transfer air movement required to maintain the pressurization difference within health care facilities in accordance with ASHRAE 170.

**[BE] 1020.6.1 Corridor ceiling.** Use of the space between the *corridor* ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The *corridor* is not required to be of *fire-resistance-rated* construction.
2. The *corridor* is separated from the plenum by *fire-resistance-rated* construction.
3. The air-handling system serving the *corridor* is shut down upon activation of the air-handling unit smoke detectors required by the *International Mechanical Code*.
4. The air-handling system serving the *corridor* is shut down upon detection of sprinkler water flow where the building is equipped throughout with an *automatic sprinkler system*.
5. The space between the *corridor* ceiling and the floor or roof structure above the *corridor* is used as a component of an *approved* engineered smoke control system.

**[BE] 1020.7 Corridor continuity.** *Fire-resistance-rated corridors* shall be continuous from the point of entry to an *exit*, and shall not be interrupted by intervening rooms. Where the path of egress travel within a *fire-resistance-rated corridor* to the *exit* includes travel along unenclosed *exit*

*access stairways* or *ramps*, the *fire-resistance-rating* shall be continuous for the length of the *stairway* or *ramp* and for the length of the connecting *corridor* on the adjacent floor leading to the *exit*.

### Exceptions:

1. Foyers, lobbies or reception rooms constructed as required for *corridors* shall not be construed as intervening rooms.
2. Enclosed elevator lobbies as permitted by Item 1 of Section 1016.2 shall not be construed as intervening rooms.

## SECTION 1021 EGRESS BALCONIES

**[BE] 1021.1 General.** Balconies used for egress purposes shall conform to the same requirements as *corridors* for minimum width, required capacity, headroom, dead ends and projections.

**[BE] 1021.2 Wall separation.** Exterior egress balconies shall be separated from the interior of the building by walls and opening protectives as required for *corridors*.

**Exception:** Separation is not required where the exterior egress balcony is served by not less than two *stairways* and a dead-end travel condition does not require travel past an unprotected opening to reach a *stairway*.

**[BE] 1021.3 Openness.** The long side of an egress balcony shall be not less than 50 percent open, and the open area above the guards shall be so distributed as to minimize the accumulation of smoke or toxic gases.

**[BE] 1021.4 Location.** Exterior egress balconies shall have a minimum *fire separation distance* of 10 feet (3048 mm) measured at right angles from the exterior edge of the egress balcony to the following:

1. Adjacent lot lines.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 of the *International Building Code* based on *fire separation distance*.

For the purposes of this section, other portions of the building shall be treated as separate buildings.

## SECTION 1022 EXITS

**[BE] 1022.1 General.** *Exits* shall comply with Sections 1022 through 1027 and the applicable requirements of Sections 1003 through 1015. An *exit* shall not be used for any purpose that interferes with its function as a *means of egress*. Once a given level of *exit* protection is achieved, such level of protection shall not be reduced until arrival at the *exit discharge*. *Exits* shall be continuous from the point of entry into the *exit* to the *exit discharge*.



**[BE] 1022.2 Exterior exit doors.** Buildings or structures used for human occupancy shall have not less than one exterior door that meets the requirements of Section 1010.1.1.

**[BE] 1022.2.1 Detailed requirements.** Exterior exit doors shall comply with the applicable requirements of Section 1010.1.

**[BE] 1022.2.2 Arrangement.** Exterior exit doors shall lead directly to the *exit discharge* or the *public way*.

## SECTION 1023 INTERIOR EXIT STAIRWAYS AND RAMPS

**[BE] 1023.1 General.** *Interior exit stairways* and *ramps* serving as an *exit* component in a *means of egress* system shall comply with the requirements of this section. *Interior exit stairways* and *ramps* shall be enclosed and lead directly to the exterior of the building or shall be extended to the exterior of the building with an *exit passageway* conforming to the requirements of Section 1024, except as permitted in Section 1028.2. An *interior exit stairway* or *ramp* shall not be used for any purpose other than as a *means of egress* and a circulation path.

**[BE] 1023.2 Construction.** Enclosures for *interior exit stairways* and *ramps* shall be constructed as *fire barriers* in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both. *Interior exit stairway* and *ramp* enclosures shall have a *fire-resistance rating* of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the *interior exit stairways* or *ramps* shall include any *basements*, but not any *mezzanines*. Enclosure for *interior exit stairways* and *ramps* shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours.

### Exceptions:

1. *Interior exit stairways* and *ramps* in Group I-3 occupancies in accordance with the provisions of Section 408.3.8 of the *International Building Code*.
2. *Interior exit stairways* within an atrium enclosed in accordance with Section 404.6 of the *International Building Code*.
3. *Interior exit stairways* in accordance with Section 510.2 of the *International Building Code*.

**[BE] 1023.3 Termination.** *Interior exit stairways* and *ramps* shall terminate at an *exit discharge* or a *public way*.

**Exception:** A combination of *interior exit stairways*, *interior exit ramps* and *exit passageways*, constructed in accordance with Sections 1023.2, 1023.3.1 and 1024, respectively, and forming a continuous protected enclosure, shall be permitted to extend an *interior exit stairway* or *ramp* to the *exit discharge* or a *public way*.

**[BE] 1023.3.1 Extension.** Where *interior exit stairways* and *ramps* are extended to an *exit discharge* or a *public way* by an *exit passageway*, the *interior exit stairway* and *ramp* shall be separated from the *exit passageway* by a *fire barrier* constructed in accordance with Section 707 of the *International Building Code* or a *horizontal assembly* constructed in accordance with Section 711 of the *International Building Code*, or both. The *fire-resistance rating* shall be not less than that required for the *interior exit stairway* and *ramp*. A *fire door* assembly complying with Section 716 of the *International Building Code* shall be installed in the *fire barrier* to provide a *means of egress* from the *interior exit stairway* and *ramp* to the *exit passageway*. Openings in the *fire barrier* other than the *fire door* assembly are prohibited. Penetrations of the *fire barrier* are prohibited.

### Exceptions:

1. Penetrations of the *fire barrier* in accordance with Section 1023.5 shall be permitted.
2. Separation between an *interior exit stairway* or *ramp* and the *exit passageway* extension shall not be required where there are no openings into the *exit passageway* extension.
3. Separation between an *interior exit stairway* or *ramp* and the *exit passageway* extension shall not be required where the *interior exit stairway* and the *exit passageway* extension are pressurized in accordance with Section 909.20.5 of the *International Building Code*.

**[BE] 1023.4 Openings.** *Interior exit stairway* and *ramp* opening protectives shall be in accordance with the requirements of Section 716 of the *International Building Code*.

Openings in *interior exit stairways* and *ramps* other than unprotected exterior openings shall be limited to those required for *exit access* to the enclosure from normally occupied spaces and for egress from the enclosure.

Elevators shall not open into *interior exit stairways* and *ramps*.

**[BE] 1023.5 Penetrations.** Penetrations into or through *interior exit stairways* and *ramps* are prohibited except for the following:

1. Equipment and ductwork necessary for independent ventilation or pressurization.
2. *Fire protection systems*.
3. Security systems.
4. Two-way communication systems.
5. Electrical raceway for fire department communication systems.
6. Electrical raceway serving the *interior exit stairway* and *ramp* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>).
7. Structural elements supporting the *interior exit stairway* or *ramp* or enclosure, such as beams or joists.



## MEANS OF EGRESS

Such penetrations shall be protected in accordance with Section 714 of the *International Building Code*. There shall not be penetrations or communication openings, whether protected or not, between adjacent *interior exit stairways* and *ramps*.

**Exception:** Membrane penetrations shall be permitted on the outside of the *interior exit stairway* and *ramp*. Such penetrations shall be protected in accordance with Section 714.4.2 of the *International Building Code*.

**[BE] 1023.6 Ventilation.** Equipment and ductwork for *interior exit stairway* and *ramp* ventilation as permitted by Section 1023.5 shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the *interior exit stairway* and *ramp* by ductwork enclosed in construction as required for shafts.
2. Where such equipment and ductwork is located within the *interior exit stairway* and *ramp*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required for shafts.
3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.

In each case, openings into the *fire-resistance-rated* construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 of the *International Building Code* for shaft enclosures.

The *interior exit stairway* and *ramp* ventilation systems shall be independent of other building ventilation systems.

**[BE] 1023.7 Interior exit stairway and ramp exterior walls.** Exterior walls of the *interior exit stairway* or *ramp* shall comply with the requirements of Section 705 of the *International Building Code* for *exterior walls*. Where nonrated walls or unprotected openings enclose the exterior of the *stairway* or *ramps* and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building *exterior walls* within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the topmost landing of the *stairway* or *ramp*, or to the roof line, whichever is lower.

**[BE] 1023.8 Barriers at level of exit discharge.** An *interior exit stairway* and *ramp* shall not continue below its *level of exit discharge* unless an *approved barrier* is provided at the *level of exit discharge* to prevent persons from unintentionally continuing into levels below. Directional exit signs shall be provided as specified in Section 1013.

**[BE] 1023.9 Stairway identification signs.** A sign shall be provided at each floor landing in an *interior exit stairway* and *ramp* connecting more than three stories designating the floor level, the terminus of the top and bottom of the *interior exit stairway* and *ramp* and the identification of the *stairway* or *ramp*. The signage shall state the story of, and the direction to, the *exit discharge* and the availability of roof access from the *interior exit stairway* and *ramp* for the fire department. The bottom of the sign shall be located not less than 5 feet (1524 mm) above the floor landing in a position that is readily visible when the doors are in the open and closed positions.

**[BE] 1023.9.1 Signage requirements.** *Stairway* identification signs shall comply with all of the following requirements:

1. The signs shall be a minimum size of 18 inches (457 mm) by 12 inches (305 mm).
2. The letters designating the identification of the *interior exit stairway* and *ramp* shall be not less than 1½ inches (38 mm) in height.
3. The number designating the floor level shall be not less than 5 inches (127 mm) in height and located in the center of the sign.
4. Other lettering and numbers shall be not less than 1 inch (25 mm) in height.
5. Characters and their background shall have a nonglare finish. Characters shall contrast with their background, with either light characters on a dark background or dark characters on a light background.
6. Where signs required by Section 1023.9 are installed in the *interior exit stairways* and *ramps* of buildings subject to Section 1025, the signs shall be made of the same materials as required by Section 1025.4.

**[BE] 1023.10 Elevator lobby identification signs.** At landings in *interior exit stairways* where two or more doors lead to the floor level, any door with direct access to an enclosed elevator lobby shall be identified by signage located on the door or directly adjacent to the door stating "Elevator Lobby." Signage shall be in accordance with Section 1023.9.1, Items 4, 5 and 6.

**[BE] 1023.11 Tactile floor-level signs.** Where floor-level signs are provided in *interior exit stairways* and *ramps*, a floor-level sign identifying in the floor level in visual characters, raised characters and braille complying with ICC A117.1 shall be located at each floor-level landing adjacent to the door leading from the *interior exit stairway* and *ramp* into the *corridor*.

**[BE] 1023.12 Smokeproof enclosures.** Where required by Section 403.5.4, 405.7.2 or 412.2.2.1 of the *International Building Code*, *interior exit stairways* and *ramps* shall be smokeproof enclosures in accordance with Section 909.20.

**[BE] 1023.12.1 Termination and extension.** A *smokeproof enclosure* shall terminate at an *exit discharge* or a *public way*. The *smokeproof enclosure* shall be permitted

to be extended by an *exit passageway* in accordance with Section 1023.3. The *exit passageway* shall be without openings other than the *fire door assembly* required by Section 1023.3.1 and those necessary for egress from the *exit passageway*. The *exit passageway* shall be separated from the remainder of the building by 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**Exceptions:**

1. Openings in the *exit passageway* serving a *smokeproof enclosure* are permitted where the *exit passageway* is protected and pressurized in the same manner as the *smokeproof enclosure*, and openings are protected as required for access from other floors.
2. The *fire barrier* separating the *smokeproof enclosure* from the *exit passageway* is not required, provided that the *exit passageway* is protected and pressurized in the same manner as the *smokeproof enclosure*.
3. A *smokeproof enclosure* shall be permitted to egress through areas on the *level of exit discharge* or vestibules as permitted by Section 1028.

**[BE] 1023.12.2 Enclosure access.** Access to the *stairway* or *ramp* within a *smokeproof enclosure* shall be by way of a vestibule or an open exterior balcony.

**Exception:** Access is not required by way of a vestibule or exterior balcony for *stairways* and *ramps* using the pressurization alternative complying with Section 909.20.5 of the *International Building Code*.

**[BE] 1023.13 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1024 EXIT PASSAGEWAYS

**[BE] 1024.1 General.** *Exit passageways* serving as an exit component in a *means of egress* system shall comply with the requirements of this section. An *exit passageway* shall not be used for any purpose other than as a *means of egress* and a circulation path.

**[BE] 1024.2 Width and capacity.** The required capacity of *exit passageways* shall be determined as specified in Section 1005.1 but the minimum width shall be not less than 44 inches (1118 mm), except that *exit passageways* serving an *occupant load* of less than 50 shall be not less than 36 inches (914 mm) in width. The minimum width or required capacity of *exit passageways* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**[BE] 1024.3 Construction.** *Exit passageway* enclosures shall have walls, floors and ceilings of not less than a 1-hour *fire-resistance rating*, and not less than that required for any connecting *interior exit stairway* or *ramp*. *Exit passageways* shall be constructed as *fire barriers* in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**[BE] 1024.4 Termination.** *Exit passageways* on the *level of exit discharge* shall terminate at an *exit discharge*. *Exit passageways* on other levels shall terminate at an *exit*.

**[BE] 1024.5 Openings.** *Exit passageway* opening protectives shall be in accordance with the requirements of Section 716 of the *International Building Code*.

Except as permitted in Section 402.8.7 of the *International Building Code*, openings in *exit passageways* other than unprotected exterior openings shall be limited to those necessary for *exit access* to the *exit passageway* from normally occupied spaces and for egress from the *exit passageway*.

Where an *interior exit stairway* or *ramp* is extended to an *exit discharge* or a *public way* by an *exit passageway*, the *exit passageway* shall comply with Section 1023.3.1.

Elevators shall not open into an *exit passageway*.

**[BE] 1024.6 Penetrations.** Penetrations into or through an *exit passageway* are prohibited except for the following:

1. Equipment and ductwork necessary for independent ventilation or pressurization.
2. *Fire protection systems*.
3. Security systems.
4. Two-way communication systems.
5. Electrical raceway for fire department communication.
6. Electrical raceway serving the *exit passageway* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>).

Such penetrations shall be protected in accordance with Section 714 of the *International Building Code*. There shall not be penetrations or communicating openings, whether protected or not, between adjacent *exit passageways*.

**Exception:** Membrane penetrations shall be permitted on the outside of the *exit passageway*. Such penetrations shall be protected in accordance with Section 714.4.2 of the *International Building Code*.

**[BE] 1024.7 Ventilation.** Equipment and ductwork for *exit passageway* ventilation as permitted by Section 1024.6 shall comply with one of the following:

1. The equipment and ductwork shall be located exterior to the building and shall be directly connected to the *exit passageway* by ductwork enclosed in construction as required for shafts.
2. Where the equipment and ductwork is located within the *exit passageway*, the intake air shall be taken

## MEANS OF EGRESS

directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or the air shall be conveyed through ducts enclosed in construction as required for shafts.

3. Where located within the building, the equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for shafts.

In each case, openings into the *fire-resistance-rated* construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 of the *International Building Code* for shaft enclosures.

*Exit passageway* ventilation systems shall be independent of other building ventilation systems.

**[BE] 1024.8 Exit passageway exterior walls.** *Exterior walls* of the *exit passageway* shall comply with Section 705. Where nonrated walls or unprotected openings enclose the exterior of the *exit passageway* and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building *exterior walls* within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the floor of the *exit passageway* or to the roof line, whichever is lower.

**[BE] 1024.9 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1025 LUMINOUS EGRESS PATH MARKINGS

**[BE] 1025.1 General.** *Approved* luminous egress path markings delineating the exit path shall be provided in high-rise buildings of Group A, B, E, I-1, M or R-1 occupancies in accordance with this section.

**Exception:** Luminous egress path markings shall not be required on the *level of exit discharge* in lobbies that serve as part of the exit path in accordance with Section 1028.2, Exception 1.

**[BE] 1025.2 Markings within exit components.** Egress path markings shall be provided in *interior exit stairways*, *interior exit ramps* and *exit passageways*, in accordance with Sections 1025.2.1 through 1025.2.6.3.

**[BE] 1025.2.1 Steps.** A solid and continuous stripe shall be applied to the horizontal leading edge of each step and shall extend for the full length of the step. Outlining stripes shall have a minimum horizontal width of 1 inch (25 mm) and a maximum width of 2 inches (51 mm). The leading edge of the stripe shall be placed not more than  $\frac{1}{2}$  inch (12.7 mm) from the leading edge of the step and the stripe shall not overlap the leading edge of the step by not

more than  $\frac{1}{2}$  inch (12.7 mm) down the vertical face of the step.

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**[BE] 1025.2.2 Landings.** The leading edge of landings shall be marked with a stripe consistent with the dimensional requirements for steps.

**[BE] 1025.2.3 Handrails.** *Handrails* and handrail extensions shall be marked with a solid and continuous stripe having a minimum width of 1 inch (25 mm). The stripe shall be placed on the top surface of the *handrail* for the entire length of the *handrail*, including extensions and newel post caps. Where *handrails* or handrail extensions bend or turn corners, the stripe shall not have a gap of more than 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**[BE] 1025.2.4 Perimeter demarcation lines.** *Stair* landings and other floor areas within *interior exit stairways*, *interior exit ramps* and *exit passageways*, with the exception of the sides of steps, shall be provided with solid and continuous demarcation lines on the floor or on the walls or a combination of both. The stripes shall be 1 to 2 inches (25 mm to 51 mm) wide with interruptions not exceeding 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**[BE] 1025.2.4.1 Floor-mounted demarcation lines.** Perimeter demarcation lines shall be placed within 4 inches (102 mm) of the wall and shall extend to within 2 inches (51 mm) of the markings on the leading edge of landings. The demarcation lines shall continue across the floor in front of all doors.

**Exception:** Demarcation lines shall not extend in front of *exit discharge* doors that lead out of an *exit* and through which occupants must travel to complete the exit path.

**[BE] 1025.2.4.2 Wall-mounted demarcation lines.** Perimeter demarcation lines shall be placed on the wall with the bottom edge of the stripe not more than 4 inches (102 mm) above the finished floor. At the top or bottom of the *stairs*, demarcation lines shall drop vertically to the floor within 2 inches (51 mm) of the step or landing edge. Demarcation lines on walls shall transition vertically to the floor and then extend across the floor where a line on the floor is the only practical method of outlining the path. Where the wall line is broken by a door, demarcation lines on walls shall continue across the face of the door or transition to the floor and extend across the floor in front of such door.

**Exception:** Demarcation lines shall not extend in front of *exit discharge* doors that lead out of an *exit* and through which occupants must travel to complete the exit path.



**[BE] 1025.2.4.3 Transition.** Where a wall-mounted demarcation line transitions to a floor-mounted demarcation line, or vice-versa, the wall-mounted demarcation line shall drop vertically to the floor to meet a complimentary extension of the floor-mounted demarcation line, thus forming a continuous marking.

**[BE] 1025.2.5 Obstacles.** Obstacles at or below 6 feet 6 inches (1981 mm) in height and projecting more than 4 inches (102 mm) into the egress path shall be outlined with markings not less than 1 inch (25 mm) in width comprised of a pattern of alternating equal bands, of luminous material and black, with the alternating bands not more than 2 inches (51 mm) thick and angled at 45 degrees (0.79 rad). Obstacles shall include, but are not limited to, standpipes, hose cabinets, wall projections, and restricted height areas. However, such markings shall not conceal any required information or indicators including but not limited to instructions to occupants for the use of standpipes.

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to markings *listed* in accordance with UL 1994.

**[BE] 1025.2.6 Doors within the exit path.** Doors through which occupants must pass in order to complete the exit path shall be provided with markings complying with Sections 1025.2.6.1 through 1025.2.6.3.

**[BE] 1025.2.6.1 Emergency exit symbol.** The doors shall be identified by a low-location luminous emergency exit symbol complying with NFPA 170. The exit symbol shall be not less than 4 inches (102 mm) in height and shall be mounted on the door, centered horizontally, with the top of the symbol not higher than 18 inches (457 mm) above the finished floor.

**[BE] 1025.2.6.2 Door hardware markings.** Door hardware shall be marked with not less than 16 square inches (10323 mm<sup>2</sup>) of luminous material. This marking shall be located behind, immediately adjacent to, or on the door handle or escutcheon. Where a panic bar is installed, such material shall be not less than 1 inch (25 mm) wide for the entire length of the actuating bar or touchpad.

**[BE] 1025.2.6.3 Door frame markings.** The top and sides of the door frame shall be marked with a solid and continuous 1-inch- to 2-inch-wide (25 mm to 51 mm) stripe. Where the door molding does not provide sufficient flat surface on which to locate the stripe, the stripe shall be permitted to be located on the wall surrounding the frame.

**[BE] 1025.3 Uniformity.** Placement and dimensions of markings shall be consistent and uniform throughout the same enclosure.

**[BE] 1025.4 Self-luminous and photoluminescent.** Luminous egress path markings shall be permitted to be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminance. Such materials shall include, but not be limited to, *self-lumi-*

*nous* materials and *photoluminescent* materials. Materials shall comply with either of the following standards:

1. UL 1994.
2. ASTM E2072, except that the charging source shall be 1 footcandle (11 lux) of fluorescent illumination for 60 minutes, and the minimum luminance shall be 30 milicandelas per square meter at 10 minutes and 5 milicandelas per square meter after 90 minutes.

**[BE] 1025.5 Illumination.** Where *photoluminescent* exit path markings are installed, they shall be provided with not less than 1 footcandle (11 lux) of illumination for not less than 60 minutes prior to periods when the building is occupied and continuously during the building occupancy.

## SECTION 1026 HORIZONTAL EXITS

**[BE] 1026.1 General.** *Horizontal exits* serving as an exit in a means of egress system shall comply with the requirements of this section. A *horizontal exit* shall not serve as the only exit from a portion of a building, and where two or more exits are required, not more than one-half of the total number of exits or total exit minimum width or required capacity shall be *horizontal exits*.

### Exceptions:

1. *Horizontal exits* are permitted to comprise two-thirds of the required exits from any building or floor area for occupancies in Group I-2.
2. *Horizontal exits* are permitted to comprise 100 percent of the exits required for occupancies in Group I-3. Not less than 6 square feet (0.6 m<sup>2</sup>) of accessible space per occupant shall be provided on each side of the *horizontal exit* for the total number of people in adjoining compartments.

**[BE] 1026.2 Separation.** The separation between buildings or refuge areas connected by a *horizontal exit* shall be provided by a *fire wall* complying with Section 706 of the *International Building Code*; or by a *fire barrier* complying with Section 707 of the *International Building Code* or a *horizontal assembly* complying with Section 711 of the *International Building Code*, or both. The minimum *fire-resistance rating* of the separation shall be 2 hours. Opening protectives in *horizontal exits* shall also comply with Section 716 of the *International Building Code*. Duct and air transfer openings in a *fire wall* or *fire barrier* that serves as a *horizontal exit* shall also comply with Section 717 of the *International Building Code*. The *horizontal exit* separation shall extend vertically through all levels of the building unless floor assemblies have a *fire-resistance rating* of not less than 2 hours and do not have unprotected openings.

**Exception:** A *fire-resistance rating* is not required at *horizontal exits* between a building area and an above-grade pedestrian walkway constructed in accordance with Section 3104 of the *International Building Code*, provided that the distance between connected buildings is more than 20 feet (6096 mm).



## MEANS OF EGRESS

*Horizontal exits* constructed as *fire barriers* shall be continuous from *exterior wall* to *exterior wall* so as to divide completely the floor served by the *horizontal exit*.

**[BE] 1026.3 Opening protectives.** *Fire doors* in *horizontal exits* shall be self-closing or automatic-closing when activated by a *smoke detector* in accordance with Section 716.2.6.6 of the *International Building Code*. Doors, where located in a cross-corridor condition, shall be automatic-closing by activation of a *smoke detector* installed in accordance with Section 716.2.6.6 of the *International Building Code*.

**[BE] 1026.4 Refuge area.** The refuge area of a *horizontal exit* shall be a space occupied by the same tenant or a public area and each such refuge area shall be adequate to accommodate the original *occupant load* of the refuge area plus the *occupant load* anticipated from the adjoining compartment. The anticipated *occupant load* from the adjoining compartment shall be based on the capacity of the *horizontal exit* doors entering the refuge area, or the total *occupant load* of the adjoining compartment, whichever is less.

**[BE] 1026.4.1 Capacity.** The capacity of the refuge area shall be computed based on a *net floor area* allowance of 3 square feet (0.2787 m<sup>2</sup>) for each occupant to be accommodated therein. Where the horizontal exit also forms a *smoke compartment*, the capacity of the refuge area for Group I-1, I-2 and I-3 occupancies and Group B ambulatory care facilities shall comply with Sections 407.5.3, 408.6.2, 420.6.1 and 422.3.2 of the *International Building Code* as applicable.

**[BE] 1026.4.2 Number of exits.** The refuge area into which a *horizontal exit* leads shall be provided with *exits* adequate to meet the occupant requirements of this chapter, but not including the added *occupant load* imposed by persons entering the refuge area through *horizontal exits* from other areas. Not less than one refuge area *exit* shall lead directly to the exterior or to an *interior exit stairway* or *ramp*.

**Exception:** The adjoining compartment shall not be required to have a *stairway* or door leading directly outside, provided that the refuge area into which a *horizontal exit* leads has *stairways* or doors leading directly outside and are so arranged that egress shall not require the occupants to return through the compartment from which egress originates.

**[BE] 1026.5 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1027 EXTERIOR EXIT STAIRWAYS AND RAMPS

**[BE] 1027.1 General.** *Exterior exit stairways* and *ramps* serving as an exit component in a *means of egress* system shall comply with the requirements of this section.

**[BE] 1027.2 Use in a means of egress.** *Exterior exit stairways* shall not be used as an element of a required *means of egress* for Group I-2 occupancies. For occupancies in other

than Group I-2, *exterior exit stairways* and *ramps* shall be permitted as an element of a required *means of egress* for buildings not exceeding six stories above *grade plane* or that are not high-rise buildings.

**[BE] 1027.3 Open side.** *Exterior exit stairways* and *ramps* serving as an element of a required *means of egress* shall be open on not less than one side, except for required structural columns, beams, *handrails* and guards. An open side shall have not less than 35 square feet (3.3 m<sup>2</sup>) of aggregate open area adjacent to each floor level and the level of each intermediate landing. The required open area shall be located not less than 42 inches (1067 mm) above the adjacent floor or landing level.

**[BE] 1027.4 Side yards.** The open areas adjoining *exterior exit stairways* or *ramps* shall be either *yards*, *courts* or *public ways*; the remaining sides are permitted to be enclosed by the *exterior walls* of the building.

**[BE] 1027.5 Location.** *Exterior exit stairways* and *ramps* shall have a minimum *fire separation distance* of 10 feet (3048 mm) measured at right angles from the exterior edge of the *stairway* or ramps, including landings, to:

1. Adjacent lot lines.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 of the *International Building Code* based on *fire separation distance*.

For the purposes of this section, other portions of the building shall be treated as separate buildings.

**Exception:** *Exterior exit stairways* and *ramps* serving individual *dwelling units* of Group R-3 shall have a *fire separation distance* of not less than 5 feet (1524 mm).

**[BE] 1027.6 Exterior exit stairway and ramp protection.** *Exterior exit stairways* and *ramps* shall be separated from the interior of the building as required in Section 1023.2. Openings shall be limited to those necessary for egress from normally occupied spaces. Where a vertical plane projecting from the edge of an *exterior exit stairway* or *ramp* and landings is exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the *exterior wall* shall be rated in accordance with Section 1023.7.

### Exceptions:

1. Separation from the interior of the building is not required for occupancies, other than those in Group R-1 or R-2, in buildings that are not more than two stories above *grade plane* where a *level of exit discharge* serving such occupancies is the first story above *grade plane*.
2. Separation from the interior of the building is not required where the *exterior exit stairway* or *ramp* is served by an *exterior exit ramp* or balcony that connects two remote *exterior exit stairways* or other *approved exits*, with a perimeter that is not less than 50 percent open. To be considered open, the opening shall be not less than 50 percent of the height of the enclosing wall, with the top of the

- openings not less than 7 feet (2134 mm) above the top of the balcony.
3. Separation from the *open-ended corridor* of the building is not required for *exterior exit stairways* or *ramps*, provided that Items 3.1 through 3.5 are met:
    - 3.1. The building, including *open-ended corridors*, and *stairways* and *ramps*, shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
    - 3.2. The *open-ended corridors* comply with Section 1020.
    - 3.3. The *open-ended corridors* are connected on each end to an *exterior exit stairway* or *ramp* complying with Section 1027.
    - 3.4. The *exterior walls* and openings adjacent to the *exterior exit stairway* or *ramp* comply with Section 1023.7.
    - 3.5. At any location in an *open-ended corridor* where a change of direction exceeding 45 degrees (0.79 rad) occurs, a clear opening of not less than 35 square feet (3.3 m<sup>2</sup>) or an *exterior stairway* or *ramp* shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.
  4. In Group R-3 occupancies not more than four stories in height, *exterior exit stairways* and *ramps* serving individual *dwelling units* are not required to be separated from the interior of the building where the *exterior exit stairway* or *ramp* discharges directly to grade.

## SECTION 1028 EXIT DISCHARGE

**[BE] 1028.1 General.** The *exit discharge* shall comply with Sections 1028 and 1029 and the applicable requirements of Sections 1003 through 1015.

**[BE] 1028.2 Exit discharge.** *Exits* shall discharge directly to the exterior of the building. The *exit discharge* shall be at grade or shall provide a direct path of egress travel to grade. The *exit discharge* shall not reenter a building. The combined use of Exceptions 1 and 2 shall not exceed 50 percent of the number and minimum width or required capacity of the required *exits*.

### Exceptions:

1. Not more than 50 percent of the number and minimum width or required capacity of *interior exit stairways* and *ramps* is permitted to egress through areas, including atriums, on the *level of discharge* provided that all of the following conditions are met:
  - 1.1. Discharge of *interior exit stairways* and *ramps* shall be provided with a free and unobstructed path of travel to an exterior exit door and such *exit* is readily visible and identifiable from the point of termination of the enclosure.
  - 1.2. The entire area of the *level of exit discharge* is separated from areas below by construction conforming to the *fire-resistance rating* for the enclosure.
  - 1.3. The egress path from the *interior exit stairway* and *ramp* on the *level of exit discharge* is protected throughout by an *approved automatic sprinkler system*. Portions of the *level of exit discharge* with access to the egress path shall either be equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, or separated from the egress path in accordance with the requirements for the enclosure of *interior exit stairways* or *ramps*.
  - 1.4. Where a required *interior exit stairway* or *ramp* and an *exit access stairway* or *ramp* serve the same floor level and terminate at the same *level of exit discharge*, the termination of the *exit access stairway* or *ramp* and the exit discharge door of the *interior exit stairway* or *ramp* shall be separated by a distance of not less than 30 feet (9144 mm) or not less than one-fourth the length of the maximum overall diagonal dimension of the building, whichever is less. The distance shall be measured in a straight line between the exit discharge door from the *interior exit stairway* or *ramp* and the last tread of the *exit access stairway* or termination of slope of the *exit access ramp*.
2. Not more than 50 percent of the number and minimum width or required capacity of the interior *exit stairways* and *ramps* is permitted to egress through a vestibule provided that all of the following conditions are met:
  - 2.1. The entire area of the vestibule is separated from areas below by construction conforming to the *fire-resistance rating* of the *interior exit stairway* or *ramp* enclosure.
  - 2.2. The depth from the exterior of the building is not greater than 10 feet (3048 mm) and the length is not greater than 30 feet (9144 mm).
  - 2.3. The area is separated from the remainder of the *level of exit discharge* by a *fire partition* constructed in accordance with Section 708 of the *International Building Code*.
 

**Exception:** The maximum transmitted temperature rise is not required.
  - 2.4. The area is used only for *means of egress* and *exits* directly to the outside.

## MEANS OF EGRESS

3. *Horizontal exits* complying with Section 1026 shall not be required to discharge directly to the exterior of the building.

**[BE] 1028.3 Exit discharge width or capacity.** The minimum width or required capacity of the *exit discharge* shall be not less than the minimum width or required capacity of the *exits* being served.

**[BE] 1028.4 Exit discharge components.** *Exit discharge* components shall be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases.

**[BE] 1028.5 Access to a public way.** The *exit discharge* shall provide a direct and unobstructed access to a *public way*.

**Exception:** Where access to a *public way* cannot be provided, a safe dispersal area shall be provided where all of the following are met:

1. The area shall be of a size to accommodate *not less than* 5 square feet (0.46 m<sup>2</sup>) for each person.
2. The area shall be located on the same lot not less than 50 feet (15 240 mm) away from the building requiring egress.
3. The area shall be permanently maintained and identified as a safe dispersal area.
4. The area shall be provided with a safe and unobstructed path of travel from the building.

## SECTION 1029 EGRESS COURTS

**[BE] 1029.1 General.** *Egress courts* serving as an *exit discharge component* in the *means of egress* system shall comply with the requirements in this section.

**[BE] 1029.2 Width or capacity.** The required capacity of *egress courts* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm), except as specified herein. *Egress courts* serving Group R-3 and U occupancies shall be not less than 36 inches (914 mm) in width. The required capacity and width of *egress courts* shall be unobstructed to a height of 7 feet (2134 mm).

The width of the *egress court* shall be not less than the required capacity.

**Exception:** Encroachments complying with Section 1005.7.

**[BE] 1029.3 Construction and openings.** Where an *egress court* serving a building or portion thereof is less than 10 feet (3048 mm) in width, the *egress court* walls shall have not less than 1-hour *fire-resistance-rated* construction for a distance of 10 feet (3048 mm) above the floor of the *egress court*. Openings within such walls shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.

**Exceptions:**

1. *Egress courts* serving an *occupant load* of less than 10.
2. *Egress courts* serving Group R-3.

## SECTION 1030 ASSEMBLY

**[BE] 1030.1 General.** A room or space used for assembly purposes that contains seats, tables, displays, equipment or other material shall comply with this section.

**[BE] 1030.1.1 Bleachers.** *Bleachers*, *grandstands* and *folding and telescopic seating*, that are not building elements, shall comply with ICC 300.

**[BE] 1030.1.1.1 Spaces under grandstands and bleachers.** Spaces under *grandstands* or *bleachers* shall be separated by *fire barriers* complying with Section 707 of the *International Building Code* and *horizontal assemblies* complying with Section 711 of the *International Building Code* with not less than 1-hour *fire-resistance-rated* construction.

**Exceptions:**

1. Ticket booths less than 100 square feet (9 m<sup>2</sup>) in area.
2. Toilet rooms.
3. Other accessory use areas 1,000 square feet (93 m<sup>2</sup>) or less in area and equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[BE] 1030.2 Assembly main exit.** A building, room or space used for assembly purposes that has an *occupant load* of greater than 300 and is provided with a main *exit*, that main *exit* shall be of sufficient capacity to accommodate not less than one-half of the *occupant load*, but such capacity shall be not less than the total required capacity of all *means of egress* leading to the *exit*. Where the building is classified as a Group A occupancy, the main *exit* shall front on not less than one street or an unoccupied space of not less than 10 feet (3048 mm) in width that adjoins a street or *public way*. In a building, room or space used for assembly purposes where there is not a well-defined main *exit* or where multiple main *exits* are provided, *exits* shall be permitted to be distributed around the perimeter of the building provided that the total capacity of egress is not less than 100 percent of the required capacity.

**[BE] 1030.3 Assembly other exits.** In addition to having access to a main *exit*, each level in a building used for assembly purposes having an *occupant load* greater than 300 and provided with a main *exit*, shall be provided with additional *means of egress* that shall provide an egress capacity for not less than one-half of the total *occupant load* served by that level and shall comply with Section 1007.1. In a building used for assembly purposes where there is not a well-defined main *exit* or where multiple main *exits* are provided, *exits* for each level shall be permitted to be distributed around the perimeter of the building, provided that the total width of egress is not less than 100 percent of the required width.

**[BE] 1030.4 Foyers and lobbies.** In Group A-1 occupancies, where persons are admitted to the building at times when seats are not available, such persons shall be allowed to wait in a lobby or similar space, provided that such lobby or similar space shall not encroach on the minimum width or required capacity of the *means of egress*. Such foyer, if not



directly connected to a public street by all the main entrances or *exits*, shall have a straight and unobstructed *corridor* or path of travel to every such main entrance or *exit*.

**[BE] 1030.5 Interior balcony and gallery means of egress.** For balconies, galleries or press boxes having a seating capacity of 50 or more located in a building, room or space used for assembly purposes, not less than two *means of egress* shall be provided, with one from each side of every balcony, gallery or press box.

**[BE] 1030.6 Capacity of aisle for assembly.** The required capacity of *aisles* shall be not less than that determined in accordance with Section 1030.6.1 where *smoke-protected assembly seating* is not provided, with Section 1030.6.2 where *smoke-protected assembly seating* is provided, and with Section 1030.6.3 where open-air assembly seating is provided.

**[BE] 1030.6.1 Without smoke protection.** The required capacity in inches (mm) of the *aisles* for assembly seating without smoke protection shall be not less than the *occupant load* served by the egress element in accordance with all of the following, as applicable:

1. Not less than 0.3 inch (7.6 mm) of *aisle* capacity for each occupant served shall be provided on stepped *aisles* having riser heights 7 inches (178 mm) or less and tread depths 11 inches (279 mm) or greater, measured horizontally between tread *nosings*.
2. Not less than 0.005 inch (0.127 mm) of additional *aisle* capacity for each occupant shall be provided for each 0.10 inch (2.5mm) of riser height above 7 inches (178 mm).
3. Where egress requires stepped *aisle* descent, not less than 0.075 inch (1.9 mm) of additional *aisle* capacity for each occupant shall be provided on those portions of *aisle* capacity that do not have a *handrail* within a horizontal distance of 30 inches (762 mm).
4. Ramped *aisles*, where slopes are steeper than 1 unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.22 inch (5.6 mm) of clear *aisle* capacity for each occupant served. Level or ramped *aisles*, where slopes are not steeper than 1 unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.20

inch (5.1 mm) of clear *aisle* capacity for each occupant served.

**[BE] 1030.6.2 Smoke-protected assembly seating.** The required capacity in inches (mm) of the *aisle* for *smoke-protected assembly seating* shall be not less than the *occupant load* served by the egress element multiplied by the appropriate factor in Table 1030.6.2. The total number of seats specified shall be those within the space exposed to the same smoke-protected environment. Interpolation is permitted between the specific values shown. A life safety evaluation, complying with NFPA 101, shall be done for a facility utilizing the reduced width requirements of Table 1030.6.2 for *smoke-protected assembly seating*.

**[BE] 1030.6.2.1 Smoke control.** *Aisles* and *aisle accessways* serving a *smoke-protected assembly seating* area shall be provided with a smoke control system complying with Section 909 or natural ventilation designed to maintain the smoke level not less than 6 feet (1829 mm) above the floor of the *means of egress*.

**[BE] 1030.6.2.2 Roof height.** A *smoke-protected assembly seating area* with a roof shall have the lowest portion of the roof deck not less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway*.

**Exception:** A roof canopy in an outdoor stadium shall be permitted to be less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway* provided that there are no objects less than 80 inches (2032 mm) above the highest *aisle* or *aisle accessway*.

**[BE] 1030.6.2.3 Automatic sprinklers.** Enclosed areas with walls and ceilings in buildings or structures containing *smoke-protected assembly seating* shall be protected with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

#### Exceptions:

1. The floor area used for contests, performances or entertainment provided that the roof construction is more than 50 feet (15 240 mm) above the floor level and the use is restricted to low fire hazard uses.
2. Press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area.

**[BE] TABLE 1030.6.2  
CAPACITY FOR AISLES FOR SMOKE-PROTECTED ASSEMBLY**

TOTAL NUMBER OF SEATS IN THE SMOKE-PROTECTED ASSEMBLY SEATING	INCHES OF CAPACITY PER SEAT SERVED			
	Stepped aisles with handrails within 30 inches	Stepped aisles without handrails within 30 inches	Level aisles or ramped aisles not steeper than 1 in 10 in slope	Ramped aisles steeper than 1 in 10 in slope
Equal to or less than 5,000	0.200	0.250	0.150	0.165
10,000	0.130	0.163	0.100	0.110
15,000	0.096	0.120	0.070	0.077
20,000	0.076	0.095	0.056	0.062
Equal to or greater than 25,000	0.060	0.075	0.044	0.048

For SI: 1 inch = 25.4 mm.



## MEANS OF EGRESS

**[BE] 1030.6.3 Open-air assembly seating.** In *open-air assembly seating*, the required capacity in inches (mm) of *aisles* shall be not less than the total *occupant load* served by the egress element multiplied by 0.08 (2.0 mm) where egress is by stepped *aisle* and multiplied by 0.06 (1.52 mm) where egress is by level *aisles* and ramped *aisles*.

**Exception:** The required capacity in inches (mm) of *aisles* shall be permitted to comply with Section 1030.6.2 for the number of seats in the *open-air assembly seating* where Section 1030.6.2 permits less capacity.

**[BE] 1030.6.3.1 Automatic sprinklers.** Enclosed areas with walls and ceilings in buildings or structures containing *open-air assembly seating* shall be protected with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**Exceptions:**

1. The floor area used for contests, performances or entertainment, provided that the roof construction is more than 50 feet (15 240 mm) above the floor level and the use is restricted to low-fire hazard uses.
2. Press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area.
3. *Open-air assembly seating* facilities where seating and the means of egress in the seating area are essentially open to the outside.

**[BE] 1030.7 Travel distance.** The *exit access* travel distance shall comply with Section 1017. Where *aisles* are provided for seating, the distance shall be measured along the *aisles* and *aisle accessways* without travel over or on the seats.

**Exceptions:**

1. In facilities with *smoke-protected assembly seating* the total *exit access* travel distance shall be not greater than 400 feet (122 m). That portion of the total permitted *exit access* travel distance from each seat to the nearest entrance to a vomitory or concourse shall not exceed 200 feet (60 960 mm). The portion of the total permitted *exit access* travel distance from the entrance to the vomitory or concourse to one of the following shall not exceed 200 feet (60 960 mm).
  - 1.1. The closest riser of an *exit access stairway*.
  - 1.2. The closest slope of an *exit access ramp*.
  - 1.3. An *exit*.
2. In facilities with *open-air assembly seating* of Type III, IV or V construction, the total *exit access* travel distance to one of the following shall not exceed 400 feet (122 m).
  - 2.1. The closest riser of an *exit access stairway*.
  - 2.2. The closest slope of an *exit access ramp*.
  - 2.3. An *exit*.
3. In facilities with *open-air assembly seating* of Type I or II construction, the *exit access* travel distance shall not be limited.

**[BE] 1030.8 Common path of egress travel.** The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any seat to a point where an occupant has a choice of two paths of egress travel to two *exits*.

**Exceptions:**

1. For areas serving less than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).
2. For *smoke-protected* or *open-air assembly seating*, the *common path of egress travel* shall not exceed 50 feet (15 240 mm).

**[BE] 1030.8.1 Path through adjacent row.** Where one of the two paths of travel is across the *aisle* through a row of seats to another *aisle*, there shall be not more than 24 seats between the two *aisles*, and the minimum clear width between rows for the row between the two *aisles* shall be 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row between *aisles*.

**Exception:** For *smoke-protected* or *open-air assembly seating* there shall be not more than 40 seats between the two *aisles* and the minimum clear width shall be 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat.

**[BE] 1030.9 Assembly aisles are required.** Every occupied portion of any building, room or space used for assembly purposes that contains seats, tables, displays, similar fixtures or equipment shall be provided with *aisles* leading to *exits* or *exit access doorways* in accordance with this section.

**[BE] 1030.9.1 Minimum aisle width.** The minimum clear width for *aisles* shall comply with one of the following:

1. Forty-eight inches (1219 mm) for stepped *aisles* having seating on both sides.
 

**Exception:** Thirty-six inches (914 mm) where the stepped *aisles* serve less than 50 seats.
2. Thirty-six inches (914 mm) for stepped *aisles* having seating on only one side.
 

**Exception:** Twenty-three inches (584 mm) between a stepped aisle *handrail* and seating where a stepped *aisle* does not serve more than five rows on one side.
3. Twenty-three inches (584 mm) between a stepped aisle *handrail* or *guard* and seating where the stepped *aisle* is subdivided by a mid-aisle *handrail*.
4. Forty-two inches (1067 mm) for level or ramped *aisles* having seating on both sides.

**Exceptions:**

1. Thirty-six inches (914 mm) where the *aisle* serves less than 50 seats.
2. Thirty inches (762 mm) where the *aisle* serves fewer than 15 seats and does not serve as part of an *accessible route*.

5. Thirty-six inches (914 mm) for level or ramped *aisles* having seating on only one side.

**Exception:** Thirty inches (762 mm) where the *aisle* serves fewer than 15 seats and does not serve as part of an *accessible route*.

**[BE] 1030.9.2 Aisle catchment area.** The *aisle* shall provide sufficient capacity for the number of persons accommodated by the catchment area served by the *aisle*. The catchment area served by an *aisle* is that portion of the total space served by that section of the *aisle*. In establishing catchment areas, the assumption shall be made that there is a balanced use of all *means of egress*, with the number of persons in proportion to egress capacity.

**[BE] 1030.9.3 Converging aisles.** Where *aisles* converge to form a single path of egress travel, the required capacity of that path shall be not less than the combined required capacity of the converging *aisles*.

**[BE] 1030.9.4 Uniform width and capacity.** Those portions of *aisles*, where egress is possible in either of two directions, shall be uniform in minimum width or required capacity.

**[BE] 1030.9.5 Dead-end aisles.** Each end of an *aisle* shall be continuous to a cross *aisle*, foyer, doorway, vomitory, concourse or *stairway* in accordance with Section 1030.9.7 having access to an *exit*.

**Exceptions:**

1. Dead-end *aisles* shall be not greater than 20 feet (6096 mm) in length.
2. Dead-end *aisles* longer than 16 rows are permitted where seats beyond the 16th row dead-end *aisle* are not more than 24 seats from another *aisle*, measured along a row of seats having a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.
3. For *smoke-protected* or *open-air assembly seating*, the dead-end *aisle* length of vertical *aisles* shall not exceed a distance of 21 rows.
4. For *smoke-protected* or *open-air assembly seating*, a longer dead-end *aisle* is permitted where seats beyond the 21-row dead-end *aisle* are not more than 40 seats from another *aisle*, measured along a row of seats having an *aisle accessway* with a minimum clear width of 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.

**[BE] 1030.9.6 Aisle measurement.** The clear width for *aisles* shall be measured to walls, edges of seating and tread edges except for permitted projections.

**Exception:** The clear width of *aisles* adjacent to seating at tables shall be permitted to be measured in accordance with Section 1030.13.1.

**[BE] 1030.9.6.1 Assembly aisle obstructions.** There shall not be obstructions in the minimum width or required capacity of *aisles*.

**Exception:** *Handrails* are permitted to project into the required width of stepped *aisles* and ramped *aisles* in accordance with Section 1014.8.

**[BE] 1030.9.7 Stairways connecting to stepped aisles.** A *stairway* that connects a stepped *aisle* to a cross *aisle* or concourse shall be permitted to comply with the assembly *aisle* walking surface requirements of Section 1030.14. Transitions between *stairways* and stepped *aisles* shall comply with Section 1030.10.

**[BE] 1030.9.8 Stairways connecting to vomitories.** A *stairway* that connects a vomitory to a cross *aisle* or concourse shall be permitted to comply with the assembly *aisle* walking surface requirements of Section 1030.14. Transitions between *stairways* and stepped *aisles* shall comply with Section 1030.10.

**[BE] 1030.10 Transitions.** Transitions between *stairways* and stepped *aisles* shall comply with either Section 1030.10.1 or 1030.10.2.

**[BE] 1030.10.1 Transitions to stairways that maintain stepped aisle riser and tread dimensions.** Stepped *aisles*, transitions and *stairways* that maintain the stepped *aisle* riser and tread dimensions shall comply with Section 1030.14 as one *exit access* component.

**[BE] 1030.10.2 Transitions to stairways that do not maintain stepped aisle riser and tread dimensions.** Transitions between *stairways* and stepped *aisles* having different riser and tread dimensions shall comply with Sections 1030.10.2.1 through 1030.10.3.

**[BE] 1030.10.2.1 Stairways and stepped aisles in a straight run.** Where *stairways* and stepped *aisles* are in a straight run, transitions shall have one of the following:

1. A depth of not less than 22 inches (559 mm) where the treads on the descending side of the transition have greater depth.
2. A depth of not less than 30 inches (762 mm) where the treads on the descending side of the transition have lesser depth.

**[BE] 1030.10.2.2 Stairways that change direction from stepped aisles.** Transitions where the *stairway* changes direction from the stepped *aisle* shall have a minimum depth of 11 inches (280 mm) or the stepped *aisle* tread depth, whichever is greater, between the stepped *aisle* and *stairway*.

**[BE] 1030.10.3 Transition marking.** A distinctive marking stripe shall be provided at each *nosing* or leading edge adjacent to the transition. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the stepped *aisle* contrasting marking stripe.

**[BE] 1030.11 Stepped aisles at vomitories.** Stepped *aisles* that change direction at vomitories shall comply with

## MEANS OF EGRESS

Section 1030.11.1. Transitions between a stepped *aisle* above a vomitory and a stepped *aisle* to the side of a vomitory shall comply with Section 1030.11.2.

**[BE] 1030.11.1 Stepped aisles that change direction at vomitories.** Stepped *aisle* treads where the stepped *aisle* changes direction at a vomitory shall have a depth of not less than 11 inches (280 mm) or the stepped aisle tread depth, whichever is greater. The height of a stepped aisle tread above a transition at a vomitory shall comply with Section 1030.14.2.2.

**[BE] 1030.11.2 Stepped aisle transitions at the top of vomitories.** Transitions between the stepped *aisle* above a vomitory and stepped *aisles* to the side of a vomitory shall have a depth of not less than 11 inches (280 mm) or the stepped aisle tread depth, whichever is greater.

**[BE] 1030.12 Construction.** *Aisles*, stepped *aisles* and ramped *aisles* shall be built of materials consistent with the types permitted for the type of construction of the building.

**Exception:** Wood *handrails* shall be permitted for all types of construction.

**[BE] 1030.12.1 Walking surface.** The surface of *aisles*, stepped *aisles* and ramped *aisles* shall be of slip-resistant materials that are securely attached. The surface for stepped *aisles* shall comply with Section 1011.7.1.

**[BE] 1030.12.2 Outdoor conditions.** Outdoor *aisles*, stepped *aisles* and ramped *aisles* and outdoor approaches to *aisles*, stepped *aisles* and ramped *aisles* shall be designed so that water will not accumulate on the walking surface.

**[BE] 1030.13 Aisle accessways.** *Aisle accessways* for seating at tables shall comply with Section 1030.13.1. *Aisle accessways* for seating in rows shall comply with Section 1030.13.2.

**[BE] 1030.13.1 Seating at tables.** Where seating is located at a table or counter and is adjacent to an *aisle* or *aisle accessway*, the measurement of required clear width of the *aisle* or *aisle accessway* shall be made to a line 19 inches (483 mm) away from and parallel to the edge of the table or counter. The 19-inch (483 mm) distance shall be measured perpendicular to the side of the table or counter. In the case of other side boundaries for *aisles* or *aisle accessways*, the clear width shall be measured to walls, edges of seating and tread edges.

**Exception:** Where tables or counters are served by fixed seats, the width of the *aisle* or *aisle accessway* shall be measured from the back of the seat.

**[BE] 1030.13.1.1 Aisle accessway capacity and width for seating at tables.** *Aisle accessways* serving arrangements of seating at tables or counters shall comply with the capacity requirements of Section 1005.1 but shall not have less than 12 inches (305 mm) of width plus  $\frac{1}{2}$  inch (12.7 mm) of width for each additional 1 foot (305 mm), or fraction thereof, beyond

12 feet (3658 mm) of *aisle accessway* length measured from the center of the seat farthest from an *aisle*.

**Exception:** Portions of an *aisle accessway* having a length not exceeding 6 feet (1829 mm) and used by a total of not more than four persons.

**[BE] 1030.13.1.2 Seating at table aisle accessway length.** The length of travel along the *aisle accessway* shall not exceed 30 feet (9144 mm) from any seat to the point where a person has a choice of two or more paths of egress travel to separate *exits*.

**[BE] 1030.13.2 Clear width of aisle accessways serving seating in rows.** Where seating rows have 14 or fewer seats, the minimum clear *aisle accessway* width shall be not less than 12 inches (305 mm) measured as the clear horizontal distance from the back of the row ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurements shall be made with the seat in the down position. For seats with folding tablet arms, row spacing shall be determined with the tablet arm in the used position.

**Exception:** For seats with folding tablet arms, row spacing is permitted to be determined with the tablet arm in the stored position where the tablet arm when raised manually to vertical position in one motion automatically returns to the stored position by force of gravity.

**[BE] 1030.13.2.1 Dual access.** For rows of seating served by *aisles* or doorways at both ends, there shall be not more than 100 seats per row. The minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.3 inch (7.6 mm) for every additional seat beyond 14 seats where seats have backrests or beyond 21 where seats are without backrests. The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected* or *open-air assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 1030.13.2.1.

**[BE] 1030.13.2.2 Single access.** For rows of seating served by an *aisle* or doorway at only one end of the row, the minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.6 inch (15.2 mm) for every additional seat beyond seven seats where seats have backrests or beyond 10 where seats are without backrests. The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected* or *open-air assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the *aisle accessway* minimum clear width shall be increased, are in Table 1030.13.2.1.

[BE] TABLE 1030.13.2.1  
SMOKE-PROTECTED OR OPEN-AIR ASSEMBLY AISLE ACCESSWAYS

NUMBER OF SEATS IN THE SMOKE-PROTECTED OR OPEN-AIR ASSEMBLY SEATING	MAXIMUM NUMBER OF SEATS PER ROW PERMITTED TO HAVE A MINIMUM 12-INCH CLEAR WIDTH AISLE ACCESSWAY			
	Aisle or doorway at both ends of row		Aisle or doorway at one end of row only	
	Seats with backrests	Seats without backrests	Seats with backrests	Seats without backrests
Less than 4,000	14	21	7	10
4,000 to 6,999	15	22	7	10
7,000 to 9,999	16	23	8	11
10,000 to 12,999	17	24	8	11
13,000 to 15,999	18	25	9	12
16,000 to 18,999	19	26	9	12
19,000 to 21,999	20	27	10	13
22,000 and greater	21	28	11	14

For SI: 1 inch = 25.4 mm.

[BE] **1030.14 Assembly aisle walking surfaces.** Ramped *aisles* shall comply with Sections 1030.14.1 through 1030.14.1.3. Stepped *aisles* shall comply with Sections 1030.14.2 through 1030.14.2.4.

[BE] **1030.14.1 Ramped aisles.** *Aisles* that are sloped more than 1 unit vertical in 20 units horizontal (5-percent slope) shall be considered to be a ramped *aisle*. Ramped *aisles* that serve as part of an *accessible route* in accordance with Section 1009 of this code and Section 1108.2 of the *International Building Code* shall have a maximum slope of 1 unit vertical in 12 units horizontal (8-percent slope). The slope of other ramped *aisles* shall not exceed 1 unit vertical in 8 units horizontal (12.5-percent slope).

[BE] **1030.14.1.1 Cross slope.** The slope measured perpendicular to the direction of travel of a ramped *aisle* shall not be steeper than 1 unit vertical in 48 units horizontal (2-percent slope).

[BE] **1030.14.1.2 Landings.** Ramped *aisles* shall have landings in accordance with Sections 1012.6 through 1012.6.5. Landings for ramped *aisles* shall be permitted to overlap required *aisles* or cross *aisles*.

[BE] **1030.14.1.3 Edge protection.** Ramped *aisles* shall have edge protection in accordance with Sections 1012.10 and 1012.10.1.

**Exception:** In assembly spaces with *fixed seating*, edge protection is not required on the sides of ramped *aisles* where the ramped *aisles* provide access to the adjacent seating and *aisle accessways*.

[BE] **1030.14.2 Stepped aisles.** *Aisles* with a slope exceeding 1 unit vertical in 8 units horizontal (12.5-percent slope) shall consist of a series of risers and treads that extends across the full width of *aisles* and complies with Sections 1030.14.2.1 through 1030.14.2.4.

[BE] **1030.14.2.1 Treads.** Tread depths shall be not less than 11 inches (279 mm) and shall have dimensional uniformity.

**Exception:** The tolerance between adjacent treads shall not exceed  $\frac{3}{16}$  inch (4.8 mm).

[BE] **1030.14.2.2 Risers.** Where the gradient of stepped *aisles* is to be the same as the gradient of adjoining seating areas, the riser height shall be not less than 4 inches (102 mm) nor more than 8 inches (203 mm) and shall be uniform within each *flight*.

**Exceptions:**

1. Riser height nonuniformity shall be limited to the extent necessitated by changes in the gradient of the adjoining seating area to maintain adequate sightlines. Where nonuniformities exceed  $\frac{3}{16}$  inch (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated with a distinctive marking stripe on each tread at the *nosing* or leading edge adjacent to the nonuniform risers. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the contrasting marking stripe.
2. Riser heights not exceeding 9 inches (229 mm) shall be permitted where they are necessitated by the slope of the adjacent seating areas to maintain sightlines.

[BE] **1030.14.2.2.1 Construction tolerances.** The tolerance between adjacent risers on a stepped *aisle* that were designed to be equal height shall not exceed  $\frac{3}{16}$  inch (4.8 mm). Where the stepped *aisle* is designed in accordance with Exception 1 of Section 1030.14.2.2, the stepped *aisle* shall be constructed so that each riser of unequal height, determined in the direction of descent, is not more than  $\frac{3}{8}$  inch (9.5 mm) in height different from adjacent risers where stepped *aisle* treads are less than 22 inches (560 mm) in depth and  $\frac{3}{4}$  inch (19.1 mm) in height different from adjacent risers where stepped *aisle* treads are 22 inches (560 mm) or greater in depth.



## MEANS OF EGRESS

**[BE] 1030.14.2.3 Tread contrasting marking stripe.**

A contrasting marking stripe shall be provided on each tread at the *nosing* or leading edge such that the location of each tread is readily apparent when viewed in descent. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide.

**Exception:** The contrasting marking stripe is permitted to be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

**[BE] 1030.14.2.4 Nosing and profile.** *Nosing* and riser profile shall comply with Sections 1011.5.5 through 1011.5.5.3.

**[BE] 1030.15 Seat stability.** In a building, room or space used for assembly purposes, the seats shall be securely fastened to the floor.

**Exceptions:**

1. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating and with 200 or fewer seats, the seats shall not be required to be fastened to the floor.
2. In a building, room or space used for assembly purposes or portions thereof with seating at tables and without ramped or tiered floors for seating, the seats shall not be required to be fastened to the floor.
3. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating and with greater than 200 seats, the seats shall be fastened together in groups of not less than three or the seats shall be securely fastened to the floor.
4. In a building, room or space used for assembly purposes where flexibility of the seating arrangement is an integral part of the design and function of the space and seating is on tiered levels, not more than 200 seats shall not be required to be fastened to the floor. Plans showing seating, tiers and *aisles* shall be submitted for approval.
5. Groups of seats within a building, room or space used for assembly purposes separated from other seating by railings, *guards*, partial height walls or similar barriers with level floors and having not more than 14 seats per group shall not be required to be fastened to the floor.
6. Seats intended for musicians or other performers and separated by railings, *guards*, partial height walls or similar barriers shall not be required to be fastened to the floor.

**[BE] 1030.16 Handrails.** Ramped *aisles* having a slope exceeding 1 unit vertical in 15 units horizontal (6.7-percent slope) and stepped *aisles* shall be provided with *handrails* in

compliance with Section 1014 located either at one or both sides of the *aisle* or within the *aisle* width. Where stepped *aisles* have seating on one side and the *aisle* width is 74 inches (1880 mm) or greater, two *handrails* are required. Where two *handrails* are required, one of the *handrails* shall be within 30 inches (762 mm) horizontally of the stepped *aisle*.

**Exceptions:**

1. *Handrails* are not required for ramped *aisles* with seating on both sides.
2. *Handrails* are not required where, at the side of the *aisle*, there is a *guard* with a top surface that complies with the graspability requirements of *handrails* in accordance with Section 1014.3.
3. *Handrail* extensions are not required at the top and bottom of stepped *aisles* and ramped *aisles* to permit crossovers within the *aisles*.

**[BE] 1030.16.1 Discontinuous handrails.** Where there is seating on both sides of the *aisle*, the mid-*aisle handrails* shall be discontinuous. Where a stepped *aisle* is required to have two *handrails*, the mid-*aisle handrails* shall be discontinuous. Gaps or breaks shall be provided at intervals not exceeding five rows to facilitate access to seating and to permit crossing from one side of the *aisle* to the other. These gaps or breaks shall have a clear width of not less than 22 inches (559 mm) and not greater than 36 inches (914 mm), measured horizontally, and the mid-*aisle handrail* shall have rounded terminations or bends.

**[BE] 1030.16.2 Handrail termination.** *Handrails* located on the side of stepped *aisles* shall return to a wall, *guard* or the walking surfaces or shall be continuous to the *handrail* of an adjacent stepped *aisle flight*.

**[BE] 1030.16.3 Mid-aisle termination.** Mid-*aisle handrails* shall not extend beyond the lowest riser and shall terminate within 18 inches (381 mm), measured horizontally, from the lowest riser. *Handrail* extensions are not required.

**Exception:** Mid-*aisle handrails* shall be permitted to extend beyond the lowest riser where the *handrail* extensions do not obstruct the width of the cross *aisle*.

**[BE] 1030.16.4 Rails.** Where mid-*aisle handrails* are provided in stepped *aisles*, there shall be an additional rail located approximately 12 inches (305 mm) below the *handrail*. The rail shall be adequate in strength and attachment in accordance with Section 1607.9.1.2 of the *International Building Code*.

**[BE] 1030.17 Assembly guards.** *Guards* adjacent to seating in a building, room or space used for assembly purposes shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015 except where provided in accordance with Sections 1030.17.1 through 1030.17.4. At *bleachers*, *grandstands* and *folding*

and telescopic seating, guards must be provided where required by ICC 300 and Section 1030.17.1.

**[BE] 1030.17.1 Perimeter guards.** Perimeter guards shall be provided where the footboards or walking surface of seating facilities are more than 30 inches (762 mm) above the floor or grade below. Where the seatboards are adjacent to the perimeter, guard height shall be 42 inches (1067 mm) high minimum, measured from the seatboard. Where the seats are self-rising, guard height shall be 42 inches (1067 mm) high minimum, measured from the floor surface. Where there is an aisle between the seating and the perimeter, the guard height shall be measured in accordance with Section 1015.3.

**Exceptions:**

1. Guards that impact sightlines shall be permitted to comply with Section 1030.17.3.
2. Bleachers, grandstands and folding and telescopic seating shall not be required to have perimeter guards where the seating is located adjacent to a wall and the space between the wall and the seating is less than 4 inches (102 mm).

**[BE] 1030.17.2 Cross aisles.** Cross aisles located more than 30 inches (762 mm) above the floor or grade below shall have guards in accordance with Section 1015.

Where an elevation change of 30 inches (762 mm) or less occurs between a cross aisle and the adjacent floor or grade below, guards not less than 26 inches (660 mm) above the aisle floor shall be provided.

**Exception:** Where the backs of seats on the front of the cross aisle project 24 inches (610 mm) or more above the adjacent floor of the aisle, a guard need not be provided.

**[BE] 1030.17.3 Sightline-constrained guard heights.** Unless subject to the requirements of Section 1030.17.4, a fascia or railing system in accordance with the guard requirements of Section 1015 and having a minimum height of 26 inches (660 mm) shall be provided where the floor or footboard elevation is more than 30 inches (762 mm) above the floor or grade below and the fascia or railing would otherwise interfere with the sightlines of immediately adjacent seating.

**[BE] 1030.17.4 Guards at the end of aisles.** A fascia or railing system complying with the guard requirements of Section 1015 shall be provided for the full width of the aisle where the foot of the aisle is more than 30 inches (762 mm) above the floor or grade below. The fascia or railing shall be not less than 36 inches (914 mm) high and shall provide not less than 42 inches (1067 mm) measured diagonally between the top of the rail and the nosing of the nearest tread.

## SECTION 1031 EMERGENCY ESCAPE AND RESCUE

**[BE] 1031.1 General.** Emergency escape and rescue openings shall comply with the requirements of this section.

**[BE] 1031.2 Where required.** In addition to the means of egress required by this chapter, emergency escape and rescue openings shall be provided in the following occupancies:

1. Group R-2 occupancies located in stories with only one exit or access to only one exit as permitted by Tables 1006.3.4(1) and 1006.3.4(2).
2. Group R-3 and R-4 occupancies.

Basements and sleeping rooms below the fourth story above grade plane shall have not fewer than one emergency escape and rescue opening in accordance with this section. Where basements contain one or more sleeping rooms, an emergency escape and rescue opening shall be required in each sleeping room, but shall not be required in adjoining areas of the basement. Such openings shall open directly into a public way or to a yard or court that opens to a public way.

**Exceptions:**

1. Basements with a ceiling height of less than 80 inches (2032 mm) shall not be required to have emergency escape and rescue openings.
2. Emergency escape and rescue openings are not required from basements or sleeping rooms that have an exit door or exit access door that opens directly into a public way or to a yard, court or exterior egress balcony that opens to a public way.
3. Basements without habitable spaces and having not more than 200 square feet (18.6 m<sup>2</sup>) in floor area shall not be required to have emergency escape and rescue openings.
4. Storm shelters are not required to comply with this section where the shelter is constructed in accordance with ICC 500.
5. Within individual dwelling and sleeping units in Groups R-2 and R-3, where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3, sleeping rooms in basements shall not be required to have emergency escape and rescue openings provided that the basement has one of the following:

- 5.1. One means of egress and one emergency escape and rescue opening.
- 5.2. Two means of egress.

**[BE] 1031.2.1 Operational constraints and opening control devices.** Emergency escape and rescue openings shall be operational from inside the room without the use of keys or tools. Window-opening control devices complying with ASTM F2090 shall be permitted for use

## MEANS OF EGRESS

on windows serving as a required emergency escape and rescue opening.

**[BE] 1031.3 Emergency escape and rescue openings.** *Emergency escape and rescue openings* shall comply with Sections 1031.3.1 through 1031.3.3.

**[BE] 1031.3.1 Minimum size.** *Emergency escape and rescue openings* shall have a minimum net clear opening of 5.7 square feet (0.53 m<sup>2</sup>).

**Exception:** The minimum net clear opening for grade-floor *emergency escape and rescue openings* shall be 5 square feet (0.46 m<sup>2</sup>).

**[BE] 1031.3.2 Minimum dimensions.** The minimum net clear opening height dimension shall be 24 inches (610 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening dimensions shall be the result of normal operation of the opening.

**[BE] 1031.3.3 Maximum height from floor.** *Emergency escape and rescue openings* shall have the bottom of the clear opening not greater than 44 inches (1118 mm) measured from the floor.

**[BE] 1031.4 Emergency escape and rescue doors.** Where a door is provided as the required *emergency escape and rescue opening*, it shall be a swinging door or a sliding door.

**[BE] 1031.5 Area wells.** An *emergency escape and rescue opening* with the bottom of the clear opening below the adjacent grade shall be provided with an area well in accordance with Sections 1031.5.1 through 1031.5.3.

**[BE] 1031.5.1 Minimum size.** The minimum horizontal area of the area well shall be 9 square feet (0.84 m<sup>2</sup>), with a horizontal projection and width of not less than 36 inches (914 mm). The area well shall allow the *emergency escape and rescue opening* to be fully opened.

**Exception:** The ladder or steps required by Section 1031.5.2 shall be permitted to encroach not more than 6 inches (152 mm) into the required dimensions of the area well.

**[BE] 1031.5.2 Ladders or steps.** Area wells with a vertical depth of more than 44 inches (1118 mm) shall be equipped with an *approved* permanently affixed ladder or steps. The ladder or steps shall not be obstructed by the *emergency escape and rescue opening* when the window or door is in the open position. Ladders or steps required by this section shall not be required to comply with Section 1011.

**[BE] 1031.5.2.1 Ladders.** Ladders or rungs shall have an inside width of at least 12 inches (305 mm), shall project at least 3 inches (76 mm) from the wall and shall be spaced not more than 18 inches (457 mm) on center (o.c.) vertically for the full height of the area well.

**[BE] 1031.5.2.2 Steps.** Steps shall have an inside width of not less than 12 inches (305 mm), shall have treads greater than 5 inches (127 mm) in depth and a riser height not greater than 18 inches (457 mm) for the full height of the area well.

**[BE] 1031.5.3 Drainage.** Area wells shall be designed for proper drainage by connecting to the building's foundation drainage system required by Section 1805 of the *International Building Code*.

**Exception:** A drainage system for area wells is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, in accordance with Section 1803.5.1 of the *International Building Code*.

**[BE] 1031.6 Bars, grilles, covers and screens.** Where bars, grilles, covers, screens or similar devices are permitted to be placed over *emergency escape and rescue openings*, or area wells that serve such openings, the minimum net clear opening size shall comply with Sections 1031.3 and 1031.5. Such devices shall be releasable or removable from the inside without the use of a key, tool or force greater than that which is required for normal operation of the escape and rescue opening.

## SECTION 1032 MAINTENANCE OF THE MEANS OF EGRESS

**1032.1 General.** The *means of egress* for buildings or portions thereof shall be maintained in accordance with this section.

**1032.2 Reliability.** Required *exit accesses*, *exits* and *exit discharges* shall be continuously maintained free from obstructions or impediments to full instant use in the case of fire or other emergency where the building area served by the *means of egress* is occupied. An *exit* or *exit passageway* shall not be used for any purpose that interferes with a *means of egress*.

**1032.2.1 Security devices and egress locks.** Security devices affecting *means of egress* shall be subject to approval of the *fire code official*. Security devices and locking arrangements in the *means of egress* that restrict, control, or delay egress shall be installed and maintained as required by this chapter.

**1032.2.1.1 Fire escapes.** Security enclosures, fences or screening for fire escape stairways shall be *approved* by the *fire code official* and shall be constructed such that they do not impede egress to the *public way*. Means shall be provided for emergency personnel to access the fire escape stair from the exterior of the enclosure.

**[BE] 1032.2.2 Locking arrangements in educational occupancies.** In Group E occupancies, Group B educational occupancies and Group I-4 occupancies, egress doors with locking arrangements designed to keep intruders from entering the room shall comply with Section 1010.2.8.

**1032.3 Obstructions.** A *means of egress* shall be free from obstructions that would prevent its use, including the accumulation of snow and ice.

**1032.3.1 Group I-2.** In Group I-2, the required clear width for *aisles*, *corridors* and *ramps* that are part of the



required *means of egress* shall comply with Section 407.4.3 of the *International Building Code* and Section 1020.3. The facility shall have a plan to maintain the required clear width during emergency situations.

**Exception:** In areas required for bed movement, equipment shall be permitted in the required width where all of the following provisions are met:

1. The equipment is low hazard and wheeled.
2. The equipment does not reduce the effective clear width for the *means of egress* to less than 5 feet (1525 mm).
3. The equipment is limited to:
  - 3.1. Equipment and carts in use.
  - 3.2. Medical emergency equipment.
  - 3.3. Infection control carts.
  - 3.4. Patient lift and transportation equipment.
4. Medical emergency equipment and patient lift and transportation equipment, when not in use, are required to be located on one side of the corridor.
5. The equipment is limited in number to not more than one per patient sleeping room or patient care room within each *smoke compartment*.

**[BE] 1032.4 Exit signs.** Exit signs shall be installed and maintained in accordance with the building code that was in effect at the time of construction and the applicable provisions in Section 1104. Decorations, furnishings, equipment or adjacent signage that impairs the visibility of exit signs, creates confusion or prevents identification of the *exit* shall not be allowed.

**1032.5 Nonexit identification.** Where a door is adjacent to, constructed similar to and can be confused with a *means of egress* door, that door shall be identified with an *approved* sign that identifies the room name or use of the room.

**1032.6 Finishes, furnishings and decorations.** *Means of egress* doors shall be maintained in such a manner as to be distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Furnishings, decorations or other objects shall not be placed so as to obstruct *exits*, access thereto, egress therefrom, or visibility thereof. Hangings and draperies shall not be placed over *exit* doors or otherwise be located to conceal or obstruct an *exit*. Mirrors shall not be placed on *exit* doors. Mirrors shall not be placed in or adjacent to any *exit* in such a manner as to confuse the direction of egress.

**1032.7 Emergency escape and rescue openings.** Required *emergency escape and rescue openings* shall be maintained in accordance with the code in effect at the time of construction, and both of the following:

1. Required *emergency escape and rescue openings* shall be operational from the inside of the room without the use of keys or tools.
2. Bars, grilles, grates or similar devices are permitted to be placed over *emergency escape and rescue*

*openings* provided that the minimum net clear opening size complies with the code that was in effect at the time of construction and the unit is equipped with smoke alarms installed in accordance with Section 907.2.11. Such devices shall be releasable or removable from the inside without the use of a key, tool or force greater than that which is required for normal operation of the *emergency escape and rescue opening*.

**1032.8 Inspection, testing and maintenance.** Two-way communication systems shall be inspected and tested on a yearly basis to verify that all components are operational. Where required, the tests shall be conducted in the presence of the *fire code official*. Records of inspection, testing and maintenance shall be maintained.

**1032.9 Floor identification signs.** The floor identification signs required by Sections 1023.9 and 1104.24 shall be maintained in an *approved* manner.

**1032.10 Emergency lighting equipment inspection and testing.** Emergency lighting shall be maintained in accordance with Section 109 and shall be inspected and tested in accordance with Sections 1032.10.1 and 1032.10.2.

**1032.10.1 Activation test.** Emergency lighting equipment shall be tested monthly for a duration of not less than 30 seconds. The test shall be performed manually or by an automated self-testing and self-diagnostic routine. Where testing is performed by self-testing and self-diagnostics, a visual inspection of the emergency lighting equipment shall be conducted monthly to identify any equipment displaying a trouble indicator or that has become damaged or otherwise impaired.

**1032.10.2 Power test.** Battery-powered emergency lighting equipment shall be tested annually by operating the equipment on battery power for not less than 90 minutes.





## CHAPTER 11

# CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

### User note:

**About this chapter:** Chapter 11 applies to existing buildings constructed prior to the adoption of the code and is intended to ensure a minimum degree of fire and life safety to persons occupying existing buildings by providing for alterations to such buildings that do not comply with the minimum requirements of the International Building Code®. The provisions address general fire safety features such as requirements for fire alarm systems in some existing buildings and general means of egress, and include a section dedicated to existing Group I-2 occupancies.

### SECTION 1101 GENERAL

**1101.1 Scope.** The provisions of this chapter shall apply to existing buildings constructed prior to the adoption of this code.

**1101.2 Intent.** The intent of this chapter is to provide a minimum degree of fire and life safety to persons occupying existing buildings by providing minimum construction requirements where such existing buildings do not comply with the minimum requirements of the *International Building Code*.

**1101.3 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6 and the *International Building Code*.

**1101.4 Owner notification.** When a building is found to be in noncompliance with this chapter, the *fire code official* shall duly notify the *owner* of the building. Upon receipt of such notice, the *owner* shall, subject to the following time limits, take necessary actions to comply with the provisions of this chapter.

**1101.4.1 Construction documents.** *Construction documents* necessary to comply with this chapter shall be completed and submitted within a time schedule *approved* by the *fire code official*.

**1101.4.2 Completion of work.** Work necessary to comply with this chapter shall be completed within a time schedule *approved* by the *fire code official*.

**1101.4.3 Extension of time.** The *fire code official* is authorized to grant necessary extensions of time where it can be shown that the specified time periods are not physically practical or pose an undue hardship. The granting of an extension of time for compliance shall be based on the showing of good cause and subject to the filing of an acceptable systematic plan of correction with the *fire code official*.

### SECTION 1102 DEFINITIONS

**1102.1 Definitions.** The following terms are defined in Chapter 2:

**DUTCH DOOR.**

**EXISTING.**

### SECTION 1103 FIRE SAFETY REQUIREMENTS FOR EXISTING BUILDINGS

**1103.1 Required construction.** Existing buildings shall comply with not less than the minimum provisions specified in Table 1103.1 and as further enumerated in Sections 1103.2 through 1103.10.

The provisions of this chapter shall not be construed to allow the elimination of *fire protection systems* or a reduction in the level of fire safety provided in buildings constructed in accordance with previously adopted codes.

#### Exceptions:

1. Where a change in *fire-resistance rating* has been *approved* in accordance with Section 501.2 or 802.6 of the *International Existing Building Code*.
2. Group U occupancies.

**1103.1.1 Historic buildings.** Facilities designated as historic buildings shall develop a fire protection plan in accordance with NFPA 914. The fire protection plans shall comply with the maintenance and availability provisions in Sections 404.3 and 404.4.

**1103.2 Emergency responder communication coverage in existing buildings.** Existing buildings other than Group R-3, that do not have *approved* in-building, two-way emergency response communication coverage for emergency responders in the building based on existing coverage levels of the public safety communication systems, shall be equipped with such coverage according to one of the following:

1. Where an existing wired communication system cannot be repaired or is being replaced, or where not *approved* in accordance with Section 510.1, Exception 1.
2. Within a time frame established by the adopting authority.

**Exception:** Where it is determined by the *fire code official* that the in-building, two-way emergency responder communication coverage system is not needed.

**1103.3 Existing elevators.** In other than Group R-3, existing elevators, escalators and moving walks shall comply with the requirements of Sections 1103.3.1 and 1103.3.2.

**1103.3.1 Elevators, escalators and moving walks.** Existing elevators, escalators and moving walks in Group

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

TABLE 1103.1  
OCCUPANCY AND USE REQUIREMENTS<sup>a</sup>

SECTION	USE				OCCUPANCY CLASSIFICATION																				
	High-rise	Atrium or covered mall	Under-ground building	Tire storage	A	B	E	F	H-1	H-2	H-3	H-4	H-5	I-1	I-2	I-3	I-4	M	R-1	R-2	R-3	R-4	S		
1103.2	R	R	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	—	R		
1103.3	R	—	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	—	R		
1103.4.1	R	—	R	—	—	—	—	—	—	—	—	—	—	—	R	R	—	—	—	—	—	—			
1103.4.2	R	—	R	—	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	—	—	R		
1103.4.3	R	—	R	—	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	—	—	R		
1103.4.4	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
1103.4.5	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—		
1103.4.6	—	—	—	—	R	—	R	R	R	R	R	R	R	R	R	R	R	—	R	R	R	R	R		
1103.4.7	—	—	—	—	R	—	R	R	R	R	R	R	R	R	R	R	R	—	R	R	R	R	R		
1103.4.8	R	—	R	—	R	R	R	R	R	R	R	R	R	R	—	—	R	R	R	R	R	R	R		
1103.4.9	R	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—		
1103.4.10	—	—	—	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		
1103.5.1	—	—	—	—	R <sup>c</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
1103.5.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—		
1103.5.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R <sup>b</sup>	—	—	—	—	—	—	—	—		
1103.5.5	—	—	—	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		
1103.6.1	R	—	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	—	R		
1103.6.2	R	—	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	—	—	R		
1103.7.1	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		
1103.7.2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—		
1103.7.3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—		
1103.7.4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—		
1103.7.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—		
1103.7.6	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—		
1103.8	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	R	R	R	R	—		
1103.9	R	—	—	—	—	—	—	—	—	—	—	—	—	R	R	—	R	—	R	R	R	R	—		
1103.10	—	—	—	—	—	—	—	—	—	—	—	—	—	R	R	—	—	—	—	—	—	—	—		
1104	R	R	R	—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R		
1105	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—		
1106	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—		

R = The building is required to comply.

- a. Existing buildings shall comply with the sections identified as “Required” (R) based on occupancy classification or use, or both, whichever is applicable.  
b. Only applies to Group I-2, Condition 2 occupancies as established by the adopting ordinance or legislation of the jurisdiction.  
c. Only applies to Group A-2 occupancies where alcoholic beverages are consumed.

I-2, Condition 2 occupancies and serving ambulatory care facilities shall comply with ASME A17.3.

**1103.3.2 Elevator emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more above or below the main floor or other level of a building and intended to serve the needs of emergency personnel for fire-fighting or rescue purposes shall be provided with emergency operation in accordance with ASME A17.3.

**Exceptions:**

- Buildings without occupied floors located more than 55 feet (16 764 mm) above or 25 feet (7620 mm) below the lowest level of fire department vehicle access where protected at

the elevator shaft openings with additional fire doors in accordance with Section 716 of the *International Building Code* and where all of the following conditions are met:

- The doors shall be provided with vision panels of *approved* fire-protection-rated glazing so located as to furnish clear vision of the approach to the elevator. Such glazing shall not exceed 100 square inches (0.065 m<sup>2</sup>) in area.
- The doors shall be held open but be automatic-closing by activation of a

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

fire alarm initiating device installed in accordance with the requirements of NFPA 72 as for Phase I Emergency Recall Operation, and shall be located at each floor served by the elevator; in the associated elevator machine room, control space, or control room; and in the elevator hoistway, where sprinklers are located in those hoistways.

- 1.3. The doors, when closed, shall have signs visible from the approach area stating: "WHEN THESE DOORS ARE CLOSED OR IN FIRE EMERGENCY, DO NOT USE ELEVATOR. USE EXIT STAIRWAYS."
2. Buildings without occupied floors located more than 55 feet (16 764 mm) above or 25 feet (7620 mm) below the lowest level of fire department vehicle access where provided with *automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. Freight elevators in buildings provided with both *automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and not less than one ASME 17.3-compliant elevator serving the same floors.

Elimination of previously installed Phase I emergency recall or Phase II emergency in-car systems shall not be permitted.

**1103.4 Vertical openings.** Interior vertical openings, including but not limited to *stairways*, elevator hoistways, service and utility shafts, that connect two or more stories of a building shall be enclosed or protected as specified in Sections 1103.4.1 through 1103.4.10.

**1103.4.1 Group I-2 and I-3 occupancies.** In Group I-2 and I-3 occupancies, interior vertical openings connecting two or more stories shall be protected with 1-hour *fire-resistance-rated* construction.

**Exceptions:**

1. In Group I-2, unenclosed vertical openings not exceeding two connected stories and not concealed within the building construction shall be permitted as follows:
  - 1.1. The unenclosed vertical openings shall be separated from other unenclosed vertical openings serving other floors by a *smoke barrier*.
  - 1.2. The unenclosed vertical openings shall be separated from *corridors* by smoke partitions.
  - 1.3. The unenclosed vertical openings shall be separated from other fire or *smoke compartments* on the same floors by a *smoke barrier*.
- 1.4. On other than the lowest level, the unenclosed vertical openings shall not serve as a required *means of egress*.
2. In Group I-2, atriums connecting three or more stories shall not require 1-hour *fire-resistance-rated* construction where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3, and all of the following conditions are met:
  - 2.1. For other than existing *approved* atriums with a smoke control system, where the atrium was constructed and is maintained in accordance with the code in effect at the time the atrium was created, the atrium shall have a smoke control system that is in compliance with Section 909.
  - 2.2. Glass walls forming a smoke partition or a glass-block wall assembly shall be permitted where in compliance with Condition 2.2.1 or 2.2.2.
    - 2.2.1. Glass walls forming a smoke partition shall be permitted where all of the following conditions are met:
      - 2.2.1.1. Automatic sprinklers are provided along both sides of the separation wall and doors, or on the room side only if there is not a walkway or occupied space on the atrium side.
      - 2.2.1.2. The sprinklers shall be not more than 12 inches (305 mm) away from the face of the glass and at intervals along the glass of not greater than 72 inches (1829 mm).
      - 2.2.1.3. Windows in the glass wall shall be nonoperating type.
      - 2.2.1.4. The glass wall and windows shall be installed in a gasketed frame in a manner that the framing system deflects without breaking (loading) the glass before the



## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

sprinkler system operates.

2.2.1.5. The sprinkler system shall be designed so that the entire surface of the glass is wet upon activation of the sprinkler system without obstruction.

2.2.2. A *fire barrier* is not required where a glass-block wall assembly complying with Section 2110 of the *International Building Code* and having a  $\frac{3}{4}$ -hour *fire protection rating* is provided.

2.3. Where doors are provided in the glass wall, they shall be either self-closing or automatic-closing and shall be constructed to resist the passage of smoke.

3. In Group I-3 occupancies, *exit stairways* or *ramps* and *exit access stairways* or *ramps* constructed in accordance with Section 408 of the *International Building Code*.

**1103.4.2 Three to five stories.** In other than Group I-2 and I-3 occupancies, interior vertical openings connecting three to five stories shall be protected by either 1-hour *fire-resistance-rated* construction or an *automatic sprinkler system* shall be installed throughout the building in accordance with Section 903.3.1.1 or 903.3.1.2.

### Exceptions:

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.
3. Vertical opening protection for escalators shall be in accordance with Section 1103.4.5, 1103.4.6 or 1103.4.7.
4. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

**1103.4.3 More than five stories.** In other than Group I-2 and I-3 occupancies, interior vertical openings connecting more than five stories shall be protected by 1-hour *fire-resistance-rated* construction.

### Exceptions:

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.

3. Vertical opening protection for escalators shall be in accordance with Section 1103.4.5, 1103.4.6 or 1103.4.7.

4. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

**1103.4.4 Atriums and covered malls.** In other than Group I-2 and I-3 occupancies, interior vertical openings in a covered mall building or a building with an atrium shall be protected by either 1-hour *fire-resistance-rated* construction or an *automatic sprinkler system* shall be installed throughout the building in accordance with Section 903.3.1.1 or 903.3.1.2.

### Exceptions:

1. Vertical opening protection is not required for Group R-3 occupancies.
2. Vertical opening protection is not required for open parking garages.
3. *Exit access stairways* and *ramps* shall be in accordance with Section 1103.4.8.

**1103.4.5 Escalators in Group B and M occupancies.** In Group B and M occupancies, escalators creating vertical openings connecting any number of stories shall be protected by either 1-hour *fire-resistance-rated* construction or an *automatic sprinkler system* in accordance with Section 903.3.1.1 installed throughout the building, with a draft curtain and closely spaced sprinklers around the escalator opening.

**1103.4.6 Escalators connecting four or fewer stories.** In other than Group B and M occupancies, escalators creating vertical openings connecting four or fewer stories shall be protected by either 1-hour *fire-resistance-rated* construction or an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 shall be installed throughout the building, and a draft curtain with closely spaced sprinklers shall be installed around the escalator opening.

**1103.4.7 Escalators connecting more than four stories.** In other than Group B and M occupancies, escalators creating vertical openings connecting five or more stories shall be protected by 1-hour *fire-resistance-rated* construction.

**1103.4.8 Occupancies other than Groups I-2 and I-3.** In other than Group I-2 and I-3 occupancies, floor openings containing *exit access stairways* or *ramps* that do not comply with one of the conditions listed in this section shall be protected by 1-hour *fire-resistance-rated* construction.

1. *Exit access stairways* and *ramps* that serve, or atmospherically communicate between, only two stories. Such interconnected stories shall not be open to other stories.
2. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual *dwelling unit* or *sleeping unit* or live/work unit.

3. *Exit access stairways and ramps* in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the *stairway* or *ramp*, and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.
4. *Exit access stairways and ramps* within an atrium complying with the provisions of Section 404 of the *International Building Code*.
5. *Exit access stairways and ramps* in open parking garages that serve only the parking garage.
6. *Exit access stairways and ramps* serving open-air seating complying with the *exit access* travel distance requirements of Section 1030.7 of the *International Building Code*.
7. *Exit access stairways and ramps* serving the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, places of religious worship, auditoriums and sports facilities.

**1103.4.9 Waste and linen chutes.** In Group I-2 occupancies, existing waste and linen chutes shall comply with Sections 1103.4.9.1 through 1103.4.9.5.

**1103.4.9.1 Enclosure.** Chutes shall be enclosed with 1-hour *fire-resistance-rated* construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**1103.4.9.2 Chute intakes.** Chute intakes shall comply with Section 1103.4.9.2.1 or 1103.4.9.2.2.

**1103.4.9.2.1 Chute intake direct from corridor.** Where intake to chutes is direct from a *corridor*, the intake opening shall be equipped with a chute-intake door in accordance with Section 716 of the *International Building Code* and having a *fire protection rating* of not less than 1 hour.

**1103.4.9.2.2 Chute intake via a chute-intake room.** Where the intake to chutes is accessed through a chute-intake room, the room shall be enclosed with 1-hour *fire-resistance-rated* construction. Opening protectives for the intake room shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than  $\frac{3}{4}$  hour. Opening protectives for the chute enclosure shall be in accordance with Section 1103.4.9.1.

**1103.4.9.3 Automatic sprinkler system.** Chutes shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.2.11.2.

**1103.4.9.4 Chute discharge rooms.** Chutes shall terminate in a dedicated chute discharge room. Such rooms shall be separated from the remainder of the building by not less than 1-hour *fire-resistance-rated* construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**1103.4.9.5 Chute discharge protection.** Chute discharges shall be equipped with a self-closing or automatic-closing opening protective in accordance with Section 716 of the *International Building Code* and having a *fire protection rating* of not less than 1 hour.

**1103.4.10 Flue-fed incinerators.** Existing flue-fed incinerator rooms and associated flue shafts shall be protected with 1-hour *fire-resistance-rated* construction and shall not have other vertical openings connected with the space other than the associated flue. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**1103.5 Sprinkler systems.** An *automatic sprinkler system* shall be provided in existing buildings in accordance with Sections 1103.5.1 through 1103.5.5.

**1103.5.1 Group A-2.** Effective January 1, 2027, where alcoholic beverages are consumed in a Group A-2 occupancy having an occupant load of 300 or more, the *fire area* containing the Group A-2 occupancy shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**1103.5.2 Group I-2.** In Group I-2, an *automatic sprinkler system* shall be provided in accordance with Section 1105.9.

**1103.5.3 Group I-2, Condition 2.** In addition to the requirements of Section 1103.5.2, existing buildings of Group I-2, Condition 2 occupancy shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The *automatic sprinkler system* shall be installed as established by the adopting ordinance. [DATE BY WHICH SPRINKLER SYSTEM MUST BE INSTALLED].

**1103.5.4 High-rise buildings.** Where Appendix M has not been adopted, existing high-rise buildings that do not have a previously *approved* fire sprinkler system shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where any of the following conditions apply:

1. The high-rise building has an occupied floor located more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access.
2. The high-rise building has occupied floors located more than 75 feet (22 860 mm) and not more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, and the building does not have at least two interior exit stairways complying with Section 1104.10 that are sepa-

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

rated from the building interior by fire assemblies having a fire-resistance rating of not less than 2 hours with opening protection in accordance with Table 716.1(2) of the International Building Code.

3. The high-rise building has occupied floors located more than 75 feet (22 860 mm) and not more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, and the building does not have a fire alarm system that includes smoke detection in mechanical equipment, electrical, transformer, telephone equipment and similar rooms; corridors; elevator lobbies; and at doors penetrating interior exit stairway enclosures.

Building owners shall file a compliance schedule with the fire code official not later than 365 days after receipt of a written notice. The compliance schedule shall not exceed 12 years for completion of the automatic sprinkler system retrofit.

**1103.5.5 Pyroxylin plastics.** An *automatic sprinkler system* shall be provided throughout existing buildings where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds (45 kg). Vaults located within buildings for the storage of raw pyroxylin shall be protected with an *approved automatic sprinkler system* capable of discharging 1.66 gallons per minute per square foot (68 L/min/m<sup>2</sup>) over the area of the vault.

**1103.6 Standpipes.** Existing structures shall be equipped with standpipes installed in accordance with Section 905 where required in Sections 1103.6.1 and 1103.6.2. The *fire code official* is authorized to approve the installation of manual standpipe systems to achieve compliance with this section where the responding fire department is capable of providing the required hose flow at the highest standpipe outlet.

**1103.6.1 Existing multiple-story buildings.** Existing buildings with occupied floors located more than 50 feet (15 240 mm) above the lowest level of fire department access or more than 50 feet (15 240 mm) below the highest level of fire department access shall be equipped with standpipes.

**1103.6.2 Existing helistops and heliports.** Existing buildings with a rooftop helistop or heliport located more than 30 feet (9144 mm) above the lowest level of fire department access to the roof level on which the helistop or heliport is located shall be equipped with standpipes in accordance with Section 2007.5.

**1103.7 Fire alarm systems.** An *approved* fire alarm system shall be installed in existing buildings and structures in accordance with Sections 1103.7.1 through 1103.7.6 and provide occupant notification in accordance with Section 907.5 unless other requirements are provided by other sections of this code.

**Exception:** Occupancies with an existing, previously *approved* fire alarm system.

**1103.7.1 Group E.** A fire alarm system shall be installed in existing Group E occupancies in accordance with Section 907.2.3.

### Exceptions:

1. A manual fire alarm system is not required in a building with a maximum area of 1,000 square feet (93 m<sup>2</sup>) that contains a single classroom and is located not closer than 50 feet (15 240 mm) from another building.
2. A manual fire alarm system is not required in Group E occupancies with an *occupant load* less than 50.

**1103.7.2 Group I-1.** An automatic fire alarm system shall be installed in existing Group I-1 facilities in accordance with Section 907.2.6.1.

**Exception:** Where each sleeping room has a *means of egress* door opening directly to an exterior egress balcony that leads directly to the *exits* in accordance with Section 1021, and the building is not more than three stories in height.

**1103.7.3 Group I-2.** In Group I-2, an automatic fire alarm system shall be installed in accordance with Section 1105.10.

**1103.7.4 Group I-3.** An automatic and manual fire alarm system shall be installed in existing Group I-3 occupancies in accordance with Section 907.2.6.3.

**1103.7.5 Group R-1.** A fire alarm system and smoke alarms shall be installed in existing Group R-1 occupancies in accordance with Sections 1103.7.5.1 through 1103.7.5.2.1.

**1103.7.5.1 Group R-1 hotel and motel manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 hotels and motels more than one story in height or with more than 20 *sleeping units*.

### Exceptions:

1. A manual fire alarm system is not required in buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour *fire-resistance-rated* construction and each *sleeping unit* has direct access to a *public way*, *egress court* or yard.
2. A manual fire alarm system is not required in buildings not more than three stories in height with not more than 20 *sleeping units* and equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. Manual fire alarm boxes are not required throughout the building where the following conditions are met:

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

- 3.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
- 3.2. The notification appliances will activate upon sprinkler water flow.
- 3.3. Not less than one manual fire alarm box is installed at an *approved* location.

**1103.7.5.1.1 Group R-1 hotel and motel automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 hotels and motels throughout all interior *corridors* serving sleeping rooms not equipped with an *approved*, supervised *automatic sprinkler system* installed in accordance with Section 903.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

**1103.7.5.2 Group R-1 boarding and rooming houses manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 boarding and rooming houses.

**Exception:** Buildings less than two stories in height where all *sleeping units*, attics and crawl spaces are separated by 1-hour *fire-resistance-rated* construction and each *sleeping unit* has direct access to a *public way*, *egress court* or yard.

**1103.7.5.2.1 Group R-1 boarding and rooming houses automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-1 boarding and rooming houses throughout all interior *corridors* serving *sleeping units* not equipped with an *approved*, supervised sprinkler system installed in accordance with Section 903.

**Exception:** Buildings equipped with single-station smoke alarms meeting or exceeding the requirements of Section 907.2.11.1 and where the fire alarm system includes not less than one manual fire alarm box per floor arranged to initiate the alarm.

**1103.7.6 Group R-2.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in existing Group R-2

occupancies more than three stories in height or with more than 16 *dwelling* or *sleeping units*.

**Exceptions:**

1. Where each living unit is separated from other contiguous living units by *fire barriers* having a *fire-resistance rating* of not less than  $\frac{3}{4}$  hour, and where each living unit has either its own independent *exit* or its own independent *stairway* or *ramp* discharging at grade.
2. A separate fire alarm system is not required in buildings that are equipped throughout with an *approved* supervised *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and having a local alarm to notify all occupants.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units* and are protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the *exits* or are served by open-ended *corridors* designed in accordance with Section 1027.6, Exception 3.
4. A fire alarm system is not required in buildings that do not have interior *corridors* serving *dwelling units*, do not exceed three stories in height and comply with both of the following:
  - 4.1. Each *dwelling unit* is separated from other contiguous *dwelling units* by *fire barriers* having a *fire-resistance rating* of not less than  $\frac{3}{4}$  hour.
  - 4.2. Each *dwelling unit* is provided with smoke alarms complying with the requirements of Section 907.2.11.

**1103.8 Single- and multiple-station smoke alarms.** Single- and multiple-station smoke alarms shall be installed in existing Group I-1 and R occupancies in accordance with Sections 1103.8.1 through 1103.8.3.

**1103.8.1 Where required.** Existing Group I-1 and R occupancies shall be provided with single-station smoke alarms in accordance with Section 907.2.11. Interconnection and power sources shall be in accordance with Sections 1103.8.2 and 1103.8.3, respectively.

**Exceptions:**

1. Where the code that was in effect at the time of construction required smoke alarms and smoke alarms complying with those requirements are already provided.
2. Where smoke alarms have been installed in occupancies and *dwelling*s that were not required to have them at the time of construction.



## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

tion, additional smoke alarms shall not be required provided that the existing smoke alarms comply with requirements that were in effect at the time of installation.

- Where smoke detectors connected to a fire alarm system have been installed as a substitute for smoke alarms.

**1103.8.2 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling* or *sleeping unit*, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. Physical interconnection of smoke alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

### Exceptions:

- Interconnection is not required in buildings that are not undergoing *alterations*, repairs or construction of any kind.
- Smoke alarms in existing areas are not required to be interconnected where *alterations* or repairs do not result in the removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available that could provide access for interconnection without the removal of interior finishes.

**1103.8.3 Power source.** Single-station smoke alarms shall receive their primary power from the building wiring provided that such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

### Exceptions:

- Smoke alarms are permitted to be solely battery operated in existing buildings where construction is not taking place.
- Smoke alarms are permitted to be solely battery operated in buildings that are not served from a commercial power source.
- Smoke alarms are permitted to be solely battery operated in existing areas of buildings undergoing *alterations* or repairs that do not result in the removal of interior walls or ceiling finishes exposing the structure, unless there is an attic, crawl space or *basement* available that could provide access for building wiring without the removal of interior finishes.

**1103.9 Carbon monoxide detection.** Carbon monoxide detection shall be installed in existing Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies where those units include any of the conditions identified in Sections 915.1.2 through 915.1.6. The carbon monoxide alarms shall be installed in the locations specified in Section 915.2 and the installation shall be in accordance with Section 915.4.

### Exceptions:

- Carbon monoxide alarms are permitted to be solely battery operated where the code that was in effect at the time of construction did not require carbon monoxide detectors to be provided.
- Carbon monoxide alarms are permitted to be solely battery operated in *dwelling units* that are not served from a commercial power source.
- A carbon monoxide detection system in accordance with Section 915.5 shall be an acceptable alternative to carbon monoxide alarms.

**1103.10 Medical gases.** Medical gases stored and transferred in health-care-related facilities shall be in accordance with Chapter 53.

## SECTION 1104

### MEANS OF EGRESS FOR EXISTING BUILDINGS

**1104.1 General.** *Means of egress* in existing buildings shall comply with the minimum egress requirements where specified in Table 1103.1 as further enumerated in Sections 1104.2 through 1104.25, and the building code that applied at the time of construction. Where the provisions of this chapter conflict with the building code that applied at the time of construction, the most restrictive provision shall apply. Existing buildings that were not required to comply with a building code at the time of construction shall comply with the minimum egress requirements where specified in Table 1103.1 as further enumerated in Sections 1104.2 through 1104.25.

**1104.2 Elevators, escalators and moving walks.** Elevators, escalators and moving walks shall not be used as a component of a required *means of egress*.

### Exceptions:

- Elevators used as an *accessible means of egress* where allowed by Section 1009.4.
- Previously *approved* elevators, escalators and moving walks in existing buildings.

**1104.3 Exit sign illumination.** Exit signs shall be internally or externally illuminated. The face of an exit sign illuminated from an external source shall have an intensity of not less than 5 footcandles (54 lux). Internally illuminated signs shall provide equivalent luminance and be *listed* for the purpose.

**Exception:** *Approved* self-luminous signs that provide evenly illuminated letters shall have a minimum luminance of 0.06 foot-lamberts (0.21 cd/m<sup>2</sup>).

**1104.4 Power source.** Where emergency illumination is required in Section 1104.5, exit signs shall be visible under emergency illumination conditions.

**Exception:** *Approved* signs that provide continuous illumination independent of external power sources are not required to be connected to an emergency electrical system.

**1104.5 Illumination emergency power.** Where *means of egress* illumination is provided, the power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply. In the event of power supply failure, illumination shall be automatically provided from an emergency system for the following occupancies where such occupancies require two or more *means of egress*:

1. Group A having 50 or more occupants.

**Exception:** Assembly occupancies used exclusively as a place of worship and having an *occupant load* of less than 300.

2. Group B buildings three or more stories in height, buildings with 100 or more occupants above or below a *level of exit discharge* serving the occupants or buildings with 1,000 or more total occupants.
3. Group E in interior *exit access* and *exit stairways* and *ramps*, *corridors*, windowless areas with student occupancy, shops and laboratories.
4. Group F having more than 100 occupants.

**Exception:** Buildings used only during daylight hours and that are provided with windows for natural light in accordance with the *International Building Code*.

5. Group I.
6. Group M.

**Exception:** Buildings less than 3,000 square feet (279 m<sup>2</sup>) in gross sales area on one story only, excluding mezzanines.

7. Group R-1.

**Exception:** Where each *sleeping unit* has direct access to the outside of the building at grade.

8. Group R-2.

**Exception:** Where each *dwelling unit* or *sleeping unit* has direct access to the outside of the building at grade.

**1104.5.1 Emergency power duration and installation.** Emergency power for *means of egress* illumination shall be provided in accordance with Section 1203. In other than Group I-2, emergency power shall be provided for not less than 60 minutes for systems requiring emergency power.

**1104.6 Guards.** Guards complying with this section shall be provided at the open sides of *means of egress* that are more than 30 inches (762 mm) above the floor or grade below.

**1104.6.1 Height of guards.** Guards shall form a protective barrier not less than 42 inches (1067 mm) high.

**Exceptions:**

1. Existing guards on the open side of *stairways* shall be not less than 30 inches (760 mm) high.
2. Existing *guards* within *dwelling units* shall be not less than 36 inches (910 mm) high.
3. Existing *guards* in assembly seating areas.

**1104.6.2 Opening limitations.** Open *guards* shall have balusters or ornamental patterns such that a 6-inch-diameter (152 mm) sphere cannot pass through any opening up to a height of 34 inches (864 mm).

**Exceptions:**

1. At elevated walking surfaces for access to, and use of, electrical, mechanical or plumbing systems or equipment, *guards* shall have balusters or be of solid materials such that a sphere with a diameter of 21 inches (533 mm) cannot pass through any opening.
2. In occupancies in Group I-3, F, H or S, the clear distance between intermediate rails measured at right angles to the rails shall not exceed 21 inches (533 mm).
3. *Approved* existing open *guards*.

**1104.7 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear opening width of 28 inches (711 mm). Where this section requires a minimum clear opening width of 28 inches (711 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a clear opening width of 28 inches (711 mm). The minimum clear opening height of doorways shall be 80 inches (2032 mm).

**Exceptions:**

1. The minimum and maximum width shall not apply to door openings that are not part of the required *means of egress* in occupancies in Group R-2 and R-3 units that are not required to be an Accessible Type A unit or Type B unit.
2. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum clear opening width.
3. The width of door leaves in revolving doors that comply with Section 1010.3.1 shall not be limited.
4. The maximum width of door leaves in power-operated doors that comply with Section 1010.3.2 shall not be limited.
5. Door openings within a *dwelling unit* shall have a minimum clear opening height of 78 inches (1981 mm).
6. In *dwelling* and *sleeping units* that are not required to be Accessible units, Type A units or Type B

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

- units, exterior door openings, other than the required exit door, shall have a minimum clear opening height of 76 inches (1930 mm).
7. *Exit access* doors serving a room not larger than 70 square feet (6.5 m<sup>2</sup>) shall have a minimum door leaf width of 24 inches (610 mm).
  8. The minimum clear opening width shall not apply to doors for nonaccessible showers or sauna compartments.
  9. The minimum clear opening width shall not apply to the doors for nonaccessible toilet stalls.
  10. Door closers and door stops shall be permitted to be 78 inches (1980 mm) minimum above the floor.

**1104.7.1 Group I-2.** In Group I-2 occupancies, *means of egress* doors where used for the movement of beds shall provide a minimum clear opening width of 41<sup>1</sup>/<sub>2</sub> inches (1054 mm).

Doors serving as *means of egress* doors and not used for movement of beds shall provide a minimum clear opening width of 32 inches (813 mm).

**1104.7.2 Ambulatory care.** In ambulatory care facilities, doors serving as *means of egress* from patient treatment rooms shall provide a minimum clear opening width of 32 inches (813 mm).

**1104.8 Opening force for doors.** The opening force for interior side-swinging doors without closers shall not exceed a 5-pound (22 N) force. The opening forces do not apply to the force required to retract latch bolts or disengage other devices that hold the door in a closed position. For other side-swinging, sliding and folding doors, the door latch shall release when subjected to a force of not more than 15 pounds (66 N). The door shall be set in motion when subjected to a force not exceeding 30 pounds (133 N). The door shall swing to a full-open position when subjected to a force of not more than 50 pounds (222 N). Forces shall be applied to the latch side.

**1104.9 Revolving doors.** Revolving doors shall comply with the following:

1. A revolving door shall not be located within 10 feet (3048 mm) of the foot or top of *stairways* or escalators. A dispersal area shall be provided between the *stairways* or escalators and the revolving doors.
2. The revolutions per minute for a revolving door shall not exceed those shown in Table 1104.9.
3. Each revolving door shall have a conforming side-hinged swinging door in the same wall as the revolving door and within 10 feet (3048 mm).

### Exceptions:

1. A revolving door is permitted to be used without an adjacent swinging door for street-floor elevator lobbies provided that a *stairway*, escalator or door from other parts of the building does not discharge through the lobby and the lobby does not have any occupancy or use other than as a means of travel between elevators and a street.

2. Existing revolving doors where the number of revolving doors does not exceed the number of swinging doors within 20 feet (6096 mm).

**TABLE 1104.9  
REVOLVING DOOR SPEEDS**

INSIDE DIAMETER (feet-inches)	POWER-DRIVEN-TYPE SPEED CONTROL (rpm)	MANUAL-TYPE SPEED CONTROL (rpm)
6-6	11	12
7-0	10	11
7-6	9	11
8-0	9	10
8-6	8	9
9-0	8	9
9-6	7	8
10-0	7	8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**1104.9.1 Egress component.** A revolving door used as a component of a *means of egress* shall comply with Section 1104.9 and all of the following conditions:

1. Revolving doors shall not be given credit for more than 50 percent of the required egress capacity.
2. Each revolving door shall be credited with not more than a 50-person capacity.
3. Revolving doors shall be capable of being collapsed when a force of not more than 130 pounds (578 N) is applied within 3 inches (76 mm) of the outer edge of a wing.

**1104.10 Stair dimensions for existing stairways.** Existing *stairways* in buildings shall be permitted to remain if the rise does not exceed 8<sup>1</sup>/<sub>4</sub> inches (210 mm) and the run is not less than 9 inches (229 mm). Existing *stairways* can be rebuilt.

**Exception:** Other *stairways* approved by the fire code official.

**1104.10.1 Dimensions for replacement stairways.** The replacement of an existing *stairway* in a structure shall not be required to comply with the new *stairway* requirements of Section 1011 where the existing space and construction will not allow a reduction in pitch or slope.

**1104.11 Winders.** Existing winders shall be allowed to remain in use if they have a minimum tread depth of 6 inches (152 mm) and a minimum tread depth of 9 inches (229 mm) at a point 12 inches (305 mm) from the narrowest edge.

**1104.12 Curved stairways.** Existing curved *stairways* shall be allowed to continue in use, provided that the minimum depth of tread is 10 inches (254 mm) and the smallest radius shall be not less than twice the width of the *stairway*.

**1104.13 Stairway handrails.** *Stairways* shall have *handrails* on at least one side. *Handrails* shall be located so that all portions of the *stairway* width required for egress capacity are within 44 inches (1118 mm) of a *handrail*.

**Exception:** *Aisle stairs* provided with a center *handrail* are not required to have additional *handrails*.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

**1104.13.1 Height.** *Handrail* height, measured above *stair* tread nosings, shall be uniform, not less than 30 inches (762 mm) and not more than 42 inches (1067 mm).

**1104.14 Slope of ramps.** *Ramp* runs utilized as part of a *means of egress* shall have a running slope not steeper than 1 unit vertical in 10 units horizontal (10-percent slope). The slope of other *ramps* shall not be steeper than 1 unit vertical in 8 units horizontal (12.5-percent slope).

**1104.15 Width of ramps.** Existing *ramps* are permitted to have a minimum width of 30 inches (762 mm) but not less than the width required for the number of occupants served as determined by Section 1005.1. In Group I-2, *ramps* serving as a *means of egress* and used for the movement of patients in beds shall comply with Section 1105.6.4.

**[BE] 1104.16 Fire escape stairways.** Fire escape *stairways* shall comply with Sections 1104.16.1 through 1104.16.7.

**[BE] 1104.16.1 Existing means of egress.** Fire escape *stairways* shall be permitted in existing buildings but shall not constitute more than 50 percent of the required exit capacity.

**[BE] 1104.16.2 Opening protectives.** Doors and windows within 10 feet (3048 mm) of fire escape *stairways* shall be protected with  $\frac{3}{4}$ -hour opening protectives.

**Exception:** Opening protectives shall not be required in buildings equipped throughout with an *approved automatic sprinkler system*.

**[BE] 1104.16.3 Dimensions.** Fire escape *stairways* shall meet the minimum width, capacity, riser height and tread depth as specified in Section 1104.10.

**[BE] 1104.16.4 Access.** Access to a fire escape *stairway* from a *corridor* shall not be through an intervening room. Access to a fire escape *stairway* shall be from a door or window meeting the criteria of Section 1005.1. Access to a fire escape *stairway* shall be directly to a balcony, landing or platform. These shall not be higher than the floor or window sill level and not lower than 8 inches (203 mm) below the floor level or 18 inches (457 mm) below the window sill.

**[BE] 1104.16.5 Materials and strength.** Components of fire escape *stairways* shall be constructed of noncombustible materials. Fire escape *stairways* and balconies shall support the dead load plus a live load of not less than 100 pounds per square foot (4.78 kN/m<sup>2</sup>). Fire escape *stairways* and balconies shall be provided with a top and intermediate *handrail* on each side.

**[BE] 1104.16.5.1 Examination.** Fire escape *stairways* and balconies shall be examined for structural adequacy and safety in accordance with Section 1104.16.5 by a *registered design professional* or others acceptable to the *fire code official* every 5 years, or as required by the *fire code official*. An inspection report shall be submitted to the *fire code official* after such examination.

**[BE] 1104.16.6 Termination.** The lowest balcony shall not be more than 18 feet (5486 mm) from the ground. Fire escape *stairways* shall extend to the ground or be

provided with counterbalanced *stairs* reaching the ground.

**Exception:** For fire escape *stairways* serving 10 or fewer occupants, an *approved* fire escape ladder is allowed to serve as the termination.

**[BE] 1104.16.7 Maintenance.** Fire escape *stairways* shall be kept clear and unobstructed at all times and shall be maintained in good working order.

**1104.17 Corridor construction.** *Corridors* serving an *occupant load* greater than 30 and the openings therein shall provide an effective barrier to resist the movement of smoke. Transoms, louvers, doors and other openings shall be kept closed or be self-closing. In Group I-2, *corridors* in areas housing patient sleeping or care rooms shall comply with Section 1105.5.

#### Exceptions:

1. *Corridors* in occupancies other than in Group H, that are equipped throughout with an *approved automatic sprinkler system*.
2. *Corridors* in occupancies in Group E where each room utilized for instruction or assembly has not less than one-half of the required *means of egress* doors opening directly to the exterior of the building at ground level.
3. *Corridors* that are in accordance with the *International Building Code*.

**1104.17.1 Corridor openings.** Openings in *corridor* walls shall comply with the requirements of the *International Building Code*.

#### Exceptions:

1. Where 20-minute fire door assemblies are required, solid wood doors not less than 1.75 inches (44 mm) thick or insulated steel doors are allowed.
2. Openings protected with fixed wire glass set in steel frames.
3. Openings covered with 0.5-inch (12.7 mm) gypsum wallboard or 0.75-inch (19.1 mm) plywood on the room side.
4. Opening protection is not required where the building is equipped throughout with an *approved automatic sprinkler system*.

**1104.18 Dead ends.** Where more than one *exit* or *exit access doorway* is required, the *exit access* shall be arranged such that dead ends do not exceed the limits specified in Table 1104.18.

#### Exceptions:

1. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.
2. In existing buildings, existing dead-end *corridors* shall be permitted to comply with lengths established in Section 804.7 of the *International Existing Building Code*. Any newly constructed



## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

dead-end *corridors* within an existing building shall be limited to the lengths allowed by the *International Building Code*.

**1104.19 Exit access travel distance.** *Exits* shall be located so that the maximum length of *exit access* travel, measured from the most remote point to an *approved exit* along the natural and unobstructed path of egress travel, does not exceed the distances given in Table 1104.18.

**1104.20 Common path of egress travel.** The *common path of egress travel* shall not exceed the distances given in Table 1104.18.

**1104.21 Stairway discharge identification.** An interior *exit stairway* or *ramp* that continues below its *level of exit discharge* shall be arranged and marked to make the direction of egress to a *public way* readily identifiable.

**Exception:** *Stairways* that continue one-half story beyond their *levels of exit discharge* need not be provided with barriers where the *exit discharge* is obvious.

**TABLE 1104.18  
COMMON PATH, DEAD-END AND TRAVEL DISTANCE LIMITS (by occupancy)**

OCCUPANCY	COMMON PATH OF EGRESS TRAVEL LIMIT		DEAD-END LIMIT		EGRESS ACCESS TRAVEL DISTANCE LIMIT	
	Unsprinklered (feet)	Sprinklered (feet)	Unsprinklered (feet)	Sprinklered (feet) <sup>j</sup>	Unsprinklered (feet)	Sprinklered (feet)
Group A	75	20/75 <sup>i</sup>	20 <sup>a</sup>	20 <sup>a</sup>	200	250 <sup>j</sup>
Group B <sup>h</sup>	75 <sup>g</sup>	100 <sup>j</sup>	50	50	200	300 <sup>j</sup>
Group E	75	75 <sup>j</sup>	20	50	200	250 <sup>j</sup>
Group F-1, S-1	75 <sup>g</sup>	100 <sup>j</sup>	50	50	200 <sup>c</sup>	250 <sup>c, h, j</sup>
Group F-2, S-2	75 <sup>g</sup>	100 <sup>j</sup>	50	50	300	400 <sup>j</sup>
Group H-1	25	25 <sup>l</sup>	0	0	75	75 <sup>j, l</sup>
Group H-2	50	100 <sup>l</sup>	0	0	75	100 <sup>j, l</sup>
Group H-3	50	100 <sup>l</sup>	20	20	100	150 <sup>j, l</sup>
Group H-4	75	75 <sup>l</sup>	20	20	150	175 <sup>j, l</sup>
Group H-5	75	75 <sup>l</sup>	20	50	150	200 <sup>j, l</sup>
Group I-1	75	75 <sup>j</sup>	20	50	200	250 <sup>j</sup>
Group I-2	Notes d, e, f	Notes d, e, f, j	Note e	Note e	150	200 <sup>b, j</sup>
Group I-3	100	100 <sup>j</sup>	NR	NR	150 <sup>b</sup>	200 <sup>b, j</sup>
Group I-4	NR	NR	20	20	200	250 <sup>j</sup>
Group M	75	100 <sup>j</sup>	50	50	200	250 <sup>j, j</sup>
Group R-1	75	75 <sup>j, k</sup>	50	50	200	250 <sup>j, k</sup>
Group R-2	75	125 <sup>j, k</sup>	50	50	200	250 <sup>j, k</sup>
Group R-3	NR	NR	NR	NR	NR	NR
Group R-4	NR	NR	NR	NR	NR	NR
Group U	75 <sup>g</sup>	100 <sup>j</sup>	20	50	300	400 <sup>j</sup>

NR = No Requirements.

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. See Section 1030.9.5 for dead-end aisles in Group A occupancies.

b. This dimension is for the total travel distance, assuming incremental portions have fully utilized their allowable maximums. For travel distance within the room, and from the room exit access door to the exit, see the appropriate occupancy chapter.

c. See Section 412 of the *International Building Code* for special requirements on spacing of doors in aircraft hangars.

d. Separation of exit access doors within a care recipient sleeping room, or any suite that includes care recipient sleeping rooms, shall comply with Section 1105.5.6.

e. In smoke compartments containing care recipient sleeping rooms and treatment rooms, dead-end corridors shall comply with Section 1105.6.5.

f. In Group I-2, Condition 2, care recipient sleeping rooms or any suite that includes care recipient sleeping rooms shall comply with Section 1105.7.

g. Where a tenant space in Group B, S and U occupancies has an occupant load of not more than 30, the length of a common path of egress travel shall be not more than 100 feet.

h. Where the building, or portion of the building, is limited to one story and the height from the finished floor to the bottom of the ceiling or roof slab or deck is 24 feet or more, the exit access travel distance is increased to 400 feet.

i. For covered and open malls, the exit access travel distance is increased to 400 feet.

j. Buildings equipped with an approved automatic sprinkler system in accordance with Section 903.3.1.1.

k. Buildings equipped with an approved automatic sprinkler system in accordance with Section 903.3.1.2.

l. Group H occupancies equipped with an approved automatic sprinkler system in accordance with Section 903.2.5.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

**1104.22 Exterior stairway protection.** *Exterior exit stairways* shall be separated from the interior of the building as required in Section 1027.6. Openings shall be limited to those necessary for egress from normally occupied spaces.

**Exceptions:**

1. Separation from the interior of the building is not required for buildings that are two stories or less above grade where the *level of exit discharge* serving such occupancies is the first story above grade.
2. Separation from the interior of the building is not required where the exterior *stairway* is served by an exterior balcony that connects two remote exterior *stairways* or other *approved exits*, with a perimeter that is not less than 50 percent open. To be considered open, the opening shall be not less than 50 percent of the height of the enclosing wall, with the top of the opening not less than 7 feet (2134 mm) above the top of the balcony.
3. Separation from the interior of the building is not required for an exterior *stairway* located in a building or structure that is permitted to have unenclosed interior *stairways* in accordance with Section 1023.
4. Separation from the *open-ended corridors* of the building is not required for exterior *stairways* provided that:
  - 4.1. The *open-ended corridors* comply with Section 1020.
  - 4.2. The *open-ended corridors* are connected on each end to an *exterior exit stairway* complying with Section 1027.
  - 4.3. At any location in an *open-ended corridor* where a change of direction exceeding 45 degrees (0.79 rad) occurs, a clear opening of not less than 35 square feet (3 m<sup>2</sup>) or an exterior *stairway* shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.

**1104.23 Minimum aisle width.** The minimum clear width of *aisles* shall comply with the following:

1. Forty-two inches (1067 mm) for stepped *aisles* having seating on each side.
- Exception:** Thirty-six inches (914 mm) where the stepped *aisle* serves fewer than 50 seats.
2. Thirty-six inches (914 mm) for stepped *aisles* having seating on only one side.

**Exceptions:**

1. Thirty inches (760 mm) for catchment areas serving not more than 60 seats.
2. Twenty-three inches (584 mm) between a stepped aisle *handrail* and seating where a stepped *aisle* does not serve more than five rows on one side.

3. Twenty inches (508 mm) between a stepped *aisle handrail* or guard and seating where the *aisle* is subdivided by a mid-aisle *handrail*.
4. Forty-two inches (1067 mm) for level or ramped *aisles* having seating on both sides.

**Exceptions:**

1. Thirty-six inches (914 mm) where the *aisle* serves fewer than 50 seats.
  2. Thirty inches (760 mm) where the *aisle* serves fewer than 15 seats and does not serve as part of an *accessible route*.
  5. Thirty-six inches (914 mm) for level or ramped *aisles* having seating on only one side.
- Exception:** Thirty inches (760 mm) for catchment areas serving not more than 60 seats and not serving as part of an *accessible route*.
6. In Group I-2, where *aisles* are used for movement of patients in beds, *aisles* shall comply with Section 1105.6.8.

**1104.24 Stairway floor number signs.** Existing *stairways* shall be marked in accordance with Section 1023.9.

**1104.25 Egress path markings.** Existing high-rise buildings of Group A, B, E, I, M and R-1 occupancies shall be provided with luminous *egress* path markings in accordance with Section 1025.

**Exception:** Open, unenclosed stairwells in historic buildings designated as historic under a state or local historic preservation program.

## SECTION 1105 CONSTRUCTION REQUIREMENTS FOR EXISTING GROUP I-2

**1105.1 General.** Existing Group I-2 shall meet all of the following requirements:

1. The minimum fire safety requirements in Section 1103.
2. The minimum *means of egress* requirements in Section 1104.
3. The additional egress and construction requirements in Section 1105.

Where the provisions of this chapter conflict with the construction requirements that applied at the time of construction, the most restrictive provision shall apply.

**1105.2 Applicability.** The provisions of Sections 1105.3 through 1105.8, 1105.10 and 1105.11 shall apply to the existing Group I-2 *fire area*.

**1105.3 Construction.** Group I-2, Condition 2 shall not be located on a floor level higher than the floor level limitation in Table 1105.3 based on the type of construction.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

**TABLE 1105.3**  
**FLOOR LEVEL LIMITATIONS FOR GROUP I-2, CONDITION 2**

CONSTRUCTION TYPE	AUTOMATIC SPRINKLER SYSTEM	ALLOWABLE FLOOR LEVEL <sup>a</sup>			
		1	2	3	4 or more
IA	Note b	P	P	P	P
	Note c	P	P	P	P
IB	Note b	P	P	P	P
	Note c	P	P	P	P
IIA	Note b	P	P	P	NP
	Note c	P	NP	NP	NP
IIB	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
IIIA	Note b	P	P	NP	NP
	Note c	P	NP	NP	NP
IIIB	Note b	P	NP	NP	NP
	Note c	NP	NP	NP	NP
IV	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
VA	Note b	P	P	NP	NP
	Note c	NP	NP	NP	NP
VB	Note b	P	NP	NP	NP
	Note c	NP	NP	NP	NP

P = Permitted; NP = Not Permitted.

- Floor level shall be counted based on the number of stories above grade.
- The building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
- The building is equipped with an automatic sprinkler system in accordance with Section 1105.8.

**1105.4 Incidental uses in existing Group I-2.** Incidental uses associated with and located within existing single-occupancy or mixed-occupancy Group I-2 buildings and that generally pose a greater level of risk to such occupancies shall comply with the provisions of Sections 1105.4.1 through 1105.4.3.2.1. Incidental uses in Group I-2 occupancies are limited to those listed in Table 1105.4.

**1105.4.1 Occupancy classification.** Incidental uses shall not be individually classified in accordance with Section 302.1 of the *International Building Code*. Incidental uses shall be included in the building occupancies within which they are located.

**1105.4.2 Area limitations.** Incidental uses shall not occupy more than 10 percent of the *building area* of the story in which they are located.

**1105.4.3 Separation and protection.** The incidental uses listed in Table 1105.4 shall be separated from the remainder of the building or equipped with an *automatic sprinkler system*, or both, in accordance with the provisions of that table.

**1105.4.3.1 Separation.** Where Table 1105.4 specifies a *fire-resistance-rated* separation, the incidental uses shall be separated from the remainder of the building in accordance with Section 509.4.1 of the *International Building Code*.

**1105.4.3.2 Protection.** Where Table 1105.4 permits an *automatic sprinkler system* without a *fire-resistance-rated* separation, the incidental uses shall be separated from the remainder of the building by construction capable of resisting the passage of smoke in accordance with Section 509.4.2 of the *International Building Code*.

**TABLE 1105.4**  
**INCIDENTAL USES IN EXISTING GROUP I-2 OCCUPANCIES**

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen fuel gas rooms, not classified as Group H	2 hours
Incinerator rooms	2 hours and provide automatic sprinkler system
Paint shops not classified as Group H	2 hours; or 1 hour and provide automatic sprinkler system
Laboratories and vocational shops, not classified as Group H	1 hour or provide automatic sprinkler system
Laundry rooms over 100 square feet	1 hour or provide automatic sprinkler system
Patient rooms equipped with padded surfaces	1 hour or provide automatic sprinkler system
Physical plant maintenance shops	1 hour or provide automatic sprinkler system
Waste and linen collection rooms with containers with total volume of 10 cubic feet or greater	1 hour or provide automatic sprinkler system
Storage rooms greater than 100 square feet	1 hour or provide automatic sprinkler system
Stationary storage battery systems having a liquid electrolyte capacity of more than 50 gallons for flooded lead-acid, nickel cadmium or VRLA, or more than 1,000 pounds for lithium-ion and lithium metal polymer used for facility standby power, emergency power or uninterruptible power supplies	2 hours

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch (psi) = 6.9 kPa, 1 British thermal unit (Btu) per hour = 0.293 watts, 1 horsepower = 746 watts, 1 gallon = 3.785 L.

**1105.4.3.2.1 Protection limitation.** Except as otherwise specified in Table 1105.4 for certain incidental uses, where an *automatic sprinkler system* is provided in accordance with Table 1105.4, only the space occupied by the incidental use need be equipped with such a system.

**1105.5 Corridor construction.** In Group I-2, in areas housing patient sleeping or care rooms, *corridor* walls and the opening protectives therein shall provide a barrier designed to resist the passage of smoke in accordance with Sections 1105.5.1 through 1105.5.7.

**1105.5.1 Materials.** The walls shall be of materials permitted by the building type of construction.

**1105.5.2 Fire-resistance rating.** Unless required elsewhere in this code, *corridor* walls are not required to have a *fire-resistance rating*. *Corridor* walls that were installed as *fire-resistance-rated* assemblies in accordance with the applicable codes under which the building was constructed, remodeled or altered shall be maintained unless modified in accordance with the *International Existing Building Code*.

**1105.5.3 Corridor wall continuity.** *Corridor* walls shall extend from the top of the foundation or floor below to one of the following:

1. The underside of the floor or roof sheathing, deck or slab above.
2. The underside of a ceiling above where the ceiling membrane is constructed to limit the passage of smoke.
3. The underside of a lay-in ceiling system where the ceiling system is constructed to limit the passage of smoke and where the ceiling tiles weigh not less than 1 pound per square foot (4.88 kg/m<sup>2</sup>) of tile.

**1105.5.4 Openings in corridor walls.** Openings in *corridor* walls shall provide protection in accordance with Sections 1105.5.4.1 through 1105.5.4.3.

**1105.5.4.1 Windows.** Windows in *corridor* walls shall be sealed to limit the passage of smoke, or the window shall be automatic-closing upon detection of smoke, or the window opening shall be protected by an automatic closing device that closes upon detection of smoke.

**Exception:** In *smoke compartments* not containing patient sleeping rooms, pass-through windows or similar openings shall be permitted in accordance with Section 1105.5.4.3.

**1105.5.4.2 Doors.** Doors in *corridor* walls shall comply with Sections 1105.5.4.2.1 through 1105.5.4.2.3.

**1105.5.4.2.1 Louvers.** Doors in *corridor* walls shall not include louvers, transfer grills or similar openings.

**Exception:** Doors shall be permitted to have louvers, transfer grills or similar openings at toilet rooms or bathrooms; storage rooms that do not contain storage of flammable or combustible

material; and storage rooms that are not required to be separated as incidental uses.

**1105.5.4.2.2 Corridor doors.** Doors in *corridor* walls shall limit the transfer of smoke by complying with the following:

1. Doors shall be constructed of not less than 1<sup>3</sup>/<sub>4</sub> inch-thick (44 mm) solid bonded-core wood or capable of resisting fire not less than 1<sup>1</sup>/<sub>3</sub> hour.

**Exception:** *Corridor* doors in buildings equipped throughout with an *automatic sprinkler system*.

2. Frames for side-hinged swinging doors shall have stops on the sides and top to limit transfer of smoke.
3. Where provided, vision panels in doors shall be a fixed glass window assembly installed to limit the passage of smoke. Existing wired glass panels with steel frames shall be permitted to remain in place.
4. The clearance between the bottom of the door and floor shall not exceed 1 inch (25 mm).
5. Doors shall be positive latching with devices that resist not less than 5 pounds (22.2 N). Roller latches are prohibited.
6. Mail slots or similar openings shall be permitted in accordance with Section 1105.5.4.3.

**1105.5.4.2.3 Dutch doors.** Where provided, Dutch doors shall comply with Section 1105.5.4.2.2. In addition, Dutch doors shall be equipped with latching devices on either the top or bottom leaf to allow leaves to latch together. The space between the leaves shall be protected with devices such as astragals to limit the passage of smoke.

**1105.5.4.2.4 Self- or automatic-closing doors.** Where self- or automatic-closing doors are required, closers shall be maintained in operational condition. Hold-open devices on doors shall be capable of manual release.

**1105.5.4.2.5 Protective plates.** Protective plates installed on *corridor* doors shall not be limited in size.

**1105.5.4.3 Openings in corridor walls and doors.** In other than *smoke compartments* containing patient sleeping rooms, mail slots, pass-through windows or similar openings shall not be required to be protected where the aggregate area of the openings between the *corridor* and a room are not greater than 80 square inches (51 613 mm<sup>2</sup>) and are located with the top edge of any opening not higher than 48 inches above the floor.



## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

**1105.5.5 Penetrations.** The space around penetrating items shall be filled with an *approved* material to limit the passage of smoke.

**1105.5.6 Joints.** Joints shall be filled with an *approved* material to limit the passage of smoke.

**1105.5.7 Ducts and air transfer openings.** The space around a duct penetrating a smoke partition shall be filled with an *approved* material to limit the passage of smoke. Air transfer openings in smoke partitions shall be provided with a smoke damper complying with Section 717.3.2.2 of the *International Building Code*.

**Exception:** Where the installation of a smoke damper will interfere with the operation of a required smoke control system in accordance with Section 909, *approved* alternative protection shall be utilized.

**1105.6 Means of egress.** In addition to the *means of egress* requirements in Section 1104, Group I-2 facilities shall meet the *means of egress* requirements in Sections 1105.6.1 through 1105.6.8.

**1105.6.1 Two means of egress.** A *means of egress* shall be provided from each *smoke compartment* created by *smoke barriers* without having to return through the *smoke compartment* from which the *means of egress* originated. *Smoke compartments* that do not contain an *exit* shall be provided with direct access to not less than two adjacent *smoke compartments*.

**1105.6.2 Size of door.** *Means of egress* doors used for the movement of patients in beds shall provide a minimum clear width of 41½ inches (1054 mm). The height of the door opening shall be not less than 80 inches (2032 mm).

### Exceptions:

1. Door closers and door stops shall be permitted to be 78 inches (1981 mm) minimum above the floor.
2. In Group I-2, Condition 1, existing *means of egress* doors used for the movement of patients in beds that provide a minimum clear width of 32 inches (813 mm) shall be permitted to remain.

**1105.6.3 Group I-2 occupancies.** In Group I-2, where a door serves as an opening protective in a *fire barrier*, *smoke barrier* or *fire wall* and where the door is equipped with a hold-open device, such door shall automatically close upon any of the following conditions:

1. Actuation of smoke detectors initiating the hold-open device.
2. Activation of the fire alarm system within the zone.
3. Activation of an *automatic sprinkler system* within the zone.

**1105.6.4 Ramps.** In areas where *ramps* are used for movement of patients in beds, the clear width of the *ramp* shall be not less than 48 inches (1219 mm).

**1105.6.5 Corridor width.** In areas where *corridors* are used for movement of patients in beds, the clear width of the *corridor* shall be not less than 48 inches (1219 mm).

**1105.6.6 Dead-end corridors.** In *smoke compartments* containing patient sleeping rooms and treatment rooms, dead-end *corridors* shall not exceed 30 feet (9144 mm) unless *approved* by the *fire code official*.

**1105.6.7 Separation of exit access doors.** Patient sleeping rooms, or any suite that includes patient sleeping rooms, of more than 1,000 square feet (92.9 m²) shall have not less than two *exit access* doors placed a distance apart equal to not less than one-third of the length of the maximum overall diagonal dimension of the patient sleeping room or suite to be served, measured in a straight line between *exit access* doors.

**1105.6.8 Aisles.** In areas where *aisles* are used for movement of patients in beds, the clear width of the *aisle* shall be not less than 48 inches (1219 mm).

**1105.7 Smoke compartments.** *Smoke compartments* shall be provided in existing Group I-2, Condition 2, in accordance with Sections 1105.7.1 through 1105.7.6.

**1105.7.1 Design.** *Smoke barriers* shall be provided to subdivide each story used for patients sleeping with an *occupant load* of more than 30 patients into not fewer than two *smoke compartments*.

**1105.7.1.1 Refuge areas.** Refuge areas shall be provided within each *smoke compartment*. The size of the refuge area shall accommodate the occupants and care recipients from the adjoining *smoke compartment*. Where a *smoke compartment* is adjoined by two or more *smoke compartments*, the minimum area of the refuge area shall accommodate the largest *occupant load* of the adjoining compartments.

The size of the refuge area shall provide the following:

1. Not less than 30 net square feet (2.8 m²) for each care recipient confined to a bed or stretcher.
2. Not less than 15 square feet (1.4 m²) for each resident in a Group I-2 using mobility assistance devices.
3. Not less than 6 square feet (0.56 m²) for each occupant not addressed in Items 1 and 2.

Areas of spaces permitted to be included in the calculation of the refuge area are *corridors*, sleeping areas, treatment rooms, lounge or dining areas and other low-hazard areas.

**1105.7.2 Smoke barriers.** *Smoke barriers* shall be constructed in accordance with Section 709 of the *International Building Code*.

### Exceptions:

1. Existing *smoke barriers* are permitted to remain where the existing *smoke barrier* has a minimum *fire-resistance* rating of ½ hour.

## CONSTRUCTION REQUIREMENTS FOR EXISTING BUILDINGS

2. *Smoke barriers* shall be permitted to terminate at an atrium enclosure in accordance with Section 404.6 of the *International Building Code*.

**1105.7.3 Opening protectives.** Openings in *smoke barriers* shall be protected in accordance with Section 716 of the *International Building Code*. Opening protectives shall have a minimum *fire protection rating* of  $1\frac{1}{3}$  hour.

**Exceptions:**

1. Existing wired glass vision panels in doors shall be permitted to remain.
2. Existing nonlabeled protection plates shall be permitted to remain.

**1105.7.4 Penetrations.** Penetrations of *smoke barriers* shall comply with the *International Building Code*.

**Exception:** *Approved* existing materials and methods of construction.

**1105.7.5 Joints.** Joints made in or between *smoke barriers* shall comply with the *International Building Code*.

**Exception:** *Approved* existing materials and methods of construction.

**1105.7.6 Duct and air transfer openings.** Penetrations in a *smoke barrier* by duct and air transfer openings shall comply with Section 717 of the *International Building Code*.

**Exception:** Where existing duct and air transfer openings in *smoke barriers* exist without smoke dampers, they shall be permitted to remain. Any changes to existing smoke dampers shall be submitted for review and *approved* in accordance with Section 717 of the *International Building Code*.

**1105.8 Group I-2 care suites.** Care suites in existing Group I-2, Condition 2 occupancies shall comply with Sections 407.4.4 through 407.4.4.6.2 of the *International Building Code*.

**1105.9 Group I-2 automatic sprinkler system.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.1 shall be provided throughout the floor containing the Group I-2 *fire area*. The sprinkler system shall be provided throughout the floor where the Group I-2 occupancy is located, on all floors between the Group I-2 occupancy *fire area* and the *level of exit discharge*, the *level of exit discharge*, and all floors below the *level of exit discharge*.

**Exception:** Floors classified as an open parking garage are not required to be sprinklered.

**1105.10 Group I-2 automatic fire alarm system.** An automatic fire alarm system shall be installed in existing Group I-2 occupancies in accordance with Section 907.2.6.2.

**Exception:** Manual fire alarm boxes in patient sleeping areas shall not be required at *exits* if located at all nurses' control stations or other constantly attended staff locations, provided such that manual fire alarm boxes are visible, are provided with *ready access*, and travel distances required in Section 907.4.2.1 are not exceeded.

**1105.11 Essential electrical systems.** Essential electrical systems in Group I-2, Condition 2 occupancies shall be in accordance with Sections 1105.11.1 and 1105.11.2.

**1105.11.1 Where required.** Where required by NFPA 99, Group I-2, Condition 2 occupancies shall be provided with an essential electrical system in accordance with NFPA 99.

**1105.11.2 Installation and duration.** In Group I-2, Condition 2 occupancies, the installation and duration of operation of existing essential electrical systems shall be based on a hazard vulnerability analysis conducted in accordance with NFPA 99.

## SECTION 1106 REQUIREMENTS FOR OUTDOOR OPERATIONS

**1106.1 Tire storage yards.** Existing tire storage yards shall be provided with fire apparatus access roads in accordance with Sections 1106.1.1 and 1106.1.2.

**1106.1.1 Access to piles.** Access roadways shall be within 150 feet (45 720 mm) of any point in the storage yard where storage piles are located not less than 20 feet (6096 mm) from any storage pile.

**1106.1.2 Location within piles.** Fire apparatus access roads shall be located within all pile clearances identified in Section 3405.4 and within all fire breaks required in Section 3405.5.



## CHAPTER 12

# ENERGY SYSTEMS

### User note:

**About this chapter:** Chapter 12 was added to address the current energy systems found in this code, and is provided for the introduction of a wide range of systems to generate and store energy in, on and adjacent to buildings and facilities. The expansion of such energy systems is related to meeting today's energy, environmental and economic challenges. Ensuring appropriate criteria to address the safety of such systems in building and fire codes is an important part of protecting the public at large, building occupants and emergency responders. More specifically, this chapter addresses standby and emergency power, portable generators, photovoltaic systems, fuel cell energy systems, and energy storage systems.

### SECTION 1201 GENERAL

**1201.1 Scope.** The provisions of this chapter shall apply to the installation, operation, maintenance, repair, retrofitting, testing, commissioning and decommissioning of energy systems used for generating or storing energy. It shall not apply to equipment associated with the generation, control, transformation, transmission, or distribution of energy installations that is under the exclusive control of an electric utility or lawfully designated agency.

**1201.2 Electrical wiring and equipment.** Electrical wiring and equipment used in connection with energy systems shall be installed and maintained in accordance with this chapter, Section 603 and NFPA 70.

**1201.3 Mixed system installation.** Where *approved*, the aggregate nameplate kWh energy of all energy storage systems in a *fire area* shall not exceed the maximum quantity specified for any of the energy systems in this chapter. Where required by the *fire code official*, a hazard mitigation analysis shall be provided and *approved* in accordance with Section 104.8.2 to evaluate any potential adverse interaction between the various energy systems and technologies.

### SECTION 1202 DEFINITIONS

**1202.1 Definitions.** The following terms are defined in Chapter 2:

**BATTERY SYSTEM, STATIONARY STORAGE.**

**BATTERY TYPES.**

**CAPACITOR ENERGY STORAGE SYSTEM.**

**CRITICAL CIRCUIT.**

**EMERGENCY POWER SYSTEM.**

**ENERGY STORAGE MANAGEMENT SYSTEMS.**

**ENERGY STORAGE SYSTEM (ESS).**

**ENERGY STORAGE SYSTEM,  
ELECTROCHEMICAL.**

**ENERGY STORAGE SYSTEM, MOBILE.**

**ENERGY STORAGE SYSTEM, WALK-IN UNIT.**

**ENERGY STORAGE SYSTEM CABINET.**

**ENERGY STORAGE SYSTEM COMMISSIONING.**  
**ENERGY STORAGE SYSTEM DECOMMISSIONING.**  
**FUEL CELL POWER SYSTEM, STATIONARY.**  
**PORTABLE GENERATOR.**  
**STANDBY POWER SYSTEM.**

### SECTION 1203 EMERGENCY AND STANDBY POWER SYSTEMS

**1203.1 General.** Emergency power systems and standby power systems required by this code or the *International Building Code* shall comply with Sections 1203.1.1 through 1203.1.9.

**1203.1.1 Stationary generators.** Stationary emergency and standby power generators required by this code shall be *listed* in accordance with UL 2200.

**1203.1.2 Fuel line piping protection.** Fuel lines supplying a generator set inside a high-rise building shall be separated from areas of the building other than the room the generator is located in by one of the following methods:

1. A fire-resistant pipe-protection system that has been tested in accordance with UL 1489. The system shall be installed as tested and in accordance with the manufacturer's installation instructions, and shall have a rating of not less than 2 hours. Where the building is protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1, the required rating shall be reduced to 1 hour.
2. An assembly that has a *fire-resistance rating* of not less than 2 hours. Where the building is protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1, the required *fire-resistance rating* shall be reduced to 1 hour.
3. Other *approved* methods.

**1203.1.3 Installation.** Emergency power systems and standby power systems shall be installed in accordance with the *International Building Code*, NFPA 70, NFPA 110 and NFPA 111.



## ENERGY SYSTEMS

**1203.1.4 Load transfer.** Emergency power systems shall automatically provide secondary power within 10 seconds after primary power is lost, unless specified otherwise in this code. Standby power systems shall automatically provide secondary power within 60 seconds after primary power is lost, unless specified otherwise in this code.

**1203.1.5 Load duration.** Emergency power systems and standby power systems shall be designed to provide the required power for a minimum duration of 2 hours without being refueled or recharged, unless specified otherwise in this code.

**1203.1.6 Uninterruptable power source.** An uninterrupted source of power shall be provided for equipment where required by the manufacturer's instructions, the listing, this code or applicable referenced standards.

**1203.1.7 Interchangeability.** Emergency power systems shall be an acceptable alternative for installations that require standby power systems.

**1203.1.8 Group I-2 occupancies.** In Group I-2 occupancies located in flood hazard areas established in Section 1612.3 of the *International Building Code* where new essential electrical systems are installed, and where new essential electrical system generators are installed, the systems and generators shall be located and installed in accordance with ASCE 24. Where connections for hook up of temporary generators are provided, the connections shall be located at or above the elevation required in ASCE 24.

**1203.1.9 Maintenance.** Existing installations shall be maintained in accordance with the original approval and Section 1203.4.

**1203.2 Where required.** Emergency and standby power systems shall be provided where required by Sections 1203.2.1 through 1203.2.19.

**1203.2.1 Ambulatory care facilities.** Essential electrical systems for ambulatory care facilities shall be in accordance with Section 422.6 of the *International Building Code*.

**1203.2.2 Elevators and platform lifts.** Standby power shall be provided for elevators and platform lifts as required in Sections 604.3, 1009.4.1 and 1009.5.

**1203.2.3 Emergency responder communication coverage systems.** Standby power shall be provided for in-building, two-way emergency responder communication coverage systems as required in Section 510.4.2.3. The standby power supply shall be capable of operating the in-building, two-way emergency responder communication coverage system at 100-percent system operation capacity for a duration of not less than 12 hours.

**1203.2.4 Emergency voice/alarm communication systems.** Standby power shall be provided for emergency voice/alarm communication systems in accordance with NFPA 72.

**1203.2.5 Exhaust ventilation.** Standby power shall be provided for mechanical exhaust ventilation systems as required in Section 1207.6.1.2.1. The system shall be capable of powering the required load for a duration of not less than 2 hours.

**1203.2.6 Exit signs.** Emergency power shall be provided for exit signs as required in Section 1013.6.3. The system shall be capable of powering the required load for a duration of not less than 90 minutes.

**1203.2.7 Gas detection systems.** Emergency power shall be provided for gas detection systems where required by Sections 1203.2.10 and 1203.2.17. Standby power shall be provided for gas detection systems where required by Sections 916.5 and 1207.6.1.2.4.

**1203.2.8 Group I-2 occupancies.** Essential electrical systems for Group I-2 occupancies shall be in accordance with Section 407.11 of the *International Building Code*.

**1203.2.9 Group I-3 occupancies.** Power-operated sliding doors or power-operated locks for swinging doors in Group I-3 occupancies shall be operable by a manual release mechanism at the door. Emergency power shall be provided for the doors and locks.

#### Exceptions:

1. Emergency power is not required in facilities where provisions for remote locking and unlocking of occupied rooms in Occupancy Condition 4 are not required as set forth in the *International Building Code*.
2. Emergency power is not required where remote mechanical operating releases are provided.

**1203.2.10 Hazardous materials.** Emergency and standby power shall be provided in occupancies with hazardous materials as required in the following sections:

1. Sections 5004.7 and 5005.1.5 for hazardous materials.
2. Sections 6004.2.2.8 and 6004.3.4.2 for highly toxic and toxic gases.
3. Section 6204.1.11 for organic peroxides.

**1203.2.11 High-rise buildings.** Standby power and emergency power shall be provided for high-rise buildings as required in Section 403 of the *International Building Code*, and shall be in accordance with Section 1203.

**1203.2.12 Special purpose horizontal sliding doors.** Standby power shall be provided for horizontal sliding doors as required in Section 1010.3.3. The standby power supply shall have a capacity to operate not fewer than 50 closing cycles of the door.

**1203.2.13 Hydrogen fuel gas rooms.** Standby power shall be provided for hydrogen fuel gas rooms as required by Section 5808.7.

**1203.2.14 Laboratory suites.** Standby or emergency power shall be provided in accordance with Section 5004.7 where *laboratory suites* are located above the

sixth story above *grade plane* or located in a story below *grade plane*.

**1203.2.15 Means of egress illumination.** Emergency power shall be provided for *means of egress* illumination in accordance with Sections 1008.3 and 1104.5.1.

**1203.2.16 Membrane structures.** Standby power shall be provided for auxiliary inflation systems in permanent membrane structures in accordance with Section 2702 of the *International Building Code*. Auxiliary inflation systems shall be provided in temporary air-supported and air-inflated membrane structures in accordance with Section 3103.10.4.

**1203.2.17 Semiconductor fabrication facilities.** Emergency power shall be provided for semiconductor fabrication facilities as required in Section 2703.15.

**1203.2.18 Smoke control systems.** Standby power shall be provided for smoke control systems as required in Section 909.11.

**1203.2.19 Underground buildings.** Emergency and standby power shall be provided in underground buildings as required in Section 405 of the *International Building Code* and shall be in accordance with Section 1203.

**1203.3 Critical circuits.** Required *critical circuits* shall be protected using one of the following methods:

1. Cables used for survivability of required *critical circuits* shall be *listed* in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 1 hour.
2. Electrical circuit protective systems shall have a *fire-resistance rating* of not less than 1 hour. Electrical circuit protective systems shall be installed in accordance with their listing requirements.
3. Construction having a *fire-resistance rating* of not less than 1 hour.

**1203.4 Maintenance.** Emergency and standby power systems shall be maintained in accordance with NFPA 110 and NFPA 111 such that the system is capable of supplying service within the time specified for the type and duration required.

**1203.4.1 Group I-2 and ambulatory care facilities.** In Group I-2 occupancies and ambulatory care facilities, emergency and standby power systems shall be maintained in accordance with NFPA 99.

**1203.4.2 Schedule.** Inspection, testing and maintenance of emergency and standby power systems shall be in accordance with an *approved* schedule established upon completion and approval of the system installation.

**1203.4.3 Records.** Records of the inspection, testing and maintenance of emergency and standby power systems shall include the date of service, name of the servicing technician, a summary of conditions noted and a detailed description of any conditions requiring correction and what corrective action was taken. Such records shall be maintained.

**1203.4.4 Switch maintenance.** Emergency and standby power system transfer switches shall be included in the inspection, testing and maintenance schedule required by Section 1203.4.2. Transfer switches shall be maintained free from accumulated dust and dirt. Inspection shall include examination of the transfer switch contacts for evidence of deterioration. When evidence of contact deterioration is detected, the contacts shall be replaced in accordance with the transfer switch manufacturer's instructions.

**1203.5 Operational inspection and testing.** Emergency power systems, including all appurtenant components, shall be inspected and tested under load in accordance with NFPA 110 and NFPA 111.

**Exception:** Where the emergency power system is used for standby power or peak load shaving, such use shall be recorded and shall be allowed to be substituted for scheduled testing of the generator set, provided that appropriate records are maintained.

**1203.5.1 Group I-2 and ambulatory care facilities.** In Group I-2 occupancies and ambulatory care facilities, emergency and standby power systems shall be inspected and tested under load in accordance with NFPA 99.

**1203.5.2 Transfer switch test.** The test of the transfer switch shall consist of electrically operating the transfer switch from the normal position to the alternate position and then return to the normal position.

**1203.6 Supervision of maintenance and testing.** Routine maintenance, inspection and operational testing shall be overseen by a properly instructed individual.

## SECTION 1204 PORTABLE GENERATORS

**1204.1 Portable generators.** The use, operation and maintenance of portable generators shall comply with this section.

**1204.2 Listing.** Portable generators manufactured after January 1, 2021, shall be *listed* and *labeled* in accordance with UL 2201.

**1204.3 Operation and maintenance.** Portable generators shall be operated and maintained in accordance with the manufacturer's instructions.

**1204.4 Grounding.** Portable generators shall be grounded in accordance with NFPA 70.

**1204.5 Operating locations.** Portable generators shall be operated only outdoors a minimum of 5 feet (1524 mm) from any building openings such as windows and doors or air intakes. Portable generators shall not be operated within buildings or enclosed areas. Additional separation shall be provided for tents, membrane structures and outdoor assembly events as specified in Chapter 31.

**1204.6 Cords and wiring.** Extension cords and temporary wiring used to connect portable generators shall be in accordance with Section 603 and shall be provided with GFCI protection.

## ENERGY SYSTEMS

**1204.7 Connections to premise wiring.** Connections to a premise wiring system shall comply with all of the following:

1. Power shall not be provided in a manner that “back-feeds” receptacles or the premise wiring system.
2. Connection to a premise served by commercial power shall be made through a *listed* transfer switch installed, used and maintained in accordance with NFPA 70.
3. Connection to buildings not served by commercial power shall comply with NFPA 70.

**1204.8 Refueling.** Portable generators shall not be refueled while operating.

**1204.9 Storage and repair.** Storage and repair of fuel-fired portable generators shall comply with Section 313.

**1204.10 Fire extinguisher.** A *listed* portable fire extinguisher complying with Section 906 with a minimum rating of 2-A:20-B:C shall be provided not more than 50 feet (15 240 mm) from the portable generator.

## SECTION 1205 SOLAR PHOTOVOLTAIC POWER SYSTEMS

**1205.1 General.** Solar photovoltaic (PV) systems shall be installed in accordance with the *International Building Code* or *International Residential Code*. The electrical portion of solar PV systems shall be installed in accordance with NFPA 70. Rooftop-mounted solar photovoltaic systems shall be installed in accordance with Sections 1205.2 through 1205.4.3. Ground-mounted solar photovoltaic systems shall comply with Section 1205.5.

**1205.2 Access and pathways.** Roof access, pathways and spacing requirements shall be provided in accordance with Sections 1205.2.1 through 1205.3.3. Pathways shall be over areas capable of supporting fire fighters accessing the roof. Pathways shall be located in areas with minimal obstructions, such as vent pipes, conduit or mechanical equipment.

### Exceptions:

1. Detached, nonhabitable Group U structures including, but not limited to, detached garages serving Group R-3 buildings, parking shade structures, carports, solar trellises and similar structures.
2. Roof access, pathways and spacing requirements need not be provided where the *fire code official* has determined that rooftop operations will not be employed.
3. Building-integrated photovoltaic (BIPV) systems where the BIPV systems are *approved*, integrated into the finished roof surface and are *listed* in accordance with a national test standard developed to address Section 690.12(B)(2) of NFPA 70. The removal or cutting away of portions of the BIPV system during fire-fighting operations shall

not expose a fire fighter to electrical shock hazards.

**1205.2.1 Solar photovoltaic (PV) systems for Group R-3 buildings.** Solar photovoltaic (PV) systems for Group R-3 buildings shall comply with Sections 1205.2.1.1 through 1205.2.3.

### Exceptions:

1. These requirements shall not apply to structures designed and constructed in accordance with the *International Residential Code*.
2. These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal (16.7-percent slope) or less.

**1205.2.1.1 Pathways to ridge.** Not fewer than two 36-inch-wide (914 mm) pathways on separate roof planes, from lowest roof edge to ridge, shall be provided on all buildings. Not fewer than one pathway shall be provided on the street or driveway side of the roof. For each roof plane with a photovoltaic array, not fewer than one 36-inch-wide (914 mm) pathway from lowest roof edge to ridge shall be provided on the same roof plane as the photovoltaic array, on an adjacent roof plane or straddling the same and adjacent roof planes.

**1205.2.1.2 Setbacks at ridge.** For photovoltaic arrays occupying 33 percent or less of the plan view total roof area, a setback of not less than 18 inches (457 mm) wide is required on both sides of a horizontal ridge. For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, a setback of not less than 36 inches (457 mm) wide is required on both sides of a horizontal ridge.

**1205.2.1.3 Alternative setbacks at ridge.** Where an *automatic sprinkler system* is installed within the *dwelling* in accordance with Section 903.3.1.3, setbacks at the ridge shall conform to one of the following:

1. For photovoltaic arrays occupying 66 percent or less of the plan view total roof area, a setback of not less than 18 inches (457 mm) wide is required on both sides of a horizontal ridge.
2. For photovoltaic arrays occupying more than 66 percent of the plan view total roof area, a setback of not less than 36 inches (914 mm) wide is required on both sides of a horizontal ridge.

**1205.2.2 Emergency escape and rescue openings.** Panels and modules installed on Group R-3 buildings shall not be placed on the portion of a roof that is below an emergency escape and rescue opening. A pathway of not less than 36 inches (914 mm) wide shall be provided to the emergency escape and rescue opening.

**1205.2.3 Building-integrated photovoltaic (BIPV) systems.** Where building-integrated photovoltaic (BIPV) systems are installed in a manner that creates areas with



electrical hazards to be hidden from view, markings shall be provided to identify the hazardous areas to avoid. The markings shall be reflective and be visible from grade.

**Exception:** BIPV systems *listed* in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the BIPV system during fire-fighting operations have been determined to not expose a fire fighter to electrical shock hazards.

**1205.3 Other than Group R-3 buildings.** Access to systems for buildings, other than those containing Group R-3 occupancies, shall be provided in accordance with Sections 1205.3.1 through 1205.3.3.

**Exception:** Where it is determined by the *fire code official* that the roof configuration is similar to that of a Group R-3 occupancy, the residential access and ventilation requirements in Sections 1205.2.1.1 through 1205.2.1.3 are a suitable alternative.

**1205.3.1 Perimeter pathways.** There shall be a minimum 6-foot-wide (1829 mm) clear perimeter around the edges of the roof.

**Exception:** Where either axis of the building is 250 feet (76 200 mm) or less, the clear perimeter around the edges of the roof shall be permitted to be reduced to a minimum width of 4 feet (1219 mm).

**1205.3.2 Interior pathways.** Interior pathways shall be provided between array sections to meet the following requirements:

1. Pathways shall be provided at intervals not greater than 150 feet (45 720 mm) throughout the length and width of the roof.
2. A pathway not less than 4 feet (1219 mm) wide in a straight line to roof standpipes or ventilation hatches.
3. A pathway not less than 4 feet (1219 mm) wide around roof access hatches, with not fewer than one such pathway to a parapet or roof edge.

**1205.3.3 Smoke ventilation.** The solar installation shall be designed to meet the following requirements:

1. Where nongravity-operated smoke and heat vents occur, a pathway not less than 4 feet (1219 mm) wide shall be provided bordering all sides.
2. Where gravity-operated dropout smoke and heat vents occur, a pathway not less than 4 feet (1219 mm) wide on not fewer than one side.
3. Smoke ventilation options between array sections shall be one of the following:
  - 3.1. A pathway not less than 8 feet (2438 mm) wide.
  - 3.2. A pathway not less than 4 feet (1219 mm) wide bordering 4-foot by 8-foot (1219 mm by 2438 mm) venting cutouts every 20 feet (6096 mm) on alternating sides of the pathway.

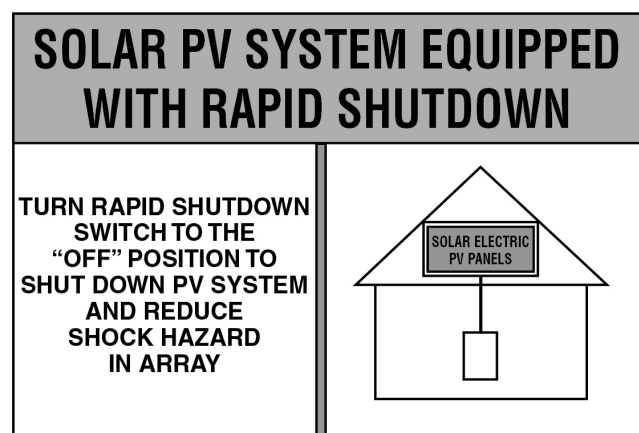
**1205.4 Buildings with rapid shutdown.** Buildings with rapid shutdown solar photovoltaic systems shall have perma-

nent labels in accordance with Sections 1205.4.1 through 1205.4.3.

**1205.4.1 Rapid shutdown type.** The type of solar photovoltaic system rapid shutdown shall be labeled with one of the following:

1. For solar photovoltaic systems that shut down the array and the conductors leaving the array, a label shall be provided. The first two lines of the label shall be uppercase characters with a minimum height of  $\frac{3}{8}$  inch (10 mm) in black on a yellow background. The remaining characters shall be uppercase with a minimum height of  $\frac{3}{16}$  inch (5 mm) in black on a white background. The label shall be in accordance with Figure 1205.4.1(1) and state the following:

SOLAR PV SYSTEM EQUIPPED WITH  
RAPID SHUTDOWN. TURN RAPID  
SHUTDOWN SWITCH TO THE "OFF"  
POSITION TO SHUT DOWN PV SYSTEM  
AND REDUCE SHOCK HAZARD IN ARRAY.

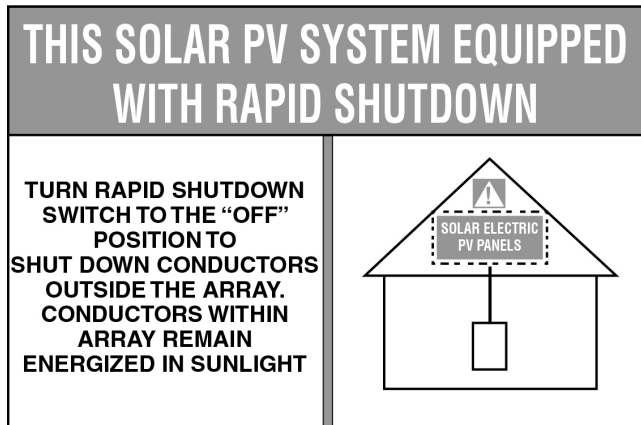


**FIGURE 1205.4.1(1)**  
**LABEL FOR SOLAR PV SYSTEMS THAT REDUCE**  
**SHOCK HAZARD WITHIN ARRAY AND SHUT**  
**DOWN CONDUCTORS LEAVING ARRAY**

2. For photovoltaic systems that only shut down conductors leaving the array, a label shall be provided. The first two lines of the label shall be uppercase characters with a minimum height of  $\frac{3}{8}$  inch (10 mm) in white on a red background and the remaining characters shall be capitalized with a minimum height of  $\frac{3}{16}$  inch (5 mm) in black on a white background. The label shall be in accordance with Figure 1205.4.1(2) and state the following:

THIS SOLAR PV SYSTEM EQUIPPED  
WITH RAPID SHUTDOWN. TURN RAPID  
SHUTDOWN SWITCH TO THE "OFF"  
POSITION TO SHUT DOWN CONDUCTORS  
OUTSIDE THE ARRAY. CONDUCTORS  
WITHIN ARRAY REMAIN ENERGIZED  
IN SUNLIGHT.





**FIGURE 1205.4.1(2)**  
**LABEL FOR SOLAR PV SYSTEMS THAT ONLY SHUT DOWN**  
**CONDUCTORS LEAVING THE ARRAY**

**1205.4.1.1 Diagram.** The labels in Section 1205.4.1 shall include a simple diagram of a building with a roof. Diagram sections in red signify sections of the solar photovoltaic system that are not shut down when the rapid shutdown switch is turned off.

**1205.4.1.2 Location.** The rapid shutdown label in Section 1205.4.1 shall be located not greater than 3 feet (914 mm) from the service disconnecting means to which the photovoltaic systems are connected, and shall indicate the location of all identified rapid shutdown switches if not at the same location.

**1205.4.2 Buildings with more than one rapid shutdown type.** Solar photovoltaic systems that contain rapid shutdown in accordance with both Items 1 and 2 of Section 1205.4.1 or solar photovoltaic systems where only portions of the systems on the building contain rapid shutdown, shall provide a detailed plan view diagram of the roof showing each different photovoltaic system and a dotted line around areas that remain energized after the rapid shutdown switch is operated.

**1205.4.3 Rapid shutdown switch.** A rapid shutdown switch shall have a label located not greater than 3 feet (914 mm) from the switch that states the following:

RAPID SHUTDOWN SWITCH  
FOR SOLAR PV SYSTEM

**1205.5 Ground-mounted photovoltaic panel systems.** Ground-mounted photovoltaic panel systems shall be installed in accordance with this section. Setback requirements shall not apply to ground-mounted, free-standing photovoltaic arrays.

**1205.5.1 Vegetation control.** A clear, brush-free area of 10 feet (3048 mm) shall be required around the perimeter of the ground-mounted photovoltaic arrays. A maintained vegetative surface or a noncombustible base, *approved* by the *fire code official*, shall be installed and maintained under the photovoltaic arrays and associated electrical equipment installations.

## SECTION 1206

### STATIONARY FUEL CELL POWER SYSTEMS

**1206.1 General.** *Stationary fuel cell power systems* in new and existing occupancies shall comply with this section.

**Exception:** The temporary use of a fuel cell-powered electric vehicle to power a Group R-3 or R-4 building while parked shall comply with Section 1206.14.

**1206.2 Permits.** Permits shall be obtained for *stationary fuel cell power systems* as set forth in Section 105.6.9.

**1206.3 Equipment.** *Stationary fuel cell power systems* shall comply with the following:

1. *Prepackaged fuel cell power systems* shall be listed and labeled in accordance with CSA FC 1.
2. The modules and components in a *preengineered fuel cell power system* shall be listed and labeled in accordance with CSA FC 1 and interconnected to complete the assembly of the system at the job site in accordance with the manufacturer's instructions and the module and component listings.
3. *Field-fabricated fuel cell power systems* shall be approved based on a review of the technical report provided in accordance with Section 104.8.2. The report shall be prepared by and bear the stamp of a *registered design professional* and shall include:
  - 3.1. A fire risk evaluation.
  - 3.2. An evaluation demonstrating that modules and components in the fuel cell power system comply with applicable requirements in CSA FC 1.
  - 3.3. Documentation of the fuel cell power system's compliance with applicable NFPA 2 and NFPA 853 construction requirements.

**1206.4 Installation.** *Stationary fuel cell power systems* shall be installed and maintained in accordance with NFPA 70 and NFPA 853, the manufacturer's installation instructions, and the listing. *Stationary fuel cell power systems* fueled by hydrogen shall be installed and maintained in accordance with NFPA 2 and NFPA 70, the manufacturer's installation instructions and the listing.

**1206.5 Residential use.** *Stationary fuel cell power systems* shall not be installed in Group R-3 and R-4 buildings, or *dwelling units* associated with Group R-2 buildings unless they are specifically *listed* for residential use.

**Exception:** The temporary use of a fuel cell-powered electric vehicle to power a Group R-3 or R-4 building while parked shall comply with Section 1206.14.

**1206.6 Indoor installations.** *Stationary fuel cell power systems* installed in indoor locations shall comply with Sections 1206.6 through 1206.6.2. For purposes of this section, an indoor location includes a roof and 50 percent or greater enclosing walls.

**1206.6.1 Listed.** *Stationary fuel cell power systems* installed indoors shall be specifically *listed* and *labeled* for indoor use.

**1206.6.2 Separation.** Rooms containing *stationary fuel cell power systems* shall be separated from the following occupancies by *fire barriers* or *horizontal assemblies*, or both, constructed in accordance with the *International Building Code*.

1. Group B, F, M, S and U occupancies by 1-hour *fire-resistance-rated* construction.
2. Group A, E, I and R occupancies by 2-hour *fire-resistance-rated* construction.

**Exception:** *Stationary fuel cell power systems* with an aggregate rating less than 50 kW shall not be required to be separated from other occupancies provided that the systems comply with Section 9.3 of NFPA 853.

**1206.7 Vehicle impact protection.** Where *stationary fuel cell power systems* are subject to impact by a motor vehicle, vehicle impact protection shall be provided in accordance with Section 312.

**1206.8 Outdoor installation.** *Stationary fuel cell power systems* located outdoors shall be separated by not less than 5 feet (1524 mm) from the following:

1. Lot lines.
2. Public ways.
3. Buildings.
4. Stored combustible materials.
5. Hazardous materials.
6. High-piled stock.
7. Any portion of a designated *means of egress* system.
8. Other exposure hazards.

**1206.9 Fuel supply.** The design, location and installation of the fuel supply for *stationary fuel cell power systems* shall comply with Chapter 53, Chapter 58 and the *International Fuel Gas Code*, based on the particular fuel being supplied to the system.

**1206.10 Manual shutoff.** Access to a manual shutoff valve shall be provided for the fuel piping within 6 feet (1829 mm) of any fuel storage tank serving the fuel cell and within 6 feet (1829 mm) of the power system. If the fuel tank and the *stationary fuel cell power system* are less than 12 feet (3658 mm) apart, a single shutoff valve shall be permitted. If the *stationary fuel cell power system* is located indoors, the shutoff valve shall be located outside of the room in which the system is installed, unless otherwise *approved* by the *fire code official*.

**1206.11 Ventilation and exhaust.** Ventilation and exhaust for stationary fuel cell power systems shall be provided in accordance with NFPA 853.

**1206.12 Fire protection.** Fire protection systems for stationary fuel cell power system installations shall be provided in accordance with NFPA 853.

**1206.13 Gas detection systems.** *Stationary fuel cell power systems* shall be provided with a gas detection system. Detection shall be provided in *approved* locations in the fuel cell power system enclosure, the exhaust system or the room that encloses the fuel cell power system. The system shall be

designed to activate at a flammable gas concentration of not more than 25 percent of the lower flammable limit (LFL).

**1206.13.1 System activation.** The activation of the gas detection system shall automatically:

1. Close valves between the gas supply and the fuel cell power system.
2. Shut down the fuel cell power system.
3. Initiate local audible and visible alarms in *approved* locations.

**1206.14 Group R-3 and R-4 fuel cell vehicle energy storage system use.** The temporary use of the *dwelling unit owner* or occupant's fuel cell-powered electric vehicle to power a Group R-3 or R-4 dwelling while parked in an attached or detached garage or outside shall comply with the vehicle manufacturer's instructions and NFPA 70.

## SECTION 1207 ELECTRICAL ENERGY STORAGE SYSTEMS (ESS)

**1207.1 General.** The provisions in this section are applicable to stationary and mobile electrical energy storage systems (ESS).

**Exception:** ESS in Group R-3 and R-4 occupancies shall comply with Section 1207.11.

**1207.1.1 Scope.** ESS having capacities exceeding the values shown in Table 1207.1.1 shall comply with this section.

TABLE 1207.1.1  
ENERGY STORAGE SYSTEM (ESS) THRESHOLD QUANTITIES

TECHNOLOGY	ENERGY CAPACITY <sup>a</sup>
Capacitor ESS	3 kWh
Flow batteries <sup>b</sup>	20 kWh
Lead-acid batteries, all types	70 kWh <sup>c</sup>
Lithium-ion batteries	20 kWh
Nickel metal hydride (Ni-MH)	70 kWh
Nickel-cadmium batteries (Ni-Cd)	70 kWh
Other battery technologies	10 kWh
Other electrochemical ESS technologies	3 kWh

For SI: 1 kilowatt hour = 3.6 megajoules.

- a. Energy capacity is the total energy capable of being stored (nameplate rating), not the usable energy rating. For units rated in amp-hours, kWh shall equal rated voltage times amp-hour rating divided by 1,000.
- b. Shall include vanadium, zinc-bromine, polysulfide-bromide and other flowing electrolyte-type technologies.
- c. Fifty gallons of lead-acid battery electrolyte shall be considered equivalent to 70 kWh.

**1207.1.2 Permits.** Permits shall be obtained for ESS as follows:

1. Construction permits shall be obtained for stationary ESS installations and for mobile ESS charging and storage installations covered by Section 1207.10.1. Permits shall be obtained in accordance with Section 105.6.5.

2. Operational permits shall be obtained for stationary ESS installations and for mobile ESS deployment operations covered by Section 1207.10.3. Permits shall be obtained in accordance with Section 105.5.14.

**1207.1.2.1 Communication utilities.** Operational permits shall not be required for lead-acid and nickel-cadmium battery systems at facilities under the exclusive control of communications utilities that comply with NFPA 76 and operate at less than 50 voltage alternating current (VAC) and 60 voltage direct current (VDC).

**1207.1.3 Construction documents.** The following information shall be provided with the permit application:

1. Location and layout diagram of the room or area in which the ESS is to be installed.
2. Details on the hourly *fire-resistance ratings* of assemblies enclosing the ESS.
3. The quantities and types of ESS to be installed.
4. Manufacturer's specifications, ratings and listings of each ESS.
5. Description of energy (battery) management systems and their operation.
6. Location and content of required signage.
7. Details on fire suppression, smoke or fire detection, thermal management, ventilation, exhaust and *deflagration* venting systems, if provided.
8. Support arrangement associated with the installation, including any required seismic restraint.
9. A commissioning plan complying with Section 1207.2.1.
10. A decommissioning plan complying with Section 1207.2.3.

**1207.1.4 Hazard mitigation analysis.** A failure modes and effects analysis (FMEA) or other *approved* hazard mitigation analysis shall be provided in accordance with Section 104.8.2 under any of the following conditions:

1. Where ESS technologies not specifically identified in Table 1207.1 are provided.
2. More than one ESS technology is provided in a room or enclosed area where there is a potential for adverse interaction between technologies.
3. Where allowed as a basis for increasing maximum allowable quantities. See Section 1207.5.2.

**1207.1.4.1 Fault condition.** The hazard mitigation analysis shall evaluate the consequences of the following failure modes. Only single failure modes shall be considered.

1. A thermal runaway condition in a single ESS rack, module or unit.
2. Failure of any battery (energy) management system.
3. Failure of any required ventilation or exhaust system.

4. Voltage surges on the primary electric supply.
5. Short circuits on the load side of the ESS.
6. Failure of the smoke detection, fire detection, fire suppression or gas detection system.
7. Required spill neutralization not being provided or failure of a required secondary containment system.

**1207.1.4.2 Analysis approval.** The *fire code official* is authorized to approve the hazardous mitigation analysis provided that the consequences of the hazard mitigation analysis demonstrate:

1. Fires will be contained within unoccupied ESS rooms or areas for the minimum duration of the fire-resistance-rated separations identified in Section 1207.7.4.
2. Fires in occupied work centers will be detected in time to allow occupants within the room or area to safely evacuate.
3. Toxic and highly toxic gases released during fires will not reach concentrations in excess of the IDLH level in the building or adjacent *means of egress* routes during the time deemed necessary to evacuate occupants from any affected area.
4. Flammable gases released from ESS during charging, discharging and normal operation will not exceed 25 percent of their lower flammability limit (LFL).
5. Flammable gases released from ESS during fire, overcharging and other abnormal conditions will be controlled through the use of ventilation of the gases, preventing accumulation, or by *deflagration* venting.

**1207.1.4.3 Additional protection measures.** Construction, equipment and systems that are required for the ESS to comply with the hazardous mitigation analysis, including but not limited to those specifically described in Section 1207, shall be installed, maintained and tested in accordance with nationally recognized standards and specified design parameters.

**1207.1.5 Large-scale fire test.** Where required elsewhere in Section 1207, large-scale fire testing shall be conducted on a representative ESS in accordance with UL 9540A. The testing shall be conducted or witnessed and reported by an *approved* testing laboratory and show that a fire involving one ESS will not propagate to an adjacent ESS, and where installed within buildings, enclosed areas and walk-in units will be contained within the room, enclosed area or walk-in unit for a duration equal to the *fire-resistance rating* of the room separation specified in Section 1207.7.4. The test report shall be provided to the *fire code official* for review and approval in accordance with Section 104.8.2.

**1207.1.6 Fire remediation.** Where a fire or other event has damaged the ESS and ignition or re-ignition of the ESS is possible, the system *owner*, agent or lessee shall

take the following actions, at their expense, to mitigate the hazard or remove damaged equipment from the premises to a safe location.

**1207.1.6.1 Fire mitigation personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety that trained personnel be on-site to respond to possible ignition or re-ignition of a damaged ESS, the system owner, agent or lessee shall immediately dispatch one or more fire mitigation personnel to the premise, as required and *approved*, at their expense. These personnel shall remain on duty continuously after the fire department leaves the premise until the damaged energy storage equipment is removed from the premises, or earlier if the *fire code official* indicates the public safety hazard has been abated.

**1207.1.6.2 Duties.** On-duty fire mitigation personnel shall have the following responsibilities:

1. Keep a diligent watch for fires, obstructions to *means of egress* and other hazards.
2. Immediately contact the fire department if their assistance is needed to mitigate any hazards or extinguish fires.
3. Take prompt measures for remediation of hazards in accordance with the decommissioning plan per Section 1207.2.3.
4. Take prompt measures to assist in the evacuation of the public from the structures.

**1207.2 Commissioning, decommissioning, operation and maintenance.** Commissioning, decommissioning, operation and maintenance shall be conducted in accordance with this section.

**1207.2.1 Commissioning.** Commissioning of newly installed ESS and existing ESS that have been retrofitted, replaced or previously decommissioned and are returning to service shall be conducted prior to the ESS being placed in service in accordance with a commissioning plan that has been *approved* prior to initiating commissioning. The commissioning plan shall include the following:

1. A narrative description of the activities that will be accomplished during each phase of commissioning, including the personnel intended to accomplish each of the activities.
2. A listing of the specific ESS and associated components, controls and safety-related devices to be tested, a description of the tests to be performed and the functions to be tested.
3. Conditions under which all testing will be performed, which are representative of the conditions during normal operation of the system.
4. Documentation of the owner's project requirements and the basis of design necessary to

understand the installation and operation of the ESS.

5. Verification that required equipment and systems are installed in accordance with the *approved* plans and specifications.
6. Integrated testing for all fire and safety systems.
7. Testing for any required thermal management, ventilation or exhaust systems associated with the ESS installation.
8. Preparation and delivery of operation and maintenance documentation.
9. Training of facility operating and maintenance staff.
10. Identification and documentation of the requirements for maintaining system performance to meet the original design intent during the operation phase.
11. Identification and documentation of personnel who are qualified to service, maintain and decommission the ESS, and respond to incidents involving the ESS, including documentation that such service has been contracted for.
12. A decommissioning plan for removing the ESS from service, and from the facility in which it is located. The plan shall include details on providing a safe, orderly shutdown of energy storage and safety systems with notification to the code officials prior to the actual decommissioning of the system. The decommissioning plan shall include contingencies for removing an intact operational ESS from service, and for removing an ESS from service that has been damaged by a fire or other event.

**Exception:** Commissioning shall not be required for lead-acid and nickel-cadmium battery systems at facilities under the exclusive control of communications utilities that comply with NFPA 76 and operate at less than 50 VAC and 60 VDC. A decommissioning plan shall be provided and maintained where required by the *fire code official*.

**1207.2.1.1 Initial acceptance testing.** During the commissioning process an ESS shall be evaluated for proper operation in accordance with the manufacturer's instructions and the commissioning plan prior to final approval.

**1207.2.1.2 Commissioning report.** A report describing the results of the system commissioning, including the results of the initial acceptance testing required in Section 1207.2.1.1, shall be provided to the *fire code official* prior to final inspection and approval and maintained at an *approved* on-site location.

**1207.2.2 Operation and maintenance.** An operation and maintenance manual shall be provided to both the ESS owner or their authorized agent and the ESS operator



## ENERGY SYSTEMS

before the ESS is put into operation and shall include the following:

1. Manufacturer's operation manuals and maintenance manuals for the entire ESS, or for each component of the system requiring maintenance, that clearly identify the required routine maintenance actions.
2. Name, address and phone number of a service agency that has been contracted to service the ESS and its associated safety systems.
3. Maintenance and calibration information, including wiring diagrams, control drawings, schematics, system programming instructions and control sequence descriptions, for all energy storage control systems.
4. Desired or field-determined control set points that are permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions.
5. A schedule for inspecting and recalibrating all ESS controls.
6. A service record log form that lists the schedule for all required servicing and maintenance actions and space for logging such actions that are completed over time and retained on-site.

The ESS shall be operated and maintained in accordance with the manual and a copy of the manual shall be retained at an approved on-site location.

**1207.2.2.1 Ongoing inspection and testing.** Systems that monitor and protect the ESS installation shall be inspected and tested in accordance with the manufacturer's instructions and the operation and maintenance manual. Inspection and testing records shall be maintained in the operation and maintenance manual.

**1207.2.3 Decommissioning.** The code official shall be notified prior to the decommissioning of an ESS. Decommissioning shall be performed in accordance with the decommissioning plan that includes the following:

1. A narrative description of the activities to be accomplished for removing the ESS from service, and from the facility in which it is located.
2. A listing of any contingencies for removing an intact operational ESS from service, and for removing an ESS from service that has been damaged by a fire or other event.

**1207.3 Equipment.** ESS equipment shall be in accordance with Sections 1207.3.1 through 1207.3.9.

**1207.3.1 Energy storage system listings.** ESS shall be *listed* in accordance with UL 9540.

**Exception:** Lead-acid and nickel-cadmium battery systems installed in facilities under the exclusive control of communications utilities, and operating at less than 50 VAC and 60 VDC in accordance with NFPA 76, are not required to be *listed*.

**1207.3.2 Equipment listing.** Chargers, inverters and energy storage management systems shall be covered as part of the UL 9540 listing or shall be *listed* separately.

**1207.3.3 Utility interactive systems.** Inverters shall be *listed* and *labeled* in accordance with UL 1741. Only inverters *listed* and *labeled* for utility interactive system use and identified as interactive shall be allowed to operate in parallel with the electric utility power system to supply power to common loads.

**1207.3.4 Energy storage management system.** Where required by the ESS listing, an *approved* energy storage management system that monitors and balances cell voltages, currents and temperatures within the manufacturer's specifications shall be provided. The system shall disconnect electrical connections to the ESS or otherwise place it in a safe condition if potentially hazardous temperatures or other conditions such as short circuits, over voltage or under voltage are detected.

**1207.3.5 Enclosures.** Enclosures of ESS shall be of noncombustible construction.

**1207.3.6 Repairs.** Repairs of ESS shall only be done by qualified personnel. Repairs with other than identical parts shall be considered retrofitting and comply with Section 1207.3.7. Repairs shall be documented in the service records log.

**1207.3.7 Retrofits.** Retrofitting of an existing ESS shall comply with the following:

1. A construction permit shall be obtained in accordance with Section 105.6.5.
2. New batteries, battery modules, capacitors and similar ESS components shall be *listed*.
3. Battery management and other monitoring systems shall be connected and installed in accordance with the manufacturer's instructions.
4. The overall installation shall continue to comply with UL 9540 listing requirements, where applicable.
5. Systems that have been retrofitted shall be commissioned in accordance with Section 1207.2.1.
6. Retrofits shall be documented in the service records log.

**1207.3.7.1 Retrofitting lead acid and nickel cadmium.** Section 1207.3.7 shall not apply to retrofitting of lead-acid and nickel-cadmium batteries with other lead-acid and nickel-cadmium batteries at facilities under the exclusive control of communications utilities that comply with NFPA 76 and operate at less than 50 VAC and 60 VDC.

**1207.3.8 Replacements.** Replacements of ESS shall be considered new ESS installations and shall comply with the provisions of Section 1207 as applicable to new ESS. The ESS being replaced shall be decommissioned in accordance with Section 1207.2.3.

**1207.3.9 Reused and repurposed equipment.** Equipment and materials shall only be reused or reinstalled as permitted in Section 104.8.1. Storage batteries previously used in other applications, such as electric vehicle propulsion, shall not be reused in applications regulated by Chapter 12 unless *approved* by the *fire code official* and unless the equipment is refurbished by a battery refurbishing company *approved* in accordance with UL 1974.

**1207.4 General installations requirements.** Stationary and mobile ESS shall comply with the requirements of Sections 1207.4.1 through 1207.4.12.

**1207.4.1 Electrical disconnects.** Where the ESS disconnecting means is not within sight of the main electrical service disconnecting means, placards or directories shall be installed at the location of the main electrical service disconnecting means indicating the location of stationary storage battery system disconnecting means in accordance with NFPA 70.

**Exception:** Electrical disconnects for lead-acid and nickel-cadmium battery systems at facilities under the exclusive control of communications utilities and operating at less than 50 VAC and 60 VDC shall be permitted to have electrical disconnects signage in accordance with NFPA 76.

**1207.4.2 Working clearances.** Access and working space shall be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment in accordance with NFPA 70 and the manufacturer's instructions.

**1207.4.3 Fire-resistance-rated separations.** Rooms and other indoor areas containing ESS shall be separated from other areas of the building in accordance with Section 1207.7.4. ESS shall be permitted to be in the same room with the equipment they support.

**1207.4.4 Seismic and structural design.** Stationary ESS shall comply with the seismic design requirements in Chapter 16 of the *International Building Code*, and shall not exceed the floor loading limitation of the building.

**1207.4.5 Vehicle impact protection.** Where ESS are subject to impact by a motor vehicle, including fork lifts, vehicle impact protection shall be provided in accordance with Section 312.

**1207.4.6 Combustible storage.** Combustible materials shall not be stored in ESS rooms, areas or walk-in units. Combustible materials in occupied work centers covered by Section 1207.4.10 shall be stored at least 3 feet (914 mm) from ESS cabinets.

**1207.4.7 Toxic and highly toxic gases.** ESS that have the potential to release toxic and highly toxic gas during charging, discharging and normal use conditions shall be provided with a hazardous exhaust system in accordance with Section 502.8 of the *International Mechanical Code*.

**1207.4.8 Signage.** *Approved* signs shall be provided on or adjacent to all entry doors for ESS rooms or areas and on enclosures of ESS cabinets and walk-in units located outdoors, on rooftops or in open parking garages. Signs designed to meet both the requirements of this section and

NFPA 70 shall be permitted. The signage shall include the following or equivalent:

1. "ENERGY STORAGE SYSTEM," "BATTERY STORAGE SYSTEM," "CAPACITOR ENERGY STORAGE SYSTEM" or the equivalent.
2. The identification of the electrochemical ESS technology present.
3. "ENERGIZED ELECTRICAL CIRCUITS."
4. Where water-reactive electrochemical ESS are present, the signage shall include "APPLY NO WATER."
5. Current contact information, including phone number, for personnel authorized to service the equipment and for fire mitigation personnel required by Section 1207.1.6.1.

**Exception:** Existing electrochemical ESS shall be permitted to include the signage required at the time they were installed.

**1207.4.9 Security of installations.** Rooms, areas and walk-in units in which electrochemical ESS are located shall be secured against unauthorized entry and safeguarded in an *approved* manner. Security barriers, fences, landscaping and other enclosures shall not inhibit the required air flow to or exhaust from the electrochemical ESS and its components.

**1207.4.10 Occupied work centers.** Electrochemical ESS located in rooms or areas occupied by personnel not directly involved with maintenance, service and testing of the systems shall comply with the following:

1. Electrochemical ESS located in occupied work centers shall be housed in locked noncombustible cabinets or other enclosures to prevent access by unauthorized personnel.
2. Where electrochemical ESS are contained in cabinets in occupied work centers, the cabinets shall be located within 10 feet (3048 mm) of the equipment that they support.
3. Cabinets shall include signage complying with Section 1207.4.8.

**1207.4.11 Open rack installations.** Where electrochemical ESS are installed in a separate equipment room and only authorized personnel have access to the room, they shall be permitted to be installed on an open rack for ease of maintenance.

**1207.4.12 Walk-in units.** Walk-in units shall be entered only for inspection, maintenance and repair of ESS units and ancillary equipment, and shall not be occupied for other purposes.

**1207.5 Electrochemical ESS protection.** The protection of electrochemical ESS shall be in accordance with Sections 1207.5.1 through 1207.5.8 where required by Sections 1207.7 through 1207.10.

**TABLE 1207.5**  
**MAXIMUM ALLOWABLE QUANTITIES OF**  
**ELECTROCHEMICAL ESS**

TECHNOLOGY	MAXIMUM ALLOWABLE QUANTITIES <sup>a</sup>
<b>STORAGE BATTERIES</b>	
Flow batteries <sup>b</sup>	600 kWh
Lead-acid, all types	Unlimited
Lithium-ion	600 kWh
Nickel metal hydride (Ni-MH)	Unlimited
Nickel-cadmium (Ni-Cd)	Unlimited
Other battery technologies	200 kWh
<b>CAPACITORS</b>	
All types	20 kWh
<b>OTHER ELECTROCHEMICAL ESS</b>	
All types	20 kWh

For SI: 1 kilowatt hour = 3.6 megajoules.

- For electrochemical ESS units rated in amp-hours, kWh shall equal rated voltage times the amp-hour rating divided by 1,000.
- Shall include vanadium, zinc-bromine, polysulfide-bromide and other flowing electrolyte-type technologies.

**1207.5.1 Size and separation.** Electrochemical ESS shall be segregated into groups not exceeding 50 kWh (180 megajoules). Each group shall be separated a minimum of 3 feet (914 mm) from other groups and from walls in the storage room or area. The storage arrangements shall comply with Chapter 10.

- Lead-acid and nickel-cadmium battery systems in facilities under the exclusive control of communications utilities and operating at less than 50 VAC and 60 VDC in accordance with NFPA 76.
- The *fire code official* is authorized to approve larger capacities or smaller separation distances based on large-scale fire testing complying with Section 1207.1.5.

**1207.5.2 Maximum allowable quantities.** *Fire areas* within rooms, areas and walk-in units containing electrochemical ESS shall not exceed the maximum allowable quantities in Table 1207.5.

**Exceptions:**

- Where approved by the fire code official, rooms, areas and walk-in units containing electrochemical ESS that exceed the amounts in Table 1207.5 shall be permitted based on a hazardous mitigation analysis in accordance with Section 1207.1.4 and large-scale fire testing complying with Section 1207.1.5.
- Lead-acid and nickel-cadmium battery systems installed in facilities under the exclusive control of communications utilities, and operating at less than 50 VAC and 60 VDC in accordance with NFPA 76.
- Dedicated-use buildings in compliance with Section 1207.7.1.

**1207.5.2.1 Mixed electrochemical energy systems.** Where rooms, areas and walk-in units contain different

types of electrochemical energy technologies, the total aggregate quantities of the systems shall be determined based on the sum of percentages of each technology-type quantity divided by the maximum allowable quantity of each technology type. The sum of the percentages shall not exceed 100 percent of the maximum allowable quantity.

**1207.5.3 Elevation.** Electrochemical ESS shall not be located in the following areas:

- Where the floor is located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.
- Where the floor is located below the lowest *level of exit discharge*.

**Exceptions:**

- Lead-acid and nickel-cadmium battery systems less than 50 VAC and 60 VDC installed in facilities under the exclusive control of communications utilities in accordance with NFPA 76.
- Where *approved*, installations shall be permitted in underground vaults complying with NFPA 70, Article 450, Part III.
- Where *approved* by the *fire code official*, installations shall be permitted on higher and lower floors.

**1207.5.4 Fire detection.** An *approved* automatic smoke detection system or radiant energy-sensing fire detection system complying with Section 907.2 shall be installed in rooms, indoor areas and walk-in units containing electrochemical ESS. An *approved* radiant energy-sensing fire detection system shall be installed to protect open parking garage and rooftop installations. Alarm signals from detection systems shall be transmitted to a central station, proprietary or remote station service in accordance with NFPA 72, or where *approved* to a constantly attended location.

**1207.5.4.1 System status.** Where required by the *fire code official*, visible annunciation shall be provided on cabinet exteriors or in other *approved* locations to indicate that potentially hazardous conditions associated with the ESS exist.

**1207.5.5 Fire suppression systems.** Rooms and areas within buildings and walk-in units containing electrochemical ESS shall be protected by an automatic fire suppression system designed and installed in accordance with one of the following:

- An *automatic sprinkler system* designed and installed in accordance with Section 903.3.1.1 with a minimum density of 0.3 gpm/ft<sup>2</sup> (1.14 L/min) based on the *fire area* or 2,500 square-foot (232 m<sup>2</sup>) design area, whichever is smaller.
- Where *approved*, an *automatic sprinkler system* designed and installed in accordance with Section 903.3.1.1 with a sprinkler hazard classification

based on large-scale fire testing complying with Section 1207.1.5.

3. The following alternative automatic fire-extinguishing systems designed and installed in accordance with Section 904, provided that the installation is *approved* by the *fire code official* based on large-scale fire testing complying with Section 1207.1.5:
  - 3.1. NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*.
  - 3.2. NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*.
  - 3.3. NFPA 750, *Standard on Water Mist Fire Protection Systems*.
  - 3.4. NFPA 2001, *Standard on Clean Agent Fire-Extinguishing Systems*.
  - 3.5. NFPA 2010, *Standard for Fixed Aerosol Fire-Extinguishing Systems*.

**Exception:** Fire suppression systems for lead-acid and nickel-cadmium battery systems at facilities under the exclusive control of communications utilities that operate at less than 50 VAC and 60 VDC shall be provided where required by NFPA 76.

**1207.5.5.1 Water-reactive systems.** Electrochemical ESS that utilize water-reactive materials shall be protected by an *approved* alternative automatic fire-extinguishing system in accordance with Section 904, where the installation is *approved* by the *fire code official* based on large-scale fire testing complying with Section 1207.1.5.

**1207.5.6 Maximum enclosure size.** Outdoor walk-in units housing ESS shall not exceed 53 feet by 8 feet by 9.5 feet high (16 154 mm × 2438 mm × 2896 mm), not including bolt-on HVAC and related equipment, as *approved*. Outdoor walk-in units exceeding these limitations shall be considered indoor installations and comply with the requirements in Section 1207.7.

**1207.5.7 Vegetation control.** Areas within 10 feet (3048 mm) on each side of outdoor ESS shall be cleared of

combustible vegetation and other combustible growth. Single specimens of trees, shrubbery or cultivated ground cover such as green grass, ivy, succulents or similar plants used as ground cover shall be permitted to be exempt provided that they do not form a means of readily transmitting fire.

**1207.5.8 Means of egress separation.** ESS located outdoors and in open parking garages shall be separated from any *means of egress* as required by the *fire code official* to ensure safe egress under fire conditions, but in no case less than 10 feet (3048 mm).

**Exception:** The fire code official is authorized to approve a reduced separation distance if large-scale fire testing complying with Section 1207.1.5 is provided that shows that a fire involving the ESS will not adversely impact occupant egress.

**1207.6 Electrochemical ESS technology-specific protection.** Electrochemical ESS installations shall comply with the requirements of this section in accordance with the applicable requirements of Table 1207.6.

**1207.6.1 Exhaust ventilation.** Where required by Table 1207.6 or elsewhere in this code, exhaust ventilation of rooms, areas and walk-in units containing electrochemical ESS shall be provided in accordance with the *International Mechanical Code* and Section 1207.6.1.1 or 1207.6.1.2.

**1207.6.1.1 Ventilation based on LFL.** The exhaust ventilation system shall be designed to limit the maximum concentration of flammable gas to 25 percent of the lower flammable limit (LFL) of the total volume of the room, area or walk-in unit during the worst-case event of simultaneous charging of batteries at the maximum charge rate, in accordance with nationally recognized standards.

**1207.6.1.2 Ventilation based on exhaust rate.** Mechanical exhaust ventilation shall be provided at a rate of not less than 1 ft<sup>3</sup>/min/ft<sup>2</sup> (5.1 L/sec/m<sup>2</sup>) of floor area of the room, area or walk-in unit. The ventilation shall be either continuous or shall be activated by a gas

TABLE 1207.6  
ELECTROCHEMICAL ESS TECHNOLOGY-SPECIFIC REQUIREMENTS

COMPLIANCE REQUIRED <sup>a</sup>		BATTERY TECHNOLOGY				OTHER ESS AND BATTERY TECHNOLOGIES <sup>b</sup>	CAPACITOR ESS <sup>b</sup>
Feature	Section	Lead-acid	Ni-Cd and Ni-MH	Lithium-ion	Flow		
Exhaust ventilation	1207.6.1	Yes	Yes	No	Yes	Yes	Yes
Explosion control	1207.6.3	Yes <sup>a</sup>	Yes <sup>a</sup>	Yes	No	Yes	Yes
Safety caps	1207.6.4	Yes	Yes	No	No	Yes	Yes
Spill control and neutralization	1207.6.2	Yes <sup>c</sup>	Yes <sup>c</sup>	No	Yes	Yes	Yes
Thermal runaway	1207.6.5	Yes <sup>d</sup>	Yes	Yes <sup>e</sup>	No	Yes <sup>e</sup>	Yes

- a. Not required for lead-acid and nickel-cadmium batteries at facilities under the exclusive control of communications utilities that comply with NFPA 76 and operate at less than 50 VAC and 60 VDC.
- b. Protection shall be provided unless documentation acceptable to the fire code official is provided in accordance with Section 104.8.2 that provides justification why the protection is not necessary based on the technology used.
- c. Applicable to vented-type (i.e., flooded) nickel-cadmium and lead-acid batteries.
- d. Not required for vented-type (i.e., flooded) lead-acid batteries.
- e. The thermal runaway protection is permitted to be part of a battery management system that has been evaluated with the battery as part of the evaluation to UL 1973.



detection system in accordance with Section 1207.6.1.2.4.

**1207.6.1.2.1 Standby power.** Mechanical exhaust ventilation shall be provided with a minimum of 2 hours of standby power in accordance with Section 1203.2.5.

**1207.6.1.2.2 Installation instructions.** Required mechanical exhaust ventilation systems shall be installed in accordance with the manufacturer's installation instructions and the *International Mechanical Code*.

**1207.6.1.2.3 Supervision.** Required mechanical exhaust ventilation systems shall be supervised by an *approved* central station, proprietary or remote station service in accordance with NFPA 72, or shall initiate an audible and visible signal at an *approved* constantly attended on-site location.

**1207.6.1.2.4 Gas detection system.** Where required by Section 1207.6.1.2, rooms, areas and walk-in units containing ESS shall be protected by an *approved* continuous gas detection system that complies with Section 916 and with the following:

1. The gas detection system shall be designed to activate the mechanical ventilation system when the level of flammable gas in the room, area or walk-in unit exceeds 25 percent of the LFL.
2. The mechanical ventilation system shall remain on until the flammable gas detected is less than 25 percent of the LFL.
3. The gas detection system shall be provided with a minimum of 2 hours of standby power in accordance with Section 1203.2.5.
4. Failure of the gas detection system shall annunciate a trouble signal at an approved central station, proprietary or remote station service in accordance with NFPA 72, or shall initiate an audible and visible trouble signal at an approved constantly attended on-site location.

**1207.6.2 Spill control and neutralization.** Where required by Table 1207.6 or elsewhere in this code, areas containing free-flowing liquid electrolyte or hazardous materials shall be provided with spill control and neutralization in accordance with this section.

**1207.6.2.1 Spill control.** Spill control shall be provided to prevent the flow of liquid electrolyte or hazardous materials to adjoining rooms or areas. The method shall be capable of containing a spill from the single largest battery or vessel.

**1207.6.2.2 Neutralization.** An *approved* method that is capable of neutralizing spilled liquid electrolyte from the largest battery or vessel to a pH between 5.0 and 9.0 shall be provided.

**1207.6.2.3 Communications utilities.** The requirements of Section 1207.6.2 shall apply only when the aggregate capacity of multiple vessels exceeds 1,000 gallons (3785 L) for lead-acid and nickel-cadmium battery systems operating at less than 50 VAC and 60 VDC that are located at facilities under the exclusive control of communications utilities, and those facilities comply with NFPA 76 in addition to applicable requirements of this code.

**1207.6.3 Explosion control.** Where required by Table 1207.6 or elsewhere in this code, explosion control complying with Section 911 shall be provided for rooms, areas or walk-in units containing electrochemical ESS technologies.

**Exceptions:**

1. Where approved, explosion control is permitted to be waived by the fire code official based on large-scale fire testing complying with Section 1207.1.5 that demonstrates that flammable gases are not liberated from electrochemical ESS cells or modules where tested in accordance with UL 9540A.
2. Where approved, explosion control is permitted to be waived by the fire code official based on documentation provided in accordance with Section 104.7 that demonstrates that the electrochemical ESS technology to be used does not have the potential to release flammable gas concentrations in excess of 25 percent of the LFL anywhere in the room, area, walk-in unit or structure under thermal runaway or other fault conditions.

**1207.6.4 Safety caps.** Where required by Table 1207.6 or elsewhere in this code, vented batteries and other ESS shall be provided with flame-arresting safety caps.

**1207.6.5 Thermal runaway.** Where required by Table 1207.6 or elsewhere in this code, batteries and other ESS shall be provided with a *listed* device or other *approved* method to prevent, detect and minimize the impact of thermal runaway.

**1207.7 Indoor installations.** Indoor ESS installations shall be in accordance with Sections 1207.7.1 through 1207.7.4.

**1207.7.1 Dedicated-use buildings.** For the purpose of Table 1207.7, dedicated-use ESS buildings shall be classified as Group F-1 occupancies and comply with all the following:

1. The building shall only be used for ESS, electrical energy generation and other electrical grid-related operations.
2. Occupants in the rooms and areas containing ESS are limited to personnel that operate, maintain, service, test and repair the ESS and other energy systems.
3. No other occupancy types shall be permitted in the building.

**TABLE 1207.7  
INDOOR ESS INSTALLATIONS**

COMPLIANCE REQUIRED		DEDICATED-USE BUILDINGS <sup>a</sup>	NONDEDICATED-USE BUILDINGS <sup>b</sup>
Feature	Section		
Dwelling units and sleeping units	1207.7.3	NA	Yes
Elevation	1207.5.3	Yes	Yes
Fire suppression systems	1207.5.5	Yes <sup>c</sup>	Yes
Fire-resistance-rated separations	1207.7.4	Yes	Yes
General installation requirements	1207.4	Yes	Yes
Maximum allowable quantities	1207.5.2	No	Yes
Size and separation	1207.5.1	Yes	Yes
Smoke and automatic fire detection <sup>e</sup>	1207.5.4	Yes <sup>d</sup>	Yes
Technology specific protection	1207.6	Yes	Yes

NA = Not Allowed.

a. See Section 1207.7.1.

b. See Section 1207.7.2.

c. Where approved by the fire code official, fire suppression systems are permitted to be omitted in dedicated-use buildings located more than 100 feet (30.5 m) from buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock and other exposure hazards.

d. Where approved by the fire code official, alarm signals are not required to be transmitted to a central station, proprietary or remote station service in accordance with NFPA 72, or a constantly attended location where local fire alarm annunciation is provided and trained personnel are always present.

e. Lead-acid and nickel-cadmium battery systems installed in Group U buildings and structures less than 1,500 square feet (139 m<sup>2</sup>) under the exclusive control of communications utilities, and operating at less than 50 VAC and 60 VDC in accordance with NFPA 76, are not required to have an approved automatic smoke or fire detection system.

4. Administrative and support personnel shall be permitted in areas within the buildings that do not contain ESS, provided that:

- 4.1. The areas do not occupy more than 10 percent of the building area of the story in which they are located.

- 4.2. A means of egress is provided from the incidental use areas to the public way that does not require occupants to traverse through areas containing ESS or other energy system equipment.

**1207.7.2 Nondedicated-use buildings.** For the purpose of Table 1207.7, nondedicated-use buildings include all buildings that contain ESS and do not comply with Section 1207.7.1 dedicated-use building requirements.

**1207.7.3 Dwelling units and sleeping units.** ESS shall not be installed in *sleeping units* or in *habitable spaces* of *dwelling units*.

**1207.7.4 Fire-resistance-rated separations.** Rooms and areas containing ESS shall include *fire-resistance-rated* separations as follows:

1. In dedicated-use buildings, rooms and areas containing ESS shall be separated from areas in which administrative and support personnel are located.
2. In nondedicated-use buildings, rooms and areas containing ESS shall be separated from other areas in the building.

Separation shall be provided by 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* and 2-hour *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, as appropriate.

**1207.8 Outdoor installations.** Outdoor installations shall be in accordance with Sections 1207.8.1 through 1207.8.3. Exterior wall installations for individual ESS units not exceeding 20 kWh shall be in accordance with Section 1207.8.4.

**1207.8.1 Remote outdoor installations.** For the purpose of Table 1207.8, remote outdoor installations include ESS located more than 100 feet (30 480 mm) from buildings, lot lines, public ways, stored combustible materials, hazardous materials, high-piled stock and other exposure hazards.

**1207.8.2 Installations near exposures.** For the purpose of Table 1207.8, installations near exposures include all outdoor ESS installations that do not comply with Section 1207.8.1 remote outdoor location requirements.

**1207.8.3 Clearance to exposures.** ESS located outdoors shall be separated by a minimum of 10 feet (3048 mm) from the following exposures:

1. Lot lines.
2. Public ways.
3. Buildings.
4. Stored combustible materials.
5. Hazardous materials.
6. High-piled stock.
7. Other exposure hazards.

**Exceptions:**

1. Clearances are permitted to be reduced to 3 feet (914 mm) where a 1-hour free-standing fire barrier suitable for exterior use and extending 5 feet (1524 mm) above and 5 feet (1524 mm) beyond the physical boundary of the ESS installation is provided to protect the exposure.

**TABLE 1207.8  
OUTDOOR ESS INSTALLATIONS<sup>a</sup>**

COMPLIANCE REQUIRED		REMOTE INSTALLATIONS <sup>a</sup>	INSTALLATIONS NEAR EXPOSURES <sup>b</sup>
Feature	Section		
All ESS installations	1207.4	Yes	Yes
Clearance to exposures	1207.8.3	Yes	Yes
Fire suppression systems	1207.5.5	Yes <sup>c</sup>	Yes
Maximum allowable quantities	1207.5.2	No	Yes
Maximum enclosure size	1207.5.6	Yes	Yes
Means of egress separation	1207.5.8	Yes	Yes
Size and separation	1207.5.1	No	Yes <sup>d</sup>
Smoke and automatic fire detection	1207.5.4	Yes	Yes
Technology-specific protection	1207.6	Yes	Yes
Vegetation control	1207.5.7	Yes	Yes

a. See Section 1207.8.1.

b. See Section 1207.8.2.

c. Where approved by the fire code official, fire suppression systems are permitted to be omitted.

d. In outdoor walk-in units, spacing is not required between ESS units and the walls of the enclosure.

- Clearances to buildings are permitted to be reduced to 3 feet (914 mm) where noncombustible exterior walls with no openings or combustible overhangs are provided on the wall adjacent to the ESS and the fire-resistance rating of the exterior wall is a minimum of 2 hours.
- Clearances to buildings are permitted to be reduced to 3 feet (914 mm) where a weather-proof enclosure constructed of noncombustible materials is provided over the ESS, and it has been demonstrated that a fire within the enclosure will not ignite combustible materials outside the enclosure based on large-scale fire testing complying with Section 1207.1.5.

**1207.8.4 Exterior wall installations.** ESS shall be permitted to be installed outdoors on exterior walls of buildings when all of the following conditions are met:

- The maximum energy capacity of individual ESS units shall not exceed 20 kWh.
- The ESS shall comply with applicable requirements in Section 1207.
- The ESS shall be installed in accordance with the manufacturer's instructions and their listing.
- Individual ESS units shall be separated from each other by at least 3 feet (914 mm).
- The ESS shall be separated from doors, windows, operable openings into buildings or HVAC inlets by at least 5 feet (1524 mm).

**Exception:** Where approved, smaller separation distances in Items 4 and 5 shall be permitted based on large-scale fire testing complying with Section 1207.1.5.

**1207.9 Special installations.** Rooftop and open parking garage ESS installations shall comply with Sections 1207.9.1 through 1207.9.6.

**1207.9.1 Rooftop installations.** For the purpose of Table 1207.9, rooftop ESS installations are those located on the roofs of buildings.

**1207.9.2 Open parking garage installations.** For the purpose of Table 1207.9, open parking garage ESS installations are those located in a structure or portion of a structure that complies with Section 406.5 of the *International Building Code*.

**1207.9.3 Clearance to exposures.** ESS located on rooftops and in open parking garages shall be separated by a minimum of 10 feet (3048 mm) from the following exposures:

- Buildings, except the building on which rooftop ESS is mounted.
- Any portion of the building on which a rooftop system is mounted that is elevated above the rooftop on which the system is installed.
- Lot lines.
- Public ways.
- Stored combustible materials.
- Locations where motor vehicles can be parked.
- Hazardous materials.
- Other exposure hazards.

**Exceptions:**

- Clearances are permitted to be reduced to 3 feet (914 mm) where a 1-hour free-standing fire barrier suitable for exterior use and extending 5 feet (1524 mm) above and 5 feet (1524 mm) beyond the physical boundary of the ESS installation is provided to protect the exposure.

**TABLE 1207.9  
SPECIAL ESS INSTALLATIONS**

COMPLIANCE REQUIRED		ROOFTOPS <sup>a</sup>	OPEN PARKING GARAGES <sup>b</sup>
Feature	Section		
All ESS installations	1207.4	Yes	Yes
Clearance to exposures	1207.9.3	Yes	Yes
Fire suppression systems	1207.9.4	Yes	Yes
Maximum allowable quantities	1207.5.2	Yes	Yes
Maximum enclosure size	1207.5.6	Yes	Yes
Means of egress separation	1207.5.8	Yes	Yes
Open parking garage installations	1207.9.6	No	Yes
Rooftop installations	1207.9.5	Yes	No
Size and separation	1207.5.1	Yes	Yes
Smoke and automatic fire detection	1207.5.4	Yes	Yes
Technology-specific protection	1207.6	Yes	Yes

a. See Section 1207.9.1.

b. See Section 1207.9.2.

- Clearances are permitted to be reduced to 3 feet (914 mm) where a weatherproof enclosure constructed of noncombustible materials is provided over the ESS, and it has been demonstrated that a fire within the enclosure will not ignite combustible materials outside the enclosure based on large-scale fire testing complying with Section 1207.1.5.

**1207.9.4 Fire suppression systems.** ESS located in walk-in units on rooftops or in walk-in units in open parking garages shall be provided with automatic fire suppression systems within the ESS enclosure in accordance with Section 1207.5.5. Areas containing ESS other than walk-in units in open parking structures on levels not open above to the sky shall be provided with an automatic fire suppression system complying with Section 1207.5.5.

**Exception:** A fire suppression system is not required in open parking garages if large-scale fire testing complying with Section 1207.1.5 is provided that shows that a fire will not impact the exposures in Section 1207.9.3.

**1207.9.5 Rooftop installations.** ESS and associated equipment that are located on rooftops and not enclosed by building construction shall comply with the following:

- Stairway access to the roof for emergency response and fire department personnel shall be provided either through a bulkhead from the interior of the building or a stairway on the exterior of the building.
- Service walkways at least 5 feet (1524 mm) in width shall be provided for service and emergency personnel from the point of access to the roof to the system.
- ESS and associated equipment shall be located from the edge of the roof a distance equal to at

least the height of the system, equipment or component but not less than 5 feet (1524 mm).

- The roofing materials under and within 5 feet (1524 mm) horizontally from an ESS or associated equipment shall be noncombustible or shall have a Class A rating when tested in accordance with ASTM E108 or UL 790.
- A Class I standpipe outlet shall be installed at an approved location on the roof level of the building or in the stairway bulkhead at the top level.
- The ESS shall be the minimum of 10 feet (3048 mm) from the fire service access point on the rooftop.

**1207.9.6 Open parking garages.** ESS and associated equipment that are located in open parking garages shall comply with all of the following:

- ESS shall not be located within 50 feet (15 240 mm) of air inlets for building HVAC systems.

**Exception:** This distance shall be permitted to be reduced to 25 feet (7620 mm) if the automatic fire alarm system monitoring the radiant-energy sensing detectors de-energizes the ventilation system connected to the air intakes upon detection of fire.

- ESS shall not be located within 25 feet (7620 mm) of *exits* leading from the attached building where located on a covered level of the parking structure not directly open to the sky above.
- An *approved* fence with a locked gate or other *approved* barrier shall be provided to keep the general public at least 5 feet (1524 mm) from the outer enclosure of the ESS.

**1207.10 Mobile ESS equipment and operations.** Mobile ESS equipment and operations shall comply with Sections 1207.10.1 through 1207.10.7.7.



**TABLE 1207.10**  
**MOBILE ENERGY STORAGE SYSTEMS (ESS)**

COMPLIANCE REQUIRED		DEPLOYMENT <sup>a</sup>
Feature	Section	
All ESS installations	1207.4	Yes <sup>b</sup>
Fire suppression systems	1207.5.5	Yes <sup>c</sup>
Maximum allowable quantities	1207.5.2	Yes
Maximum enclosure size	1207.5.6	Yes
Means of egress separation	1207.5.8	Yes
Size and separation	1207.5.1	Yes <sup>d</sup>
Smoke and automatic fire detection	1207.5.4	Yes <sup>e</sup>
Technology-specific protection	1207.6	Yes
Vegetation control	1207.5.7	Yes

a. See Section 1207.10.2.

b. Mobile operations on wheeled vehicles and trailers shall not be required to comply with Section 1207.4.4 seismic and structural load requirements.

c. Fire suppression system connections to the water supply shall be permitted to use approved temporary connections.

d. In walk-in units, spacing is not required between ESS units and the walls of the enclosure.

e. Alarm signals are not required to be transmitted to an approved location for mobile ESS deployed 30 days or less.

**1207.10.1 Charging and storage.** For the purpose of Section 1207.10, charging and storage covers the operation where mobile ESS are charged and stored so they are ready for deployment to another site, and where they are charged and stored after a deployment.

**1207.10.2 Deployment.** For the purpose of Section 1207.10, deployment covers operations where mobile ESS are located at a site other than the charging and storage site and are being used to provide power.

**1207.10.3 Permits.** Construction and operational permits shall be provided for charging and storage of mobile ESS and operational permits shall be provided for deployment of mobile ESS as required by Section 1207.1.2.

**1207.10.4 Construction documents.** *Construction documents* complying with Section 1207.1.3 shall be provided with the construction permit application for mobile ESS charging and storage locations.

**1207.10.4.1 Deployment documents.** The following information shall be provided with the operation permit applications for mobile ESS deployments:

1. Relevant information for the mobile ESS equipment and protection measures in the *construction documents* required by Section 1207.1.3.
2. Location and layout diagram of the area in which the mobile ESS is to be deployed, including a scale diagram of all nearby exposures.
3. Location and content of signage, including no smoking signs.
4. Description of fencing to be provided around the ESS, including locking methods.

5. Details on fire suppression, smoke and automatic fire detection, system monitoring, thermal management, exhaust ventilation and explosion control, if provided.

6. For deployment, the intended duration of operation, including anticipated connection and disconnection times and dates.

7. Location and description of local staging stops during transit to the deployment site. See Section 1207.10.7.5.

8. Description of the temporary wiring, including connection methods, conductor type and size, and circuit overcurrent protection to be provided.

9. Description of how fire suppression system connections to water supplies or extinguishing agents are to be provided.

10. Contact information for personnel who are responsible for maintaining and servicing the equipment, and responding to emergencies as required by Section 1207.1.6.1.

**1207.10.5 Approved locations.** Locations where mobile ESS are charged, stored and deployed shall be restricted to the locations established on the construction and operational permits.

**1207.10.6 Charging and storage.** Installations where mobile ESS are charged and stored shall be treated as permanent ESS indoor or outdoor installations, and shall comply with the following sections, as applicable:

1. Indoor charging and storage shall comply with Section 1207.7.
2. Outdoor charging and storage shall comply with Section 1207.8.
3. Charging and storage on rooftops and in open parking garages shall comply with Section 1207.9.

**Exceptions:**

1. Electrical connections shall be permitted to be made using temporary wiring complying with the manufacturer's instructions, the UL 9540 listing and NFPA 70.
2. Fire suppression system connections to the water supply shall be permitted to use approved temporary connections.

**1207.10.7 Deployed mobile ESS requirements.** Deployed mobile ESS equipment and operations shall comply with this section and Table 1207.10.

**1207.10.7.1 Duration.** The duration of mobile ESS deployment shall not exceed 30 days.

**Exceptions:**

1. Mobile ESS deployments that provide power for durations longer than 30 days shall comply with Section 1207.10.6.

2. Mobile ESS deployments shall not exceed 180 days unless additional operational permits are obtained.

**1207.10.7.2 Restricted locations.** Deployed mobile ESS operations shall not be located indoors, in covered parking garages, on rooftops, below grade or under building overhangs.

**1207.10.7.3 Clearance to exposures.** Deployed mobile ESS shall be separated by a minimum of 10 feet (3048 mm) from the following exposures:

1. Public ways.
2. Buildings.
3. Stored combustible materials.
4. Hazardous materials.
5. High-piled storage.
6. Other exposure hazards.

Deployed mobile ESS shall be separated by a minimum of 50 feet (15 240 mm) from public seating areas and from tents, canopies and membrane structures with an *occupant load* of 30 or more.

**1207.10.7.4 Electrical connections.** Electrical connections shall be made in accordance with the manufacturer's instructions and the UL 9540 listing. Temporary wiring for electrical power connections shall comply with NFPA 70. Fixed electrical wiring shall not be provided.

**1207.10.7.5 Local staging.** Mobile ESS in transit from the charging and storage location to the deployment location and back shall not be parked within 100 feet (30 480 mm) of an occupied building for more than 1 hour during transit, unless specifically *approved* by the *fire code official* when the permit is issued.

**1207.10.7.6 Fencing.** An *approved* fence with a locked gate or other *approved* barrier shall be provided to keep the general public at least 5 feet (1524 mm) from the outer enclosure of a deployed mobile ESS.

**1207.10.7.7 Smoking.** Smoking shall be prohibited within 10 feet (3048 mm) of mobile ESS. Signs shall be posted in accordance with Section 310.

**1207.11 ESS in Group R-3 and R-4 occupancies.** ESS in Group R-3 and R-4 occupancies shall be installed and maintained in accordance with Sections 1207.11.1 through 1207.11.9. The temporary use of an *owner* or occupant's electric-powered vehicle as an ESS shall be in accordance with Section 1207.11.10.

**1207.11.1 Equipment listings.** ESS shall be *listed* and *labeled* in accordance with UL 9540. ESS *listed* and *labeled* solely for utility or commercial use shall not be used for residential applications.

#### Exceptions:

1. Where approved, repurposed unlisted battery systems from electric vehicles are allowed to be installed outdoors or in detached dedicated cabinets located not less than 5 feet (1524 mm)

from exterior walls, property lines and public ways.

2. ESS less than 1 kWh (3.6 megajoules).

**1207.11.2 Installation.** ESS shall be installed in accordance with the manufacturer's instructions and their listing.

**1207.11.2.1 Spacing.** Individual units shall be separated from each other by at least 3 feet (914 mm) of spacing unless smaller separation distances are documented to be adequate based on large-scale fire testing complying with Section 1207.1.5.

**1207.11.3 Location.** ESS shall be installed only in the following locations:

1. Detached garages and detached accessory structures.
2. Attached garages separated from the *dwelling unit* living space and *sleeping units* in accordance with Section 406.3.2 of the *International Building Code*.
3. Outdoors on exterior walls located a minimum of 3 feet (914 mm) from doors and windows.
4. Utility closets and storage or utility spaces within *dwelling units* and *sleeping units*.

**1207.11.4 Energy ratings.** Individual ESS units shall have a maximum rating of 20 kWh. The aggregate rating structure shall not exceed:

1. 40 kWh within utility closets and storage or utility spaces.
2. 80 kWh in attached or detached garages and detached accessory structures.
3. 80 kWh on exterior walls.
4. 80 kWh outdoors on the ground.

**1207.11.5 Electrical installation.** ESS shall be installed in accordance with NFPA 70. Inverters shall be *listed* and *labeled* in accordance with UL 1741 or provided as part of the UL 9540 listing. Systems connected to the utility grid shall use inverters *listed* for utility interaction.

**1207.11.6 Fire detection.** Rooms and areas within *dwelling units*, *sleeping units* and attached garages in which ESS are installed shall be protected by smoke alarms in accordance with Section 907.2.11. A *heat detector listed* and interconnected to the smoke alarms shall be installed in locations within *dwelling units*, *sleeping units* and attached garages where smoke alarms cannot be installed based on their listing.

**1207.11.7 Protection from impact.** Stationary storage battery systems installed in a location subject to vehicle damage shall be protected by *approved* barriers. Appliances in garages shall also be installed in accordance with Section 304.3 of the *International Mechanical Code*.

**1207.11.8 Ventilation.** Indoor installations of ESS that include batteries that produce hydrogen or other flammable gases during charging shall be provided with exhaust ventilation in accordance with Section 1207.6.1.

**ENERGY SYSTEMS**

**1207.11.9 Toxic and highly toxic gas.** ESS that have the potential to release toxic or highly toxic gas during charging, discharging and normal use conditions shall not be installed within Group R-3 or R-4 occupancies.

**1207.11.10 Electric vehicle use.** The temporary use of an *owner* or occupant's electric-powered vehicle to power a *dwelling unit* or *sleeping unit* while parked in an attached or detached garage or outside shall comply with the vehicle manufacturer's instructions and NFPA 70.

# CHAPTERS 13 through 19 RESERVED





# Part IV—Special Occupancies and Operations

## CHAPTER 20 AVIATION FACILITIES

### User note:

**About this chapter:** Chapter 20 specifies minimum requirements for the fire-safe operation of airports, heliports and helistops. The principal nonflight operational hazards associated with aviation involve fuel, facilities and operations. Therefore, safe use of flammable and combustible liquids during fueling and maintenance operations is emphasized. Availability of portable Class B:C-rated fire extinguishers for prompt control or suppression of incipient fires is required.

### SECTION 2001 GENERAL

**2001.1 Scope.** Airports, heliports, helistops and aircraft hangars shall be in accordance with this chapter.

**2001.2 Regulations not covered.** Regulations not specifically contained herein pertaining to airports, aircraft maintenance, aircraft hangars and appurtenant operations shall be in accordance with nationally recognized standards.

**2001.3 Permits.** For permits to operate aircraft-refueling vehicles, application of flammable or combustible finishes and hot work, see Section 105.5.

### SECTION 2002 DEFINITIONS

**2002.1 Definitions.** The following terms are defined in Chapter 2:

**AIRCRAFT OPERATION AREA (AOA).**

**AIRPORT.**

**HELIPORT.**

**HELISTOP.**

### SECTION 2003 GENERAL PRECAUTIONS

**2003.1 Sources of ignition.** Open flames, flame-producing devices and other sources of ignition shall not be permitted in a hangar, except in *approved* locations or in any location within 50 feet (15 240 mm) of an aircraft-fueling operation.

**2003.2 Smoking.** Smoking shall be prohibited in aircraft-refueling vehicles, aircraft hangars and aircraft operation areas used for cleaning, paint removal, painting operations or fueling. “No Smoking” signs shall be provided in accordance with Section 310.

**Exception:** Designated and *approved* smoking areas.

**2003.3 Housekeeping.** The aircraft operation area (AOA) and related areas shall be kept free from combustible debris at all times.

**2003.4 Fire department access.** Fire apparatus access roads shall be provided and maintained in accordance with

Chapter 5. Fire apparatus access roads and aircraft parking positions shall be designed in a manner so as to preclude the possibility of fire vehicles traveling under any portion of a parked aircraft.

**2003.5 Dispensing of flammable and combustible liquids.** The dispensing, transferring and storage of *flammable* and *combustible liquids* shall be in accordance with this chapter and Chapter 57. Aircraft motor vehicle fuel-dispensing facilities shall be in accordance with Chapter 23.

**2003.6 Combustible storage.** Combustible materials stored in aircraft hangars shall be stored in *approved* locations and containers.

**2003.7 Hazardous material storage.** Hazardous materials shall be stored in accordance with Chapter 50.

### SECTION 2004 AIRCRAFT MAINTENANCE

**2004.1 Transferring flammable and combustible liquids.** *Flammable* and *combustible liquids* shall not be dispensed into or removed from a container, tank, vehicle or aircraft except in *approved* locations.

**2004.2 Application of flammable and combustible liquid finishes.** The application of *flammable* or Class II *combustible liquid* finishes is prohibited unless both of the following conditions are met:

1. The application of the liquid finish is accomplished in an *approved* location.
2. The application methods and procedures are in accordance with Chapter 24.

**2004.3 Cleaning parts.** Class IA *flammable liquids* shall not be used to clean aircraft, aircraft parts or aircraft engines. Cleaning with other *flammable* and *combustible liquids* shall be in accordance with Section 5705.3.6.

**2004.4 Spills.** Sections 2004.4.1 through 2004.4.3 shall apply to spills of *flammable* and *combustible liquids* and other hazardous materials. Fuel spill control shall also comply with Section 2006.11.

**2004.4.1 Cessation of work.** Activities in the affected area not related to the mitigation of the spill shall cease

## AVIATION FACILITIES

until the spilled material has been removed or the hazard has been mitigated.

**2004.4.2 Vehicle movement.** Aircraft or other vehicles shall not be moved through the spill area until the spilled material has been removed or the hazard has been mitigated.

**2004.4.3 Mitigation.** Spills shall be reported, documented and mitigated in accordance with the provisions of this chapter and Section 5003.3.

**2004.5 Running engines.** Aircraft engines shall not be run in aircraft hangars except in *approved* engine test areas.

**2004.6 Open flame.** Repairing of aircraft requiring the use of open flames, spark-producing devices or the heating of parts above 500°F (260°C) shall only be done outdoors or in an area complying with the provisions of the *International Building Code* for a Group F-1 occupancy.

**2004.7 Other aircraft maintenance.** Maintenance, repairs, modifications, or construction performed on aircraft not addressed elsewhere in this code shall be conducted in accordance with NFPA 410.

## SECTION 2005 PORTABLE FIRE EXTINGUISHERS

**2005.1 General.** Portable fire extinguishers suitable for *flammable* or *combustible liquid* and electrical-type fires shall be provided as specified in Sections 2005.2 through 2005.6 and Section 906. Extinguishers required by this section shall be inspected and maintained in accordance with Section 906.

**2005.2 On towing vehicles.** Vehicles used for towing aircraft shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906 and having a minimum rating of 20-B:C.

**2005.3 On welding apparatus.** Welding apparatus shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906 and having a minimum rating of 2-A:20-B:C.

**2005.4 On aircraft fuel-servicing tank vehicles.** Aircraft fuel-servicing tank vehicles shall be equipped with not less than two *listed* portable fire extinguishers complying with Section 906, each having a minimum rating of 20-B:C. A portable fire extinguisher shall be provided with *ready access* from either side of the vehicle.

**2005.5 On hydrant fuel-servicing vehicles.** Hydrant fuel-servicing vehicles shall be equipped with not less than one *listed* portable fire extinguisher complying with Section 906 and having a minimum rating of 20-B:C.

**2005.6 At fuel-dispensing stations.** Portable fire extinguishers at fuel-dispensing stations shall be located such that pumps or dispensers are not more than 75 feet (22 860 mm) from one such extinguisher. Fire extinguishers shall be provided as follows:

1. Where the open-hose discharge capacity of the fueling system is not more than 200 gallons per minute (13 L/s), not less than two *listed* portable fire extin-

guishers complying with Section 906 and having a minimum rating of 20-B:C shall be provided.

2. Where the open-hose discharge capacity of the fueling system is more than 200 gallons per minute (13 L/s) but not more than 350 gallons per minute (22 L/s), not less than one *listed* wheeled extinguisher complying with Section 906 and having a minimum extinguishing rating of 80-B:C, and a minimum agent capacity of 125 pounds (57 kg), shall be provided.
3. Where the open-hose discharge capacity of the fueling system is more than 350 gallons per minute (22 L/s), not less than two *listed* wheeled extinguishers complying with Section 906 and having a minimum rating of 80-B:C each, and a minimum capacity agent of 125 pounds (57 kg) each, shall be provided.

**2005.7 Fire extinguisher access.** Access to portable fire extinguishers required by this chapter shall be maintained at all times. Where necessary, provisions shall be made to clear accumulations of snow, ice and other forms of weather-induced obstructions.

**2005.7.1 Cabinets.** Cabinets and enclosed compartments used to house portable fire extinguishers shall be clearly marked with the words "FIRE EXTINGUISHER" in letters not less than 2 inches (51 mm) high. Cabinets and compartments shall be provided with *ready access* at all times.

**2005.8 Reporting use.** Use of a fire extinguisher under any circumstances shall be immediately reported to the manager of the airport and the *fire code official*.

## SECTION 2006 AIRCRAFT FUELING

**2006.1 Aircraft motor vehicle fuel-dispensing facilities.** Aircraft motor vehicle fuel-dispensing facilities shall be in accordance with Chapter 23.

**2006.2 Airport fuel systems.** Airport fuel systems shall be designed and constructed in accordance with NFPA 407.

**2006.3 Construction of aircraft-fueling vehicles and accessories.** Aircraft-fueling vehicles shall comply with this section and shall be designed and constructed in accordance with NFPA 407.

**2006.3.1 Transfer apparatus.** Aircraft-fueling vehicles shall be equipped and maintained with an *approved* transfer apparatus.

**2006.3.1.1 Internal combustion type.** Where such transfer apparatus is operated by an individual unit of the internal-combustion-motor type, such power unit shall be located as remotely as practicable from pumps, piping, meters, air eliminators, water separators, hose reels and similar equipment, and shall be housed in a separate compartment from any of the aforementioned items. The fuel tank in connection therewith shall be suitably designed and installed, and the maximum fuel capacity shall not exceed 5 gallons (19 L) where the tank is installed on the engine. The exhaust pipe, muffler and tail pipe shall be shielded.

**2006.3.1.2 Gear operated.** Where operated by gears or chains, the gears, chains, shafts, bearings, housing and all parts thereof shall be of an *approved* design and shall be installed and maintained in an *approved* manner.

**2006.3.1.3 Vibration isolation.** Flexible connections for the purpose of eliminating vibration are allowed if the material used therein is designed, installed and maintained in an *approved* manner, provided that such connections do not exceed 24 inches (610 mm) in length.

**2006.3.2 Pumps.** Pumps of a positive-displacement type shall be provided with a bypass relief valve set at a pressure of not more than 35 percent in excess of the normal working pressure of such unit. Such units shall be equipped and maintained with a pressure gauge on the discharge side of the pump.

**2006.3.3 Dispensing hoses and nozzles.** Hoses shall be designed for the transferring of hydrocarbon liquids and shall not be any longer than necessary to provide efficient fuel-transfer operations. Hoses shall be equipped with an *approved* shutoff nozzle. Fuel-transfer nozzles shall be self-closing and designed to be actuated by hand pressure only. Notches and other devices shall not be used for holding a nozzle valve handle in the open position. Nozzles shall be equipped with a bonding cable complete with proper attachment for aircraft to be serviced.

**2006.3.4 Protection of electrical equipment.** Electric wiring, switches, lights and other sources of ignition, where located in a compartment housing piping, pumps, air eliminators, water separators, hose reels or similar equipment, shall be enclosed in a vapor-tight housing. Electrical motors located in such a compartment shall be of a type *approved* for use as specified in NFPA 70.

**2006.3.5 Venting of equipment compartments.** Compartments housing piping, pumps, air eliminators, water separators, hose reels and similar equipment shall be adequately ventilated at floor level or within the floor itself.

**2006.3.6 Accessory equipment.** Ladders, hose reels and similar accessory equipment shall be of an *approved* type and constructed substantially as follows:

1. Ladders constructed of noncombustible material are allowed to be used with or attached to aircraft-fueling vehicles, provided that the manner of attachment or use of such ladders is *approved* and does not constitute an additional fire or accident hazard in the operation of such fueling vehicles.
2. Hose reels used in connection with fueling vehicles shall be constructed of noncombustible materials and shall be provided with a packing gland or other device that will preclude fuel leakage between reels and fuel manifolds.

**2006.3.7 Electrical bonding provisions.** Transfer apparatus shall be metallicity interconnected with tanks, chassis, axles and springs of aircraft-fueling vehicles.

**2006.3.7.1 Bonding cables.** Aircraft-fueling vehicles shall be provided and maintained with a substantial

heavy-duty electrical cable of sufficient length to be bonded to the aircraft to be serviced. Such cable shall be metallicity connected to the transfer apparatus or chassis of the aircraft-fueling vehicle on one end and shall be provided with a suitable metal clamp on the other end, to be fixed to the aircraft.

**2006.3.7.2 Bonding cable protection.** The bonding cable shall be bare or have a transparent protective sleeve and be stored on a reel or in a compartment provided for no other purpose. It shall be carried in such a manner that it will not be subjected to sharp kinks or accidental breakage under conditions of general use.

**2006.3.8 Smoking.** Smoking in aircraft-fueling vehicles is prohibited. Signs to this effect shall be conspicuously posted in the driver's compartment of all fueling vehicles.

**2006.3.9 Smoking equipment.** Smoking equipment such as cigarette lighters and ash trays shall not be provided in aircraft-fueling vehicles.

**2006.4 Operation, maintenance and use of aircraft-fueling vehicles.** The operation, maintenance and use of aircraft-fueling vehicles shall be in accordance with Sections 2006.4.1 through 2006.4.4 and other applicable provisions of this chapter.

**2006.4.1 Proper maintenance.** Aircraft-fueling vehicles and all related equipment shall be properly maintained and kept in good repair. Accumulations of oil, grease, fuel and other flammable or combustible materials is prohibited. Maintenance and servicing of such equipment shall be accomplished in *approved* areas.

**2006.4.2 Vehicle integrity.** Tanks, pipes, hoses, valves and other fuel delivery equipment shall be maintained leak free at all times.

**2006.4.3 Removal from service.** Aircraft-fueling vehicles and related equipment that are in violation of Section 2006.4.1 or 2006.4.2 shall be immediately defueled and removed from service and shall not be returned to service until proper repairs have been made.

**2006.4.4 Operators.** Aircraft-fueling vehicles that are operated by a person, firm or corporation other than the permittee or the permittee's authorized employee shall be provided with a legible sign visible from outside the vehicle showing the name of the person, firm or corporation operating such unit.

**2006.5 Fueling and defueling.** Aircraft-fueling and defueling operations shall be in accordance with Sections 2006.5.1 through 2006.5.5.

**2006.5.1 Positioning of aircraft-fueling vehicles.** Aircraft-fueling vehicles shall not be located, parked or permitted to stand in a position where such unit would obstruct egress from an aircraft should a fire occur during fuel-transfer operations. Aircraft-fueling vehicles shall not be located, parked or permitted to stand under any portion of an aircraft.

**Exception:** Aircraft-fueling vehicles shall be allowed to be located under aircraft wings during underwing fueling of turbine-engine powered aircraft.



## AVIATION FACILITIES

**2006.5.1.1 Fueling vehicle egress.** A clear path shall be maintained for aircraft-fueling vehicles to provide for prompt and timely egress from the fueling area.

**2006.5.1.2 Aircraft vent openings.** A clear space of not less than 10 feet (3048 mm) shall be maintained between aircraft fuel-system vent openings and any part or portion of an aircraft-fueling vehicle.

**2006.5.1.3 Parking.** Prior to leaving the cab, the aircraft-fueling vehicle operator shall ensure that the parking brake has been set. Not less than two chock blocks not less than 5 inches by 5 inches by 12 inches (127 mm by 127 mm by 305 mm) in size and dished to fit the contour of the tires shall be utilized and positioned in such a manner as to preclude movement of the vehicle in any direction.

**2006.5.2 Electrical bonding.** Aircraft-fueling vehicles shall be electrically bonded to the aircraft being fueled or defueled. Bonding connections shall be made prior to making fueling connections and shall not be disconnected until the fuel-transfer operations are completed and the fueling connections have been removed.

Where a hydrant service vehicle or cart is used for fueling, the hydrant coupler shall be connected to the hydrant system prior to bonding the fueling equipment to the aircraft.

**2006.5.2.1 Conductive hose.** In addition to the bonding cable required by Section 2006.5.2, conductive hose shall be used for all fueling operations.

**2006.5.2.2 Bonding conductors on transfer nozzles.** Transfer nozzles shall be equipped with *approved* bonding conductors that shall be clipped or otherwise positively engaged with the bonding attachment provided on the aircraft adjacent to the fuel tank cap prior to removal of the cap.

**Exception:** In the case of overwing fueling where an appropriate bonding attachment adjacent to the fuel fill port has not been provided on the aircraft, the fueling operator shall touch the fuel tank cap with the nozzle spout prior to removal of the cap. The nozzle shall be kept in contact with the fill port until fueling is completed.

**2006.5.2.3 Funnels.** Where required, metal funnels are allowed to be used during fueling operations. Direct contact between the fueling receptacle, the funnel and the fueling nozzle shall be maintained during the fueling operation.

**2006.5.3 Training.** Aircraft-fueling vehicles shall be attended and operated only by persons instructed in methods of proper use and operation and who are qualified to use such fueling vehicles in accordance with minimum safety requirements.

**2006.5.3.1 Fueling hazards.** Fuel-servicing personnel shall know and understand the hazards associated with each type of fuel dispensed by the airport fueling-system operator.

**2006.5.3.2 Fire safety training.** Employees of fuel agents who fuel aircraft, accept fuel shipments or otherwise handle fuel shall receive *approved* fire safety training.

**2006.5.3.2.1 Fire extinguisher training.** Fuel-servicing personnel shall receive *approved* training in the operation of fire-extinguishing equipment.

**2006.5.3.2.2 Records.** The airport fueling-system operator shall maintain records of all training administered to its employees.

**2006.5.4 Transfer personnel.** During fuel-transfer operations, a qualified person shall be in control of each transfer nozzle and another qualified person shall be in immediate control of the fuel-pumping equipment to shut off or otherwise control the flow of fuel from the time fueling operations are begun until they are completed.

### Exceptions:

1. For underwing refueling, the person stationed at the point of fuel intake is not required.
2. For overwing refueling, the person stationed at the fuel-pumping equipment shall not be required where the person at the fuel-dispensing device is within 75 feet (22 800 mm) of the emergency shutoff device; is not on the wing of the aircraft and has a clear and unencumbered path to the fuel-pumping equipment; and the fuel-dispensing line does not exceed 50 feet (15 240 mm) in length.

The fueling operator shall monitor the panel of the fueling equipment and the aircraft control panel during pressure fueling or shall monitor the fill port during overwing fueling.

**2006.5.5 Fuel flow control.** Fuel flow-control valves shall be operable only by the direct hand pressure of the operator. Removal of the operator's hand pressure shall cause an immediate cessation of the flow of fuel.

**2006.6 Emergency fuel shutoff.** Emergency fuel shutoff controls and procedures shall comply with Sections 2006.6.1 through 2006.6.4.

**2006.6.1 Controls.** Emergency fuel shutoff controls shall be provided with *ready access* at all times when the fueling system is being operated.

**2006.6.2 Notification of the fire department.** The fueling-system operator shall establish a procedure by which the fire department will be notified in the event of an activation of an emergency fuel shutoff control.

**2006.6.3 Determining cause.** Prior to reestablishment of normal fuel flow, the cause of fuel shutoff conditions shall be determined and corrected.

**2006.6.4 Testing.** Emergency fuel shutoff devices shall be operationally tested at intervals not exceeding three months. The fueling-system operator shall maintain testing records.

**2006.7 Protection of hoses.** Before an aircraft-fueling vehicle is moved, fuel-transfer hoses shall be properly placed on

the *approved* reel or in the compartment provided, or stored on the top decking of the fueling vehicle if proper height rail is provided for security and protection of such equipment. Fuel-transfer hose shall not be looped or draped over any part of the fueling vehicle, except as herein provided. Fuel-transfer hose shall not be dragged when such fueling vehicle is moved from one fueling position to another.

**2006.8 Loading and unloading.** Aircraft-fueling vehicles shall be loaded only at an *approved* loading rack. Such loading racks shall be in accordance with Section 5706.5.1.12.

**Exceptions:**

1. Aircraft-refueling units are allowed to be loaded from the fuel tanks of an aircraft during defueling operations.
2. Fuel transfer between tank vehicles is allowed to be performed in accordance with Section 5706.6 where the operation is not less than 200 feet (60 960 mm) from an aircraft.

The fuel cargo of such units shall be unloaded only by *approved* transfer apparatus into the fuel tanks of aircraft, underground storage tanks or *approved* gravity storage tanks.

**2006.9 Passengers.** Passenger traffic is allowed during the time fuel-transfer operations are in progress, provided that the following provisions are strictly enforced by the *owner* of the aircraft or the *owner's* authorized employee:

1. Smoking and producing an open flame in the cabin of the aircraft or the outside thereof within 50 feet (15 240 mm) of such aircraft shall be prohibited.  
A qualified employee of the aircraft *owner* shall be responsible for seeing that the passengers are not allowed to smoke when remaining aboard the aircraft or while going across the ramp from the gate to such aircraft, or vice versa.
2. Passengers shall not be permitted to linger about the plane, but shall proceed directly between the loading gate and the aircraft.
3. Passenger loading stands or walkways shall be left in loading position until all fuel-transfer operations are completed.
4. Fuel-transfer operations shall not be performed on the main *exit* side of any aircraft containing passengers except when the *owner* of such aircraft or a capable and qualified employee of such *owner* remains inside the aircraft to direct and assist the escape of such passengers through regular and emergency *exits* in the event fire should occur during fuel-transfer operations.

**2006.10 Sources of ignition.** Smoking and producing open flames within 50 feet (15 240 mm) of a point where fuel is being transferred shall be prohibited. Electrical and motor-driven devices shall not be connected to or disconnected from an aircraft at any time fueling operations are in progress on such aircraft.

**2006.11 Fuel spill prevention and procedures.** Fuel spill prevention and the procedures for handling spills shall comply with Sections 2006.11.1 through 2006.11.7.

**2006.11.1 Fuel-servicing equipment maintenance.** Aircraft fuel-servicing equipment shall be maintained and kept free from leaks. Fuel-servicing equipment that malfunctions or leaks shall not be continued in service.

**2006.11.2 Transporting fuel nozzles.** Fuel nozzles shall be carried utilizing appropriate handles. Dragging fuel nozzles along the ground shall be prohibited.

**2006.11.3 Drum fueling.** Fueling from drums or other containers having a capacity greater than 5 gallons (19 L) shall be accomplished with the use of an *approved* pump.

**2006.11.4 Fuel spill procedures.** The fueling-system operator shall establish procedures to follow in the event of a fuel spill. These procedures shall be comprehensive and shall provide for all of the following:

1. Upon observation of a fuel spill, the aircraft-fueling operator shall immediately stop the delivery of fuel by releasing hand pressure from the fuel flow-control valve.
2. Failure of the fuel control valve to stop the continued spillage of fuel shall be cause for the activation of the appropriate emergency fuel shut-off device.
3. A supervisor for the fueling-system operator shall respond to the fuel spill area immediately.

**2006.11.5 Notification of the fire department.** The fire department shall be notified of any fuel spill that is considered a hazard to people or property or which meets one or more of the following criteria:

1. Any dimension of the spill is greater than 10 feet (3048 mm).
2. The spill area is greater than 50 square feet (4.65 m<sup>2</sup>).
3. The fuel flow is continuous in nature.

**2006.11.6 Investigation required.** An investigation shall be conducted by the fueling-system operator of all spills requiring notification of the fire department. The investigation shall provide conclusive proof of the cause and verification of the appropriate use of emergency procedures. Where it is determined that corrective measures are necessary to prevent future incidents of the same nature, they shall be implemented immediately.

**2006.11.7 Multiple fuel delivery vehicles.** Simultaneous delivery of fuel from more than one aircraft-fueling vehicle to a single aircraft-fueling manifold is prohibited unless proper backflow prevention devices are installed to prevent fuel flow into the tank vehicles.

**2006.12 Aircraft engines and heaters.** Operation of aircraft onboard engines and combustion heaters shall be terminated prior to commencing fuel-servicing operations and shall remain off until the fuel-servicing operation is completed.

**Exception:** In an emergency, a single jet engine is allowed to be operated during fuel servicing where all of the following conditions are met:

1. The emergency shall have resulted from an onboard failure of the aircraft's auxiliary power unit.

## AVIATION FACILITIES

2. Restoration of auxiliary power to the aircraft by ground support services is not available.
3. The engine to be operated is either at the rear of the aircraft or on the opposite side of the aircraft from the fuel-servicing operation.
4. The emergency operation is in accordance with a written procedure *approved* by the *fire code official*.

**2006.13 Vehicle and equipment restrictions.** During aircraft-fueling operations, only the equipment actively involved in the fueling operation is allowed within 50 feet (15 240 mm) of the aircraft being fueled. Other equipment shall be prohibited in this area until the fueling operation is complete.

A clear space of not less than 10 feet (3048 mm) shall be maintained between aircraft fuel-system vent openings and any part or portion of aircraft-servicing vehicles or equipment.

**Exception:** Aircraft-fueling operations utilizing single-point refueling with a sealed, mechanically locked fuel line connection and the fuel is not a Class I *flammable liquid*.

**2006.13.1 Overwing fueling.** Vehicles or equipment shall not be allowed beneath the trailing edge of the wing when aircraft fueling takes place over the wing and the aircraft fuel-system vents are located on the upper surface of the wing.

**2006.14 Electrical equipment.** Electrical equipment, including but not limited to, battery chargers, ground or auxiliary power units, fans, compressors or tools, shall not be operated, nor shall they be connected or disconnected from their power source, during fuel-servicing operations.

**2006.14.1 Other equipment.** Electrical or other spark-producing equipment shall not be used within 10 feet (3048 mm) of fueling equipment, aircraft fill or vent points, or spill areas unless that equipment is intrinsically safe and *approved* for use in an explosive atmosphere.

**2006.15 Open flames.** Open flames and open-flame devices are prohibited within 50 feet (15 240 mm) of any aircraft fuel-servicing operation or fueling equipment.

**2006.15.1 Other areas.** The *fire code official* is authorized to establish other locations where open flames and open-flame devices are prohibited.

**2006.15.2 Matches and lighters.** Personnel assigned to and engaged in fuel-servicing operations shall not carry matches or lighters on or about their person. Matches or lighters shall be prohibited in, on or about aircraft-fueling equipment.

**2006.16 Lightning procedures.** The *fire code official* is authorized to require the airport authority and the fueling-system operator to establish written procedures to follow when lightning flashes are detected on or near the airport.

These procedures shall establish criteria for the suspension and resumption of aircraft-fueling operations.

**2006.17 Fuel-transfer locations.** Aircraft fuel-transfer operations shall be prohibited indoors.

**Exception:** In aircraft hangars built in accordance with the provisions of the *International Building Code* for Group F-1 occupancies, aircraft fuel-transfer operations are allowed where either of the following conditions exist:

1. Necessary to accomplish aircraft fuel-system maintenance operations. Such operations shall be performed in accordance with nationally recognized standards.
2. The fuel being used has a *flash point* greater than 100°F (37.8°C).

**2006.17.1 Position of aircraft.** Aircraft being fueled shall be positioned such that any fuel system vents and other fuel tank openings are not less than:

1. Twenty-five feet (7620 mm) from buildings or structures other than jet bridges.
2. Fifty feet (15 240 mm) from air intake vents for boiler, heater or incinerator rooms.

**2006.17.2 Fire equipment access.** Access for fire service equipment to aircraft shall be maintained during fuel-servicing operations.

**2006.18 Defueling operations.** The requirements for fueling operations contained in this section shall also apply to aircraft defueling operations. Additional procedures shall be established by the fueling-system operator to prevent overfilling of the tank vehicle used in the defueling operation.

**2006.19 Maintenance of aircraft-fueling hose.** Aircraft-fueling hoses shall be maintained in accordance with Sections 2006.19.1 through 2006.19.4.

**2006.19.1 Inspections.** Hoses used to fuel or defuel aircraft shall be inspected periodically to ensure their serviceability and suitability for continued service. The fuel service operator shall maintain records of all tests and inspections performed on fueling hoses. Hoses found to be defective or otherwise damaged shall be immediately removed from service.

**2006.19.1.1 Daily inspection.** Each hose shall be inspected daily. This inspection shall include a complete visual scan of the exterior for evidence of damage, blistering or leakage. Each coupling shall be inspected for evidence of leaks, slippage or misalignment.

**2006.19.1.2 Monthly inspection.** A more thorough inspection, including pressure testing, shall be accomplished for each hose on a monthly basis. This inspection shall include examination of the fuel delivery inlet screen for rubber particles, which indicates problems with the hose lining.

**2006.19.2 Damaged hose.** Hose that has been subjected to severe abuse shall be immediately removed from service. Such hoses shall be hydrostatically tested prior to being returned to service.

**2006.19.3 Repairing hose.** Hoses are allowed to be repaired by removing the damaged portion and recoupling the undamaged end. When recoupling hoses, only couplings designed and *approved* for the size and type of hose in question shall be used. Hoses repaired in this manner shall be visually inspected and hydrostatically tested prior to being placed back in service.

**2006.19.4 New hose.** New hose shall be visually inspected prior to being placed into service.

**2006.20 Aircraft fuel-servicing vehicles parking.** Unattended aircraft fuel-servicing vehicles shall be parked in areas that provide for both the unencumbered dispersal of vehicles in the event of an emergency and the control of leakage such that adjacent buildings and storm drains are not contaminated by leaking fuel.

**2006.20.1 Parking area design.** Parking areas for tank vehicles shall be designed and utilized such that a clearance of 10 feet (3048 mm) is maintained between each parked vehicle for fire department access. In addition, a minimum clearance of 50 feet (15 240 mm) shall be maintained between tank vehicles and parked aircraft and structures other than those used for the maintenance or garaging of aircraft fuel-servicing vehicles.

**2006.21 Radar equipment.** Aircraft fuel-servicing operations shall be prohibited while the weather-mapping radar of that aircraft is operating.

Aircraft fuel-servicing or other operations in which *flammable liquids*, vapors or mists could be present shall not be conducted within 300 feet (91 440 mm) of an operating aircraft surveillance radar.

Aircraft fuel-servicing operations shall not be conducted within 300 feet (91 440 mm) of airport flight traffic surveillance radar equipment.

Aircraft fuel-servicing or other operations in which *flammable liquids*, vapors or mists could be present shall not be conducted within 100 feet (30 480 mm) of airport ground traffic surveillance radar equipment.

**2006.21.1 Direction of radar beams.** The beam from ground radar equipment shall not be directed toward fuel storage or loading racks.

#### Exceptions:

1. Fuel storage and loading racks in excess of 300 feet (91 440 mm) from airport flight traffic surveillance equipment.
2. Fuel storage and loading racks in excess of 100 feet (30 480 mm) from airport ground traffic surveillance equipment.

## SECTION 2007 HELISTOPS AND HELIPORTS

**2007.1 General.** Helistops and heliports shall be maintained in accordance with Sections 2007.2 through 2007.8. Helistops and heliports on buildings shall be constructed in accordance with the *International Building Code*.

**2007.2 Clearances.** The touchdown area shall be surrounded on all sides by a clear area having minimum average width at roof level of 15 feet (4572 mm) and not less than 5 feet (1524 mm) at any point. The clear area shall be maintained.

**2007.3 Flammable and Class II combustible liquid spillage.** Landing areas on structures shall be maintained so as to confine *flammable* or Class II *combustible liquid* spillage to the landing area itself, and provisions shall be made to drain such spillage away from *exits* or *stairways* serving the helicopter landing area or from a structure housing such *exit* or *stairway*.

**2007.4 Exits.** *Exits* and *stairways* shall be maintained in accordance with Section 412.7 of the *International Building Code*.

**2007.5 Standpipe systems.** A building with a rooftop helistop or heliport shall be provided with a Class I or III standpipe system extended to the roof level on which the helistop or heliport is located. All portions of the helistop and heliport area shall be within 150 feet (45 720 mm) of a 2 $\frac{1}{2}$ -inch (63.5 mm) outlet on the standpipe system.

**2007.6 Foam protection.** Foam fire-protection capabilities shall be provided for rooftop heliports. Such systems shall be designed, installed and maintained in accordance with the applicable provisions of Sections 903, 904 and 905.

**2007.7 Fire extinguishers.** Not less than one portable fire extinguisher having a minimum 80-B:C rating shall be provided for each permanent takeoff and landing area and for the aircraft parking areas. Installation, inspection and maintenance of these extinguishers shall be in accordance with Section 906.

**2007.8 Federal approval.** Before operating helicopters from helistops and heliports, approval shall be obtained from the Federal Aviation Administration.





## CHAPTER 21

# DRY CLEANING

### User note:

**About this chapter:** Chapter 21 provides provisions that are intended to reduce hazards associated with use of flammable and combustible dry cleaning solvents. These materials, like all volatile organic chemicals, generate significant quantities of static electricity and are thus readily ignitable. Many flammable and nonflammable dry cleaning solvents also possess health hazards when involved in a fire.

### SECTION 2101 GENERAL

**2101.1 Scope.** Dry cleaning plants and their operations shall comply with the requirements of this chapter.

**2101.2 Permit required.** Permits shall be required as set forth in Section 105.5.

### SECTION 2102 DEFINITIONS

**2102.1 Definitions.** The following terms are defined in Chapter 2:

**DRY CLEANING.**

**DRY CLEANING PLANT.**

**DRY CLEANING ROOM.**

**DRY CLEANING SYSTEM.**

**SOLVENT OR LIQUID CLASSIFICATIONS.**

Class I solvents.

Class II solvents.

Class IIIA solvents.

Class IIIB solvents.

Class IV solvents.

### SECTION 2103 CLASSIFICATIONS

**2103.1 Solvent classification.** Dry cleaning solvents shall be classified according to their *flash points* as follows:

1. Class I solvents are liquids having a *flash point* below 100°F (38°C).
2. Class II solvents are liquids having a *flash point* at or above 100°F (38°C) and below 140°F (60°C).
3. Class IIIA solvents are liquids having a *flash point* at or above 140°F (60°C) and below 200°F (93°C).
4. Class IIIB solvents are liquids having a *flash point* at or above 200°F (93°C).
5. Class IV solvents are liquids classified as nonflammable.

### 2103.2 Classification of dry cleaning plants and systems.

Dry cleaning plants and systems shall be classified based on the solvents used as follows:

1. Type I—systems using Class I solvents.
2. Type II—systems using Class II solvents.
3. Type III-A—systems using Class IIIA solvents.
4. Type III-B—systems using Class IIIB solvents.
5. Type IV—systems using Class IV solvents in which dry cleaning is not conducted by the public.
6. Type V—systems using Class IV solvents in which dry cleaning is conducted by the public.

Spotting and pretreating operations conducted in accordance with Section 2106 shall not change the type of the dry cleaning plant.

**2103.2.1 Multiple solvents.** Dry cleaning plants using more than one class of solvent for dry cleaning shall be classified based on the numerically lowest solvent class.

**2103.3 Design.** The occupancy classification, design and construction of dry cleaning plants shall comply with the applicable requirements of the *International Building Code*.

### SECTION 2104 GENERAL REQUIREMENTS

**2104.1 Prohibited use.** Type I dry cleaning plants shall be prohibited. Limited quantities of Class I solvents stored and used in accordance with this section shall not be prohibited in dry cleaning plants.

**2104.2 Building services.** Building services and systems shall be designed, installed and maintained in accordance with this section and Chapter 6.

**2104.2.1 Ventilation.** Ventilation shall be provided in accordance with Section 502 of the *International Mechanical Code* and DOL 29 CFR Part 1910.1000, where applicable.

**2104.2.2 Heating.** In Type II dry cleaning plants, heating shall be by indirect means using steam, hot water or hot oil only.

**2104.2.3 Electrical wiring and equipment.** Electrical wiring and equipment in dry cleaning rooms or other locations subject to flammable vapors shall be installed in accordance with NFPA 70.

## DRY CLEANING

**2104.2.4 Bonding and grounding.** Storage tanks, treatment tanks, filters, pumps, piping, ducts, dry cleaning units, stills, tumblers, drying cabinets and other such equipment, where not inherently electrically conductive, shall be bonded together and grounded. Isolated equipment shall be grounded.

### SECTION 2105 OPERATING REQUIREMENTS

**2105.1 General.** The operation of dry cleaning systems shall comply with the requirements of Sections 2105.1.1 through 2105.3.

**2105.1.1 Written instructions.** Written instructions covering the proper installation and safe operation and use of equipment and solvent shall be given to the buyer.

**2105.1.1.1 Type II, III-A, III-B and IV systems.** In Type II, III-A, III-B and IV dry cleaning systems, machines shall be operated in accordance with the operating instructions furnished by the machinery manufacturer. Employees shall be instructed as to the hazards involved in their departments and in the work they perform.

**2105.1.1.2 Type V systems.** Operating instructions for customer use of Type V dry cleaning systems shall be conspicuously posted in a location near the dry cleaning unit. A telephone number shall be provided for emergency assistance.

**2105.1.2 Equipment identification.** The manufacturer shall provide nameplates on dry cleaning machines indicating the class of solvent for which each machine is designed.

**2105.1.3 Open systems prohibited.** Dry cleaning by immersion and agitation in open vessels shall be prohibited.

**2105.1.4 Prohibited use of solvent.** The use of solvents with a *flash point* below that for which a machine is designed or *listed* shall be prohibited.

**2105.1.5 Equipment maintenance and housekeeping.** Proper maintenance and operating practices shall be observed in order to prevent the leakage of solvent or the accumulation of lint. The handling of waste material generated by dry cleaning operations and the maintenance of facilities shall comply with the provisions of this section.

**2105.1.5.1 Floors.** Class I and II liquids shall not be used for cleaning floors.

**2105.1.5.2 Filters.** Filter residue and other residues containing solvent shall be handled and disposed of in covered metal containers.

**2105.1.5.3 Lint.** Lint and refuse shall be removed from traps daily, deposited in *approved* waste cans, removed from the premises, and disposed of safely. At all other times, traps shall be held securely in place.

**2105.1.5.4 Customer areas.** In Type V dry cleaning systems, customer areas shall be kept clean.

**2105.2 Type II systems.** Special operating requirements for Type II dry cleaning systems shall comply with the provisions of Sections 2105.2.1 through 2105.2.3.

**2105.2.1 Inspection of materials.** Materials to be dry cleaned shall be searched thoroughly and foreign materials, including matches and metallic substances, shall be removed.

**2105.2.2 Material transfer.** In removing materials from the washer, provisions shall be made for minimizing the dripping of solvent on the floor. Where materials are transferred from a washer to a drain tub, a nonferrous metal drip apron shall be placed so that the apron rests on the drain tub and the cylinder of the washer.

**2105.2.3 Ventilation.** A mechanical ventilation system that is designed to exhaust 1 cubic foot of air per minute for each square foot of floor area [ $0.0058 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] shall be installed in dry cleaning rooms and in drying rooms. The ventilation system shall operate automatically when the dry cleaning equipment is in operation and shall have manual controls at an *approved* location.

**2105.3 Type IV and V systems.** Type IV and V dry cleaning systems shall be provided with an automatically activated exhaust ventilation system to maintain an air velocity of not less than 100 feet per minute (0.51 m/s) through the loading door when the door is opened. Such systems for dry cleaning equipment shall comply with the *International Mechanical Code*.

**Exception:** Dry cleaning units are not required to be provided with exhaust ventilation where an exhaust hood is installed immediately outside of and above the loading door and operates at an airflow rate as follows:

$$Q = 100 \times A_{LD} \quad (\text{Equation 21-1})$$

where:

$Q$  = flow rate exhausted through the hood, cubic feet per minute ( $\text{m}^3/\text{s}$ ).

$A_{LD}$  = area of the loading door, square feet ( $\text{m}^2$ ).

### SECTION 2106 SPOTTING AND PRETREATING

**2106.1 General.** Spotting and pretreating operations and equipment shall comply with the provisions of Sections 2106.2 through 2106.5.

**2106.2 Class I solvents.** The maximum quantity of Class I solvents permitted at any work station shall be 1 gallon (4 L). Spotting or prespotting shall be permitted to be conducted with Class I solvents where they are stored in and dispensed from *approved* safety cans or in sealed DOT-*approved* metal shipping containers of not more than 1-gallon (4 L) capacity.

**2106.2.1 Spotting and prespotting.** Spotting and prespotting shall be permitted to be conducted with Class I solvents where dispensed from plastic containers of not more than 1 pint (0.5 L) capacity.

**2106.3 Class II and III solvents.** Scouring, brushing, and spotting and pretreating shall be permitted to be conducted with Class II or III solvents. The maximum quantity of Class II or III solvents permitted at any work station shall be 1 gallon (4 L). In other than Group H-2 occupancy, the aggregate quantities of solvents shall not exceed the *maximum allowable quantity per control area* for use-open system.

**2106.3.1 Spotting tables.** Scouring, brushing or spotting tables on which articles are soaked in solvent shall have a liquid-tight top with a curb on all sides not less than 1 inch (25 mm) high. The top of the table shall be pitched to ensure thorough draining to a 1½-inch (38 mm) drain connected to an *approved* container.

**2106.3.2 Special handling.** Where *approved*, articles that cannot be washed in the usual washing machines are allowed to be cleaned in scrubbing tubs. Scrubbing tubs shall comply with the following:

1. Only Class II or III liquids shall be used.
2. The total amount of solvent used in such open containers shall not exceed 3 gallons (11 L).
3. Scrubbing tubs shall be secured to the floor.
4. Scrubbing tubs shall be provided with permanent 1½-inch (38 mm) drains. Such drain shall be provided with a trap and shall be connected to an *approved* container.

**2106.3.3 Ventilation.** Scrubbing tubs, scouring, brushing or spotting operations shall be located such that solvent vapors are captured and exhausted by the ventilating system.

**2106.3.4 Bonding and grounding.** Metal scouring, brushing and spotting tables and scrubbing tubs shall be permanently and effectively bonded and grounded.

**2106.4 Type IV systems.** *Flammable* and *combustible liquids* used for spotting operations shall be stored in *approved* safety cans or in sealed DOTn-approved shipping containers of not more than 1 gallon (4 L) in capacity. Aggregate amounts shall not exceed 10 gallons (38 L).

**2106.5 Type V systems.** Spotting operations using *flammable* or *combustible liquids* are prohibited in Type V dry cleaning systems.

## SECTION 2107 DRY CLEANING SYSTEMS

**2107.1 General equipment requirements.** Dry cleaning systems, including dry cleaning units, washing machines, stills, drying cabinets, tumblers and their appurtenances, including pumps, piping, valves, filters and solvent coolers, shall be installed and maintained in accordance with NFPA 32. The construction of buildings in which such systems are located shall comply with the requirements of this section and the *International Building Code*.

**2107.2 Type II systems.** Type II dry cleaning and solvent tank storage rooms shall not be located below grade or above

the lowest floor level of the building and shall comply with Sections 2107.2.1 through 2107.2.3.

**Exception:** Solvent storage tanks installed underground, in vaults or in special enclosures in accordance with Chapter 57.

**2107.2.1 Fire-fighting access.** Type II dry cleaning plants shall be located so that access is provided and maintained from one side for fire-fighting and fire control purposes in accordance with Section 503.

**2107.2.2 Number of means of egress.** Type II dry cleaning rooms shall have not less than two *means of egress* doors located at opposite ends of the room, not less than one of which shall lead directly to the outside.

**2107.2.3 Spill control and secondary containment.** Curbs, drains or other provisions for spill control and secondary containment shall be provided in accordance with Section 5004.2 to collect solvent leakage and fire protection water and direct it to a safe location.

**2107.3 Solvent storage tanks.** Solvent storage tanks for Class II, IIIA and IIIB liquids shall conform to the requirements of Chapter 57 and be located underground or outside, above ground.

**Exception:** As provided in NFPA 32 for inside storage or treatment tanks.

## SECTION 2108 FIRE PROTECTION

**2108.1 General.** Where required by this section, *fire protection systems*, devices and equipment shall be installed, inspected, tested and maintained in accordance with Chapter 9.

**2108.2 Automatic sprinkler system.** An *automatic sprinkler system* shall be installed in accordance with Section 903.3.1.1 throughout dry cleaning plants containing Type II, Type III-A or Type III-B dry cleaning systems.

### Exceptions:

1. An *automatic sprinkler system* shall not be required in Type III-A dry cleaning plants where the aggregate quantity of Class III-A solvent in dry cleaning machines and storage does not exceed 330 gallons (1250 L) and dry cleaning machines are equipped with a feature that will accomplish any one of the following:
  - 1.1. Prevent oxygen concentrations from reaching 8 percent or more by volume.
  - 1.2. Keep the temperature of the solvent not less than 30°F (16.7°C) below the *flash point*.
  - 1.3. Maintain the solvent vapor concentration at a level lower than 25 percent of the lower explosive limit (LEL).



## DRY CLEANING

- 1.4. Utilize equipment *approved* for use in Class I, Division 2, hazardous locations in accordance with NFPA 70.
- 1.5. Utilize an integrated dry-chemical, clean agent or water-mist automatic fire-extinguishing system designed in accordance with Chapter 9.
2. An *automatic sprinkler system* shall not be required in Type III-B dry cleaning plants where the aggregate quantity of Class III-B solvent in dry cleaning machines and storage does not exceed 3,300 gallons (12 490 L).

**2108.3 Automatic fire-extinguishing systems.** Type II dry cleaning units, washer-extractors, and drying tumblers in Type II dry cleaning plants shall be provided with an *approved* automatic fire-extinguishing system installed and maintained in accordance with Chapter 9.

**Exception:** Where *approved*, a manual steam jet not less than  $\frac{3}{4}$  inch (19 mm) with a continuously available steam supply at a pressure not less than 15 pounds per square inch gauge (psig) (103 kPa) is allowed to be substituted for the automatic fire-extinguishing system.

**2108.4 Portable fire extinguishers.** Portable fire extinguishers shall be selected, installed and maintained in accordance with this section and Section 906. Not fewer than two 2-A:10-B:C portable fire extinguishers shall be provided near the doors inside dry cleaning rooms containing Type II, Type III-A and Type III-B dry cleaning systems.

## CHAPTER 22

# COMBUSTIBLE DUST-PRODUCING OPERATIONS

### User note:

**About this chapter:** Chapter 22 provides requirements that seek to reduce the likelihood of dust explosions by managing the hazards of ignitable suspensions of combustible dusts associated with a variety of operations including woodworking, mining, food processing, agricultural commodity storage and handling and pharmaceutical manufacturing, among others. This chapter provides various requirements to control ignition sources, use properly listed and designed dust collection systems, maintain good housekeeping practices and provide proper training to those involved in these processes. Appropriate standards are referenced to deal with the specific dust hazards.

### SECTION 2201 GENERAL

**2201.1 Scope.** The equipment, processes and operations involving dust explosion hazards and use or handling of *combustible dust* shall comply with the provisions of this chapter.

#### Exceptions:

1. Storage and use of consumer materials in Group B or R occupancies.
2. Storage and use of commercially packaged materials in Group M occupancies.
3. Materials displayed in original packaging in Group M occupancies and intended as building materials or for personal or household use.
4. Storage of sealed containers of *combustible dust* at facilities not associated with an operation that uses, handles or generates *combustible dust*.
5. Materials stored or used in farm buildings or similar occupancies intended for on-premises agricultural purposes.

**2201.2 Permits.** Permits shall be required for *combustible dust*-producing operations as set forth in Section 105.5.

### SECTION 2202 DEFINITIONS

**2202.1 Definition.** The following terms are defined in Chapter 2:

**COMBUSTIBLE DUST.**

**DUST COLLECTION SYSTEM.**

### SECTION 2203 DUST EXPLOSION PREVENTION

**2203.1 Critical depth layer.** The maximum dust layer on all surfaces, including but not limited to walls, ceilings, beams, equipment, furniture, pipes and ducts, shall not exceed the critical depth layer specified in Table 2203.1. The critical depth layer is permitted to be adjusted for explosion hazard

where further evaluated in accordance with one of the following:

1. Section 7.2.1.3 of NFPA 654.
2. Section 4.1.3.3 of NFPA 664 for wood flour.

Accumulated *combustible dust* shall be collected by one of the methods listed in Section 2203.5.

**TABLE 2203.1  
CRITICAL DEPTH LAYER**

TYPE OF DUST	CRITICAL DEPTH LAYER (INCHES)
Wood flour	1/8
All other dusts	1/32

For SI: 1 inch = 25.4 mm.

**2203.2 Dust-producing and dust-handling equipment.** Dust-producing equipment and dust-handling equipment, including but not limited to vacuums, dust collection systems, dryers, mixers, blenders, separators, conveyors, storage containers, silos or other similar devices, shall be *listed* and shall be maintained in accordance with the manufacturer's recommended standards.

**2203.2.1 Signages and markings.** Signages and markings shall be provided in accordance with Sections 2203.2.1.1 through 2203.2.1.3.

**2203.2.1.1 Deflagration vent discharge area markings.** Where dust collection systems and other equipment, systems or system components are provided with deflagration vents, the area within the deflagration vent's discharge area shall be marked in an *approved* manner.

**2203.2.1.2 Caution signs.** Signs that read as follows shall be posted near the dust-containing equipment with deflagration vents:

CAUTION: THIS EQUIPMENT CAN  
CONTAIN EXPLOSIVE DUST.  
KEEP OUTSIDE THE MARKED AREA  
WHILE EQUIPMENT IS OPERATING.

**2203.2.1.3 Warning signs.** Where dust collection systems and other equipment, systems or system

## COMBUSTIBLE DUST-PRODUCING OPERATIONS

components are provided with deflagration vents, vent closures shall be clearly marked as follows:

**WARNING: EXPLOSION RELIEF  
DEVICE. STAY CLEAR.**

**2203.3 Dust-collection and dust-conveying systems.** Dust-collection and dust-conveying systems shall be in accordance with Sections 2203.3.1 through 2203.3.3.

**2203.3.1 Dust-collection systems.** Dust-collection systems shall be designed to collect dust emissions from dust-producing equipment at the point of generation. Dust-collection systems shall be in accordance with Section 511 of the *International Mechanical Code*.

**Exception:** *Closed systems* using *listed* equipment and designed in accordance with manufacturer's recommendations and specifications, where cleanouts are provided in accordance with Section 2203.3.3.

Heating, ventilation, and air conditioning (HVAC) systems shall not be used as the means to collect dusts from localized sources.

**2203.3.1.1 Location.** Dust collectors shall be located outside of buildings.

**Exceptions:**

1. Dust collectors inside buildings complying with Section 511 of the *International Mechanical Code*.
2. Wet-type dust collectors specifically *listed* for the type of dust conveyed shall be permitted inside buildings where in accordance with the manufacturer's instructions and specifications.
3. Dust collectors designed to specific NFPA standards listed in Table 2205.1 for the specific type of dust conveyed.

**2203.3.1.2 Minimum conveying velocities.** The minimum velocities within ducts used as part of the dust collection system shall be in accordance with Table 2203.3.1.2.

**TABLE 2203.3.1.2  
MINIMUM CONVEYING VELOCITIES**

TYPE OF PRODUCT	FEET PER MINUTE
Fine light dust such as cotton, lint and wood flour (100 mesh and under)	2,000
Dry dust such as fine rubber molding powder	2,500
Average dust such as sawdust, grinding dust and coal dust	3,500
Heavy dust such as metal turnings, including aluminum and magnesium powder	4,000

For SI: 1 foot per minute = 0.00508 m/s.

**2203.3.2 Plastic ducts and conveying systems.** Plastic, fiberglass, other nonconductive ducts, duct liners or pipes shall not be used as part of ducts and conveying systems. Ductwork utilizing a combustible lining shall be permitted only in high-impact areas and where *approved*.

Flexible hose shall be permitted if designed and installed in accordance with the following requirements:

1. Manufactured of static dissipative construction.
2. Used only for connections and isolation purposes.
3. Limited to 18 inches (457 mm) in length.
4. Properly grounded.

**2203.3.3 Cleanouts.** Openings in enclosed equipment and conveyors shall be provided to allow access to all parts of the equipment and conveyors to permit inspection, cleaning, maintenance and the effective use of portable fire extinguishers or hose streams. Cleanouts for ducts used as part of the dust-collection system shall be in accordance with the *International Mechanical Code*.

**2203.4 Sources of ignition.** Sources of ignition shall be controlled in accordance with Sections 2203.4.1 through 2203.4.9.5.

**2203.4.1 Classified electrical.** Classified electrical shall be in accordance with NFPA 70. Electrical motors and electrical components of the equipment shall not be installed in the dust-laden airstream unless *listed* for Class II, Division 1, locations.

**2203.4.2 Static electricity.** Bonding and grounding is required to minimize accumulation of static electric charge in the following locations:

1. Dust-producing equipment.
2. Dust-collection system.
3. Pneumatic dust-conveying systems conveying *combustible dust* from one location to another, *combustible dust* conveyors, piping and conductive components. Conveying systems include transport modes such as railcars, hopper cars, boxcars, tank cars and trucks into which or from which commodities or products are pneumatically conveyed.
4. Conveying systems using metallic piping.

**2203.4.3 Hot works.** Hot work and similar spark-producing operations shall not be conducted in or adjacent to *combustible dust*-producing areas unless precautions have been taken to provide safety. Hot work shall be permitted only in safe, designated areas in accordance with Chapter 35. Hot work is prohibited on equipment that is operating.

**2203.4.3.1 Signs.** Conspicuous signs with the following warning shall be posted in the vicinity of *combustible dust*-producing areas or in the vicinity of *combustible dust* use:

**NO WELDING. THE USE OF WELDING  
OR CUTTING EQUIPMENT IN OR NEAR  
THIS AREA IS DANGEROUS BECAUSE  
OF FIRE AND EXPLOSION HAZARDS.**

**WELDING AND CUTTING SHALL BE  
DONE ONLY UNDER THE SUPERVISION  
OF THE PERSON IN CHARGE.**

**2203.4.4 Hot surfaces and hot equipment.** In areas where a dust explosion hazard or dust flash fire hazard exists, the temperature (in degrees Celsius) of external surfaces shall be maintained below 80 percent of the lower of the dust-surface ignition temperature or the dust-cloud ignition temperature for worst-case dusts. External surfaces shall include but are not limited to:

1. Compressors.
2. Steam, water or process piping.
3. Ducts.
4. Conveyors.
5. Process equipment.

Where steam pipes or hot surfaces occur in dust-producing or dust-handling areas, accumulation of dust on the surfaces shall be minimized by an *approved* method.

**Exception:** Drying apparatus *listed* for the intended use and installed in accordance with the manufacturer's instructions.

**2203.4.5 Powered industrial trucks.** Powered industrial trucks used in electrically classified areas shall be *listed* for such use.

**2203.4.6 Smoking prohibited.** Smoking shall be prohibited in or adjacent to dust-producing or dust-handling areas. "No Smoking" signs complying with Section 310 shall be conspicuously posted in such areas. Smoking shall be permitted only in designated areas.

**2203.4.7 Spark-producing devices.** Spark-producing devices shall not be located within 20 feet (6096 mm) of areas requiring classified electrical unless separated by a permanent partition.

**2203.4.8 Self-heating materials.** Materials in silos and other large storage piles of particulates prone to self-heating shall be in accordance with Section 9.4.11 of NFPA 652.

**2203.4.9 Open flames and fuel-fired equipment.** Open flames and fuel-fired equipment shall be in accordance with Sections 2203.4.9.1 through 2203.4.9.5.

**2203.4.9.1 Release of airborne combustible dust.** Production, maintenance or repair activities that have the potential to release or force *combustible dust* to become airborne shall not be conducted within 35 feet (11 m) of an open flame or pilot flame.

**2203.4.9.2 Space heaters.** Fuel-fired space heaters drawing local ambient air shall not be located within electrically classified areas. Space-heating appliances in dust-producing or dust-handling areas shall be located where not subject to the accumulation of deposits of *combustible dust*.

**2203.4.9.3 Equipment listing.** Fuel-fired process equipment shall be *listed* for its intended use and shall be operated and maintained in accordance with the manufacturer's instructions.

**2203.4.9.4 Inspection and preventive maintenance.** Inspection and maintenance of fuel-fired process

equipment shall include verification that significant *combustible dust* accumulations do not exist within or around the equipment.

**2203.4.9.5 Sources of combustion air.** In Class II electrically classified locations, heating units shall be provided with a source of combustion air ducted directly from the building exterior or from an unclassified location.

**2203.5 Housekeeping.** Accumulation of *combustible dust* on surfaces inside buildings shall be maintained below the critical depth layer in Section 2203.1. Pressurized air or similar methods shall not be used to remove dust from surfaces. Accumulated combustible dust shall be collected by one of the following methods:

1. Portable vacuum cleaners *listed* for use in Class II, Group G, Division 1, atmospheres as defined in NFPA 70.
2. Dust collection systems.
3. Other *approved* means that will not place *combustible dust* into suspension in air.

**Exception:** Forced-air or similar methods shall be permitted to remove dust in accordance with NFPA 652, NFPA 654 or NFPA 664.

**2203.6 Standard operational procedures.** Dust-producing equipment and all associated equipment, including dust-collection equipment, shall be maintained in accordance with the manufacturer's instructions and specifications and applicable codes. The inspection, testing and maintenance program shall include the following, as applicable:

1. Fire and explosion protection and prevention equipment, as applicable, in accordance with the appropriate NFPA standards.
2. Dust-control equipment.
3. Control of potential ignition sources.
4. Electrical, process and mechanical equipment, including applicable process interlocks.
5. Lubrication of bearings for dust-collection, dust-handling and dust-producing equipment.
6. Additional maintenance in accordance with the manufacturer's instructions and specifications for dust-collection, dust-handling and dust-producing equipment.

Records shall be kept of maintenance and repairs performed. The standard operating procedures shall be submitted to the *fire code official* for review and approval. The written standard operating procedures shall be signed by the person responsible for facility operations.

**2203.7 Emergency response plan.** A written emergency response plan shall be developed for preventing, preparing for and responding to work-related emergencies, including but not limited to fire and explosion. The following information shall be developed into the plan:

1. Identification of dust hazards.
2. Identification and location of all utilities to affected areas.



## COMBUSTIBLE DUST-PRODUCING OPERATIONS

3. Site plans or floor plans locating utility shutoff controls, including water, gas and power.
4. The potential for explosion.
5. Locations of fire-extinguishing equipment compatible with the hazards present.
6. Any additional information required by the *fire code official*.

**2203.8 Training.** The plans and procedures required in Sections 2203.5, 2203.6 and 2203.7 shall be *approved* by the *fire code official*. The plans and procedures shall be reviewed annually and updated as required by process changes. Initial and annual refresher training shall be provided to employees who are involved in operating, maintaining and supervising facilities that handle *combustible dust*. Initial and annual refresher training shall include:

1. Workplace hazards.
2. General orientation, plant diagrams and plant safety rules.
3. Process description or flowchart.
4. Equipment operation, safe startup and shutdown, and response to hazard conditions or an incident.
5. The location and use of all related fire and explosion protection and prevention systems.
6. Equipment maintenance requirements and practices, including visual inspections of conveyors and ducts.
7. Housekeeping requirements, including the maintenance of the critical depth layer in Section 2203.1.
8. Emergency response plans as required in Section 2203.7.

The employer shall maintain records of initial and annual training and review.

### SECTION 2204 DUST EXPLOSION SCREENING TESTS

**2204.1 Combustibility and explosivity tests.** Where combustibility or explosivity screening tests are required to analyze the *combustible dust* as part of compliance with Section 104.8 and Section 414.1.3 of the *International Building Code*, they shall be in accordance with Section 5.4 of NFPA 652.

**2204.2 Samples.** Representative samples for the screening test shall be obtained in accordance with Section 5.5 of NFPA 652.

## SECTION 2205 STANDARDS

**2205.1 Specific hazards standards.** The *fire code official* is authorized to enforce additional industry- or material-specific provisions of the codes and standards listed in Table 2205.1 to prevent and control dust explosions, as applicable.

**TABLE 2205.1  
EXPLOSION PROTECTION STANDARDS**

STANDARD	SUBJECT
NFPA 61	Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities
NFPA 68	Standard on Explosion Protection by Deflagration Venting
NFPA 69	Standard on Explosion Prevention Systems
NFPA 70	National Electrical Code
NFPA 77	Recommended Practice on Static Electricity
NFPA 85	Boiler and Combustion System Hazards Code
NFPA 120	Standard for Fire Prevention and Control in Coal Mines
NFPA 484	Standard for Combustible Metals
NFPA 654	Standard for Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids
NFPA 655	Standard for the Prevention of Sulfur Fires and Explosions
NFPA 664	Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities

**2205.1.1 Dust hazard analysis.** If a dust hazard analysis (DHA) is required by the *fire code official* for new or existing facilities and operations, it shall be in accordance with NFPA 652. The DHA for existing facilities shall be in accordance with Section 7.1.1 of NFPA 652.

## CHAPTER 23

# MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

### User note:

**About this chapter:** Chapter 23 sets forth regulations for motor fuel-dispensing stations and repair garages. It addresses both liquid and gaseous motor fuels associated with automotive, marine, aircraft and fleet vehicle motor fuel-dispensing facilities. The repair garage provisions specifically address hazards associated with the different types of fuel used, including flammable and combustible liquids, hydrogen, LPG, LNG and CNG.

### SECTION 2301 GENERAL

**2301.1 Scope.** Automotive motor fuel-dispensing facilities, marine motor fuel-dispensing facilities, fleet vehicle motor fuel-dispensing facilities, aircraft motor-vehicle fuel-dispensing facilities and repair garages shall be in accordance with this chapter and the *International Mechanical Code*; *Arkansas Fire Prevention Code*, Volume II; and the *Arkansas Gas Code*. Such facilities shall include both those that are open to the public and private operations.

**2301.2 Permits.** Permits shall be required as set forth in Section 105.5.

**2301.3 Construction documents.** *Construction documents* shall be submitted for review and approval prior to the installation or construction of automotive, marine or fleet vehicle motor fuel-dispensing facilities and repair garages in accordance with Section 106.1.

**2301.4 Indoor motor fuel-dispensing facilities.** Motor fuel-dispensing facilities located inside buildings shall comply with the *International Building Code* and NFPA 30A.

**2301.4.1 Protection of floor openings in indoor motor fuel-dispensing facilities.** Where motor fuel-dispensing facilities are located inside buildings and the dispensers are located above spaces within the building, openings beneath dispensers shall be sealed to prevent the flow of leaked fuel to lower building spaces.

**2301.5 Electrical.** Electrical wiring and equipment shall be suitable for the locations in which they are installed and shall comply with Section 603, NFPA 30A and NFPA 70.

**2301.6 Heat-producing appliances.** Heat-producing appliances shall be suitable for the locations in which they are installed and shall comply with NFPA 30A and the *International Fuel Gas Code* or the *International Mechanical Code*.

### SECTION 2302 DEFINITIONS

**2302.1 Definitions.** The following terms are defined in Chapter 2:

**AIRCRAFT MOTOR-VEHICLE FUEL-DISPENSING FACILITY.**

**ALCOHOL-BLENDED FUELS.**

**AUTOMOTIVE MOTOR FUEL-DISPENSING FACILITY.**

**DISPENSING DEVICE, OVERHEAD TYPE.**

**FLEET VEHICLE MOTOR FUEL-DISPENSING FACILITY.**

**LIQUEFIED NATURAL GAS (LNG).**

**MARINE MOTOR FUEL-DISPENSING FACILITY.**

**REPAIR GARAGE.**

**SELF-SERVICE MOTOR FUEL-DISPENSING FACILITY.**

### SECTION 2303 LOCATION OF DISPENSING DEVICES

**2303.1 Location of dispensing devices.** Dispensing devices shall be located as follows:

1. Ten feet (3048 mm) or more from *lot lines*.
2. Ten feet (3048 mm) or more from buildings having combustible exterior wall surfaces or buildings having noncombustible exterior wall surfaces that are not part of a 1-hour fire-resistance-rated assembly or buildings having combustible overhangs.

**Exception:** Canopies constructed in accordance with the *International Building Code* providing weather protection for the fuel islands.

3. Such that all portions of the vehicle being fueled will be on the premises of the motor fuel-dispensing facility.
4. Such that the nozzle, where the hose is fully extended, will not reach within 5 feet (1524 mm) of building openings.
5. Twenty feet (6096 mm) or more from fixed sources of ignition.
6. Such that fuel dispensing is in view of the attendant at attended self-service motor fuel-dispensing facilities, as required by Section 2304.2.4.

**2303.2 Emergency disconnect switches.** An *approved* emergency disconnect switch shall be provided at an *approved* location to stop the transfer of fuel to the fuel dispensers in the event of a fuel spill or other emergency. The emergency disconnect switch for exterior fuel dispensers shall be provided with *ready access* and shall be located

MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, the fuel dispensers. For interior fuel-dispensing operations, the emergency disconnect switch shall be provided with *ready access* and be installed at an *approved* location. Such devices shall be distinctly *labeled* as: “EMERGENCY FUEL SHUTOFF.” Signs shall be provided in *approved* locations.

**2303.2.1 Height.** The height of the emergency disconnect switch shall be not less than 42 inches (1067 mm) and not more than 48 inches (1219 mm) measured vertically, from the floor level to the activating button.

SECTION 2304  
DISPENSING OPERATIONS

**2304.1 Supervision of dispensing.** The dispensing of fuel at motor fuel-dispensing facilities shall be conducted by a qualified attendant or shall be under the supervision of a qualified attendant at all times or shall be in accordance with Section 2304.3.

**2304.2 Attended self-service motor fuel-dispensing facilities.** Attended self-service motor fuel-dispensing facilities shall comply with Sections 2304.2.1 through 2304.2.5. Attended self-service motor fuel-dispensing facilities shall have not less than one qualified attendant on duty while the facility is open for business. The attendant’s primary function shall be to supervise, observe and control the dispensing of fuel. The attendant shall prevent the dispensing of fuel into containers that do not comply with Section 2304.4.1, control sources of ignition, give immediate attention to accidental spills or releases, and be prepared to use fire extinguishers.

**2304.2.1 Special-type dispensers.** *Approved* special-dispensing devices and systems such as, but not limited to, card- or coin-operated and remote-preset types, are allowed at motor fuel-dispensing facilities provided that there is not less than one qualified attendant on duty while the facility is open to the public. Remote preset-type devices shall be set in the “off” position while not in use so that the dispenser cannot be activated without the knowledge of the attendant.

**2304.2.2 Emergency controls.** *Approved* emergency controls shall be provided in accordance with Section 2303.2.

**2304.2.3 Operating instructions.** Dispenser operating instructions shall be conspicuously posted in *approved* locations on every dispenser.

**2304.2.4 Obstructions to view.** The attendant shall have a direct line of sight to observe fuel-dispensing operations at all times. Obstructions shall not be placed between the dispensing area and the attendant.

**Exception:** Video monitoring systems shall be permitted to supplement direct line of sight supervision where *approved* by the *fire code official*.

**2304.2.5 Communications.** The attendant shall be able to communicate with persons in the dispensing area at all

times. An *approved* method of communicating with the fire department shall be provided for the attendant.

**2304.3 Unattended self-service motor fuel-dispensing facilities.** Unattended self-service motor fuel-dispensing facilities shall comply with Sections 2304.3.1 through 2304.3.7.

**2304.3.1 General.** Where *approved*, unattended self-service motor fuel-dispensing facilities are allowed. As a condition of approval, the *owner* or operator shall provide, and be accountable for, daily site visits, regular equipment inspection and maintenance.

**2304.3.2 Dispensers.** Dispensing devices shall comply with Section 2306.7. Dispensing devices operated by the insertion of coins or currency shall not be used unless *approved*.

**2304.3.3 Emergency controls.** *Approved* emergency controls shall be provided in accordance with Section 2303.2. Emergency controls shall be of a type that is only manually resettable.

**2304.3.4 Operating instructions.** Dispenser operating instructions shall be conspicuously posted in *approved* locations on every dispenser and shall indicate the location of the emergency controls required by Section 2304.3.3.

**2304.3.5 Emergency procedures.** An *approved* emergency procedures sign, in addition to the signs required by Section 2305.6, shall be posted in a conspicuous location and shall read:

IN CASE OF FIRE, SPILL OR RELEASE

- 1. USE EMERGENCY PUMP SHUTOFF
- 2. REPORT THE ACCIDENT!

FIRE DEPARTMENT TELEPHONE NO. \_\_\_\_\_

FACILITY ADDRESS \_\_\_\_\_

**2304.3.6 Communications.** Deleted in its entirety.

**2304.3.7 Quantity limits.** Dispensing equipment used at unsupervised locations shall comply with one of the following:

- 1. Dispensing devices shall be programmed or set to limit uninterrupted fuel delivery to 35 gallons (133 L) for cars, pickups, vans and similar small vehicles; and 100 gallons (379 L) per transaction at facilities serving large trucks and requiring a manual action to resume delivery.
- 2. The amount of fuel being dispensed shall be limited in quantity by a preprogrammed card as *approved*.

**2304.4 Dispensing into portable containers.** The dispensing of *flammable* or *combustible liquids* into portable *approved* containers shall comply with Sections 2304.4.1 through 2304.4.3.

**2304.4.1 Approved containers required.** Class I, II and IIIA liquids shall not be dispensed into a portable container unless such container does not exceed a 6-gallon (22.7 L) capacity, is *listed* or of *approved* material

and construction, and has a tight closure with a screwed or spring-loaded cover so designed that the contents can be dispensed without spilling. Liquids shall not be dispensed into portable or cargo tanks.

**2304.4.2 Nozzle operation.** A hose nozzle valve used for dispensing Class I liquids into a portable container shall be in compliance with Section 2306.7.6 and be manually held open during the dispensing operation.

**2304.4.3 Location of containers being filled.** Portable containers shall not be filled while located inside the trunk, passenger compartment or truck bed of a vehicle.

## SECTION 2305 OPERATIONAL REQUIREMENTS

**2305.1 Tank filling operations for Class I, II or III liquids.** Delivery operations to tanks for Class I, II or III liquids shall comply with Sections 2305.1.1 through 2305.1.3 and the applicable requirements of Chapter 57.

**2305.1.1 Delivery vehicle location.** Where liquid delivery to above-ground storage tanks is accomplished by positive-pressure operation, tank vehicles shall be positioned not less than 25 feet (7620 mm) from tanks receiving Class I liquids and 15 feet (4572 mm) from tanks receiving Class II and IIIA liquids, measured from the tank to the nearest unloading valve on the tank vehicle.

**2305.1.2 Tank capacity calculation.** The driver, operator or attendant of a tank vehicle shall, before making delivery to a tank, determine the unfilled, available capacity of such tank by an *approved* gauging device.

**2305.1.3 Tank fill connections.** Delivery of *flammable liquids* to tanks more than 1,000 gallons (3785 L) in capacity shall be made by means of *approved* liquid- and vapor-tight connections between the delivery hose and tank fill pipe. Where tanks are equipped with any type of vapor recovery system, all connections required to be made for the safe and proper functioning of the particular vapor recovery process shall be made. Such connections shall be made liquid and vapor tight and remain connected throughout the unloading process. Vapors shall not be discharged at grade level during delivery.

**2305.2 Equipment maintenance and inspection.** Motor fuel-dispensing facility equipment shall be maintained in proper working order at all times in accordance with Sections 2305.2.1 through 2305.2.5.

**2305.2.1 Inspections.** *Flammable* and *combustible liquid* fuel-dispensing and containment equipment shall be periodically inspected where required by the *fire code official* to verify that the equipment is in proper working order and not subject to leakage. Records of inspections shall be maintained.

**2305.2.2 Repairs and service.** The *fire code official* is authorized to require damaged or unsafe containment and dispensing equipment to be repaired or serviced in an *approved* manner.

**2305.2.3 Dispensing devices.** Where maintenance to Class I liquid dispensing devices becomes necessary and such maintenance could allow the accidental release or ignition of liquid, the following precautions shall be taken before such maintenance is begun:

1. Only persons knowledgeable in performing the required maintenance shall perform the work.
2. Electrical power to the dispensing device and pump serving the dispenser shall be shut off at the main electrical disconnect panel.
3. The emergency shutoff valve at the dispenser, where installed, shall be closed.
4. Vehicle traffic and unauthorized persons shall be prevented from coming within 12 feet (3658 mm) of the dispensing device.

**2305.2.4 Emergency shutoff valves.** Automatic emergency shutoff valves required by Section 2306.7.4 shall be checked not less than once per year by manually tripping the hold-open linkage.

**2305.2.5 Leak detectors.** Leak detection devices required by Section 2306.7.7.1 shall be checked and tested not less than annually in accordance with the manufacturer's specifications to ensure proper installation and operation.

**2305.3 Spill control.** Provisions shall be made to prevent liquids spilled during dispensing operations from flowing into buildings. Acceptable methods include, but shall not be limited to, grading driveways, raising doorsills or other *approved* means.

**2305.4 Sources of ignition.** Smoking and open flames shall be prohibited in areas where fuel is dispensed. The engines of vehicles being fueled shall be shut off during fueling. Electrical equipment shall be in accordance with NFPA 70.

**2305.5 Fire extinguishers.** *Approved* portable fire extinguishers complying with Section 906 with a minimum rating of 2-A:20-B:C shall be provided and located such that an extinguisher is not more than 75 feet (22 860 mm) from pumps, dispensers or storage tank fill-pipe openings.

**2305.6 Warning signs.** Warning signs shall be conspicuously posted within sight of each dispenser in the fuel-dispensing area and shall state the following:

1. No smoking.
2. Shut off motor.
3. Discharge your static electricity before fueling by touching a metal surface away from the nozzle.
4. To prevent static charge, do not reenter your vehicle while gasoline is pumping.
5. If a fire starts, do not remove nozzle—back away immediately.
6. It is unlawful and dangerous to dispense gasoline into unapproved containers.
7. No filling of portable containers in or on a motor vehicle. Place container on ground before filling.



## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

**2305.7 Control of brush and debris.** Fenced and diked areas surrounding above-ground tanks shall be kept free from vegetation, debris and other material that is not necessary to the proper operation of the tank and piping system.

Weeds, grass, brush, trash and other combustible materials shall be kept not less than 10 feet (3048 mm) from fuel-handling equipment.

### SECTION 2306 FLAMMABLE AND COMBUSTIBLE LIQUID MOTOR FUEL-DISPENSING FACILITIES

**2306.1 General.** Storage of *flammable* and *combustible liquids* shall be in accordance with Chapter 57 and Sections 2306.2 through 2306.6.3.

**2306.2 Method of storage.** *Approved* methods of storage for Class I, II and III liquid fuels at motor fuel-dispensing facilities shall be in accordance with Sections 2306.2.1 through 2306.2.6.

**2306.2.1 Underground tanks.** Underground tanks for the storage of Class I, II and IIIA liquid fuels shall comply with Chapter 57.

★ **2306.2.1.1 Inventory control for underground tanks.** Deleted.

**2306.2.2 Above-ground tanks located inside buildings.** Above-ground tanks for the storage of Class I, II and IIIA liquid fuels are allowed to be located in buildings. Such tanks shall be located in special enclosures complying with Section 2306.2.6, in a liquid storage room or a liquid storage warehouse complying with Chapter 57, or shall be *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085.

**2306.2.3 Above-ground tanks located outdoors, above grade.** Above-ground tanks shall not be used for the storage of Class I, II or III liquid motor fuels, except as provided by this section.

1. Above-ground tanks used for outdoor, above-grade storage of Class I liquids shall be designed, constructed and maintained in accordance with one or more of the following nationally recognized engineering standards and shall be in accordance with Chapter 57. Such tanks shall be located in accordance with Table 2306.2.3.

4.1. Atmospheric tanks: API Standard 650, API Specifications 12B, 12D or 12F, UL 80, UL 142, UL 2080 or UL 2085.

4.2. Low-pressure tanks: ASME Boiler and Pressure Vessel Code, Section VIII or API Standard 620.

4.3. Pressure Vessels: ASME Boiler and Pressure Vessel Code, Section VIII.

2. Above-ground tanks used for above-grade storage of Class II or IIIA are allowed to be protected above-ground tanks or, when approved by the fire code official, other above-ground tanks that comply with Chapter 57. Tank locations shall be in accordance with Table 2306.2.3.

**Exception:** Other above-ground tanks that comply with Chapter 57 where *approved* by the *fire code official*.

3. Tanks containing fuels shall not exceed 12,000 gallons (45 420 L) in individual capacity or 48,000 gallons (181 680 L) in aggregate capacity. Installations with the maximum allowable aggregate capacity shall be separated from other such installations by not less than 100 feet (30 480 mm).

4. Tanks located at farms, construction projects or rural areas shall comply with Section 5706.2.

5. Above-ground tanks used for outdoor, above-grade storage of Class IIIB liquid motor fuel shall be *listed* and *labeled* in accordance with UL 142

TABLE 2306.2.3  
MINIMUM SEPARATION REQUIREMENTS FOR ABOVE-GROUND TANKS

TANK TYPE	INDIVIDUAL TANK CAPACITY (gallons)	MINIMUM DISTANCE FROM NEAREST IMPORTANT BUILDING ON SAME PROPERTY (feet)	MINIMUM DISTANCE FROM NEAREST FUEL DISPENSER (feet)	MINIMUM DISTANCE FROM LOT LINE THAT IS OR CAN BE BUILT ON, INCLUDING THE OPPOSITE SIDE OF A PUBLIC WAY (feet)	MINIMUM DISTANCE FROM NEAREST SIDE OF ANY PUBLIC WAY (feet)	MINIMUM DISTANCE BETWEEN TANKS (feet)
Protected above-ground tanks	Less than or equal to 6,000	5	25 <sup>a, c</sup>	15	5	3
	Greater than 6,000	15	25 <sup>a, c</sup>	25	15	3
Tanks in vaults	0–20,000	0 <sup>b</sup>	0	0 <sup>b</sup>	0	Separate compartment required for each tank
Other tanks	All	50	50	100	50	3

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

a. At fleet vehicle motor fuel-dispensing facilities, a minimum separation distance is not required.

b. Underground vaults shall be located such that they will not be subject to loading from nearby structures, or they shall be designed to accommodate applied loads from existing or future structures that can be built nearby.

c. For Class IIIB liquids in protected above-ground tanks, a minimum separation distance is not required.

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

or *listed* and *labeled* as protected above-ground tanks in accordance with UL 2085 and shall be installed in accordance with Chapter 57. Tank locations shall be in accordance with Table 2306.2.3.

**2306.2.4 Above-ground tanks located in above-grade vaults or below-grade vaults.** Above-ground tanks used for storage of Class I, II or IIIA liquid motor fuels are allowed to be installed in vaults located above grade or below grade in accordance with Section 5704.2.8 and shall comply with Sections 2306.2.4.1 and 2306.2.4.2. Tanks in above-grade vaults shall also comply with Table 2306.2.3.

**2306.2.4.1 Tank capacity limits.** Tanks storing Class I and Class II liquids at an individual site shall be limited to a maximum individual capacity of 15,000 gallons (56 775 L) and an aggregate capacity of 48,000 gallons (181 680 L).

**2306.2.4.2 Fleet vehicle motor fuel-dispensing facilities.** Tanks storing Class II and Class IIIA liquids at a fleet vehicle motor fuel-dispensing facility shall be limited to a maximum individual capacity of 20,000 gallons (75 700 L) and an aggregate capacity of 80,000 gallons (302 800 L).

**2306.2.5 Portable tanks.** Where *approved* by the *fire code official*, portable tanks are allowed to be temporarily used in conjunction with the dispensing of Class I, II or III liquids into the fuel tanks of motor vehicles or motorized equipment on premises not normally open to the public. The approval shall include a definite time limit.

**2306.2.6 Special enclosures.** Where installation of tanks in accordance with Section 5704.2.11 is impractical, or because of property or building limitations, tanks for liquid motor fuels are allowed to be installed in buildings in special enclosures in accordance with all of the following:

1. The special enclosure shall be liquid tight and vapor tight.
2. The special enclosure shall not contain backfill.
3. Sides, top and bottom of the special enclosure shall be of reinforced concrete not less than 6 inches (152 mm) thick, with openings for inspection through the top only.
4. Tank connections shall be piped or closed such that neither vapors nor liquid can escape into the enclosed space between the special enclosure and any tanks inside the special enclosure.
5. Means shall be provided whereby portable equipment can be employed to discharge to the outside any vapors that might accumulate inside the special enclosure should leakage occur.
6. Tanks containing Class I, II or IIIA liquids inside a special enclosure shall not exceed 6,000 gallons (22 710 L) in individual capacity or 18,000 gallons (68 130 L) in aggregate capacity.

7. Each tank within special enclosures shall be surrounded by a clear space of not less than 3 feet (910 mm) to allow for maintenance and inspection.

**2306.3 Security.** Above-ground tanks for the storage of liquid motor fuels shall be safeguarded from public access or unauthorized entry in an *approved* manner.

**2306.4 Physical protection.** Guard posts complying with Section 312 or other *approved* means shall be provided to protect above-ground tanks against impact by a motor vehicle unless the tank is *listed* as a protected above-ground tank with vehicle impact protection.

**2306.5 Secondary containment.** Above-ground tanks shall be provided with drainage control or diking in accordance with Chapter 57. Drainage control and diking is not required for *listed* secondary containment tanks. Secondary containment systems shall be monitored either visually or automatically. Enclosed secondary containment systems shall be provided with emergency venting in accordance with Section 2306.6.2.5.

**2306.6 Piping, valves, fittings and ancillary equipment for use with flammable or combustible liquids.** The design, fabrication, assembly, testing and inspection of piping, valves, fittings and ancillary equipment for use with *flammable* or *combustible liquids* shall be in accordance with Chapter 57 and Sections 2306.6.1 through 2306.6.3.

**2306.6.1 Protection from damage.** Piping shall be located such that it is protected from physical damage.

**2306.6.2 Piping, valves, fittings and ancillary equipment for above-ground tanks for Class I, II and III liquids.** Piping, valves, fittings and ancillary equipment for above-ground tanks storing Class I, II and III liquids shall comply with Sections 2306.6.2.1 through 2306.6.2.6.

**2306.6.2.1 Tank openings.** Tank openings for above-ground tanks shall be through the top only.

**2306.6.2.2 Fill-pipe connections.** The fill pipe for above-ground tanks shall be provided with a means for making a direct connection to the tank vehicle's fuel-delivery hose so that the delivery of fuel is not exposed to the open air during the filling operation. Where any portion of the fill pipe exterior to the tank extends below the level of the top of the tank, a check valve shall be installed in the fill pipe not more than 12 inches (305 mm) from the fill-hose connection.

**2306.6.2.3 Overfill protection.** Overfill protection shall be provided for above-ground *flammable* and *combustible liquid* storage tanks in accordance with Sections 5704.2.7.5.8 and 5704.2.9.7.5.

**2306.6.2.4 Siphon prevention.** An *approved* anti-siphon method shall be provided in the piping system to prevent flow of liquid by siphon action.

**2306.6.2.5 Emergency relief venting.** Above-ground storage tanks, tank compartments and enclosed secondary containment spaces shall be provided with

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

emergency relief venting in accordance with Chapter 57.

**2306.6.2.6 Spill containers.** A spill container having a capacity of not less than 5 gallons (19 L) shall be provided for each fill connection. For tanks with a top fill connection, spill containers shall be noncombustible and shall be fixed to the tank and equipped with a manual drain valve that drains into the primary tank. For tanks with a remote fill connection, a portable spill container is allowed.

**2306.6.3 Piping, valves, fittings and ancillary equipment for underground tanks.** Piping, valves, fittings and ancillary equipment for underground tanks shall comply with Chapter 57 and NFPA 30A.

**2306.7 Fuel-dispensing systems for flammable or combustible liquids.** The design, fabrication and installation of fuel-dispensing systems for *flammable* or *combustible liquid* fuels shall be in accordance with Sections 2306.7.1 through 2306.7.9.2.4. Alcohol-blended fuel-dispensing systems shall also comply with Section 2306.8.

**2306.7.1 Listed equipment.** Electrical equipment, dispensers, hose, nozzles and submersible or subsurface pumps used in fuel-dispensing systems shall be *listed*.

**2306.7.2 Fixed pumps required.** Class I and II liquids shall be transferred from tanks by means of fixed pumps designed and equipped to allow control of the flow and prevent leakage or accidental discharge.

**2306.7.3 Mounting of dispensers.** Dispensing devices, except those installed on top of a protected above-ground tank that qualifies as vehicle-impact resistant, shall be protected against physical damage by mounting on a concrete island 6 inches (152 mm) or more in height, or shall be protected in accordance with Section 312. Dispensing devices shall be installed and securely fastened to their mounting surface in accordance with the dispenser manufacturer's instructions. Dispensing devices installed indoors shall be located in an *approved* position where they cannot be struck by an out-of-control vehicle descending a ramp or other slope.

**2306.7.3.1 Additional impact protection.** The *fire code official* is authorized to require additional impact protection in accordance with Section 312 where dispensing devices are located in areas near parking areas, multiple dispensing devices, highway on- and off-ramps, and other areas where there is a higher potential for vehicle impacts.

**2306.7.4 Dispenser emergency shutoff valve.** An *approved* automatic emergency shutoff valve designed to close in the event of a fire or impact shall be properly installed in the liquid supply line at the base of each dispenser supplied by a remote pump. The valve shall be installed so that the shear groove is flush with or within  $\frac{1}{2}$  inch (12.7 mm) of the top of the concrete dispenser island and there is clearance provided for maintenance purposes around the valve body and operating parts. The valve shall be installed at the liquid supply line inlet of each overhead-type dispenser. Where installed, a vapor return

line located inside the dispenser housing shall have a shear section or *approved* flexible connector for the liquid supply line emergency shutoff valve to function. Emergency shutoff valves shall be installed and maintained in accordance with the manufacturer's instructions, tested at the time of initial installation and not less than yearly thereafter in accordance with Section 2305.2.4.

**2306.7.5 Dispenser hose.** Dispenser hoses shall be not more than 18 feet (5486 mm) in length unless otherwise *approved*. Dispenser hoses shall be *listed* and *approved*. When not in use, hoses shall be reeled, racked or otherwise protected from damage.

**2306.7.5.1 Emergency breakaway devices.** Dispenser hoses for Class I and II liquids shall be equipped with a *listed* emergency breakaway device designed to retain liquid on both sides of a breakaway point. Such devices shall be installed and maintained in accordance with the manufacturer's instructions. Where hoses are attached to hose-retrieving mechanisms, the emergency breakaway device shall be located between the hose nozzle and the point of attachment of the hose-retrieval mechanism to the hose.

**2306.7.6 Fuel delivery nozzles.** A *listed* automatic-closing-type hose nozzle valve with or without a latch-open device shall be provided on island-type dispensers used for dispensing Class I, II or III liquids.

Overhead-type dispensing units shall be provided with a *listed* automatic-closing-type hose nozzle valve without a latch-open device.

**Exception:** A *listed* automatic-closing-type hose nozzle valve with latch-open device is allowed to be used on overhead-type dispensing units where the design of the system is such that the hose nozzle valve will close automatically in the event the valve is released from a fill opening or upon impact with a driveway.

**2306.7.6.1 Special requirements for nozzles.** Where dispensing of Class I, II or III liquids is performed, a *listed* automatic-closing-type hose nozzle valve shall be used incorporating all of the following features:

1. The hose nozzle valve shall be equipped with an integral latch-open device.
2. Where the flow of product is normally controlled by devices or equipment other than the hose nozzle valve, the hose nozzle valve shall not be capable of being opened unless the delivery hose is pressurized. If pressure to the hose is lost, the nozzle shall close automatically.

**Exception:** Vapor recovery nozzles incorporating insertion interlock devices designed to achieve shutoff on disconnect from the vehicle fill pipe.

3. The hose nozzle shall be designed such that the nozzle is retained in the fill pipe during the filling operation.



4. The system shall include *listed* equipment with a feature that causes or requires the closing of the hose nozzle valve before the product flow can be resumed or before the hose nozzle valve can be replaced in its normal position in the dispenser.

**2306.7.7 Remote pumping systems.** Remote pumping systems for liquid fuels shall comply with Sections 2306.7.7.1 and 2306.7.7.2.

**2306.7.7.1 Leak detection.** Where remote pumps are used to supply fuel dispensers, each pump shall have installed on the discharge side a *listed* leak detection device that will detect a leak in the piping and dispensers and provide an indication. A leak detection device is not required if the piping from the pump discharge to under the dispenser is above ground and visible.

**2306.7.7.2 Location.** Remote pumps installed above grade, outside of buildings, shall be located not less than 10 feet (3048 mm) from lines of adjoining property that can be built on and not less than 5 feet (1524 mm) from any building opening. Where an outside pump location is impractical, pumps are permitted to be installed inside buildings as provided for dispensers in Section 2301.4 and Chapter 57. Pumps shall be substantially anchored and protected against physical damage.

**2306.7.8 Gravity and pressure dispensing.** *Flammable liquids* shall not be dispensed by gravity from tanks, drums, barrels or similar containers. *Flammable* or *combustible liquids* shall not be dispensed by a device operating through pressure within a storage tank, drum or container.

**2306.7.9 Vapor-recovery and vapor-processing systems.** Vapor-recovery and vapor-processing systems shall be in accordance with Sections 2306.7.9.1 through 2306.7.9.2.4.

**2306.7.9.1 Vapor-balance systems.** Vapor-balance systems shall comply with Sections 2306.7.9.1.1 through 2306.7.9.1.5.

**2306.7.9.1.1 Dispensing devices.** Dispensing devices incorporating provisions for vapor recovery shall be *listed* and *labeled*. Where existing *listed* or *labeled* dispensing devices are modified for vapor recovery, such modifications shall be *listed* by report by a nationally recognized testing laboratory. The listing by report shall contain a description of the component parts used in the modification and recommended method of installation on specific dispensers. Such report shall be made available on request of the *fire code official*.

Means shall be provided to shut down fuel dispensing in the event the vapor return line becomes blocked.

**2306.7.9.1.2 Vapor-return line closeoff.** An acceptable method shall be provided to close off the vapor return line from dispensers when the product is not being dispensed.

**2306.7.9.1.3 Piping.** Piping in vapor-balance systems shall be in accordance with Sections 5703.6, 5704.2.9 and 5704.2.11. Nonmetallic piping shall be installed in accordance with the manufacturer's instructions.

Existing and new vent piping shall be in accordance with Sections 5703.6 and 5704.2. Vapor return piping shall be installed in a manner that drains back to the tank, without sags or traps in which liquid can become trapped. If necessary, because of grade, condensate tanks are allowed in vapor return piping. Condensate tanks shall be designed and installed so that they can be drained without opening.

**2306.7.9.1.4 Flexible joints and shear joints.** Flexible joints shall be installed in accordance with Section 5703.6.9.

An *approved* shear joint shall be rigidly mounted and connected by a union in the vapor return piping at the base of each dispensing device. The shear joint shall be mounted flush with the top of the surface on which the dispenser is mounted.

**2306.7.9.1.5 Testing.** Vapor return lines and vent piping shall be tested in accordance with Section 5703.6.3.

**2306.7.9.2 Vapor-processing systems.** Vapor-processing systems shall comply with Sections 2306.7.9.2.1 through 2306.7.9.2.4.

**2306.7.9.2.1 Equipment.** Equipment in vapor-processing systems, including hose nozzle valves, vapor pumps, flame arresters, fire checks or systems for prevention of flame propagation, controls and vapor-processing equipment, shall be individually *listed* for the intended use in a specified manner.

Vapor-processing systems that introduce air into the underground piping or storage tanks shall be provided with equipment for prevention of flame propagation that has been tested and *listed* as suitable for the intended use.

**2306.7.9.2.2 Location.** Vapor-processing equipment shall be located at or above grade. Sources of ignition shall be located not less than 50 feet (15 240 mm) from fuel-transfer areas and not less than 18 inches (457 mm) above tank fill openings and tops of dispenser islands. Vapor-processing units shall be located not less than 10 feet (3048 mm) from the nearest building or *lot line* of a property that can be built on.

**Exception:** Where the required distances to buildings, *lot lines* or fuel-transfer areas cannot be obtained, means shall be provided to protect equipment against fire exposure. Acceptable means shall include but not be limited to either of the following:

1. *Approved* protective enclosures, which extend not less than 18 inches (457 mm)



## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

above the equipment, constructed of fire-resistant or noncombustible materials.

2. Fire protection using an *approved* water-spray system.

**2306.7.9.2.2.1 Distance from dispensing devices.** Vapor-processing equipment shall be located not less than 20 feet (6096 mm) from dispensing devices.

**2306.7.9.2.2.2 Physical protection.** Vapor-processing equipment shall be protected against physical damage by guardrails, curbs, protective enclosures or fencing. Where *approved* protective enclosures are used, *approved* means shall be provided to ventilate the volume within the enclosure to prevent pocketing of flammable vapors.

**2306.7.9.2.2.3 Downslopes.** Where a downslope exists toward the location of the vapor-processing unit from a fuel-transfer area, the *fire code official* is authorized to require additional separation by distance and height.

**2306.7.9.2.3 Installation.** Vapor-processing units shall be securely mounted on concrete, masonry or structural steel supports on concrete or other noncombustible foundations. Vapor-recovery and vapor-processing equipment is allowed to be installed on roofs where *approved*.

**2306.7.9.2.4 Piping.** Piping in a mechanical-assist system shall be in accordance with Section 5703.6.

**2306.8 Alcohol-blended fuel-dispensing operations.** The design, fabrication and installation of *alcohol-blended fuel*-dispensing systems shall be in accordance with Section 2306.7 and Sections 2306.8.1 through 2306.8.6.

**2306.8.1 Listed equipment.** Dispensers shall be *listed* in accordance with UL 87A. Hoses, nozzles, breakaway fittings, swivels, flexible connectors or dispenser emergency shutoff valves, vapor recovery systems, leak detection devices and pumps used in alcohol-blended fuel-dispensing systems shall be *listed* for the specific purpose.

**2306.8.2 Compatibility.** Dispensers shall be used only with the fuels for which they have been *listed* and that are marked on the product. Field-installed components including hose assemblies, breakaway fittings, swivel connectors and hose nozzle valves shall be provided in accordance with the listing and the marking on the unit.

**2306.8.3 Change of system contents.** Fuel-dispensing systems subject to change in contents from gasoline to alcohol-blended fuels shall be subject to *fire code official* review and approval prior to commencing dispensing operations.

**2306.8.4 Facility identification.** Facilities dispensing alcohol-blended fuels shall be identified by an *approved* means.

**2306.8.5 Marking.** Dispensers shall be marked in an *approved* manner to identify the types of *alcohol-blended fuels* to be dispensed.

**2306.8.6 Maintenance and inspection.** Equipment shall be maintained and inspected in accordance with Section 2305.2.

## SECTION 2307 LIQUEFIED PETROLEUM GAS MOTOR FUEL-DISPENSING FACILITIES

**2307.1 General.** Motor fuel-dispensing facilities for liquefied petroleum gas (LP-gas) fuel shall be in accordance with this section and Chapter 61.

**2307.2 Approvals.** Storage vessels and equipment used for the storage or dispensing of LP-gas shall be *approved* or *listed* in accordance with Sections 2307.2.1 and 2307.2.2.

**2307.2.1 Approved equipment.** Containers, pressure relief devices (including pressure relief valves), pressure regulators and piping for LP-gas shall be *approved*.

**2307.2.2 Listed equipment.** Hoses, hose connections, vehicle fuel connections, dispensers, LP-gas pumps and electrical equipment used for LP-gas shall be *listed*.

**2307.3 Attendants.** Motor fuel-dispensing operations for LP-gas shall be conducted by qualified attendants or in accordance with Section 2307.7 by persons trained in the proper handling of LP-gas.

**2307.4 Location of dispensing operations and equipment.** The point of transfer for LP-gas dispensing operations shall be separated from buildings and other exposures in accordance with the following:

1. Not less than 25 feet (7620 mm) from buildings where the *exterior wall* is not part of a *fire-resistance-rated* assembly having a rating of 1 hour or greater.
2. Not less than 25 feet (7620 mm) from combustible overhangs on buildings, measured from a vertical line dropped from the face of the overhang at a point nearest the point of transfer.
3. Not less than 25 feet (7620 mm) from the *lot line* of property that can be built on.
4. Not less than 25 feet (7620 mm) from the centerline of the nearest mainline railroad track.
5. Not less than 10 feet (3048 mm) from public streets, highways, thoroughfares, sidewalks and driveways.
6. Not less than 10 feet (3048 mm) from buildings where the *exterior wall* is part of a *fire-resistance-rated* assembly having a rating of 1 hour or greater.

**Exception:** The point of transfer for LP-gas dispensing operations need not be separated from canopies that are constructed in accordance with the *International Building Code* and that provide weather protection for the dispensing equipment.

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

LP-gas containers shall be located in accordance with Chapter 61. LP-gas storage and dispensing equipment shall be located outdoors.

**2307.5 Additional requirements for LP-gas dispensers and equipment.** LP-gas dispensers and related equipment shall comply with the following provisions:

1. Pumps shall be fixed in place and shall be designed to allow control of the flow and to prevent leakage and accidental discharge.
2. Dispensing devices installed within 10 feet (3048 mm) of where vehicle traffic occurs shall be protected against physical damage by mounting on a concrete island 6 inches (152 mm) or more in height, or shall be protected in accordance with Section 312.
3. Dispensing devices shall be securely fastened to their mounting surface in accordance with the dispenser manufacturer's instructions.

**2307.6 Installation of LP-gas dispensing devices and equipment.** The installation and operation of LP-gas dispensing systems shall be in accordance with Sections 2307.6.1 through 2307.6.4 and Chapter 61. LP-gas dispensers and dispensing stations shall be installed in accordance with the manufacturer's specifications and their listing.

**2307.6.1 Product control valves.** The dispenser system piping shall be protected from uncontrolled discharge in accordance with the following:

1. Where mounted on a concrete base, a means shall be provided and installed within  $\frac{1}{2}$  inch (12.7 mm) of the top of the concrete base that will prevent flow from the supply piping in the event that the dispenser is displaced from its mounting.
2. A manual shutoff valve and an excess flow-control check valve shall be located in the liquid line between the pump and the dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.
3. An excess flow-control check valve or an emergency shutoff valve shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping.
4. A *listed* automatic-closing type hose nozzle valve with or without a latch-open device shall be provided on island-type dispensers.

**2307.6.2 Hoses.** Hoses and piping for the dispensing of LP-gas shall be provided with hydrostatic relief valves. The hose length shall not exceed 18 feet (5486 mm). An *approved* method shall be provided to protect the hose against mechanical damage.

**2307.6.3 Emergency breakaway devices.** Dispenser hoses shall be equipped with a *listed* emergency breakaway device designed to retain liquid on both sides of the breakaway point. Where hoses are attached to hose-retrieving mechanisms, the emergency breakaway device

shall be located such that the breakaway device activates to protect the dispenser from being displaced.

**2307.6.4 Vehicle impact protection.** Where installed within 10 feet of vehicle traffic, LP-gas storage containers, pumps and dispensers shall be protected in accordance with Section 2307.5, Item 2.

**2307.7 Public fueling of motor vehicles.** Self-service LP-gas dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted containers providing fuel to the LP-gas powered vehicle.

The requirements for self-service LP-gas dispensing systems shall be in accordance with the following:

1. The arrangement and operation of the transfer of product into a vehicle shall be in accordance with this section and Chapter 61.
2. The system shall be provided with an emergency shutoff switch located within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, dispensers.
3. The *owner* of the LP-gas motor fuel-dispensing facility or the *owner's* designee shall provide for the safe operation of the system and the training of users.
4. The dispenser and hose-end valve shall release not more than  $\frac{1}{8}$  fluid ounce (4 cc) of liquid to the atmosphere upon breaking the connection with the fill valve on the vehicle.
5. Portable fire extinguishers shall be provided in accordance with Section 2305.5.
6. Warning signs shall be provided in accordance with Section 2305.6.
7. The area around the dispenser shall be maintained in accordance with Section 2305.7.

**2307.8 Overfilling.** LP-gas containers shall not be filled with LP-gas in excess of the volume determined using the fixed maximum liquid level gauge installed on the container, the volume determined by the overfilling prevention device installed on the container or the weight determined by the required percentage of the water capacity marked on the container.

## SECTION 2308 COMPRESSED NATURAL GAS MOTOR FUEL-DISPENSING FACILITIES

**2308.1 General.** Motor fuel-dispensing facilities for compressed natural gas (CNG) fuel shall be in accordance with this section, Chapter 53 and Section 413 of the *International Fuel Gas Code*.

**2308.2 Approvals.** Storage vessels and equipment used for the storage, compression or dispensing of CNG shall be *approved* or *listed* in accordance with Sections 2308.2.1 through 2308.2.4.

**2308.2.1 Approved equipment.** Containers, compressors, pressure relief devices (including pressure relief

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

valves), and pressure regulators and piping used for CNG shall be *approved*.

**2308.2.2 Listed equipment.** Hoses, hose connections, dispensers and electrical equipment used for CNG shall be *listed*. Vehicle-fueling connections shall be *listed* and *labeled*.

**2308.2.3 Residential fueling appliance (RFA).** Residential fueling appliances shall be *listed* and installed in accordance with the installation requirements of CSA/ANSI NGV 5.1, manufacturer's installation instructions and Section 413 of the *International Fuel Gas Code*. The capacity of an RFA shall not exceed 5 cubic feet per minute (0.14 m<sup>3</sup>/min) of natural gas.

**2308.2.4 Vehicle fueling appliance (VFA).** Nonresidential fueling appliances shall be *listed* and installed in accordance with the installation requirements of CSA/ANSI NGV 5.2, manufacturer's installation instructions and the requirements of Section 413 of the *International Fuel Gas Code* for VFAs. The capacity of the VFA shall not exceed 10 cubic feet per minute (0.28 m<sup>3</sup>/min) of natural gas.

**2308.3 Location of dispensing operations and equipment.** Compression, storage and dispensing equipment shall be located above ground, outdoors.

### Exceptions:

1. Compression, storage or dispensing equipment shall be allowed in buildings of noncombustible construction, as set forth in the *International Building Code*, that are unenclosed for three-quarters or more of the perimeter.
2. Compression, storage and dispensing equipment shall be allowed indoors or in vaults in accordance with Chapter 53.

**2308.3.1 Location on property.** In addition to the requirements of Section 2303.1, compression, storage and dispensing equipment not located in vaults complying with Chapter 53 shall be installed as follows:

1. Not beneath power lines.
2. Ten feet (3048 mm) or more from the nearest building or *lot line* that could be built on, public street, sidewalk or source of ignition.

**Exception:** Dispensing equipment need not be separated from canopies that are constructed in accordance with the *International Building Code* and that provide weather protection for the dispensing equipment.

3. Twenty-five feet (7620 mm) or more from the nearest rail of any railroad track and 50 feet (15 240 mm) or more from the nearest rail of any railroad main track or any railroad or transit line where power for train propulsion is provided by an outside electrical source, such as third rail or overhead catenary.
4. Fifty feet (15 240 mm) or more from the vertical plane below the nearest overhead wire of a trolley bus line.

**2308.4 Private fueling of motor vehicles.** Self-service CNG-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted fuel containers on CNG-powered vehicles.

In addition to the requirements in Section 2305, the *owner* of a self-service CNG motor fuel-dispensing facility shall ensure the safe operation of the system and the training of users.

**2308.5 Pressure regulators.** Pressure regulators shall be designed and installed or protected so that their operation will not be affected by the elements (freezing rain, sleet, snow or ice), mud or debris. The protection is allowed to be an integral part of the regulator.

**2308.6 Valves.** Gas piping to equipment shall be provided with a remote, manual shutoff valve that is provided with *ready access*.

**2308.7 Emergency shutdown control.** An emergency shutdown control shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and shall be provided in the compressor area. Upon activation, the emergency shutdown system shall automatically shut off the power supply to the compressor and close valves between the main gas supply and the compressor and between the storage containers and dispensers.

**2308.8 Discharge of CNG from motor vehicle fuel storage containers.** The discharge of CNG from motor vehicle fuel cylinders for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with Sections 2308.8.1 through 2308.8.1.2.6.

**2308.8.1 Methods of discharge.** The discharge of CNG from motor vehicle fuel cylinders shall be accomplished through a closed transfer system in accordance with Section 2308.8.1.1 or an *approved* method of atmospheric venting in accordance with Section 2308.8.1.2.

**2308.8.1.1 Closed transfer system.** A documented procedure that explains the logical sequence for discharging the cylinder shall be provided to the *fire code official* for review and approval. The procedure shall include what actions the operator will take in the event of a low-pressure or high-pressure natural gas release during the discharging activity. A drawing illustrating the arrangement of piping, regulators and equipment settings shall be provided to the *fire code official* for review and approval. The drawing shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

**2308.8.1.2 Atmospheric venting.** Atmospheric venting of CNG shall comply with Sections 2308.8.1.2.1 through 2308.8.1.2.6.

**2308.8.1.2.1 Plans and specifications.** A drawing illustrating the location of the vessel support, piping, the method of grounding and bonding, and other requirements specified herein shall be provided to the *fire code official* for review and approval.



**2308.8.1.2.2 Cylinder stability.** A method of rigidly supporting the vessel during the venting of CNG shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel's rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials.

**2308.8.1.2.3 Separation.** The structure or appurtenance used for stabilizing the cylinder shall be separated from the site equipment, features and exposures and shall be located in accordance with Table 2308.8.1.2.3.

**TABLE 2308.8.1.2.3  
SEPARATION DISTANCE FOR ATMOSPHERIC VENTING OF CNG**

EQUIPMENT OR FEATURE	MINIMUM SEPARATION (feet)
Buildings	25
Building openings	25
CNG compressor and storage vessels	25
CNG dispensers	25
Lot lines	15
Public ways	15
Vehicles	25

For SI: 1 foot = 304.8 mm.

**2308.8.1.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with NFPA 70. The cylinder valve shall be bonded prior to the commencement of venting operations.

**2308.8.1.2.5 Vent tube.** A vent tube that will divert the gas flow to the atmosphere shall be installed on the cylinder prior to commencement of the venting and purging operation. The vent tube shall be constructed of pipe or tubing materials *approved* for use with CNG in accordance with Chapter 53.

The vent tube shall be capable of dispersing the gas not less than 10 feet (3048 mm) above grade level. The vent tube shall not be provided with a rain cap or other feature that would limit or obstruct the gas flow.

At the connection fitting of the vent tube and the CNG cylinder, a *listed* bidirectional detonation flame arrester shall be provided.

**2308.8.1.2.6 Signage.** *Approved* "No Smoking" signs complying with Section 310 shall be posted within 10 feet (3048 mm) of the cylinder support structure or appurtenance. *Approved* "Cylinder Shall Be Bonded" signs shall be posted on the cylinder support structure or appurtenance.

## SECTION 2309 HYDROGEN MOTOR FUEL-DISPENSING AND GENERATION FACILITIES

**2309.1 General.** Hydrogen motor fuel-dispensing and generation facilities shall be in accordance with this section, Chapter 58 and NFPA 2. Where a fuel-dispensing facility includes a repair garage, the repair operation shall comply with Section 2311.

**2309.2 Equipment.** Equipment used for the generation, compression, storage or dispensing of hydrogen shall be designed for the specific application in accordance with Sections 2309.2.1 through 2309.2.3.

**2309.2.1 Approved equipment.** Cylinders, containers and tanks; pressure relief devices, including pressure valves; hydrogen vaporizers; pressure regulators; and piping used for gaseous hydrogen systems shall be designed and constructed in accordance with Chapters 53, 55 and 58.

**2309.2.2 Listed or approved equipment.** Hoses, hose connections, compressors, hydrogen generators, dispensers, motor-fueling connections and electrical equipment used for hydrogen shall be *listed* or *approved* for use with hydrogen.

**2309.2.3 Electrical equipment.** Electrical installations shall be in accordance with NFPA 70.

**2309.3 Location on property.** In addition to the requirements of Section 2303.1, dispensing equipment shall be located in accordance with Sections 2309.3.1 through Section 2309.3.2.

**2309.3.1 Location of operations and equipment.** Generation, compression, storage and dispensing equipment shall be located in accordance with Sections 2309.3.1.1 through 2309.3.1.5.5.

**2309.3.1.1 Outdoors.** Generation, compression or storage equipment shall be allowed outdoors in accordance with Chapter 58 and NFPA 2.

**2309.3.1.2 Indoors.** Generation, compression, storage and dispensing equipment shall be located in indoor rooms or areas constructed in accordance with the requirements of the *International Building Code*, the *International Fuel Gas Code*, the *International Mechanical Code* and NFPA 2.

**2309.3.1.2.1 Maintenance.** Gaseous hydrogen systems and detection devices shall be maintained in accordance with the manufacturer's instructions.

**2309.3.1.2.2 Smoking.** Smoking shall be prohibited in hydrogen cutoff rooms. "No Smoking" signs shall be provided at all entrances to hydrogen fuel gas rooms.

**2309.3.1.2.3 Ignition source control.** Open flames, flame-producing devices and other sources of ignition shall be controlled in accordance with Chapter 58.



## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

**2309.3.1.2.4 Housekeeping.** Hydrogen fuel gas rooms shall be kept free from combustible debris and storage.

**2309.3.1.3 Gaseous hydrogen storage.** Storage of gaseous hydrogen shall be in accordance with Chapters 53 and 58.

**2309.3.1.4 Liquefied hydrogen storage.** Storage of liquefied hydrogen shall be in accordance with Chapters 55 and 58.

**2309.3.1.5 Canopy tops.** Gaseous hydrogen compression and storage equipment located on top of motor fuel-dispensing facility canopies shall be in accordance with Sections 2309.3.1.5.1 through 2309.3.1.5.5, Chapters 53 and 58, and the *International Fuel Gas Code*.

**2309.3.1.5.1 Construction.** Canopies shall be constructed in accordance with the motor fuel-dispensing facility canopy requirements of Section 406.7 of the *International Building Code*.

**2309.3.1.5.2 Fire-extinguishing systems.** Fuel-dispensing areas under canopies shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The design of the sprinkler system shall be not less than that required for Extra Hazard Group 2 occupancies. Operation of the sprinkler system shall activate the emergency functions of Sections 2309.3.1.5.3 and 2309.3.1.5.4.

**2309.3.1.5.3 Emergency discharge.** Operation of the *automatic sprinkler system* shall activate an automatic emergency discharge system, which will discharge the hydrogen gas from the equipment on the canopy top through the vent pipe system.

**2309.3.1.5.4 Emergency shutdown control.** Operation of the *automatic sprinkler system* shall activate the emergency shutdown control required by Section 2309.5.3.

**2309.3.1.5.5 Signage.** *Approved* signage having 2-inch (51 mm) block letters shall be affixed at *approved* locations on the exterior of the canopy structure stating: "CANOPY TOP HYDROGEN STORAGE."

**2309.3.2 Canopies.** Dispensing equipment need not be separated from canopies of Type I or II construction that are constructed in a manner that prevents the accumulation of hydrogen gas and in accordance with Section 406.7 of the *International Building Code*.

**2309.4 Dispensing into motor vehicles at hydrogen motor fuel-dispensing facilities.** Hydrogen motor fuel-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted motor vehicle fuel tanks on hydrogen-powered vehicles.

In addition to the requirements in Section 2311, the *owner* of a hydrogen motor fuel-dispensing facility shall provide for the safe operation of the system by complying with this

code and the fueling protocols in NFPA 2 and through the institution of a fire safety plan submitted in accordance with Section 404, the training of employees and operators who use and maintain the system in accordance with Section 406, and provisions for hazard communication in accordance with Section 407.

**Exception:** Filling of nonpermanently mounted storage containers or tanks for motor fuel-dispensing system testing purposes is permitted.

**2309.4.1 Dispensing systems.** Dispensing systems shall be equipped with an overpressure protection device set at not greater than 140 percent of the service pressure of the fueling nozzle it supplies.

**2309.5 Safety precautions.** Safety precautions at hydrogen motor fuel-dispensing and generation facilities shall be in accordance with Sections 2309.5.1 through 2309.5.3.1.

**2309.5.1 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect hydrogen storage systems and use areas subject to vehicular damage in accordance with Section 312.

**2309.5.1.1 Vehicle fueling pad.** The vehicle shall be fueled on noncoated concrete or other *approved* paving material having a resistance not exceeding 1 megohm as determined by the methodology specified in EN 1081.

**2309.5.2 Emergency shutoff valves.** A manual emergency shutoff valve shall be provided to shut down the flow of gas from the hydrogen supply to the piping system.

**2309.5.2.1 Identification.** Manual emergency shutoff valves shall be identified and the location shall be clearly visible, accessible and indicated by means of a sign.

**2309.5.3 Emergency shutdown controls.** In addition to the manual emergency shutoff valve required by Section 2309.5.2, a remotely located, manually activated emergency shutdown control shall be provided. An emergency shutdown control shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and hydrogen generators.

**2309.5.3.1 System requirements.** Activation of the emergency shutdown control shall automatically shut off the power supply to all hydrogen storage, compression and dispensing equipment; shut off natural gas or other fuel supply to the hydrogen generator; and close valves between the main supply and the compressor and between the storage containers and dispensing equipment.

**2309.6 Repairs, purging, defueling and discharge.** The repair, purging, defueling or discharge activities associated with hydrogen motor fuel-dispensing and generation systems, storage tanks and the installation of the systems shall be in accordance with Chapters 53 and 58 and NFPA 2.

**Exception:** The motor vehicle fuel tank and the fuel supply piping from the motor vehicle fuel tank to the engine compartment on a motor vehicle or forklift unless

the fuel tank is required to be defueled in accordance with Section 2311.8.11.

**2309.6.1 Documented procedure.** A documented procedure that explains the logic sequence for defueling or discharging operations shall be maintained on-site and shall be provided to the *fire code official* upon request. The procedure shall include what actions the operator is required to take in the event of a low-pressure or high-pressure hydrogen release during discharging activity. Schematic design documents shall be maintained on-site, illustrating the arrangement of piping, regulators and equipment settings. The schematic shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the vehicle being defueled and, if applicable, to the compressor, storage vessels and emergency shutdown devices.

## SECTION 2310 MARINE MOTOR FUEL-DISPENSING FACILITIES

**2310.1 General.** The construction of marine motor fuel-dispensing facilities shall be in accordance with the *International Building Code* and NFPA 30A. The storage of Class I, II or IIIA liquids at marine motor fuel-dispensing facilities shall be in accordance with this chapter and Chapter 57.

**2310.2 Storage and handling.** The storage and handling of Class I, II or IIIA liquids at marine motor fuel-dispensing facilities shall be in accordance with Sections 2310.2.1 through 2310.2.3.

**2310.2.1 Class I, II or IIIA liquid storage.** Class I, II or IIIA liquids stored inside buildings used for marine motor fuel-dispensing facilities shall be stored in *approved* containers or portable tanks. Storage of Class I liquids shall not exceed 10 gallons (38 L).

**Exception:** Storage in liquid storage rooms in accordance with Section 5704.3.7.

**2310.2.2 Class II or IIIA liquid storage and dispensing.** Class II or IIIA liquids stored or dispensed inside buildings used for marine motor fuel-dispensing facilities shall be stored in and dispensed from *approved* containers or portable tanks. Storage of Class II and IIIA liquids shall not exceed 120 gallons (454 L).

**2310.2.3 Heating equipment.** Heating equipment installed in Class I, II or IIIA liquid storage or dispensing areas shall comply with Section 2301.6.

**2310.3 Dispensing.** The dispensing of liquid fuels at marine motor fuel-dispensing facilities shall comply with Sections 2310.3.1 through 2310.3.5.

**2310.3.1 General.** Wharves, piers or floats at marine motor fuel-dispensing facilities shall be used exclusively for the dispensing or transfer of petroleum products to or from marine craft, except that transfer of essential ship stores is allowed.

**2310.3.2 Supervision.** Marine motor fuel-dispensing facilities shall have an attendant or supervisor who is fully aware of the operation, mechanics and hazards inherent to fueling of boats on duty whenever the facility

is open for business. The attendant's primary function shall be to supervise, observe and control the dispensing of Class I, II or IIIA liquids or flammable gases.

**2310.3.3 Hoses and nozzles.** Dispensing of Class I, II or IIIA liquids into the fuel tanks of marine craft shall be by means of an *approved*-type hose equipped with a *listed* automatic-closing nozzle without a latch-open device.

Hoses used for dispensing or transferring Class I, II or IIIA liquids, when not in use, shall be reeled, racked or otherwise protected from mechanical damage.

**2310.3.4 Portable containers.** Dispensing of Class I, II or IIIA liquids into containers, other than fuel tanks, shall be in accordance with Section 2304.4.1.

**2310.3.5 Liquefied petroleum gas.** Liquefied petroleum gas cylinders shall not be filled at *marine motor fuel-dispensing facilities* unless *approved*. *Approved* storage facilities for LP-gas cylinders shall be provided. See also Section 2307.

**2310.4 Fueling of marine vehicles at other than approved marine motor fuel-dispensing facilities.** Fueling of floating marine craft at other than a marine motor fuel-dispensing facility shall comply with Sections 2310.4.1 and 2310.4.2.

**2310.4.1 Class I liquid fuels.** Fueling of floating marine craft with Class I fuels at other than a marine motor fuel-dispensing facility is prohibited.

**2310.4.2 Class II or III liquid fuels.** Fueling of floating marine craft with Class II or III fuels at other than a marine motor fuel-dispensing facility shall be in accordance with all of the following:

1. The premises and operations shall be *approved* by the *fire code official*.
2. Tank vehicles and fueling operations shall comply with Section 5706.6.
3. The dispensing nozzle shall be of the *listed* automatic-closing type without a latch-open device.
4. Nighttime deliveries shall be made only in lighted areas.
5. The tank vehicle flasher lights shall be in operation while dispensing.
6. Fuel expansion space shall be left in each fuel tank to prevent overflow in the event of temperature increase.

**2310.5 Fire prevention regulations.** General fire safety regulations for marine motor fuel-dispensing facilities shall comply with Sections 2310.5.1 through 2310.5.7.

**2310.5.1 Housekeeping.** Marine motor fuel-dispensing facilities shall be maintained in a neat and orderly manner. Accumulations of rubbish or waste oils in excessive amounts shall be prohibited.

**2310.5.2 Spills.** Spills of Class I, II or IIIA liquids at or on the water shall be reported immediately to the fire department and jurisdictional authorities.

**2310.5.3 Rubbish containers.** Containers with tight-fitting or self-closing lids shall be provided for temporary

## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

storage of combustible debris, rubbish and waste material. The rubbish containers shall be constructed entirely of materials that comply with any one of the following:

1. Noncombustible materials.
2. Materials that meet a peak rate of heat release not exceeding  $300 \text{ kW/m}^2$  when tested in accordance with ASTM E1354 at an incident heat flux of  $50 \text{ kW/m}^2$  in the horizontal orientation.

**2310.5.4 Marine vessels and craft.** Vessels or craft shall not be made fast to fuel docks serving other vessels or craft occupying a berth at a marine motor fuel-dispensing facility.

**2310.5.5 Sources of ignition.** Construction, maintenance, repair and reconditioning work involving the use of open flames, arcs or spark-producing devices shall not be performed at marine motor fuel-dispensing facilities or within 50 feet (15 240 mm) of the dispensing facilities, including piers, wharves or floats, except for emergency repair work *approved* in writing by the *fire code official*. Fueling shall not be conducted at the pier, wharf or float during the course of such emergency repairs.

**2310.5.5.1 Smoking.** Smoking or open flames shall be prohibited within 50 feet (15 240 mm) of fueling operations. “No Smoking” signs complying with Section 310 shall be posted conspicuously about the premises. Such signs shall have letters not less than 4 inches (102 mm) in height on a background of contrasting color.

**2310.5.6 Preparation of tanks for fueling.** Boat owners and operators shall not offer their craft for fueling unless the tanks being filled are properly vented to dissipate fumes to the outside atmosphere.

**2310.5.7 Warning signs.** Warning signs shall be prominently displayed at the face of each wharf, pier or float at such elevation as to be clearly visible from the decks of marine craft being fueled. Such signs shall have letters not less than 3 inches (76 mm) in height on a background of contrasting color bearing the following or *approved* equivalent wording:

### WARNING

NO SMOKING—STOP ENGINE WHILE FUELING,  
SHUT OFF ELECTRICITY

DO NOT START ENGINE UNTIL AFTER BELOW  
DECK SPACES ARE VENTILATED.

**2310.6 Fire protection.** Fire protection features for marine motor fuel-dispensing facilities shall comply with Sections 2310.6.1 through 2310.6.4.

**2310.6.1 Standpipe hose stations.** Fire hose, where provided, shall be enclosed within a cabinet, and hose stations shall be labeled: “FIRE HOSE—EMERGENCY USE ONLY.”

**2310.6.2 Obstruction of fire protection equipment.** Materials shall not be placed on a pier in such a manner as to obstruct access to fire-fighting equipment or piping system control valves.

**2310.6.3 Access.** Where the pier is designed for vehicular traffic, an unobstructed roadway to the shore end of the wharf shall be maintained for access by fire apparatus.

**2310.6.4 Portable fire extinguishers.** Portable fire extinguishers in accordance with Section 906, each having a minimum rating of 20-B:C, shall be provided as follows:

1. One on each float.
2. One on the pier or wharf within 25 feet (7620 mm) of the head of the gangway to the float, unless the office is within 25 feet (7620 mm) of the gangway or is on the float and an extinguisher is provided thereon.

## SECTION 2311 REPAIR GARAGES

**2311.1 General.** Repair garages shall comply with this section and the *International Building Code*. Repair garages for vehicles that use more than one type of fuel shall comply with the applicable provisions of this section for each type of fuel used.

Where a repair garage includes a motor fuel-dispensing facility, the fuel-dispensing operation shall comply with the requirements of this chapter for motor fuel-dispensing facilities.

**2311.2 Storage and use of flammable and combustible liquids.** The storage and use of *flammable* and *combustible liquids* in repair garages shall comply with Chapter 57 and Sections 2311.2.1 through 2311.2.4.

**2311.2.1 Cleaning of parts.** Cleaning of parts shall be conducted in *listed* and *approved* parts-cleaning machines in accordance with Chapter 57.

**2311.2.2 Waste oil, motor oil and other Class IIIB liquids.** Waste oil, motor oil and other Class IIIB liquids shall be stored in *approved* tanks or containers, which are allowed to be stored and dispensed from inside repair garages.

**2311.2.2.1 Tank location.** Tanks storing Class IIIB liquids in *repair garages* are allowed to be located at, below or above grade, provided that adequate drainage or containment is provided.

**2311.2.2.2 Liquid classification.** Crankcase drainings shall be classified as Class IIIB liquids unless otherwise determined by testing.

**2311.2.3 Drainage and disposal of liquids and oil-soaked waste.** Garage floor drains, where provided, shall drain to *approved* oil separators or traps discharging to a sewer in accordance with the *International Plumbing Code*. Contents of oil separators, traps and floor drainage systems shall be collected at sufficiently frequent intervals and removed from the premises to prevent oil from being carried into the sewers.

**2311.2.3.1 Disposal of liquids.** Crankcase drainings and liquids shall not be dumped into sewers, streams or on the ground, but shall be stored in *approved* tanks



or containers in accordance with Chapter 57 until removed from the premises.

**2311.2.3.2 Disposal of oily waste.** Self-closing metal cans shall be used for oily waste.

**2311.2.4 Spray finishing.** Spray finishing with *flammable* or *combustible liquids* shall comply with Chapter 24.

**2311.3 Sources of ignition.** Sources of ignition shall not be located within 18 inches (457 mm) of the floor and shall comply with Chapters 3 and 35.

**2311.3.1 Equipment.** Appliances and equipment installed in a repair garage shall comply with the provisions of the *International Building Code*, the *International Mechanical Code* and NFPA 70.

**2311.3.2 Smoking.** Smoking shall not be allowed in repair garages except in *approved* locations.

**2311.4 Below-grade areas.** Pits and below-grade work areas in repair garages shall comply with Sections 2311.4.1 through 2311.4.3.

**2311.4.1 Construction.** Pits and below-grade work areas shall be constructed in accordance with the *International Building Code*.

**2311.4.2 Means of egress.** Pits and below-grade work areas shall be provided with *means of egress* in accordance with Chapter 10.

**2311.4.3 Ventilation.** Where Class I liquids or LP-gas are stored or used within a building having a *basement* or pit wherein flammable vapors could accumulate, the *basement* or pit shall be provided with mechanical ventilation in accordance with the *International Mechanical Code*, at a minimum rate of 1½ cubic feet per minute per square foot (cfm/ft²) [0.008 m³/(s × m²)] to prevent the accumulation of flammable vapors.

**2311.5 Vehicles powered by liquefied petroleum gas (LP-gas).** Vehicles powered by LP-gas and the servicing of vehicles powered by LP-gas shall be in compliance with this chapter, Chapter 61 and NFPA 58.

**2311.6 Vehicles powered by liquefied natural gas (LNG) and compressed natural gas (CNG).** LNG vehicles and CNG vehicles shall comply with Sections 2311.6.1 and 2311.6.2, as applicable.

**2311.6.1 Liquefied natural gas (LNG).** LNG vehicle fuel system pressure shall be measured and recorded prior to entering the repair facility. The maximum allowable system pressure shall be not more than 170 psig (1172 kPa). Pressure greater than 170 psig (1172 kPa) shall be reduced by operating the vehicle or limited venting outdoors, as required.

**2311.6.2 Compressed natural gas (CNG).** CNG vehicle fuel system pressure and the ambient temperature shall be measured and recorded prior to entering the repair facility. Pressure greater than the indicated maximum pressure in accordance with Table 2311.6.2 shall be reduced by defueling the vehicle.

**TABLE 2311.6.2  
TEMPERATURE COMPENSATED CYLINDER  
PRESSURE TABLE<sup>a</sup>**

GAS TEMPERATURE °F	PRESSURE IN FULL 3,600 PSI CNG CONTAINER, psig
123.6	4,500
120	4,455
110	4,272
100	4,105
90	3,936
80	3,768
70	3,600
60	3,432
50	3,263
40	3,094
30	2,926
20	2,757
10	2,589
0	2,421
-10	2,253
-20	2,086
-30	1,919
-40	1,753

For SI: °C = (°F – 32)/1.8, 1 psig = 6.895 kPa.

a. 3,600 psi service pressure calculated from the standard gas composition used to create the gasoline gallon equivalent (GGE).

**2311.7 Fire extinguishers.** Fire extinguishers shall be provided in accordance with Section 906.

**2311.8 Repair garages for vehicles fueled by lighter-than-air fuels.** The room, motor vehicle repair booth or motor vehicle repair space containing repair garage activities for the conversion or repair of vehicles that use CNG, LNG, hydrogen or other lighter-than-air motor fuels shall be in accordance with Sections 2311.8 through 2311.8.11 in addition to the other requirements of Section 2311. Repair garages for the repair of vehicles that use hydrogen fuel shall be in accordance with this code and NFPA 2.

#### Exceptions:

1. Repair garages where work is conducted only on vehicles where the motor vehicle fuel tank and system have been defueled and the motor vehicle fuel tank has been purged with nitrogen gas, and where standard operating procedures to document and maintain the fueling status throughout repair operations are *approved*.
2. Repair garages where work is not performed on the fuel system and is limited to exchange of parts and maintenance not requiring open flame or welding on the CNG-, LNG-, hydrogen- or other lighter-than-air-fueled motor vehicle. Movement of a subassembly on which the motor vehicle fuel tank remains mounted to allow access to other



## MOTOR FUEL-DISPENSING FACILITIES AND REPAIR GARAGES

parts of the vehicle that are not a portion of the fuel system shall be permitted.

3. Repair garages for hydrogen-fueled vehicles where work is not performed on the motor vehicle fuel tank and is limited to the exchange of parts and maintenance not requiring open flame or welding on the hydrogen-fueled vehicle. During the work, the entire hydrogen fuel system shall contain less than 400 cubic feet (11.3 m<sup>3</sup>) of hydrogen.
4. Repair garages for natural-gas-fueled vehicles where work is not being performed on the motor vehicle fuel tank, and is limited to the exchange of parts and maintenance not requiring open flame or welding on the natural-gas-fueled vehicle. During the work, the natural gas in the motor vehicle fuel tank shall contain a pressure of not more than 250 psi at 70°F (1724 kPa at 21°C).

**2311.8.1 Preparation of vehicles for repair.** For vehicles powered by gaseous fuels, the fuel shutoff valves shall be closed prior to repairing any portion of the vehicle fuel system.

Vehicles powered by gaseous fuels in which the fuel system has been damaged shall be inspected and evaluated for fuel system integrity prior to being brought into the repair garage. The inspection shall include testing of the entire fuel delivery system for leakage.

**2311.8.2 Repair garages used for the repair of hydrogen-fueled vehicles.** Repair garages used for the repair of hydrogen-fueled vehicles shall be provided with an *approved* exhaust ventilation system in accordance with the *International Mechanical Code* and Chapter 6 of NFPA 2.

**2311.8.3 Motor vehicle repair rooms.** Motor vehicle repair rooms shall be enclosed with not less than 1-hour fire barriers constructed in accordance with Section 707 of the *International Building Code*, or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with 1-hour-rated opening protectives.

**2311.8.4 Motor vehicle repair booths.** The design and construction of motor vehicle repair booths shall be in accordance with Sections 2311.8.4.1 through 2311.8.4.4.

**2311.8.4.1 Construction.** Motor vehicle repair booths shall be constructed of *approved* noncombustible materials. Where walls or ceiling assemblies are constructed of sheet metal, single-skin assemblies shall be not thinner than 0.0478 inch (18 gage) (1.2 mm) and each sheet of double-skin assemblies shall be not thinner than 0.0359 inch (20 gage) (0.9 mm). Structural sections of motor vehicle repair booths shall be sealed in an *approved* manner.

**2311.8.4.2 Surfaces.** The interior surfaces of motor vehicle repair booths shall be constructed to permit the free passage of exhaust air from all parts of the interior.

**2311.8.4.3 Means of egress.** *Means of egress* shall be provided in accordance with Chapter 10.

**Exception:** *Means of egress* doors from premanufactured motor vehicle repair booths shall be not less than 30 inches (762 mm) in width by 80 inches (2032 mm) in height.

**2311.8.4.4 Clear space.** Motor vehicle repair booths shall be installed so that all parts of the booth be provided with *ready access* for cleaning. A clear area of not less than 3 feet (914 mm) wide shall be maintained on all sides of the motor vehicle repair booth. This clear area shall be kept free of any storage or combustible construction.

### Exceptions:

1. This requirement shall not prohibit locating a motor vehicle repair booth closer than 3 feet (914 mm) to or directly against an interior partition, wall or floor/ceiling assembly that has a *fire-resistance rating* of not less than 1 hour, provided that the motor vehicle repair booth can be adequately maintained and cleaned.
2. This requirement shall not prohibit locating a motor vehicle repair booth closer than 3 feet (914 mm) to an exterior wall or a roof assembly, provided that the wall or roof is constructed of noncombustible material and the motor vehicle repair booth can be adequately maintained and cleaned.

**2311.8.5 Motor vehicle repair spaces.** Where such spaces are not separately enclosed, noncombustible spray curtains shall be provided to restrict the spread of flammable gases.

**2311.8.6 Fire protection.** Motor vehicle repair booths or spaces installed in a room or area protected by an *automatic sprinkler system* shall have the protection extended to include the inside of the motor vehicle repair booth or space.

**2311.8.7 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided for motor vehicle repair rooms, motor vehicle repair booths or motor vehicle repair spaces.

**2311.8.8 Exhaust ventilation system.** Repair garages used for the repair of CNG, LNG, or other lighter-than-air motor fuels other than hydrogen shall be provided with an *approved* mechanical ventilation system. The mechanical exhaust ventilation system shall be in accordance with the *International Mechanical Code* and Sections 2311.8.8.1 and 2311.8.8.2.

**Exception:** Where *approved* by the *fire code official*, natural ventilation shall be permitted in lieu of mechanical exhaust ventilation.

**2311.8.8.1 Design.** For indoor locations, air supply inlets and exhaust outlets for mechanical ventilation shall be arranged to provide uniformly distributed air

movement with inlets uniformly arranged on walls near floor level and outlets at the high point of the room in walls or the roof.

Failure of the ventilation system shall cause the fueling system to shut down.

The exhaust ventilation rate shall be not less than 1 cubic foot per minute (0.03 m<sup>3</sup>/minute) per 12 cubic feet (34 m<sup>3</sup>) of room volume.

**2311.8.8.2 Operation.** The mechanical exhaust ventilation system shall operate continuously.

**Exceptions:**

1. Mechanical exhaust ventilation systems that are interlocked with a gas detection system designed in accordance with Sections 2311.8.9 through 2311.8.9.2.
2. Mechanical exhaust ventilation systems in repair garages that are used only for repair of vehicles fueled by liquid fuels or odorized gases, such as CNG, where the ventilation system is electrically interlocked with the lighting circuit.

**2311.8.9 Gas detection system.** Repair garages used for repair of vehicles fueled by nonodorized gases, including, but not limited to, hydrogen and nonodorized LNG, shall be provided with a gas detection system that complies with Section 916. The gas detection system shall be designed to detect leakage of nonodorized gaseous fuel. Where lubrication or chassis service pits are provided in garages used for repairing nonodorized LNG-fueled vehicles, gas sensors shall be provided in such pits.

**2311.8.9.1 System activation.** Activation of the gas detection alarm shall result in all of the following:

1. Initiation of local audible and visual alarms in *approved* locations.
2. Deactivation of heating systems located in the repair garage.
3. Activation of the mechanical exhaust ventilation system, where the ventilation system is interlocked with gas detection.

**2311.8.9.2 Failure of the gas detection system.** Failure of the gas detection system shall automatically deactivate the heating system, activate the mechanical exhaust ventilation system where the system is interlocked with the gas detection system and cause a trouble signal to sound in an *approved* location.

**2311.8.10 Classified electrical area.** Areas within 18 inches (450 mm) of a ceiling within a motor vehicle repair room or motor vehicle repair booth shall be designed and installed in accordance with the requirements for Class I, Division 2, classified locations, as set forth in NFPA 70.

**Exceptions:**

1. Rooms with exhaust ventilation of not less than 1 cubic foot per minute per square foot (0.3 m<sup>3</sup>/min/m<sup>2</sup>) of floor area, with suction taken from

a point within 18 inches (450 mm) of the highest point in the ceiling in repair garages for vehicles that use CNG, liquefied natural gas (LNG) or other lighter-than-air motor fuels.

2. Rooms used for the repair of hydrogen-fueled vehicles that have an *approved* exhaust ventilation system in accordance with the *International Mechanical Code* and NFPA 2.

**2311.8.11 Defueling equipment required at vehicle maintenance and repair facilities.** Facilities for repairing or replacing hydrogen fuel tanks on hydrogen-fueled vehicles shall have equipment to defuel vehicle storage tanks. Where work must be performed on a motor vehicle's fuel tank for the purpose of maintenance, repair or cylinder certification, defueling and purging shall be conducted in accordance with Section 2309.6 and NFPA 2.



## CHAPTER 24

# FLAMMABLE FINISHES

### User note:

**About this chapter:** Chapter 24 provides requirements that govern operations where flammable or combustible finishes are applied by spraying, dipping, powder coating or flow-coating processes. As with all operations involving flammable or combustible liquids and combustible dusts or vapors, controlling ignition sources and methods of reducing or controlling flammable vapors or combustible dusts at or near these operations are emphasized.

### SECTION 2401 GENERAL

**2401.1 Scope.** This chapter shall apply to locations or areas where any of the following activities are conducted:

1. The application of flammable finishes to articles or materials by means of spray apparatus.
2. The application of flammable finishes by dipping or immersing articles or materials into the contents of tanks, vats or containers of *flammable* or *combustible liquids* for coating, finishing, treatment or similar processes.
3. The application of flammable finishes by applying combustible powders to articles or materials utilizing powder spray guns, electrostatic powder spray guns, fluidized beds or electrostatic fluidized beds.
4. Floor surfacing or finishing operations using Class I or II liquids in areas exceeding 350 square feet (32.5 m<sup>2</sup>).
5. The application of flammable finishes consisting of dual-component coatings or Class I or II liquids where applied by brush or roller in quantities exceeding 1 gallon (4 L).

**2401.2 Nonapplicability.** This chapter shall not apply to spray finishing utilizing *flammable* or *combustible liquids* that do not sustain combustion, including:

1. Liquids that do not have a fire point when tested in accordance with ASTM D92.
2. Liquids with a flashpoint greater than 95°F (35°C) in a water-miscible solution or dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight.

**2401.3 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

### SECTION 2402 DEFINITIONS

**2402.1 Definitions.** The following terms are defined in Chapter 2:

**DETEARING.**

**DIP TANK.**

**ELECTROSTATIC FLUIDIZED BED.**

**FLAMMABLE FINISHES.**  
**FLAMMABLE VAPOR AREA.**  
**FLUIDIZED BED.**  
**LIMITED SPRAYING SPACE.**  
**RESIN APPLICATION AREA.**  
**ROLL COATING.**  
**SPRAY BOOTH.**  
**SPRAY ROOM.**  
**SPRAYING SPACE.**

### SECTION 2403 PROTECTION OF OPERATIONS

**2403.1 General.** Operations covered by this chapter shall be protected as required by Sections 2403.2 through 2403.4.4.

**2403.2 Sources of ignition.** Protection against sources of ignition shall be provided in accordance with Sections 2403.2.1 through 2403.2.8.

**2403.2.1 Electrical wiring and equipment.** Electrical wiring and equipment shall comply with this chapter and NFPA 70.

**2403.2.1.1 Flammable vapor areas.** Electrical wiring and equipment in flammable vapor areas shall be of an explosionproof type *approved* for use in such hazardous locations. Such areas shall be considered to be Class I, Division 1, or Class II, Division 1, hazardous locations in accordance with NFPA 70.

**2403.2.1.2 Areas subject to deposits of residues.** Electrical equipment, flammable vapor areas or drying operations that are subject to splashing or dripping of liquids shall be specifically *approved* for locations containing deposits of readily ignitable residue and explosive vapors.

#### Exceptions:

1. This provision shall not apply to wiring in rigid conduit, threaded boxes or fittings not containing taps, splices or terminal connections.
2. This provision shall not apply to electrostatic equipment allowed by Section 2407.



## FLAMMABLE FINISHES

In resin application areas, electrical wiring and equipment that is subject to deposits of combustible residues shall be *listed* for such exposure and shall be installed as required for hazardous (classified) locations. Electrical wiring and equipment not subject to deposits of combustible residues shall be installed as required for ordinary hazard locations.

**2403.2.1.3 Areas adjacent to spray booths.** Electrical wiring and equipment located outside of, but within 3 feet (914 mm) of openings in a spray booth or a spray room, shall be *approved* for Class I, Division 2, or Class II, Division 2, hazardous locations, whichever is applicable.

**2403.2.1.4 Areas subject to overspray deposits.** Electrical equipment in flammable vapor areas located such that deposits of combustible residues could readily accumulate thereon shall be specifically *approved* for locations containing deposits of readily ignitable residue and *explosive* vapors in accordance with NFPA 70.

### Exceptions:

1. Wiring in rigid conduit.
2. Boxes or fittings not containing taps, splices or terminal connections.
3. Equipment allowed by Sections 2404 and 2407 and Chapter 30.

**2403.2.2 Open flames and sparks.** Open flames and spark-producing devices shall not be located in flammable vapor areas and shall not be located within 20 feet (6096 mm) of such areas unless separated by a permanent partition.

**Exception:** Drying and baking apparatus complying with Section 2404.6.1.2.

**2403.2.3 Hot surfaces.** Heated surfaces having a temperature sufficient to ignite vapors shall not be located in flammable vapor areas. Space-heating appliances, steam pipes or hot surfaces in a flammable vapor area shall be located such that they are not subject to accumulation of deposits of combustible residues.

**Exception:** Drying apparatus complying with Section 2404.6.1.2.

**2403.2.4 Equipment enclosures.** Equipment or apparatus that is capable of producing sparks or particles of hot metal that would fall into a flammable vapor area shall be totally enclosed.

**2403.2.5 Grounding.** Metal parts of spray booths, exhaust ducts and piping systems conveying Class I or II liquids shall be electrically grounded in accordance with NFPA 70. Metallic parts located in resin application areas, including but not limited to exhaust ducts, ventilation fans, spray application equipment, workpieces and piping, shall be electrically grounded.

**2403.2.6 Smoking prohibited.** Smoking shall be prohibited in flammable vapor areas and hazardous materials storage rooms associated with flammable finish

processes. “No Smoking” signs complying with Section 310 shall be conspicuously posted in such areas.

**2403.2.7 Welding warning signs.** Welding, cutting and similar spark-producing operations shall not be conducted in or adjacent to flammable vapor areas or dipping or coating operations unless precautions have been taken to provide safety. Conspicuous signs with the following warning shall be posted in the vicinity of flammable vapor areas, dipping operations and paint storage rooms:

NO WELDING  
THE USE OF WELDING OR CUTTING  
EQUIPMENT IN OR NEAR THIS AREA  
IS DANGEROUS BECAUSE OF FIRE  
AND EXPLOSION HAZARDS. WELDING  
AND CUTTING SHALL BE DONE ONLY  
UNDER THE SUPERVISION OF THE  
PERSON IN CHARGE.

**2403.2.8 Powered industrial trucks.** Powered industrial trucks used in electrically classified areas shall be *listed* for such use.

**2403.3 Storage, use and handling of flammable and combustible liquids.** The storage, use and handling of *flammable* and *combustible liquids* shall be in accordance with this section and Chapter 57.

**2403.3.1 Use.** Containers supplying spray nozzles shall be of a closed type or provided with metal covers that are kept closed. Containers not resting on floors shall be on noncombustible supports or suspended by wire cables. Containers supplying spray nozzles by gravity flow shall not exceed 10 gallons (37.9 L) in capacity.

**2403.3.2 Valves.** Containers and piping to which a hose or flexible connection is attached shall be provided with a shutoff valve at the connection. Such valves shall be kept shut when hoses are not in use.

**2403.3.3 Pumped liquid supplies.** Where *flammable* or *combustible liquids* are supplied to spray nozzles by positive displacement pumps, pump discharge lines shall be provided with an *approved* relief valve discharging to pump suction or a safe detached location.

**2403.3.4 Liquid transfer.** Where a flammable mixture is transferred from one portable container to another, a bond shall be provided between the two containers. Not less than one container shall be grounded. Piping systems for Class I and II liquids shall be permanently grounded.

**2403.3.5 Class I liquids as solvents.** Class I liquids used as solvents shall be used in spray gun and equipment cleaning machines that have been *listed* and *approved* for such purpose or shall be used in spray booths or spray rooms in accordance with Sections 2403.3.5.1 and 2403.3.5.2.

**2403.3.5.1 Listed devices.** Cleaning machines for spray guns and equipment shall not be located in areas open to the public and shall be separated from ignition sources in accordance with their listings or by a distance of 3 feet (914 mm), whichever is greater. The quantity of solvent used in a machine shall not exceed the design capacity of the machine.

**2403.3.5.2 Within spray booths and spray rooms.**

Where solvents are used for cleaning spray nozzles and auxiliary equipment within spray booths and spray rooms, the ventilating equipment shall be operated during cleaning.

**2403.3.6 Class II and III liquids.** Solvents used outside of spray booths, spray rooms or *listed* and *approved* spray gun and equipment cleaning machines shall be restricted to Class II and III liquids.

**2403.4 Operations and maintenance.** Flammable vapor areas, exhaust fan blades and exhaust ducts shall be kept free from the accumulation of deposits of combustible residues. Where excessive residue accumulates in such areas, spraying operations shall be discontinued until conditions are corrected.

**2403.4.1 Tools.** Scrapers, spuds and other tools used for cleaning purposes shall be constructed of nonsparking materials.

**2403.4.2 Residue.** Residues removed during cleaning and debris contaminated with residue shall be immediately removed from the premises and properly disposed.

**2403.4.3 Waste cans.** *Approved* metal waste cans equipped with self-closing lids shall be provided wherever rags or waste are impregnated with finishing material. Such rags and waste shall be deposited therein immediately after being utilized. The contents of waste cans shall be properly disposed of not less than once daily and at the end of each shift.

**2403.4.4 Solvent recycling.** Solvent distillation equipment used to recycle and clean dirty solvents shall comply with Section 5705.4.

## SECTION 2404 SPRAY FINISHING

**2404.1 General.** The application of *flammable* or *combustible liquids* by means of spray apparatus in continuous or intermittent processes shall be in accordance with the requirements of Sections 2403 and 2404.2 through 2404.9.4.

**2404.2 Location of spray-finishing operations.** Spray-finishing operations conducted in buildings used for Group A, E, I or R occupancies shall be located in a spray room protected with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1 and separated vertically and horizontally from the remainder of the building by *fire barrier* walls and *horizontal assemblies* with not less than a 1-hour *fire-resistance rating* in accordance with the *International Building Code*. In other occupancies, spray-finishing operations shall be conducted in a spray room, spray booth or limited spraying space *approved* for such use.

### Exceptions:

1. Automobile undercoating spray operations and spray-on automotive lining operations conducted in areas with *approved* natural or mechanical ventilation shall be exempt from the provisions of

Section 2404 when *approved* and where utilizing Class IIIA or IIIB *combustible liquids*.

2. In buildings other than Group A, E, I or R occupancies, *approved* limited spraying space in accordance with Section 2404.9.
3. Resin application areas used for manufacturing of reinforced plastics complying with Section 2409 shall not be required to be located in a spray room, spray booth or spraying space.

**2404.3 Design and construction.** Design and construction of spray rooms, spray booths and spray spaces shall be in accordance with Sections 2404.3.1 through 2404.3.4.1.

**2404.3.1 Spray rooms.** Spray rooms shall be constructed and designed in accordance with Section 416 of the *International Building Code* and Section 2404.3.2 of this code, and shall comply with Sections 2404.4 through 2404.8 of this code.

**2404.3.2 Floor.** Combustible floor construction in spray rooms shall be covered by *approved*, noncombustible, nonsparking material, except where combustible coverings, including but not limited to thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spray rooms.

**2404.3.3 Spray booths.** The design and construction of spray booths shall be in accordance with Sections 2404.3.3.1 through 2404.3.3.6, Sections 2404.4 through 2404.8 and NFPA 33.

**2404.3.3.1 Construction.** Spray booths shall be constructed of *approved* noncombustible materials. Aluminum shall not be used. Where walls or ceiling assemblies are constructed of sheet metal, single-skin assemblies shall be not thinner than 0.0478 inch (18 gage) (1.2 mm) and each sheet of double-skin assemblies shall be not thinner than 0.0359 inch (20 gage) (0.9 mm). Structural sections of spray booths are allowed to be sealed with latex-based or similar caulks and sealants.

**2404.3.3.2 Surfaces.** The interior surfaces of spray booths shall be smooth; shall be constructed so as to permit the free passage of exhaust air from all parts of the interior, and to facilitate washing and cleaning; and shall be designed to confine residues within the booth. Aluminum shall not be used.

**2404.3.3.3 Floor.** Combustible floor construction in spray booths shall be covered by *approved*, noncombustible, nonsparking material, except where combustible coverings, including but not limited to thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spray booths.

**2404.3.3.4 Means of egress.** *Means of egress* shall be provided in accordance with Chapter 10.

**Exception:** *Means of egress* doors from premanufactured spray booths shall be not less than 30 inches (762 mm) in width by 80 inches (2032 mm) in height.

## FLAMMABLE FINISHES

**2404.3.3.5 Clear space.** Spray booths shall be installed so that all parts of the booth are able to be accessed for cleaning. A clear space of not less than 3 feet (914 mm) shall be maintained on all sides of the spray booth. This clear space shall be kept free of any storage or combustible construction.

### Exceptions:

1. This requirement shall not prohibit locating a spray booth closer than 3 feet (914 mm) to or directly against an interior partition, wall or floor/ceiling assembly that has a *fire-resistance rating* of not less than 1 hour, provided that the spray booth can be adequately maintained and cleaned.
2. This requirement shall not prohibit locating a spray booth closer than 3 feet (914 mm) to an exterior wall or a roof assembly, provided that the wall or roof is constructed of noncombustible material and the spray booth can be adequately maintained and cleaned.

**2404.3.3.6 Size.** The aggregate area of spray booths in a building shall not exceed the lesser of 10 percent of the area of any floor of a building or the basic area allowed for a Group H-2 occupancy without area increases, as set forth in the *International Building Code*.

**Exception:** One individual booth not exceeding 500 square feet (46 m<sup>2</sup>).

**2404.3.4 Spraying spaces.** Spraying spaces shall be designed and constructed in accordance with the *International Building Code*, and Section 2404.3.4.1 and Sections 2404.4 through 2404.8 of this code.

**2404.3.4.1 Floor.** Combustible floor construction in spraying spaces shall be covered by *approved*, noncombustible, nonsparking material, except where combustible coverings, such as thin paper or plastic and strippable coatings, are utilized over noncombustible materials to facilitate cleaning operations in spraying spaces.

**2404.4 Fire protection.** Spray booths and spray rooms shall be protected by an *approved* automatic fire-extinguishing system complying with Chapter 9. Protection shall extend to exhaust plenums, exhaust ducts and both sides of dry filters where such filters are used.

**2404.4.1 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided for spraying areas in accordance with the requirements for an extra (high) hazard occupancy.

**2404.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3, 2403.4, 2404.5.1 and 2404.5.2.

**2404.5.1 Different coatings.** Spray booths, spray rooms and spraying spaces shall not be alternately utilized for different types of coating materials where the combina-

tion of materials is conducive to spontaneous ignition, unless all deposits of one material are removed from the booth, room or space and exhaust ducts prior to spraying with a different material.

**2404.5.2 Protection of sprinklers.** Automatic sprinklers installed in flammable vapor areas shall be protected from the accumulation of residue from spraying operations in an *approved* manner. Bags used as a protective covering shall be 0.003-inch-thick (0.076 mm) polyethylene or cellophane or shall be thin paper. Automatic sprinklers contaminated by overspray particles shall be replaced with new automatic sprinklers.

**2404.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2 and Sections 2404.6.1 through 2404.6.2.4.

**2404.6.1 Drying operations.** Spray booths and spray rooms shall not be alternately used for the purpose of drying by arrangements or methods that could cause an increase in the surface temperature of the spray booth or spray room except in accordance with Sections 2404.6.1.1 and 2404.6.1.2. Except as specifically provided in this section, drying or baking units utilizing a heating system having open flames or that are capable of producing sparks shall not be installed in a flammable vapor areas.

**2404.6.1.1 Spraying procedure.** The spraying procedure shall use low-volume spray application.

**2404.6.1.2 Drying apparatus.** Fixed drying apparatus shall comply with this chapter and the applicable provisions of Chapter 30. Where recirculation ventilation is provided in accordance with Section 2404.7.2, the heating system shall not be within the recirculation air path.

**2404.6.1.2.1 Interlocks.** The spraying apparatus, drying apparatus and ventilating system for the spray booth or spray room shall be equipped with interlocks arranged to accomplish all of the following:

1. Prevent operation of the spraying apparatus while drying operations are in progress.
2. Where the drying apparatus is located in the spray booth or spray room, prevent operation of the drying apparatus until a timed purge of spray vapors from the spray booth or spray room is complete. This purge time shall be based on completing not fewer than four air changes of spray booth or spray room volume or for a period of not less than 3 minutes, whichever is greater.
3. Have the ventilating system maintain a safe atmosphere within the spray booth or spray room during the drying process and automatically shut off drying apparatus in the event of a failure of the ventilating system.



4. Shut off the drying apparatus automatically if the air temperature within the booth exceeds 200°F (93°C).

**2404.6.1.2.2 Portable infrared apparatus.** Where a portable infrared drying apparatus is used, electrical wiring and portable infrared drying equipment shall comply with NFPA 70. Electrical equipment located within 18 inches (457 mm) of floor level shall be *approved* for Class I, Division 2, hazardous locations. Metallic parts of drying apparatus shall be electrically bonded and grounded. During spraying operations, portable drying apparatus and electrical connections and wiring thereto shall not be located within spray booths, spray rooms or other areas where spray residue would be deposited thereon.

**2404.6.2 Illumination.** Where spraying spaces, spray rooms or spray booths are illuminated through glass panels or other transparent materials, only fixed luminaires shall be utilized as a source of illumination.

**2404.6.2.1 Glass panels.** Panels for luminaires or for observation shall be of heat-treated glass, wired glass or hammered wire glass and shall be sealed to confine vapors, mists, residues, dusts and deposits to the flammable vapor area. Panels for luminaires shall be separated from the luminaire to prevent the surface temperature of the panel from exceeding 200°F (93°C).

**2404.6.2.2 Exterior luminaires.** Luminaires attached to the walls or ceilings of a flammable vapor area, but outside of any classified area and separated from the flammable vapor areas by vapor-tight glass panels, shall be suitable for use in ordinary hazard locations. Such luminaires shall be serviced from outside the flammable vapor areas.

**2404.6.2.3 Integral luminaires.** Luminaires that are an integral part of the walls or ceiling of a flammable vapor area are allowed to be separated from the flammable vapor area by glass panels that are an integral part of the luminaire. Such luminaires shall be *listed* for use in Class I, Division 2, or Class II, Division 2, locations, whichever is applicable, and shall be suitable for accumulations of deposits of combustible residues. Such luminaires are allowed to be serviced from inside the flammable vapor area.

**2404.6.2.4 Portable electric lamps.** Portable electric lamps shall not be used in flammable vapor areas during spraying operations. Portable electric lamps used during cleaning or repairing operations shall be of a type *approved* for hazardous locations.

**2404.7 Ventilation.** Mechanical ventilation of flammable vapor areas shall be provided in accordance with Section 502.7 of the *International Mechanical Code*.

**2404.7.1 Operation.** Mechanical ventilation shall be kept in operation at all times while spraying operations are being conducted and for a sufficient time thereafter to allow vapors from drying coated articles and finishing material residue to be exhausted. Spraying equipment

shall be interlocked with the ventilation of the flammable vapor areas such that spraying operations cannot be conducted unless the ventilation system is in operation.

**2404.7.2 Recirculation.** Air exhausted from spraying operations shall not be recirculated.

#### Exceptions:

1. Air exhausted from spraying operations is allowed to be recirculated as makeup air for unmanned spray operations, provided that all of the following conditions exist:
  - 1.1. The solid particulate has been removed.
  - 1.2. The vapor concentration is less than 25 percent of the LFL.
  - 1.3. *Approved* equipment is used to monitor the vapor concentration.
  - 1.4. When the vapor concentration exceeds 25 percent of the LFL, both of the following shall occur:
    - 1.4.1. An alarm shall sound.
    - 1.4.2. Spray operations shall automatically shut down.
  - 1.5. In the event of shutdown of the vapor concentration monitor, 100 percent of the air volume specified in Section 510 of the *International Mechanical Code* is automatically exhausted.
2. Air exhausted from spraying operations is allowed to be recirculated as makeup air to manned spraying operations where all of the conditions provided in Exception 1 are included in the installation and documents have been prepared to show that the installation does not pose a life safety hazard to personnel inside the spray booth, spraying space or spray room.

**2404.7.3 Air velocity.** The ventilation system shall be designed, installed and maintained so that the flammable contaminants are diluted in noncontaminated air to maintain concentrations in the exhaust airflow below 25 percent of the contaminant's lower flammable limit (LFL). In addition, the spray booth shall be provided with mechanical ventilation so that the average air velocity through openings is in accordance with Sections 2404.7.3.1 and 2404.7.3.2.

#### 2404.7.3.1 Open-face or open-front spray booth.

For spray application operations conducted in an open-face or open-front spray booth, the ventilation system shall be designed, installed and maintained so that the average air velocity into the spray booth through all openings is not less than 100 feet per minute (0.51 m/s).

**Exception:** For fixed or automated electrostatic spray application equipment, the average air velocity into the spray booth through all openings shall be not less than 50 feet per minute (0.25 m/s).



## FLAMMABLE FINISHES

**2404.7.3.2 Enclosed spray booth or spray room with openings for product conveyance.** For spray application operations conducted in an enclosed spray booth or spray room with openings for product conveyance, the ventilation system shall be designed, installed and maintained so that the average air velocity into the spray booth through openings is not less than 100 feet per minute (0.51 m/s).

### Exceptions:

1. For fixed or automated electrostatic spray application equipment, the average air velocity into the spray booth through all openings shall be not less than 50 feet per minute (0.25 m/s).
2. Where methods are used to reduce cross drafts that can draw vapors and overspray through openings from the spray booth or spray room, the average air velocity into the spray booth or spray room shall be that necessary to capture and confine vapors and overspray to the spray booth or spray room.

**2404.7.4 Ventilation obstruction.** Articles being sprayed shall be positioned in a manner that does not obstruct collection of overspray.

**2404.7.5 Independent ducts.** Each spray booth and spray room shall have an independent exhaust duct system discharging to the outside.

### Exceptions:

1. Multiple spray booths having a combined frontal area of 18 square feet (1.67 m<sup>2</sup>) or less are allowed to have a common exhaust where identical spray finishing material is used in each booth. If more than one fan serves one booth, fans shall be interconnected such that all fans will operate simultaneously.
2. Where treatment of exhaust is necessary for air pollution control or for energy conservation, ducts shall be allowed to be manifolded if all of the following conditions are met:
  - 2.1. The sprayed materials used are compatible and will not react or cause ignition of the residue in the ducts.
  - 2.2. Nitrocellulose-based finishing material shall not be used.
  - 2.3. A filtering system shall be provided to reduce the amount of overspray carried into the duct manifold.
  - 2.4. Automatic sprinkler protection shall be provided at the junction of each booth exhaust with the manifold, in addition to the protection required by this chapter.

**2404.7.6 Termination point.** The termination point for exhaust ducts discharging to the atmosphere shall be not less than the following distances:

1. Ducts conveying explosive or flammable vapors, fumes or dusts: 30 feet (9144 mm) from the *lot line*; 10 feet (3048 mm) from openings into the building; 6 feet (1829 mm) from exterior walls and roofs; 30 feet (9144 mm) from combustible walls or openings into the building that are in the direction of the exhaust discharge; 10 feet (3048 mm) above adjoining grade.
2. Other product-conveying outlets: 10 feet (3048 mm) from the *lot line*; 3 feet (914 mm) from exterior walls and roofs; 10 feet (3048 mm) from openings into the building; 10 feet (3048 mm) above adjoining grade.

**2404.7.7 Fan motors and belts.** Electric motors driving exhaust fans shall not be placed inside booths or ducts. Fan rotating elements shall be nonferrous or nonsparking or the casing shall consist of, or be lined with, such material. Belts shall not enter the duct or booth unless the belt and pulley within the duct are tightly enclosed.

**2404.7.8 Filters.** Air intake filters that are part of a wall or ceiling assembly shall be *listed* as Class I or II in accordance with UL 900. Exhaust filters shall be required.

**2404.7.8.1 Supports.** Supports and holders for filters shall be constructed of noncombustible materials.

**2404.7.8.2 Attachment.** Overspray collection filters shall be readily removable and able to be accessed for cleaning or replacement.

**2404.7.8.3 Maintaining air velocity.** Visible gauges, audible alarms or pressure-activated devices shall be installed to indicate or ensure that the required air velocity is maintained.

**2404.7.8.4 Filter rolls.** Spray booths equipped with a filter roll that is automatically advanced when the air velocity is reduced to less than 100 feet per minute (0.51 m/s) shall be arranged to shut down the spraying operation if the filter roll fails to advance automatically.

**2404.7.8.5 Filter disposal.** Discarded filter pads shall be immediately removed to a safe, detached location or placed in a noncombustible container with a tight-fitting lid and disposed of properly.

**2404.7.8.6 Spontaneous ignition.** Spray booths using dry filters shall not be used for spraying materials that are highly susceptible to spontaneous heating and ignition. Filters shall be changed prior to spraying materials that could react with other materials previously collected. An example of a potentially reactive combination includes lacquer when combined with varnishes, stains or primers.

**2404.7.8.7 Waterwash spray booths.** Waterwash spray booths shall be of an *approved* design so as to

prevent excessive accumulation of deposits in ducts and residue at duct outlets. Such booths shall be arranged so that air and overspray are drawn through a continuously flowing water curtain before entering an exhaust duct to the building exterior.

**2404.8 Interlocks.** Interlocks for spray application finishes shall be in accordance with Sections 2404.8.1 through 2404.8.2.

**2404.8.1 Automated spray application operations.**

Where protecting automated spray application operations, automatic fire-extinguishing systems shall be equipped with an *approved* interlock feature that will, upon discharge of the system, automatically stop the spraying operations and workpiece conveyors into and out of the flammable vapor areas. Where the building is equipped with a fire alarm system, discharge of the automatic fire-extinguishing system shall also activate the building alarm notification appliances.

**2404.8.1.1 Alarm station.** A manual fire alarm and emergency system shutdown station shall be installed to serve each flammable vapor area. When activated, the station shall accomplish the functions indicated in Section 2404.8.1.

**2404.8.1.2 Alarm station location.** Not less than one manual fire alarm and emergency system shutdown station shall be provided with *ready access* for operating personnel. Where access to this station is likely to involve exposure to danger, an additional station shall be located adjacent to an exit from the area.

**2404.8.2 Ventilation interlock prohibited.** Air makeup and flammable vapor area exhaust systems shall not be interlocked with the fire alarm system and shall remain in operation during a fire alarm condition.

**Exception:** Where the type of fire-extinguishing system used requires such ventilation to be discontinued, air makeup and exhaust systems shall shut down and dampers shall close.

**2404.9 Limited spraying spaces.** Limited spraying spaces shall comply with Sections 2404.9.1 through 2404.9.4.

**2404.9.1 Job size.** The aggregate surface area to be sprayed shall not exceed 9 square feet (0.84 m<sup>2</sup>).

**2404.9.2 Frequency.** Spraying operations shall not be of a continuous nature.

**2404.9.3 Ventilation.** Positive mechanical ventilation providing not fewer than six complete air changes per hour shall be installed. Such system shall meet the requirements of this code for handling flammable vapor areas. Explosion venting is not required.

**2404.9.4 Electrical wiring.** Electrical wiring within 10 feet (3048 mm) of the floor and 20 feet (6096 mm) horizontally of the limited spraying space shall be designed for Class I, Division 2 locations in accordance with NFPA 70.

## SECTION 2405 DIPPING OPERATIONS

**2405.1 General.** Dip-tank operations shall comply with the requirements of Section 2403 and Sections 2405.2 through 2405.11.

**2405.2 Location of dip-tank operations.** Dip-tank operations conducted in buildings used for Group A, I or R occupancies shall be located in a room designed for that purpose, equipped with an *approved automatic sprinkler system* and separated vertically and horizontally from other areas in accordance with the *International Building Code*.

**2405.3 Construction of dip tanks.** Dip tanks shall be constructed in accordance with Sections 2405.3.1 through 2405.3.4.3 and NFPA 34. Dip tanks, including drain boards, shall be constructed of noncombustible material and their supports shall be of heavy metal, reinforced concrete or masonry.

**2405.3.1 Overflow.** Dip tanks greater than 150 gallons (568 L) in capacity or 10 square feet (0.93 m<sup>2</sup>) in liquid surface area shall be equipped with a trapped overflow pipe leading to an *approved* location outside the building. The bottom of the overflow connection shall be not less than 6 inches (152 mm) below the top of the tank.

**2405.3.2 Bottom drains.** Dip tanks greater than 500 gallons (1893 L) in liquid capacity shall be equipped with bottom drains that are arranged to automatically and manually drain the tank quickly in the event of a fire unless the viscosity of the liquid at normal atmospheric temperature makes this impractical. Access to the manual operation shall be from a safe location. Where gravity flow is not practicable, automatic pumps shall be provided. Such drains shall be trapped and discharged to a closed, vented salvage tank or to an *approved* outside location.

**Exception:** Dip tanks containing Class IIIB *combustible liquids* where the liquids are not heated above room temperature and the process area is protected by automatic sprinklers.

**2405.3.3 Dipping liquid temperature control.** Protection against the accumulation of vapors, self-ignition and excessively high temperatures shall be provided for dipping liquids that are heated directly or heated by the surfaces of the object being dipped.

**2405.3.4 Dip-tank covers.** Dip-tank covers allowed by Section 2405.4.1 shall be capable of manual operation and shall be automatic closing by *approved* automatic-closing devices designed to operate in the event of a fire.

**2405.3.4.1 Construction.** Covers shall be constructed of noncombustible material or be of a tin-clad type with enclosing metal applied with locked joints.

**2405.3.4.2 Supports.** Chain or wire rope shall be utilized for cover supports or operating mechanisms.

**2405.3.4.3 Closed covers.** Covers shall be kept closed when tanks are not in use.

## FLAMMABLE FINISHES

**2405.4 Fire protection.** Dip-tank operations shall be protected in accordance with Sections 2405.4.1 through 2405.4.2.

**2405.4.1 Fixed fire-extinguishing equipment.** An *approved automatic fire-extinguishing system* or dip-tank cover in accordance with Section 2405.3.4 shall be provided for the following dip tanks:

1. Dip tanks less than 150 gallons (568 L) in capacity or 10 square feet (0.93 m<sup>2</sup>) in liquid surface area.
2. Dip tanks containing a liquid with a *flash point* below 110°F (43°C) used in such manner that the liquid temperature could equal or be greater than its *flash point* from artificial or natural causes, and having both a capacity of more than 10 gallons (37.9 L) and a liquid surface area of more than 4 square feet (0.37 m<sup>2</sup>).

**2405.4.1.1 Fire-extinguishing system.** An *approved automatic fire-extinguishing system* shall be provided for dip tanks with a 150-gallon (568 L) or more capacity or 10 square feet (0.93 m<sup>2</sup>) or larger in a liquid surface area. Fire-extinguishing system design shall be in accordance with NFPA 34.

**2405.4.2 Portable fire extinguishers.** Areas in the vicinity of dip tanks shall be provided with portable fire extinguishers complying with Section 906 and suitable for *flammable* and *combustible liquid* fires as specified for extra (high) hazard occupancies.

**2405.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4.

**2405.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2.

**2405.7 Ventilation of flammable vapor areas.** Flammable vapor areas shall be provided with mechanical ventilation adequate to prevent the dangerous accumulation of vapors. Required ventilation systems shall be arranged such that the failure of any ventilating fan shall automatically stop the dipping conveyor system.

**2405.8 Conveyor interlock.** Dip tanks utilizing a conveyor system shall be arranged such that in the event of a fire, the conveyor system shall automatically cease motion and the required tank bottom drains shall open.

**2405.9 Hardening and tempering tanks.** Hardening and tempering tanks shall comply with Sections 2405.3 through 2405.3.3, 2405.9.4 and 2405.8, but shall be exempt from other provisions of Section 2405.

**2405.9.1 Location.** Tanks shall be located as far as practical from furnaces and shall not be located on or near combustible floors.

**2405.9.2 Hoods.** Tanks shall be provided with a noncombustible hood and vent or other *approved* venting means, terminating outside of the structure to serve as a vent in case of a fire. Such vent ducts shall be treated as flues and proper clearances shall be maintained from combustible materials.

**2405.9.3 Alarms.** Tanks shall be equipped with a high-temperature limit switch arranged to sound an alarm when the temperature of the quenching medium reaches 50°F (10°C) below the *flash point*.

**2405.9.4 Fire protection.** Hardening and tempering tanks greater than 500 gallons (1893 L) in capacity or 25 square feet (2.3 m<sup>2</sup>) in liquid surface area shall be protected by an *approved automatic fire-extinguishing system* complying with Chapter 9.

**2405.9.5 Use of air pressure.** Air under pressure shall not be used to fill or agitate oil in tanks.

**2405.10 Flow-coating operations.** Flow-coating operations shall comply with the requirements for dip tanks. The area of the sump and any areas on which paint flows shall be considered to be the area of a dip tank.

**2405.10.1 Paint supply.** Paint shall be supplied by a gravity tank not exceeding 10 gallons (38 L) in capacity or by direct low-pressure pumps arranged to shut down automatically in case of a fire by means of *approved* heat-actuated devices.

**2405.11 Roll-coating operations.** Roll-coating operations shall comply with Section 2405.10. In roll-coating operations utilizing *flammable* or *combustible liquids*, sparks from static electricity shall be prevented by electrically bonding and grounding all metallic rotating and other parts of machinery and equipment and by the installation of static collectors, or by maintaining a conductive atmosphere such as a high relative humidity.

## SECTION 2406 POWDER COATING

**2406.1 General.** Operations using finely ground particles of protective finishing material applied in dry powder form by a fluidized bed, an electrostatic fluidized bed, powder spray guns or electrostatic powder spray guns shall comply with Sections 2406.2 through 2406.7. In addition, Section 2407 shall apply to fixed electrostatic equipment used in powder coating operations.

**2406.2 Location.** Powder coating operations shall be conducted in enclosed powder coating rooms, enclosed powder coating facilities that are ventilated or ventilated spray booths.

**2406.3 Construction of powder coating rooms and booths.** Powder coating rooms shall be constructed of noncombustible materials. Spray booths shall be constructed in accordance with Section 2404.3.3.

**Exception:** *Listed* spray-booth assemblies that are constructed of other materials shall be allowed.

**2406.4 Fire protection.** Areas used for powder coating shall be protected by an *approved automatic fire-extinguishing system* complying with Chapter 9.

**2406.4.1 Additional protection for fixed systems.** Automated powder application equipment shall be protected by the installation of an *approved*, supervised flame detection apparatus that shall react to the presence of



flame within 0.5 second and shall accomplish all of the following:

1. Shutting down of energy supplies (electrical and compressed air) to conveyor, ventilation, application, transfer and powder collection equipment.
2. Closing of segregation dampers in associated ductwork to interrupt airflow from application equipment to powder collectors.
3. Activation of an alarm that is audible throughout the powder coating room or booth.

**2406.4.2 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided for areas used for powder coating in accordance with the requirements for an extra-hazard occupancy.

**2406.5 Operation and maintenance.** Powder coating areas shall be kept free from the accumulation of powder coating dusts, including horizontal surfaces such as ledges, beams, pipes, hoods, booths and floors.

**2406.5.1 Cleaning.** Surfaces shall be cleaned in such a manner so as to avoid scattering dusts to other places or creating dust clouds. Vacuum sweeping equipment shall be of a type *approved* for use in hazardous locations.

**2406.6 Sources of ignition.** Control of sources of ignition shall be in accordance with Section 2403.2 and Sections 2406.6.1 through 2406.6.4.

**2406.6.1 Drying, curing and fusion equipment.** Drying, curing and fusion equipment shall comply with Chapter 30.

**2406.6.2 Spark-producing metals.** Iron or spark-producing metals shall be prevented from being introduced into the powders being applied by magnetic separators, filter-type separators or by other *approved* means.

**2406.6.3 Preheated parts.** When parts are heated prior to coating, the temperature of the parts shall not exceed the ignition temperature of the powder to be used.

**2406.6.4 Grounding and bonding.** Precautions shall be taken to minimize the possibility of ignition by static electrical sparks through static bonding and grounding, where possible, of powder transport, application and recovery equipment.

**2406.7 Ventilation.** Exhaust ventilation shall be sufficient to maintain the atmosphere below one-half the minimum *explosive* concentration for the material being applied. Nondeposited, air-suspended powders shall be removed through exhaust ducts to the powder recovery system.

## SECTION 2407 ELECTROSTATIC APPARATUS

**2407.1 General.** Electrostatic apparatus and devices used in connection with paint-spraying and paint-*detearing* operations shall be of an *approved* type.

**2407.2 Location and clear space.** A space of not less than twice the sparking distance shall be maintained between goods being painted or *detearred* and electrodes, electrostatic atomizing heads or conductors. A sign stating the sparking distance shall be conspicuously posted near the assembly.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division 1, locations.

**2407.3 Construction of equipment.** Electrodes and electrostatic atomizing heads shall be of *approved* construction, rigidly supported in permanent locations and effectively insulated from ground. Insulators shall be nonporous and noncombustible.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division 1, locations.

**2407.3.1 Barriers.** Booths, fencing, railings or guards shall be placed about the equipment such that either by their location or character, or both, isolation of the process is maintained from plant storage and personnel. Railings, fencing and guards shall be of conductive material, adequately grounded, and not less than 5 feet (1524 mm) from processing equipment.

**Exception:** Portable electrostatic paint-spraying apparatus *listed* for use in Class I, Division 1, locations.

**2407.4 Fire protection.** Areas used for electrostatic spray finishing with fixed equipment shall be protected with an *approved* automatic fire-extinguishing system complying with Chapter 9 and Section 2407.4.1.

**2407.4.1 Protection for automated liquid electrostatic spray application equipment.** Automated liquid electrostatic spray application equipment shall be protected by the installation of an *approved*, supervised flame detection apparatus that shall, in the event of ignition, react to the presence of flame within 0.5 second and shall accomplish all of the following:

1. Activation of a local alarm in the vicinity of the spraying operation and activation of the building alarm system, if such a system is provided.
2. Shutting down of the coating material delivery system.
3. Termination of all spray application operations.
4. Stopping of conveyors into and out of the flammable vapor areas.
5. Disconnection of power to the high-voltage elements in the flammable vapor areas and disconnection of power to the system.

**2407.5 Housekeeping, maintenance and storage of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3, 2403.4 and Sections 2407.5.1 and 2407.5.2.

**2407.5.1 Maintenance.** Insulators shall be kept clean and dry. Drip plates and screens subject to paint deposits shall be removable and taken to a safe place for cleaning. Grounds and bonding means for the paint-spraying appa-



## FLAMMABLE FINISHES

ratus and all associated equipment shall be periodically cleaned and maintained free of overspray.

**2407.5.2 Signs.** Signs shall be posted to provide the following information:

1. Designate the process zone as dangerous with respect to fire and accident.
2. Identify the grounding requirements for all electrically conductive objects in the flammable vapor area, including persons.
3. Restrict access to qualified personnel only.

**2407.6 Sources of ignition.** Transformers, power packs, control apparatus and all other electrical portions of the equipment, except high-voltage grids and electrostatic atomizing heads and connections, shall be located outside of the flammable vapor areas or shall comply with Section 2403.2.

**2407.7 Ventilation.** The flammable vapor area shall be ventilated in accordance with Section 2404.7.

**2407.8 Emergency shutdown.** Electrostatic apparatus shall be equipped with automatic controls operating without time delay to disconnect the power supply to the high-voltage transformer and signal the operator under any of the following conditions:

1. Stoppage of ventilating fans or failure of ventilating equipment from any cause.
2. Stoppage of the conveyor carrying articles past the high-voltage grid.
3. Occurrence of a ground or an imminent ground at any point of the high-voltage system.
4. Reduction of clearance below that required in Section 2407.2.

**2407.9 Ventilation interlock.** Hand electrostatic equipment shall be interlocked with the ventilation system for the spraying area so that the equipment cannot be operated unless the ventilating system is in operation.

### SECTION 2408 ORGANIC PEROXIDES AND DUAL-COMPONENT COATINGS

**2408.1 General.** Spraying operations involving the use of organic peroxides and other dual-component coatings shall be in accordance with the requirements of Section 2403 and Sections 2408.2 through 2408.5.

**2408.2 Use of organic peroxide coatings.** Spraying operations involving the use of organic peroxides and other dual-component coatings shall be conducted in *approved* sprinklered spray booths complying with Section 2404.3.3.

**2408.3 Equipment.** Spray guns and related handling equipment used with organic peroxides shall be of a type manufactured for such use.

**2408.3.1 Pressure tanks.** Separate pressure vessels and inserts specifically for the application shall be used for the resin and for the organic peroxide, and shall not be interchanged. Organic peroxide pressure tank inserts shall be constructed of stainless steel or polyethylene.

**2408.4 Housekeeping, maintenance, storage and use of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4 and Sections 2408.4.1 through 2408.4.7.

**2408.4.1 Contamination prevention.** Organic peroxide initiators shall not be contaminated with foreign substances.

**2408.4.2 Spilled material.** Spilled organic peroxides shall be promptly removed and any residue thereof promptly eliminated. Spilled material absorbed by using a noncombustible absorbent shall be promptly disposed of in accordance with the manufacturer's recommendation.

**2408.4.3 Residue control.** Materials shall not be contaminated by dusts and overspray residues resulting from the sanding or spraying of finishing materials containing organic peroxides.

**2408.4.4 Handling.** Handling of organic peroxides shall be conducted in a manner that avoids shock and friction that produces decomposition and violent reaction hazards.

**2408.4.5 Mixing.** Organic peroxides shall not be mixed directly with accelerators or promoters.

**2408.4.6 Personnel qualifications.** Personnel working with organic peroxides and dual-component coatings shall be specifically trained to work with these materials.

**2408.4.7 Storage.** The storage of organic peroxides shall comply with Chapter 62.

**2408.5 Sources of ignition.** Only nonsparking tools shall be used in areas where organic peroxides are stored, mixed or applied.

### SECTION 2409 INDOOR MANUFACTURING OF REINFORCED PLASTICS

**2409.1 General.** Indoor manufacturing processes involving spray or hand application of reinforced plastics and using more than 5 gallons (19 L) of resin in a 24-hour period shall be in accordance with Sections 2409.2 through 2409.6.1.

**2409.2 Resin application equipment.** Equipment used for spray application of resin shall be installed and used in accordance with Section 2408 and Sections 2409.3 through 2409.6.1.

**2409.3 Fire protection.** Resin application areas shall be protected by an *automatic sprinkler system*. The sprinkler system design shall be not less than that required for Ordinary Hazard, Group 2, with a minimum design area of 3,000 square feet (279 m<sup>2</sup>). Where the materials or storage arrangements are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

**2409.4 Housekeeping, maintenance, storage and use of hazardous materials.** Housekeeping, maintenance, storage and use of hazardous materials shall be in accordance with Sections 2403.3 and 2403.4 and Sections 2409.4.1 through 2409.4.3.

**2409.4.1 Handling of excess catalyzed resin.** A noncombustible, open-top container shall be provided for disposal of excess catalyzed resin. Excess catalyzed resin shall be drained into the container while still in the liquid state. Enough water shall be provided in the container to maintain a minimum 2-inch (51 mm) water layer over the contained resin.

**2409.4.2 Control of overchop.** In areas where chopper guns are used, exposed wall and floor surfaces shall be covered with paper, polyethylene film or other *approved* material to allow for removal of overchop. Overchop shall be allowed to cure for not less than 4 hours prior to removal.

**2409.4.2.1 Disposal.** Following removal, used wall and floor covering materials required by Section 2409.4.2 shall be placed in a noncombustible container and removed from the facility.

**2409.4.3 Storage and use of hazardous materials.** Storage and use of organic peroxides shall be in accordance with Section 2408 and Chapter 62. Storage and use of *flammable* and *combustible liquids* shall be in accordance with Chapter 57. Storage and use of unstable (reactive) materials shall be in accordance with Chapter 66.

**2409.5 Sources of ignition in resin application areas.** Sources of ignition in resin application areas shall comply with Section 2403.2.

**2409.6 Ventilation.** Mechanical ventilation shall be provided throughout resin application areas in accordance with Section 2404.7. The ventilation rate shall be adequate to maintain the concentration of flammable vapors in the resin application area at or below 25 percent of the LFL.

**Exception:** Mechanical ventilation is not required for buildings that have 75 percent of the perimeter unenclosed.

**2409.6.1 Local ventilation.** Local ventilation shall be provided inside of workpieces where personnel will be under or inside of the workpiece.

## SECTION 2410

### FLOOR SURFACING AND FINISHING OPERATIONS

**2410.1 Scope.** Floor surfacing and finishing operations exceeding 350 square feet (33 m<sup>2</sup>) and using Class I or II liquids shall comply with Sections 2410.2 through 2410.5.

**2410.2 Mechanical system operation.** Heating, ventilation and air-conditioning systems shall not be operated during resurfacing or refinishing operations or within 4 hours of the application of *flammable* or *combustible liquids*.

**2410.3 Business operation.** Floor surfacing and finishing operations shall not be conducted while an establishment is open to the public.

**2410.4 Ignition sources.** The power shall be shut down to all electrical sources of ignition within the flammable vapor area, unless those devices are classified for use in Class I, Division 1, hazardous locations.

**2410.5 Ventilation.** To prevent the accumulation of flammable vapors, mechanical ventilation at a minimum rate of 1 cubic foot per minute per square foot [0.00508 m<sup>3</sup>/(s × m<sup>2</sup>)] of area being finished shall be provided. Such exhaust shall be by *approved* temporary or portable means. Vapors shall be exhausted to the exterior of the building.



## CHAPTER 25

# FRUIT AND CROP RIPENING

### User note:

**About this chapter:** Chapter 25 provides guidance that is intended to reduce the likelihood of explosions resulting from improper use or handling of ethylene gas used for crop ripening and coloring processes. This is accomplished by regulating ethylene gas generation, regulating storage and distribution systems and controlling ignition sources. Design and construction of facilities for fruit and crop ripening are regulated by the International Building Code® to reduce the impact of potential accidents to people and buildings.

### SECTION 2501 GENERAL

**2501.1 Scope.** Ripening processes where ethylene gas is introduced into a room to promote the ripening of fruits, vegetables and other crops shall comply with this chapter.

**Exception:** Mixtures of ethylene and one or more inert gases in concentrations that prevent the gas from reaching greater than 25 percent of the lower explosive limit (LEL) when released to the atmosphere.

**2501.2 Permits.** Permits shall be required as set forth in Section 105.5.

**2501.3 Ethylene generators.** *Approved* ethylene generators shall be operated and maintained in accordance with Section 2506.

### SECTION 2502 DEFINITIONS

**2502.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

### SECTION 2503 ETHYLENE GAS

**2503.1 Location.** Ethylene gas shall be discharged only into *approved* rooms or enclosures designed and constructed for this purpose.

**2503.2 Dispensing.** Valves controlling discharge of ethylene shall provide positive and fail-closed control of flow and shall be set to limit the concentration of gas in air below 1,000 parts per million (ppm).

### SECTION 2504 SOURCES OF IGNITION

**2504.1 Ignition prevention.** Sources of ignition shall be controlled or protected in accordance with this section and Chapter 3.

**2504.2 Electrical wiring and equipment.** Electrical wiring and equipment, including luminaires, shall be *approved* for use in Class I, Division 2, Group C hazardous (classified) locations.

**2504.3 Static electricity.** Containers, piping and equipment used to dispense ethylene shall be bonded and grounded to prevent the discharge of static sparks or arcs.

**2504.4 Lighting.** Lighting shall be by *approved* electric lamps or luminaires only.

**2504.5 Heating.** Heating shall be by indirect means utilizing low-pressure steam, hot water or warm air.

**Exception:** Electric or fuel-fired heaters *approved* for use in hazardous (classified) locations and that are installed and operated in accordance with the applicable provisions of NFPA 70, the *International Mechanical Code* or the *International Fuel Gas Code*.

### SECTION 2505 COMBUSTIBLE WASTE

**2505.1 Housekeeping.** Empty boxes, cartons, pallets and other combustible waste shall be removed from ripening rooms or enclosures and disposed of at regular intervals in accordance with Chapter 3.

### SECTION 2506 ETHYLENE GENERATORS

**2506.1 Ethylene generators.** Ethylene generators shall be *listed* and *labeled* by an *approved* testing laboratory, *approved* by the *fire code official* and used only in *approved* rooms in accordance with the ethylene generator manufacturer's instructions. The listing evaluation shall include documentation that the concentration of ethylene gas does not exceed 25 percent of the lower explosive limit (LEL).

**2506.2 Ethylene generator rooms.** Ethylene generators shall be used in rooms having a volume of not less than 1,000 cubic feet (28 m<sup>3</sup>). Rooms shall have air circulation to ensure even distribution of ethylene gas and shall be free from sparks, open flames or other ignition sources.

### SECTION 2507 WARNING SIGNS

**2507.1 Where required.** *Approved* warning signs indicating the danger involved and necessary precautions shall be posted on all doors and entrances to the premises.





## CHAPTER 26

# FUMIGATION AND INSECTICIDAL FOGGING

### User note:

**About this chapter:** Chapter 26 regulates fumigation and insecticidal fogging operations that use toxic pesticide chemicals to kill insects, rodents and other vermin. Fumigants and insecticidal fogging agents pose little hazard if properly applied; however, the inherent toxicity of all these agents and the potential flammability of some make special precautions necessary when they are used. Requirements of this chapter are intended to protect both the public and fire fighters from hazards associated with these products.

### SECTION 2601 GENERAL

**2601.1 Scope.** *Fumigation and insecticidal fogging* operations within buildings, structures and spaces shall comply with this chapter.

**2601.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 2602 DEFINITIONS

**2602.1 Definitions.** The following terms are defined in Chapter 2:

**FUMIGANT.**

**FUMIGATION.**

**INSECTICIDAL FOGGING.**

### SECTION 2603 FIRE SAFETY REQUIREMENTS

**2603.1 General.** Buildings, structures and spaces in which fumigation and insecticidal fogging operations are conducted shall comply with the fire protection and safety requirements of Sections 2603.2 through 2603.7.

**2603.2 Sources of ignition.** Fires, open flames and similar sources of ignition shall be eliminated from the space under fumigation or insecticidal fogging. Heating, where needed, shall be of an *approved* type.

**2603.2.1 Electricity.** Electricity in any part of the building, structure or space where operation of switches or electrical devices, equipment or systems could serve as a source of ignition shall be shut off.

**Exception:** Circulating fans that have been specifically designed for utilization in hazardous atmospheres and installed in accordance with NFPA 70.

**2603.2.2 Electronic devices.** Electronic devices, including portable equipment and cellular phones, shall be shut off. Telephone lines shall be disconnected from telephones.

**2603.2.3 Duration.** Sources of ignition shall be shut off during the fumigation activity and remain shut off until the ventilation required in Section 2603.6 is completed.

**2603.3 Notification.** The *fire code official* and *fire chief* shall be notified in writing not less than 48 hours before the building, structure or space is to be closed in connection with the utilization of any toxic or flammable fumigant. Notification shall give the location of the enclosed space to be fumigated or fogged, the occupancy, the fumigants or insecticides to be utilized, the person or persons responsible for the operation, and the date and time at which the operation will begin. Written notice of any fumigation or insecticidal fogging operation shall be given to all affected occupants of the building, structure or space in which such operations are to be conducted with sufficient advance notice to allow the occupants to evacuate the building, structure or space. Such notice shall inform the occupants as to the purposes, anticipated duration and hazards associated with the fumigation or insecticidal fogging operation.

**2603.3.1 Warning signs.** *Approved* warning signs indicating the danger, type of chemical involved and necessary precautions shall be posted on all doors and entrances to the affected building, structure or space and on all gang-planks and ladders from the deck, pier or land to a ship. Such notices shall be printed in red ink on a white background. Letters in the headlines shall be not less than 2 inches (51 mm) in height and shall state the date and time of the operation, the name and address of the person, the name of the operator in charge, and a warning stating that the affected building, structure or space shall be vacated not less than 1 hour before the operation begins and shall not be reentered until the danger signs have been removed by the proper authorities.

**2603.3.2 Breathing apparatus.** Persons engaged in the business of fumigation or insecticidal fogging shall maintain and have available *approved* protective breathing apparatus.

**2603.3.3 Watch personnel.** During the period fumigation is in progress, except where fumigation is conducted in a gastight vault or tank, a responsible watchperson shall remain on duty at the entrance or entrances to the enclosed fumigated space until after the fumigation is completed and the building, structure or space is properly ventilated and safe for occupancy. Sufficient watchers shall be provided to prevent persons from entering the enclosed space under fumigation without being observed.

**2603.3.4 Evacuation during fumigation.** Occupants of the building, structure or space to be fumigated, except the personnel conducting the fumigation, shall be evacu-

## FUMIGATION AND INSECTICIDAL FOGGING

ated from such building, structure or space prior to commencing fumigation operations.

**2603.3.5 Evacuation during insecticidal fogging operations.** Occupants in the building, structure or space to be fogged, except the personnel conducting the insecticidal fogging operations, shall be evacuated from such building, structure or space prior to commencing fogging operations.

**2603.4 Insecticidal fogging liquids.** Insecticidal fogging liquids with a *flash point* below 100°F (38°C) shall not be utilized.

**2603.5 Sealing of buildings, structures and spaces.** Paper and other similar materials that do not meet the flame propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 shall not be used to wrap or cover a building, structure or space in excess of that required for the sealing of cracks, casements and similar openings.

**2603.5.1 Maintenance of openings.** All openings to the building, structure or space to be fumigated or fogged shall be kept securely closed during such operation.

**2603.6 Venting and cleanup.** At the end of the exposure period, fumigators shall safely and properly ventilate the premises and contents; properly dispose of fumigant containers, residues, debris and other materials used for such fumigation; and clear obstructions from gas-fired appliance vents.

**2603.7 Flammable fumigants restricted.** The use of carbon disulfide and hydrogen cyanide shall be restricted to agricultural fumigation.

## CHAPTER 27

# SEMICONDUCTOR FABRICATION FACILITIES

### User note:

**About this chapter:** Chapter 27 provides requirements that are intended to control hazards associated with the manufacture of electrical circuit boards or microchips, commonly called semiconductors. Though the finished product possesses no unusual hazards, materials commonly associated with semiconductor manufacturing are often quite hazardous and include flammable liquids, pyrophoric and flammable gases, toxic substances and corrosives. The requirements of this chapter are concerned with both life safety and property protection. However, the fire code official should recognize that the risk of extraordinary property damages is far more common than the risk of personal injuries from fire. Section 415.11 of the International Building Code® also addresses these facilities that are classified as Group H-5 occupancies.

### SECTION 2701 GENERAL

**2701.1 Scope.** Semiconductor fabrication facilities and comparable research and development areas classified as Group H-5 shall comply with this chapter and the *International Building Code*. The use, storage and handling of hazardous materials in Group H-5 shall comply with this chapter, other applicable provisions of this code and the *International Building Code*.

**2701.2 Application.** The requirements set forth in this chapter are requirements specific only to Group H-5 and shall be applied as exceptions or additions to applicable requirements set forth elsewhere in this code.

**2701.3 Multiple hazards.** Where a material poses multiple hazards, all hazards shall be addressed in accordance with Section 5001.1.

**2701.4 Existing buildings and existing fabrication areas.** Existing buildings and existing *fabrication areas* shall comply with this chapter, except that transportation and handling of HPM in *corridors* and enclosures for *stairways* and *ramps* shall be allowed where in compliance with Section 2705.3.2 and the *International Building Code*.

**2701.5 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 2702 DEFINITIONS

**2702.1 Definitions.** The following terms are defined in Chapter 2:

**EMERGENCY CONTROL STATION.**

**FABRICATION AREA.**

**GAS DETECTION SYSTEM.**

**HAZARDOUS PRODUCTION MATERIAL (HPM).**

**HPM.**

**HPM ROOM.**

**PASS-THROUGH.**

### SEMICONDUCTOR FABRICATION FACILITY. SERVICE CORRIDOR.

**TOOL.**

**WORKSTATION.**

### SECTION 2703 GENERAL SAFETY PROVISIONS

**2703.1 Emergency control station.** An *emergency control station* shall be provided in accordance with Sections 2703.1.1 through 2703.1.3.

**2703.1.1 Location.** The *emergency control station* shall be located on the premises at an *approved* location outside the fabrication area.

**2703.1.2 Staffing.** Trained personnel shall continuously staff the *emergency control station*.

**2703.1.3 Signals.** The *emergency control station* shall receive signals from emergency equipment and alarm and detection systems. Such emergency equipment and alarm and detection systems shall include, but not be limited to, the following where such equipment or systems are required to be provided either in this chapter or elsewhere in this code:

1. *Automatic sprinkler system* alarm and monitoring systems.
2. Manual fire alarm systems.
3. Emergency alarm systems.
4. Gas detection systems.
5. Smoke detection systems.
6. Emergency power systems.
7. Automatic detection and alarm systems for pyrophoric liquids and Class 3 water-reactive liquids required by Section 2705.2.3.4.
8. Exhaust ventilation flow alarm devices for pyrophoric liquids and Class 3 water-reactive liquids and cabinet exhaust ventilation systems required by Section 2705.2.3.4.



## SEMICONDUCTOR FABRICATION FACILITIES

**2703.2 Systems, equipment and processes.** Systems, equipment and processes shall be in accordance with Sections 2703.2.1 through 2703.2.3.2.

**2703.2.1 Application.** Systems, equipment and processes shall include, but not be limited to, containers, cylinders, tanks, piping, tubing, valves and fittings.

**2703.2.2 General requirements.** In addition to the requirements in Section 2703.2, systems, equipment and processes shall comply with Section 5003.2, other applicable provisions of this code, the *International Building Code* and the *International Mechanical Code*.

**2703.2.3 Additional requirements for HPM supply piping.** In addition to the requirements in Section 2703.2, HPM supply piping and tubing for HPM gases and liquids shall comply with this section.

**2703.2.3.1 General requirements.** The requirements set forth in Section 5003.2.2.2 shall apply to supply piping and tubing for HPM gases and liquids.

**2703.2.3.2 Health-hazard ranking 3 or 4 HPM.** Supply piping and tubing for HPM gases and liquids having a health-hazard ranking of 3 or 4 shall be welded throughout, except for connections located within a ventilation enclosure if the material is a gas, or an *approved* method of drainage or containment provided for connections if the material is a liquid.

**2703.3 Construction requirements.** Construction of semiconductor fabrication facilities shall be in accordance with Sections 2703.3.1 through 2703.3.9.

**2703.3.1 Fabrication areas.** Construction and location of *fabrication areas* shall comply with the *International Building Code*.

**2703.3.2 Pass-throughs in exit access corridors.** Pass-throughs in *exit access corridors* shall be constructed in accordance with the *International Building Code*.

**2703.3.3 Liquid storage rooms.** Liquid storage rooms shall comply with Chapter 57 and the *International Building Code*.

**2703.3.4 HPM rooms.** HPM rooms shall comply with the *International Building Code*.

**2703.3.5 Gas cabinets.** Gas cabinets shall comply with Section 5003.8.6.

**2703.3.6 Exhausted enclosures.** Exhausted enclosures shall comply with Section 5003.8.5.

**2703.3.7 Gas rooms.** Gas rooms shall comply with Section 5003.8.4.

**2703.3.8 Service corridors.** Service corridors shall comply with Section 2705.3 and the *International Building Code*.

**2703.3.9 Cabinets containing pyrophoric liquids or water-reactive Class 3 liquids.** Cabinets in *fabrication areas* containing pyrophoric liquids or Class 3 water-reactive liquids in containers or in amounts greater than  $\frac{1}{2}$  gallon (2 L) shall comply with Section 2705.2.3.4.

**2703.4 Emergency plan.** An emergency plan shall be established as set forth in Section 403.6.1.

**2703.5 Maintenance of equipment, machinery and processes.** Maintenance of equipment, machinery and processes shall comply with Section 5003.2.6.

**2703.6 Security of areas.** Areas shall be secured in accordance with Section 5003.9.2.

**2703.7 Electrical wiring and equipment.** Electrical wiring and equipment in HPM facilities shall comply with Sections 2703.7.1 through 2703.7.3.

**2703.7.1 Fabrication areas.** Electrical wiring and equipment in *fabrication areas* shall comply with NFPA 70.

**2703.7.2 Workstations.** Electrical equipment and devices within 5 feet (1524 mm) of workstations in which flammable or pyrophoric gases or *flammable liquids* are used shall comply with NFPA 70 for Class I, Division 2 hazardous locations. Workstations shall not be energized without adequate exhaust ventilation in accordance with Section 2703.14.

**Exception:** Class I, Division 2 hazardous electrical equipment is not required where the air removal from the workstation or dilution will prevent the accumulation of flammable vapors and fumes on a continuous basis.

**2703.7.3 Hazardous production material (HPM) rooms, gas rooms and liquid storage rooms.** Electrical wiring and equipment in HPM rooms, gas rooms and liquid storage rooms shall comply with NFPA 70.

**2703.8 Corridors and enclosures for stairways and ramps.** Hazardous materials shall not be used or stored in *corridors* or enclosures for *stairways* and *ramps*.

**2703.9 Service corridors.** Hazardous materials shall not be used in an *open-system* use condition in service corridors.

**2703.10 Automatic sprinkler system.** An *approved automatic sprinkler system* shall be provided in accordance with Sections 2703.10.1 through 2703.10.5 and Chapter 9.

**2703.10.1 Workstations and tools.** The design of the sprinkler system in the area shall take into consideration the spray pattern and the effect on the equipment.

**2703.10.1.1 Combustible workstations.** A sprinkler head shall be installed within each branch exhaust connection or individual plenums of workstations of combustible construction. The sprinkler head in the exhaust connection or plenum shall be located not more than 2 feet (610 mm) from the point of the duct connection or the connection to the plenum. Where necessary to prevent corrosion, the sprinkler head and connecting piping in the duct shall be coated with *approved* or *listed* corrosion-resistant materials. Access to the sprinkler head shall be provided for periodic inspection.

### Exceptions:

1. *Approved* alternative automatic fire-extinguishing systems are allowed. Activation

of such systems shall deactivate the related processing equipment.

2. Process equipment that operates at temperatures exceeding 932°F (500°C) and is provided with automatic shutdown capabilities for hazardous materials.
3. Exhaust ducts 10 inches (254 mm) or less in diameter from flammable gas storage cabinets that are part of a workstation.
4. Ducts *listed* or *approved* for use without internal automatic sprinkler protection.

**2703.10.1.2 Combustible tools.** Where the horizontal surface of a combustible tool is obstructed from ceiling sprinkler discharge, automatic sprinkler protection that covers the horizontal surface of the tool shall be provided.

**Exceptions:**

1. An automatic gaseous fire-extinguishing local surface application system shall be allowed as an alternative to sprinklers. Gaseous-extinguishing systems shall be actuated by infrared (IR) or ultraviolet/infrared (UV/IR) optical detectors.
2. Tools constructed of materials that are *listed* as Class 1 or Class 2 in accordance with UL 2360 or *approved* for use without internal fire-extinguishing system protection.

**2703.10.2 Gas cabinets and exhausted enclosures.** An *approved automatic sprinkler system* shall be provided in gas cabinets and exhausted enclosures containing HPM *compressed gases*.

**Exception:** Gas cabinets located in an HPM room other than those cabinets containing pyrophoric gases.

**2703.10.3 Pass-throughs in existing exit access corridors.** Pass-throughs in existing *exit access corridors* shall be protected by an *approved automatic sprinkler system*.

**2703.10.4 Exhaust ducts for HPM.** An *approved automatic sprinkler system* shall be provided in exhaust ducts conveying gases, vapors, fumes, mists or dusts generated from HPM in accordance with this section and the *International Mechanical Code*.

**2703.10.4.1 Metallic and noncombustible nonmetallic exhaust ducts.** An *approved automatic sprinkler system* shall be provided in metallic and noncombustible nonmetallic exhaust ducts where all of the following conditions apply:

1. Where the largest cross-sectional diameter is equal to or greater than 10 inches (254 mm).
2. The ducts are within the building.
3. The ducts are conveying flammable gases, vapors or fumes.

**2703.10.4.2 Combustible nonmetallic exhaust ducts.** An *approved automatic sprinkler system* shall be provided in combustible nonmetallic exhaust ducts

where the largest cross-sectional diameter of the duct is equal to or greater than 10 inches (254 mm).

**Exceptions:**

1. Ducts *listed* or *approved* for applications without *automatic sprinkler system* protection.
2. Ducts not more than 12 feet (3658 mm) in length installed below ceiling level.

**2703.10.4.3 Exhaust connections and plenums of combustible workstations.** Automatic fire-extinguishing system protection for exhaust connections and plenums of combustible workstations shall comply with Section 2703.10.1.1.

**2703.10.4.4 Exhaust duct sprinkler system requirements.** Automatic sprinklers installed in exhaust duct systems shall be hydraulically designed to provide 0.5 gallon per minute (gpm) (1.9 L/min) over an area derived by multiplying the distance between the sprinklers in a horizontal duct by the width of the duct. Minimum discharge shall be 20 gpm (76 L/min) per sprinkler from the five hydraulically most remote sprinklers.

**2703.10.4.4.1 Sprinkler head locations.** Automatic sprinklers shall be installed at 12-foot (3658 mm) intervals in horizontal ducts and at changes in direction. In vertical runs, automatic sprinklers shall be installed at the top and at alternate floor levels.

**2703.10.4.4.2 Control valve.** A separate indicating control valve shall be provided for sprinklers installed in exhaust ducts.

**2703.10.4.4.3 Drainage.** Drainage shall be provided to remove sprinkler water discharged in exhaust ducts.

**2703.10.4.4.4 Corrosive atmospheres.** Where corrosive atmospheres exist, exhaust duct sprinklers and pipe fittings shall be manufactured of corrosion-resistant materials or coated with *approved* materials.

**2703.10.4.4.5 Maintenance and inspection.** Access to sprinklers in exhaust ducts shall be provided for periodic inspection and maintenance.

**2703.10.5 Sprinkler alarms and supervision.** *Automatic sprinkler systems* shall be electrically supervised and provided with alarms in accordance with Chapter 9. *Automatic sprinkler system* alarm and supervisory signals shall be transmitted to the *emergency control station*.

**2703.11 Manual fire alarm system.** A manual fire alarm system shall be installed throughout buildings containing a Group H-5 occupancy. Activation of the alarm system shall initiate a local alarm and transmit a signal to the *emergency control station*. Manual fire alarm systems shall be designed and installed in accordance with Section 907.

**2703.12 Emergency alarm system.** Emergency alarm systems shall be provided in accordance with Sections 2703.12.1 through 2703.12.3, Section 5004.9 and Section 5005.4.4. The *maximum allowable quantity per control area*

## SEMICONDUCTOR FABRICATION FACILITIES

provisions of Section 5004.1 shall not apply to emergency alarm systems required for HPM.

**2703.12.1 Where required.** Emergency alarm systems shall be provided in the areas indicated in Sections 2703.12.1.1 through 2703.12.1.3.

**2703.12.1.1 Service corridors.** An *approved* emergency alarm system shall be provided in service corridors, with not less than one alarm device in the service corridor.

**2703.12.1.2 Corridors and interior exit stairways and ramps.** Emergency alarms for *corridors*, interior *exit stairways* and *ramps* and *exit passageways* shall comply with Section 5005.4.4.

**2703.12.1.3 Liquid storage rooms, HPM rooms and gas rooms.** Emergency alarms for liquid storage rooms, HPM rooms and gas rooms shall comply with Section 5004.9.

**2703.12.2 Alarm-initiating devices.** An *approved* emergency telephone system, local alarm manual pull stations, or other *approved* alarm-initiating devices are allowed to be used as emergency alarm-initiating devices.

**2703.12.3 Alarm signals.** Activation of the emergency alarm system shall sound a local alarm and transmit a signal to the *emergency control station*.

**2703.13 Gas detection systems.** A gas detection system complying with Section 916 shall be provided for HPM gases where the physiological warning threshold level of the gas is at a higher level than the accepted permissible exposure limit (PEL) for the gas and for flammable gases in accordance with Sections 2703.13.1 through 2703.13.2.2.

**2703.13.1 Where required.** A gas detection system shall be provided in the areas identified in Sections 2703.13.1.1 through 2703.13.1.4.

**2703.13.1.1 Fabrication areas.** A gas detection system shall be provided in *fabrication areas* where HPM gas is used in the *fabrication area*.

**2703.13.1.2 HPM rooms.** A gas detection system shall be provided in HPM rooms where HPM gas is used in the room.

**2703.13.1.3 Gas cabinets, exhausted enclosures and gas rooms.** A gas detection system shall be provided in gas cabinets and exhausted enclosures for HPM gas. A gas detection system shall be provided in gas rooms where HPM gases are not located in gas cabinets or exhausted enclosures.

**2703.13.1.4 Corridors.** Where HPM gases are transported in piping placed within the space defined by the walls of a *corridor* and the floor or roof above the *corridor*, a gas detection system shall be provided where piping is located and in the *corridor*.

**Exception:** A gas detection system is not required for occasional transverse crossings of the *corridors* by supply piping that is enclosed in a ferrous pipe or tube for the width of the *corridor*.

**2703.13.2 Gas detection system operation.** The gas detection system shall be capable of monitoring the room, area or equipment in which the HPM gas is located at or below all the following gas concentrations:

1. Immediately dangerous to life and health (IDLH) values where the monitoring point is within an exhausted enclosure, ventilated enclosure or gas cabinet.
2. Permissible exposure limit (PEL) levels where the monitoring point is in an area outside an exhausted enclosure, ventilated enclosure or gas cabinet.
3. For flammable gases, the monitoring detection threshold level shall be vapor concentrations in excess of 25 percent of the lower flammable limit (LFL) where the monitoring is within or outside an exhausted enclosure, ventilated enclosure or gas cabinet.
4. Except as noted in this section, monitoring for highly toxic and toxic gases shall also comply with Chapter 60.

**2703.13.2.1 Alarms.** The gas detection system shall initiate a local alarm and transmit a signal to the *emergency control station* when a short-term hazard condition is detected. The alarm shall be both visible and audible and shall provide warning both inside and outside the area where the gas is detected. The audible alarm shall be distinct from all other alarms.

**2703.13.2.2 Shut off of gas supply.** The gas detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for which gas is detected when a short-term hazard condition is detected. Automatic closure of shutoff valves shall comply with the following:

1. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a room and *compressed gas* containers are not in gas cabinets or exhausted enclosure, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve supplying the manifold for the *compressed gas* container of the specific gas detected shall automatically close.

**Exception:** Where the gas-detection sampling point initiating the gas detection system alarm is at the use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold,



the shutoff valve for the branch line located in the piping distribution manifold enclosure shall automatically close.

**2703.14 Exhaust ventilation systems for HPM.** Exhaust ventilation systems and materials for exhaust ducts utilized for the exhaust of HPM shall comply with Sections 2703.14.1 through 2703.14.3, other applicable provisions of this code, the *International Building Code* and the *International Mechanical Code*.

**2703.14.1 Where required.** Exhaust ventilation systems shall be provided in the following locations in accordance with the requirements of this section and the *International Building Code*:

1. *Fabrication areas:* Exhaust ventilation for *fabrication areas* shall comply with the *International Building Code*. The *fire code official* is authorized to require additional manual control switches.
2. *Workstations:* A ventilation system shall be provided to capture and exhaust gases, fumes and vapors at workstations.
3. *Liquid storage rooms:* Exhaust ventilation for liquid storage rooms shall comply with Section 5004.3.1 and the *International Building Code*.
4. *HPM rooms:* Exhaust ventilation for HPM rooms shall comply with Section 5004.3.1 and the *International Building Code*.
5. *Gas cabinets:* Exhaust ventilation for gas cabinets shall comply with Section 5003.8.6.2. The gas cabinet ventilation system is allowed to connect to a workstation ventilation system. Exhaust ventilation for gas cabinets containing highly toxic or toxic gases shall also comply with Chapter 60.
6. *Exhausted enclosures:* Exhaust ventilation for exhausted enclosures shall comply with Section 5003.8.5.2. Exhaust ventilation for exhausted enclosures containing highly toxic or toxic gases shall also comply with Chapter 60.
7. *Gas rooms:* Exhaust ventilation for gas rooms shall comply with Section 5003.8.4.2. Exhaust ventilation for gas rooms containing highly toxic or toxic gases shall also comply with Chapter 60.
8. *Cabinets containing pyrophoric liquids or Class 3 water-reactive liquids:* Exhaust ventilation for cabinets in *fabrication areas* containing pyrophoric liquids or Class 3 water-reactive liquids shall be as required in Section 2705.2.3.4.

**2703.14.2 Penetrations.** Exhaust ducts penetrating *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code* shall be contained in a shaft of equivalent *fire-resistance-rated* construction. Exhaust ducts shall not penetrate *fire walls*. *Fire dampers* shall not be installed in exhaust ducts.

**2703.14.3 Treatment systems.** Treatment systems for highly toxic and toxic gases shall comply with Chapter 60.

**2703.15 Emergency power system.** An emergency power system shall be provided in Group H-5 occupancies in accordance with Section 1203. The emergency power system shall supply power automatically to the electrical systems specified in Section 2703.15.1 when the normal supply system is interrupted.

**2703.15.1 Required electrical systems.** Emergency power shall be provided for electrically operated equipment and connected control circuits for the following systems:

1. HPM exhaust ventilation systems.
2. HPM gas cabinet ventilation systems.
3. HPM exhausted enclosure ventilation systems.
4. HPM gas room ventilation systems.
5. HPM gas detection systems.
6. Emergency alarm systems.
7. Manual fire alarm systems.
8. *Automatic sprinkler system* monitoring and alarm systems.
9. Automatic alarm and detection systems for pyrophoric liquids and Class 3 water-reactive liquids required in Section 2705.2.3.4.
10. Flow alarm switches for pyrophoric liquids and Class 3 water-reactive liquids cabinet exhaust ventilation systems required in Section 2705.2.3.4.
11. Electrically operated systems required elsewhere in this code or in the *International Building Code* applicable to the use, storage or handling of HPM.

**2703.15.2 Exhaust ventilation systems.** Exhaust ventilation systems are allowed to be designed to operate at not less than one-half the normal fan speed on the emergency power system where it is demonstrated that the level of exhaust will maintain a safe atmosphere.

**2703.16 Sub-atmospheric pressure gas systems.** Sub-atmospheric pressure gas systems (SAGS) shall be in accordance with NFPA 318.

## SECTION 2704 STORAGE

**2704.1 General.** Storage of hazardous materials shall comply with Section 2703 and this section and other applicable provisions of this code.

**2704.2 Fabrication areas.** Hazardous materials storage and the maximum quantities of hazardous materials in use and storage allowed in *fabrication areas* shall be in accordance with Sections 2704.2.1 through 2704.2.2.1.



## SEMICONDUCTOR FABRICATION FACILITIES

**2704.2.1 Location of HPM storage in fabrication areas.** Storage of HPM in *fabrication areas* shall be within *approved* or *listed* storage cabinets, gas cabinets, exhausted enclosures or within a workstation as follows:

1. *Flammable* and *combustible liquid* storage cabinets shall comply with Section 5704.3.2.
2. Hazardous materials storage cabinets shall comply with Section 5003.8.7.
3. Gas cabinets shall comply with Section 5003.8.6. Gas cabinets for highly toxic or toxic gases shall also comply with Section 6004.1.2.
4. Exhausted enclosures shall comply with Section 5003.8.5. Exhausted enclosures for highly toxic or toxic gases shall also comply with Section 6004.1.3.
5. Workstations shall comply with Section 2705.2.3.

**2704.2.2 Maximum aggregate quantities in fabrication areas.** The aggregate quantities of hazardous materials stored or used in a single *fabrication area* shall be limited as specified in this section.

**Exception:** *Fabrication areas* containing quantities of hazardous materials not exceeding the maximum allowable quantities per *control area* established by Sections 5003.1.1, 5704.3.4 and 5704.3.5.

**2704.2.2.1 Storage and use in fabrication areas.** The maximum quantities of hazardous materials stored or used in a single *fabrication area* shall not exceed the quantities set forth in Table 2704.2.2.1.

**2704.3 Indoor storage outside of fabrication areas.** The indoor storage of hazardous materials outside of *fabrication areas* shall be in accordance with Sections 2704.3.1 through 2704.3.3.

**2704.3.1 HPM storage.** The indoor storage of HPM in quantities greater than those listed in Sections 5003.1.1 and 5704.3.4 shall be in a room complying with the requirements of the *International Building Code* and this code for a liquid storage room, HPM room or gas room as appropriate for the materials stored.

**2704.3.2 Other hazardous materials storage.** The indoor storage of other hazardous materials shall comply with Sections 5001, 5003 and 5004 and other applicable provisions of this code.

**2704.3.3 Separation of incompatible hazardous materials.** Incompatible hazardous materials in storage shall be separated from each other in accordance with Section 5003.9.8.

## SECTION 2705 USE AND HANDLING

**2705.1 General.** The use and handling of hazardous materials shall comply with this section, Section 2703 and other applicable provisions of this code.

**2705.2 Fabrication areas.** The use of hazardous materials in *fabrication areas* shall be in accordance with Sections 2705.2.1 through 2705.2.3.4.

**2705.2.1 Location of HPM in use in fabrication areas.** Hazardous production materials in use in *fabrication areas* shall be within *approved* or *listed* gas cabinets, exhausted enclosures or a workstation.

**2705.2.2 Maximum aggregate quantities in fabrication areas.** The aggregate quantities of hazardous materials in a single *fabrication area* shall comply with Section 2704.2.2 and Table 2704.2.2.1. The quantity of HPM in use at a workstation shall not exceed the quantities listed in Table 2705.2.2.

**2705.2.3 Workstations.** Workstations in *fabrication areas* shall be in accordance with Sections 2705.2.3.1 through 2705.2.3.4.

**2705.2.3.1 Construction.** Workstations in *fabrication areas* shall be constructed of materials compatible with the materials used and stored at the workstation. The portion of the workstation that serves as a cabinet for HPM gases, Class I *flammable liquids* or Class II or Class IIIA *combustible liquids* shall be noncombustible and, if of metal, shall be not less than 0.0478-inch (18 gage) (1.2 mm) steel.

**2705.2.3.2 Protection of vessels.** Vessels containing hazardous materials located in or connected to a workstation shall be protected as follows:

1. HPM: Vessels containing HPM shall be protected from physical damage and shall not project from the workstation.
2. Hazardous *cryogenic fluids*, gases and liquids: Hazardous *cryogenic fluid*, gas and liquid vessels located within a workstation shall be protected from seismic forces in an *approved* manner in accordance with the *International Building Code*.
3. *Compressed gases*: Protection for *compressed gas* vessels shall also comply with Section 5303.5.
4. *Cryogenic fluids*: Protection for *cryogenic fluid* vessels shall also comply with Section 5503.5.

**2705.2.3.3 Drainage and containment for HPM liquids.** Each workstation utilizing HPM liquids shall have all of the following:

1. Drainage piping systems connected to a compatible system for disposition of such liquids.
2. The work surface provided with a slope or other means for directing spilled materials to the containment or drainage system.
3. An *approved* means of containing or directing spilled or leaked liquids to the drainage system.

## SEMICONDUCTOR FABRICATION FACILITIES

**TABLE 2704.2.2.1**  
**QUANTITY LIMITS FOR HAZARDOUS MATERIALS IN A SINGLE FABRICATION AREA IN GROUP H-5<sup>a</sup>**

HAZARD CATEGORY	SOLIDS (pounds per square foot)	LIQUIDS (gallons per square foot)	GAS (cubic feet @ NTP per square foot)
<b>Physical-Hazard Materials</b>			
Combustible dust	Note b	Not Applicable	Not Applicable
Combustible fiber			
Loose	Note b	Not Applicable	Not Applicable
Baled	Notes b and c		
Combustible liquid			
Class II	Not Applicable	0.01	Not Applicable
Class IIIA		0.02	
Class IIIB		Not Limited	
Combination Class I, II and IIIA		0.04	
Cryogenic gas			
Flammable	Not Applicable	Not Applicable	Note d
Oxidizing			1.25
Explosives	Note b	Note b	Note b
Flammable gas			
Gaseous	Not Applicable	Not Applicable	Note d
Liquefied			Note d
Flammable liquid			
Class IA	Not Applicable	0.0025	Not Applicable
Class IB		0.025	
Class IC		0.025	
Combination Class IA, IB and IC		0.025	
Combination Class I, II and IIIA		0.04	
Flammable solid	0.001	Not Applicable	Not Applicable
Organic peroxide			
Unclassified detonable	Note b	Not Applicable	Not Applicable
Class I	Note b		
Class II	0.025		
Class III	0.1		
Class IV	Not Limited		
Class V	Not Limited		
Oxidizing gas			
Gaseous	Not Applicable	Not Applicable	1.25
Liquefied			1.25
Combination of gaseous and liquefied			1.25
Oxidizer			
Class 4	Note b	Note b	Not Applicable
Class 3	0.003	0.03	
Class 2	0.003	0.03	
Class 1	0.003	0.03	
Combination Class 1, 2, 3	0.003	0.03	
Pyrophoric materials	0.01	0.00125	Notes d and e
Unstable (reactive)			
Class 4	Note b	Note b	Note b
Class 3	0.025	0.0025	Note b
Class 2	0.1	0.01	Note b
Class 1	Not Limited	Not Limited	Not Limited
Water reactive			
Class 3	0.01 <sup>f</sup>	0.00125	Not Applicable
Class 2	0.25	0.025	
Class 1	Not Limited	Not Limited	

(continued)

## SEMICONDUCTOR FABRICATION FACILITIES

**TABLE 2704.2.2.1—continued**  
**QUANTITY LIMITS FOR HAZARDOUS MATERIALS IN A SINGLE FABRICATION AREA IN GROUP H-5<sup>a</sup>**

HAZARD CATEGORY	SOLIDS (pounds per square foot)	LIQUIDS (gallons per square foot)	GAS (cubic feet @ NTP per square foot)
<b>Health-Hazard Materials</b>			
Corrosives	Not Limited	Not Limited	Not Limited
Highly toxic	Not Limited	Not Limited	Note d
Toxics	Not Limited	Not Limited	Note d

For SI: 1 pound = 0.454 kg, 1 pound per square foot = 4.882 kg/m<sup>2</sup>, 1 gallon per square foot = 40.7 L/m<sup>2</sup>, 1 cubic foot @ NTP/square foot = 0.305 m<sup>3</sup> @ NTP/m<sup>2</sup>, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. Hazardous materials within piping shall not be included in the calculated quantities.
- b. Quantity of hazardous materials in a single fabrication area shall not exceed the maximum allowable quantities per control area in Tables 5003.1.1(1) and 5003.1.1(2).
- c. Densely packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- d. The aggregate quantity of flammable, pyrophoric, toxic and highly toxic gases shall not exceed the greater of 0.2 cubic feet at NTP/square foot or 9,000 cubic feet at NTP.
- e. The aggregate quantity of pyrophoric gases in the building shall not exceed the amounts set forth in Table 5003.8.2.
- f. Quantity of Class 3 water-reactive solids in a single tool shall not exceed 1 pound.

**2705.2.3.4 Pyrophoric solids, liquids and Class 3 water-reactive liquids.** Pyrophoric liquids and Class 3 water-reactive liquids in containers greater than 0.5-gallon (2 L) but not exceeding 5.3-gallon (20 L) capacity and pyrophoric solids in containers greater than 4.4 pounds (2 kg) but not exceeding 44 pounds (20 kg) shall be allowed at workstations where located inside cabinets and the following conditions are met:

1. Maximum amount per cabinet: The maximum amount per cabinet shall be limited to 5.3 gallons (20 L) of liquids and 44 pounds (20 kg) of total liquids and solids.
2. Cabinet construction: Cabinets shall be constructed in accordance with the following:
  - 2.1. Cabinets shall be constructed of not less than 0.097-inch (2.5 mm) (12 gage) steel.
  - 2.2. Cabinets shall be permitted to have self-closing limited access ports or noncombustible windows that provide access to equipment controls.
  - 2.3. Cabinets shall be provided with self- or manual-closing doors. Manual-closing doors shall be equipped with a door switch that will initiate local audible and visual alarms when the door is in the open position.
3. Cabinet exhaust ventilation system: An exhaust ventilation system shall be provided for cabinets and shall comply with the following:
  - 3.1. The system shall be designed to operate at a negative pressure in relation to the surrounding area.
  - 3.2. The system shall be equipped with monitoring equipment to ensure that required exhaust flow or static pressure is provided.
  - 3.3. Low-flow or static pressure conditions shall send an alarm to the on-site *emer-*

*gency control station.* The alarm shall be both visual and audible.

4. Cabinet spill containment: Spill containment shall be provided in each cabinet, with the spill containment capable of holding the contents of the aggregate amount of liquids in containers in each cabinet.
5. Valves: Valves in supply piping between the product containers in the cabinet and the workstation served by the containers shall fail in the closed position upon power failure, loss of exhaust ventilation and upon actuation of the fire control system.
6. Fire detection system: Each cabinet shall be equipped with an automatic fire detection system complying with the following conditions:
  - 6.1. Automatic detection system: UV/IR, high-sensitivity smoke detection (HSSD) or other *approved* detection systems shall be provided inside each cabinet.
  - 6.2. Automatic shutoff: Activation of the detection system shall automatically close the shutoff valves at the source on the liquid supply.
  - 6.3. Alarms and signals: Activation of the detection system shall initiate a local alarm within the *fabrication area* and transmit a signal to the *emergency control station*. The alarms and signals shall be both visual and audible.

**2705.3 Transportation and handling.** The transportation and handling of hazardous materials shall comply with Sections 2705.3.1 through 2705.3.4.1 and other applicable provisions of this code.

**2705.3.1 Corridors and enclosures for stairways and ramps.** *Corridors* and enclosures for *exit stairways* and *ramps* in new buildings or serving new *fabrication areas* shall not contain HPM, except as permitted in *corridors*

**TABLE 2705.2.2**  
**MAXIMUM QUANTITIES OF HPM AT A WORKSTATION<sup>d</sup>**

HPM CLASSIFICATION	STATE	MAXIMUM QUANTITY
Flammable, highly toxic, pyrophoric and toxic combined	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
Flammable	Liquid	15 gallons <sup>a, b</sup>
	Solid	5 pounds <sup>a, b</sup>
Corrosive	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
	Liquid	Use-open system: 25 gallons <sup>b</sup> Use-closed system: 150 gallons <sup>b, e</sup>
	Solid	20 pounds <sup>a, b</sup>
Highly toxic	Liquid	15 gallons <sup>a, b</sup>
	Solid	5 pounds <sup>a, b</sup>
Oxidizer	Gas	Combined aggregate volume of all cylinders at a workstation shall not exceed an internal cylinder volume of 39.6 gallons or 5.29 cubic feet
	Liquid	Use-open system: 12 gallons <sup>b</sup> Use-closed system: 60 gallons <sup>b</sup>
	Solid	20 pounds <sup>a, b</sup>
Pyrophoric	Liquid	0.5 gallon <sup>c, f</sup>
	Solid	4.4 pounds <sup>c, f</sup>
Toxic	Liquid	Use-open system: 15 gallons <sup>b</sup> Use-closed system: 60 gallons <sup>b</sup>
	Solid	5 pounds <sup>a, b</sup>
Unstable reactive Class 3	Liquid	0.5 gallon <sup>a, b</sup>
	Solid	5 pounds <sup>a, b</sup>
Water-reactive Class 3	Liquid	0.5 gallon <sup>c, f</sup>
	Solid	See Table 2704.2.2.1

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L.

- Maximum allowable quantities shall be increased 100 percent for closed system operations. Where Note b applies, the increase for both notes shall be allowed.
- Quantities shall be allowed to be increased 100 percent where workstations are internally protected with an approved automatic fire-extinguishing or suppression system complying with Chapter 9. Where Note a applies, the increase for both notes shall be allowed. Where Note e applies, the maximum increase allowed for both Notes b and e shall not exceed 100 percent.
- Allowed only in workstations that are internally protected with an approved automatic fire-extinguishing or fire protection system complying with Chapter 9 and compatible with the reactivity of materials in use at the workstation.
- The quantity limits apply only to materials classified as HPM.
- Quantities shall be allowed to be increased 100 percent for nonflammable, noncombustible corrosive liquids where the materials of construction for workstations are listed or approved for use without internal fire-extinguishing or suppression system protection. Where Note b applies, the maximum increase allowed for both Notes b and e shall not exceed 100 percent.
- A maximum quantity of 5.3 gallons of liquids and 44 pounds of total liquids and solids shall be allowed at a workstation where conditions are in accordance with Section 2705.2.3.4.

by Section 415.11.7.4 of the *International Building Code* and Section 2705.3.2 of this code.

**2705.3.2 Transport in corridors and enclosures for stairways and ramps.** Transport in *corridors* and enclosures for *stairways* and *ramps* shall be in accordance with Sections 2705.3.2.1 through 2705.3.3.

**2705.3.2.1 Fabrication area alterations.** Where existing *fabrication areas* are altered or modified in existing buildings, HPM is allowed to be transported in existing *corridors* where such *corridors* comply with Section 5003.10 of this code and Section 415.11.2 of the *International Building Code*.

**2705.3.2.2 HPM transport in corridors and enclosures for stairways and ramps.** Nonproduction HPM is allowed to be transported in *corridors* and enclosures for *stairways* and *ramps* where utilized for maintenance, lab work and testing when the transportation is in accordance with Section 5003.10.

**2705.3.3 Service corridors.** Where a new *fabrication area* is constructed, a service corridor shall be provided where it is necessary to transport HPM from a liquid storage room, HPM room, gas room or from the outside of a building to the perimeter wall of a *fabrication area*. Service corridors shall be designed and constructed in accordance with the *International Building Code*.



**SEMICONDUCTOR FABRICATION FACILITIES**

**2705.3.4 Carts and trucks.** Carts and trucks used to transport HPM in *corridors* and enclosures for *stairways* and *ramps* shall comply with Section 5003.10.3.

**2705.3.4.1 Identification.** Carts and trucks shall be marked to indicate the contents.

## CHAPTER 28

# LUMBER YARDS AND AGRO-INDUSTRIAL, SOLID BIOMASS AND WOODWORKING FACILITIES

### User note:

**About this chapter:** Chapter 28 provides requirements that are intended to prevent fires and explosions, facilitate fire control and reduce exposures to and from facilities storing, selling or processing wood and forest products, including sawdust, wood chips, shavings, bark mulch, shorts, finished planks, sheets, posts, poles, timber and raw logs and the hazard they represent once ignited. Also included are solid biomass feedstock and raw products associated with agro-industrial facilities and the outdoor storage of pallets at pallet manufacturing and recycling facilities. This chapter requires active and passive fire protection features to reduce on- and off-site exposures, limit fire size and development and facilitate fire fighting by employees and the fire service.

### SECTION 2801 GENERAL

**2801.1 Scope.** The storage, manufacturing and processing of solid biomass feedstock, timber, lumber, plywood, veneers and agro-industrial byproducts shall be in accordance with this chapter.

**2801.2 Permit.** Permits shall be required as set forth in Section 105.5.

### SECTION 2802 DEFINITIONS

**2802.1 Definitions.** The following terms are defined in Chapter 2:

AGRO-INDUSTRIAL.

BIOMASS.

COLD DECK.

FINES.

HOGGED MATERIALS.

PLYWOOD AND VENEER MILLS.

RAW PRODUCT.

SOLID BIOFUEL.

SOLID BIOMASS FEEDSTOCK.

STATIC PILES.

TIMBER AND LUMBER PRODUCTION FACILITIES.

### SECTION 2803 GENERAL REQUIREMENTS

**2803.1 Open yards.** Open yards required by the *International Building Code* shall be maintained around structures.

**2803.2 Dust control.** Equipment or machinery located inside buildings that generates or emits *combustible dust* shall be provided with an *approved* dust collection and

exhaust system installed in accordance with Chapter 22 and the *International Mechanical Code*. Equipment or systems that are used to collect, process or convey *combustible dusts* shall be provided with an *approved* explosion control system.

**2803.2.1 Explosion venting.** Where a dust explosion hazard exists in equipment rooms, buildings or other enclosures, such areas shall be provided with explosion (*deflagration*) venting or an *approved* explosion suppression system complying with Section 911.

**2803.3 Waste removal.** Sawmills, planing mills and other woodworking plants shall be equipped with a waste removal system that will collect and remove sawdust and shavings. Such systems shall be installed in accordance with Chapter 22 and the *International Mechanical Code*.

**Exception:** Manual waste removal where *approved*.

**2803.3.1 Housekeeping.** Provisions shall be made for a systematic and thorough cleaning of the entire plant at sufficient intervals to prevent the accumulations of *combustible dust* and spilled *combustible* or *flammable liquids*.

**2803.3.2 Metal scrap.** Provision shall be made for separately collecting and disposing of any metal scrap so that such scrap will not enter the wood handling or processing equipment.

**2803.4 Electrical equipment.** Electrical wiring and equipment shall comply with NFPA 70.

**2803.5 Control of ignition sources.** Protection from ignition sources shall be provided in accordance with Sections 2803.5.1 through 2803.5.3.

**2803.5.1 Cutting and welding.** Cutting and welding shall comply with Chapter 35.

**2803.5.2 Static electricity.** Static electricity shall be prevented from accumulating on machines and equipment subject to static electricity buildup by permanent grounding and bonding wires or other *approved* means.

## LUMBER YARDS AND AGRO-INDUSTRIAL, SOLID BIOMASS AND WOODWORKING FACILITIES

**2803.5.3 Smoking.** Where smoking constitutes a fire hazard, the *fire code official* is authorized to order the owner or occupant to post *approved* “No Smoking” signs complying with Section 310. The *fire code official* is authorized to designate specific locations where smoking is allowed.

**2803.6 Fire apparatus access roads.** Fire apparatus access roads shall be provided for buildings and facilities in accordance with Section 503.

**2803.7 Access plan.** Where storage pile configurations could change because of changes in product operations and processing, the access plan shall be submitted for approval where required by the *fire code official*.

## SECTION 2804 FIRE PROTECTION

**2804.1 General.** Fire protection in timber and lumber production mills, plywood and veneer mills and agro-industrial facilities shall comply with Sections 2804.2 through 2804.4.

**2804.2 Fire alarms.** An *approved* means for transmitting alarms to the fire department shall be provided in timber and lumber production mills and plywood and veneer mills.

**2804.2.1 Manual fire alarms.** A manual fire alarm system complying with Section 907.2 shall be installed in areas of timber and lumber production mills and for plywood and veneer mills that contain product dryers.

**Exception:** Where dryers or other sources of ignition are protected by a supervised *automatic sprinkler system* complying with Section 903.

**2804.3 Portable fire extinguishers or standpipes and hose.** Portable fire extinguishers or standpipes and hose supplied from an *approved* water system shall be provided within a 50-foot (15 240 mm) distance of travel from any machine producing shavings or sawdust. Portable fire extinguishers shall be provided in accordance with Section 906 for extra-high hazards.

**2804.4 Automatic sprinkler systems.** *Automatic sprinkler systems* shall be installed in accordance with Section 903.3.1.1.

## SECTION 2805 PLYWOOD, VENEER AND COMPOSITE BOARD MILLS

**2805.1 General.** Plant operations of plywood, veneer and composite board mills shall comply with Sections 2805.2 and 2805.3.

**2805.2 Dryer protection.** Dryers shall be protected throughout by an *approved*, automatic deluge water-spray suppression system complying with Chapter 9. Deluge heads shall be inspected quarterly for pitch buildup. Deluge heads shall be flushed during regular maintenance for functional operation. Manual activation valves shall be located within 75 feet (22 860 mm) of the drying equipment.

**2805.3 Thermal oil-heating systems.** Facilities that use heat transfer fluids to provide process equipment heat through piped, indirect heating systems shall comply with this code and NFPA 664.

## SECTION 2806 LOG STORAGE AREAS

**2806.1 General.** Log storage areas shall comply with Sections 2806.2 and 2806.3.

**2806.2 Cold decks.** Cold decks shall not exceed 500 feet (152.4 m) in length, 300 feet (91 440 mm) in width and 20 feet (6096 mm) in height. Cold decks shall be separated from adjacent cold decks or other exposures by not less than 100 feet (30 480 mm).

**Exception:** The size of cold decks shall be determined by the *fire code official* where the decks are protected by special fire protection including, but not limited to, additional fire flow, portable turrets and deluge sets, and hydrant hose houses equipped with *approved* fire-fighting equipment capable of reaching the entire storage area in accordance with Chapter 9.

**2806.3 Pile stability.** Log and pole piles shall be stabilized by *approved* means.

## SECTION 2807 STORAGE OF WOOD CHIPS AND HOGGED MATERIALS ASSOCIATED WITH TIMBER AND LUMBER PRODUCTION FACILITIES

**2807.1 General.** The storage of wood chips and hogged materials associated with timber and lumber production facilities shall comply with Sections 2807.2 through 2807.5.

**2807.2 Size of piles.** Piles shall not exceed 60 feet (18 288 mm) in height, 300 feet (91 440 mm) in width and 500 feet (152 m) in length. Piles shall be separated from adjacent piles or other exposures by *approved* fire apparatus access roads.

**Exception:** The *fire code official* is authorized to allow the pile size to be increased where additional fire protection is provided in accordance with Chapter 9. The increase shall be based on the capabilities of the system installed.

**2807.3 Pile fire protection.** Automatic sprinkler protection shall be provided in conveyor tunnels and combustible enclosures that pass under a pile. Combustible or enclosed conveyor systems shall be equipped with an *approved automatic sprinkler system*.

**2807.4 Material-handling equipment.** *Approved* material-handling equipment shall be readily available for moving wood chips and hogged material.

**2807.5 Emergency plan.** The owner or operator shall develop a plan for monitoring, controlling and extinguishing spot fires. The plan shall be submitted to the *fire code official* for review and approval.

## SECTION 2808 STORAGE AND PROCESSING OF WOOD CHIPS, HOGGED MATERIALS, FINES, COMPOST, SOLID BIOMASS FEEDSTOCK AND RAW PRODUCT ASSOCIATED WITH YARD WASTE, AGRO- INDUSTRIAL AND RECYCLING FACILITIES

**2808.1 General.** The storage and processing of wood chips, hogged materials, fines, compost, solid biomass feedstock and raw product produced from yard waste, debris and agro-industrial and recycling facilities shall comply with Sections 2808.2 through 2808.10.

**2808.2 Storage site.** Storage sites shall be level and on solid ground, elevated soil lifts or other all-weather surface. Sites shall be thoroughly cleaned before transferring wood products to the site.

**2808.3 Size of piles.** Piles shall not exceed 25 feet (7620 mm) in height, 150 feet (45 720 mm) in width and 250 feet (76 200 mm) in length. Stackable products shall not be stacked in excess of 25 feet (7620 mm) in height, 80 feet (24 384 mm) in width and 250 feet (76 200 mm) in length.

**2808.3.1 Increase in pile or stack size.** Piles or stackable products are permitted to be increased beyond the dimensions in Section 2808.3 provided that a written fire protection plan is *approved* by the *fire code official*. The fire protection plan shall include, but not be limited to, the following:

1. Contact information for after-hours response by facility personnel.
2. Storage yard areas and material-handling equipment selection, pile design and arrangement shall be based on sound safety and fire protection principles.
3. Fire apparatus access roads around the piles or stacks and access roads to the top of piles, if applicable, shall be established, identified and maintained.
4. The potential for spontaneous heating shall be evaluated and provisions made to control the temperature of the piles. Methods for monitoring the internal temperature of the pile shall be provided.
5. Routine yard inspections shall be conducted by trained personnel.
6. A means for early fire detection and reporting to the public fire department shall be provided.
7. Facilities and equipment needed by the fire department for fire extinguishment shall be provided, including a water supply in compliance with Section 507 and heavy equipment necessary to move material.
8. A de-inventory plan shall be utilized to remove alternating piles or stacked products in a manner to increase the separation distances between the remaining piles or stacks.

9. The increased pile size shall be based on the capabilities of the installed fire protection systems and features.
10. A controlled burn area shall be provided on-site for smoldering or damaged product.

**2808.4 Pile separation.** Piles or stacked product shall be separated from buildings, property lines and adjacent piles or stacks by a distance of not less than one and one-half times the height of the pile or stack. The distance between rows shall be a minimum of 30 feet (9144 mm). *Approved* fire apparatus access roads shall be provided within the separation space in accordance with Section 503.

**2808.5 Combustible waste.** The storage, accumulation and handling of combustible materials and control of vegetation shall comply with Chapter 3.

**2808.6 Static pile protection.** Static piles shall be monitored by an *approved* means to measure temperatures within the static piles. Internal pile temperatures shall be monitored and recorded weekly. Such records shall be maintained. An operational plan indicating procedures and schedules for the inspection, monitoring and restricting of excessive internal temperatures in static piles shall be submitted to the *fire code official* for review and approval.

**2808.7 Pile fire protection.** Automatic sprinkler protection shall be provided in conveyor tunnels and combustible enclosures that pass under a pile. Combustible conveyor systems and enclosed conveyor systems shall be equipped with an *approved automatic sprinkler system*.

**2808.8 Fire extinguishers.** Portable fire extinguishers complying with Section 906 and with a minimum rating of 4-A:60-B:C shall be provided on all vehicles and equipment operating on piles and at all processing equipment.

**2808.9 Material-handling equipment.** *Approved* material-handling equipment shall be available for moving wood chips, hogged material, wood fines and raw product during fire-fighting operations.

**2808.10 Emergency plan.** The *owner* or operator shall develop a plan for monitoring, controlling and extinguishing spot fires and submit the plan to the *fire code official* for review and approval.

## SECTION 2809 EXTERIOR STORAGE OF FINISHED LUMBER AND SOLID BIOFUEL PRODUCTS

**2809.1 General.** Exterior storage of finished lumber and solid biofuel products shall comply with Sections 2809.2 through 2809.5.

**2809.2 Size of piles.** Exterior storage shall be arranged to form stable piles with a maximum height of 20 feet (6096 mm). Piles shall not exceed 150,000 cubic feet (4248 m<sup>3</sup>) in volume.

**2809.3 Fire apparatus access roads.** Fire apparatus access roads in accordance with Section 503 shall be located so that a maximum grid system unit of 50 feet by 150 feet (15 240 mm by 45 720 mm) is established.



## LUMBER YARDS AND AGRO-INDUSTRIAL, SOLID BIOMASS AND WOODWORKING FACILITIES

**2809.4 Security.** Permanent storage areas shall be surrounded with an *approved* fence. Fences shall be not less than 6 feet (1829 mm) in height.

### Exceptions:

1. Lumber piles inside of buildings and production mills for lumber, plywood and veneer.
2. Solid biofuel piles inside of buildings and agro-industrial processing facilities for solid biomass feedstock.

**2809.5 Fire protection.** An *approved* hydrant and hose system or portable fire-extinguishing equipment suitable for the fire hazard involved shall be provided for open storage yards. Hydrant and hose systems shall be installed in accordance with NFPA 24. Portable fire extinguishers complying with Section 906 shall be located so that the distance of travel from the nearest unit does not exceed 75 feet (22 860 mm).

## SECTION 2810 OUTDOOR STORAGE OF PALLETS AT PALLET MANUFACTURING AND RECYCLING FACILITIES

**2810.1 General.** The outside storage of wood pallets and wood composite pallets on the same site as a pallet manufacturing or pallet recycling facility shall comply with Sections 2810.2 through 2810.11.

**2810.2 Site plan.** Each site shall maintain a current site plan. The site plan shall be submitted to the *fire code official* for approval and contain all of the following:

1. *Lot lines.*
2. *Utilities.*
3. Size, location and type of construction of the buildings on the property.
4. Presence of the *fire protection systems.*
5. Water supply sources for fire-fighting purposes.
6. Location of hazardous material storage areas.
7. Location of pallet storage.
8. Equipment protected with a dust collection system.
9. *Fire apparatus access roads.*
10. Designated smoking areas.
11. Location of fire alarm control panels.

**2810.3 Fire prevention plan.** The *owner* or *owner's* authorized representative shall submit a fire prevention plan for review and approval by the *fire code official* that includes all of the following:

1. Frequency of walk-through inspections to verify compliance with the plan.
2. Hot work permit program in accordance with Chapter 35.
3. Preventative maintenance program for equipment associated with pallet activities.
4. Inspection, testing and maintenance of *fire protection systems* in accordance with Chapter 9.

**2810.4 Fire safety and evacuation plan.** The *owner* or *owner's* authorized representative shall prepare and train employees in an *approved* fire safety and evacuation plan in accordance with Chapter 4.

**2810.5 Security management plan.** The *owner* or *owner's* authorized representative shall prepare a security management plan based on a security risk assessment and shall make the plan and assessment available to the *fire code official* upon request.

**2810.6 Clearance to property line.** Stacks of pallets shall not be stored within 0.75 times the stack height or 8 feet (2438 mm) of the property line, whichever is greater, or shall comply with Section 2810.11.

**2810.7 Clearance to important buildings.** Stacks of pallets shall not be stored within 0.75 times the stack height of any important building on site, or shall comply with Section 2810.11.

**2810.8 Height.** Pallet stacks shall not exceed 20 feet (6096 mm) in height.

**2810.9 Fire flow.** Fire-flow requirements for the site shall be determined by the *fire code official*.

**2810.10 Portable fire extinguishers.** Portable fire extinguishers shall be selected, installed and maintained in accordance with Section 906.

**2810.11 Alternative approach.** Where *approved* by the *fire code official*, pallet stacks are permitted to be located closer to a property line or structure than as required by Sections 2810.6 and 2810.7 where additional fire protection is provided, including, but not limited to, the following:

1. The storage yard areas and materials-handling equipment selection, design, and arrangement are based on an *approved* risk assessment.
2. Automatic fire detection that transmits an alarm to a supervising station in accordance with NFPA 72.
3. Fire apparatus access roads around all storage areas.

## CHAPTER 29

# MANUFACTURE OF ORGANIC COATINGS

### User note:

**About this chapter:** Chapter 29 regulates materials and processes associated with the manufacture of paints as well as bituminous, asphaltic and other diverse compounds formulated to protect buildings, machines and objects from the effects of weather, corrosion and hostile environmental exposures. Paint for decorative, architectural and industrial uses comprises the bulk of organic coating production. Painting and processes related to the manufacture of nonflammable and noncombustible or water-based products are exempt from the provisions of this chapter. The application of organic coatings is covered by Chapter 24. Elimination of ignition sources, maintenance of fire protection equipment and isolation or segregation of hazardous operations are emphasized.

### SECTION 2901 GENERAL

**2901.1 Scope.** Organic coating manufacturing processes shall comply with this chapter, except that this chapter shall not apply to processes manufacturing nonflammable or water-thinned coatings or to operations applying coating materials.

**2901.2 Permits.** Permits shall be required as set forth in Section 105.5.

**2901.3 Maintenance.** Structures and their service equipment shall be maintained in accordance with this code and NFPA 35.

### SECTION 2902 DEFINITION

**2902.1 Definition.** The following term is defined in Chapter 2:

**ORGANIC COATING.**

### SECTION 2903 GENERAL PRECAUTIONS

**2903.1 Building features.** Manufacturing of organic coatings shall be done only in buildings that do not have pits or basements.

**2903.2 Location.** Organic coating manufacturing operations and operations incidental to or connected with organic coating manufacturing shall not be located in buildings having other occupancies.

**2903.3 Fire-fighting access.** The fire department shall be able to access the organic coating manufacturing operations from not less than one side for the purpose of fire control. Approved aisles shall be maintained for the unobstructed movement of personnel and fire suppression equipment.

**2903.4 Fire protection systems.** Fire protection systems shall be installed, maintained, periodically inspected and tested in accordance with Chapter 9.

**2903.5 Portable fire extinguishers.** Not less than one portable fire extinguisher complying with Section 906 for extra hazard shall be provided in organic coating areas.

**2903.6 Open flames.** Open flames and direct-fired heating devices shall be prohibited in areas where flammable vapor-air mixtures exist.

**2903.7 Smoking.** Smoking shall be prohibited in accordance with Section 310.

**2903.8 Power equipment.** Power-operated equipment and industrial trucks shall be of a type approved for the location.

**2903.9 Tank maintenance.** The cleaning of tanks and vessels that have contained flammable or combustible liquids shall be performed under the supervision of persons knowledgeable of the fire and explosion potential.

**2903.9.1 Repairs.** Where necessary to make repairs involving hot work, the work shall be authorized by the responsible individual before the work begins.

**2903.9.2 Empty containers.** Empty flammable or combustible liquid containers shall be removed to a detached, outside location and, if not cleaned on the premises, the empty containers shall be removed from the plant as soon as practical.

**2903.10 Drainage.** Drainage facilities shall be provided to direct flammable and combustible liquid leakage and fire protection water to an approved location away from the building, any other structure, storage area or adjoining premises.

**2903.11 Alarm system.** An approved fire alarm system shall be provided in accordance with Section 907.

### SECTION 2904 ELECTRICAL EQUIPMENT AND PROTECTION

**2904.1 Wiring and equipment.** Electrical wiring and equipment shall comply with this chapter and shall be installed in accordance with NFPA 70.

**2904.2 Hazardous locations.** Where Class I liquids are exposed to the air, the design of equipment and ventilation of structures shall be such as to limit the Class I, Division 1, locations to the following:

1. Piping trenches.
2. The interior of equipment.
3. The immediate vicinity of pumps or equipment locations, such as dispensing stations, open centrifuges,

## MANUFACTURE OF ORGANIC COATINGS

plate and frame filters, opened vacuum filters, change cans and the surfaces of open equipment. The immediate vicinity shall include a zone extending from the vapor liberation point 5 feet (1524 mm) horizontally in all directions and vertically from the floor to a level 3 feet (914 mm) above the highest point of vapor liberation.

**2904.2.1 Other locations.** Locations within the confines of the manufacturing room where Class I liquids are handled shall be Class I, Division 2, except locations indicated in Section 2904.2.

**2904.2.2 Ordinary equipment.** Ordinary electrical equipment, including switchgear, shall be prohibited, except where installed in a room maintained under positive pressure with respect to the hazardous area. The air or other media utilized for pressurization shall be obtained from a source that will not cause any amount or type of flammable vapor to be introduced into the room.

**2904.3 Bonding.** Equipment including, but not limited to, tanks, machinery and piping shall be bonded and connected to a ground where an ignitable mixture is capable of being present.

**2904.3.1 Piping.** Electrically isolated sections of metallic piping or equipment shall be grounded or bonded to the other grounded portions of the system.

**2904.3.2 Vehicles.** Tank vehicles loaded or unloaded through open connections shall be grounded and bonded to the receiving system.

**2904.3.3 Containers.** Where a flammable mixture is transferred from one portable container to another, a bond shall be provided between the two containers, and one shall be grounded.

**2904.4 Ground.** Metal framing of buildings shall be grounded with resistance of not more than 5 ohms.

### SECTION 2905 PROCESS STRUCTURES

**2905.1 Design.** Process structures shall be designed and constructed in accordance with the *International Building Code*.

**2905.2 Fire apparatus access.** Fire apparatus access complying with Section 503 shall be provided for the purpose of fire control to not less than one side of organic coating manufacturing operations.

**2905.3 Drainage.** Drainage facilities shall be provided in accordance with Section 2903.10 where topographical conditions are such that *flammable* and *combustible liquids* are capable of flowing from the organic coating manufacturing operation so as to constitute a fire hazard to other premises.

**2905.4 Explosion control.** Explosion control shall be provided in areas subject to potential *deflagration* hazards as indicated in NFPA 35. Explosion control shall be provided in accordance with Section 911.

**2905.5 Ventilation.** Enclosed structures in which Class I liquids are processed or handled shall be ventilated at a rate of not less than 1 cubic foot per minute per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of solid floor area. Ventilation shall be accomplished by exhaust fans that take suction at floor levels and discharge to a safe location outside the structure. Noncontaminated intake air shall be introduced in such a manner that all portions of solid floor areas are provided with continuous uniformly distributed air movement.

**2905.6 Heating.** Heating provided in hazardous areas shall be by indirect means. Ignition sources such as open flames or electrical heating elements, except as provided for in Section 2904, shall not be permitted within the structure.

### SECTION 2906 PROCESS MILLS AND KETTLES

**2906.1 Mills.** Mills, operating with close clearances, which process flammable and heat-sensitive materials, such as nitrocellulose, shall be located in a detached building or in a noncombustible structure without other occupancies. The amount of nitrocellulose or other flammable material brought into the area shall not be more than the amount required for a batch.

**2906.2 Mixers.** Mixers shall be of the enclosed type or, where of the open type, shall be provided with properly fitted covers. Where flow is by gravity, a shutoff valve shall be installed as close as practical to the mixer, and a control valve shall be provided near the end of the fill pipe.

**2906.3 Open kettles.** Open kettles shall be located in an outside area provided with a protective roof; in a separate structure of noncombustible construction; or separated from other areas by a noncombustible wall having a *fire-resistance rating* of not less than 2 hours.

**2906.4 Closed kettles.** Contact-heated kettles containing solvents shall be equipped with safety devices that, in case of a fire, will turn off the process heat, turn on the cooling medium and inject inert gas into the kettle.

**2906.4.1 Vaporizer location.** The vaporizer section of heat-transfer systems that heat closed kettles containing solvents shall be remotely located.

**2906.5 Kettle controls.** The kettle and thin-down tank shall be instrumented, controlled and interlocked so that any failure of the controls will result in a safe condition. The kettle shall be provided with a pressure-rupture disc in addition to the primary vent. The vent piping from the rupture disc shall be of minimum length and shall discharge to an *approved* location. The thin-down tank shall be adequately vented. Thinning operations shall be provided with an adequate vapor removal system.

### SECTION 2907 PROCESS PIPING

**2907.1 Design.** Piping, valves and fittings shall be designed for the working pressures and structural stresses to which the

piping, valves and fittings will be subjected, and shall be of steel or other material *approved* for the service intended.

**2907.2 Valves.** Valves shall be of an indicating type. Terminal valves on remote pumping systems shall be of the dead-man type, shutting off both the pump and the flow of solvent.

**2907.3 Support.** Piping systems shall be supported adequately and protected against physical damage. Piping shall be pitched to avoid unintentional trapping of liquids, or *approved* drains shall be provided.

**2907.4 Connectors.** *Approved* flexible connectors shall be installed where vibration exists or frequent movement is necessary. Hose at dispensing stations shall be of an *approved* type.

**2907.5 Tests.** Before being placed in service, all piping shall be free of leaks when tested for not less than 30 minutes at not less than 1.5 times the working pressure or not less than 5 pounds per square inch gauge (psig) (35 kPa) at the highest point in the system.

## SECTION 2908 RAW MATERIALS IN PROCESS AREAS

**2908.1 Nitrocellulose quantity.** The amount of nitrocellulose brought into the operating area shall not exceed the amount required for a work shift. Nitrocellulose spillage shall be promptly swept up and disposed of properly.

**2908.2 Organic peroxides quantity.** Organic peroxides brought into the operating area shall be in the original shipping container. When in the operating area, the organic peroxide shall not be placed in locations exposed to ignition sources, heat or mechanical shocks.

## SECTION 2909 RAW MATERIALS AND FINISHED PRODUCTS

**2909.1 General.** The storage, handling and use of *flammable* and *combustible liquids* in process areas shall be in accordance with Chapter 57.

**2909.2 Tank storage.** Tank storage for *flammable* and *combustible liquids* located inside of structures shall be limited to storage areas at or above grade that are separated from the processing area in accordance with the *International Building Code*. Processing equipment containing *flammable* and *combustible liquids* and storage in quantities essential to the continuity of the operations shall not be prohibited in the processing area.

**2909.3 Tank vehicle.** Tank car and tank vehicle loading and unloading stations for Class I liquids shall be separated from the processing area, other plant structures, nearest *lot line* of property that can be built on or public thoroughfare by a minimum clear distance of 25 feet (7620 mm).

**2909.3.1 Loading.** Loading and unloading structures and platforms for *flammable* and *combustible liquids* shall be designed and installed in accordance with Chapter 57.

**2909.3.2 Safety.** Tank cars for *flammable liquids* shall be unloaded such that the safety to persons and property is

ensured. Tank vehicles for *flammable* and *combustible liquids* shall be loaded and unloaded in accordance with Chapter 57.

**2909.4 Nitrocellulose storage.** Nitrocellulose storage shall be located on a detached pad or in a separate structure or a room enclosed in accordance with the *International Building Code*. The nitrocellulose storage area shall not be utilized for any other purpose. Electrical wiring and equipment installed in storage areas adjacent to process areas shall comply with Section 2904.2.

**2909.4.1 Containers.** Nitrocellulose shall be stored in closed containers. Barrels shall be stored on end and not more than two tiers high. Barrels or other containers of nitrocellulose shall not be opened in the main storage structure but at the point of use or other location intended for that purpose.

**2909.4.2 Spills.** Spilled nitrocellulose shall be promptly wetted with water and disposed of by use or burning in the open at an *approved* detached location.

**2909.5 Organic peroxide storage.** The storage of organic peroxides shall be in accordance with Chapter 62.

**2909.5.1 Size.** The size of the package containing organic peroxide shall be selected so that, as nearly as practical, full packages are utilized at one time. Spilled peroxide shall be promptly cleaned up and disposed of as specified by the supplier.

**2909.6 Finished products.** Finished products that are *flammable* or *combustible liquids* shall be stored outside of structures, in a separate structure, or in a room separated from the processing area in accordance with the *International Building Code*. The storage of finished products shall be in tanks or closed containers in accordance with Chapter 57.





## CHAPTER 30

# INDUSTRIAL OVENS

### User note:

**About this chapter:** Chapter 30 addresses the fuel supply, ventilation, emergency shutdown equipment, fire protection and the operation and maintenance of industrial ovens, which are sometimes referred to as industrial heat enclosures or industrial furnaces. Compliance with this chapter is intended to reduce the likelihood of fires involving industrial ovens, which are usually the result of the fuel in use or volatile vapors given off by the materials being heated, or to manage the impact if a fire should occur.

### SECTION 3001 GENERAL

**3001.1 Scope.** This chapter shall apply to the installation and operation of industrial ovens and furnaces. Industrial ovens and furnaces shall comply with the applicable provisions of the *International Fuel Gas Code*, the *International Mechanical Code*, NFPA 86 and this chapter. The terms “ovens” and “furnaces” are used interchangeably in this chapter.

**3001.2 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

### SECTION 3002 DEFINITIONS

**3002.1 Definitions.** The following terms are defined in Chapter 2:

**FURNACE CLASS A.**

**FURNACE CLASS B.**

**FURNACE CLASS C.**

**FURNACE CLASS D.**

### SECTION 3003 LOCATION

**3003.1 Ventilation.** Enclosed rooms or *basements* containing industrial ovens or furnaces shall be provided with combustion air in accordance with the *International Fuel Gas Code* and the *International Mechanical Code*, and with ventilation air in accordance with the *International Mechanical Code*.

**3003.2 Exposure.** When locating ovens, oven heaters and related equipment, the possibility of fire resulting from overheating or from the escape of fuel gas or fuel oil and the possibility of damage to the building and injury to persons resulting from explosion shall be considered.

**3003.3 Ignition source.** Industrial ovens and furnaces shall be located so as not to pose an ignition hazard to flammable vapors or mists or *combustible dusts*.

**3003.4 Temperatures.** Roofs and floors of ovens shall be insulated and ventilated to prevent temperatures at combustible ceilings and floors from exceeding 160°F (71°C).

### SECTION 3004 FUEL PIPING

**3004.1 Fuel-gas piping.** Fuel-gas piping serving industrial ovens shall comply with the *International Fuel Gas Code*. Piping for other fuel sources shall comply with this section.

**3004.2 Shutoff valves.** Each industrial oven or furnace shall be provided with an *approved* manual fuel shutoff valve in accordance with the *International Fuel Gas Code* or the *International Mechanical Code*.

**3004.2.1 Fuel supply lines.** Valves for fuel supply lines shall be located within 6 feet (1829 mm) of the appliance served.

**Exception:** Where *approved* and the valve is located in the same general area as the appliance served.

**3004.3 Valve position.** The design of manual fuel shutoff valves shall incorporate a permanent feature that visually indicates the open or closed position of the valve. Manual fuel shutoff valves shall not be equipped with removable handles or wrenches unless the handle or wrench can only be installed parallel with the fuel line when the valve is in the open position.

### SECTION 3005 INTERLOCKS

**3005.1 Shut down.** Interlocks shall be provided for Class A ovens so that conveyors or sources of flammable or combustible materials shall shut down if either the exhaust or recirculation air supply fails.

### SECTION 3006 FIRE PROTECTION

**3006.1 Required protection.** Class A and B ovens that contain, or are utilized for the processing of, combustible materials shall be protected by an *approved automatic fire-extinguishing system* complying with Chapter 9.

#### Exceptions:

1. Small tabletop ovens used in laboratory facilities.
2. Nonwalk-in ovens that are less than 4 feet (1219 mm) in length and width.

## INDUSTRIAL OVENS

**3006.2 Fixed fire-extinguishing systems.** Fixed fire-extinguishing systems shall be provided for Class C or D ovens to protect against such hazards as overheating, spillage of molten salts or metals, quench tanks, ignition of hydraulic oil and escape of fuel. It shall be the user's responsibility to consult with the *fire code official* concerning the necessary requirements for such protection.

**3006.3 Fire extinguishers.** Portable fire extinguishers complying with Section 906 shall be provided not closer than 15 feet (4572 mm) or not more than 50 feet (15 240 mm) or in accordance with NFPA 10. This shall apply to the oven and related equipment.

### SECTION 3007 OPERATION AND MAINTENANCE

**3007.1 Furnace system information.** An *approved*, clearly worded, and prominently displayed safety design data form or manufacturer's nameplate shall be provided stating the safe operating condition for which the furnace system was designed, built, altered or extended.

**3007.2 Oven nameplate.** Safety data for Class A solvent atmosphere ovens shall be furnished on the manufacturer's nameplate. The nameplate shall provide the following design data:

1. The solvent used.
2. The number of gallons (L) used per batch or per hour of solvent entering the oven.
3. The required purge time.
4. The oven operating temperature.
5. The exhaust blower rating for the number of gallons (L) of solvent per hour or batch at the maximum operating temperature.

**Exception:** For low-oxygen ovens, the maximum allowable oxygen concentration shall be included in place of the exhaust blower ratings.

**3007.3 Training.** Operating, maintenance and supervisory personnel shall be thoroughly instructed and trained in the operation of ovens or furnaces.

**3007.4 Equipment maintenance.** Equipment shall be maintained in accordance with the manufacturer's instructions.

# CHAPTER 31

## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

### User note:

**About this chapter:** Chapter 31 provides requirements that are intended to protect temporary as well as permanent tents and air-supported and other membrane structures and temporary stage special event structures from fire and similar hazards. The provisions regulate structure location and access, anchorage, egress, heat-producing equipment, hazardous materials and operations, combustible vegetation, ignition sources, and waste accumulation. This is accomplished through requiring regular inspections and certifying continued compliance with fire safety regulations. This chapter also addresses outdoor assembly events, which are not limited to those events with tents or other membrane structures, but are regulated due to the number of people, density of those people and hazards associated with large outdoor events related to egress, fire hazards from cooking and other related concerns.

### SECTION 3101 GENERAL

**3101.1 Scope.** *Tents*, temporary special event structures and *membrane structures* shall comply with this chapter. The provisions of Section 3103 are applicable only to temporary *tents* and *membrane structures*. The provisions of Sections 3104 and 3106 are applicable to temporary and permanent *tents* and *membrane structures*. The provisions of Section 3105 are applicable to temporary special event structures. The provisions of Section 3106 are applicable to outdoor assembly events. Other temporary structures shall comply with the *International Building Code*.

### SECTION 3102 DEFINITIONS

**3102.1 Definitions.** The following terms are defined in Chapter 2:

**AIR-INFLATED STRUCTURE.**

**AIR-SUPPORTED STRUCTURE.**

**MEMBRANE STRUCTURE.**

**TEMPORARY SPECIAL EVENT STRUCTURE.**

**TENT.**

### SECTION 3103 TEMPORARY TENTS AND MEMBRANE STRUCTURES

**3103.1 General.** *Tents* and *membrane structures* used for temporary periods shall comply with this section and Section 3106. Other temporary structures erected for a period of 180 days or less shall comply with the *International Building Code*.

**3103.2 Approval required.** *Tents* and *membrane structures* having an area in excess of 400 square feet (37 m<sup>2</sup>) shall not be erected, operated or maintained for any purpose without

first obtaining a permit and approval from the *fire code official*.

#### Exceptions:

1. *Tents* used exclusively for recreational camping purposes.
2. *Tents* open on all sides that comply with all of the following:
  - 2.1. Individual *tents* having a maximum size of 700 square feet (65 m<sup>2</sup>).
  - 2.2. The aggregate area of multiple *tents* placed side by side without a fire break clearance of 12 feet (3658 mm), not exceeding 700 square feet (65 m<sup>2</sup>) total.
  - 2.3. A minimum clearance of 12 feet (3658 mm) to all structures and other *tents*.

**3103.3 Outdoor assembly event.** For the purposes of this chapter, an outdoor assembly event shall include a circus, carnival, tent show, theater, skating rink, dance hall or other place of assembly in or under which persons gather for any purpose.

**3103.3.1 Special amusement area.** *Tents* and other *membrane structures* erected as a special amusement area shall be equipped with an *automatic sprinkler system* in accordance with Section 914.7.1.

**3103.4 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

**3103.5 Use period.** Temporary *tents*, air-supported, air-inflated or tensioned *membrane structures* shall not be erected for a period of more than 180 days within a 12-month period on a single premises.

**3103.6 Construction documents.** A detailed site and floor plan for *tents* or *membrane structures* with an *occupant load* of 50 or more shall be provided with each application for approval. The *tent* or *membrane structure* floor plan shall indicate details of the *means of egress* facilities, seating capacity, arrangement of the seating and location and type of



## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

heating and electrical equipment. The *construction documents* shall include an analysis of structural stability.

**3103.7 Inspections.** The entire *tent*, air-supported, air-inflated or tensioned *membrane structure* system shall be inspected at regular intervals, but not less than two times per permit use period, by the permittee, *owner* or agent to determine that the installation is maintained in accordance with this chapter.

**Exception:** Permit use periods of less than 30 days.

**3103.7.1 Inspection report.** Where required by the *fire code official*, an inspection report shall be provided and shall consist of maintenance, anchors and fabric inspections.

**3103.8 Access, location and parking.** Access, location and parking for temporary *tents* and *membrane structures* shall be in accordance with this section.

**3103.8.1 Access.** Fire apparatus access roads shall be provided in accordance with Section 503.

**3103.8.2 Location.** *Tents* or *membrane structures* shall not be located within 20 feet (6096 mm) of *lot lines*, buildings, other *tents* or *membrane structures*, parked vehicles or internal combustion engines. For the purpose of determining required distances, support ropes and guy wires shall be considered as part of the temporary *membrane structure* or *tent*.

### Exceptions:

1. Separation distance between *membrane structures* and *tents* not used for cooking is not required where the aggregate floor area does not exceed 15,000 square feet (1394 m<sup>2</sup>).
2. *Membrane structures* or *tents* need not be separated from buildings where all of the following conditions are met:
  - 2.1. The aggregate floor area of the *membrane structure* or *tent* shall not exceed 10,000 square feet (929 m<sup>2</sup>).
  - 2.2. The aggregate floor area of the building and *membrane structure* or *tent* shall not exceed the allowable floor area including increases as indicated in the *International Building Code*.
  - 2.3. Required *means of egress* are provided for both the building and the *membrane structure* or *tent* including travel distances.
  - 2.4. Fire apparatus access roads are provided in accordance with Section 503.

**3103.8.3 Location of structures in excess of 15,000 square feet in area.** *Membrane structures* having an area of 15,000 square feet (1394 m<sup>2</sup>) or more shall be located not less than 50 feet (15 240 mm) from any other *tent* or structure as measured from the sidewall of the *tent* or *membrane structure* unless joined together by a corridor.

**3103.8.4 Membrane structures on buildings.** *Membrane structures* that are erected on buildings, balconies, decks or other structures shall be regulated as permanent *membrane structures* in accordance with Section 3102 of the *International Building Code*.

**3103.8.5 Connecting corridors.** *Tents* or *membrane structures* are allowed to be joined together by means of corridors. *Exit* doors shall be provided at each end of such corridor. On each side of such corridor and approximately opposite each other, there shall be provided openings not less than 12 feet (3658 mm) wide.

**3103.8.6 Fire break.** An unobstructed fire break passageway or fire road not less than 12 feet (3658 mm) wide and free from guy ropes or other obstructions shall be maintained on all sides of all *tents* and *membrane structures* unless otherwise approved by the *fire code official*.

**3103.9 Structural stability and anchorage required.** *Tents* or *membrane structures* and their appurtenances shall be designed and installed to withstand the elements of weather and prevent collapsing. Documentation of structural stability shall be furnished to the *fire code official*.

**3103.9.1 Tents and membrane structures greater than one story.** *Tents* and *membrane structures* exceeding one story shall be designed and constructed to comply with Sections 1606 through 1609 of the *International Building Code*.

**3103.9.2 Tents and membrane structures greater than 7,500 square feet.** *Tents* and *membrane structures* greater than 7,500 square feet (697 m<sup>2</sup>) shall be designed and constructed to comply with Sections 1606 through 1609 of the *International Building Code*.

**3103.9.3 Tents and membrane structures with an occupant load greater than 1,000.** *Tents* and *membrane structures* with an occupant capacity greater than 1,000 persons shall be designed and constructed to comply with Sections 1606 through 1609 of the *International Building Code*.

**3103.10 Temporary air-supported and air-inflated membrane structures.** Temporary air-supported and air-inflated *membrane structures* shall be in accordance with Sections 3103.10.1 through 3103.10.4.

**3103.10.1 Door operation.** During high winds exceeding 50 miles per hour (22 m/s) or in snow conditions, the use of doors in air-supported structures shall be controlled to avoid excessive air loss. Doors shall not be left open.

**3103.10.2 Fabric envelope design and construction.** Air-supported and air-inflated structures shall have the design and construction of the fabric envelope and the method of anchoring in accordance with Architectural Fabric Structures Institute FSAAS.

**3103.10.3 Blowers.** An air-supported structure used as a place of assembly shall be furnished with not less than two blowers, each of which has adequate capacity to maintain full inflation pressure with normal leakage. The design of the blower shall be so as to provide integral limiting pressure at the design pressure specified by the manufacturer.

## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

**3103.10.4 Auxiliary inflation systems.** Places of public assembly for more than 200 persons shall be furnished with an auxiliary inflation system capable of powering a blower with the capacity to maintain full inflation pressure with normal leakage in accordance with Section 3103.10.3 for a minimum duration of 4 hours. The auxiliary inflation system shall be either a fully automatic auxiliary engine-generator set or a supplementary blower powered by an internal combustion engine that shall be automatic in operation. The system shall be capable of automatically operating the required blowers at full power within 60 seconds of a commercial power failure.

**3103.11 Seating arrangements.** Seating in *tents* or *membrane structures* shall be in accordance with Chapter 10.

**3103.12 Means of egress.** *Means of egress* for temporary *tents* and *membrane structures* shall be in accordance with Sections 3103.12.1 through 3103.12.8.

**3103.12.1 Distribution.** *Exits* shall be spaced at approximately equal intervals around the perimeter of the *tent* or *membrane structure*, and shall be located such that all points are 100 feet (30 480 mm) or less from an *exit*.

**3103.12.2 Number.** *Tents* or *membrane structures* or a usable portion thereof shall have not less than one *exit* and not less than the number of *exits* required by Table 3103.12.2. The total width of *means of egress* in inches (mm) shall be not less than the total *occupant load* served by a *means of egress* multiplied by 0.2 inches (5 mm) per person.

**3103.12.3 Exit openings from tents.** *Exit* openings from *tents* shall remain open unless covered by a flame-resistant curtain. The curtain shall comply with the following requirements:

1. Curtains shall be free sliding on a metal support. The support shall be not less than 80 inches (2032 mm) above the floor level at the *exit*. The curtains shall be so arranged that, when open, no part of the curtains obstructs the *exit*.
2. Curtains shall be of a color, or colors, that contrasts with the color of the *tent*.

**3103.12.4 Doors.** *Exit* doors shall swing in the direction of *exit* travel. To avoid hazardous air and pressure loss in air-supported *membrane structures*, such doors shall be automatic closing against operating pressures. Opening force at the door edge shall not exceed 15 pounds (66 N).

**3103.12.5 Aisle.** The width of *aisles* without fixed seating shall be in accordance with the following:

1. In areas serving employees only, the minimum *aisle* width shall be 24 inches (610 mm) but not less than the width required by the number of employees served.
2. In public areas, smooth-surfaced, unobstructed *aisles* having a minimum width of not less than 44 inches (1118 mm) shall be provided from seating areas, and *aisles* shall be progressively increased in width to provide, at all points, not less than 1 foot (305 mm) of *aisle* width for each 50 persons served by such *aisle* at that point.

**3103.12.5.1 Arrangement and maintenance.** The arrangement of *aisles* shall be subject to approval by the *fire code official* and shall be maintained clear at all times during occupancy.

**3103.12.6 Exit signs.** *Exits* shall be clearly marked. *Exit* signs shall be installed at required *exit* doorways and where otherwise necessary to indicate clearly the direction of egress where the *exit* serves an *occupant load* of 50 or more.

**3103.12.6.1 Exit sign illumination.** *Exit* signs shall be either *listed* and *labeled* in accordance with UL 924 as the internally illuminated type and used in accordance with the listing or shall be externally illuminated by luminaires supplied in either of the following manners:

1. Two separate circuits, one of which shall be separate from all other circuits, for *occupant loads* of 300 or less.
2. Two separate sources of power, one of which shall be an *approved* emergency system, shall be provided where the *occupant load* exceeds 300. Emergency systems shall be supplied from storage batteries or from the on-site

TABLE 3103.12.2  
MINIMUM NUMBER OF MEANS OF EGRESS AND MEANS OF EGRESS WIDTHS  
FROM TEMPORARY MEMBRANE STRUCTURES AND TENTS

OCCUPANT LOAD	MINIMUM NUMBER OF MEANS OF EGRESS	MINIMUM WIDTH OF EACH MEANS OF EGRESS (inches)	MINIMUM WIDTH OF EACH MEANS OF EGRESS (inches)
		Tent	Membrane Structure
10 to 199	2	72	36
200 to 499	3	72	72
500 to 999	4	96	72
1,000 to 1,999	5	120	96
2,000 to 2,999	6	120	96
Over 3,000 <sup>a</sup>	7	120	96

For SI: 1 inch = 25.4 mm.

a. When the occupant load exceeds 3,000, the total width of means of egress (in inches) shall be not less than the total occupant load multiplied by 0.2 inch per person.

## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

generator set, and the system shall be installed in accordance with NFPA 70. The emergency system provided shall have a minimum duration of 90 minutes when operated at full design demand.

**3103.12.7 Means of egress illumination.** *Means of egress* shall be illuminated with light having an intensity of not less than 1 foot-candle (11 lux) at floor level while the structure is occupied. Fixtures required for *means of egress* illumination shall be supplied from a separate circuit or source of power.

**3103.12.8 Maintenance of means of egress.** The required width of *exits, aisles* and passageways shall be maintained at all times to a *public way*. Guy wires, guy ropes and other support members shall not cross a *means of egress* at a height of less than 8 feet (2438 mm). The surface of *means of egress* shall be maintained in an *approved* manner.

### SECTION 3104 TEMPORARY AND PERMANENT TENTS AND MEMBRANE STRUCTURES

**3104.1 General.** *Tents* and *membrane structures*, both temporary and permanent, shall be in accordance with this section and Sections 3106 and 3107. Permanent *tents* and *membrane structures* shall also comply with the *International Building Code*.

**3104.2 Flame propagation performance testing and certification.** Before a permit is granted, the *owner* or agent shall file with the *fire code official* a certificate provided by the product manufacturer to verify that the materials have been tested and certified by an *approved* testing laboratory. The certificate shall indicate that the floor coverings, *tents, membrane structures* and their appurtenances, which include sidewalls, drops and tarpaulins, are composed of materials meeting the flame propagation performance of Test Method 2 of NFPA 701. Additionally, it shall indicate that the bunting and combustible decorative materials and effects are composed of material meeting the flame propagation performance criteria of Test Method 1 or Test Method 2 of NFPA 701, as applicable. Alternatively, the materials shall be treated with a flame retardant in an *approved* manner and meet the flame propagation performance criteria of the applicable test method of NFPA 701. The certificate shall indicate compliance with the testing requirements of NFPA 701, Chapter 16. The flame propagation performance criteria shall be effective for the period specified by the permit.

**3104.3 Label.** *Membrane structures* or *tents* shall have a permanently affixed label bearing the following information:

1. The identification of size and fabric or material.
2. The names and addresses of the manufacturers of the *tent* or air-supported structure.
3. A statement that the fabric or material meets the requirements of Section 3104.2.
4. If treated, the date the fabric or material was last treated with flame-retardant solution, the trade name

or kind of chemical used in treatment, name of person or firm treating the fabric or material, and name of testing agency and test standard by which the fabric or material was tested.

5. If untreated, a statement that no treatment was applied when the fabric or material met the requirements of Section 3104.2.

**3104.4 Affidavit.** The affidavit required by Section 3104.2 shall contain all of the information specified in Section 3104.3.

### SECTION 3105 TEMPORARY SPECIAL EVENT STRUCTURES

**3105.1 General.** Temporary special event structures shall comply with Section 3104, Sections 3105.2 through 3105.9 and ANSI E1.21.

**3105.2 Approval.** Temporary special event structures in excess of 400 square feet (37 m<sup>2</sup>) shall not be erected, operated or maintained for any purpose without first obtaining approval and a permit from the *fire code official* and the building official.

**3105.3 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

**3105.4 Use period.** Temporary special event structures erected in accordance with ANSI E1.21 shall not be erected for a period of more than six consecutive weeks.

**3105.5 Required documents.** The following documents shall be submitted to the *fire code official* and the building official for review before a permit is *approved*:

1. Construction documents: *Construction documents* shall be prepared by a *registered design professional* in accordance with the *International Building Code* and ANSI E1.21 where applicable. *Construction documents* shall include:
  - 1.1. A summary sheet showing the building code used, design criteria, loads and support reactions.
  - 1.2. Detailed construction and installation drawings.
  - 1.3. Design calculations.
  - 1.4. Operating limits of the structure explicitly outlined by the *registered design professional* including environmental conditions and physical forces.
  - 1.5. Effects of additive elements such as video walls, supported scenery, audio equipment, vertical and horizontal coverings.
  - 1.6. Means for adequate stability including specific requirements for guying and cross-bracing, ground anchors or ballast for different ground conditions.
2. Designation of responsible party: The *owner* of the temporary special event structure shall designate in writing a person to have responsibility for the temporary special event structure on the site. The



## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

designated person shall have sufficient knowledge of the construction documents, manufacturer's recommendations and operations plan to make judgments regarding the structure's safety and to coordinate with the *fire code official*.

3. Operations plan: The operations plan shall reflect manufacturer's operational guidelines, procedures for environmental monitoring and actions to be taken under specified conditions consistent with the *construction documents*.

**3105.6 Inspections.** Inspections shall comply with Section 107 and Sections 3105.6.1 and 3105.6.2.

**3105.6.1 Independent inspector.** The *owner* of a temporary special event structure shall employ a qualified, independent *approved* agency or individual to inspect the installation of a temporary special event structure.

**3105.6.2 Inspection report.** The inspecting agency or individual shall furnish an inspection report to the *fire code official*. The inspection report shall indicate that the temporary special event structure was inspected and was or was not installed in accordance with the *approved construction documents*. Discrepancies shall be brought to the immediate attention of the installer for correction. Where any discrepancy is not corrected, it shall be brought to the attention of the *fire code official* and the designated responsible party.

**3105.7 Means of egress.** The *means of egress* for temporary special event structures shall comply with Chapter 10.

**3105.8 Location.** Temporary special event structure shall be located a distance from property lines and buildings to accommodate distances indicated in the construction drawings for guy wires, cross-bracing, ground anchors or ballast. Location shall not interfere with egress from a building or encroach on fire apparatus access roads.

**3105.9 Portable fire extinguishers.** Portable fire extinguishers shall be provided as required by Section 906.

## SECTION 3106 OUTDOOR ASSEMBLY EVENTS

**3106.1 Scope.** Outdoor assembly events shall comply with this section.

**3106.2 General.** Outdoor assembly events shall be in accordance with this section and Section 403.11. Temporary structures erected for outdoor assembly events shall comply with this chapter.

**3106.2.1 Approval required.** Outdoor assembly events shall be *approved* by the *fire code official*.

**3106.2.2 Permits.** An operational permit shall be required as set forth in Section 105.5.

**3106.2.3 Access.** An *approved* means of fire apparatus access shall be provided.

**3106.2.3.1 Fire service features.** Unobstructed access to fire hydrants, drafting sources and other fire protection features shall be maintained at all times.

**3106.3 Occupancy and means of egress.** The number and location of emergency egress and escape routes shall be *approved* by the *fire code official*.

**3106.3.1 Occupant load.** The *fire code official* shall establish an *occupant load* for the event site.

**3106.3.2 Maintenance of emergency egress and escape routes.** Emergency egress and escape routes shall be maintained at all times.

**3106.4 Public safety for events.** Outdoor assembly events shall comply with Sections 3106.4.1 through 3106.4.7.

**3106.4.1 Public safety plan for gatherings.** A public safety plan shall be prepared where required by Section 403.11.2. The public safety plan shall be submitted to the *fire code official* with the application for an operational permit as required by Section 3106.2.2.

**3106.4.2 Weather monitoring person.** Where required by the *fire code official*, the event operator or agent shall designate one qualified individual to continuously monitor local weather reports, forecasts and conditions. Said person shall be responsible for initiating weather-related event mitigation activities, ordering the suspension or cancellation of the outdoor assembly event and issuing the evacuation signal in accordance with the *approved* public safety plan.

**3106.4.3 Crowd managers.** Where events involve a gathering of more than 1,000 people, trained crowd managers shall be provided in accordance with Section 403.11.3.

**3106.4.4 Portable fire extinguishers.** *Approved* portable fire extinguishers complying with Section 906 shall be provided and placed in locations *approved* by the *fire code official*.

**3106.4.5 Smoking.** Smoking shall be permitted only in designated areas. Other areas shall have *approved* "No Smoking" signs conspicuously posted and maintained in accordance with Section 310.

**3106.4.6 Combustible vegetation.** Combustible vegetation that could create a fire hazard shall be removed from the outdoor assembly event area.

**3106.4.7 Combustible refuse.** Combustible refuse shall be kept in noncombustible containers with tight-fitting or self-closing lids. Combustible refuse shall be removed from the event site at regular intervals to prevent an unsafe accumulation within the event site.

**3106.5 Cooking appliances or devices.** Outdoor assembly events with concession stands or booths using cooking appliances or devices shall comply with Sections 3106.5.1 through 3106.5.3.

**3106.5.1 Separation from tents or structures.** Cooking appliances or devices that produce sparks or grease-laden vapors or flying embers (firebrands) shall not be used within 20 feet (6096 mm) of a *tent* or temporary structure.

### Exceptions:

1. Designated cooking *tents* not occupied by the public when *approved* by the *fire code official*.



## TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES

2. *Tents* or structures where cooking appliances are protected with an automatic fire-extinguishing system in accordance with Section 904.13.

**3106.5.2 Protection.** Cooking equipment using combustible oils or solids shall meet the following:

1. A noncombustible lid shall be immediately available. The lid shall be of sufficient size to cover the cooking well completely.
2. The equipment shall be placed on a noncombustible surface.
3. An *approved* portable fire extinguisher for protection from cooking grease fires shall be provided at a location *approved* by the *fire code official*.

**3106.5.3 Liquefied petroleum gas (LP-gas).** The use of liquefied petroleum gas (LP-gas) shall be in accordance with Chapter 61.

**3106.6 Electrical equipment and wiring.** Outdoor assembly events with concession stands or booths using electrical equipment and temporary wiring for electrical power or lighting shall comply with the applicable provisions of NFPA 70 and Sections 3106.6.1 through 3106.6.3.

**3106.6.1 Outdoor use.** Electrical equipment and wiring shall be *listed* and *labeled* for outdoor use.

**3106.6.2 Generators.** Generators shall be installed not less than 10 feet (3048 mm) from combustible materials, and shall be isolated from the public by physical guard, fence or enclosure installed not less than 3 feet (914 mm) away from the internal combustion power source.

**3106.6.3 Portable fire extinguishers.** Each generator shall be provided with an *approved* portable fire extinguisher complying with Section 906.

### SECTION 3107 OPERATIONAL REQUIREMENTS

**3107.1 General.** Temporary and permanent *tents* and *membrane structures* shall comply with this section.

**3107.2 Combustible materials.** Hay, straw, shavings or similar combustible materials shall not be located within any *tent* or *membrane structure* containing an assembly occupancy, except the materials necessary for the daily feeding and care of animals. Sawdust and shavings utilized for a public performance or exhibit shall not be prohibited provided that the sawdust and shavings are kept damp. Combustible materials shall not be permitted under stands or seats at any time.

**3107.3 Smoking.** Smoking shall not be permitted in *tents* or *membrane structures*. *Approved* "No Smoking" signs shall be conspicuously posted in accordance with Section 310.

**3107.4 Open or exposed flame.** Open flame or other devices emitting flame, fire or heat or any *flammable* or *combustible liquids*, gas, charcoal or other cooking device or any other unapproved devices shall not be permitted inside or located within 20 feet (6096 mm) of the *tent* or *membrane*

*structures* while open to the public unless *approved* by the *fire code official*.

**3107.5 Fireworks.** Fireworks shall not be used within 100 feet (30 480 mm) of *tents* or *membrane structures*.

**3107.6 Spot lighting.** Spot or effect lighting shall only be by electricity, and all combustible construction located within 6 feet (1829 mm) of such equipment shall be protected with *approved* noncombustible insulation not less than 9<sup>1</sup>/<sub>4</sub> inches (235 mm) thick.

**3107.7 Safety film.** Motion pictures shall not be displayed in *tents* or *membrane structures* unless the motion picture film is safety film.

**3107.8 Clearance.** There shall be a clearance of not less than 3 feet (914 mm) between the fabric envelope and all contents located inside *membrane structures*.

**3107.9 Portable fire extinguishers.** *Approved* portable fire extinguishers complying with Section 906 shall be provided and placed in locations as required by the *fire code official*.

**3107.10 Fire protection equipment.** Fire hose lines, water supplies and other auxiliary fire equipment shall be maintained at the site in such numbers and sizes as required by the *fire code official*.

**3107.11 Occupant load factors.** The *occupant load* allowed in an assembly structure, or portion thereof, shall be determined in accordance with Chapter 10.

**3107.12 Heating and cooking equipment.** Heating and cooking equipment shall be in accordance with Sections 3107.12.1 through 3107.12.7.

**3107.12.1 Installation.** Heating or cooking equipment, tanks, piping, hoses, fittings, valves, tubing and other related components shall be installed as specified in the *International Fuel Gas Code* and the *International Mechanical Code*, and shall be *approved* by the *fire code official*.

**3107.12.2 Venting.** Gas, liquid and solid fuel-burning equipment designed to be vented shall be vented to the outside air as specified in the *International Fuel Gas Code* and the *International Mechanical Code*. Such vents shall be equipped with *approved* spark arresters where required. Where vents or flues are used, all portions of the *tent* or *membrane structure* shall be not less than 12 inches (305 mm) from the flue or vent.

**3107.12.3 Location.** Cooking and heating equipment shall not be located within 10 feet (3048 mm) of *exits* or combustible materials.

**3107.12.4 Operations.** Operations such as warming of foods, cooking demonstrations and similar operations that use solid flammables, butane or other similar devices that do not pose an ignition hazard, shall be *approved*.

**3107.12.5 Cooking tents.** *Tents* with sidewalls or drops where cooking is performed shall be separated from other *tents* or *membrane structures* by not less than 20 feet (6096 mm).

**3107.12.6 Outdoor cooking.** Outdoor cooking that produces sparks or grease-laden vapors shall not be

performed within 20 feet (6096 mm) of a *tent* or *membrane structure*.

**3107.12.7 Electrical heating and cooking equipment.** Electrical cooking and heating equipment shall comply with NFPA 70.

**3107.13 LP-gas.** The storage, handling and use of LP-gas and LP-gas equipment shall be in accordance with Sections 3107.13.1 through 3107.13.3.

**3107.13.1 General.** LP-gas equipment such as containers, tanks, piping, hoses, fittings, valves, tubing and other related components shall be *approved* and in accordance with Chapter 61 and with the *International Fuel Gas Code*.

**3107.13.2 Location of containers.** LP-gas containers and tanks shall be located outside in accordance with Table 6104.3. Pressure relief devices shall be pointed away from the *tent* or *membrane structure*.

**3107.13.3 Protection and security.** Portable LP-gas containers, tanks, piping, valves and fittings that are located outside and are being used to fuel equipment inside a *tent* or *membrane structure* shall be adequately protected to prevent tampering, damage by vehicles or other hazards and shall be located in an *approved* location. Portable LP-gas containers shall be secured to prevent unauthorized movement.

**3107.14 Flammable and combustible liquids.** The storage of *flammable* and *combustible liquids* and the use of flammable-liquid-fueled equipment shall be in accordance with Sections 3107.14.1 through 3107.14.3.

**3107.14.1 Use.** Flammable-liquid-fueled equipment shall not be used in *tents* or *membrane structures*.

**3107.14.2 Flammable and combustible liquid storage.** *Flammable* and *combustible liquids* shall be stored outside in an *approved* manner not less than 50 feet (15 240 mm) from *tents* or *membrane structures*. Storage shall be in accordance with Chapter 57.

**3107.14.3 Refueling.** Refueling shall be performed in an *approved* location not less than 20 feet (6096 mm) from *tents* or *membrane structures*.

**3107.15 Display of motor vehicles.** Liquid- and gas-fueled vehicles and equipment used for display within *tents* or *membrane structures* shall be in accordance with Sections 3107.15.1 through 3107.15.5.3.

**3107.15.1 Batteries.** Batteries shall be disconnected except where the *fire code official* requires that the batteries remain connected to maintain safety features.

**3107.15.2 Fuel.** Vehicles or equipment shall not be fueled or defueled within the *tent* or *membrane structure*.

**3107.15.2.1 Quantity limit.** Fuel in the fuel tank shall not exceed one-quarter of the tank capacity or 5 gallons (19 L), whichever is less.

**3107.15.2.2 Inspection.** Fuel systems shall be inspected for leaks.

**3107.15.2.3 Closure.** Fuel tank openings shall be locked and sealed to prevent the escape of vapors.

**3107.15.3 Location.** The location of vehicles or equipment shall not obstruct *means of egress*.

**3107.15.4 Places of assembly.** When a compressed natural gas (CNG) or liquefied petroleum gas (LP-gas) powered vehicle is parked inside a place of assembly, all of the following conditions shall be met:

1. The quarter-turn shutoff valve or other shutoff valve on the outlet of the CNG or LP-gas container shall be closed and the engine shall be operated until it stops. Valves shall remain closed while the vehicle is indoors.
2. The hot lead of the battery shall be disconnected.
3. Dual-fuel vehicles equipped to operate on gasoline and CNG or LP-gas shall comply with this section and Sections 3107.15.1 through 3107.15.3 for gasoline-powered vehicles.

**3107.15.5 Competitions and demonstrations.** Liquid- and gas-fueled vehicles and equipment used for competition or demonstration within a *tent* or *membrane structure* shall comply with Sections 3107.15.5.1 through 3107.15.5.3.

**3107.15.5.1 Fuel storage.** Fuel for vehicles or equipment shall be stored in *approved* containers in an *approved* location outside of the structure in accordance with Section 3107.14.2.

**3107.15.5.2 Fueling.** Refueling shall be performed outside of the structure in accordance with Section 3107.14.3.

**3107.15.5.3 Spills.** Fuel spills shall be cleaned up immediately.

**3107.16 Separation of generators.** Generators and other internal combustion power sources shall be separated from *tents* or *membrane structures* by not less than 20 feet (6096 mm) and shall be isolated from contact with the public by fencing, enclosure or other *approved* means.

**3107.17 Standby personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety in a *tent* or *membrane structure* used as a place of assembly or any other use where people congregate, because of the number of persons, or the nature of the performance, exhibition, display, contest or activity, the *owner*, agent or lessee shall employ one or more qualified persons, as required and *approved*, to remain on duty during the times such places are open to the public, or when such activity is being conducted.

**3107.17.1 Duties.** Before each performance or the start of such activity, standby personnel shall keep diligent watch for fires during the time such place is open to the public or such activity is being conducted and take prompt measures for extinguishment of fires that occur and assist in the evacuation of the public from the structure.

**3107.17.2 Crowd managers.** There shall be trained crowd managers or trained crowd supervisors at a ratio of one crowd manager or supervisor for every 250 occupants, as *approved*.

**3107.18 Combustible vegetation.** Combustible vegetation that could create a fire hazard shall be removed from the area

**TENTS, TEMPORARY SPECIAL EVENT STRUCTURES AND OTHER MEMBRANE STRUCTURES**

occupied by a *tent* or *membrane structure*, and from areas within 30 feet (9144 mm) of such structures.

**3107.19 Combustible waste material.** The floor surface inside *tents* or *membrane structures* and the grounds outside and within a 30-foot (9144 mm) perimeter shall be kept free from combustible waste and other combustible materials that could create a fire hazard. Such waste shall be stored in *approved* containers and removed from the premises not less than once a day during the period the structure is occupied by the public.

## CHAPTER 32

# HIGH-PILED COMBUSTIBLE STORAGE

### User note:

**About this chapter:** Chapter 32 provides guidance for reasonable protection of life from hazards associated with the storage of combustible materials in closely packed piles or on pallets, in racks or on shelves where the top of storage is greater than 12 feet in height, or 6 feet for high-hazard commodities. It provides requirements for identifying various classes of commodities; and general fire and life safety features including storage arrangements, smoke and heat venting, fire department access and housekeeping and maintenance. This chapter attempts to define the potential fire severity and, in turn, determine fire and life safety protection measures needed to control and in some cases suppress a potential fire. This chapter does not cover miscellaneous combustible material storage as regulated in Section 315.

### SECTION 3201 GENERAL

**3201.1 Scope.** *High-piled combustible storage* shall be in accordance with this chapter. In addition to the requirements of this chapter, the following material-specific requirements shall apply:

1. Aerosols shall be in accordance with Chapter 51.
2. *Flammable* and *combustible liquids* shall be in accordance with Chapter 57.
3. Hazardous materials shall be in accordance with Chapter 50.
4. Storage of combustible paper records shall be in accordance with NFPA 13.
5. Storage of *combustible fibers* shall be in accordance with Chapter 37.
6. General storage of combustible material shall be in accordance with Chapter 3.

**3201.2 Permits.** A permit shall be required as set forth in Sections 105.5 and 105.6.

**3201.3 Construction documents.** At the time of building permit application for new structures designed to accommodate high-piled storage or for requesting a change of occupancy/use, and at the time of application for a storage permit, plans and specifications shall be submitted for review and approval. In addition to the information required by the *International Building Code*, the storage permit submittal shall include the information specified in this section. The *construction documents* shall include all of the following:

1. Floor plan of the building showing locations and dimensions of *high-piled storage areas*.
2. Usable storage height for each storage area.
3. Number of tiers within each rack, if applicable.
4. Commodity clearance between top of storage and the sprinkler deflector for each storage arrangement.
5. Aisle dimensions between each storage array.
6. Maximum pile volume for each storage array.
7. Location and classification of commodities in accordance with Section 3203.

8. Location of commodities that are banded or encapsulated.
9. Location of required fire department access doors.
10. Type of fire protection systems.
11. Location of valves controlling the water supply of ceiling and in-rack sprinklers.
12. Type, location and specifications of smoke removal and curtain board systems.
13. Dimension and location of transverse and longitudinal flue spaces.
14. Additional information regarding required design features, commodities, storage arrangement and fire protection features within the *high-piled storage area* shall be provided at the time of permit, where required by the *fire code official*.

**3201.3.1 Approved construction documents.** Following approval of the *construction documents*, a copy of the *approved* plans shall be maintained on the premises in an *approved* location.

**3201.3.2 Approved storage layout.** A floor plan, of legible size, shall be provided, mounted on a wall and protected from damage. The floor plan shall be mounted in an *approved* location and show the following:

1. Locations, dimensions and rack layout of *high-piled storage areas*.
2. Design storage height for each storage area.
3. Types of commodities.
4. Commodity clearance between top of storage and the sprinkler deflector for each storage arrangement.
5. Aisle dimensions between each storage array.
6. For palletized and solid-piled storage, the maximum pile volume for each storage array.
7. Location and classification of commodities in accordance with Section 3203.
8. Location of required fire department access doors.
9. Location of valves controlling the water supply of ceiling and in-rack sprinklers.



## HIGH-PILED COMBUSTIBLE STORAGE

**3201.4 Fire safety and evacuation plan.** Where required by the Section 403, a fire safety and evacuation plan shall be submitted at the time of permit application for review and approval. A copy of the *approved* fire safety and evacuation plan shall be maintained on the premises in an *approved* location.

### SECTION 3202 DEFINITIONS

**3202.1 Definitions.** The following terms are defined in Chapter 2:

**ARRAY.**

**ARRAY, CLOSED.**

**AUTOMATED RACK STORAGE.**

**BIN BOX.**

**COMMODITY.**

**EARLY SUPPRESSION FAST-RESPONSE (ESFR) SPRINKLER.**

**EXPANDED PLASTIC.**

**EXTRA-HIGH-RACK COMBUSTIBLE STORAGE.**

**HIGH-PILED COMBUSTIBLE STORAGE.**

**HIGH-PILED STORAGE AREA.**

**LONGITUDINAL FLUE SPACE.**

**MANUAL STOCKING METHODS.**

**MECHANICAL STOCKING METHODS.**

**SHELF STORAGE.**

**SOLID SHELVING.**

**TRANSVERSE FLUE SPACE.**

### SECTION 3203 COMMODITY CLASSIFICATION

**3203.1 Classification of commodities.** Commodities shall be classified as Class I, II, III, IV or high hazard in accordance with Sections 3203.2 through 3203.10.3. Materials listed within each commodity classification are assumed to be unmodified for improved combustibility characteristics. Use of flame-retarding modifiers or the physical form of the material could change the classification.

**3203.2 Class I commodities.** Class I commodities are noncombustible products in ordinary corrugated cartons with or without single-thickness dividers, or in ordinary paper wrappings with or without wood pallets. The amount of Group A plastics shall be limited in accordance with Section 3203.9.

**3203.3 Class II commodities.** Class II commodities are Class I products in slatted wooden crates, solid wooden boxes, multiple-thickness paperboard cartons or equivalent combustible packaging material with or without wood pallets. The amount of Group A plastics shall be limited in accordance with Section 3203.9.

**3203.4 Class III commodities.** Class III commodities are products of wood, paper, natural fiber cloth, or Group C plastics or products thereof, with or without wood pallets. The amount of Group A plastics shall be limited in accordance with Section 3203.9.

**3203.5 Class IV commodities.** Class IV commodities are Class I, II or III products containing Group A plastics in ordinary corrugated cartons; Class I, II and III products with Group A plastic packaging; Group B plastics; and free-flowing Group A plastics with or without wood pallets. The total amount of nonfree-flowing Group A plastics shall be limited in accordance with Section 3203.9.

**3203.6 High-hazard commodities.** High-hazard commodities are products presenting special fire hazards beyond those of Class I, II, III or IV. Group A plastics not otherwise classified are included in this class.

**3203.7 Classification of plastics.** Plastics shall be designated as Group A, B or C in accordance with Sections 3203.7.1 through 3203.7.3.

**3203.7.1 Group A plastics.** Group A plastics are plastic materials having a heat of combustion that is much higher than that of ordinary combustibles, and a burning rate higher than that of Group B plastics.

**3203.7.2 Group B plastics.** Group B plastics are plastic materials having a heat of combustion and a burning rate higher than that of ordinary combustibles, but not as high as those of Group A plastics.

**3203.7.3 Group C plastics.** Group C plastics are plastic materials having a heat of combustion and a burning rate similar to those of ordinary combustibles.

**3203.8 Examples of commodity classification.** Table 3203.8 shall be used to determine the commodity classification for various products and materials. Products not found in the list shall be classified based on the classification descriptions in Sections 3203.2 through 3203.6 and the products they most nearly represent in Table 3203.8. Table 3203.8 considers the product and the packaging if *listed* with the item. Products with additional packaging consisting of Group A plastics shall be classified in accordance with Section 3203.9.

The commodity classifications are based on products with, or without, wood pallets. Where plastic pallets are used, the commodity classification shall be modified in accordance with Section 3203.10.

**3203.9 Limited quantities of Group A plastics in mixed commodities.** Figures 3203.9(1) and 3203.9(2) shall be used to determine the commodity classification based on the quantity of Group A plastics in the following situations:

1. The product is not listed in Table 3203.8 and contains Group A plastics.
2. The commodity contains Group A plastics and is not classified as high hazard in Table 3203.8.
3. The product listing in Table 3203.8 does not specifically include packaging, and the packaging material includes Group A plastics.

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Aerosols	Level 1	Class III (See Chapter 51)
	Level 2	Class IV (See Chapter 51)
	Level 3	High-hazard (See Chapter 51)
Batteries	Dry cells (excludes lithium, lithium-ion and other similar exotic metals or combustible electrolyte); without blister packing (if blister packed, refer to the commodity classification definitions)	Class I
	Dry cells (nonlithium or similar exotic metals); in blister packing; cartoned	Class II
	Vehicle; any size (for example, automobile or truck); empty plastic casing	High-hazard (Group A unexpanded)
	Vehicle; large (in other words, truck or larger); dry or wet cells (excludes lithium-ion and other cells containing combustible electrolytes)	High-hazard (Group A unexpanded)
	Vehicle; small (for example, automobile); wet cells (excludes lithium-ion and other cells containing combustible electrolytes)	Class I
	Lithium-ion	High-hazard
Biomass	Circular baled corn stover	Class IV
	Rectangular baled corn stover	Class III
	Rectangular baled switchgrass	High-hazard
Empty containers	Noncombustible	Class I
	PET	Class IV
	Rigid plastic (not including PET)	High-hazard (Group A unexpanded)
	Wood; solid sided (such as crates, boxes)	Class II
Film rolls, including photographic	Polypropylene, polyester, polyethylene; rolled on any reel type	High-hazard (Group A unexpanded)
	35 mm metal film cartridges in polyethylene cans; cartoned	Class III
	Motion picture or bulk rolls in polycarbonate, polyethylene or in metal cans; polyethylene bagged; cartoned	Class II
	Rolls in polycarbonate plastic cassettes; cartoned	Class IV
	Photographic paper; sheets; bagged in polyethylene; cartoned	Class III
Flammable and combustible liquids	Glycol in combustible containers (50 percent or greater)	High-hazard
	Lacquers, which dry by solvent evaporation, in metal cans or cartons	High-hazard
	Lighters; butane; blister-packed; cartoned	High-hazard (Group A unexpanded)
	Over 20- and up to 50-percent alcohol (such as alcoholic beverages, hair spray); up to 1-gallon glass bottles or jars; in racks; cartoned	Class III
	Over 20- and up to 50-percent alcohol (such as alcoholic beverages, hair spray); up to 1-gallon glass bottles or jars; palletized; cartoned	Class IV
	Over 20- and up to 50-percent alcohol (such as alcoholic beverages, hair spray); up to 1-gallon plastic bottles or jars; cartoned	Class IV
	Up to 20-percent alcohol (such as alcoholic beverages, flavoring extracts); greater than 5-gallon plastic containers with wall thickness greater than 0.25 inch	High-hazard (Group A unexpanded)
	Up to 20-percent alcohol (such as alcoholic beverages, flavoring extracts); metal, glass or ceramic containers	Class I
	Up to 20-percent alcohol (such as alcoholic beverages, flavoring extracts); plastic containers greater than 5 gallons and wall thickness up to $\frac{1}{4}$ inch	Class II

(continued)

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Flammable and combustible liquids (continued)	Up to 20-percent alcohol (such as alcoholic beverages, flavoring extracts); up to 5-gallon plastic bottles or jars	Class I
	Up to 20-percent alcohol (such as alcoholic beverages, flavoring extracts); wood containers	Class II
	Lubricating or hydraulic fluid in plastic containers	High-hazard
	Nail polish; up to 2-ounce glass bottles or jars; cartoned	Class IV
	Nail polish; up to 2-ounce plastic bottles or jars; cartoned	High-hazard (Group A unexpanded)
Flammable solids	Except solid combustible metals	High-hazard
Food products, frozen	In nonwaxed or nonplastic packaging	Class I
	In plastic trays	Class III
	In waxed or plastic-coated paper packaging	Class II
Food products, nonfrozen	Butter (stick or whipped spread) or margarine (up to 50-percent oil)	Class III
	Butter; whipped spread	Class III
	Dry foods (such as baked goods, candy, cereals, cheese, chocolate, cocoa, coffee, grains, granular sugar, nuts); bagged or cartoned	Class III
	Foods (such as coffee, fish products, fruit, meat products, nuts, poultry); metal cans	Class I
	Fruits and vegetables (noncombustible semiliquid); crushed; plastic containers up to 5 gallons	Class I
	Fruits and vegetables; fresh; wood spacers, nonplastic trays or containers	Class I
	Margarine; over 50- and up to 80-percent oil	High-hazard (Group A unexpanded)
	Meat; fresh; no plastic packaging; uncartoned	Class I
	Meat; fresh; no plastic packaging; cartoned	Class II
	Meat; fresh; plastic tray	Class III
	Milk; any container; stored in solid plastic crates	High-hazard (Group A unexpanded)
	Milk; paper containers, or plastic bottles or jars up to 5 gallons	Class I
	Salt; bagged	Class I
	Salt; cartoned	Class II
	Snack foods (such as potato chips); plasticized aluminum bags; cartoned	High-hazard (Group A unexpanded)
	Syrup; wooden container	Class II
Furniture and bedding	Box spring; standard (minimal plastic materials)	Class III
	Box spring; wrapped in plastic cover	Class IV
	Furniture and bedding; with foam cushioning	High-hazard (Group A expanded)
	Furniture; metal (such as file cabinets or desks with minimal plastic trim); cartoned	Class I
	Furniture; wood (such as doors, windows, cabinets); no plastic coverings or foam cushioning	Class III
	Furniture; wood; plastic coverings; nonexpanded plastic trim	Class IV
	Mattress; foam (in finished form)	High-hazard (Group A expanded)
	Pillows, foam rubber and foam plastics	High-hazard (Group A expanded)

(continued)

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Housing materials and appliances	Appliances; major (for example, stoves, refrigerators); no appreciable plastic interior or exterior trim; cartoned	Class II
	Appliances; major (for example, stoves, refrigerators); no appreciable plastic interior or exterior trim; uncartoned	Class I
	Appliances; no appreciable plastic exterior trim (interior of unit can have appreciable plastic)	Class III
	Carpet tiles; cartoned	High-hazard (Group A unexpanded)
	Fiberglass insulation; paper-backed rolls; bagged or unbagged	Class IV
	Floor coverings; vinyl, stacked tiles	Class IV
	Floor coverings; vinyl; rolled	High-hazard (Group A unexpanded)
	Gypsum board	Class I
	Housing materials (such as sinks, countertops); noncombustible, cartoned or crated	Class II
	Light fixtures; nonplastic; cartoned	Class II
	Paint; oil-based; friction-top metal containers; cartoned	Class IV
	Paint; water-based (latex); friction-top metal containers; cartoned	Class I
	Paper; asphalt; rolled, horizontal or vertical storage	High-hazard
	Roofing shingles; asphalt-coated fiberglass	Class III
	Roofing shingles; asphalt-impregnated felt	Class IV
Miscellaneous	Ammunition; small arms and shotgun; cartoned	Class IV
	Charcoal; mineral-spirit impregnated; bagged	High-hazard (Group A expanded)
	Charcoal; standard (nonmineral-spirit impregnated); bagged	Class III
	Fertilizers; nitrates; bagged	Class II
	Fertilizers; phosphates; bagged	Class I
	Leather hides; baled	Class II
	Leather; finished products (such as shoes, jackets, gloves, bags, luggage, belts)	Class III
	Motors; electric	Class I
	Pallets and flats that are idle; combustible	High-hazard
	Shock absorbers; metal dust cover	Class II
	Shock absorbers; plastic dust cover	Class III
	Skis; wood	Class III
	Skis; composite materials (such as plastic, fiberglass, foam)	Class IV
	Tobacco products; cartoned	Class III
	Toys; stuffed; foam or synthetic	High-hazard (Group A expanded)
	Transformer; dry or empty (in other words, void of oil)	Class I
Noncombustible liquids	Liquids or semiliquids; PET containers greater than 5 gallons having a nominal wall thickness greater than $\frac{1}{4}$ inch	Class IV
	Liquids or semiliquids; PET containers up to 5 gallons having a nominal wall thickness less than $\frac{1}{4}$ inch	Class I
	Liquids or semiliquids (such as crushed fruits and vegetables); plastic containers up to 5-gallon capacity	Class I
	Liquids or semiliquids; plastic (except PET) containers greater than 5-gallon capacity having a nominal wall thickness greater than $\frac{1}{4}$ inch	High-hazard (Group A unexpanded)

(continued)



## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Noncombustible liquids (continued)	Liquids or semiliquids; plastic (except PET) containers greater than 5-gallon capacity having a nominal wall thickness up to $\frac{1}{4}$ inch	Class II
	Liquids; cardboard drink boxes, plastic coated, wax coated, and/or aluminum lined; uncartoned or on corrugated carton trays with plastic sheeting	Class I
	Liquids; cardboard drink boxes, plastic coated, wax coated, and/or aluminum lined; stored in plastic containers	High-hazard (Group A unexpanded)
	Liquids; glass bottles or jars; cartoned	Class I
	Liquids; less than 5-gallon plastic containers	Class I
	Liquids; pharmaceuticals (nonflammable); glass bottles or jars; cartoned	Class II
	Liquids; plastic bottles or jars; stored in open or solid plastic crates	High-hazard (Group A unexpanded)
Paper products	Book signatures (paper part of book without hard cover)	Class II
	Cartons (such as cardboard flats); corrugated; partially assembled	Class IV
	Cartons (such as cardboard flats); corrugated; unassembled in neat piles	Class III
	Cartons; wax coated, single-walled corrugated	High-hazard (Group A unexpanded)
	Cellulosic paper products; nonwax coated (such as books, cardboard games, cartoned tissue products, magazines, newspapers, paper cups, paper plates, paper towels, plastic-coated paper food containers, stationary)	Class III
	Cellulosic paper products; wax coated (such as paper plates, cups); loosely packed; cartoned	High-hazard (Group A unexpanded)
	Cellulosic paper products; wax coated (such as paper plates, cups); nested; cartoned	Class IV
	Matches; paper-type; cartoned	Class IV
	Matches; wooden; cartoned	High-hazard (Group A unexpanded)
	Rolled; lightweight; in storage racks	Class IV
	Rolled; medium or heavyweight; in storage racks or onside	Class III
	Rolled; in horizontal storage or vertical storage that is banded or protected with an approved wrap	Class III
	Rolled; in vertical storage that is unbanded or not protected with an approved wrap	High-hazard
	Tissue products; plastic wrapped; cartoned	Class III
	Tissue products; plastic wrapped; uncartoned	High-hazard (Group A unexpanded)
Plastic, rubber	ABS (Acrylonitrile-butadiene-styrene copolymer)	High-hazard (Group A unexpanded)
	Acetal (polyformaldehyde)	High-hazard (Group A unexpanded)
	Acrylic (polymethyl methacrylate)	High-hazard (Group A unexpanded)
	Automobile bumpers and dashboards	High-hazard (Group A expanded)
	Butyl rubber	High-hazard (Group A unexpanded)
	Cellulose acetate	Class IV (Group B plastic)
	Cellulose acetate butyrate	High-hazard (Group A unexpanded)

(continued)

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Plastic, rubber (continued)	Chloroprene rubber	Class IV (Group B plastic)
	Containers; Nonexpanded plastic gridded or solid; collapsed or nested with no air spaces	High-hazard (Group A unexpanded)
	ECTFE (ethylene-chlorotrifluoro-ethylene copolymer)	Class IV (Group B plastic)
	EPDM (ethylene-propylene rubber)	High-hazard (Group A unexpanded)
	ETFE (ethylene-tetrafluoroethylene copolymer)	Class IV (Group B plastic)
	Ethyl cellulose	High-hazard (Group A unexpanded)
	FEP (fluorinated ethylene-propylene copolymer)	Class IV (Group B plastic)
	FRP (fiberglass-reinforced polyester)	High-hazard (Group A unexpanded)
	Melamine (melamine formaldehyde)	Class III (Group C plastic)
	Nitrile rubber (acrylonitrile-butadiene rubber)	High-hazard (Group A unexpanded)
	Nylon (nylon 6, nylon 6/6)	High-hazard (Group A unexpanded)
	PCTFE (polychlorotrifluoroethylene)	Class III (Group C plastic)
	PET (Polyethylene terephthalate-thermoplastic polyester)	High-hazard (Group A unexpanded)
	Phenolic	Class III (Group C plastic)
	Plastics; stored in fully closed and solid (no openings) metal containers	Class I
	Polybutadiene	High-hazard (Group A unexpanded)
	Polycarbonate	High-hazard (Group A unexpanded)
	Polyester elastomer	High-hazard (Group A unexpanded)
	Polyethylene	High-hazard (Group A unexpanded)
	Polypropylene	High-hazard (Group A unexpanded)
	Polystyrene; foam products (such as plates, cups)	High-hazard (Group A expanded)
	Polystyrene; rigid products	High-hazard (Group A unexpanded)
	Polyurethane	High-hazard (Group A expanded)
	PTFE (polytetrafluoroethylene)	Class III (Group C plastic)
	PVC (polyvinyl chloride) products; plasticizer content 20 percent or less	Class III (Group C plastic)

(continued)

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Plastic, rubber (continued)	PVC (polyvinyl chloride) products; plasticizer content greater than 20 percent	High-hazard (Group A unexpanded)
	PVC resins; bagged	Class III (Group C plastic)
	PVDC (polyvinylidene chloride)	Class III (Group C plastic)
	PVDF (polyvinylidene fluoride)	Class III (Group C plastic)
	PVF (polyvinyl fluoride)	High-hazard (Group A unexpanded)
	Pyroxylin	High-hazard
	Rubber; natural in blocks; cartoned	High-hazard (Group A unexpanded)
	Rubber; natural; expanded	High-hazard (Group A expanded)
	Rubber; natural; Nonexpanded	High-hazard (Group A unexpanded)
	Rubber; synthetic (santoprene)	High-hazard (Group A unexpanded)
	Rubber tires	High-hazard
	SAN (styrene acrylonitrile)	High-hazard (Group A unexpanded)
	SBR (styrene-butadiene rubber)	High-hazard (Group A unexpanded)
	Silicone rubber	Class IV (Group B plastic)
	Urea (urea formaldehyde)	Class III (Group C plastic)
Plastic containers	Bottles or jars greater than 1 gallon containing noncombustible solids	High-hazard (Group A unexpanded)
	Bottles or jars up to 1 gallon containing noncombustible solids	High-hazard (Group A unexpanded)
Powders, pills	Pharmaceutical pills; glass bottles or jars; cartoned	Class II
	Pharmaceuticals pills; plastic bottles or jars; cartoned	Class IV
	Polyvinyl alcohol (PVA) resins; bagged	Class IV
	Powders; combustible (ordinary—such as sugar or flour); free-flowing; bagged	Class II
	Powders; noncombustible free-flowing powdered or granular materials (such as cement, calcium chloride, clay, iron oxide, sodium chloride, sodium silicate); bagged	Class I
	Powders; noncombustible; glass bottles or jars; cartoned	Class I
	Powders; noncombustible; PET bottles or jars	Class II
	Powders; noncombustible; plastic (other than PET) bottles or jars; uncartoned	High-hazard (Group A unexpanded)
	Powders; noncombustible; plastic bottles or jars greater than 1-gallon capacity	High-hazard (Group A unexpanded)
	Powders; noncombustible; plastic bottles or jars up to 1-gallon capacity; cartoned	Class IV

(continued)

## HIGH-PILED COMBUSTIBLE STORAGE

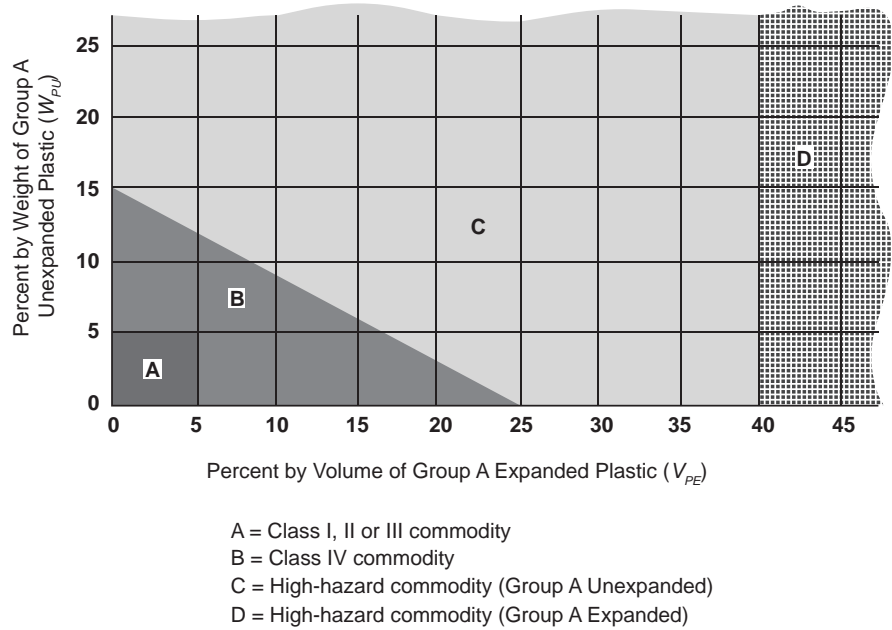
**TABLE 3203.8—continued**  
**EXAMPLES OF COMMODITY CLASSIFICATION**

PRODUCT CATEGORY	PRODUCT	CLASSIFICATION
Textile materials and products	Cloth; natural fibers; baled	Class III
	Cloth; synthetic cloth	Class IV
	Clothing; natural fibers (such as wool, cotton) and viscose	Class III
	Cotton; cartoned	Class III
	Diapers; cotton or linen	Class III
	Diapers; plastic or nonwoven fabric; cartoned	Class IV
	Diapers; plastic or nonwoven fabric; plastic-wrapped; uncartoned	High-hazard (Group A unexpanded)
	Fabric; rayon and nylon	Class IV
	Fabric; synthetic (except rayon and nylon); greater than 50/50 blend	High-hazard (Group A unexpanded)
	Fabric; synthetic (except rayon and nylon); up to 50/50 blend	Class III
	Fabric; vinyl-coated (such as tablecloth); cartoned	High-hazard (Group A unexpanded)
	Fibers; rayon and nylon; baled	Class IV
	Fibers; synthetic (except rayon and nylon); baled	High-hazard (Group A unexpanded)
	Thread or yarn; rayon and nylon; wood or paper spools	Class IV
	Thread or yarn; rayon or nylon; plastic spools	High-hazard (Group A unexpanded)
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; paper or wood spools	Class IV
	Thread or yarn; synthetic (except rayon and nylon); greater than 50/50 blend; plastic spools	High-hazard (Group A unexpanded)
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; plastic spools	High-hazard (Group A unexpanded)
	Thread or yarn; synthetic (except rayon and nylon); up to 50/50 blend; wood or paper spools	Class III
Wax products	Candles	High-hazard (Group A expanded)
	Paraffin or petroleum wax; blocks	High-hazard (Group A expanded)
Wire, cable, spools	Spools; plastic; empty	High-hazard (Group A unexpanded)
	Spools; wood; empty	Class III
	Wire or cable; PVC insulated; metal or wood spools	Class II
	Wire or cable; PVC insulated; plastic spools	Class IV
	Wire; bare; metal spools; uncartoned	Class I
	Wire; bare; metal spools; cartoned	Class II
	Wire; bare; plastic spools; cartoned	Class IV
	Wire; bare; plastic spools; uncartoned	High-hazard (Group A unexpanded)
	Wire; bare; wood or cardboard spools	Class II
Wood products	Wood patterns	Class IV
	Wood products (such as fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); bundled solid blocks	Class II
	Wood products (such as fiberboard, lumber, particle board, plywood, pressboard with smooth ends and edges); unbundled or nonsolid blocks	Class III
	Wood products (such as toothpicks, clothespins and hangers)	Class III

For SI: 1 inch = 25.4 mm, 1 gallon = 3.8 L, 1 ounce = 29.57 mL.

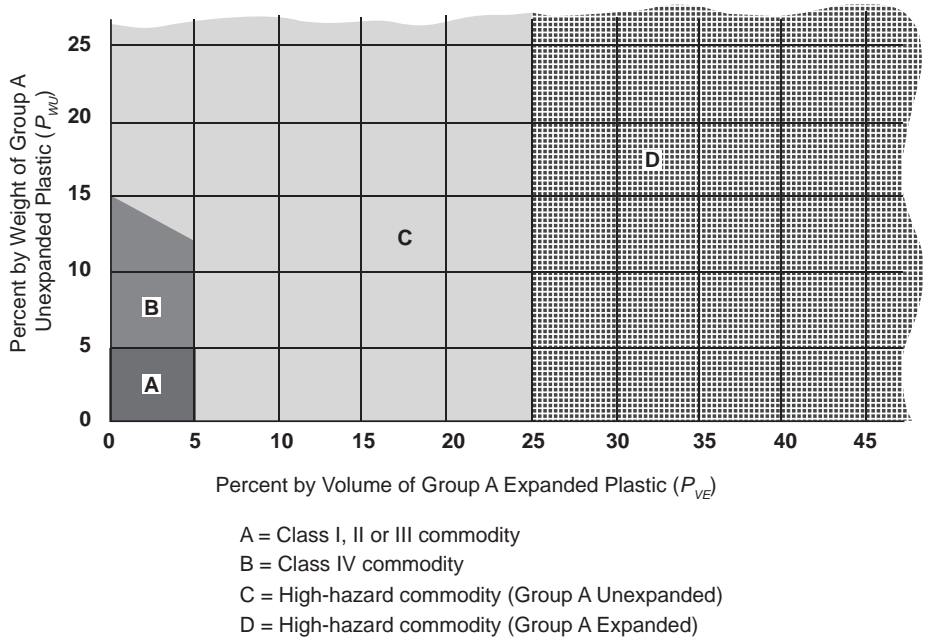


HIGH-PILED COMBUSTIBLE STORAGE



**FIGURE 3203.9(1)**  
**EVALUATION OF CARTONED COMMODITIES CONTAINING GROUP A PLASTICS <sup>a, b</sup>**

- a. This figure is used to determine the commodity classification of a mixed commodity with Group A plastics in a package or crate.
- b. The following is an example of how to apply Figure 3203.9(1): A pallet load consists of a Class III commodity in cardboard boxes with components of unexpanded Group A plastic and packing material of expanded Group A plastic. Using Equation 32-1, the weight of unexpanded Group A plastic is 5 percent. Using Equation 32-2, the volume of expanded Group A plastic is 15 percent. This commodity is classified as a Class IV commodity. If the volume of the expanded Group A plastic is increased to 20 percent, the classification changes to a high-hazard (Group A unexpanded) commodity. Where the load is stored on a plastic pallet, the requirements in Section 3203.10 also apply.



**FIGURE 3203.9(2)**  
**EVALUATION OF EXPOSED COMMODITIES CONTAINING GROUP A PLASTICS <sup>a, b</sup>**

- a. This figure is used to determine the commodity classification of a mixed commodity with Group A plastics where the products are exposed.
- b. The following is an example of how to apply Figure 3203.9(2): A pallet load consists of an exposed Class III commodity with components of unexpanded Group A plastic and packing material of expanded Group A plastic. Using Equation 32-1, the weight of unexpanded Group A plastic is 5 percent. Using Equation 32-2, the volume of expanded Group A plastic is 6 percent. This commodity is classified as a high-hazard (Group A unexpanded) commodity. Where the load is stored on a plastic pallet, the requirements in Section 3203.10 also apply.

## HIGH-PILED COMBUSTIBLE STORAGE

**3203.9.1 Classifying mixed commodities with limited Group A plastics.** The percentage of Group A plastics determined in accordance with Section 3203.9.2 shall be used in Figures 3203.9(1) and 3203.9(2). Results from Figure 3203.9(1) must be compared to results from Figure 3203.9(2) and the commodity will be classified with the highest commodity classification.

Figures 3203.9(1) and 3203.9(2) shall not be used to reduce the commodity classification shown in Table 3203.8.

**3203.9.2 Percentage of Group A plastics.** The pallet, if any, shall not be included when measuring the weight of the commodity ( $W_{PU}$  or  $W_{PE}$ ) or the volume of the commodity ( $V_{PE}$ ). The pallet, if any, shall be included when measuring the weight of the entire load ( $W_L$ ) or the volume of the entire load ( $V_L$ ).

**Exception:** Where noncombustible pallets are used, the pallets shall not be included in the volume and weight calculations.

The percentage by weight of Group A unexpanded plastics in the load shall be calculated in accordance with Equation 32-1.

The percentage by volume of Group A expanded plastics in the load shall be calculated in accordance with Equation 32-2.

The percentage by weight of Group A expanded plastics in the load shall be calculated in accordance with Equation 32-3.

$$P_{WU} = W_{PU} / W_L \quad (\text{Equation 32-1})$$

where:

$P_{WU}$  = Percentage by weight of Group A unexpanded plastic.

$W_{PU}$  = Weight of Group A unexpanded plastic in the commodity, not including the weight of the pallet, if any.

$W_L$  = Weight of the entire load, including the weight of the pallet, if any.

$$P_{VE} = V_{PE} / V_L \quad (\text{Equation 32-2})$$

where:

$P_{VE}$  = Percentage by volume of Group A expanded plastic.

$V_{PE}$  = Volume of Group A expanded plastic in the commodity, not including the volume of the pallet, if any.

$V_L$  = Volume of the entire load, including the volume of the pallet, if any.

$$P_{WE} = W_{PE} / W_L \quad (\text{Equation 32-3})$$

where:

$P_{WE}$  = Percentage by weight of Group A expanded plastic.

$W_{PE}$  = Weight of Group A expanded plastic in the commodity, not including the weight of the pallet, if any.

$W_L$  = Weight of the entire load, including the weight of the pallet, if any.

**3203.10 Plastic pallets.** The commodity classification determined in Section 3203.8 or 3203.9 shall be modified in accordance with Sections 3203.10.1 through 3203.10.3 where plastic pallets are used.

**Exception:** The commodity classification is not modified where any of the following conditions occur:

1. Group A plastic commodities are stored on plastic pallets.
2. Sprinkler protection consists of sprinklers at the ceiling only, using sprinklers with a minimum K-factor of K-16.8 (240).
3. The plastic pallets are *listed* and *labeled* in accordance with Section 3206.4.1.1.

**3203.10.1 Unreinforced plastic pallets.** For Class I through IV commodities, where unreinforced polypropylene or unreinforced high-density polyethylene plastic pallets are used, the commodity classification shall be increased one class. To be considered unreinforced plastic pallets, the pallets shall be marked with a permanent symbol indicating the pallet is unreinforced.

**3203.10.2 Reinforced plastic pallets.** For Class I through IV commodities, where reinforced polypropylene or reinforced high-density polyethylene plastic pallets are used, the commodity classification shall be increased two classes except for Class IV commodities, which shall be increased to a high-hazard (Group A plastic, cartoned, unexpanded) commodity.

**3203.10.3 Other pallets.** For Class I through IV commodities stored on plastic pallets other than polypropylene or high-density polyethylene plastic pallets, the commodity classification shall be increased two classes unless specific testing is conducted by a testing laboratory.

## SECTION 3204

## DESIGNATION OF HIGH-PILED STORAGE AREAS

**3204.1 General.** *High-piled storage areas*, and portions of *high-piled storage areas* intended for storage of a different commodity class than adjacent areas, shall be designed and specifically designated to contain Class I, Class II, Class III, Class IV or high-hazard commodities. The designation of a *high-piled storage area*, or portion thereof intended for storage of a different commodity class, shall be based on the highest hazard commodity class stored except as provided in Section 3204.2.

**3204.2 Designation based on engineering analysis.** The designation of a *high-piled combustible storage area*, or portion thereof, is allowed to be based on a lower hazard class than that of the highest class of commodity stored where a limited quantity of the higher hazard commodity has been demonstrated by engineering analysis to be adequately

## HIGH-PILED COMBUSTIBLE STORAGE

protected by the *automatic sprinkler system* provided. The engineering analysis shall consider the ability of the sprinkler system to deliver the higher density required by the higher hazard commodity. The higher density shall be based on the actual storage height of the pile or rack and the minimum allowable design area for sprinkler operation as set forth in the density/area figures provided in NFPA 13. The contiguous area occupied by the higher hazard commodity shall not exceed 120 square feet (11 m<sup>2</sup>) and additional areas of higher hazard commodity shall be separated from other such areas by 25 feet (7620 mm) or more. The sprinkler system shall be capable of delivering the higher density over a minimum area of 900 square feet (84 m<sup>2</sup>) for wet pipe systems and 1,200 square feet (111 m<sup>2</sup>) for dry pipe systems. The shape of the design area shall be in accordance with Section 903.

### SECTION 3205 HOUSEKEEPING AND MAINTENANCE

**3205.1 Storage layout plan maintenance.** The *approved* storage layout shall be verified and evaluated annually in accordance with Section 3201.3.2. Modifications or changes to the provisions of the *approved* storage layout shall not be made without the prior approval of the *fire code official*.

**3205.2 Rack structures.** The structural integrity of racks shall be maintained.

**3205.3 Ignition sources.** Clearance from ignition sources shall be provided in accordance with Section 305.

**3205.4 Smoking.** Smoking shall be prohibited. *Approved* “No Smoking” signs shall be conspicuously posted in accordance with Section 310.

**3205.5 Aisle maintenance.** When restocking is not being conducted, aisles shall be kept clear of storage, waste material and debris. Fire department access doors, aisles and exit doors shall not be obstructed. During restocking operations using manual stocking methods, a minimum unobstructed aisle width of 24 inches (610 mm) shall be maintained in 48-inch (1219 mm) or smaller aisles, and a minimum unobstructed aisle width of one-half of the required aisle width shall be maintained in aisles greater than 48 inches (1219 mm). During mechanical stocking operations, a minimum unobstructed aisle width of 44 inches (1118 mm) shall be maintained in accordance with Section 3206.10.

**Exception:** In high-piled single- and double-row rack storage of combustible materials protected by *automatic sprinkler systems* designed and installed in accordance with the requirements of NFPA 13 governing the use of K-25.2 (360) sprinklers, displays and wing stacks not exceeding 48 inches (1219 mm) in height provided that they do not obstruct or reduce the clear width of the aisle to less than 48 inches (1219 mm).

**3205.6 Pile dimension and height limitations.** Pile dimensions and height limitations shall comply with Section 3207.3.

**3205.7 Designation of storage heights.** Where required by the *fire code official*, a visual method of indicating the maximum allowable storage height shall be provided.

**3205.8 Arrays.** Arrays shall comply with Section 3207.4.

**3205.9 Flue spaces.** Flue spaces shall comply with Section 3208.3.

### SECTION 3206 GENERAL FIRE PROTECTION AND LIFE SAFETY FEATURES

**3206.1 General.** Fire protection and life safety features for *high-piled storage areas* shall be in accordance with Sections 3206.2 through 3206.11.

**3206.2 Type of protection.** Where required by Table 3206.2, fire detection systems, smoke and heat removal and automatic sprinkler design densities shall be provided to protect the *high-piled storage area*.

**3206.2.1 Extent of protection.** The fire safety features required in Table 3206.2 shall extend to the lesser of 15 feet (4572 mm) beyond the *high-piled storage area* or a full height wall. Where portions of *high-piled storage areas* have different fire protection requirements because of commodity, method of storage or storage height, the fire protection features required by Table 3206.2 within this area shall be based on the most restrictive design requirements.

**3206.3 High-piled storage areas.** For the application of Table 3206.2, the size of the *high-piled storage areas* shall be determined in accordance with Sections 3206.3.1 through 3206.3.2.1.

**3206.3.1 Size of high-piled storage area.** The size of each *high-piled storage area* shall include the footprint of the actual high-piled storage racks, shelves or piles and the following aisles:

1. Interior aisles within the footprint of the storage area.
2. An aisle around the perimeter of the footprint with a minimum width as required in Section 3206.10.1 or the dimension to a full height wall, whichever is less.

**3206.3.2 Multiple high-piled storage areas.** Where a building contains multiple *high-piled storage areas*, the aggregate of all *high-piled storage areas* shall be used for the application of Table 3206.2 unless the *high-piled storage areas* are separated in accordance with one of the following:

1. *High-piled storage areas* separated by *fire barriers* with a minimum *fire-resistance-rating* of 1 hour constructed in accordance with Section 707 of the *International Building Code*.
2. In buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, *high-piled storage areas* separated by 100 feet (30 480 mm) or more. The area providing the separation shall not contain *high-piled combustible storage*.

## HIGH-PILED COMBUSTIBLE STORAGE

**TABLE 3206.2**  
**GENERAL FIRE PROTECTION AND LIFE SAFETY REQUIREMENTS**

COMMODITY CLASS	SIZE OF HIGH-PILED STORAGE AREA <sup>a</sup> (square feet) (see Sections 3206.2 and 3206.3)	ALL STORAGE AREAS (see Sections 3206, 3207 and 3208) <sup>b</sup>				SOLID-PILED STORAGE, SHELF STORAGE AND PALLETIZED STORAGE (see Section 3207.3)		
		Automatic fire-extinguishing system (see Section 3206.4)	Fire detection system (see Section 3206.5)	Fire department access doors (see Section 3206.7)	Smoke and heat removal (see Section 3206.8)	Maximum pile dimension <sup>c</sup> (feet)	Maximum permissible storage height <sup>d</sup> (feet)	Maximum pile volume (cubic feet)
I-IV	0-500	Not Required <sup>a</sup>	Not Required	Not Required	Not Required	Not Required	Not Required	Not Required
	501-2,500	Not Required <sup>a</sup>	Yes <sup>g</sup>	Not Required	Not Required	120	40	100,000
	2,501-12,000 Open to the public	Yes	Not Required	Not Required	Not Required	120	40	400,000
	2,501-12,000 Not open to the public (Option 1)	Yes	Not Required	Not Required	Not Required	120	40	400,000
	2,501-12,000 Not open to the public (Option 2)	Not Required <sup>a</sup>	Yes	Yes	Yes <sup>h,i</sup>	120	30 <sup>e</sup>	200,000
	12,001-500,000	Yes	Not Required	Yes	Yes <sup>h,i</sup>	120	40	400,000
	Greater than 500,000 <sup>f</sup>	Yes	Not Required	Yes	Yes <sup>h,i</sup>	120	40	400,000
High hazard	0-500	Not Required <sup>a</sup>	Not Required	Not Required	Not Required	60	Not Required	Not Required
	501-2,500 Open to the public	Yes	Not Required	Not Required	Not Required	60	30	75,000
	501-2,500 Not open to the public (Option 1)	Yes	Not Required	Not Required	Not Required	60	30	75,000
	501-2,500 Not open to the public (Option 2)	Not Required <sup>a</sup>	Yes <sup>g</sup>	Yes	Yes <sup>h,i</sup>	60	20	50,000
	2,501-300,000	Yes	Not Required	Yes	Yes <sup>h,i</sup>	60	30	75,000
	Greater than 300,000 <sup>f</sup>	Yes	Not Required	Yes	Yes <sup>h,i</sup>	60	30	75,000

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>, 1 square foot = 0.0929 m<sup>2</sup>.

- Where automatic sprinklers are required for reasons other than those in Chapter 32, the portion of the sprinkler system protecting the high-piled storage area shall be designed and installed in accordance with Sections 3207 and 3208.
- For aisles, see Section 3206.10.
- Piles shall be separated by aisles complying with Section 3206.10.
- For storage in excess of the height indicated, special fire protection shall be provided in accordance with Note f where required by the fire code official. See Chapters 51 and 57 for special limitations for aerosols and flammable and combustible liquids, respectively.
- For storage exceeding 30 feet in height, Option 1 shall be used.
- Special fire protection provisions including, but not limited to, fire protection of exposed steel columns; increased sprinkler density; additional in-rack sprinklers, without associated reductions in ceiling sprinkler density; or fire department hose connections shall be provided where required by the fire code official.
- Not required where an automatic fire-extinguishing system is designed and installed to protect the high-piled storage area in accordance with Sections 3207 and 3208.
- Not required where storage areas are protected by either early suppression fast response (ESFR) sprinkler systems or control mode special application sprinklers with a response time index of 50 (meters-seconds)<sup>1/2</sup> or less that are listed to control a fire in the stored commodities with 12 or fewer sprinklers, installed in accordance with NFPA 13.
- Not required in frozen food warehouses used solely for storage of Class I and II commodities where protected by an approved automatic sprinkler system.



## HIGH-PILED COMBUSTIBLE STORAGE

### 3206.3.2.1 Multiple class high-piled storage areas.

*High-piled storage areas* classified as Class I through IV not separated from *high-piled storage areas* classified as high hazard shall utilize the aggregate of all *high-piled storage areas* as high hazard for the purposes of the application of Table 3206.2. Multiple class *high-piled storage areas* meeting the separation requirements in Section 3206.3.2 shall be considered as separated. The fire safety features in Table 3206.2 shall be extended beyond the higher-hazard storage area in accordance with Section 3206.2.1.

**Exception:** Multiple class *high-piled storage areas* do not need to be separated where in accordance with Section 3204.2.

**3206.4 Automatic sprinklers.** *Automatic sprinkler systems* shall be provided in accordance with Sections 3207, 3208 and 3209.

**3206.4.1 Pallets.** *Automatic sprinkler system* requirements based on the presence of pallets shall be in accordance with NFPA 13.

**3206.4.1.1 Plastic pallets.** Plastic pallets *listed and labeled* in accordance with FM 4996 or UL 2335 shall be treated as wood pallets for determining required sprinkler protection.

**3206.5 Fire detection.** Where fire detection is required by Table 3206.2, an *approved* automatic fire detection system shall be installed throughout the *high-piled storage area*. The system shall be monitored and be in accordance with Section 907.

**3206.6 Building access.** Fire apparatus access roads in accordance with Section 503 shall be provided within 150 feet (45 720 mm) of all portions of the *exterior walls* of buildings used for high-piled storage.

**Exception:** Where fire apparatus access roads cannot be installed because of topography, railways, waterways, nonnegotiable grades or other similar conditions, the *fire code official* is authorized to require additional fire protection.

**3206.7 Fire department access doors.** Where fire department access doors are required by Table 3206.2, fire department access doors shall be provided in accordance Sections 3206.7.1 through 3206.7.8.

**3206.7.1 Exterior walls without fire department access doors.** Fire department access doors are not required in an exterior wall that does not face a fire apparatus access road provided that all of the following conditions occur:

1. The opposite exterior wall faces a fire apparatus access road.
2. The opposite exterior wall is provided with fire department access doors.
3. The entire interior surface of the exterior wall is less than 150 feet (45 720 mm) away from a fire department access door.

4. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**3206.7.2 Where located.** Where exterior walls surrounding *high-piled storage areas* face fire apparatus access roads, such walls shall be provided with fire department access doors.

**3206.7.3 Access to doors.** Fire department access doors shall be able to be accessed without the use of a ladder.

**3206.7.4 Marking on fire department access doors.** Fire department access doors shall be labeled on the exterior side with the following sign or other *approved* sign:

FIRE DEPARTMENT ACCESS DOOR  
DO NOT BLOCK

The lettering shall be in a contrasting color to the background. Letters shall have a minimum height of 2 inches (51 mm) with a minimum stroke of  $\frac{3}{8}$  inch (10 mm).

**3206.7.5 Number of doors required.** The required fire department access doors shall be distributed such that the linear distance between adjacent fire department access doors does not exceed 125 feet (38 100 mm) measured center to center.

**Exception:** The linear distance between adjacent access doors shall not exceed 200 feet (60 960 mm) in existing buildings where change in occupancy is not proposed.

**3206.7.6 Door size and type.** Fire department access doors shall be not less than 3 feet (914 mm) in width and 6 feet 8 inches (2032 mm) in height. Roll-up doors shall not be considered fire department access doors unless *approved*.

**3206.7.7 Locking devices.** Locking devices on fire department access doors shall be *approved*.

**3206.7.8 Key box.** Where fire department access doors are required, a key box shall be installed in accordance with Section 506.1. The key box shall contain keys or devices to allow for entry through the fire department access doors.

**3206.8 Smoke and heat removal.** Where smoke and heat removal is required by Table 3206.2 it shall be provided in accordance with Section 910.

**3206.9 Fire department hose connections.** Where exit *passageways* are required by the *International Building Code* for egress, a Class I standpipe system shall be provided in accordance with Section 905.

**3206.10 Aisles.** Aisles providing access to *exits* and fire department access doors shall be provided in *high-piled storage areas* exceeding 500 square feet (46 m<sup>2</sup>), in accordance with Sections 3206.10.1 through 3206.10.3. Aisles separating storage piles or racks shall comply with NFPA 13. Aisles shall comply with Chapter 10.

**Exception:** Where aisles are precluded by rack storage systems, alternate methods of access and protection are allowed where *approved*.

**3206.10.1 Width.** Aisle width shall be in accordance with Sections 3206.10.1.1 and 3206.10.1.2.

**Exceptions:**

1. Aisles crossing rack structures or storage piles, that are used only for employee access, shall be not less than 24 inches (610 mm) wide.
2. Aisles separating shelves classified as shelf storage shall be not less than 30 inches (762 mm) wide.

**3206.10.1.1 Sprinklered buildings.** Aisles in sprinklered buildings shall be not less than 44 inches (1118 mm) wide. Aisles shall be not less than 96 inches (2438 mm) wide in *high-piled storage areas* exceeding 2,500 square feet (232 m<sup>2</sup>) in area, that are accessible to the public and designated to contain high-hazard commodities.

Aisles shall be not less than 96 inches (2438 mm) wide in areas open to the public where mechanical stocking methods are used.

**Exceptions:**

1. Aisles in *high-piled storage areas* exceeding 2,500 square feet (232 m<sup>2</sup>) in area, that are open to the public and designated to contain high-hazard commodities, and that are protected by a sprinkler system designed for multiple-row racks of high-hazard commodities, shall be not less than 44 inches (1118 mm) wide.
2. Aisles that are in *high-piled storage areas* exceeding 2,500 square feet (232 m<sup>2</sup>) in area, not open to the public and protected by a sprinkler system designed for multiple-row racks, shall be not less than 24 inches (610 mm) wide.

**3206.10.1.2 Nonsprinklered buildings.** Aisles in nonsprinklered buildings shall be not less than 96 inches (2438 mm) wide.

**3206.10.2 Clear height.** The required aisle width shall extend from floor to ceiling. Rack structural supports and catwalks are allowed to cross aisles at a minimum height of 6 feet 8 inches (2032 mm) above the finished floor level, provided that such supports do not interfere with fire department hose stream trajectory.

**3206.10.3 Dead-end aisles.** Dead-end aisles shall not exceed 20 feet (6096 mm) in length in Group M occupancies. Dead-end aisles shall not exceed 50 feet (15 240 mm) in length in all other occupancies.

**Exception:** Dead-end aisles are not limited where the length of the dead-end aisle is less than 2.5 times the least width of the dead-end aisle.

**3206.11 Portable fire extinguishers.** Portable fire extinguishers shall be provided in accordance with Section 906.

## SECTION 3207 SOLID-PILED AND SHELF STORAGE

**3207.1 General.** Shelf storage and storage in solid piles, solid piles on pallets and bin box storage in bin boxes not exceeding 5 feet (1524 mm) in any dimension, shall be in accordance with Section 3206 and this section.

**3207.2 Fire protection.** Where automatic sprinklers are required by Table 3206.2, an *approved automatic sprinkler system* shall be installed throughout the building or to 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*. The design and installation of the *automatic sprinkler system* and other applicable fire protection shall be in accordance with the *International Building Code* and NFPA 13.

**3207.2.1 Shelf storage.** Shelf storage greater than 12 feet (3658 mm) but less than 15 feet (4572 mm) in height shall be in accordance with the fire protection requirements set forth in NFPA 13. Shelf storage 15 feet (4572 mm) or more in height shall be protected in an *approved* manner with special fire protection, such as in-rack sprinklers.

**3207.3 Pile dimension and height limitations.** Pile dimensions, the maximum permissible storage height and pile volume shall be in accordance with Table 3206.2.

**3207.4 Arrays.** Where an *automatic sprinkler system* design utilizes protection based on a closed array, array clearances shall be provided and maintained as specified by the standard used.

## SECTION 3208 RACK STORAGE

**3208.1 General.** Rack storage shall be in accordance with Section 3206 and this section. Bin boxes exceeding 5 feet (1524 mm) in any dimension shall be regulated as rack storage.

**3208.1.1 Storage racks.** The design and installation of storage racks shall be in accordance with the *International Building Code*.

**3208.2 Fire protection.** Where automatic sprinklers are required by Table 3206.2, an *approved automatic sprinkler system* shall be installed throughout the building or to 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code*. Openings in such *fire barriers* shall be protected by opening protectives having a 1-hour *fire protection rating*. The design and installation of the *automatic sprinkler system* and other applicable fire protection shall be in accordance with Section 903.3.1.1 and the *International Building Code*.

**3208.2.1 Plastic shelves.** Storage on plastic shelves shall be protected by *approved* specially engineered *fire protection systems*.

**3208.2.2 Racks with solid shelving.** Racks with solid shelving having an area greater than 20 square feet (1.9 m<sup>2</sup>), measured between *approved* flue spaces at all four

## HIGH-PILED COMBUSTIBLE STORAGE

edges of the shelf, shall be in accordance with this section.

### Exceptions:

1. Racks with mesh, grated, slatted or similar shelves having uniform openings not more than 6 inches (152 mm) apart, comprising not less than 50 percent of the overall shelf area, and with *approved* flue spaces are allowed to be treated as racks without solid shelves.
2. Racks used for the storage of combustible paper records, with solid shelving, shall be in accordance with NFPA 13.

**3208.2.2.1 Fire protection.** Fire protection for racks with solid shelving shall be in accordance with NFPA 13.

**3208.3 Flue spaces.** Rack storage areas protected with an *automatic sprinkler system* shall be provided with flue spaces in accordance with Table 3208.3. Required flue spaces shall be maintained.

**3208.3.1 Flue space protection.** Flue spaces required by Table 3208.3 above the first tier of storage in single-, double- or multiple-row rack storage installations shall, where required by the *fire code official*, be equipped with *approved* protection devices. Such devices shall not be removed or modified.

**3208.4 Column protection.** Steel building columns shall be protected in accordance with NFPA 13.

**3208.5 Extra-high-rack storage systems.** Approval of the *fire code official* shall be obtained prior to installing extra-high-rack combustible storage.

**3208.5.1 Fire protection.** Buildings with extra-high-rack combustible storage shall be protected with a specially engineered *automatic sprinkler system*. Extra-high-rack combustible storage shall be provided with additional special fire protection, such as separation from other buildings and additional built-in fire protection features and fire department access, where required by the *fire code official*.

## SECTION 3209 AUTOMATED STORAGE

**3209.1 General.** Automated storage shall be in accordance with this section.

**3209.2 Automatic sprinklers.** Where automatic sprinklers are required by Table 3206.2, the building shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**3209.3 Carousel storage.** *High-piled storage areas* having greater than 500 square feet (46 m<sup>2</sup>) of carousel storage shall be provided with automatic shutdown in accordance with one of the following:

1. An automatic smoke detection system installed in accordance with Section 907, with coverage extending 15 feet (4575 mm) in all directions beyond unenclosed carousel storage systems and that sounds a local alarm at the operator's station and stops the carousel storage system upon the activation of a single detector.
2. An automatic smoke detection system installed in accordance with Section 907 and within enclosed carousel storage systems, that sounds a local alarm at

**TABLE 3208.3  
REQUIRED FLUE SPACES FOR RACK STORAGE**

RACK CONFIGURATION	FLUE DESIGN		AUTOMATIC SPRINKLER PROTECTION		
			Sprinklers at the ceiling with or without minimum in-rack sprinklers		In-rack sprinklers at every tier
			Storage height ≤ 25 feet	Storage height > 25 feet	Any height
Single-row rack	Transverse flue space	Size <sup>b</sup>	3 inches	3 inches	Not required
		Vertically aligned	Not required	Yes	Not required
	Longitudinal flue space		Not required	Not required	Not required
Double-row rack (Option 1)	Transverse flue space	Size <sup>b</sup>	6 inches <sup>a</sup>	3 inches	Not required
		Vertically aligned	Not required	Yes	Not required
	Longitudinal flue space		Not required	6 inches	Not required
Double-row rack (Option 2)	Transverse flue space	Size <sup>b</sup>	3 inches	6 inches	Not required
		Vertically aligned	Not required	Yes	Not required
	Longitudinal flue space		6 inches	Not required	Not required
Multiple-row rack	Transverse flue space	Size <sup>b</sup>	6 inches	6 inches	Not required
		Vertically aligned	Not required	Yes	Not required
	Longitudinal flue space		Not required	Not required	Not required

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Three-inch transverse flue spaces shall be provided not less than every 10 feet where ESFR sprinkler protection is provided.

b. Random variations are allowed, provided that the configuration does not obstruct water penetration.

the operator's station and stops the carousel storage system upon the activation of a single detector.

3. A single dead-man-type control switch that allows the operation of the carousel storage system only when the operator is present. The switch shall be in the same room as the carousel storage system and located to provide for observation of the carousel system.

**3209.4 Automated rack storage.** *High-piled storage areas* with automated rack storage shall be provided with a manually activated emergency shutdown switch and automatic shutdown in accordance with Sections 3209.4.1 and 3209.4.2.

**3209.4.1 Manual activated shutdown.** A manually activated switch shall be provided to initiate the *approved* automatic shutdown process. The switch shall be clearly identified and shall be in a location *approved* by the *fire code official*.

**3209.4.2 Automatic shutdown.** Automatic shutdown shall be required for *high-piled combustible storage* areas greater than 500 square feet (46 m<sup>2</sup>). The *approved* automatic shutdown process shall commence upon any of the following events:

1. Water flow is detected in the *automatic sprinkler system*, if present.
2. Activation of the fire detection system, if present.

## SECTION 3210 SPECIALTY STORAGE

**3210.1 General.** Records storage facilities used for the rack or shelf storage of combustible paper records greater than 12 feet (3658 mm) in height shall be in accordance with Sections 3206 and 3208. Palletized storage of records shall be in accordance with Section 3207.

**3210.1.1 Alternative fire protection.** The design and installation of automatic fire-extinguishing systems in archives, vaults and record storage rooms shall be in accordance with NFPA 232.





## CHAPTER 33

# FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION

### User note:

**About this chapter:** Chapter 33 outlines general fire safety precautions for all structures and all occupancies during construction and demolition operations. In general, these requirements seek to maintain required levels of fire protection, limit fire spread, establish the appropriate operation of equipment and promote prompt response to fire emergencies. There is an emphasis on owner responsibility and the need to create and implement a site safety plan. Features regulated include fire protection systems, fire fighter access to the site and building, water supply, means of egress, hazardous materials storage and use, and temporary heating equipment and other ignition sources. Fire watches are an important component of this chapter. This chapter correlates with Chapter 33 of the International Building Code®.

### SECTION 3301 GENERAL

**3301.1 Scope.** This chapter shall apply to structures in the course of construction, *alteration* or demolition, including those in underground locations. Compliance with NFPA 241 is required for items not specifically addressed herein.

**3301.2 Purpose.** This chapter prescribes minimum safeguards for construction, *alteration* and demolition operations to provide reasonable safety to life and property from fire during such operations.

### SECTION 3302 DEFINITIONS

**3302.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

5. Location of fire protection equipment, including portable fire extinguishers, standpipes, fire department connections and fire hydrants.
6. Smoking and cooking policies, designated areas to be used where *approved*, and signage locations in accordance with Section 3305.8.
7. Location and safety considerations for temporary heating equipment.
8. Hot work permit plan.
9. Plans for control of combustible waste material.
10. Locations and methods for storage and use of *flammable* and *combustible liquids* and other hazardous materials.
11. Provisions for site security.
12. Changes that affect this plan.
13. Other site-specific information required by the *fire code official*.

**3303.2 Site safety director.** The *owner* shall designate a person to be the site safety director. The site safety director shall be responsible for ensuring compliance with the *site safety plan*. The site safety director shall have the authority to enforce the provisions of this chapter and other provisions as necessary to secure the intent of this chapter. Where guard service is provided in accordance with NFPA 241, the site safety director shall be responsible for the guard service.

**3303.3 Daily fire safety inspection.** The site safety director shall be responsible for completion of a daily fire safety inspection at the project site. Each day, all building and outdoor areas shall be inspected to ensure compliance with the inspection list in this section. The results of each inspection shall be documented and maintained on-site until a certificate of occupancy has been issued. Documentation shall be immediately available on-site for presentation to the *fire code official* upon request.

### SECTION 3303 OWNER'S RESPONSIBILITY FOR FIRE PROTECTION

**3303.1 Program development and maintenance.** The *owner* or *owner's* authorized agent shall be responsible for the development, implementation and maintenance of an *approved*, written *site safety plan* establishing a fire prevention program at the project site applicable throughout all phases of the construction, repair, *alteration* or demolition work. The plan addresses the requirements of this chapter and other applicable portions of this code, the duties of staff and staff training requirements. The plan shall be submitted and approved before a building permit is issued. Any changes to the plan shall be submitted for approval.

**3303.1.1 Components of site safety plans.** *Site safety plans* shall include the following as applicable:

1. Name and contact information of site safety director.
2. Documentation of the training of the site safety director and fire watch personnel.
3. Procedures for reporting emergencies.
4. Fire department vehicle access routes.

1. Any contractors entering the site to perform hot work each day have been instructed in the hot work safety requirements in Chapter 35, and hot work is performed only in areas *approved* by the site safety director.

## FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION

2. Temporary heating equipment is maintained away from combustible materials in accordance with the equipment manufacturer's instructions.
3. Combustible debris, rubbish and waste material is removed from the building in areas where work is not being performed.
4. Temporary wiring does not have exposed conductors.
5. *Flammable liquids* and other hazardous materials are stored in locations that have been *approved* by the site safety director when not involved in work that is being performed.
6. Fire apparatus access roads required by Section 3311 are maintained clear of obstructions that reduce the width of the usable roadway to less than 20 feet (6096 mm).
7. Fire hydrants are clearly visible from access roads and are not obstructed.
8. The location of fire department connections to standpipe and in-service sprinkler systems are clearly identifiable from the access road and such connections are not obstructed.
9. Standpipe systems are in service and continuous to the highest work floor, as specified in Section 3313.1.
10. Portable fire extinguishers are available in locations required by Sections 3316 and 3318.3.

**3303.3.1 Violations.** Failure to properly conduct, document and maintain documentation required by this section shall constitute an unlawful act in accordance with Section 112.1 and shall result in the issuance of a notice of violation to the site safety director in accordance with Section 112.3. Upon the third offense, the *fire code official* is authorized to issue a stop work order in accordance with Section 113, and work shall not resume until satisfactory assurances of future compliance have been presented to and *approved* by the *fire code official*.

**3303.4 Qualifications.** Site safety directors shall acquire training specific to their roles and responsibilities. Upon request, the training and qualifications of the site safety director shall be submitted to the *fire code official* for approval.

**3303.5 Fire safety requirements for buildings of Types IV-A, IV-B and IV-C construction.** Buildings of Types IV-A, IV-B and IV-C construction designed to be greater than six stories above *grade plane* shall comply with the following requirements during construction unless otherwise *approved* by the *fire code official*:

1. Standpipes shall be provided in accordance with Section 3313.
2. A water supply for fire department operations, as *approved* by the *fire code official* and the *fire chief*.
3. Where building construction exceeds six stories above *grade plane* and noncombustible protection is required by Section 602.4 of the *International Building Code*, at least one layer of noncombustible

protection shall be installed on all building elements on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

**Exception:** Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.

4. Where building construction exceeds six stories above *grade plane*, required exterior wall coverings shall be installed on floor levels, including mezzanines, more than four levels below active mass timber construction before additional floor levels can be erected.

**Exception:** Shafts and vertical exit enclosures shall not be considered part of the active mass timber construction.

**3303.6 Training.** Training of fire watch and other responsible personnel in the use of fire protection equipment shall be the responsibility of the site safety director. Records of training shall be kept and made a part of the written plan for the *site safety plan*.

**3303.7 Fire protection devices.** The site safety director shall ensure that all fire protection equipment is maintained and serviced in accordance with this code. Fire protection equipment shall be inspected in accordance with the fire protection program.

**3303.8 Hot work operations.** The site safety director shall ensure hot work operations and permit procedures are in accordance with Chapter 35.

**3303.9 Impairment of fire protection systems.** The site safety director shall ensure impairments to any *fire protection system* are in accordance with Section 901.

**3303.9.1 Smoke detectors and smoke alarms.** Smoke detectors and smoke alarms located in an area where airborne construction dust is expected shall be covered to prevent exposure to dust or shall be temporarily removed. Smoke detectors and alarms that were removed shall be replaced upon conclusion of dust-producing work. Smoke detectors and smoke alarms that were covered shall be inspected and cleaned, as necessary, upon conclusion of dust-producing work.

**3303.10 Temporary covering of fire protection devices.** Coverings placed on or over fire protection devices to protect them from damage during construction processes shall be immediately removed upon the completion of the construction processes in the room or area in which the devices are installed.

## SECTION 3304 TEMPORARY HEATING EQUIPMENT

**3304.1 Listed.** Temporary heating devices shall be *listed* and *labeled*. The installation, maintenance and use of temporary heating devices shall be in accordance with the listing and the manufacturer's instructions.

**3304.2 Oil-fired heaters.** Oil-fired heaters shall comply with Section 605.

**3304.3 LP-gas heaters.** Fuel supplies for liquefied-petroleum gas-fired heaters shall comply with Chapter 61 and the *International Fuel Gas Code*.

**3304.4 Refueling.** Refueling operations for liquid-fueled equipment or appliances shall be conducted in accordance with Section 5705. The equipment or appliance shall be allowed to cool prior to refueling.

**3304.5 Installation.** Clearance to combustibles from temporary heating devices shall be maintained in accordance with the *labeled* equipment. When in operation, temporary heating devices shall be fixed in place and protected from damage, dislodgement or overturning in accordance with the manufacturer's instructions.

**3304.6 Supervision.** The use of temporary heating devices shall be supervised and maintained only by competent personnel.

## SECTION 3305 PRECAUTIONS AGAINST FIRE

**3305.1 Smoking.** Smoking shall be prohibited except in *approved* areas. Signs shall be posted in accordance with Section 310. In *approved* areas where smoking is permitted, *approved* ashtrays shall be provided in accordance with Section 310.

**3305.2 Combustible debris, rubbish and waste.** Combustible debris, rubbish and waste material shall comply with the requirements of Sections 3305.2.1 through 3305.2.4.

**3305.2.1 Combustible waste material accumulation.** Combustible debris, rubbish and waste material shall not be accumulated within buildings.

**3305.2.2 Combustible waste material removal.** Combustible debris, rubbish and waste material shall be removed from buildings at the end of each shift of work.

**3305.2.3 Rubbish containers.** Where rubbish containers with a capacity exceeding 5.33 cubic feet (40 gallons) (0.15 m<sup>3</sup>) are used for temporary storage of combustible debris, rubbish and waste material, they shall have tight-fitting or self-closing lids. Such rubbish containers shall be constructed entirely of materials that comply with either of the following:

1. Noncombustible materials.
2. Materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

**3305.2.4 Spontaneous ignition.** Materials susceptible to spontaneous ignition, such as oily rags, shall be stored in a *listed* disposal container.

**3305.3 Burning of combustible debris, rubbish and waste.** Combustible debris, rubbish and waste material shall not be disposed of by burning on the site unless *approved*.

**3305.4 Open burning.** *Open burning* shall comply with Section 307.

**3305.5 Fire watch.** Where required by the *fire code official* or the *site safety plan* established in accordance with Section 3303.1, a fire watch shall be provided for building demolition and for building construction.

**3305.5.1 Fire watch during construction.** A fire watch shall be provided during nonworking hours for new construction that exceeds 40 feet (12 192 mm) in height above the lowest adjacent grade at any point along the building perimeter, for new multistory construction with an aggregate area exceeding 50,000 square feet (4645 m<sup>2</sup>) per story or as required by the *fire code official*.

**3305.5.2 Fire watch personnel.** Fire watch personnel shall be provided in accordance with this section.

**3305.5.2.1 Duties.** The primary duty of fire watch personnel shall be to perform constant patrols and watch for the occurrence of fire. The combination of fire watch duties and site security duties is acceptable.

**3305.5.2.2 Training.** Personnel shall be trained to serve as an on-site fire watch. Training shall include the use of portable fire extinguishers. Fire extinguishers and fire reporting shall be in accordance with Section 3310.

**3305.5.2.3 Means of notification.** Fire watch personnel shall be provided with not fewer than one *approved* means for notifying the fire department.

**3305.5.3 Fire watch location and records.** The fire watch shall include areas specified by the *site safety plan* established in accordance with Section 3303.

**3305.5.4 Fire watch records.** Fire watch personnel shall keep a record of all time periods of duty, including the log entry for each time the site was patrolled and each time a structure was entered and inspected. Records shall be made available for review by the *fire code official* upon request.

**3305.6 Cutting and welding.** Welding, cutting, open torches and other hot work operations and equipment shall comply with Chapter 35.

**3305.7 Electrical.** Temporary wiring for electrical power and lighting installations used in connection with the construction, *alteration* or demolition of buildings, structures, equipment or similar activities shall comply with NFPA 70.

**3305.8 Cooking.** Cooking shall be prohibited except in *approved* designated cooking areas separated from combustible materials by a minimum of 10 feet (3048 mm). Signs with a minimum letter height of 3 inches (76 mm) and a minimum brush stroke of 1/2 inch (13 mm) shall be posted in conspicuous locations in designated cooking areas and state:

DESIGNATED COOKING AREA  
COOKING OUTSIDE OF A DESIGNATED  
COOKING AREA IS PROHIBITED

**3305.9 Separations between construction areas.** Separations used in Type I and Type II construction to separate



## FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION

construction areas from occupied portions of the building shall be constructed of materials that comply with one of the following:

1. Noncombustible materials.
2. Materials that exhibit a flame spread index not exceeding 25 when tested in accordance with ASTM E84 or UL 723.
3. Materials exhibiting a peak heat release rate not exceeding 300 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation on specimens at the thickness intended for use.

### SECTION 3306 FLAMMABLE AND COMBUSTIBLE LIQUIDS

**3306.1 Storage of flammable and combustible liquids.** Storage of *flammable* and *combustible liquids* shall be in accordance with Section 5704.

**3306.2 Class I and Class II liquids.** The storage, use and handling of *flammable* and *combustible liquids* at construction sites shall be in accordance with Section 5706.2. Ventilation shall be provided for operations involving the application of materials containing flammable solvents.

**3306.3 Housekeeping.** *Flammable* and *combustible liquid* storage areas shall be maintained clear of combustible vegetation and waste materials. Such storage areas shall not be used for the storage of combustible materials.

**3306.4 Precautions against fire.** Sources of ignition and smoking shall be prohibited in *flammable* and *combustible liquid* storage areas. Signs shall be posted in accordance with Section 310.

**3306.5 Handling at point of final use.** Class I and II liquids shall be kept in *approved* safety containers.

**3306.6 Leakage and spills.** Leaking vessels shall be immediately repaired or taken out of service and spills shall be cleaned up and disposed of properly.

### SECTION 3307 FLAMMABLE GASES

**3307.1 Storage and handling.** The storage, use and handling of flammable gases shall comply with Chapter 58.

**3307.2 Cleaning with flammable gas.** Flammable gases shall not be used to clean or remove debris from piping open to the atmosphere.

**3307.2.1 Pipe cleaning and purging.** The cleaning and purging of flammable gas piping systems, including cleaning new or existing piping systems, purging piping systems into service and purging piping systems out of service, shall comply with NFPA 56.

#### Exceptions:

1. *Compressed gas* piping systems other than fuel gas piping systems where in accordance with Chapter 53.

2. Piping systems regulated by the *International Fuel Gas Code*.
3. Liquefied petroleum gas systems in accordance with Chapter 61.

\*

### SECTION 3308 EXPLOSIVE MATERIALS

**3308.1 Storage and handling.** *Explosive* materials shall be stored, used and handled in accordance with Chapter 56.

**3308.2 Supervision.** Blasting operations shall be conducted in accordance with Chapter 56.

**3308.3 Demolition using explosives.** *Approved* fire hoses for use by demolition personnel shall be maintained at the demolition site wherever *explosives* are used for demolition. Such fire hoses shall be connected to an *approved* water supply and shall be capable of being brought to bear on post-detonation fires anywhere on the site of the demolition operation.

### SECTION 3309 PORTABLE GENERATORS

**3309.1 General.** Portable generators used at construction and demolition sites shall comply with Section 1204.

### SECTION 3310 FIRE REPORTING

**3310.1 Emergency telephone.** Emergency telephone facilities with *ready access* shall be provided in an *approved* location at the construction site, or an *approved* equivalent means of communication shall be provided. The street address of the construction site and the emergency telephone number of the fire department shall be posted adjacent to the telephone. Alternatively, where an equivalent means of communication has been *approved*, the site address and fire department emergency telephone number shall be posted at the main entrance to the site, in guard shack and in the construction site office.

### SECTION 3311 ACCESS FOR FIRE FIGHTING

**3311.1 Required access.** *Approved* vehicle access for fire fighting shall be provided to all construction or demolition sites. Vehicle access shall be provided to within 100 feet (30 480 mm) of temporary or permanent fire department connections. Vehicle access shall be provided by either temporary or permanent roads, capable of supporting vehicle loading under all weather conditions. Vehicle access shall be maintained until permanent fire apparatus access roads are available.

**3311.2 Key boxes.** Key boxes shall be provided as required by Chapter 5.

## SECTION 3312 MEANS OF EGRESS

**[BE] 3312.1 Stairways required.** Where building construction exceeds 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access, a temporary or permanent *stairway* shall be provided. As construction progresses, such *stairway* shall be extended to within one floor of the highest point of construction having secured decking or flooring.

**3312.2 Maintenance.** Required *means of egress* and required *accessible means of egress* shall be maintained during construction and demolition, remodeling or *alterations* and additions to any building.

**Exception:** *Approved temporary means of egress and accessible means of egress systems and facilities.*

**3312.3 Storage.** Combustible materials associated with construction, demolition, remodeling or *alterations* to an occupied structure shall not be stored in *exits*, enclosures for *stairways* and *ramps*, or *exit access corridors* serving an occupant load of 30 or more.

### Exceptions:

1. Where the only occupants are construction workers.
2. Combustible materials that are temporarily accumulated to support work being performed when workers are present.

## SECTION 3313 WATER SUPPLY FOR FIRE PROTECTION

**3313.1 When required.** An *approved* water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible building materials arrive on the site, on commencement of vertical combustible construction and on installation of a standpipe system in buildings under construction, in accordance with Sections 3313.2 through 3313.5.

**Exception:** The *fire code official* is authorized to reduce the fire-flow requirements for isolated buildings or a group of buildings in rural areas or small communities where the development of full fire-flow requirements is impractical.

**3313.2 Combustible building materials.** When combustible building materials of the building under construction are delivered to a site, a minimum fire flow of 500 gallons per minute (1893 L/m) shall be provided. The fire hydrant used to provide this fire-flow supply shall be within 500 feet (152 m) of the combustible building materials, as measured along an *approved* fire apparatus access lane. Where the site configuration is such that one fire hydrant cannot be located within 500 feet (152 m) of all combustible building materials, additional fire hydrants shall be required to provide coverage in accordance with this section.

**3313.3 Vertical construction of Types III, IV and V construction.** Prior to commencement of vertical construction of Type III, IV or V buildings that utilize any

combustible building materials, the fire flow required by Sections 3313.3.1 through 3313.3.3 shall be provided, accompanied by fire hydrants in sufficient quantity to deliver the required fire flow and proper coverage.

**3313.3.1 Fire separation up to 30 feet.** Where a building of Type III, IV or V construction has a *fire separation distance* of less than 30 feet (9144 mm) from property lot lines, and an adjacent property has an existing structure or otherwise can be built on, the water supply shall provide either a minimum of 500 gallons per minute (1893 L/m) or the entire fire flow required for the building when constructed, whichever is greater.

**3313.3.2 Fire separation of 30 feet up to 60 feet.** Where a building of Type III, IV or V construction has a fire separation distance of 30 feet (9144 mm) up to 60 feet (18 288 mm) from property lot lines, and an adjacent property has an existing structure or otherwise can be built on, the water supply shall provide a minimum of 500 gallons per minute (1893 L/m) or 50 percent of the fire flow required for the building when constructed, whichever is greater.

**3313.3.3 Fire separation of 60 feet or greater.** Where a building of Type III, IV or V construction has a fire separation of 60 feet (18 288 mm) or greater from a property *lot line*, a water supply of 500 gallons per minute (1893 L/m) shall be provided.

**3313.4 Vertical construction, Type I and II construction.** If combustible building materials are delivered to the construction site, water supply in accordance with Section 3313.2 shall be provided. Additional water supply for fire flow is not required prior to commencing vertical construction of Type I and II buildings.

**3313.5 Standpipe supply.** Regardless of the presence of combustible building materials, the construction type or the *fire separation distance*, where a standpipe is required in accordance with Section 3314, a water supply providing a minimum flow of 500 gallons per minute (1893 L/m) shall be provided. The fire hydrant used for this water supply shall be located within 100 feet (30 480 mm) of the fire department connection supplying the standpipe.

## SECTION 3314 STANDPIPES

**3314.1 Where required.** In buildings required to have standpipes by Section 905.3.1, not less than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipes shall be provided with fire department hose connections at locations adjacent to *stairways* complying with Section 3312.1. As construction progresses, such standpipes shall be extended to within one floor of the highest point of construction having secured decking or flooring.

**3314.2 Buildings being demolished.** Where a building is being demolished and a standpipe is existing within such a building, such standpipe shall be maintained in an operable

## FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION

condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

**3314.3 Detailed requirements.** Standpipes shall be installed in accordance with the provisions of Section 905.

**Exception:** Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes comply with the requirements of Section 905 as to capacity, outlets and materials.

### SECTION 3315 AUTOMATIC SPRINKLER SYSTEM

**3315.1 Completion before occupancy.** In buildings where an *automatic sprinkler system* is required by this code or the *International Building Code*, it shall be unlawful to occupy any portion of a building or structure until the *automatic sprinkler system* installation has been tested and *approved*, except as provided in Section 105.3.4.

**3315.2 Operation of valves.** Operation of sprinkler control valves shall be allowed only by properly authorized personnel and shall be accompanied by notification of duly designated parties. Where the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

### SECTION 3316 PORTABLE FIRE EXTINGUISHERS

**3316.1 Where required.** Structures under construction, *alteration* or demolition shall be provided with not less than one *approved* portable fire extinguisher in accordance with Section 906 and sized for not less than ordinary hazard as follows:

1. At each *stairway* on all floor levels where combustible materials have accumulated.
2. In every storage and construction shed.
3. Additional portable fire extinguishers shall be provided where special hazards exist including, but not limited to, the storage and use of *flammable* and *combustible liquids*.

### SECTION 3317 MOTORIZED CONSTRUCTION EQUIPMENT

**3317.1 Conditions of use.** Internal-combustion-powered construction equipment shall be used in accordance with all of the following conditions:

1. Equipment shall be located so that exhausts do not discharge against combustible material.
2. Exhausts shall be piped to the outside of the building.
3. Equipment shall not be refueled while in operation.

4. Fuel for equipment shall be stored in an *approved* area outside of the building.

### SECTION 3318 SAFEGUARDING ROOFING OPERATIONS

**3318.1 General.** Roofing operations utilizing heat-producing systems or other ignition sources shall be conducted in accordance with Sections 3318.2 and 3318.3 and Chapter 35.

**3318.2 Asphalt and tar kettles.** Asphalt and tar kettles shall be operated in accordance with Section 303.

**3318.3 Fire extinguishers for roofing operations.** Fire extinguishers shall comply with Section 906. There shall be not less than one multiple-purpose portable fire extinguisher with a minimum 3-A 40-B:C rating on the roof being covered or repaired.

## CHAPTER 34

# TIRE REBUILDING AND TIRE STORAGE

### User note:

**About this chapter:** Chapter 34 provides requirements that are intended to prevent or control fires and explosions associated with the remanufacture and storage of tires and tire byproducts. Additionally, the requirements are intended to minimize the impact of indoor and outdoor tire storage fires by regulating pile volume and location, segregating the various operations, providing for fire department access and a water supply, and controlling ignition sources.

### SECTION 3401 GENERAL

**3401.1 Scope.** Tire rebuilding plants, tire storage and tire byproduct facilities shall comply with this chapter, other applicable requirements of this code and NFPA 13. Tire storage in buildings shall also comply with Chapter 32.

**3401.2 Permit required.** Permits shall be required as set forth in Section 105.5.

### SECTION 3402 DEFINITIONS

**3402.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

### SECTION 3403 TIRE REBUILDING

**3403.1 Construction.** Tire rebuilding plants shall comply with the requirements of the *International Building Code*, as to construction, separation from other buildings or other portions of the same building, and protection.

**3403.2 Location.** Buffing operations shall be located in a room separated from the remainder of the building housing the tire rebuilding or tire recapping operations by a 1-hour fire barrier.

**Exception:** Buffing operations are not required to be separated where all of the following conditions are met:

1. Buffing operations are equipped with an *approved* continuous automatic water-spray system directed at the point of cutting action.
2. Buffing machines are connected to particle-collecting systems providing a minimum air movement of 1,500 cubic feet per minute (cfm) (0.71 m<sup>3</sup>/s) in volume and 4,500 feet per minute (fpm) (23 m/s) in-line velocity.
3. The collecting system shall discharge the rubber particles to an *approved* outdoor noncombustible or fire-resistant container that is emptied at frequent intervals to prevent overflow.

**3403.3 Cleaning.** The buffing area shall be cleaned at frequent intervals to prevent the accumulation of rubber particles.

**3403.4 Spray rooms and booths.** Each *spray room* or *spray booth* where flammable or combustible solvents are applied, shall comply with Chapter 24.

### SECTION 3404 PRECAUTIONS AGAINST FIRE

**3404.1 Open burning.** *Open burning* is prohibited in tire storage yards.

**3404.2 Sources of heat.** Cutting, welding or heating devices shall not be operated in tire storage yards.

**3404.3 Smoking prohibited.** Smoking is prohibited in tire storage yards, except in designated areas.

**3404.4 Power lines.** Tire storage piles shall not be located beneath electrical power lines having a voltage in excess of 750 volts or that supply power to fire emergency systems.

**3404.5 Fire safety plan.** The *owner* or individual in charge of the tire storage yard shall be required to prepare and submit to the *fire code official* a fire safety plan for review and approval. The fire safety plan shall include provisions for fire department vehicle access. Not less than one copy of the fire safety plan shall be prominently posted and maintained at the storage yard.

**3404.6 Telephone number.** The telephone number of the fire department and location of the nearest telephone shall be posted conspicuously in attended locations.

### SECTION 3405 OUTDOOR STORAGE

**3405.1 Individual piles.** Tire storage shall be restricted to individual piles not exceeding 5,000 square feet (464.5 m<sup>2</sup>) of continuous area. Piles shall not exceed 50,000 cubic feet (1416 m<sup>3</sup>) in volume or 10 feet (3048 mm) in height.

**3405.2 Separation of piles.** Individual tire storage piles shall be separated from other piles by a clear space of not less than 40 feet (12 192 mm).

**3405.3 Distance between piles of other stored products.** Tire storage piles shall be separated by a clear space of not less than 40 feet (12 192 mm) from piles of other stored product.

**3405.4 Distance from lot lines and buildings.** Tire storage piles shall be located not less than 50 feet (15 240 mm) from *lot lines* and buildings.



## TIRE REBUILDING AND TIRE STORAGE

**3405.5 Fire breaks.** Storage yards shall be maintained free from combustible ground vegetation for a distance of 40 feet (12 192 mm) from the stored material to grass and weeds; and for a distance of 100 feet (30 480 mm) from the stored product to brush and forested areas.

**3405.6 Volume more than 150,000 cubic feet.** Where the bulk volume of stored product is more than 150,000 cubic feet (4248 m<sup>3</sup>), storage arrangement shall be in accordance with the following:

1. Individual storage piles shall comply with size and separation requirements in Sections 3405.1 through 3405.5.
2. Adjacent storage piles shall be considered to be a group, and the aggregate volume of storage piles in a group shall not exceed 150,000 cubic feet (4248 m<sup>3</sup>).

Separation between groups shall be not less than 75 feet (22 860 mm) wide.

**3405.7 Location of storage.** Outdoor waste tire storage shall not be located under bridges, elevated trestles, elevated roadways or elevated railroads.

### SECTION 3406 FIRE DEPARTMENT ACCESS

**3406.1 Required access.** New tire storage yards shall be provided with fire apparatus access roads in accordance with Section 503 and Section 3406.2. Existing tire storage yards shall be provided with fire apparatus access roads where required in Chapter 11.

**3406.2 Location.** Fire apparatus access roads shall be located within all pile clearances identified in Section 3405.4 and within all fire breaks required in Section 3405.5. Access roadways shall be within 150 feet (45 720 mm) of any point in the storage yard where storage piles are located, not less than 20 feet (6096 mm) from any storage pile.

### SECTION 3407 FENCING

**3407.1 Where required.** Where the bulk volume of stored material is more than 20,000 cubic feet (566 m<sup>3</sup>), a firmly anchored fence or other *approved* method of security that controls unauthorized access to the storage yard shall surround the storage yard.

**3407.2 Construction.** The fence shall be constructed of *approved* materials and shall be not less than 6 feet (1829 mm) high and provided with gates not less than 20 feet (6096 mm) wide.

**3407.3 Locking.** Gates to the storage yard shall be locked when the storage yard is not staffed.

**3407.4 Unobstructed.** Gateways shall be kept clear of obstructions and be fully openable at all times.

### SECTION 3408 FIRE PROTECTION

**3408.1 Water supply.** A public or private fire protection water supply shall be provided in accordance with Section 507. The water supply shall be arranged such that any part of the storage yard can be reached by using not more than 500 feet (152 m) of hose.

**3408.2 Fire extinguishers.** Buildings or structures shall be provided with portable fire extinguishers in accordance with Section 906. Fuel-fired vehicles operating in the storage yard shall be equipped with a minimum 2-A:20-B:C-rated portable fire extinguisher.

### SECTION 3409 INDOOR STORAGE ARRANGEMENT

**3409.1 Pile dimensions.** Where tires are stored on-tread, the dimension of the pile in the direction of the wheel hole shall be not more than 50 feet (15 240 mm). Tires stored adjacent to or along one wall shall not extend more than 25 feet (7620 mm) from that wall. Other piles shall be not more than 50 feet (15 240 mm) in width.

## CHAPTER 35

# WELDING AND OTHER HOT WORK

### User note:

**About this chapter:** Chapter 35 covers requirements for safety in welding and other types of hot work by reducing the potential for fire ignitions that usually result in large losses. Several different types of hot work would fall under the requirements found in Chapter 35, including both gas and electric arc methods and any open-torch operations. Many of the activities of this chapter focus on the actions of the occupants.

### SECTION 3501 GENERAL

**3501.1 Scope.** Welding, cutting, open torches and other hot work operations and equipment shall comply with this chapter.

**3501.2 Permits.** Permits shall be required as set forth in Section 105.5.

**3501.3 Restricted areas.** Hot work shall only be conducted in areas designed or authorized for that purpose by the personnel responsible for a hot work program. Hot work shall not be conducted in the following areas unless approval has been obtained from the *fire code official*:

1. Areas where the sprinkler system is impaired.
2. Areas where there exists the potential of an explosive atmosphere, such as locations where flammable gases, liquids or vapors are present.
3. Areas with readily ignitable materials, such as storage of large quantities of bulk sulfur, baled paper, cotton, lint, dust or loose combustible materials.
4. On board ships at dock or ships under construction or repair.
5. At other locations as specified by the *fire code official*.

**3501.4 Cylinders and containers.** Compressed gas cylinders and fuel containers shall comply with this chapter and Chapter 53.

**3501.5 Design and installation of oxygen-fuel gas systems.** An oxygen-fuel gas system with two or more manifolded cylinders of oxygen shall be in accordance with NFPA 51.

### SECTION 3502 DEFINITIONS

**3502.1 Definitions.** The following terms are defined in Chapter 2:

**HOT WORK.**

**HOT WORK AREA.**

**HOT WORK EQUIPMENT.**

**HOT WORK PERMITS.**

**HOT WORK PROGRAM.**

**RESPONSIBLE PERSON.**

### SECTION 3503 GENERAL REQUIREMENTS

**3503.1 General.** Hot work conditions and operations shall comply with this chapter.

**3503.2 Temporary and fixed hot work areas.** Temporary and fixed hot work areas shall comply with this section.

**3503.3 Hot work program permit.** Hot work permits, issued by an *approved* responsible person under a hot work program, shall be available for review by the *fire code official* at the time the work is conducted and for 48 hours after work is complete.

**3503.4 Qualifications of operators.** A permit for hot work operations shall not be issued unless the individuals in charge of performing such operations are capable of performing such operations safely. Demonstration of a working knowledge of the provisions of this chapter shall constitute acceptable evidence of compliance with this requirement.

**3503.5 Records.** The individual responsible for the hot work area shall maintain “prework check” reports in accordance with Section 3504.3.1. Such reports shall be maintained on the premises for not less than 48 hours after work is complete.

**3503.6 Signage.** Visible hazard identification signs shall be provided where required by Chapter 50. Where the hot work area is open to persons other than the operator of the hot work equipment, conspicuous signs shall be posted to warn others before they enter the hot work area. Such signs shall display the following warning:

CAUTION  
HOT WORK IN PROGRESS  
STAY CLEAR

### SECTION 3504 FIRE SAFETY REQUIREMENTS

**3504.1 Protection of combustibles.** Protection of combustibles shall be in accordance with Sections 3504.1.1 through 3504.1.9.

**3504.1.1 Combustibles.** Hot work areas shall not contain combustibles or shall be provided with appropriate shielding to prevent sparks, slag or heat from igniting exposed combustibles.

## WELDING AND OTHER HOT WORK

**3504.1.2 Openings.** Openings or cracks in walls, floors, ducts or shafts within the hot work area shall be tightly covered to prevent the passage of sparks to adjacent combustible areas, or shielded by metal fire-resistant guards, or curtains shall be provided to prevent passage of sparks or slag.

**3504.1.3 Housekeeping.** Floors shall be kept clean within the hot work area.

**3504.1.4 Conveyor systems.** Conveyor systems that are capable of carrying sparks to distant combustibles shall be shielded or shut down.

**3504.1.5 Partitions.** Partitions segregating hot work areas from other areas of the building shall be noncombustible. In fixed hot work areas, the partitions shall be securely connected to the floor such that gaps do not exist between the floor and the partition. Partitions shall prevent the passage of sparks, slag, and heat from the hot work area.

**3504.1.6 Floors.** Fixed hot work areas shall have floors with noncombustible surfaces.

**3504.1.7 Precautions in hot work.** Hot work shall not be performed on containers or equipment that contain or have contained *flammable liquids*, gases or solids until the containers and equipment have been thoroughly cleaned, inerted or purged; except that “hot tapping” shall be allowed on tanks and pipe lines where such work is to be conducted by *approved* personnel. Hot work on *flammable* and *combustible liquid* storage tanks shall be conducted in accordance with Section 3510.

**3504.1.8 Sprinkler protection.** Automatic sprinkler protection shall not be shut off while hot work is performed. Where hot work is performed close to automatic sprinklers, noncombustible barriers or damp cloth guards shall shield the individual sprinkler heads and shall be removed when the work is completed. If the work extends over several days, the shields shall be removed at the end of each workday. The *fire code official* shall approve hot work where sprinkler protection is impaired.

**3504.1.9 Fire detection systems.** *Approved* special precautions shall be taken to avoid accidental operation of automatic fire detection systems.

**3504.2 Fire watch.** Fire watches shall be established and conducted in accordance with Sections 3504.2.1 through 3504.2.6.

**3504.2.1 When required.** A fire watch shall be provided during hot work activities and shall continue for not less than 30 minutes after the conclusion of the work. The *fire code official*, or the responsible manager under a hot work program, is authorized to extend the fire watch based on the hazards or work being performed.

**Exception:** Where the hot work area has no fire hazards or combustible exposures.

**3504.2.2 Location.** The fire watch shall include the entire hot work area. Hot work conducted in areas with vertical or horizontal fire exposures that are not observable by a single individual shall have additional personnel assigned

to fire watches to ensure that exposed areas are monitored.

**3504.2.3 Duties.** Individuals designated to fire watch duty shall have fire-extinguishing equipment readily available and shall be trained in the use of such equipment. Individuals assigned to fire watch duty shall be responsible for extinguishing spot fires and communicating an alarm.

**3504.2.4 Fire training.** The individuals responsible for performing the hot work and individuals responsible for providing the fire watch shall be trained in the use of portable fire extinguishers.

**3504.2.5 Fire hoses.** Where hoselines are required, they shall be connected, charged and ready for operation.

**3504.2.6 Fire extinguisher.** Not less than one portable fire extinguisher complying with Section 906 and with a minimum 2-A:20-B:C rating shall be provided with *ready access* within 30 feet (9144 mm) of the location where hot work is performed.

**3504.3 Area reviews.** Before hot work is permitted and not less than once per day while the permit is in effect, the area shall be inspected by the individual responsible for authorizing hot work operations to ensure that it is a fire safe area. Information shown on the permit shall be verified prior to signing the permit in accordance with Section 105.5.

**3504.3.1 Pre-hot-work check.** A pre-hot-work check shall be conducted prior to work to ensure that all equipment is safe and hazards are recognized and protected. A report of the check shall be kept at the work site during the work and available upon request. The pre-hot-work check shall determine all of the following:

1. Hot work equipment to be used shall be in satisfactory operating condition and in good repair.
2. Hot work site is clear of combustibles or combustibles are protected.
3. Exposed construction is of noncombustible materials or, if combustible, then protected.
4. Openings are protected.
5. Floors are kept clean.
6. Exposed combustibles are not located on the opposite side of partitions, walls, ceilings or floors.
7. Fire watches, where required, are assigned.
8. *Approved* actions have been taken to prevent accidental activation of fire protection system equipment in accordance with Sections 3504.1.8 and 3504.1.9.
9. Fire extinguishers and fire hoses (where provided) are operable and available.

## SECTION 3505 GAS WELDING AND CUTTING

**3505.1 General.** Devices or attachments mixing air or oxygen with combustible gases prior to consumption, except

at the burner or in a standard torch or blow pipe, shall not be allowed unless *approved*.

**3505.2 Cylinder and container storage, handling and use.** Storage, handling and use of *compressed gas* cylinders, containers and tanks shall be in accordance with this section and Chapter 53.

**3505.2.1 Cylinders connected for use.** The storage or use of a single cylinder of oxygen and a single cylinder of fuel gas located on a cart shall be allowed without requiring the cylinders to be separated in accordance with Section 5003.9.8 or 5003.10.3.6 when the cylinders are connected to regulators, ready for service, equipped with apparatus designed for cutting or welding and all of the following:

1. Carts shall be kept away from the cutting or welding operation in accordance with Section 3505.5 or fire-resistant shields shall be provided.
2. Cylinders shall be secured to the cart to resist movement.
3. Carts shall be in accordance with Section 5003.10.3.
4. Cylinder valves not having fixed hand wheels shall have keys, handles or nonadjustable wrenches on valve stems while the cylinders are in service.
5. Cylinder valve outlet connections shall conform to the requirements of CGA V-1.
6. Cylinder valves shall be closed when work is finished.
7. Cylinder valves shall be closed before moving the cart.

**3505.2.1.1 Individual cart separation.** Individual carts shall be separated from each other in accordance with Section 5003.9.8.

**3505.3 Precautions.** Cylinders, valves, regulators, hose and other apparatus and fittings for oxygen shall be kept free from oil or grease. Oxygen cylinders, apparatus and fittings shall not be handled with oily hands, oily gloves, or greasy tools or equipment.

**3505.4 Acetylene gas.** Acetylene gas shall not be piped except in *approved* cylinder manifolds and cylinder manifold connections, or utilized at a pressure exceeding 15 pounds per square inch gauge (psig) (103 kPa) unless dissolved in a suitable solvent in cylinders manufactured in accordance with DOTn 49 CFR Part 178. Acetylene gas shall not be brought in contact with unalloyed copper, except in a blowpipe or torch.

**3505.5 Remote locations.** Oxygen and fuel-gas cylinders and acetylene generators shall be located away from the hot work area to prevent such cylinders or generators from being heated by radiation from heated materials, sparks or slag, or misdirection of the torch flame.

**3505.6 Cylinders shutoff.** The torch valve shall be closed and the gas supply to the torch completely shut off when gas welding or cutting operations are discontinued for a period of 1 hour or more.

**3505.7 Prohibited operation.** Welding or cutting work shall not be held or supported on *compressed gas* cylinders or containers.

**3505.8 Tests.** Tests for leaks in piping systems and equipment shall be made with soapy water. The use of flames shall be prohibited for leak testing.

## SECTION 3506 ELECTRIC ARC HOT WORK

**3506.1 General.** The frame or case of electric hot work machines, except internal-combustion-engine-driven machines, shall be grounded. Ground connections shall be mechanically strong and electrically adequate for the required current.

**3506.2 Return circuits.** Welding current return circuits from the work to the machine shall have proper electrical contact at joints. The electrical contact shall be periodically inspected.

**3506.3 Disconnecting.** Electrodes shall be removed from the holders when electric arc welding or cutting is discontinued for any period of 1 hour or more. The holders shall be located to prevent accidental contact and the machines shall be disconnected from the power source.

**3506.4 Emergency disconnect.** A switch or circuit breaker shall be provided so that fixed electric welders and control equipment can be disconnected from the supply circuit. The disconnect shall be installed in accordance with NFPA 70.

**3506.5 Damaged cable.** Damaged cable shall be removed from service until properly repaired or replaced.

## SECTION 3507 CALCIUM CARBIDE SYSTEMS

**3507.1 Calcium carbide storage.** Storage and handling of calcium carbide shall comply with Chapter 50 of this code and Chapter 9 of NFPA 51.

## SECTION 3508 ACETYLENE GENERATORS

**3508.1 Use of acetylene generators.** The use of acetylene generators shall comply with this section and Chapter 15 of NFPA 55.

**3508.2 Portable generators.** The minimum volume of rooms containing portable generators shall be 35 times the total gas-generating capacity per charge of all generators in the room. The gas-generating capacity in cubic feet per charge shall be assumed to be 4.5 times the weight of carbide per charge in pounds. The minimum ceiling height of rooms containing generators shall be 10 feet (3048 mm). An acetylene generator shall not be moved by derrick, crane or hoist while charged.

**3508.3 Protection against freezing.** Generators shall be located where water will not freeze. Common salt such as sodium chloride or other corrosive chemicals shall not be utilized for protection against freezing.



## WELDING AND OTHER HOT WORK

### SECTION 3509 PIPING MANIFOLDS AND HOSE SYSTEMS FOR FUEL GASES AND OXYGEN

**3509.1 General.** The use of piping manifolds and hose systems shall be in accordance with Sections 3509.2 through 3509.7, Chapter 53 and Chapter 5 of NFPA 51.

**3509.2 Protection.** Piping shall be protected against physical damage.

**3509.3 Signage.** Signage shall be provided for piping and hose systems as follows:

1. Above-ground piping systems shall be marked in accordance with ASME A13.1.
2. Station outlets shall be marked to indicate their intended usage.
3. Signs shall be posted, indicating clearly the location and identity of section shutoff valves.

**3509.4 Manifolding of cylinders.** Oxygen manifolds shall not be located in an acetylene generator room. Oxygen manifolds shall be located not less than 20 feet (6096 mm) away from combustible material such as oil or grease, and gas cylinders containing flammable gases, unless the gas cylinders are separated by a *fire partition*.

**3509.5 Identification of manifolds.** Signs shall be posted for oxygen manifolds with service pressures not exceeding 200 psig (1379 kPa). Such signs shall include the words:

LOW-PRESSURE MANIFOLD  
DO NOT CONNECT HIGH-PRESSURE CYLINDERS  
MAXIMUM PRESSURE 250 PSIG

**3509.6 Clamps.** Hose connections shall be clamped or otherwise securely fastened.

**3509.7 Inspection.** Hoses shall be inspected frequently for leaks, burns, wear, loose connections or other defects rendering the hose unfit for service.

continuing monitoring while conducting the hot work.

5. Qualified employees and contractors performing hot work shall use an industry-approved hot work permit system to control the work.
6. Personnel shall be properly trained on hot work policies and procedures regarding equipment, safety, hazard controls and job-specific requirements.
7. On-site safety supervision shall be present where hot work is in progress to protect the personnel conducting the hot work and provide additional overview of site-specific hazards.

### SECTION 3510 HOT WORK ON FLAMMABLE AND COMBUSTIBLE LIQUID STORAGE TANKS

**3510.1 General.** Hot work performed on the interior or exterior of tanks that hold or have held *flammable* or *combustible liquids* shall be in accordance with Section 3510.2 and Chapters 4, 5, 6, 7 and 10 of NFPA 326.

**3510.2 Prevention.** The following steps shall be taken to minimize hazards where hot work must be performed on a *flammable* or *combustible liquid* storage container:

1. Use alternative methods to avoid hot work where possible.
2. Analyze the hazards prior to performing hot work, identify the potential hazards and the methods of hazard control.
3. Hot work shall conform to the requirements of the code or standard to which the container was originally fabricated.
4. Test the immediate and surrounding work area with a combustible gas detector and provide for a means of

## CHAPTER 36

# MARINAS

### User note:

**About this chapter:** Chapter 36 addresses the fire protection and prevention requirements for marinas. It was developed in response to the complications encountered by a number of fire departments responsible for the protection of marinas as well as fire loss history in marinas that lacked fire protection. Compliance with this chapter intends to establish safe practices in marina areas, provide an identification method for mooring spaces in the marina, and provide fire fighters with safe operational areas and fire protection methods to extend hose lines in a safe manner.

### SECTION 3601 SCOPE

**3601.1 Scope.** Marina facilities shall be in accordance with this chapter.

**3601.2 Plans and approvals.** Plans for marina fire protection facilities shall be *approved* prior to installation. The work shall be subject to final inspection and approval after installation.

### SECTION 3602 DEFINITIONS

**3602.1 Definitions.** The following terms are defined in Chapter 2:

**FLOAT.**

**MARINA.**

**PIER.**

**VESSEL.**

**WHARF.**

### SECTION 3603 GENERAL PRECAUTIONS

**3603.1 Combustible debris.** Combustible debris and rubbish shall not be deposited or accumulated on land beneath marina structures, piers or wharves.

**3603.2 Sources of ignition.** Open-flame devices used for lighting or decoration on the exterior of a vessel, float, pier or wharf shall be approved.

**3603.3 Flammable or combustible liquid spills.** Spills of *flammable* or *combustible liquids* at or on the water shall be reported immediately to the fire department or jurisdictional authorities.

**3603.4 Rubbish containers.** Containers with tight-fitting or self-closing lids shall be provided for temporary storage of combustible debris, rubbish and waste material. The rubbish containers shall be constructed entirely of materials that comply with any one of the following:

1. Noncombustible materials.
2. Materials that meet a peak rate of heat release not exceeding 300 kW/m<sup>2</sup> where tested in accordance

with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation.

**3603.5 Electrical equipment.** Electrical equipment shall be installed and used in accordance with its listing, Section 608 of this code and Chapter 5 of NFPA 303 as required for wet, damp and hazardous locations.

**3603.6 Berthing and storage.** Berthing and storage shall be in accordance with Chapter 7 of NFPA 303.

**3603.7 Slip identification.** Slips and mooring spaces shall be individually identified by an *approved* numeric or alphabetic designator. Space designators shall be posted at the space. Signs indicating the space designators located on finger piers and floats shall be posted at the base of all piers, finger piers, floats and finger floats.

### SECTION 3604 FIRE PROTECTION EQUIPMENT

**3604.1 General.** Piers, marinas and wharves with facilities for mooring or servicing five or more vessels, and marine motor fuel-dispensing facilities shall be equipped with fire protection equipment in accordance with Sections 3604.2 through 3604.6.

**3604.2 Standpipes.** Marinas and boatyards shall be equipped throughout with standpipe systems in accordance with NFPA 303. Systems shall be provided with hose connections located such that no point on the marina pier or float system exceeds 150 feet (15 240 mm) from a standpipe hose connection.

**3604.2.1 Identification of standpipe outlets.** Standpipe hose connection locations shall be clearly identified by a flag or other *approved* means designed to be readily visible from the pier accessing the float system.

**3604.3 Access and water supply.** Piers and wharves shall be provided with fire apparatus access roads and water-supply systems with on-site fire hydrants where required by the *fire code official*. Such roads and water systems shall be provided and maintained in accordance with Sections 503 and 507.

**3604.4 Portable fire extinguishers.** One portable fire extinguisher of the ordinary (moderate) hazard type shall be provided at each required standpipe hose connection. Additional portable fire extinguishers, suitable for the hazards

## MARINAS

involved, shall be provided and maintained in accordance with Section 906.

**3604.5 Communications.** A telephone not requiring a coin to operate or other *approved*, clearly identified means to notify the fire department shall be provided on the site in a location *approved* by the *fire code official*.

**3604.6 Emergency operations staging areas.** Space shall be provided on all float systems for the staging of emergency equipment. Emergency operation staging areas shall provide a minimum of 4 feet wide by 10 feet long (1219 mm by 3048 mm) clear area exclusive of walkways and shall be located at each standpipe hose connection. Emergency operation staging areas shall be provided with a curb or barrier having a minimum height of 4 inches (102 mm) and maximum space between the bottom edge and the surface of the staging area of 2 inches (51 mm) on the outboard sides of the staging area.

An *approved* sign reading “FIRE EQUIPMENT STAGING AREA—KEEP CLEAR” shall be provided at each staging area.

### SECTION 3605

#### MARINE MOTOR FUEL-DISPENSING FACILITIES

**3605.1 Fuel dispensing.** Marine motor fuel-dispensing facilities shall be in accordance with Chapter 23.

## CHAPTER 37

# COMBUSTIBLE FIBERS

### User note:

**About this chapter:** Chapter 37 establishes the requirements for storage and handling of combustible fibers, including animal, vegetable and synthetic fibers, whether woven into textiles, baled, packaged or loose. Operations involving combustible fibers are typically associated with salvage, paper milling, recycling, cloth manufacturing, carpet and textile mills and agricultural operations, among others. The primary hazard associated with these operations is the abundance of materials and their ready ignitability.

### SECTION 3701 GENERAL

**3701.1 Scope.** The equipment, processes and operations involving *combustible fibers* shall comply with this chapter.

**3701.2 Applicability.** Storage of *combustible fibers* in any quantity shall comply with this section.

**3701.3 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 3702 DEFINITIONS

**3702.1 Definitions.** The following terms are defined in Chapter 2:

**BALED COTTON.**

**BALED COTTON, DENSELY PACKED.**

**COMBUSTIBLE FIBERS.**

**COTTON.**

**SEED COTTON.**

### SECTION 3703 GENERAL PRECAUTIONS

**3703.1 Use of combustible receptacles.** Ashes, waste, rubbish or sweepings shall not be placed in wood or other combustible receptacles and shall be removed daily from the structure.

**3703.2 Vegetation.** Grass or weeds shall not be allowed to accumulate at any point on the premises.

**3703.3 Clearances.** A minimum clearance of 3 feet (914 mm) shall be maintained between automatic sprinklers and the top of piles.

**3703.4 Agricultural products.** Hay, straw, *seed cotton* or similar agricultural products shall not be stored adjacent to structures or combustible materials unless a clear horizontal distance equal to the height of a pile is maintained between such storage and structures or combustible materials. Storage shall be limited to stacks of 100 tons (91 metric tons) each. Stacks shall be separated by not less than 20 feet (6096 mm) of clear space. Quantities of hay, straw, seed cotton and other agricultural products shall not be limited where stored

in or near farm structures located outside closely built areas. A permit shall not be required for agricultural storage.

**3703.5 Dust collection.** Where located within a building, equipment or machinery that generates or emits *combustible fibers* shall be provided with an *approved* dust-collecting and exhaust system. Such systems shall comply with Chapter 22 of this code and Section 511 of the *International Mechanical Code*.

**3703.6 Portable fire extinguishers.** Portable fire extinguishers shall be provided in accordance with Section 906 as required for extra-hazard occupancy protection as indicated in Table 906.1.

**3703.7 Sources of ignition.** Sources of ignition shall comply with Sections 3703.7.1 and 3703.7.2.

**3703.7.1 Smoking.** Smoking shall be prohibited and “No Smoking” signs provided as follows:

1. In rooms or areas where materials are stored or dispensed or used in *open systems*.
2. Within 25 feet (7620 mm) of outdoor storage or open use areas.
3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facility or area. Designated areas within such facilities where smoking is permitted either permanently or temporarily shall be identified with signs designating that smoking is permitted in these areas only.

Signs required by this section shall be in English as a primary language or in symbols allowed by this code and shall comply with Section 310.

**3703.7.2 Open flames.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition. High-temperature devices and those devices utilizing an open flame shall be *listed* for use with the materials stored or used.

### SECTION 3704 LOOSE FIBER STORAGE

**3704.1 General.** Loose *combustible fibers*, not in suitable bales or packages and stored outdoors in the open, shall comply with Section 2808. Occupancies involving the indoor storage of loose *combustible fibers* in amounts



## COMBUSTIBLE FIBERS

exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall comply with Sections 3704.2 through 3704.6.

**3704.2 Storage of 100 cubic feet or less.** Loose *combustible fibers* in quantities of not more than 100 cubic feet (3 m<sup>3</sup>) located in a structure shall be stored in a metal or metal-lined bin equipped with a self-closing cover.

**3704.3 Storage of more than 100 cubic feet to 500 cubic feet.** Loose *combustible fibers* in quantities exceeding 100 cubic feet (3 m<sup>3</sup>) but not exceeding 500 cubic feet (14 m<sup>3</sup>) shall be stored in rooms enclosed with 1-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of  $\frac{3}{4}$  hour in accordance with the *International Building Code*.

**3704.4 Storage of more than 500 cubic feet to 1,000 cubic feet.** Loose *combustible fibers* in quantities exceeding 500 cubic feet (14 m<sup>3</sup>) but not exceeding 1,000 cubic feet (28 m<sup>3</sup>) shall be stored in rooms enclosed with 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of 1½ hours in accordance with the *International Building Code*.

**3704.5 Storage of more than 1,000 cubic feet.** Loose *combustible fibers* in quantities exceeding 1,000 cubic feet (28 m<sup>3</sup>) shall be stored in rooms enclosed with 2-hour *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with openings protected by an *approved* opening protective assembly having a *fire protection rating* of 1½ hours in accordance with the *International Building Code*. The storage room shall be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**3704.6 Detached storage structure.** Not more than 2,500 cubic feet (70 m<sup>3</sup>) of loose *combustible fibers* shall be stored in a detached structure suitably located, with openings protected against entrance of sparks. The structure shall not be occupied for any other purpose.

point of the piles and projecting not less than 1 foot (305 mm) beyond the sides of the piles.

**3705.2 Special baling conditions.** Sisal and other fibers in bales bound with combustible tie ropes, jute and other fibers that swell when wet, shall be stored to allow for expansion in any direction without affecting building walls, ceilings or columns. A minimum clearance of 3 feet (914 mm) shall be required between walls and sides of piles, except that where the storage compartment is not more than 30 feet (9144 mm) wide, the minimum clearance at side walls shall be 1 foot (305 mm), provided that a center aisle not less than 5 feet (1524 mm) wide is maintained.

## SECTION 3705 BALED STORAGE

**3705.1 Bale size and separation.** Baled *combustible fibers* shall be limited to single blocks or piles not more than 25,000 cubic feet (700 m<sup>3</sup>) in volume, not including aisles or clearances. Blocks or piles of baled fiber shall be separated from adjacent storage by aisles not less than 5 feet (1524 mm) wide, or by flash-fire barriers constructed of continuous sheets of noncombustible material extending from the floor to a minimum height of 1 foot (305 mm) above the highest

## CHAPTER 38

# HIGHER EDUCATION LABORATORIES

### User note:

**About this chapter:** Chapter 38 addresses the unique needs of laboratories in higher education institutions. These academic institutions often have chemistry, biology, medical, engineering and other laboratories where hazardous materials are used. This chapter addresses both new and existing buildings and new and existing laboratories. Applying the general hazardous material provisions has been difficult because of the way these laboratories operate. Often there are many small laboratories with very small quantities of hazardous materials that individually do not exceed the maximum allowable quantities (MAQs). In aggregate, the quantities will exceed the MAQs and could result in the need for a Group H occupancy classification. However, it is believed that the lower density of hazardous materials often mitigates the overall risk. This chapter also addresses the use of certain materials typically prohibited for existing buildings not protected throughout with a sprinkler system. These allowances come with certain safety measures such as the use of storage cabinets and fume hoods. Note that Section 428 of the International Building Code® addresses the construction requirements found in this chapter for laboratory suites.

### SECTION 3801 GENERAL

**3801.1 Scope.** Higher education laboratories complying with the requirements of this chapter shall be permitted to exceed the maximum allowable quantities of hazardous materials in control areas set forth in Chapter 50 without requiring classification as a Group H occupancy. Except as specified in this chapter, such laboratories shall comply with all applicable provisions of this code and the *International Building Code*.

**3801.2 Application.** The provisions of this chapter shall be applied as exceptions or additions to applicable requirements of this code. Unless specifically modified by this chapter, the storage, use and handling of hazardous materials shall comply with the provisions in Chapters 50 through 67 and the *International Building Code* for quantities not exceeding the maximum allowable quantity.

### SECTION 3802 DEFINITIONS

**3802.1 Definitions.** The following terms are defined in Chapter 2:

**CHEMICAL FUME HOOD.**

**GLOVE BOX.**

**HIGHER EDUCATION LABORATORY.**

**LABORATORY SUITE.**

**SPECIAL EXPERT.**

### SECTION 3803 GENERAL SAFETY PROVISIONS

**3803.1 Scope.** Laboratories and *laboratory suites* applying the requirements of this chapter shall be in accordance with the general safety provisions in Sections 3803.1.1 through 3803.2.2.

**3803.1.1 Chemical safety reviews.** Operating and emergency procedures planning and documentation shall be provided in accordance with Sections 5001.3.3.11

through 5001.3.3.17. Such documentation shall be prepared by laboratory safety personnel or *special experts*, and shall be made available in the workplace for reference and review by employees. Copies of such documentation shall be made available to the *fire code official* for review upon request.

**3803.1.2 Chemical handling.** Receiving, transporting on site, unpacking and dispensing of hazardous materials shall be carried out by persons trained in proper handling of such materials and shall be performed in accordance with Chapters 50 through 67, as applicable.

**3803.1.3 Warning signage.** Warning signs shall be provided in accordance with Section 5003.5.

**3803.1.4 Maintenance of equipment, machinery and processes.** Maintenance of equipment, machinery and processes used with hazardous materials shall comply with Section 5003.2.6.

**3803.1.5 Time-sensitive materials.** Containers of materials that have the potential to become hazardous during prolonged storage shall be dated when first opened, and shall be managed in accordance with NFPA 45, Section 8.3.4.4.1.

**3803.1.6 Hazardous wastes.** Storage, dispensing, use and handling of hazardous waste shall comply with this chapter and Chapters 50 through 67, as applicable.

**3803.1.7 Automatic fire-extinguishing systems.** New laboratories in new or existing buildings that increase maximum allowable quantities of hazardous materials based on the requirements in this chapter shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**3803.2 Hazardous materials storage and use.** Hazardous materials storage, handling and use in laboratories and *laboratory suites* complying with Chapter 38 shall be in accordance with this chapter and Chapters 50 through 67.

**3803.2.1 Container size.** The maximum container size for all hazardous materials shall be 5.3 gallons (20 L) for liquids, 50 pounds (22.7 kg) for solids, 100 cubic feet (2.83 m<sup>3</sup>) for *health-hazard* gases per Table 5003.1.1(2)

## HIGHER EDUCATION LABORATORIES

and 500 cubic feet (14.15 m<sup>3</sup>) for all other gases in accordance with Table 5003.1.1(1).

**Exception:** Hazardous waste collection containers, for other than Class I *flammable liquids* and Class II combustible liquids, are permitted to exceed 5.3 gallons (20 L) where *approved*.

**3803.2.2 Density.** Quantities of Class I *flammable liquids* in storage and use shall not exceed 8 gallons (30 L) per 100 square feet (9.29 m<sup>2</sup>) of floor area. Densities shall be reduced by 25 percent on the 4th through 6th floors of the building, and by 50 percent above the 6th floor. Regardless of the density, the *maximum allowable quantity per control area* or *laboratory suite* in accordance with this chapter, shall not be exceeded.

**Exception:** Designated hazardous waste collection areas or rooms within a *laboratory suite* or *control area* are not limited, but such materials shall not exceed the maximum allowable quantity per *laboratory suite* or *control area*.

### SECTION 3804 LABORATORY SUITE CONSTRUCTION

**3804.1 General.** Where *laboratory suites* are provided, they shall be constructed in accordance with this chapter and Section 428 of the *International Building Code*.

**3804.1.1 Laboratory suites.** The number of *laboratory suites* and percentage of maximum allowable quantities of hazardous materials in *laboratory suites* shall be in accordance with Table 3804.1.1.

**3804.1.1.1 Separation from other nonlaboratory areas.** *Laboratory suites* shall be separated from other portions of the building in accordance with the most restrictive of the following:

1. *Fire barriers* and *horizontal assemblies* as required in Table 3804.1.1. *Fire barriers* shall

be constructed in accordance with Section 707 of the *International Building Code* and *horizontal assemblies* shall be constructed in accordance with Section 711 of the *International Building Code*.

**Exception:** Where an individual *laboratory suite* occupies more than one story, the *fire-resistance rating* of intermediate floors contained within the *laboratory suite* shall comply with the requirements of the *International Building Code*.

2. Separations as required in Section 508 of the *International Building Code*.

**3804.1.1.2 Separation from other laboratory suites.** *Laboratory suites* shall be separated from other *laboratory suites* in accordance with Table 3804.1.1.

**3804.1.1.3 Floor assembly fire resistance.** The floor assembly supporting *laboratory suites* and the construction supporting the floor of *laboratory suites* shall have a *fire-resistance rating* of not less than 2 hours.

**Exception:** The floor assembly of *laboratory suites* and the construction supporting the floor of *laboratory suites* are permitted to be 1-hour fire-resistance-rated in buildings of Types IIA, IIIA and VA construction, provided that the building is three or fewer stories.

**3804.1.1.4 Maximum number.** The maximum number of *laboratory suites* shall be in accordance with Table 3804.1.1. Where a building contains both *laboratory suites* and *control areas*, the total number of *laboratory suites* and *control areas* within a building shall not exceed the maximum number of *laboratory suites* in accordance with Table 3804.1.1.

**3804.1.1.5 Means of egress.** *Means of egress* shall be in accordance with Chapter 10.

TABLE 3804.1.1  
DESIGN AND NUMBER OF LABORATORY SUITES PER FLOOR

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER LAB SUITE <sup>a</sup>	NUMBER OF LAB SUITES PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b</sup>
Above grade plane	21+	Not Allowed	Not Allowed	Not Allowed
	16–20	25	1	2 <sup>c</sup>
	11–15	50	1	2 <sup>c</sup>
	7–10	50	2	2 <sup>c</sup>
	4–6	75	4	1
	3	100	4	1
	1–2	100	6	1
Below grade plane	1	75	4	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

- Percentages shall be of the maximum allowable quantity per control area shown in Table 5003.1.1(1) and Table 5003.1.1(2), with all increases allowed in the footnotes to those tables.
- Fire barriers shall include walls, floors and ceilings necessary to provide separation from other portions of the building.
- Vertical fire barriers separating laboratory suites from other spaces on the same floor are permitted to be 1-hour rated.

**3804.1.1.6 Standby or emergency power.** Higher education *laboratory suites* shall be provided with emergency or standby power in accordance with Section 1203.2.14.

**3804.1.1.7 Ventilation.** Ventilation shall be in accordance with the *International Mechanical Code* and Chapter 7 of NFPA 45.

**3804.1.1.8 Liquid-tight floor.** Portions of *laboratory suites* where hazardous materials are present shall be provided with a liquid-tight floor.

**3804.1.1.9 Automatic fire-extinguishing systems.** Buildings containing *laboratory suites* shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**3804.1.2 Percentage of maximum allowable quantity in each laboratory suite.** The percentage of maximum allowable quantities of hazardous materials in each *laboratory suite* shall be in accordance with Table 3804.1.1.

## SECTION 3805 NONSPRINKLERED LABORATORIES

**3805.1 Scope.** Storage and use of hazardous materials in existing laboratories located within existing buildings not equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 is permitted where such use complies with Section 3803, Chapters 50 through 67, as applicable, and Sections 3805.2 through 3805.4.

**3805.2 Nonsprinklered laboratories.** The maximum allowable quantities of hazardous materials in storage and use in *control areas* in laboratories located in buildings not equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be in accordance with Table 5003.1.1(1), Table 5003.1.1(2) and Table 5003.8.3.2, except as modified by Sections 3805.2.1 and 3805.2.2.

**3805.2.1 Restricted materials storage.** Where *approved* by the *fire code official*, storage of the following hazardous materials prohibited by Table 5003.1.1(1) in buildings not equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be allowed within a *laboratory control area* at 25 percent of Table 5003.1.1(1) limits for a building equipped throughout with an *automatic sprinkler system*.

1. Class 4 oxidizers.
2. Pyrophorics.

The percentage of the *maximum allowable quantity per control area* shown in Table 3805.4 shall be applied to 25 percent of Table 5003.1.1(1) limits for Class 4 oxidizers or pyrophoric materials.

Additional quantity increases shall be prohibited, and such materials shall be stored in accordance with all of the following:

1. Containers shall be completely sealed and stored in accordance with the manufacturers' recommendations.

2. Storage shall be within *approved* hazardous material storage cabinets in accordance with Section 5003.8.7, or shall be located in an inert atmosphere glove box in accordance with NFPA 45, Section 7.11.
3. The storage cabinet or *glove box* shall not contain any storage of *incompatible materials*.

**3805.2.2 Restricted materials use.** Where *approved* by the *fire code official*, use of the following hazardous materials prohibited by Table 5003.1.1(1) in buildings not equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, shall be allowed within a *laboratory control area* at 25 percent of Table 5003.1.1(1) limits for buildings equipped throughout with an *automatic sprinkler system*.

1. Class 4 oxidizers.
2. Pyrophorics.

The percentage of the *maximum allowable quantity per control area* shown in Table 3805.4 shall be applied to 25 percent of Table 5003.1.1(1) limits for Class 4 oxidizers or pyrophoric materials.

Additional quantity increases shall be prohibited, and such materials shall be stored in accordance with all of the following:

1. Use shall be within an *approved* chemical fume hood *listed* in accordance with UL 1805, or in an inert atmosphere glove box in accordance with NFPA 45, Section 7.11, or other *approved* equipment designed for the specific hazard of the material.
2. Combustible materials shall be kept not less than 2 feet (610 mm) away from the work area, except for those items directly related to the research.
3. A portable fire extinguisher appropriate for the specific material shall be provided within 20 feet (6096 mm) of the use in accordance with Section 906.

**3805.3 Restricted materials automatic fire detection.** An automatic fire detection system shall be installed in all existing laboratories in nonsprinklered buildings in accordance with this section. Detectors shall be connected to the building's fire alarm control unit where a fire alarm system is provided. Detector initiation shall activate the occupant notification system in accordance with Section 907.5 where connected to the building's fire alarm control unit. Activation of the detection system shall sound a local alarm in buildings not equipped with a fire alarm notification system.

**3805.3.1 System supervision and monitoring.** Automatic fire detection systems shall be electronically supervised and monitored by an *approved* supervising station or, where *approved*, shall initiate an audible and visual signal at a constantly attended, on-site location.

**3805.4 Percentage of maximum allowable quantity per control area.** The percentage of *maximum allowable quantities per control area* of hazardous materials shall comply with Table 3805.4.



## HIGHER EDUCATION LABORATORIES

### SECTION 3806 EXISTING SPRINKLERED LABORATORIES

**3806.1 Scope.** Storage and use of hazardous materials in existing laboratories within buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be in accordance with Section 3803 and with Chapters 50 through 67, as applicable, except as modified by this section.

**3806.2 Hazardous materials storage and use.** Storage and use of hazardous materials within *control areas* in new and existing laboratories equipped with an *automatic sprinkler system* shall be in accordance with this section and Chapters 50 through 67, as applicable.

**Exception:** Existing laboratories in buildings equipped throughout with an automatic sprinkler system meeting

the requirements for *laboratory suites* are permitted to comply with Section 3804.

**3806.2.1 Percentage of maximum allowable quantities per control area.** The percentage of *maximum allowable quantities per control area* of hazardous materials shall be in accordance with Table 3806.2.1.

**TABLE 3805.4  
DESIGN AND NUMBER OF CONTROL AREAS IN EXISTING NONSPRINKLERED LABORATORIES**

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA <sup>a, e</sup>	NUMBER OF CONTROL AREAS PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b, c, d</sup>
Above grade plane	Higher than 9	5		2 <sup>c</sup>
	7–9	10	1	2 <sup>c</sup>
	4–6	25	2	2 <sup>c</sup>
	3	75	22	1
	1–2	100	4	1
Below grade plane	1	100	3	1
	2	75	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

a. Percentages shall be of the maximum allowable quantity per control area shown in Table 5003.1.1(1) and Table 5003.1.1(2), excluding all increases allowed in the footnotes to those tables.

b. Fire barriers shall include walls, floors and ceilings necessary to provide separation from other portions of the building.

c. Vertical fire barriers separating control areas from other spaces on the same floor are permitted to be 1-hour fire-resistance rated.

d. See Section 414.2.4 of the *International Building Code* for additional requirements.

e. The percentage of the maximum allowable quantity per control area shown in Table 3805.4 shall be applied to 25 percent of Table 5003.1.1(1) limits for Class 4 oxidizers or pyrophoric materials.

**TABLE 3806.2.1  
DESIGN AND NUMBER OF CONTROL AREAS IN EXISTING SPRINKLERED LABORATORIES**

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA <sup>a</sup>	NUMBER OF CONTROL AREAS PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b, d</sup>
Above grade plane	21+	5	1	2 <sup>c</sup>
	11–20	10	1	2 <sup>c</sup>
	7–10	25	2	2 <sup>c</sup>
	4–6	50	2	2 <sup>c</sup>
	3	75	3	1
	1–2	100	4	1
Below grade plane	1	100	3	1
	2	75	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

a. Percentages shall be of the maximum allowable quantity per control area shown in Table 5003.1.1(1) and Table 5003.1.1(2), with all increases allowed in the footnotes to those tables.

b. Fire barriers shall include walls, floors and ceilings necessary to provide separation from other portions of the building.

c. Vertical fire barriers separating control areas from other spaces on the same floor are permitted to be 1-hour fire-resistance rated.

d. See Section 414.2.4 of the *International Building Code* for additional requirements.

## CHAPTER 39

# PROCESSING AND EXTRACTION FACILITIES

### User note:

**About this chapter:** Chapter 39 focuses on the processing and extraction of oils and fats from various plants. This process includes extraction by use of a solvent, desolventizing the raw material, production of the miscella, distillation of the solvent from the miscella and solvent recovery. The processes used are not necessarily typical hazardous material processes, and often the systems and equipment associated with such processes may not be listed. This chapter provides the tools to appropriately address the hazards while also meeting the unique needs of industry. This chapter has provisions for a technical report prepared by a registered design professional and requires site inspections to make sure equipment and systems are installed as designed and approved.

### SECTION 3901 GENERAL

**3901.1 Scope.** Plant processing or extraction facilities shall comply with this chapter and the *International Building Code*. The extraction process includes the act of extraction of the oils and fats by use of a solvent, desolventizing of the raw material, production of the miscella, distillation of the solvent from the miscella and solvent recovery. The use, storage, transfilling and handling of hazardous materials in these facilities shall comply with this chapter, other applicable provisions of this code and the *International Building Code*.

**3901.2 Existing buildings or facilities.** Existing buildings or facilities used for the processing of plants shall comply with this chapter. Existing extraction processes where the medium of extraction or solvent is changed shall comply with this chapter.

**3901.3 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

### SECTION 3902 DEFINITIONS

**3902.1 Definitions.** The following terms are defined in Chapter 2:

**DESOLVENTIZING.**  
**MISCELLA.**

### SECTION 3903 PROCESSING AND EXTRACTION

**3903.1 Construction.** Processing shall be located in a building complying with the *International Building Code*.

**3903.2 Prohibited occupancies.** Extraction processes utilizing flammable gases or flammable *cryogenic fluids* shall not be located in any building containing a Group A, E, I or R occupancy.

**3903.3 Location.** The extraction equipment and extraction processes utilizing hydrocarbon solvents shall be located in a room or area dedicated to extraction.

**3903.4 Post-process purification and winterization.** Post-processing and winterization involving the heating or pres-

surizing of the miscella to other than normal pressure or temperature shall be *approved* and performed in an appliance *listed* for such use. Domestic or commercial cooking appliances shall not be used.

**3903.4.1 Industrial ovens.** The use of industrial ovens shall comply with Chapter 30.

**3903.5 Use of flammable and combustible liquids.** The use of *flammable* and *combustible liquids* for liquid extraction processes where the liquid is boiled, distilled or evaporated shall be located within a hazardous exhaust fume hood, rated for exhausting flammable vapors. Electrical equipment used within the hazardous exhaust fume hood shall be rated for use in flammable atmospheres. Heating of *flammable* or *combustible liquids* over an open flame is prohibited.

**Exception:** The use of a heating element not rated for flammable atmospheres, where documentation from the manufacture, or *approved* testing laboratory indicates the element is rated for heating of *flammable liquids*.

**3903.6 Liquefied petroleum gas.** Liquefied petroleum gases shall not be released to the atmosphere except where released in accordance with Section 7.3 of NFPA 58.

### SECTION 3904 SYSTEMS AND EQUIPMENT

**3904.1 General requirements.** Systems and equipment used with the processing and extraction of oils and products from plants shall comply with Sections 3904.2 through 3904.2.2.3 and Section 5003.2, and other applicable provisions of this code, the *International Building Code* and the *International Mechanical Code*.

**3904.2 Systems and equipment.** Systems or equipment used for the extraction of oils from plant material shall comply with Section 3904.2.1 or 3904.2.2.

**3904.2.1 Listings.** Systems or equipment used for the extraction of oils from plant material shall be *listed* and *labeled* in accordance with UL 1389 and installed in accordance with the listing and the manufacturer's installation instructions.

**3904.2.2 Approvals.** Systems or equipment used for the extraction of oils from plant material shall be *approved* for the specific use. The system shall be reviewed by a

## PROCESSING AND EXTRACTION FACILITIES

*registered design professional*. The *registered design professional* shall review and consider any information provided by the system's designer or manufacturer. A technical report in accordance with Section 3904.2.2.1 shall be prepared and submitted to the *fire code official* for review and approval. The firm or individual preparing the technical report shall be *approved* by the *fire code official* prior to performing the analysis.

**3904.2.2.1 Technical report.** A technical report, reviewed and *approved* by the *fire code official* as required by Section 3904.2, is required prior to the equipment being located or installed at the facility. The report shall be prepared by a *registered design professional* or other professional *approved* by the *fire code official*.

**3904.2.2.2 Report content.** The technical report shall contain all of the following:

1. Manufacturer information.
2. Preparer of record of the technical report.
3. Date of review and report revision history.
4. Signature page, including all of the following:
  - 4.1. Author of the report.
  - 4.2. Date of report.
  - 4.3. Date and signature of *registered design professional* of record performing the design or peer review.
5. Model number of the item evaluated. If the equipment is provided with a serial number, the serial number shall be included for verification at the time of site inspection.
6. Methodology of the design or peer review process used to determine minimum safety requirements. Methodology shall consider the basis of design, and shall include a code analysis and code path to demonstrate whether specific codes or standards are applicable.
7. Equipment description. A list of every component and subassembly, such as fittings, hose, quick disconnects, gauges, site glass, gaskets, valves, pumps, vessels, containers and switches, of the system or equipment, indicating the manufacturer, model number, material and solvent compatibility. Manufacturer's data sheets shall be provided.
8. A general flow schematic or general process flow diagram of the process. Post-processing or winterization shall be included in this diagram. Primary components of the process equipment shall be identified and match the equipment list required in Item 7. Operating temperatures, pressures and solvent state of matter shall be identified in each primary step or component. A piping and instrumentation diagram (PID or P&ID) shall be provided.
9. Analysis of the vessel(s) if pressurized beyond standard atmospheric pressure. Analysis shall include purchased and fabricated components.
10. Structural analysis for the frame system supporting the equipment.
11. Process safety analysis of the extraction system, from the introduction of raw product to the end of the extraction process.
12. Comprehensive process hazard analysis considering failure modes and points of failure throughout the process. The process hazard analysis shall include a review of emergency procedure information provided by the manufacturer of the equipment or process and not that of the facility, building or room.
13. Review of the assembly instructions, operational and maintenance manuals provided by the manufacturer.
14. List of references used in the analysis.

**3904.2.2.3 Site inspection.** Prior to operation of the extraction equipment, where required by the *fire code official*, the engineer of record or *approved* professional, as *approved* in Section 3904.2, shall inspect the site of the extraction process once equipment has been installed for compliance with the technical report and the building analysis. The engineer of record or *approved* professional shall provide a report of findings and observations of the site inspection to the *fire code official* prior to the approval of the extraction process. The field inspection report authored by the engineer of record shall include the serial number of the equipment used in the process and shall confirm that the equipment installed is the same model and type of equipment identified in the technical report.

## SECTION 3905 SAFETY SYSTEMS

**3905.1 Gas detection.** For extraction processes utilizing flammable gases as solvents, a gas detection system complying with Section 916 shall be provided.

**3905.1.1 Operation.** Activation of the gas detection system shall result in all the following:

1. Initiation of distinct audible and visual alarm signals in the extraction room.
2. Deactivation of all heating systems located in the extraction room.
3. Activation of the mechanical ventilation system, where the system is interlocked with gas detection.
4. De-energize all light switches and electrical outlets.

**3905.1.2 Failure of the gas detection system.** Failure of the gas detection system shall result in the deactivation of the heating system; activation of the mechanical ventilation system where the system is interlocked with the gas

detection system; and initiation of a trouble signal to sound in an *approved* location.



**3905.2 Emergency shutoff.** Extraction processes utilizing gaseous hydrocarbon-based solvents shall be provided with emergency shutoff systems in accordance with Section 5803.1.3.





## CHAPTER 40

# STORAGE OF DISTILLED SPIRITS AND WINES

### User note:

**About this chapter:** Chapter 40 provides specific requirements for the storage of distilled spirits and wines. In accordance with Section 307.1.1 of the International Building Code®, these occupancies are not classified as a Group H occupancy. Instead, as listed in Sections 311.2 and 311.3 of the International Building Code, the storage of beverages that contain up to and including 16-percent alcohol are classified as a Group S-2 occupancy, and those that contain over 16-percent alcohol content are classified as a Group S-1 occupancy. Note that those that are classified as a Group S-1 occupancy are required to be provided with an automatic sprinkler system throughout the Group S-1 fire area, regardless of size, in accordance with Section 903.

### SECTION 4001 GENERAL

**4001.1 General.** The storage of distilled spirits and wines in barrels and casks shall comply with this chapter in addition to other applicable requirements of this code.

**4001.1.1 Nonapplicability.** Chapter 50 and Chapter 57 are not applicable to the storage of distilled spirits and wines in barrels and casks as identified in Section 5001.1, Exception 10, and Section 5701.2, Item 10.

### SECTION 4002 DEFINITIONS

**4002.1 Definitions.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

### SECTION 4003 PRECAUTIONS AGAINST FIRE

**4003.1 Spill control.** Drainage or containment systems shall be provided by means of curbs, scuppers, special drains or other suitable means to prevent the flow of spills throughout the building.

**4003.2 Ventilation.** For rooms and spaces where distilled spirits and wines in barrels and casks are stored, ventilation shall be provided in accordance with the *International Mechanical Code* and one of the following:

1. The rooms and spaces shall be ventilated at a rate sufficient to maintain the concentration of vapors within the area at or below 25 percent of the *lower flammable limit* (LFL). This shall be confirmed by sampling the actual vapor concentration under normal operating conditions. The sampling shall be conducted throughout the enclosed storage area, extending to or toward the bottom and the top of the enclosed storage area. The vapor concentration used to determine the required ventilation rate shall be the highest measured concentration during the sampling procedure. The sampling shall be conducted manually or by installation of a continuously monitoring flammable vapor detection system.

2. The rooms and spaces shall be provided exhaust ventilation at a rate of not less than 1 cfm per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of solid floor area. The exhaust ventilation shall be accomplished by natural or mechanical means, with discharge of the exhaust to a safe location outside the building.

**4003.3 Sources of ignition.** Sources of ignition shall be controlled in accordance with Sections 4003.3.1 through 4003.4.

**4003.3.1 Smoking.** Smoking shall be prohibited and “No Smoking” signs provided as follows:

1. In rooms or areas where hazardous materials are stored or dispensed or used in open systems in amounts requiring a permit in accordance with Sections 105.5 and 105.6.
2. Within 25 feet (7620 mm) of outdoor storage, dispensing or open-use areas.
3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facility or area. Designated areas within such facilities where smoking is permitted either permanently or temporarily shall be identified with signs designating that smoking is permitted in these areas only.
4. In rooms or areas where flammable or combustible hazardous materials are stored, dispensed or used.

Signs required by this section shall be in English as a primary language or in symbols allowed by this code and shall comply with Section 310.

**4003.3.2 Open flame.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition and shall be *listed* for use with the hazardous materials stored or used.

**4003.3.3 Industrial trucks.** Powered industrial trucks used in areas designated as hazardous (classified) locations in accordance with NFPA 70 shall be *listed* and *labeled* for use in the environment intended in accordance with NFPA 505.

## STORAGE OF DISTILLED SPIRITS AND WINES

**4003.3.4 Electrical.** Electrical wiring and equipment shall be installed and maintained in accordance with Section 608 and NFPA 70.

**4003.4 Lightning.** Structures containing barrel storage should be protected from lightning. The lightning protection equipment shall be installed in accordance with NFPA 70 and NFPA 780.

### SECTION 4004 STORAGE

**4004.1 Storage.** Storage shall be in accordance with this section and Section 315.

**4004.2 Empty containers.** The storage of empty containers previously used for the storage of *flammable* or *combustible liquids*, unless free from explosive vapors, shall be stored as required for filled containers.

**4004.3 Basement storage.** Class I liquids shall be allowed to be stored in basements in amounts not exceeding the *maximum allowable quantity per control area* for use-open systems in Table 5003.1.1(1), provided that automatic suppression and other fire protection are provided in accordance with Chapter 9. Class II and IIIA liquids shall also be allowed to be stored in *basements*, provided that automatic suppression and other fire protection are provided in accordance with Chapter 9.

**4004.4 Bulk beverage storage areas.** There shall be no storage of combustible materials in the bulk beverage storage areas not related to the beverage storage activities.

### SECTION 4005 FIRE PROTECTION

**4005.1 Automatic sprinkler system.** The storage of distilled spirits and wines shall be protected by an *approved automatic sprinkler system* as required by Chapter 9.

**4005.2 Portable fire extinguishers.** *Approved* portable fire extinguishers shall be provided in accordance with Section 906.

### SECTION 4006 SIGNAGE

**4006.1 Hazard identification signs.** Unless otherwise exempted by the *fire code official*, visible hazard identification signs, as specified in NFPA 704 for the specific material contained, shall be placed on stationary containers and above-ground tanks; at entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities requiring a permit; and at specific entrances and locations designated by the *fire code official*.

**4006.1.1 Maintenance and style.** Signs and markings required by Section 4006.1 shall not be obscured or removed; shall be in English as a primary language or in symbols allowed by this code; shall be durable; and the size, color and lettering shall be *approved*.

**CHAPTERS 41 through 49**

**RESERVED**

**I**





# Part V—Hazardous Materials

## CHAPTER 50

# HAZARDOUS MATERIALS—GENERAL PROVISIONS

### User note:

**About this chapter:** Chapter 50 contains the general requirements for all hazardous materials in all occupancies. Hazardous materials are defined as those that pose an unreasonable risk to the health and safety of operating or emergency personnel, the public and the environment if not properly controlled during handling, storage, manufacture, processing, packaging, use, disposal or transportation. The general provisions of this chapter are intended to be companion provisions with the specific requirements of Chapters 51 through 67 regarding a given hazardous material. Also, Sections 414 and 415 of the International Building Code® contain construction requirements related to the storage and use of such materials.

### SECTION 5001 GENERAL

**5001.1 Scope.** Prevention, control and mitigation of dangerous conditions related to storage, dispensing, use and handling of hazardous materials shall be in accordance with this chapter.

This chapter shall apply to all hazardous materials, including those materials regulated elsewhere in this code, except that where specific requirements are provided in other chapters, those specific requirements shall apply in accordance with the applicable chapter. Where a material has multiple hazards, all hazards shall be addressed.

#### Exceptions:

1. In retail or wholesale sales occupancies, medicines, foodstuff, cosmetics and commercial or institutional products containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5 L).
2. Alcoholic beverages in retail or wholesale sales occupancies, provided that the liquids are packaged in individual containers not exceeding 1.3 gallons (5 L).
3. Application and release of pesticide and agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications where applied in accordance with the manufacturer's instructions and label directions.
4. The off-site transportation of hazardous materials where in accordance with Department of Transportation (DOTn) regulations.
5. Building materials not otherwise regulated by this code.
6. Refrigeration systems (see Section 608).
7. Stationary storage battery systems regulated by Section 1207.

8. The display, storage, sale or use of fireworks and explosives in accordance with Chapter 56.
9. Corrosives utilized in personal and household products in the manufacturer's original consumer packaging in Group M occupancies.
10. The storage of beer, distilled spirits and wines in barrels and casks.
11. The use of wall-mounted dispensers containing alcohol-based hand rubs classified as Class I or II liquids where in accordance with Section 5705.5.
12. Specific provisions for flammable liquids in motor fuel-dispensing facilities, repair garages, airports and marinas in Chapter 23.
13. Storage and use of fuel oil in tanks and containers connected to oil-burning equipment. Such storage and use shall be in accordance with Section 605. For abandonment of fuel oil tanks, Chapter 57 applies.
14. Storage and display of aerosol products complying with Chapter 51.
15. Storage and use of *flammable* or *combustible liquids* that do not have a fire point when tested in accordance with ASTM D92, not otherwise regulated by this code.
16. *Flammable* or *combustible liquids* with a *flash point* greater than 95°F (35°C) in a water-miscible solution or dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight, which do not sustain combustion, not otherwise regulated by this code.
17. Commercial cooking oil storage tank systems located within a building and designed and installed in accordance with Section 607 and NFPA 30.

**5001.1.1 Waiver.** The provisions of this chapter are waived where the *fire code official* determines that such enforcement is preempted by other codes, statutes or ordinances. The details of any action granting such a waiver

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

shall be recorded and entered in the files of the code enforcement agency.

**5001.2 Material classification.** Hazardous materials are those chemicals or substances defined as such in this code. Definitions of hazardous materials shall apply to all hazardous materials, including those materials regulated elsewhere in this code.

**5001.2.1 Mixtures.** Mixtures shall be classified in accordance with hazards of the mixture as a whole. Mixtures of hazardous materials shall be classified in accordance with nationally recognized reference standards; by an *approved* qualified organization, individual, or Safety Data Sheet (SDS); or by other *approved* methods.

**5001.2.2 Hazard categories.** Hazardous materials shall be classified according to hazard categories. The categories include materials regulated by this chapter and materials regulated elsewhere in this code.

**5001.2.2.1 Physical hazards.** The material categories listed in this section are classified as *physical hazards*. A material with a primary classification as a *physical hazard* can also pose a *health hazard*.

1. *Explosives* and blasting agents.
2. *Combustible liquids*.
3. Flammable solids, liquids and gases.
4. Organic peroxide solids or liquids.
5. Oxidizer, solids or liquids.
6. Oxidizing gases.
7. Pyrophoric solids, liquids or gases.
8. Unstable (reactive) solids, liquids or gases.
9. Water-reactive materials solids or liquids.
10. *Cryogenic fluids*.

**5001.2.2.2 Health hazards.** The material categories listed in this section are classified as *health hazards*. A material with a primary classification as a *health hazard* can also pose a *physical hazard*.

1. Highly toxic and toxic materials.
2. *Corrosive* materials.

**5001.3 Performance-based design alternative.** Where *approved* by the *fire code official*, buildings and facilities where hazardous materials are stored, used or handled shall be permitted to comply with this section as an alternative to compliance with the other requirements set forth in this chapter and Chapters 51 through 67.

**5001.3.1 Objective.** The objective of Section 5001.3 is to protect people and property from the consequences of unauthorized discharge, fires or explosions involving hazardous materials.

**5001.3.2 Functional statements.** Performance-based design alternatives are based on the following functional statements:

1. Provide safeguards to minimize the risk of unwanted releases, fires or explosions involving hazardous materials.

2. Provide safeguards to minimize the consequences of an unsafe condition involving hazardous materials during normal operations and in the event of an abnormal condition.

**5001.3.3 Performance requirements.** Where safeguards, systems, documentation, written plans or procedures, audits, process hazards analysis, mitigation measures, engineering controls or construction features are required by Sections 5001.3.3.1 through 5001.3.3.18, the details of the design alternative shall be subject to approval by the *fire code official*. The details of actions granting the use of the design alternatives shall be recorded and entered in the files of the jurisdiction.

**5001.3.3.1 Properties of hazardous materials.** The physical- and health-hazard properties of hazardous materials on-site shall be known and shall be made readily available to employees, neighbors and the *fire code official*.

**5001.3.3.2 Reliability of equipment and operations.** Equipment and operations involving hazardous materials shall be designed, installed and maintained to ensure that they reliably operate as intended.

**5001.3.3.3 Prevention of unintentional reaction or release.** Safeguards shall be provided to minimize the risk of an unintentional reaction or release that could endanger people or property.

**5001.3.3.4 Spill mitigation.** Spill containment systems or means to render a spill harmless to people or property shall be provided where a spill is determined to be a plausible event and where such an event would endanger people or property.

**5001.3.3.5 Ignition hazards.** Safeguards shall be provided to minimize the risk of exposing combustible hazardous materials to unintended sources of ignition.

**5001.3.3.6 Protection of hazardous materials.** Safeguards shall be provided to minimize the risk of exposing hazardous materials to a fire or physical damage whereby such exposure could endanger or lead to the endangerment of people or property.

**5001.3.3.7 Exposure hazards.** Safeguards shall be provided to minimize the risk of and limit damage from a fire or explosion involving explosive hazardous materials whereby such fire or explosion could endanger or lead to the endangerment of people or property.

**5001.3.3.8 Detection of gas or vapor release.** Where a release of hazardous materials gas or vapor would cause immediate harm to persons or property, means of mitigating the dangerous effects of a release shall be provided.

**5001.3.3.9 Reliable power source.** Where a power supply is relied on to prevent or control an emergency condition that could endanger people or property, the power supply shall be from a reliable source.

**5001.3.3.10 Ventilation.** Where ventilation is necessary to limit the risk of creating an emergency condition resulting from normal or abnormal operations, means of ventilation shall be provided.

**5001.3.3.11 Process hazard analyses.** Process hazard analyses shall be conducted to ensure reasonably the protection of people and property from dangerous conditions involving hazardous materials.

**5001.3.3.12 Prestartup safety review.** Written documentation of prestartup safety review procedures shall be developed and enforced to ensure that operations are initiated in a safe manner. The process of developing and updating such procedures shall involve the participation of affected employees.

**5001.3.3.13 Operating and emergency procedures.** Written documentation of operating procedures and procedures for emergency shutdown shall be developed and enforced to ensure that operations are conducted in a safe manner. The process of developing and updating such procedures shall involve the participation of affected employees.

**5001.3.3.14 Management of change.** A written plan for management of change shall be developed and enforced. The process of developing and updating the plan shall involve the participation of affected employees.

**5001.3.3.15 Emergency plan.** A written emergency plan shall be developed to ensure that proper actions are taken in the event of an emergency, and the plan shall be followed if an emergency condition occurs. The process of developing and updating the plan shall involve the participation of affected employees.

**5001.3.3.16 Accident procedures.** Written procedures for investigation and documentation of accidents shall be developed, and accidents shall be investigated and documented in accordance with these procedures.

**5001.3.3.17 Consequence analysis.** Where an accidental release of hazardous materials could endanger people or property, either on- or off-site, an analysis of the expected consequences of a plausible release shall be performed and utilized in the analysis and selection of active and passive hazard mitigation controls.

**5001.3.3.18 Safety audits.** Safety audits shall be conducted on a periodic basis to verify compliance with the requirements of this section.

**5001.4 Retail and wholesale storage and display.** For retail and wholesale storage and display of nonflammable solid and nonflammable or noncombustible liquid hazardous materials in Group M occupancies and storage in Group S occupancies, see Section 5003.11.

**5001.5 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

Where required by the *fire code official*, permittees shall apply for approval to permanently close a storage, use or handling facility. Such application shall be submitted not less than 30 days prior to the termination of the storage, use or handling of hazardous materials. The *fire code official* is authorized to require that the application be accompanied by an *approved* facility closure plan in accordance with Section 5001.6.3.

### **5001.5.1 Hazardous Materials Management Plan.**

Where required by the *fire code official*, an application for a permit shall include a Hazardous Materials Management Plan (HMMP). The HMMP shall include a facility site plan designating the following:

1. Access to each storage and use area.
2. Location of emergency equipment.
3. Location where liaison will meet emergency responders.
4. Facility evacuation meeting point locations.
5. The general purpose of other areas within the building.
6. Location of all above-ground and underground tanks and their appurtenances including, but not limited to, sumps, vaults, below-grade treatment systems and piping.
7. The hazard classes in each area.
8. Locations of all *control areas* and Group H occupancies.
9. Emergency *exits*.

### **5001.5.2 Hazardous Materials Inventory Statement (HMIS).**

Where required by the *fire code official*, an application for a permit shall include an HMIS, such as Superfund Amendments and Reauthorization Act of 1986 (SARA) Title III, Tier II Report or other *approved* statement. The HMIS shall include the following information:

1. Product name.
2. Component.
3. Chemical Abstract Service (CAS) number.
4. Location where stored or used.
5. Container size.
6. Hazard classification.
7. Amount in storage.
8. Amount in use-*closed systems*.
9. Amount in use-*open systems*.

**5001.6 Facility closure.** Facilities shall be placed out of service in accordance with Sections 5001.6.1 through 5001.6.3.

**5001.6.1 Temporarily out-of-service facilities.** Facilities that are temporarily out of service shall continue to maintain a permit and be monitored and inspected.

**5001.6.2 Permanently out-of-service facilities.** Facilities for which a permit is not kept current or is not monitored and inspected on a regular basis shall be deemed to be permanently out of service and shall be closed in an *approved* manner. Where required by the *fire code official*, permittees shall apply for approval to close permanently storage, use or handling facilities. The *fire code official* is authorized to require that such application be accompanied by an *approved* facility closure plan in accordance with Section 5001.6.3.



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**5001.6.3 Facility closure plan.** Where a facility closure plan is required in accordance with Section 5001.5 to terminate storage, dispensing, handling or use of hazardous materials, it shall be submitted to the *fire code official* not less than 30 days prior to facility closure. The plan shall demonstrate that hazardous materials that are stored, dispensed, handled or used in the facility will be transported, disposed of or reused in a manner that eliminates the need for further maintenance and any threat to public health and safety.

## SECTION 5002 DEFINITIONS

**5002.1 Definitions.** The following terms are defined in Chapter 2:

**BOILING POINT.**  
**CEILING LIMIT.**  
**CHEMICAL.**  
**CHEMICAL NAME.**  
**CLOSED CONTAINER.**  
**CONTAINER.**  
**CONTROL AREA.**  
**CYLINDER.**  
**DAY BOX.**  
**DEFLAGRATION.**  
**DESIGN PRESSURE.**  
**DETACHED BUILDING.**  
**DISPENSING.**  
**EXCESS FLOW CONTROL.**  
**EXHAUSTED ENCLOSURE.**  
**EXPLOSION.**  
**FLAMMABLE VAPORS OR FUMES.**  
**GAS CABINET.**  
**GAS ROOM.**  
**HANDLING.**  
**HAZARDOUS MATERIALS.**  
**HEALTH HAZARD.**  
**IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH).**  
**INCOMPATIBLE MATERIALS.**  
**LIQUID.**  
**LOWER EXPLOSIVE LIMIT (LEL).**  
**LOWER FLAMMABLE LIMIT (LFL).**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA.**

**NORMAL TEMPERATURE AND PRESSURE (NTP).**  
**OUTDOOR CONTROL AREA.**  
**PERMISSIBLE EXPOSURE LIMIT (PEL).**  
**PESTICIDE.**  
**PHYSICAL HAZARD.**  
**PRESSURE VESSEL.**  
**SAFETY CAN.**  
**SAFETY DATA SHEET (SDS).**  
**SECONDARY CONTAINMENT.**  
**SEGREGATED.**  
**SOLID.**  
**STORAGE, HAZARDOUS MATERIALS.**  
**SYSTEM.**  
**TANK, ATMOSPHERIC.**  
**TANK, PORTABLE.**  
**TANK, STATIONARY.**  
**TANK VEHICLE.**  
**UNAUTHORIZED DISCHARGE.**  
**USE (MATERIAL).**  
**VAPOR PRESSURE.**

## SECTION 5003 GENERAL REQUIREMENTS

**5003.1 Scope.** The storage, use and handling of all hazardous materials shall be in accordance with this section.

**5003.1.1 Maximum allowable quantity per control area.** The *maximum allowable quantity per control area* shall be as specified in Tables 5003.1.1(1) through 5003.1.1(4).

For retail and wholesale storage and display in Group M occupancies and Group S storage, see Section 5003.11.

**5003.1.2 Conversion.** Where quantities are indicated in pounds and where the weight per gallon of the liquid is not provided to the *fire code official*, a conversion factor of 10 pounds per gallon (1.2 kg/L) shall be used.

**5003.1.3 Quantities not exceeding the maximum allowable quantity per control area.** The storage, use and handling of hazardous materials in quantities not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

**5003.1.4 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of hazardous materials in quantities exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with this chapter.

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5003.1.1(1)**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>**

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible dust	NA	H-2	See Note q	NA	NA	See Note q	NA	NA	See Note q	NA
Combustible fibers <sup>a</sup>	Loose	H-3	(100)	NA	NA	(100)	NA	NA	(20)	NA
	Baled <sup>p</sup>		(1,000)	NA	NA	(1,000)	NA	NA	(200)	NA
Combustible liquid <sup>a, i</sup>	II	H-2 or H-3	NA	120 <sup>d, e</sup>	NA	NA	120 <sup>d</sup>	NA	NA	30 <sup>d</sup>
	IIIA	H-2 or H-3		330 <sup>d, e</sup>			330 <sup>d</sup>			80 <sup>d</sup>
	IIIB	NA		13,200 <sup>e, f</sup>			13,200 <sup>f</sup>			3,300 <sup>f</sup>
Cryogenic Flammable	NA	H-2	NA	45 <sup>d</sup>	NA	NA	45 <sup>d</sup>	NA	NA	10 <sup>d</sup>
Cryogenic Inert	NA	NA	NA	NA	NL	NA	NA	NL	NA	NA
Cryogenic Oxidizing	NA	H-3	NA	45 <sup>d</sup>	NA	NA	45 <sup>d</sup>	NA	NA	10 <sup>d</sup>
Explosives	Division 1.1	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.2	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.3	H-1 or H-2	5 <sup>e, g</sup>	(5) <sup>e, g</sup>		1 <sup>g</sup>	(1) <sup>g</sup>		1 <sup>g</sup>	(1) <sup>g</sup>
	Division 1.4	H-3	50 <sup>e, g</sup>	(50) <sup>e, g</sup>		50 <sup>g</sup>	(50) <sup>g</sup>		NA	NA
	Division 1.4G	H-3	125 <sup>e, i</sup>	NA		NA	NA		NA	NA
	Division 1.5	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.6	H-1	1 <sup>e, g</sup>	NA		NA	NA		NA	NA
Flammable gas	Gaseous	H-2	NA	NA	1,000 <sup>d, e</sup>	NA	NA	1,000 <sup>d, e</sup>	NA	NA
	Liquefied			(150) <sup>d, e</sup>	NA		(150) <sup>d, e</sup>	NA		
Flammable liquid <sup>e</sup>	IA IB and IC	H-2 or H-3	NA	30 <sup>d, e</sup>	NA	NA	30 <sup>d</sup>	NA	NA	10d
				120 <sup>d, e</sup>			120 <sup>d</sup>			30d
Flammable liquid, combination (IA, IB, IC)	NA	H-2 or H-3	NA	120 <sup>d, e, h</sup>	NA	NA	120 <sup>d, h</sup>	NA	NA	30 <sup>d, h</sup>
Flammable solid	NA	H-3	125 <sup>d, e</sup>	NA	NA	125 <sup>d</sup>	NA	NA	25 <sup>d</sup>	NA

(continued)

HAZARDOUS MATERIALS—GENERAL PROVISIONS

TABLE 5003.1.1(1)—continued  
MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>		
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	
Inert gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA	NA
Organic peroxide	UD	H-1	1 <sup>c, g</sup>	(1) <sup>c, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	
	I	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>		1 <sup>d</sup>	(1) <sup>d</sup>		1 <sup>d</sup>	(1) <sup>d</sup>	
	II	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>		50 <sup>d</sup>	(50) <sup>d</sup>		10 <sup>d</sup>	(10) <sup>d</sup>	
	III	H-3	125 <sup>d, e</sup>	(125) <sup>d, e</sup>		125 <sup>d</sup>	(125) <sup>d</sup>		25 <sup>d</sup>	(25) <sup>d</sup>	
	IV	NA	NL	NL		NL	NL		NL	NL	
Oxidizer	V	NA	NL	NL	NA	NL	NL	NA	NL	NL	
	4	H-1	1 <sup>g</sup>	(1) <sup>c, g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>	
	3 <sup>k</sup>	H-2 or H-3	10 <sup>d, e</sup>	(10) <sup>d, e</sup>		2 <sup>d</sup>	(2) <sup>d</sup>		2 <sup>d</sup>	(2) <sup>d</sup>	
	2	H-3	250 <sup>d, e</sup>	(250) <sup>d, e</sup>		250 <sup>d</sup>	(250) <sup>d</sup>		50 <sup>d</sup>	(50) <sup>d</sup>	
	1	NA	4,000 <sup>c, f</sup>	(4,000) <sup>c, f</sup>		4,000 <sup>f</sup>	(4,000) <sup>f</sup>		1,000 <sup>f</sup>	(1,000) <sup>f</sup>	
Oxidizing gas	Gaseous	H-3	NA	NA	1,500 <sup>d, e</sup>	NA	NA	1,500 <sup>d, e</sup>	NA	NA	NA
	Liquefied			(150) <sup>d, e</sup>	NA		(150) <sup>d, e</sup>	NA			
Pyrophoric	NA	H-2	4 <sup>c, g</sup>	(4) <sup>c, g</sup>	50 <sup>c, g</sup>	1 <sup>g</sup>	(1) <sup>g</sup>	10 <sup>c, g</sup>	0	0	
	4	H-1	1 <sup>c, g</sup>	(1) <sup>c, g</sup>	10 <sup>c, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	2 <sup>c, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	
	3	H-1 or H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	50 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	10 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	750 <sup>d, e</sup>	50 <sup>d</sup>	(50) <sup>d</sup>	750 <sup>d, e</sup>	10 <sup>d</sup>	(10) <sup>d</sup>	
	1	NA	NL	NL	NL	NL	NL	NL	NL	NL	
Unstable (reactive)	3	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	NA	5 <sup>d</sup>	(5) <sup>d</sup>	NA	1 <sup>d</sup>	(1) <sup>d</sup>	
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>		50 <sup>d</sup>	(50) <sup>d</sup>		10 <sup>d</sup>	(10) <sup>d</sup>	
	1	NA	NL	NL		NL	NL		NL	NL	
Water reactive	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	NA	50 <sup>d</sup>	(50) <sup>d</sup>	NA	10 <sup>d</sup>	(10) <sup>d</sup>	
	1	NA	NL	NL		NL	NL		NL	NL	

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

NA = Not Applicable, NL = Not Limited, UD = Unclassified Detonable.

a. For use of control areas, see Section 5003.8.3.

b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e applies, the increase for both notes shall be applied cumulatively.

e. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, day boxes, gas cabinets, gas rooms, exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10. Where Note d applies, the increase for both notes shall be applied cumulatively.

f. Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.

g. Allowed only in buildings equipped throughout with an approved automatic sprinkler system.

(footnotes continued)

**TABLE 5003.1.1(1)—continued**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>**

- h. Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.
- i. The maximum allowable quantity shall not apply to fuel oil storage complying with Section 605.4.2.
- j. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
- k. A maximum quantity of 220 pounds of solid or 22 gallons of liquid Class 3 oxidizers is allowed where such materials are necessary for maintenance purposes, operation or sanitation of equipment where the storage containers and the manner of storage are approved.
- l. Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
- m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.11, see Table 5003.11.1.
- o. Densely-packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
- p. The following shall not be included in determining the maximum allowable quantities:
  - 1. Liquid or gaseous fuel in fuel tanks on vehicles.
  - 2. Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with this code.
  - 3. Gaseous fuels in piping systems and fixed appliances regulated by the *International Fuel Gas Code*.
  - 4. Liquid fuels in piping systems and fixed appliances regulated by the *International Mechanical Code*.
  - 5. Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 5705.5 and 5705.5.1. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction documents.
- q. Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.8.2.



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5003.1.1(2)**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A HEALTH HAZARD<sup>a, c, f, h, i</sup>**

MATERIAL	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
	Solid pounds <sup>d, e</sup>	Liquid gallons (pounds) <sup>d, e</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>
Corrosives	5,000	500	Gaseous 810 <sup>e</sup> Liquefied (150)	5,000	500	Gaseous 810 <sup>e</sup> Liquefied (150)	1,000	100
Highly toxics	10	(10)	Gaseous 20 <sup>g</sup> Liquefied (4) <sup>g</sup>	10	(10)	Gaseous 20 <sup>g</sup> Liquefied (4) <sup>g</sup>	3	(3)
Toxics	500	(500)	Gaseous 810 <sup>e</sup> Liquefied (150) <sup>e</sup>	500	(500)	Gaseous 810 <sup>e</sup> Liquefied (150) <sup>e</sup>	125	(125)

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

- For use of control areas, see Section 5003.8.3.
- The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
- In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.
- Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.
- Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, gas cabinets or exhausted enclosures. Where Note d applies, the increase for both notes shall be applied accumulatively.
- For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.1.1, see Table 5003.1.1.1.
- Allowed only where stored in approved exhausted gas cabinets or exhausted enclosures.
- Quantities in parentheses indicate quantity units in parentheses at the head of each column.
- For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

TABLE 5003.1.1(3) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD IN AN OUTDOOR CONTROL AREA<sup>a, b, c, d</sup>

MATERIAL	CLASS	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
		Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds) <sup>d</sup>
Flammable gas	Gaseous Liquefied	Not Applicable	Not Applicable (300)	3,000 Not Applicable	Not Applicable	Not Applicable (150)	1,500 Not Applicable	Not Applicable	Not Applicable
Flammable solid	Not Applicable	500	Not Applicable	Not Applicable	250	Not Applicable	Not Applicable	50	Not Applicable
Inert Gas	Gaseous	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
Cryogenic inert	Liquefied	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
	Not Applicable	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
	Unclassified Detonable	1	(1)	Not Applicable	0.25	(0.25)	Not Applicable	0.25	(0.25)
Organic peroxide	I	20	(20)		10	(10)		2	(2)
	II	200	(200)		100	(100)		20	(20)
	III	500	(500)	Not Applicable	250	(250)	Not Applicable	50	(50)
	IV	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited
	V	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited
Oxidizer	4	2	(2)		1	(1)		0.25	(0.25)
	3	40	(40)		20	(20)		4	(4)
	2	1,000	(1,000)	Not Applicable	500	(500)	Not Applicable	100	(100)
	1	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited
Oxidizing gas	Gaseous Liquefied	Not Applicable	Not Applicable (600)	6,000 Not Applicable	Not Applicable	Not Applicable (300)	1,500 Not Applicable	Not Applicable	Not Applicable
Pyrophoric materials	Not Applicable	8	(8)	100	4	(4)	10	0	0
Unstable (reactive)	4	2	(2)	20	1	(1)	2	0.25	(0.25)
	3	20	(20)	200	10	(10)	10	1	(1)
	2	200	(200)	1,000	100	(100)	250	10	(10)
	1	Not Limited	Not Limited	1,500	Not Limited	Not Limited	Not Limited	Not Limited	Not Limited
Water reactive	3	20	(20)		10	(10)		1	(1)
	2	200	(200)	Not Applicable	100	(100)	Not Applicable	10	(10)
	1	Not Limited	Not Limited		Not Limited	Not Limited		Not Limited	Not Limited

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>.

a. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.

b. The aggregate quantities in storage and use shall not exceed the quantity listed for storage.

c. The aggregate quantity of nonflammable solid and nonflammable liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.11.

d. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5003.1.1(4)**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A HEALTH HAZARD IN AN OUTDOOR CONTROL AREA<sup>a, b, c, f</sup>**

MATERIAL	STORAGE			USE-CLOSED SYSTEMS				USE-OPEN SYSTEMS	
	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)		Solid pounds	Liquid gallons (pounds)
Corrosives	20,000	2,000	Gaseous 1,620 Liquefied (300)	10,000	1,000	Gaseous 810 Liquefied (150)		1,000	100
Highly toxics	20	(20)	Gaseous 40 <sup>d</sup> Liquefied (8) <sup>d</sup>	10	(10)	Gaseous 20 <sup>d</sup> Liquefied (4) <sup>d</sup>		3	(3)
Toxics	1,000	(1,000) <sup>e</sup>	Gaseous 1,620 Liquefied (300)	500	50 <sup>e</sup>	Gaseous 810 Liquefied (150)		125	(125) <sup>e</sup>

For SI: 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 pound per square inch absolute = 6.895 kPa, °C = (°F – 32)/1.8.

- For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
- The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
- The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.1.1.
- Allowed only where used in approved exhausted gas cabinets, exhausted enclosures or under fume hoods.
- The maximum allowable quantity per control area for toxic liquids with vapor pressures in excess of 1 psia at 77°F shall be the maximum allowable quantity per control area listed for highly toxic liquids.
- Quantities in parentheses indicate quantity units in parentheses at the head of each column.

**5003.2 Systems, equipment and processes.** Systems, equipment and processes utilized for storage, dispensing, use or handling of hazardous materials shall be in accordance with Sections 5003.2.1 through 5003.2.9.

**5003.2.1 Design and construction of containers, cylinders and tanks.** Containers, cylinders and tanks shall be designed and constructed in accordance with *approved* standards. Containers, cylinders, tanks and other means used for containment of hazardous materials shall be of an *approved* type. Pressure vessels not meeting DOTn requirements for transportation shall comply with the *ASME Boiler and Pressure Vessel Code*.

**5003.2.2 Piping, tubing, valves and fittings.** Piping, tubing, valves, and fittings conveying hazardous materials shall be designed and installed in accordance with ASME B31.1 or other *approved* standards, and shall be in accordance with Sections 5003.2.2.1 and 5003.2.2.2.

**5003.2.2.1 Design and construction.** Piping, tubing, valves, fittings and related components used for hazardous materials shall be in accordance with the following:

1. Piping, tubing, valves, fittings and related components shall be designed and fabricated from materials that are compatible with the material to be contained and shall be of adequate strength and durability to withstand the pressure, structural and seismic stress and exposure to which they are subject.
2. Piping and tubing shall be identified in accordance with ASME A13.1 to indicate the material conveyed.
3. Manual valves or automatic remotely activated fail-safe emergency shutoff valves shall be installed on supply piping and tubing and provided with *ready access* at the following locations:
  - 3.1. The point of use.
  - 3.2. The tank, cylinder or bulk source.
4. Manual emergency shutoff valves and controls for remotely activated emergency shutoff valves shall be clearly visible, provided with *ready access* and identified in an *approved* manner.
5. Backflow prevention or check valves shall be provided where the backflow of hazardous materials could create a hazardous condition or cause the unauthorized discharge of hazardous materials.

**Exceptions:**

1. Piping for inlet connections designed to prevent backflow.
2. Piping for pressure relief devices.

**5003.2.2.2 Additional regulations for supply piping for health-hazard materials.** Supply piping and tubing for gases and liquids having a health-hazard

ranking of 3 or 4 in accordance with NFPA 704 shall be in accordance with ASME B31.3 and the following:

1. Piping and tubing utilized for the transmission of highly toxic, toxic or highly volatile *corrosive* liquids and gases shall have welded, threaded or flanged connections throughout except for connections located within a ventilated enclosure if the material is a gas, or an *approved* method of drainage or containment is provided for connections if the material is a liquid.
2. Piping and tubing shall not be located within *corridors*, within any portion of a *means of egress* required to be enclosed in *fire-resistance-rated* construction or in concealed spaces in areas not classified as Group H occupancies.

**Exception:** Piping and tubing within the space defined by the walls of *corridors* and the floor or roof above or in concealed spaces above other occupancies where installed in accordance with Section 415.11.7.4 of the *International Building Code* for Group H-5 occupancies.

**5003.2.3 Equipment, machinery and alarms.** Equipment, machinery and required detection and alarm systems associated with the use, storage or handling of hazardous materials shall be *listed* or *approved*.

**5003.2.4 Installation of tanks.** Installation of tanks shall be in accordance with Sections 5003.2.4.1 through 5003.2.4.2.1.

**5003.2.4.1 Underground tanks.** Underground tanks used for the storage of liquid hazardous materials shall be provided with secondary containment. In lieu of providing secondary containment for an underground tank, an above-ground tank in an underground vault complying with Section 5704.2.8 shall be permitted.

**5003.2.4.2 Above-ground tanks.** Above-ground stationary tanks used for the storage of hazardous materials shall be located and protected in accordance with the requirements for outdoor storage of the particular material involved.

**Exception:** Above-ground tanks that are installed in vaults complying with Section 5303.16 or 5704.2.8 shall not be required to comply with location and protection requirements for outdoor storage.

**5003.2.4.2.1 Marking.** Above-ground stationary tanks shall be marked as required by Section 5003.5.

**5003.2.5 Empty containers and tanks.** Empty containers and tanks previously used for the storage of hazardous materials shall be free from residual material and vapor as defined by DOTn, the Resource Conservation and Recovery Act (RCRA) or other regulating authority or maintained as specified for the storage of hazardous material.

**5003.2.6 Maintenance.** In addition to the requirements of Section 5003.2.3, equipment, machinery and required detection and alarm systems associated with hazardous



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

materials shall be maintained in an operable condition. Defective containers, cylinders and tanks shall be removed from service, repaired or disposed of in an *approved* manner. Defective equipment or machinery shall be removed from service and repaired or replaced. Required detection and alarm systems shall be replaced or repaired where defective.

**5003.2.6.1 Tanks out of service for 90 days.** Stationary tanks not used for a period of 90 days shall be properly safeguarded or removed in an *approved* manner. Such tanks shall have the fill line, gauge opening and pump connection secured against tampering. Vent lines shall be properly maintained.

**5003.2.6.1.1 Return to service.** Tanks that are to be placed back in service shall be tested in an *approved* manner.

**5003.2.6.2 Defective containers and tanks.** Defective containers and tanks shall be removed from service, repaired in accordance with *approved* standards or disposed of in an *approved* manner.

**5003.2.7 Liquid-level limit control.** Atmospheric tanks having a capacity greater than 500 gallons (1893 L) and that contain hazardous material liquids shall be equipped with a liquid-level limit control or other *approved* means to prevent overfilling of the tank.

**5003.2.8 Seismic protection.** Machinery and equipment utilizing hazardous materials shall be braced and anchored in accordance with the seismic design requirements of the *International Building Code* for the seismic design category in which the machinery or equipment is classified.

**5003.2.9 Testing.** The equipment, devices and systems listed in Section 5003.2.9.1 shall be tested at the time of installation and at one of the intervals listed in Section 5003.2.9.2. Records of the tests conducted or maintenance performed shall be maintained in accordance with the provisions of Section 109.3.

#### Exceptions:

1. Periodic testing shall not be required where *approved* written documentation is provided stating that testing will damage the equipment, device or system and the equipment, device or system is maintained as specified by the manufacturer.
2. Periodic testing shall not be required for equipment, devices and systems that fail in a fail-safe manner.
3. Periodic testing shall not be required for equipment, devices and systems that self-diagnose and report trouble. Records of the self-diagnosis and trouble reporting shall be made available to the *fire code official*.
4. Periodic testing shall not be required if system activation occurs during the required test cycle for the components activated during the test cycle.

5. *Approved* maintenance in accordance with Section 5003.2.6 that is performed not less than annually or in accordance with an *approved* schedule shall be allowed to meet the testing requirements set forth in Sections 5003.2.9.1 and 5003.2.9.2.

**5003.2.9.1 Equipment, devices and systems requiring testing.** The following equipment, systems and devices shall be tested in accordance with Sections 5003.2.9 and 5003.2.9.2.

1. Gas detection systems, alarms and automatic emergency shutoff valves required by Section 6004.2.2.10 for highly toxic and toxic gases.
2. Limit control systems for liquid level, temperature and pressure required by Sections 5003.2.7, 5004.8 and 5005.1.4.
3. Emergency alarm systems and supervision required by Sections 5004.9 and 5005.4.4.
4. Monitoring and supervisory systems required by Sections 5004.10 and 5005.1.6.
5. Manually activated shutdown controls required by Section 6403.1.1.1 for *compressed gas systems* conveying pyrophoric gases.

**5003.2.9.2 Testing frequency.** The equipment, systems and devices listed in Section 5003.2.9.1 shall be tested at one of the following frequencies:

1. Not less than annually.
2. In accordance with the *approved* manufacturer's requirements.
3. In accordance with *approved* recognized industry standards.
4. In accordance with an *approved* schedule.

**5003.3 Release of hazardous materials.** Hazardous materials in any quantity shall not be released into a sewer, storm drain, ditch, drainage canal, creek, stream, river, lake or tidal waterway or on the ground, sidewalk, street, highway or into the atmosphere.

#### Exceptions:

1. The release or emission of hazardous materials is allowed where in compliance with federal, state or local governmental agencies, regulations or permits.
2. The release of pesticides is allowed where used in accordance with registered label directions.
3. The release of fertilizer and soil amendments is allowed where used in accordance with manufacturer's specifications.

**5003.3.1 Unauthorized discharges.** In the event hazardous materials are released in quantities reportable under state, federal or local regulations, the *fire code official* shall be notified and the following procedures required in accordance with Sections 5003.3.1.1 through 5003.3.1.4.

**5003.3.1.1 Records.** Records of the unauthorized discharge of hazardous materials by the permittee shall be maintained.

**5003.3.1.2 Preparation.** Provisions shall be made for controlling and mitigating unauthorized discharges.

**5003.3.1.3 Control.** Where an unauthorized discharge caused by primary container failure is discovered, the involved primary container shall be repaired or removed from service.

**5003.3.1.4 Responsibility for cleanup.** The person, firm or corporation responsible for an unauthorized discharge shall institute and complete all actions necessary to remedy the effects of such unauthorized discharge, whether sudden or gradual, without cost to the jurisdiction. Where deemed necessary by the *fire code official*, cleanup can be initiated by the fire department or by an authorized individual or firm. Costs associated with such cleanup shall be borne by the *owner*, operator or other person responsible for the unauthorized discharge.

**5003.4 Safety Data Sheets.** Safety Data Sheets (SDS) shall be readily available on the premises for hazardous materials regulated by this chapter. Where a hazardous substance is developed in a laboratory, available information shall be documented.

**Exception:** Designated hazardous waste.

**5003.5 Hazard identification signs.** Unless otherwise exempted by the *fire code official*, visible hazard identification signs as specified in NFPA 704 for the specific material contained shall be placed on stationary containers and above-ground tanks and at entrances to locations where hazardous materials are stored, dispensed, used or handled in quantities requiring a permit and at specific entrances and locations designated by the *fire code official*.

**5003.5.1 Markings.** Individual containers, cartons or packages shall be conspicuously marked or labeled in an *approved* manner. Rooms or cabinets containing *compressed gases* shall be conspicuously labeled: “COMPRESSED GAS.”

**5003.6 Signs.** Signs and markings required by Sections 5003.5 and 5003.5.1 shall not be obscured or removed, shall be in English as a primary language or in symbols allowed by this code, shall be durable, and the size, color and lettering shall be *approved*.

**5003.7 Sources of ignition.** Sources of ignition shall comply with Sections 5003.7.1 through 5003.7.3.

**5003.7.1 Smoking.** Smoking shall be prohibited and “No Smoking” signs provided as follows:

1. In rooms or areas where hazardous materials are stored or dispensed or used in *open systems* in amounts requiring a permit in accordance with Section 5001.5.
2. Within 25 feet (7620 mm) of outdoor storage, dispensing or open use areas.
3. Facilities or areas within facilities that have been designated as totally “no smoking” shall have “No Smoking” signs placed at all entrances to the facil-

ity or area. Designated areas within such facilities where smoking is permitted either permanently or temporarily, shall be identified with signs designating that smoking is permitted in these areas only.

4. In rooms or areas where flammable or combustible hazardous materials are stored, dispensed or used.

Signs required by this section shall be in English as a primary language or in symbols allowed by this code and shall comply with Section 310.

**5003.7.2 Open flames.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition and shall be *listed* for use with the hazardous materials stored or used.

**5003.7.3 Industrial trucks.** Powered industrial trucks used in areas designated as hazardous (classified) locations shall be in accordance with Section 309.2.

**5003.7.4 Respiratory therapy.** In Group I-2 and ambulatory care facilities, within areas with respiratory therapy services, sources of ignition shall be regulated in accordance with NFPA 99.

**5003.8 Construction requirements.** Buildings, *control areas*, enclosures and cabinets for hazardous materials shall be in accordance with Sections 5003.8.1 through 5003.8.7.2.

**5003.8.1 Buildings.** Buildings, or portions thereof, in which hazardous materials are stored, handled or used shall be constructed in accordance with the *International Building Code*.

**5003.8.2 Required detached buildings.** Group H occupancies containing quantities of hazardous materials in excess of those set forth in Table 5003.8.2 shall be in detached buildings.

**5003.8.3 Control areas.** *Control areas* shall comply with Sections 5003.8.3.1 through 5003.8.3.5.3.

**Exception:** Higher education laboratories in accordance with Chapter 38 of this code and Section 428 of the *International Building Code*.

**5003.8.3.1 Construction requirements.** *Control areas* shall be separated from each other by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both.

**5003.8.3.2 Percentage of maximum allowable quantities.** The percentage of maximum allowable quantities of hazardous materials per *control area* allowed at each story within a building shall be in accordance with Table 5003.8.3.2.

**5003.8.3.3 Number.** The maximum number of *control areas* per floor within a building shall be in accordance with Table 5003.8.3.2. For the purposes of determining the number of *control areas* within a building, each portion of a building separated by one or more *fire walls* complying with Section 706 of the *International Building Code* shall be considered a separate building.

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5003.8.2**  
**DETACHED BUILDING REQUIRED**

A DETACHED BUILDING IS REQUIRED WHERE THE QUANTITY OF MATERIAL EXCEEDS THAT LISTED HEREIN			
Material	Class	Solids and liquids (tons) <sup>a, b</sup>	Gases (cubic feet) <sup>a, b</sup>
Explosives	Division 1.1	Maximum Allowable Quantity	Not Applicable
	Division 1.2	Maximum Allowable Quantity	
	Division 1.3	Maximum Allowable Quantity	
	Division 1.4	Maximum Allowable Quantity	
	Division 1.4 <sup>c</sup>	1	
	Division 1.5	Maximum Allowable Quantity	
	Division 1.6	Maximum Allowable Quantity	
Oxidizers	Class 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Unstable (reactives) detonable	Class 3 or 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Oxidizer, liquids and solids	Class 3	1,200	Not Applicable
	Class 2	2,000	
Organic peroxides	Detonable	Maximum Allowable Quantity	Not Applicable
	Class I	Maximum Allowable Quantity	
	Class II	25	
	Class III	50	
Unstable (reactives) nondetonable	Class 3	125	2,000
	Class 2		10,000
Water reactives	Class 3	125	Not Applicable
	Class 2		
Pyrophoric gases <sup>d</sup>	Not Applicable	Not Applicable	2,000

For SI: 1 pound = 0.454 kg, 1 cubic foot = 0.02832 m<sup>3</sup>, 1 ton = 2000 lb = 907.2 kg.

- a. For materials that are detonable, the distance to other buildings or lot lines shall be in accordance with Section 415.6 of the *International Building Code* or Chapter 56 based on the trinitrotoluene (TNT) equivalence of the material, whichever is greater.
- b. “Maximum Allowable Quantity” means the maximum allowable quantity per control area set forth in Table 5003.1.1(1).
- c. Limited to Division 1.4 materials and articles, including articles packaged for shipment, that are not regulated as an explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpackaged articles used in process operations that do not propagate a detonation or deflagration between articles, providing the net explosive weight of individual articles does not exceed 1 pound.
- d. Detached buildings are not required for gases in gas rooms that support H-5 fabrication facilities where the gas room is separated from other areas by a fire barrier with a fire-resistance rating of not less than 2 hours and the gas is located in a gas cabinet that is internally sprinklered, equipped with continuous leak detection, automatic shutdown, and is not manifolded upstream of pressure controls. The gas supply is limited to cylinders that do not exceed 125 pounds water capacity in accordance with DOTn 49 CFR 173.192 for Hazard Zone A toxic gases.

**TABLE 5003.8.3.2**  
**DESIGN AND NUMBER OF CONTROL AREAS**

STORY		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA <sup>a</sup>	NUMBER OF CONTROL AREAS PER STORY	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b</sup>
Above grade plane	Higher than 9	5	1	2
	7–9	5	2	2
	6	12.5	2	2
	5	12.5	2	2
	4	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below grade plane	1	75	3	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

- a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 5003.1.1(1) and 5003.1.1(2), with all increases allowed in the footnotes to those tables.
- b. Separation shall include fire barriers and horizontal assemblies as necessary to provide separation from other portions of the building.

**5003.8.3.4 Fire-resistance-rating requirements.** The required *fire-resistance rating* for *fire barriers* shall be in accordance with Table 5003.8.3.2. The floor assembly of the *control area* and the construction supporting the floor of the *control area* shall have a *fire-resistance rating* of not less than 2 hours.

**Exception:** The floor assembly of the *control area* and the construction supporting the floor of the *control area* is allowed to be 1-hour *fire-resistance* rated in buildings of Types IIA, IIIA, IV and VA construction, provided that both of the following conditions exist:

1. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
2. The building is three stories or less above *grade plane*.

**5003.8.3.5 Hazardous materials in Group M display and storage areas and in Group S storage areas.** Hazardous materials located in Group M and Group S occupancies shall be in accordance with Sections 5003.8.3.5.1 through 5003.8.3.5.3.

**5003.8.3.5.1 Nonflammable solids and nonflammable and noncombustible liquids.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed within a single *control area* of a Group M display and storage area or a Group S storage area is allowed to exceed the *maximum allowable quantities per control area* specified in Tables 5003.1.1(1) and 5003.1.1(2) without classifying the building or use as a Group H occupancy, provided that the materials are displayed and stored in accordance with Section 5003.11.

**5003.8.3.5.2 Flammable and combustible liquids.** In Group M occupancy wholesale and retail sales uses, indoor storage of *flammable* and *combustible liquids* shall not exceed the *maximum allowable quantities per control area* as indicated in Table 5704.3.4.1, provided that the materials are displayed and stored in accordance with Chapter 57.

**5003.8.3.5.3 Aerosols.** The maximum quantity of aerosol products in Group M occupancy retail display areas, storage areas adjacent to retail display areas and retail storage areas shall be in accordance with Chapter 51.

**5003.8.4 Gas rooms.** Where a gas room is used to increase the *maximum allowable quantity per control area* or provided to comply with the provisions of Chapter 60, the gas room shall be in accordance with Sections 5003.8.4.1 and 5003.8.4.2.

**5003.8.4.1 Construction.** Gas rooms shall be protected with an *automatic sprinkler system*. Gas rooms shall be separated from the remainder of the building in accordance with the requirements of the *International Building Code* based on the occupancy group into which it has been classified.

**5003.8.4.2 Ventilation system.** The ventilation system for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding area. Highly toxic and toxic gases shall also comply with Section 6004.2.2.6. The ventilation system shall be installed in accordance with the *International Mechanical Code*.

**5003.8.5 Exhausted enclosures.** Where an exhausted enclosure is used to increase *maximum allowable quantity per control area* or where the location of hazardous materials in exhausted enclosures is provided to comply with the provisions of Chapter 60, the exhausted enclosure shall be in accordance with Sections 5003.8.5.1 through 5003.8.5.3.

**5003.8.5.1 Construction.** Exhausted enclosures shall be of noncombustible construction.

**5003.8.5.2 Ventilation.** Exhausted enclosures shall be provided with an exhaust ventilation system. The ventilation system for exhausted enclosures shall be designed to operate at a negative pressure in relation to the surrounding area. Ventilation systems used for highly toxic and toxic gases shall also comply with Items 1, 2 and 3 of Section 6004.1.3. The ventilation system shall be installed in accordance with the *International Mechanical Code*.

**5003.8.5.3 Fire-extinguishing system.** Exhausted enclosures where flammable materials are used shall be protected by an *approved* automatic fire-extinguishing system in accordance with Chapter 9.

**5003.8.6 Gas cabinets.** Where a gas cabinet is used to increase the *maximum allowable quantity per control area* or where the location of *compressed gases* in *gas cabinets* is provided to comply with the provisions of Chapter 60, the gas cabinet shall be in accordance with Sections 5003.8.6.1 through 5003.8.6.3.

**5003.8.6.1 Construction.** Gas cabinets shall be constructed with the following:

1. Not less than 0.097-inch (2.5 mm) (No. 12 gage) steel.
2. Self-closing limited access ports or noncombustible windows to give access to equipment controls.
3. Self-closing doors.
4. Interiors treated, coated or constructed of materials that are compatible with the hazardous materials stored. Such treatment, coating or construction shall include the entire interior of the cabinet.

**5003.8.6.2 Ventilation.** Gas cabinets shall be provided with an exhaust ventilation system. The ventilation system for gas cabinets shall be designed to operate at a negative pressure in relation to the surrounding area. Ventilation systems used for highly toxic and toxic gases shall also comply with Items 1, 2 and 3 of Section 6004.1.2. The ventilation system shall be installed in accordance with the *International Mechanical Code*.



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**5003.8.6.3 Maximum number of cylinders per gas cabinet.** The number of cylinders contained in a single gas cabinet shall not exceed three.

**5003.8.7 Hazardous materials storage cabinets.** Where storage cabinets are used to increase *maximum allowable quantity per control area* or to comply with this chapter, such cabinets shall be in accordance with Sections 5003.8.7.1 and 5003.8.7.2.

**5003.8.7.1 Construction.** The interior of cabinets shall be treated, coated or constructed of materials that are nonreactive with the hazardous material stored. Such treatment, coating or construction shall include the entire interior of the cabinet. Cabinets shall either be *listed* in accordance with UL 1275 as suitable for the intended storage or constructed in accordance with the following:

1. Cabinets shall be of steel having a thickness of not less than 0.0478 inch (1.2 mm) (No. 18 gage). The cabinet, including the door, shall be double walled with a 1½-inch (38 mm) airspace between the walls. Joints shall be riveted or welded and shall be tight fitting. Doors shall be well fitted, self-closing and equipped with a self-latching device.
2. The bottoms of cabinets utilized for the storage of liquids shall be liquid tight to a minimum height of 2 inches (51 mm).

Electrical equipment and devices within cabinets used for the storage of hazardous gases or liquids shall be in accordance with NFPA 70.

**5003.8.7.2 Warning markings.** Cabinets shall be clearly identified in an *approved* manner with red letters on a contrasting background to read:

HAZARDOUS—KEEP FIRE AWAY

**5003.9 General safety precautions.** General precautions for the safe storage, handling or care of hazardous materials shall be in accordance with Sections 5003.9.1 through 5003.9.10.

**5003.9.1 Personnel training and written procedures.** Persons responsible for the operation of areas in which hazardous materials are stored, dispensed, handled or used shall be familiar with the chemical nature of the materials and the appropriate mitigating actions necessary in the event of fire, leak or spill.

**5003.9.1.1 Fire department liaison.** Responsible persons shall be designated and trained to be liaison personnel to the fire department. These persons shall aid the fire department in preplanning emergency responses and identifying the locations where hazardous materials are located, and shall have access to Safety Data Sheets and be knowledgeable in the site's emergency response procedures.

**5003.9.2 Security.** Storage, dispensing, use and handling areas shall be secured against unauthorized entry and safeguarded in a manner *approved* by the *fire code official*.

**5003.9.3 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect storage tanks and connected piping, valves and fittings; dispensing areas; and use areas subject to vehicular damage in accordance with Section 312.

**5003.9.4 Electrical wiring and equipment.** Electrical wiring and equipment shall be installed and maintained in accordance with NFPA 70.

**5003.9.5 Static accumulation.** Where processes or conditions exist where a flammable mixture could be ignited by static electricity, means shall be provided to prevent the accumulation of a static charge.

**5003.9.6 Protection from light.** Materials that are sensitive to light shall be stored in containers designed to protect them from such exposure.

**5003.9.7 Shock padding.** Materials that are shock sensitive shall be padded, suspended or otherwise protected against accidental dislodgement and dislodgement during seismic activity.

**5003.9.8 Separation of incompatible materials.** *Incompatible materials* in storage and storage of materials that are incompatible with materials in use shall be separated where the stored materials are in containers having a capacity of more than 5 pounds (2 kg), 0.5 gallon (2 L) or any amount of *compressed gases*. Separation shall be accomplished by:

1. Segregating *incompatible materials* in storage by a distance of not less than 20 feet (6096 mm).
2. Isolating *incompatible materials* in storage by a noncombustible partition extending not less than 18 inches (457 mm) above and to the sides of the stored material.
3. Storing liquid and solid materials in hazardous material storage cabinets.
4. Storing *compressed gases* in gas cabinets or exhausted enclosures in accordance with Sections 5003.8.5 and 5003.8.6.

Materials that are incompatible shall not be stored within the same cabinet or exhausted enclosure.

**5003.9.9 Shelf storage.** Shelving shall be of substantial construction, and shall be braced and anchored in accordance with the seismic design requirements of the *International Building Code* for the seismic zone in which the material is located. Shelving shall be treated, coated or constructed of materials that are compatible with the hazardous materials stored. Shelves shall be provided with a lip or guard where used for the storage of individual containers.

Shelf storage of hazardous materials shall be maintained in an orderly manner.

#### Exceptions:

1. Storage in hazardous material storage cabinets or laboratory furniture specifically designed for such use.

2. Storage of hazardous materials in amounts not requiring a permit in accordance with Section 5001.5.

**5003.9.10 Safety cans.** *Safety cans* shall be listed in accordance with UL 30 where used to increase the *maximum allowable quantities per control area of flammable or combustible liquids* in accordance with Table 5003.1.1(1). *Safety cans* listed in accordance with UL 1313 are allowed for *flammable and combustible liquids* where not used to increase the *maximum allowable quantities per control area* and for other hazardous material liquids in accordance with the listing.

**5003.10 Handling and transportation.** In addition to the requirements of Section 5003.2, the handling and transportation of hazardous materials in *corridors* or enclosures for *stairways* and *ramps* shall be in accordance with Sections 5003.10.1 through 5003.10.3.6.

**5003.10.1 Valve protection.** Hazardous material gas containers, cylinders and tanks in transit shall have their protective caps in place. Containers, cylinders and tanks of highly toxic or toxic *compressed gases* shall have their valve outlets capped or plugged with an *approved* closure device in accordance with Chapter 53.

**5003.10.2 Carts and trucks required.** Liquids in containers exceeding 5 gallons (19 L) in a *corridor* or enclosure for a *stairway* or *ramp* shall be transported on a cart or truck. Containers of hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 and transported within *corridors* or interior *exit stairways* and *ramps*, shall be on a cart or truck. Where carts and trucks are required for transporting hazardous materials, they shall be in accordance with Section 5003.10.3.

**Exceptions:**

1. Two hazardous material liquid containers that are hand carried in acceptable safety carriers.
2. Not more than four drums not exceeding 55 gallons (208 L) each that are transported by suitable drum trucks.
3. Containers and cylinders of *compressed gases* that are transported by *approved* hand trucks, and containers and cylinders not exceeding 25 pounds (11 kg) that are hand carried.
4. Solid hazardous materials not exceeding 100 pounds (45 kg) that are transported by *approved* hand trucks, and a single container not exceeding 50 pounds (23 kg) that is hand carried.

**5003.10.3 Carts and trucks.** Carts and trucks required by Section 5003.10.2 to be used to transport hazardous materials shall be in accordance with Sections 5003.10.3.1 through 5003.10.3.6.

**5003.10.3.1 Design.** Carts and trucks used to transport hazardous materials shall be designed to provide a stable base for the commodities to be transported and

shall have a means of restraining containers to prevent accidental dislodgement. *Compressed gas* cylinders placed on carts and trucks shall be individually restrained.

**5003.10.3.2 Speed-control devices.** Carts and trucks shall be provided with a device that will enable the operator to control safely movement by providing stops or speed-reduction devices.

**5003.10.3.3 Construction.** Construction materials for hazardous material carts or trucks shall be compatible with the material transported. The cart or truck shall be of substantial construction.

**5003.10.3.4 Spill control.** Carts and trucks transporting liquids shall be capable of containing a spill from the largest single container transported.

**5003.10.3.5 Attendance.** Carts and trucks used to transport materials shall not obstruct or be left unattended within any part of a *means of egress*.

**5003.10.3.6 Incompatible materials.** *Incompatible materials* shall not be transported on the same cart or truck.

**5003.11 Group M storage and display and Group S storage.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single *control area* of a Group M occupancy, or an outdoor *control area*, or stored in a single *control area* of a Group S occupancy, is allowed to exceed the *maximum allowable quantity per control area* indicated in Section 5003.1 where in accordance with Sections 5003.11.1 through 5003.11.3.11.

**5003.11.1 Maximum allowable quantity per control area in Group M or S occupancies.** The aggregate amount of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single *control area* of a Group M occupancy or stored in a single *control area* of a Group S occupancy shall not exceed the amounts set forth in Table 5003.11.1.

**5003.11.2 Maximum allowable quantity per outdoor control area in Group M or S occupancies.** The aggregate amount of nonflammable solid and nonflammable or noncombustible liquid hazardous materials stored and displayed within a single *outdoor control area* of a Group M occupancy shall not exceed the amounts set forth in Table 5003.11.1.

**5003.11.3 Storage and display.** Storage and display shall be in accordance with Sections 5003.11.3.1 through 5003.11.3.11.

**5003.11.3.1 Density.** Storage and display of solids shall not exceed 200 pounds per square foot (976 kg/m<sup>2</sup>) of floor area actually occupied by solid merchandise. Storage and display of liquids shall not exceed 20 gallons per square foot (0.50 L/m<sup>2</sup>) of floor area actually occupied by liquid merchandise.

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5003.11.1**  
**MAXIMUM ALLOWABLE QUANTITY PER INDOOR AND OUTDOOR CONTROL AREA IN GROUP M**  
**AND S OCCUPANCIES—NONFLAMMABLE SOLIDS, NONFLAMMABLE AND NONCOMBUSTIBLE LIQUIDS<sup>d, e, f</sup>**

CONDITION		MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA	
Material <sup>a</sup>	Class	Solids (pounds)	Liquids (gallons)
<b>A. Health-Hazard Materials—Nonflammable and Noncombustible Solids and Liquids</b>			
1. Corrosives <sup>b, c</sup>	Not Applicable	9,750	975
2. Highly toxics	Not Applicable	20 <sup>b, c</sup>	2 <sup>b, c</sup>
3. Toxics <sup>b, c</sup>	Not Applicable	1,000 <sup>k</sup>	100
<b>B. Physical-Hazard Materials—Nonflammable and Noncombustible Solids and Liquids</b>			
1. Oxidizers <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	1,350 <sup>g</sup>	135
	2	2,250 <sup>h</sup>	225
	1	18,000 <sup>i, j</sup>	1,800 <sup>i, j</sup>
2. Unstable (reactives) <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	550	55
	2	1,150	115
	1	Not Limited	Not Limited
3. Water reactives	3 <sup>b, c</sup>	550	55
	2 <sup>b, c</sup>	1,150	115
	1	Not Limited	Not Limited

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. Hazard categories are as specified in Section 5001.2.2.
- b. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note c applies, the increase for both notes shall be applied cumulatively.
- c. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets in accordance with Section 5003.8. Where Note b applies, the increase for both notes shall be applied cumulatively.
- d. See Table 5003.8.3.2 for design and number of control areas.
- e. Maximum allowable quantities for other hazardous material categories shall be in accordance with Section 5003.1.
- f. Maximum allowable quantities shall be increased 100 percent in outdoor control areas.
- g. Maximum allowable quantities shall be increased to 2,250 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- h. Maximum allowable quantities shall be increased to 4,500 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- i. Quantities are unlimited where protected by an automatic sprinkler system.
- j. Quantities are unlimited in an outdoor control area.
- k. Maximum allowable quantity of consumer products shall be increased to 10,000 pounds where individual packages are in the original sealed containers from the manufacturer and the toxic classification is exclusively based on the LC<sub>50</sub> threshold and no other hazardous materials classifications apply.

**5003.11.3.2 Storage and display height.** Display height shall not exceed 6 feet (1829 mm) above the finished floor in display areas of Group M occupancies. Storage height shall not exceed 8 feet (2438 mm) above the finished floor in storage areas of Group M and Group S occupancies.

**5003.11.3.3 Container location.** Individual containers less than 5 gallons (19 L) or less than 25 pounds (11 kg) shall be stored or displayed on pallets, racks or shelves.

**5003.11.3.4 Racks and shelves.** Racks and shelves used for storage or display shall be in accordance with Section 5003.9.9.

**5003.11.3.5 Container type.** Containers shall be *approved* for the intended use and identified as to their content.

**5003.11.3.6 Container size.** Individual containers shall not exceed 100 pounds (45 kg) for solids or 10 gallons (38 L) for liquids in storage and display areas.

**5003.11.3.7 Incompatible materials.** *Incompatible materials* shall be separated in accordance with Section 5003.9.8.

**5003.11.3.8 Floors.** Floors shall be in accordance with Section 5004.12.

**5003.11.3.9 Aisles.** Aisles 4 feet (1219 mm) in width shall be maintained on three sides of the storage or display area.

**5003.11.3.10 Signs.** Hazard identification signs shall be provided in accordance with Section 5003.5.

**5003.11.3.11 Storage plan.** A storage plan illustrating the intended storage arrangement, including the loca-

tion and dimensions of aisles, and storage racks shall be provided.

**5003.12 Outdoor control areas.** *Outdoor control areas* for hazardous materials shall be in accordance with the following general requirements:

1. *Outdoor control areas* shall be kept free from weeds, debris and common combustible materials not necessary to the storage. The area surrounding an *outdoor control area* shall be kept clear of such materials for not less than 15 feet (4572 mm).
2. *Outdoor control areas* shall be located not closer than 20 feet (6096 mm) from a public street, public alley, *public way* or *lot line* that can be built on.

**Exceptions:**

1. For solid and liquid hazardous materials, a 2-hour *fire-resistance-rated* wall without openings extending not less than 30 inches (762 mm) above and to the sides of the storage area shall be allowed in lieu of such distance.
2. For *compressed gas* hazardous materials, unless otherwise specified, the minimum required distances shall not apply where *fire barriers* without openings or penetrations having a minimum *fire-resistance rating* of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the *fire barrier* shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.
3. Where a property exceeds 10,000 square feet (929 m<sup>2</sup>), a group of two *outdoor control areas* is allowed where *approved* and where each control area is separated by a minimum distance of 50 feet (15 240 mm).
4. Where a property exceeds 35,000 square feet (3252 m<sup>2</sup>), additional groups of *outdoor control areas* are allowed where *approved* and where each group is separated by a minimum distance of 300 feet (91 440 mm).

## SECTION 5004 STORAGE

**5004.1 Scope.** Storage of hazardous materials in amounts exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5004. Storage of hazardous materials in amounts not exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with Sections 5001 and 5003. Retail and wholesale storage and display of nonflammable solid and nonflammable and noncombustible liquid hazardous materials in Group M occupancies and Group S storage shall be in accordance with Section 5003.11.

**5004.2 Spill control and secondary containment for liquid and solid hazardous materials.** Rooms, buildings or areas used for the storage of liquid or solid hazardous materials shall be provided with spill control and secondary containment in accordance with Sections 5004.2.1 through 5004.2.3.

**Exception:** Outdoor storage of containers on *approved* containment pallets in accordance with Section 5004.2.3.

### 5004.2.1 Spill control for hazardous material liquids.

Rooms, buildings or areas used for the storage of hazardous material liquids in individual vessels having a capacity of more than 55 gallons (208 L), or in which the aggregate capacity of multiple vessels exceeds 1,000 gallons (3785 L), shall be provided with spill control to prevent the flow of liquids to adjoining areas. Floors in indoor locations and similar surfaces in outdoor locations shall be constructed to contain a spill from the largest single vessel by one of the following methods:

1. Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations.
2. Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid-tight raised or recessed sills or dikes.
3. Sumps and collection systems.
4. Other *approved* engineered systems.

Except for surfacing, the floors, sills, dikes, sumps and collection systems shall be constructed of noncombustible material, and the liquid-tight seal shall be compatible with the material stored. Where liquid-tight sills or dikes are provided, they are not required at perimeter openings having an open-grate trench across the opening that connects to an *approved* collection system.

### 5004.2.2 Secondary containment for hazardous material liquids and solids.

Where required by Table 5004.2.2, buildings, rooms or areas used for the storage of hazardous materials liquids or solids shall be provided with secondary containment in accordance with this section where the capacity of an individual vessel or the aggregate capacity of multiple vessels exceeds both of the following:

1. Liquids: Capacity of an individual vessel exceeds 55 gallons (208 L) or the aggregate capacity of multiple vessels exceeds 1,000 gallons (3785 L).
2. Solids: Capacity of an individual vessel exceeds 550 pounds (250 kg) or the aggregate capacity of multiple vessels exceeds 10,000 pounds (4540 kg).

**5004.2.2.1 Containment and drainage methods.** The building, room or area shall contain or drain the hazardous materials and fire protection water through the use of one of the following methods:

1. Liquid-tight sloped or recessed floors in indoor locations or similar areas in outdoor locations.
2. Liquid-tight floors in indoor locations or similar areas in outdoor locations provided with liquid-tight raised or recessed sills or dikes.



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**TABLE 5004.2.2**  
**REQUIRED SECONDARY CONTAINMENT—HAZARDOUS MATERIAL SOLIDS AND LIQUIDS STORAGE**

MATERIAL		INDOOR STORAGE		OUTDOOR STORAGE	
		Solids	Liquids	Solids	Liquids
1. Physical-hazard materials					
Combustible liquids	Class II	Not Applicable	See Chapter 57	Not Applicable	See Chapter 57
	Class IIIA		See Chapter 57		See Chapter 57
	Class IIIB		See Chapter 57		See Chapter 57
Cryogenic fluids			See Chapter 55		See Chapter 55
Explosives		See Chapter 56		See Chapter 56	
Flammable liquids	Class IA	Not Applicable	See Chapter 57	Not Applicable	See Chapter 57
	Class IB		See Chapter 57		See Chapter 57
	Class IC		See Chapter 57		See Chapter 57
Flammable solids		Not Required	Not Applicable	Not Required	Not Applicable
Organic peroxides	Unclassified Detonable	Required	Required	Not Required	Not Required
	Class I				
	Class II				
	Class III				
	Class IV				
	Class V	Not Required	Not Required	Not Required	Not Required
Oxidizers	Class 4	Required	Required	Not Required	Not Required
	Class 3				
	Class 2	Not Required	Not Required	Not Required	Not Required
	Class 1				
Pyrophorics		Not Required	Required	Not Required	Required
Unstable (reactives)	Class 4	Required	Required	Required	Required
	Class 3				
	Class 2				
	Class 1	Not Required	Not Required	Not Required	Not Required
Water reactives	Class 3	Required	Required	Required	Required
	Class 2				
	Class 1	Not Required	Not Required	Not Required	Not Required
2. Health-hazard materials					
Corrosives		Not Required	Required	Not Required	Required
Highly toxics		Required	Required	Required	Required
Toxics					

3. Sumps and collection systems.
4. Drainage systems leading to an *approved* location.
5. Other *approved* engineered systems.

**5004.2.2.2 Incompatible materials.** *Incompatible materials* used in *open systems* shall be separated from each other in the secondary containment system.

**5004.2.2.3 Indoor design.** Secondary containment for indoor storage areas shall be designed to contain a spill from the largest vessel plus the design flow volume of fire protection water calculated to discharge from the fire-extinguishing system over the minimum required

system design area or area of the room or area in which the storage is located, whichever is smaller. The containment capacity shall be designed to contain the flow for a period of 20 minutes.

**5004.2.2.4 Outdoor design.** Secondary containment for outdoor storage areas shall be designed to contain a spill from the largest individual vessel. If the area is open to rainfall, secondary containment shall be designed to include the volume of a 24-hour rainfall as determined by a 25-year storm and provisions shall be made to drain accumulations of groundwater and rainwater.

**5004.2.2.5 Monitoring.** An *approved* monitoring method shall be provided to detect hazardous materials in the secondary containment system. The monitoring method is allowed to be visual inspection of the primary or secondary containment, or other *approved* means. Where secondary containment is subject to the intrusion of water, a monitoring method for detecting water shall be provided. Where monitoring devices are provided, they shall be connected to *approved* visual or audible alarms.

**5004.2.2.6 Drainage system design.** Drainage systems shall be in accordance with the *International Plumbing Code* and all of the following:

1. The slope of floors to drains in indoor locations, or similar areas in outdoor locations shall be not less than 1 percent.
2. Drains from indoor storage areas shall be sized to carry the volume of the fire protection water as determined by the design density discharged from the automatic fire-extinguishing system over the minimum required system design area or area of the room or area in which the storage is located, whichever is smaller.
3. Drains from outdoor storage areas shall be sized to carry the volume of the fire flow and the volume of a 24-hour rainfall as determined by a 25-year storm.
4. Materials of construction for drainage systems shall be compatible with the materials stored.
5. *Incompatible materials* used in *open systems* shall be separated from each other in the drainage system.
6. Drains shall terminate in an *approved* location away from buildings, valves, *means of egress*, fire access roadways, adjoining property and storm drains.

**5004.2.3 Containment pallets.** Where used as an alternative to spill control and secondary containment for outdoor storage in accordance with the exception in Section 5004.2, containment pallets shall comply with all of the following:

1. A liquid-tight sump with access for visual inspection shall be provided.
2. The sump shall be designed to contain not less than 66 gallons (250 L).
3. Exposed surfaces shall be compatible with material stored.
4. Containment pallets shall be protected to prevent collection of rainwater within the sump.

**5004.3 Ventilation.** Indoor storage areas and storage buildings shall be provided with mechanical exhaust ventilation or natural ventilation where natural ventilation can be shown to be acceptable for the materials as stored.

#### Exceptions:

1. Storage areas for flammable solids complying with Chapter 59.

2. Storage areas for medical gases complying with Chapter 53.

**5004.3.1 System requirements.** Exhaust ventilation systems shall comply with all of the following:

1. Installation shall be in accordance with the *International Mechanical Code*.
2. Mechanical ventilation shall be at a rate of not less than 1 cubic foot per minute per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of floor area over the storage area.
3. Systems shall operate continuously unless alternative designs are *approved*.
4. A manual shutoff control shall be provided outside of the room in a position adjacent to the access door to the room or in an *approved* location. The switch shall be a break-glass or other *approved* type and shall be labeled: "VENTILATION SYSTEM EMERGENCY SHUTOFF."
5. Exhaust ventilation shall be designed to consider the density of the potential fumes or vapors released. For fumes or vapors that are heavier than air, exhaust shall be taken from a point within 12 inches (305 mm) of the floor. For fumes or vapors that are lighter than air, exhaust shall be taken from a point within 12 inches (305 mm) of the highest point of the room.
6. The location of both the exhaust and inlet air openings shall be designed to provide air movement across all portions of the floor or room to prevent the accumulation of vapors.
7. Exhaust air shall not be recirculated to occupied areas if the materials stored are capable of emitting hazardous vapors and contaminants have not been removed. Air contaminated with explosive or flammable vapors, fumes or dusts; flammable, highly toxic or toxic gases; or radioactive materials shall not be recirculated.

**5004.4 Separation of incompatible hazardous materials.** *Incompatible materials* shall be separated in accordance with Section 5003.9.8.

**5004.5 Automatic sprinkler systems.** Indoor storage areas and storage buildings shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. The design of the sprinkler system shall be not less than that required for Ordinary Hazard Group 2 with a minimum design area of 3,000 square feet (279  $\text{m}^2$ ). Where the materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

**5004.6 Explosion control.** Indoor storage rooms, areas and buildings shall be provided with explosion control in accordance with Section 911.

**5004.7 Standby or emergency power.** Where mechanical ventilation, treatment systems, temperature control, alarm, detection or other electrically operated systems are required,

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

such systems shall be provided with an emergency or standby power in accordance with Section 1203.

For storage areas for highly toxic or toxic materials, see Sections 6004.2.2.8 and 6004.3.4.2.

**5004.7.1 Exempt applications.** Standby or emergency power is not required for mechanical ventilation systems for any of the following:

1. Storage of Class IB and IC *flammable liquids* and Class II and III *combustible liquids* in closed containers not exceeding a capacity of 6½ gallons (25 L).
2. Storage of Class 1 and 2 oxidizers.
3. Storage of Class II, III, IV and V organic peroxides.
4. Storage of asphyxiant, irritant and radioactive gases.

**5004.7.2 Fail-safe engineered systems.** Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an *approved* fail-safe engineered system is installed.

**5004.8 Limit controls.** Limit controls shall be provided in accordance with Sections 5004.8.1 and 5004.8.2.

**5004.8.1 Temperature control.** Materials that must be kept at temperatures other than normal ambient temperatures to prevent a hazardous reaction shall be provided with an *approved* means to maintain the temperature within a safe range. Redundant temperature control equipment that will operate on failure of the primary temperature control system shall be provided. Where *approved*, alternative means that prevent a hazardous reaction are allowed.

**5004.8.2 Pressure control.** Stationary tanks and equipment containing hazardous material liquids that can generate pressures exceeding design limits because of exposure fires or internal reaction shall have some form of construction or other *approved* means that will relieve excessive internal pressure. The means of pressure relief shall vent to an *approved* location or to an exhaust scrubber or treatment system where required by Chapter 60.

**5004.9 Emergency alarm.** An *approved* manual emergency alarm system shall be provided in buildings, rooms or areas used for storage of hazardous materials. Emergency alarm-initiating devices shall be installed outside of each interior *exit* or *exit access* door of storage buildings, rooms or areas. Activation of an emergency alarm-initiating device shall sound a local alarm to alert occupants of an emergency situation involving hazardous materials.

**5004.10 Supervision and monitoring.** Emergency alarm, detection and automatic fire-extinguishing systems required by Section 5004 shall be electrically supervised and monitored by an *approved* supervising station or, where *approved*, shall initiate an audible and visual signal at a constantly attended on-site location.

**5004.11 Clearance from combustibles.** The area surrounding an outdoor storage area or tank shall be kept clear of

combustible materials and vegetation for a minimum distance of 25 feet (7620 mm).

**5004.12 Noncombustible floor.** Except for surfacing, floors of storage areas shall be of noncombustible construction.

**5004.13 Weather protection.** Where overhead noncombustible construction is provided for sheltering outdoor hazardous material storage areas, such storage shall not be considered indoor storage where the area is constructed in accordance with the requirements for weather protection as required by the *International Building Code*.

**Exception:** Storage of *explosive* materials shall be considered as indoor storage.

**5004.14 Outdoor storage location.** Outdoor storage areas for hazardous materials shall be located as required by Section 5003.12 except where material-specific requirements, including requirements in referenced standards, are provided in other chapters of this code.

## SECTION 5005 USE, DISPENSING AND HANDLING

**5005.1 General.** Use, dispensing and handling of hazardous materials in amounts exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5005. Use, dispensing and handling of hazardous materials in amounts not exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be in accordance with Sections 5001 and 5003.

**5005.1.1 Separation of incompatible materials.** Separation of *incompatible materials* shall be in accordance with Section 5003.9.8.

**5005.1.2 Noncombustible floor.** Except for surfacing, floors of areas where liquid or solid hazardous materials are dispensed or used in *open systems* shall be of noncombustible, liquid-tight construction.

**5005.1.3 Spill control and secondary containment for hazardous material liquids.** Where required by other provisions of Section 5005, spill control and secondary containment shall be provided for hazardous material liquids in accordance with Section 5004.2.

**5005.1.4 Limit controls.** Limit controls shall be provided in accordance with Sections 5005.1.4.1 through 5005.1.4.4.

**5005.1.4.1 High-liquid-level control.** Open tanks in which liquid hazardous materials are used shall be equipped with a liquid-level limit control or other means to prevent overfilling of the tank.

**5005.1.4.2 Low-liquid-level control.** *Approved* safeguards shall be provided to prevent a low-liquid level in a tank from creating a hazardous condition, including but not limited to, overheating of a tank or its contents.

**5005.1.4.3 Temperature control.** Temperature control shall be provided in accordance with Section 5004.8.1.

**5005.1.4.4 Pressure control.** Pressure control shall be provided in accordance with Section 5004.8.2.

**5005.1.5 Standby or emergency power.** Where mechanical ventilation, treatment systems, temperature control, manual alarm, detection or other electrically operated systems are required by this code, such systems shall be provided with emergency or standby power in accordance with Section 1203.

**5005.1.5.1 Exempt applications.** Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an *approved* fail-safe engineered system is installed.

**5005.1.6 Supervision and monitoring.** Manual alarm, detection and automatic fire-extinguishing systems required by other provisions of Section 5005 shall be electrically supervised and monitored by an *approved* supervisory service or, where *approved*, shall initiate an audible and visual signal at a constantly attended on-site location.

**5005.1.7 Lighting.** Adequate lighting by natural or artificial means shall be provided.

**5005.1.8 Fire protection systems.** Indoor rooms or areas in which hazardous materials are dispensed or used shall be protected by an *automatic sprinkler system* or automatic fire-extinguishing system in accordance with Chapter 9. Sprinkler system design shall be not less than that required for Ordinary Hazard, Group 2, with a minimum design area of 3,000 square feet (279 m<sup>2</sup>). Where the materials or storage arrangement are required by other regulations to be provided with a higher level of sprinkler system protection, the higher level of sprinkler system protection shall be provided.

**5005.1.9 Ventilation.** Indoor dispensing and use areas shall be provided with exhaust ventilation in accordance with Section 5004.3.

**Exception:** Ventilation is not required for dispensing and use of flammable solids other than finely divided particles.

**5005.1.10 Liquid transfer.** Liquids having a hazard ranking of 3 or 4 in accordance with NFPA 704 shall be transferred by one of the following methods:

1. From safety cans complying with UL 30.
2. Through an *approved* closed piping system.
3. From containers or tanks by an *approved* pump taking suction through an opening in the top of the container or tank.
4. From containers or tanks by gravity through an *approved* self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment in accordance with Section 5004.2. Highly toxic liquids shall not be dispensed by gravity from tanks.

5. *Approved* engineered liquid transfer systems.

**Exceptions:**

1. Liquids having a hazard ranking of 4 where dispensed from *approved* containers not exceeding 1.3 gallons (5 L).
2. Liquids having a hazard ranking of 3 where dispensed from *approved* containers not exceeding 5.3 gallons (20 L).

**5005.1.11 Design.** Systems shall be suitable for the use intended and shall be designed by persons competent in such design. Controls shall be designed to prevent materials from entering or leaving the process or reaction system at other than the intended time, rate or path. Where failure of an automatic control could result in a dangerous condition or reaction, the automatic control shall be fail-safe.

**5005.1.12 Emergency isolation.** Where gases or liquids having a hazard ranking of Health Class 3 or 4, Flammability Class 4 or Instability Class 3 or 4 in accordance with NFPA 704 are carried in pressurized piping above 15 pounds per square inch gauge (psig) (103 kPa), an *approved* means of leak detection and emergency shutoff or excess flow control shall be provided. Where the piping originates from within a hazardous material storage room or area, the excess flow control shall be located within the storage room or area. Where the piping originates from a bulk source, the excess flow control shall be located as close to the bulk source as practical.

**Exceptions:**

1. Piping for inlet connections designed to prevent backflow.
2. Piping for pressure relief devices.

**5005.2 Indoor dispensing and use.** Indoor dispensing and use of hazardous materials shall be in buildings complying with the *International Building Code* and in accordance with Section 5005.1 and Sections 5005.2.1 through 5005.2.2.4.

**5005.2.1 Open systems.** Dispensing and use of hazardous materials in open containers or systems shall be in accordance with Sections 5005.2.1.1 through 5005.2.1.4.

**5005.2.1.1 Ventilation.** Where gases, liquids or solids having a hazard ranking of 3 or 4 in accordance with NFPA 704 are dispensed or used, mechanical exhaust ventilation shall be provided to capture gases, fumes, mists or vapors at the point of generation.

**Exception:** Gases, liquids or solids that can be demonstrated not to create harmful gases, fumes, mists or vapors.

**5005.2.1.2 Explosion control.** Explosion control shall be provided in accordance with Section 5004.6 where an explosive environment can occur because of the characteristics or nature of the hazardous materials dispensed or used, or as a result of the dispensing or use process.



## HAZARDOUS MATERIALS—GENERAL PROVISIONS

**5005.2.1.3 Spill control for hazardous material liquids.** Buildings, rooms or areas where hazardous material liquids are dispensed into vessels exceeding a 1.3-gallon (5 L) capacity or used in *open systems* exceeding a 5.3-gallon (20 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

**5005.2.1.4 Secondary containment for hazardous material liquids.** Where required by Table 5005.2.1.4, buildings, rooms or areas where hazardous material liquids are dispensed or used in *open systems* shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an indi-

vidual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 1.3 gallons (5 L).
2. Multiple vessels or systems: greater than 5.3 gallons (20 L).

**5005.2.2 Closed systems.** Use of hazardous materials in closed containers or systems shall be in accordance with Sections 5005.2.2.1 through 5005.2.2.4.

**5005.2.2.1 Ventilation.** Where *closed systems* are designed to be opened as part of normal operations, ventilation shall be provided in accordance with Section 5005.2.1.1.

**TABLE 5005.2.1.4  
REQUIRED SECONDARY CONTAINMENT—HAZARDOUS MATERIAL LIQUIDS USE**

MATERIAL	INDOOR LIQUIDS USE	OUTDOOR LIQUIDS USE	
1. Physical-hazard materials			
Combustible liquids	Class II	See Chapter 57	See Chapter 57
	Class IIIA	See Chapter 57	See Chapter 57
	Class IIIB	See Chapter 57	See Chapter 57
Cryogenic fluids		See Chapter 55	See Chapter 55
Explosives		See Chapter 56	See Chapter 56
Flammable liquids	Class IA	See Chapter 57	See Chapter 57
	Class IB	See Chapter 57	See Chapter 57
	Class IC	See Chapter 57	See Chapter 57
Flammable solids		Not Applicable	Not Applicable
Organic peroxides	Unclassified Detonable	Required	Required
	Class I	Required	Required
	Class II		
	Class III		
	Class IV		
	Class V	Not Required	Not Required
Oxidizers	Class 4	Required	Required
	Class 3		
	Class 2		
	Class 1		
Pyrophorics		Required	Required
Unstable (reactives)	Class 4	Required	Required
	Class 3		
	Class 2		
	Class 1	Not Required	Required
Water reactives	Class 3	Required	Required
	Class 2		
	Class 1	Not Required	Required
2. Health-hazard materials			
Corrosives		Required	Required
Highly toxics			
Toxics			

**5005.2.2.2 Explosion control.** Explosion control shall be provided in accordance with Section 5004.6 where an explosive environment exists because of the hazardous materials dispensed or used, or as a result of the dispensing or use process.

**Exception:** Where process vessels are designed to contain fully the worst-case explosion anticipated within the vessel under process conditions based on the most likely failure.

**5005.2.2.3 Spill control for hazardous material liquids.** Buildings, rooms or areas where hazardous material liquids are used in individual vessels exceeding a 55-gallon (208 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

**5005.2.2.4 Secondary containment for hazardous material liquids.** Where required by Table 5005.2.1.4, buildings, rooms or areas where hazardous material liquids are used in vessels or systems shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 55 gallons (208 L).
2. Multiple vessels or systems: greater than 1,000 gallons (3785 L).

**5005.3 Outdoor dispensing and use.** Dispensing and use of hazardous materials outdoors shall be in accordance with Sections 5005.3.1 through 5005.3.9.

**5005.3.1 Quantities exceeding the maximum allowable quantity per control area.** Outdoor dispensing or use of hazardous materials, in either closed or open containers or systems, in amounts exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001, 5003, 5005.1 and 5005.3.

**5005.3.2 Quantities not exceeding the maximum allowable quantity per control area.** Outdoor dispensing or use of hazardous materials, in either closed or open containers or systems, in amounts not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

**5005.3.3 Outdoor location.** Outdoor dispensing and use areas for hazardous materials shall be located as required by Section 5003.12 except where material-specific requirements, including requirements in referenced standards, are provided in other chapters of this code.

**5005.3.4 Spill control for hazardous material liquids in open systems.** Outdoor areas where hazardous material liquids are dispensed in vessels exceeding a 1.3-gallon (5 L) capacity or used in *open systems* exceeding a 5.3-gallon (20 L) capacity shall be provided with spill control in accordance with Section 5004.2.1.

**5005.3.5 Secondary containment for hazardous material liquids in open systems.** Where required by Table

5005.2.1.4, outdoor areas where hazardous material liquids are dispensed or used in *open systems* shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 1.3 gallons (5 L).
2. Multiple vessels or systems: greater than 5.3 gallons (20 L).

**5005.3.6 Spill control for hazardous material liquids in closed systems.** Outdoor areas where hazardous material liquids are used in *closed systems* exceeding 55 gallons (208 L) shall be provided with spill control in accordance with Section 5004.2.1.

**5005.3.7 Secondary containment for hazardous material liquids in closed systems.** Where required by Table 5005.2.1.4, outdoor areas where hazardous material liquids are dispensed or used in *closed systems* shall be provided with secondary containment in accordance with Section 5004.2.2 where the capacity of an individual vessel or system or the capacity of multiple vessels or systems exceeds the following:

1. Individual vessel or system: greater than 55 gallons (208 L).
2. Multiple vessels or systems: greater than 1,000 gallons (3785 L).

**5005.3.8 Clearance from combustibles.** The area surrounding an outdoor dispensing or use area shall be kept clear of combustible materials and vegetation for a minimum distance of 30 feet (9144 mm).

**5005.3.9 Weather protection.** Where overhead noncombustible construction is provided for sheltering outdoor hazardous material use areas, such use shall not be considered indoor use where the area is constructed in accordance with the requirements for weather protection as required in the *International Building Code*.

**Exception:** Use of *explosive materials* shall be considered as indoor use.

**5005.4 Handling.** Handling of hazardous materials shall be in accordance with Sections 5005.4.1 through 5005.4.4.

**5005.4.1 Quantities exceeding the maximum allowable quantity per control area.** Handling of hazardous materials in indoor and outdoor locations in amounts exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) through 5003.1.1(4) shall be in accordance with Sections 5001, 5003, 5005.1 and 5005.4.

**5005.4.2 Quantities not exceeding the maximum allowable quantity per control area.** Handling of hazardous materials in indoor locations in amounts not exceeding the *maximum allowable quantity per control area* indicated in Tables 5003.1.1(1) and 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 5005.1. Handling of hazardous materials in outdoor locations in amounts not exceeding the *maximum allowable*

## HAZARDOUS MATERIALS—GENERAL PROVISIONS

*quantity per control area* indicated in Tables 5003.1.1(3) and 5003.1.1(4) shall be in accordance with Sections 5001 and 5003.

**5005.4.3 Outdoor location.** Outdoor handling areas for hazardous materials shall be located as required by Section 5003.12 except where material-specific requirements, including requirements in referenced standards, are provided in other chapters of this code.

**5005.4.4 Dispensing, use and handling.** Where hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 are transported through *corridors*, interior *exit stairways* or *ramps* or *exit passageways*, there shall be an emergency telephone system, a local manual alarm station or an *approved* alarm-initiating device at not more than 150-foot (45 720 mm) intervals and at each *exit* and *exit access* doorway throughout the transport route. The signal shall be relayed to an *approved* central, proprietary or remote station service or constantly attended on-site location and shall initiate a local audible alarm.

# CHAPTER 51

## AEROSOLS

### User note:

**About this chapter:** Chapter 51 provides requirements for the prevention, control and extinguishment of fires and explosions in facilities where retail aerosol products are displayed or stored. It is concerned with both life safety and property protection from a fire; however, historically, aerosol product fires have caused property loss more frequently than loss of life. Requirements for storing aerosol products are dependent on the level of aerosol product, level of sprinkler protection, type of storage condition and quantity of aerosol products.

### SECTION 5101 GENERAL

**5101.1 Scope.** The provisions of this chapter, the *International Building Code* and NFPA 30B shall apply to the manufacturing, storage and display of aerosol products, aerosol cooking spray products and plastic aerosol 3 products. Manufacturing of aerosol products, aerosol cooking spray products and plastic aerosol 3 products using hazardous materials shall also comply with Chapter 50.

**5101.2 Permit required.** Permits shall be required as set forth in Section 105.5.

**5101.3 Safety Data Sheets.** Safety Data Sheet (SDS) information for aerosol products displayed shall be kept on the premises at an *approved* location.

**5101.4 Containers.** Metal aerosol containers shall be limited to a maximum size of 33.8 fluid ounces (1000 ml). Plastic aerosol containers shall be limited to a maximum of 4 fluid ounces (118 ml) except as provided in Sections 5104.1.1 and 5104.1.2. Glass aerosol containers shall be limited to a maximum of 4 fluid ounces (118 ml).

### SECTION 5102 DEFINITIONS

**5102.1 Definitions.** The following terms are defined in Chapter 2:

**AEROSOL CONTAINER.**

**AEROSOL PRODUCT.**

Level 1 aerosol products.

Level 2 aerosol products.

Level 3 aerosol products.

**AEROSOL PRODUCT WAREHOUSE.**

**PROPELLANT.**

**RETAIL DISPLAY AREA.**

### SECTION 5103 CLASSIFICATION OF AEROSOL PRODUCTS

**5103.1 Classification levels.** Aerosol products shall be classified as Level 1, 2 or 3 in accordance with Table 5103.1 and NFPA 30B. Aerosol products in cartons that are not identi-

fied in accordance with this section shall be classified as Level 3.

**TABLE 5103.1  
CLASSIFICATION OF AEROSOL PRODUCTS**

CHEMICAL HEAT OF COMBUSTION		AEROSOL CLASSIFICATION
Greater than (Btu/lb)	Less than or equal to (Btu/lb)	
0	8,600	1
8,600	13,000	2
13,000	—	3

For SI: 1 British thermal unit per pound = 0.002326 kJ/g.

**5103.2 Identification.** Cartons or outer packaging shall be identified on not fewer than one exterior side with the classification level of the aerosol products contained within the carton.

**5103.2.1 Aerosol products.** Cartons or outer packaging containing aerosol products in metal containers or glass and plastic containers 4 fluid ounces. (118 ml) or less shall be clearly marked as follows:

LEVEL \_\_\_\_\_ AEROSOLS

**5103.2.2 Aerosol cooking spray products.** Cartons or outer packaging containing aerosol cooking spray products in metal containers shall be clearly marked as follows:

AEROSOL COOKING SPRAY

**5103.2.3 Plastic aerosol products.** Cartons or outer packaging containing aerosol products in plastic containers greater than 4 fluid ounces (118 ml) shall be clearly marked as follows:

PLASTIC AEROSOL 1, 3 or X

### SECTION 5104 INSIDE STORAGE OF AEROSOL PRODUCTS

**5104.1 General.** The inside storage of Level 2 and 3 aerosol products shall comply with Sections 5104.2 through 5104.8 and NFPA 30B. Level 1 aerosol products and those aerosol products covered by Section 5104.1.1 shall be considered to be equivalent to a Class III commodity and shall comply with the requirements for palletized or rack storage in NFPA 13.



## AEROSOLS

**5104.1.1 Plastic aerosol products.** Aerosol products in plastic containers larger than 4 fluid ounces (118 ml), but not to exceed 33.8 fluid ounces (1000 ml), shall be allowed only where in accordance with this section. The commodity classification shall be Class III commodities, as defined in NFPA 13 where any of the following conditions are met:

1. Base product does not have a fire point where tested in accordance with ASTM D92, and nonflammable propellant.
2. Base product does not sustain combustion as tested in accordance with DOTn 49 CFR Part 173, Appendix H, and nonflammable propellant.
3. Base product contains up to 20 percent by volume (15.8 percent by weight) of ethanol, isopropyl alcohol or a combination thereof in an aqueous mix, and nonflammable propellant.
4. Base product contains 4 percent by weight or less of an emulsified flammable liquefied gas propellant within an aqueous base. The propellant shall remain emulsified for the life of the product. Where such propellant is not permanently emulsified, the propellant shall be nonflammable.

**5104.1.2 Plastic aerosol 3 products.** Plastic aerosol 3 products shall be defined as those that meet one of the following criteria:

1. Base product does not have a fire point where tested in accordance with ASTM D92, and there is not more than 10 percent by weight flammable propellant.
2. Base product does not sustain combustion as tested in accordance with DOTn 49 CFR 173, Appendix H, and there is not more than 10 percent by weight flammable propellant.
3. Base product contains 50 percent by volume or less of flammable or combustible water-miscible alcohols in an aqueous mix, and there is not more than 10 percent by weight of flammable propellant.

**5104.1.3 Plastic aerosol X products.** Plastic aerosol X products are those products, in containers larger than 4 fluid ounces (118 ml), that do not meet the criteria provided in Section 5104.1.1 or 5104.1.2.

**5104.1.3.1 Storage, use or handling.** The storage, use or handling of plastic aerosol X products shall be prohibited.

**5104.2 Storage in Groups A, B, E, F, I and R.** Storage of Level 2 and 3 aerosol products in occupancies in Groups A, B, E, F, I and R shall be limited to the following maximum quantities:

1. A net weight of 1,000 pounds (454 kg) of Level 2 aerosol products.

2. A net weight of 500 pounds (227 kg) of Level 3 aerosol products.
3. A combined net weight of 1,000 pounds (454 kg) of Level 2 and 3 aerosol products.

The maximum quantity shall be increased 100 percent where the excess quantity is stored in storage cabinets in accordance with Section 5704.3.2.

**5104.2.1 Excess storage.** Storage of quantities exceeding the maximum quantities indicated in Section 5104.2 shall be stored in separate inside *flammable liquid* storage rooms in accordance with Section 5104.5.

**5104.2.2 Aerosol cooking spray products.** Storage of aerosol cooking spray products in Group A, B, E, F, I and R occupancies shall not be more than 1,000 pounds (454 kg) net weight.

**5104.3 Storage in general purpose warehouses.** Aerosol product storage in general purpose warehouses utilized only for warehousing-type operations involving mixed commodities shall comply with Section 5104.3.1, 5104.3.2, or 5104.3.3.

**5104.3.1 Nonsegregated storage.** Storage consisting of solid pile, palletized or rack storage of Level 2 and 3 aerosol products not segregated into areas utilized exclusively for the storage of aerosol products shall comply with Table 5104.3.1.

**TABLE 5104.3.1  
NONSEGREGATED STORAGE OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS IN GENERAL PURPOSE WAREHOUSES<sup>a</sup>**

AEROSOL LEVEL	MAXIMUM NET WEIGHT PER FLOOR (pounds) <sup>b</sup>			
	Palletized or solid-pile storage		Rack storage	
	Unprotected	Protected <sup>a</sup>	Unprotected	Protected <sup>a</sup>
2	2,500	12,000	2,500	24,000
3	1,000	12,000	1,000	24,000
Combination 2 and 3	2,500	12,000	2,500	24,000

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Approved automatic sprinkler system protection and storage arrangements shall comply with NFPA 30B. Sprinkler system protection shall extend 20 feet beyond the storage area containing the aerosol products.
- b. Storage quantities indicated are the maximum permitted in any 50,000-square-foot area.

**5104.3.2 Segregated storage.** Storage of Level 2 and 3 aerosol products segregated into areas utilized exclusively for the storage of aerosol products shall comply with Table 5104.3.2 and Sections 5104.3.2.1 and 5104.3.2.2.

**TABLE 5104.3.2  
SEGREGATED STORAGE OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS AND PLASTIC AEROSOL 3 PRODUCTS IN  
GENERAL PURPOSE WAREHOUSES**

STORAGE SEPARATION	MAXIMUM SEGREGATED STORAGE AREA <sup>a</sup>		SPRINKLER REQUIREMENTS
	Percentage of building area (percent)	Area limitation (square feet)	
Separation area <sup>c, f</sup>	15	20,000	Notes b, c
Chain-link fence enclosure <sup>d</sup>	20	20,000	Notes b, c
1-hour fire-resistance-rated interior walls	20	30,000	Note b
2-hour fire-resistance-rated interior walls	25	40,000	Note b
3-hour fire-resistance-rated interior walls	30	50,000	Note b

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- The maximum segregated storage area shall be limited to the smaller of the two areas resulting from the percentage of building area limitation and the area limitation.
- Automatic sprinkler system protection in aerosol product storage areas shall comply with NFPA 30B and be approved. Building areas not containing aerosol product storage shall be equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.
- Automatic sprinkler system protection in aerosol product storage areas shall comply with NFPA 30B and be approved. Sprinkler system protection shall extend a minimum 20 feet beyond the aerosol storage area.
- Chain-link fence enclosures shall comply with Section 5104.3.2.1.
- A separation area shall be defined as an area extending outward from the periphery of the segregated aerosol product storage area as follows:
  - The limits of the aerosol product storage shall be clearly marked on the floor.
  - The separation distance shall be not less than 25 feet and maintained clear of all materials with a commodity classification greater than Class III in accordance with Section 903.3.1.1.
- Separation areas shall only be permitted where approved.

**5104.3.2.1 Chain-link fence enclosures.** Chain-link fence enclosures required by Table 5104.3.2 shall comply with the following:

- The fence shall be not less than No. 9 gage steel wire, woven into a maximum 2-inch (51 mm) diamond mesh.
- The fence shall be installed from the floor to the underside of the roof or ceiling above.
- Class IV and high-hazard commodities shall be stored outside of the aerosol storage area and not less than 8 feet (2438 mm) from the fence.
- Access openings in the fence shall be provided with either self- or automatic-closing devices or a labyrinth opening arrangement preventing aerosol containers from rocketing through the access openings.
- Not less than two *means of egress* shall be provided from the fenced enclosure.

**5104.3.2.2 Aisles.** The minimum aisle requirements for segregated storage in general purpose warehouses shall comply with Table 5104.3.2.2.

**TABLE 5104.3.2.2  
SEGREGATED STORAGE AISLE WIDTHS AND DISTANCE TO  
AISLES IN GENERAL PURPOSE WAREHOUSES**

STORAGE CONDITION	MINIMUM AISLE WIDTH (feet)	MAXIMUM DISTANCE FROM STORAGE TO AISLE (feet)
Solid pile or palletized <sup>a</sup>	4 feet between piles	25
Racks with ESFR sprinklers <sup>a</sup>	4 feet between racks and adjacent Level 2 and 3 aerosol product storage	25
Racks without ESFR sprinklers <sup>a</sup>	8 feet between racks and adjacent Level 2 and 3 aerosol product storage	25

For SI: 1 foot = 304.8 mm.

- Sprinklers shall comply with NFPA 30B.

**5104.3.3 Aerosol cooking spray products.** Solid pile, palletized or rack storage of aerosol cooking spray products in a general purpose warehouse shall not be more than 2,500 pounds (1135 kg) net weight, unless protected in accordance with NFPA 30B.

**5104.4 Storage in aerosol product warehouses.** The total quantity of Level 2 and 3 aerosol products in a warehouse utilized for the storage, shipping and receiving of aerosol products shall not be restricted in structures complying with Sections 5104.4.1 through 5104.4.4.

**5104.4.1 Automatic sprinkler system.** Aerosol product warehouses shall be protected by an *approved* wet-pipe *automatic sprinkler system* in accordance with NFPA 30B. Sprinkler protection shall be designed based on the highest classification level of aerosol product present.

**5104.4.2 Pile and palletized storage aisles.** Solid pile and palletized storage shall be arranged so the maximum travel distance to an aisle is 25 feet (7620 mm). Aisles shall have a minimum width of 4 feet (1219 mm).

**5104.4.3 Rack storage aisles.** Rack storage shall be arranged with a minimum aisle width of 8 feet (2438 mm) between rows of racks and 8 feet (2438 mm) between racks and adjacent solid pile or palletized storage. Where early suppression fast-response (ESFR) sprinklers provide automatic sprinkler protection, the minimum aisle width shall be 4 feet (1219 mm).

**5104.4.4 Combustible commodities.** Combustible commodities other than *flammable* and *combustible liquids* shall be permitted to be stored in an aerosol product warehouse.

**Exception:** *Flammable* and *combustible liquids* in 1-quart (946 ml) metal containers and smaller shall be permitted to be stored in an aerosol product warehouse.

**5104.5 Storage in inside flammable liquid storage rooms.** Inside *flammable liquid* storage rooms shall comply with

## AEROSOLS

Section 5704.3.7. The maximum quantities of aerosol products shall comply with Section 5104.5.1 or 5104.5.2.

**5104.5.1 Storage rooms of 500 square feet or less.** The storage of aerosol products in *flammable liquid* storage rooms less than or equal to 500 square feet (46 m<sup>2</sup>) in area shall not exceed the following quantities:

1. A net weight of 1,000 pounds (454 kg) of Level 2 aerosol products.
2. A net weight of 500 pounds (227 kg) of Level 3 aerosol products.
3. A combined net weight of 1,000 pounds (454 kg) of Level 2 and 3 aerosol products.

**5104.5.2 Storage rooms greater than 500 square feet.** The storage of aerosol products in *flammable liquid* storage rooms greater than 500 square feet (46 m<sup>2</sup>) in area shall not exceed the following quantities:

1. A net weight of 2,500 pounds (1135 kg) of Level 2 aerosol products.
2. A net weight of 1,000 pounds (454 kg) of Level 3 aerosol products.
3. A combined net weight of 2,500 pounds (1135 kg) of Level 2 and 3 aerosol products.

The maximum aggregate storage quantity of Level 2 and 3 aerosol products permitted in separate inside storage rooms protected by an *approved automatic sprinkler system* in accordance with NFPA 30B shall be 5,000 pounds (2270 kg).

**5104.6 Storage in liquid warehouses.** The storage of Level 2 and 3 aerosol products in liquid warehouses shall comply with NFPA 30B. The storage shall be located within segregated storage areas in accordance with Section 5104.3.2 and Sections 5104.6.1 through 5104.6.3.

**5104.6.1 Containment.** Spill control or drainage shall be provided to prevent the flow of liquid to within 8 feet (2438 mm) of the segregated storage area.

**5104.6.2 Sprinkler design.** Sprinkler protection shall be designed based on the highest level of aerosol product present.

**5104.6.3 Opening protection into segregated storage areas.** Fire doors or gates opening into the segregated storage area shall either be self-closing or provided with automatic-closing devices activated by sprinkler water flow or an *approved* fire detection system.

**5104.7 Storage in Group M occupancies.** Storage of Level 2 and 3 aerosol products, aerosol cooking spray products and plastic aerosol 3 products in occupancies in Group M shall comply with Table 5104.7. Retail display shall comply with Section 5106.

**TABLE 5104.7  
MAXIMUM QUANTITIES OF LEVEL 2 AND 3 AEROSOL PRODUCTS, AEROSOL COOKING SPRAY PRODUCTS AND PLASTIC AEROSOL 3 PRODUCTS IN RETAIL STORAGE AREAS**

MAXIMUM NET WEIGHT PER FLOOR (pounds)			
Floor	Nonsegregated storage <sup>a, b</sup>	Segregated storage	
		Storage cabinets <sup>b</sup>	Separated from retail area <sup>c</sup>
Basement	Not Permitted	Not Permitted	Not Permitted
Ground	2,500	5,000	Note d
Upper	500	1,000	Note d

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

- a. The total aggregate quantity on display and in storage shall not exceed the maximum retail display quantity indicated in Section 5106.3.
- b. Storage quantities indicated are the maximum permitted in any 50,000-square-foot area.
- c. The storage area shall be separated from the retail area with a 1-hour fire-resistance-rated assembly.
- d. See Table 5104.3.2.

**5104.8 Storage of aerosol cooking spray products.** *Aerosol cooking spray products* shall be permitted to be stored in a general purpose warehouse.

**5104.8.1 Mixed storage.** Where *aerosol cooking spray products* are mixed with other higher-hazard aerosol products, the provided isolation, storage height restrictions and protection shall be based on the highest-hazard aerosol product present.

**5104.8.2 Storage conditions.** The storage and handling of *aerosol cooking spray products* shall comply with this chapter and NFPA 30B.

## SECTION 5105 OUTSIDE STORAGE

**5105.1 General.** The outside storage of Level 2 and 3 aerosol products and plastic aerosol 3 products, including storage in temporary storage trailers, shall be separated from exposures in accordance with Table 5105.1.

**TABLE 5105.1  
DISTANCE TO EXPOSURES FOR OUTSIDE STORAGE OF LEVEL 2 AND 3 AEROSOL PRODUCTS AND PLASTIC AEROSOL 3 PRODUCTS**

EXPOSURE	MINIMUM DISTANCE FROM AEROSOL STORAGE (feet) <sup>a</sup>
Buildings	50
Exit discharge to a public way	50
Lot lines	20
Other outside storage	50
Public alleys, public ways, public streets	20

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. The minimum separation distance indicated is not required where exterior walls having a 2-hour fire-resistance rating without penetrations separate the storage from the exposure. The walls shall extend not less than 30 inches above and to the sides of Level 2 and 3 aerosol products and plastic aerosol 3 products.

## SECTION 5106 RETAIL DISPLAY

**5106.1 General.** This section shall apply to the retail display of 500 pounds (227 kg) or more of Level 2 and 3 aerosol products, aerosol cooking spray products and plastic aerosol 3 products.

**5106.2 Aerosol display and normal merchandising not exceeding 8 feet in height.** Aerosol display and normal merchandising not exceeding 8 feet (2438 mm) in height shall be in accordance with Sections 5106.2.1 through 5106.2.5.

**5106.2.1 Maximum quantities in retail display areas.** Aerosol products, aerosol cooking spray products and plastic aerosol 3 products in retail display areas shall not exceed quantities needed for display and normal merchandising and shall not exceed the quantities in Table 5106.2.1.

**TABLE 5106.2.1  
MAXIMUM QUANTITIES OF LEVEL 2 AND 3 AEROSOL  
PRODUCTS, AEROSOL COOKING SPRAY PRODUCTS AND  
PLASTIC AEROSOL 3 PRODUCTS IN RETAIL DISPLAY AREAS**

MAXIMUM NET WEIGHT PER FLOOR (pounds) <sup>b</sup>			
Floor	Unprotected <sup>a</sup>	Protected in accordance with Section 5106.2 <sup>a, c</sup>	Protected in accordance with Section 5106.3 <sup>c</sup>
Basement	Not Allowed	500	500
Ground	2,500	10,000	10,000
Upper	500	2,000	Not Allowed

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

- The total quantity shall not exceed 1,000 pounds net weight in any one 100-square-foot retail display area.
- Per 25,000-square-foot retail display area.
- Minimum Ordinary Hazard Group 2 wet-pipe automatic sprinkler system throughout the retail sales occupancy.

**5106.2.2 Aerosol cooking spray product and plastic aerosol 3 product storage and fire protection.** The storage and handling of aerosol cooking spray products and plastic aerosol 3 products shall comply with this chapter and NFPA 30B.

**5106.2.3 Display of aerosol products.** Level 2 and 3 aerosol products shall not be stacked more than 6 feet (1829 mm) high from the base of the aerosol product array to the top of the aerosol product array unless the aerosol products are placed on fixed shelving or otherwise secured in an *approved* manner. Where storage or retail display is on shelves, the height of such storage or retail display to the top of aerosol products shall not exceed 8 feet (2438 mm).

**5106.2.4 Combustible cartons.** Aerosol products located in retail display areas shall be removed from combustible cartons.

### Exceptions:

- Display areas that use a portion of combustible cartons that consist of only the bottom panel and not more than 2 inches (51 mm) of the side panel are allowed.

- Where the display area is protected in accordance with Tables 6.4.2.7(a) through 6.4.2.7(l) of NFPA 30B, storage of aerosol products in combustible cartons is allowed.

### 5106.2.5 Retail display automatic sprinkler system.

Where an *automatic sprinkler system* is required for the protected retail display of aerosol products, the wet-pipe *automatic sprinkler system* shall be in accordance with Section 903.3.1.1. The minimum system design shall be for an Ordinary Hazard Group 2 occupancy. The system shall be provided throughout the retail display area.

**5106.3 Aerosol product display and normal merchandising exceeding 8 feet in height.** Aerosol product display and merchandising exceeding 8 feet (2438 mm) in height shall be in accordance with Sections 5106.3.1 through 5106.3.3.

### 5106.3.1 Maximum quantities in retail display areas.

Aerosol products in retail display areas shall not exceed quantities needed for display and normal merchandising and shall not exceed the quantities in Table 5106.2.1, with fire protection in accordance with Section 5106.3.2.

**5106.3.2 Automatic sprinkler protection.** Aerosol product and plastic aerosol 3 product display and merchandising areas shall be protected by an *automatic sprinkler system* based on the requirements set forth in Tables 6.4.2.7(a) through 6.4.2.7(l) of NFPA 30B and the following:

- Protection shall be based on the highest level of aerosol product in the array and the packaging method of the storage located more than 6 feet (1829 mm) above the finished floor.
- Where using the cartoned aerosol products tables of NFPA 30B, uncartoned or display-cut Level 2 and 3 aerosol products and plastic aerosol 3 products shall not be permitted more than 6 feet (1829 mm) above the finished floor.
- The design area for Level 2 and 3 aerosol products and plastic aerosol 3 products shall extend not less than 20 feet (6096 mm) beyond the Level 2 and 3 aerosol product and plastic aerosol 3 product display and merchandising areas.
- Where ordinary and high-temperature ceiling sprinkler systems are adjacent to each other, noncombustible draft curtains shall be installed at the interface.

**5106.3.3 Separation of Level 2 and 3 aerosol product and plastic aerosol 3 product areas.** Separation of Level 2 and 3 aerosol product areas or plastic aerosol 3 product areas shall comply with the following:

- Level 2 and 3 aerosol product or plastic aerosol 3 product display and merchandising areas shall be separated from each other by not less than 25 feet (7620 mm). See Table 5106.2.1.
- Level 2 and 3 aerosol product or plastic aerosol 3 product display and merchandising areas shall be separated from *flammable* and *combustible liquids*



## AEROSOLS

storage and display areas by one or a combination of the following:

- 2.1. Segregating areas from each other by horizontal distance of not less than 25 feet (7620 mm).
- 2.2. Isolating areas from each other by a noncombustible partition extending not less than 18 inches (457 mm) above the merchandise.
- 2.3. In accordance with Section 5106.5.
3. Where Item 2.2 is used to separate Level 2 or 3 aerosol products or plastic aerosol 3 products from *flammable* or *combustible liquids*, and the aerosol products are located within 25 feet (7620 mm) of *flammable* or *combustible liquids*, the area below the noncombustible partition shall be liquid tight at the floor to prevent spilled liquids from flowing beneath the aerosol products.

**5106.4 Maximum quantities in storage areas.** Aerosol products in storage areas adjacent to retail display areas shall not exceed the quantities in Table 5106.4.

**5106.5 Special protection design for Level 2 and 3 aerosol products adjacent to flammable and combustible liquids in double-row racks.** The display and merchandising of Level 2 and 3 aerosol products adjacent to *flammable* and *combustible liquids* in double-row racks shall be in accordance with Section 5106.3.3 or Sections 5106.5.1 through 5106.5.8.

**5106.5.1 Fire protection.** Fire protection for the display and merchandising of Level 2 and 3 aerosols in double-row racks shall be in accordance with Table 7.5.1 and Figure 7.5.1 of NFPA 30B.

**5106.5.2 Cartoned aerosol products.** Level 2 and 3 aerosol products displayed or merchandised more than 8 feet (2438 mm) above the finished floor shall be in cartons.

**5106.5.3 Shelving.** Shelving in racks shall be limited to wire mesh shelving having uniform openings not more than 6 inches (152 mm) apart, with the openings comprising not less than 50 percent of the overall shelf area.

**5106.5.4 Aisles.** Racks shall be arranged so that aisles not less than 7<sup>1</sup>/<sub>2</sub> feet (2286 mm) wide are maintained

between rows of racks and adjacent solid-piled or palletized merchandise.

**5106.5.5 Flue spaces.** Flue spaces in racks shall comply with the following:

1. Transverse flue spaces—Nominal 3-inch (76 mm) transverse flue spaces shall be maintained between merchandise and rack uprights.
2. Longitudinal flue spaces—Nominal 6-inch (152 mm) longitudinal flue spaces shall be maintained.

**5106.5.6 Horizontal barriers.** Horizontal barriers constructed of minimum <sup>3</sup>/<sub>8</sub>-inch-thick (10 mm) plywood or minimum 0.034-inch (0.086 mm) (No. 22 gage) sheet metal shall be provided and located in accordance with Table 7.5.1 and Figure 7.5.1 of NFPA 30B where in-rack sprinklers are installed.

**5106.5.7 Class I, II, III, IV and plastic commodities.** Class I, II, III, IV and plastic commodities located adjacent to Level 2 and 3 aerosol products and plastic aerosol 3 products shall be protected in accordance with NFPA 13.

**5106.5.8 Flammable and combustible liquids.** Class I, II, III A and III B liquids shall be allowed to be located adjacent to Level 2 and 3 aerosol products where both of the following conditions are met:

1. Class I, II, IIIA and IIIB liquid containers: Containers for Class I, II, IIIA and IIIB liquids shall be limited to 1.06-gallon (4 L) metal-relieving and nonrelieving style containers and 5.3-gallon (20 L) metal-relieving style containers.
2. Fire protection for Class I, II, IIIA and IIIB Liquids: Automatic sprinkler protection for Class I, II, IIIA and IIIB liquids shall be in accordance with Chapter 57.

## SECTION 5107 MANUFACTURING FACILITIES

**5107.1 General.** Manufacturing facilities shall be in accordance with NFPA 30B.

**TABLE 5106.4**  
**MAXIMUM STORAGE QUANTITIES FOR STORAGE AREAS ADJACENT TO RETAIL DISPLAY**  
**OF LEVEL 2 AND 3 AEROSOL PRODUCTS AND PLASTIC AEROSOL 3 PRODUCTS**

MAXIMUM NET WEIGHT PER FLOOR (pounds)			
Floor	Unseparated <sup>a, b</sup>	Separated	
		Storage cabinets <sup>b</sup>	1-hour occupancy separation
Basement	Not Allowed	Not Allowed	Not Allowed
Ground	2,500	5,000	In accordance with Sections 6.4.4.3 and 6.4.4.4 of NFPA 30B
Upper	500	1,000	In accordance with Sections 6.4.4.3 and 6.4.4.4 of NFPA 30B

For SI: 1 pound = 0.454 kg, 1 square foot = 0.0929 m<sup>2</sup>.

a. The aggregate quantity in storage and retail display shall not exceed the quantity limits for retail display.

b. In any 50,000-square-foot area.

## CHAPTER 52

# RESERVED



## CHAPTER 53

# COMPRESSED GASES

### User note:

**About this chapter:** Chapter 53 regulates the storage, use and handling of all flammable and nonflammable compressed gases, such as those that are used in medical facilities, air separation plants, industrial plants, agricultural equipment and similar occupancies. Also, this chapter regulates inert gases, such as CO<sub>2</sub> used for enrichment and beverage dispensing, that although inert are considered asphyxiants and in larger amounts pose a life safety hazard. Standards for the design, construction and marking of compressed gas cylinders and pressure vessels are referenced. Compressed gases used in welding and cutting, cryogenic liquids and liquefied petroleum gases are also regulated under Chapters 35, 55 and 61, respectively. Compressed gases that are classified as hazardous materials are also regulated in Chapter 50, which includes general requirements.

### SECTION 5301 GENERAL

**5301.1 Scope.** Storage, use and handling of *compressed gases* in *compressed gas* containers, cylinders, tanks and systems shall comply with this chapter and NFPA 55, including those gases regulated elsewhere in this code. Partially full *compressed gas* containers, cylinders or tanks containing residual gases shall be considered as full for the purposes of the controls required.

Liquefied natural gas for use as a vehicular fuel shall also comply with NFPA 52 and NFPA 59A.

*Compressed gases* classified as hazardous materials shall also comply with Chapter 50 for general requirements and chapters addressing specific hazards, including Chapters 58 (Flammable Gases and Flammable Cryogenic Fluids), 60 (Highly Toxic and Toxic Materials), 63 (Oxidizers, Oxidizing Gases and Oxidizing Cryogenic Fluids) and 64 (Pyrophoric Materials).

Compressed hydrogen (CH<sub>2</sub>) shall also comply with the applicable portions of Chapters 23 and 58 of this code, the *International Fuel Gas Code* and NFPA 2.

Cutting and welding gases shall also comply with Chapter 35.

#### Exceptions:

1. Gases used as refrigerants in refrigeration systems (see Section 608).
2. Compressed natural gas (CNG) for use as a vehicular fuel shall comply with Chapter 23, the *International Fuel Gas Code* and NFPA 52.
3. *Cryogenic fluids* shall comply with Chapter 55.
4. LP-gas shall comply with Chapter 61 and the *International Fuel Gas Code*.

**5301.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 5302 DEFINITIONS

**5302.1 Definitions.** The following terms are defined in Chapter 2:

#### COMPRESSED GAS.

#### COMPRESSED GAS CONTAINER.

#### COMPRESSED GAS SYSTEM.

#### NESTING.

#### TUBE TRAILER.

### SECTION 5303 GENERAL REQUIREMENTS

**5303.1 Containers, cylinders and tanks.** *Compressed gas* containers, cylinders and tanks shall comply with this section. *Compressed gas* containers, cylinders or tanks that are not designed for refillable use shall not be refilled after use of the original contents.

**5303.2 Design and construction.** *Compressed gas* containers, cylinders and tanks shall be designed, fabricated, tested, marked with the specifications of manufacture and maintained in accordance with the regulations of DOT 49 CFR Parts 100–185 or the *ASME Boiler and Pressure Vessel Code*, Section VIII.

**5303.3 Pressure relief devices.** Pressure relief devices shall be in accordance with Sections 5303.3.1 through 5303.3.5.

**5303.3.1 Where required.** Pressure relief devices shall be provided to protect containers, cylinders and tanks containing *compressed gases* from rupture in the event of overpressure.

**Exception:** Cylinders, containers and tanks where exempt from the requirements for pressure relief devices specified by the standards of design listed in Section 5303.3.2.

**5303.3.2 Design.** Pressure relief devices to protect containers shall be designed and provided in accordance with CGA S-1.1, CGA S-1.2, CGA S-1.3 or the *ASME Boiler and Pressure Vessel Code*, Section VIII, as applicable.

**5303.3.3 Sizing.** Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated and to material-specific requirements as applicable.

**5303.3.4 Arrangement.** Pressure relief devices shall be arranged to discharge upward and unobstructed to the open air in such a manner as to prevent any impingement



## COMPRESSED GASES

of escaping gas upon the container, adjacent structures or personnel.

**Exception:** DOTn specification containers having an internal volume of 30 cubic feet (0.855 m<sup>3</sup>) or less.

**5303.3.5 Freeze protection.** Pressure relief devices or vent piping shall be designed or located so that moisture cannot collect and freeze in a manner that would interfere with the operation of the device.

**5303.4 Marking.** Stationary and portable *compressed gas* containers, cylinders, tanks and systems shall be marked in accordance with Sections 5303.4.1 through 5303.4.3.

**5303.4.1 Stationary compressed gas containers, cylinders and tanks.** Stationary *compressed gas* containers, cylinders and tanks shall be marked with the name of the gas and in accordance with Sections 5003.5 and 5003.6. Markings shall be visible from any direction of approach.

**5303.4.2 Portable containers, cylinders and tanks.** Portable *compressed gas* containers, cylinders and tanks shall be marked in accordance with CGA C-7.

**5303.4.3 Piping systems.** Piping systems shall be marked in accordance with ASME A13.1. Markings used for piping systems shall consist of the content's name and include a direction-of-flow arrow. Markings shall be provided at each valve; at wall, floor or ceiling penetrations; at each change of direction; and at not less than every 20 feet (6096 mm) or fraction thereof throughout the piping run.

### Exceptions:

1. Piping that is designed or intended to carry more than one gas at various times shall have appropriate signs or markings posted at the manifold, along the piping and at each point of use to provide clear identification and warning.
2. Piping within gas manufacturing plants, gas processing plants, refineries and similar occupancies shall be marked in an *approved* manner.

**5303.5 Security.** *Compressed gas* containers, cylinders, tanks and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 5303.5.1 through 5303.5.3.

**5303.5.1 Security of areas.** Areas used for the storage, use and handling of *compressed gas* containers, cylinders, tanks and systems shall be secured against unauthorized entry and safeguarded in an *approved* manner.

**5303.5.2 Physical protection.** *Compressed gas* containers, cylinders, tanks and systems that could be exposed to physical damage shall be protected. Guard posts or other *approved* means shall be provided to protect *compressed gas* containers, cylinders, tanks and systems indoors and outdoors from vehicular damage and shall comply with Section 312.

**5303.5.3 Securing compressed gas containers, cylinders and tanks.** *Compressed gas* containers, cylinders and tanks shall be secured to prevent falling caused by

contact, vibration or seismic activity. Securing of *compressed gas* containers, cylinders and tanks shall be by one of the following methods:

1. Securing containers, cylinders and tanks to a fixed object with one or more restraints.
2. Securing containers, cylinders and tanks on a cart or other mobile device designed for the movement of *compressed gas* containers, cylinders or tanks.
3. *Nesting* of *compressed gas* containers, cylinders and tanks at container filling or servicing facilities or in sellers' warehouses not open to the public. *Nesting* shall be allowed provided that the nested containers, cylinders or tanks, if dislodged, do not obstruct the required *means of egress*.
4. Securing of *compressed gas* containers, cylinders and tanks to or within a rack, framework, cabinet or similar assembly designed for such use.

**Exception:** *Compressed gas* containers, cylinders and tanks in the process of examination, filling, transport or servicing.

**5303.6 Valve protection.** *Compressed gas* container, cylinder and tank valves shall be protected from physical damage by means of protective caps, collars or similar devices in accordance with Sections 5303.6.1 and 5303.6.2.

**5303.6.1 Compressed gas container, cylinder or tank protective caps or collars.** *Compressed gas* containers, cylinders and tanks designed for protective caps, collars or other protective devices shall have the caps or devices in place except when the containers, cylinders or tanks are in use or are being serviced or filled.

**5303.6.2 Caps and plugs.** *Compressed gas* containers, cylinders and tanks designed for valve protection caps or other protective devices shall have the caps or devices in place. When outlet caps or plugs are installed, they shall be in place.

**Exception:** *Compressed gas* containers, cylinders or tanks in use, being serviced or being filled.

**5303.7 Separation from hazardous conditions.** *Compressed gas* containers, cylinders and tanks and systems in storage or use shall be separated from materials and conditions that pose exposure hazards to or from each other. *Compressed gas* containers, cylinders, tanks and systems in storage or use shall be separated in accordance with Sections 5303.7.1 through 5303.7.11.2.

**5303.7.1 Incompatible materials.** *Compressed gas* containers, cylinders and tanks shall be separated from each other based on the hazard class of their contents. *Compressed gas* containers, cylinders and tanks shall be separated from *incompatible materials* in accordance with Section 5003.9.8.

**5303.7.2 Combustible waste, vegetation and similar materials.** Combustible waste, vegetation and similar materials shall be kept not less than 10 feet (3048 mm) from *compressed gas* containers, cylinders, tanks and systems. A noncombustible partition, without openings or penetrations and extending not less than 18 inches

(457 mm) above and to the sides of the storage area is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

**5303.7.3 Ledges, platforms and elevators.** *Compressed gas* containers, cylinders and tanks shall not be placed near elevators, unprotected platform ledges or other areas where falling would result in *compressed gas* containers, cylinders or tanks being allowed to drop distances exceeding one-half the height of the container, cylinder or tank.

**5303.7.4 Temperature extremes.** *Compressed gas* containers, cylinders and tanks, whether full or partially full, shall not be exposed to artificially created high temperatures exceeding 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

**5303.7.5 Falling objects.** *Compressed gas* containers, cylinders, tanks and systems shall not be placed in areas where they are capable of being damaged by falling objects.

**5303.7.6 Heating.** *Compressed gas* containers, cylinders and tanks, whether full or partially full, shall not be heated by devices that could raise the surface temperature of the container, cylinder or tank to above 125°F (52°C). Heating devices shall comply with the *International Mechanical Code* and NFPA 70. *Approved* heating methods involving temperatures of less than 125°F (52°C) are allowed to be used by trained personnel. Devices designed to maintain individual *compressed gas* containers, cylinders or tanks at constant temperature shall be *approved* and shall be designed to be fail-safe.

**5303.7.7 Sources of ignition.** Open flames and high-temperature devices shall not be used in a manner that creates a hazardous condition.

**5303.7.8 Exposure to chemicals.** *Compressed gas* containers, cylinders, tanks and systems shall not be exposed to *corrosive* chemicals or fumes that could damage containers, cylinders, tanks, valves or valve-protective caps.

**5303.7.9 Exhausted enclosures.** Where exhausted enclosures are provided as a means to segregate *compressed gas* containers, cylinders and tanks from exposure hazards, such enclosures shall comply with the requirements of Section 5003.8.5.

**5303.7.10 Gas cabinets.** Where gas cabinets are provided as a means to separate *compressed gas* containers, cylinders and tanks from exposure hazards, such gas cabinets shall comply with the requirements of Section 5003.8.6.

**5303.7.11 Tube trailers.** Tube trailers, including those containing compatible *compressed gases*, shall be surrounded by a clear space of not less than 3 feet (914 mm) to allow for maintenance, access and inspection.

**5303.7.11.1 Individual tube trailers containing incompatible materials.** Increased separation distances between individual tube trailers containing

incompatible gases shall be provided where required by Section 5303.7.1.

**5303.7.11.2 Connections.** Piping systems used to connect tube trailers to a user piping system shall not be viewed as an encroachment into the 3-foot (914 mm) clear space.

**5303.8 Wiring and equipment.** Electrical wiring and equipment shall comply with NFPA 70. *Compressed gas* containers, cylinders, tanks and systems shall not be located where they could become part of an electrical circuit. *Compressed gas* containers, cylinders, tanks and systems shall not be used for electrical grounding.

**5303.9 Service and repair.** Service, repair, modification or removal of valves, pressure-relief devices or other *compressed gas* container, cylinder or tank appurtenances shall be performed by trained personnel.

**5303.10 Unauthorized use.** *Compressed gas* containers, cylinders, tanks and systems shall not be used for any purpose other than to serve as a vessel for containing the product that it is designed to contain.

**5303.11 Exposure to fire.** *Compressed gas* containers, cylinders and tanks that have been exposed to fire shall be removed from service. Containers, cylinders and tanks so removed shall be handled by *approved*, qualified persons.

**5303.12 Leaks, damage or corrosion.** Leaking, damaged or corroded *compressed gas* containers, cylinders and tanks shall be removed from service. Leaking, damaged or corroded *compressed gas* systems shall be replaced or repaired in accordance with the following:

1. *Compressed gas* containers, cylinders and tanks that have been removed from service shall be handled in an *approved* manner.
2. *Compressed gas* systems that are determined to be leaking, damaged or corroded shall be repaired to a serviceable condition or removed from service.

**5303.13 Surface of unprotected storage or use areas.** Unless otherwise specified in Section 5303.14, *compressed gas* containers, cylinders and tanks are allowed to be stored or used without being placed under overhead cover. To prevent bottom corrosion, containers, cylinders and tanks shall be protected from direct contact with soil or unimproved surfaces. The surface of the area on which the containers are placed shall be graded to prevent accumulation of water.

**5303.14 Overhead cover.** *Compressed gas* containers, cylinders and tanks are allowed to be stored or used in the sun except in locations where extreme temperatures prevail. Where extreme temperatures prevail, overhead covers shall be provided.

**5303.15 Lighting.** *Approved* lighting by natural or artificial means shall be provided.

**5303.16 Vaults.** Generation, compression, storage and dispensing equipment for *compressed gases* shall be allowed to be located in either above- or below-grade vaults complying with Sections 5303.16.1 through 5303.16.14.

## COMPRESSED GASES

**5303.16.1 Listing required.** Vaults shall be *listed* by a nationally recognized testing laboratory.

**Exception:** Where *approved* by the *fire code official*, below-grade vaults are allowed to be constructed on site, provided that the design is in accordance with the *International Building Code* and that special inspections are conducted to verify structural strength and compliance of the installation with the *approved* design in accordance with Section 1707 of the *International Building Code*. Installation plans for below-grade vaults that are constructed on site shall be prepared by, and the design shall bear the stamp of, a professional engineer. Consideration shall be given to soil and hydrostatic loading on the floors, walls and lid; anticipated seismic forces; uplifting by ground water or flooding; and to loads imposed from above, such as traffic and equipment loading on the vault lid.

**5303.16.2 Design and construction.** The vault shall completely enclose generation, compression, storage or dispensing equipment located in the vault. There shall not be openings in the vault enclosure except those necessary for vault ventilation and access, inspection, filling, emptying or venting of equipment in the vault. The walls and floor of the vault shall be constructed of reinforced concrete not less than 6 inches (152 mm) thick. The top of an above-grade vault shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault to ensure that the thrust of any explosion occurring inside the vault is directed upward.

The top of an at- or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. The walls and floor of a vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading. Vaults shall be designed to be wind and earthquake resistant, in accordance with the *International Building Code*.

**5303.16.3 Secondary containment.** Vaults shall be substantially liquid-tight and there shall not be backfill within the vault. The vault floor shall drain to a sump. For premanufactured vaults, liquid tightness shall be certified as part of the listing provided by a nationally recognized testing laboratory. For field-erected vaults, liquid tightness shall be certified in an *approved* manner.

**5303.16.4 Internal clearance.** There shall be sufficient clearance within the vault to allow for visual inspection and maintenance of equipment in the vault.

**5303.16.5 Anchoring.** Vaults and equipment contained therein shall be suitably anchored to withstand uplifting by groundwater or flooding. The design shall verify that uplifting is prevented even where equipment within the vault is empty.

**5303.16.6 Vehicle impact protection.** Vaults shall be resistant to damage from the impact of a motor vehicle, or vehicle impact protection shall be provided in accordance with Section 312.

**5303.16.7 Arrangement.** Equipment in vaults shall be *listed* or *approved* for above-ground use. Where multiple vaults are provided, adjacent vaults shall be allowed to share a common wall. The common wall shall be liquid and vapor tight and shall be designed to withstand the load imposed when the vault on either side of the wall is filled with water.

**5303.16.8 Connections.** Connections shall be provided to permit the venting of each vault to dilute, disperse and remove vapors prior to personnel entering the vault.

**5303.16.9 Ventilation.** Vaults shall be provided with an exhaust ventilation system installed in accordance with Section 5004.3. The ventilation system shall operate continuously or be designed to operate upon activation of the vapor or liquid detection system. The system shall provide ventilation at a rate of not less than 1 cubic foot per minute (cfm) per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of floor area, but not less than 150 cfm ( $4 \text{ m}^3/\text{min}$ ). The exhaust system shall be designed to provide air movement across all parts of the vault floor for gases having a density greater than air and across all parts of the vault ceiling for gases having a density less than air. Supply ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm), of the floor. Exhaust ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm) of the floor or ceiling, for heavier-than-air or lighter-than-air gases, respectively. The exhaust system shall be installed in accordance with the *International Mechanical Code*.

**5303.16.10 Monitoring and detection.** Vaults shall be provided with *approved* vapor and liquid detection systems and equipped with on-site audible and visual warning devices with battery backup. Vapor detection systems shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower explosive limit (LEL) or one-half the immediately dangerous to life and health (IDLH) concentration for the gas in the vault. Vapor detectors shall be located not higher than 12 inches (305 mm) above the lowest point in the vault for heavier-than-air gases and not lower than 12 inches (305 mm) below the highest point in the vault for lighter-than-air gases. Liquid detection systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturer's instructions. Activation of either vapor or liquid detection systems shall cause a signal to be sounded at an *approved*, constantly attended location within the facility served by the tanks or at an *approved* location. Activation of vapor detection systems shall shut off gas-handling equipment in the vault and dispensers.

**5303.16.11 Liquid removal.** Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, it shall not be permanently installed in the vault. Electric-powered portable pumps shall be suitable for use in Class I, Division 1, locations, as defined in NFPA 70.



**5303.16.12 Relief vents.** Vent pipes for equipment in the vault shall terminate not less than 12 feet (3658 mm) above ground level.

**5303.16.13 Accessway.** Vaults shall be provided with an *approved* personnel accessway with a minimum dimension of 30 inches (762 mm) and with a permanently affixed, nonferrous ladder. Accessways shall be designed to be nonsparking. Travel distance from any point inside a vault to an accessway shall not exceed 20 feet (6096 mm). At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Entry points shall be secured against unauthorized entry and vandalism.

**5303.16.14 Classified area.** The interior of a vault containing a flammable gas shall be designated a Class I, Division 1, location, as defined in NFPA 70.

## SECTION 5304 STORAGE OF COMPRESSED GASES

**5304.1 Upright storage.** *Compressed gas* containers, cylinders and tanks, except those designed for use in a horizontal position, and all *compressed gas* containers, cylinders and tanks containing nonliquefied gases, shall be stored in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical.

### Exceptions:

1. *Compressed gas* containers with a water volume less than 1.3 gallons (5 L) are allowed to be stored in a horizontal position.
2. Cylinders, containers and tanks containing nonflammable gases, or cylinders, containers and tanks containing nonliquefied flammable gases that have been secured to a pallet for transportation purposes.

**5304.2 Material-specific regulations.** In addition to the requirements of this section, indoor and outdoor storage of *compressed gases* shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

## SECTION 5305 USE AND HANDLING OF COMPRESSED GASES

**5305.1 Compressed gas systems.** *Compressed gas* systems shall be suitable for the use intended and shall be designed by persons competent in such design. *Compressed gas* equipment, machinery and processes shall be listed or *approved*.

**5305.2 Controls.** *Compressed gas* system controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate or path. Automatic controls shall be designed to be fail-safe.

**5305.3 Piping systems.** Piping, including tubing, valves, fittings and pressure regulators, shall comply with this section and Chapter 50. Piping, tubing, pressure regulators, valves and other apparatus shall be kept gas tight to prevent leakage.

**5305.4 Valves.** Valves utilized on *compressed gas* systems shall be suitable for the use intended. Access to such valves shall be provided and maintained. Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access.

**5305.5 Venting.** Venting of gases shall be directed to an *approved* location. Venting shall comply with the *International Mechanical Code*.

**5305.6 Upright use.** *Compressed gas* containers, cylinders and tanks, except those designed for use in a horizontal position, and all *compressed gas* containers, cylinders and tanks containing nonliquefied gases, shall be used in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.80 rad) from the vertical. Use of nonflammable liquefied gases in the inverted position where the liquid phase is used shall not be prohibited provided that the container, cylinder or tank is properly secured and the dispensing apparatus is designed for liquefied gas use.

**Exception:** *Compressed gas* containers, cylinders and tanks with a water volume less than 1.3 gallons (5 L) are allowed to be used in a horizontal position.

**5305.7 Transfer.** Transfer of gases between containers, cylinders and tanks shall be performed by qualified personnel using equipment and operating procedures in accordance with CGA P-1.

**Exception:** The fueling of vehicles with CNG or CH<sub>2</sub>, conducted in accordance with Chapter 23.

**5305.8 Use of compressed gas for inflation.** Inflatable equipment, devices or balloons shall only be pressurized or filled with compressed air or inert gases.

**5305.9 Material-specific regulations.** In addition to the requirements of this section, indoor and outdoor use of *compressed gases* shall comply with the material-specific provisions of Chapters 54, 58 and 60 through 67.

**5305.10 Handling.** The handling of *compressed gas* containers, cylinders and tanks shall comply with Sections 5305.10.1 and 5305.10.2.

**5305.10.1 Carts and trucks.** Containers, cylinders and tanks shall be moved using an *approved* method. Where containers, cylinders or tanks are moved by hand cart, hand truck or other mobile device, such carts, trucks or devices shall be designed for the secure movement of containers, cylinders or tanks. Carts and trucks utilized for transport of *compressed gas* containers, cylinders and tanks within buildings shall comply with Section 5003.10. Carts and trucks utilized for transport of *compressed gas* containers, cylinders and tanks exterior to buildings shall be designed so that the containers,



## COMPRESSED GASES

cylinders and tanks will be secured against dropping or otherwise striking against each other or other surfaces.

**5305.10.2 Lifting devices.** Ropes, chains or slings shall not be used to suspend *compressed gas* containers, cylinders and tanks unless provisions at time of manufacture have been made on the container, cylinder or tank for appropriate lifting attachments, such as lugs.

### SECTION 5306 MEDICAL GASES

**5306.1 General.** Medical gases at health care-related facilities intended for patient or veterinary care shall comply with Sections 5306.2 through 5306.5 in addition to other requirements of this chapter and Section 427 of the *International Building Code*.

**5306.1.1 Training.** Personnel who handle medical gases and associated equipment and cylinders shall be trained on the use, safe handling and associated hazards.

**5306.2 Interior supply location.** Medical gases shall be located in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases in quantities greater than the permit amount are located inside buildings, they shall be in a 1-hour exterior room, a 1-hour interior room or a gas cabinet in accordance with Section 5306.2.1, 5306.2.2 or 5306.2.3, respectively. Rooms or areas where medical gases are stored or used in quantities exceeding the *maximum allowable quantity per control area* as set forth in Section 5003.1 shall be in accordance with the *International Building Code* for high-hazard Group H occupancies.

**5306.2.1 One-hour exterior rooms.** A 1-hour exterior room shall be a room or enclosure separated from the remainder of the building by *fire barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with a *fire-resistance rating* of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be self-closing smoke- and draft-control assemblies having a *fire protection rating* of not less than 1 hour. Rooms shall have not less than one exterior wall that is provided with not less than two vents. Each vent shall have a minimum free opening area of 36 square inches (232 cm<sup>2</sup>) for each 1,000 cubic feet (28 m<sup>3</sup>) at *normal temperature and pressure* (NTP) of gas stored in the room and shall be not less than 72 square inches (465 cm<sup>2</sup>) in aggregate free opening area. One vent shall be within 6 inches (152 mm) of the floor and one shall be within 6 inches (152 mm) of the ceiling. Rooms shall be provided with not less than one automatic sprinkler to provide container cooling in case of fire.

**5306.2.2 One-hour interior room.** Where an exterior wall cannot be provided for the room, a 1-hour interior room shall be provided and shall be a room or enclosure separated from the remainder of the building by *fire*

*barriers* constructed in accordance with Section 707 of the *International Building Code* or *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or both, with a *fire-resistance rating* of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be provided with self-closing, smoke- and draft-control assemblies having a *fire protection rating* of not less than 1 hour. An *automatic sprinkler system* shall be installed within the room. The room shall be exhausted through a duct to the exterior. Supply and exhaust ducts shall be enclosed in a 1-hour-rated shaft enclosure from the room to the exterior. *Approved* mechanical ventilation shall comply with the *International Mechanical Code* and be provided at a minimum rate of 1 cfm per square foot [0.00508 m<sup>3</sup>/(s × m<sup>2</sup>)] of the area of the room.

**5306.2.3 Gas cabinets.** Gas cabinets shall be constructed in accordance with Section 5003.8.6 and shall comply with the following:

1. Exhausted to the exterior through dedicated exhaust duct system installed in accordance with Chapter 5 of the *International Mechanical Code*.
2. Supply and exhaust ducts shall be enclosed in a 1-hour *fire-resistance-rated* shaft enclosure from the cabinet to the exterior. The average velocity of ventilation at the face of access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s) at any point of the access port or window.
3. Provided with an *automatic sprinkler system* internal to the cabinet.

**5306.3 Exterior supply locations.** Oxidizer medical gas systems located on the exterior of a building with quantities greater than the permit amount shall be located in accordance with Section 6304.2.1.

**5306.4 Transfilling.** Transfilling areas and operations including, but not limited to, ventilation and separation, shall comply with NFPA 99.

**5306.5 Medical gas systems and equipment.** Medical gas systems and equipment shall be installed, tested and *labeled* in accordance with NFPA 99 and the general provisions of this chapter. Existing medical gas systems and equipment shall be used and maintained in accordance with the use, maintenance, inspection and testing provisions of NFPA 99 for medical gas systems and equipment.

### SECTION 5307 COMPRESSED GASES NOT OTHERWISE REGULATED

**5307.1 General.** *Compressed gases* in storage or use not regulated by the material-specific provisions of Chapters 6, 54, 55, and 60 through 67, including asphyxiant, irritant and radioactive gases, shall comply with this section in addition to other requirements of this chapter.

**5307.2 Ventilation.** Indoor storage and use areas and storage buildings shall be provided with ventilation in accordance with Section 5004.3. Where mechanical ventilation is provided, the systems shall be operational during such time as the building or space is occupied.

**Exceptions:**

1. A gas detection system complying with Section 5307.2.1 shall be permitted in lieu of mechanical ventilation.
2. Areas containing insulated liquid carbon dioxide systems used in beverage dispensing applications shall comply with Section 5307.3.

**5307.2.1 Gas detection system.** In rooms or areas not provided with ventilation in accordance with Section 5307.2, a gas detection system complying with Section 916 or, where *approved*, an oxygen depletion alarm system, either of which initiates audible and visible alarm signals in the room or area where sensors are installed, shall be provided.

**5307.3 Insulated liquid carbon dioxide systems used in beverage dispensing applications.** Insulated liquid carbon dioxide systems with more than 100 pounds (45.4 kg) of carbon dioxide used in beverage dispensing applications shall comply with Section 5307.3.1.

**5307.3.1 Ventilation.** Where insulated liquid carbon dioxide storage tanks, cylinders, piping and equipment are located indoors, rooms or areas containing storage tanks, cylinders, piping and equipment, and other areas where a leak of carbon dioxide is expected to accumulate, shall be provided with mechanical ventilation in accordance with Section 5004.3 and designed to maintain the room containing carbon dioxide at a negative pressure in relation to the surrounding area.

**Exception:** A gas detection system complying with Section 5307.3.2 shall be permitted in lieu of mechanical ventilation.

**5307.3.2 Gas detection system.** Where ventilation is not provided in accordance with Section 5307.3.1, a gas detection system shall be provided in rooms or indoor areas and in below-grade outdoor locations with insulated carbon dioxide systems. Carbon dioxide sensors shall be provided within 12 inches (305 mm) of the floor in the area where the gas is expected to accumulate or other *approved* locations. The system shall be designed as follows:

1. Activates an audible and visible supervisory alarm at a normally attended location upon detection of a carbon dioxide concentration of 5,000 ppm (9000 mg/m<sup>3</sup>).
2. Activates an audible and visible alarm within the room or immediate area where the system is installed upon detection of a carbon dioxide concentration of 30,000 ppm (54 000 mg/m<sup>3</sup>).

**5307.4 Carbon dioxide enrichment systems.** The design, installation and maintenance of carbon dioxide enrichment systems with more than 100 pounds (45.4 kg) of carbon

dioxide, and carbon dioxide enrichment systems with any quantity of carbon dioxide having a remote fill connection, shall comply with Sections 5307.4.1 through 5307.4.7.

**5307.4.1 Documentation.** The following information shall be provided with the application for permit:

1. Total aggregate quantity of liquid carbon dioxide in pounds or cubic feet at *normal temperature and pressure*.
2. Location and total volume of the room where the carbon dioxide enrichment operation will be conducted. Identify whether the room is at grade or below grade.
3. Location of containers relative to equipment, building openings and *means of egress*.
4. Manufacturer's specifications and pressure rating, including cut sheets, of all piping and tubing to be used.
5. A piping and instrumentation diagram that shows piping support and remote fill connections.
6. Details of container venting, including but not limited to vent line size, material and termination location.
7. Alarm and detection system and equipment, if applicable.
8. Seismic support for containers.

**5307.4.2 Equipment.** Pressure relief, vent piping, fill indicators, fill connections, vent terminations, piping systems and the storage, use and handling of the carbon dioxide shall be in accordance with Chapter 53 and NFPA 55.

**5307.4.3 Gas detection system.** A gas detection system complying with Section 916 shall be provided in rooms or indoor areas in which the carbon dioxide enrichment process is located, in rooms or indoor areas in which container systems are located, and in other areas where carbon dioxide is expected to accumulate. Carbon dioxide sensors shall be provided within 12 inches (305 mm) of the floor in the area where the gas is expected to accumulate or leaks are most likely to occur. The system shall be designed as follows:

1. Activates a low-level alarm upon detection of a carbon dioxide concentration of 5,000 ppm (9000 mg/m<sup>3</sup>).
2. Activates a high-level alarm upon detection of a carbon dioxide concentration of 30,000 ppm (54 000 mg/m<sup>3</sup>).

**5307.4.3.1 System activation.** Activation of the low-level gas detection system alarm shall automatically:

1. Stop the flow of carbon dioxide to the piping system.
2. Activate the mechanical exhaust ventilation system.
3. Activate an audible and visible supervisory alarm signal at an *approved* location within the building.

## COMPRESSED GASES

Activation of the high-level gas detection system alarm shall automatically:

1. Stop the flow of carbon dioxide to the piping system.
2. Activate the mechanical exhaust ventilation system.
3. Activate an audible and visible evacuation alarm both inside and outside of the carbon dioxide enrichment area, and the area in which the carbon dioxide containers are located.

**5307.4.4 Pressurization and ventilation.** Rooms or indoor areas in which carbon dioxide enrichment is provided shall be maintained at a negative pressure in relation to the surrounding areas in the building. A mechanical ventilation system shall be provided in accordance with the *International Mechanical Code* that complies with all of the following:

1. Mechanical ventilation in the room or area shall be at a rate of not less than 1 cfm per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ].
2. When activated by the gas detection system, the mechanical ventilation system shall remain on until manually reset.
3. The exhaust system intakes shall be taken from points within 12 inches (305 mm) of the floor.
4. The ventilation system shall discharge to the outdoors in an *approved* location.

**5307.4.5 Signage.** Hazard identification signs shall be posted at the entrance to the room and indoor areas where the carbon dioxide enrichment process is located, and at the entrance to the room or indoor area where the carbon dioxide containers are located. The sign shall be not less than 8 inches (200 mm) in width and 6 inches (150 mm) in height and indicate:

CAUTION—CARBON DIOXIDE GAS  
VENTILATE THE AREA BEFORE ENTERING.  
A HIGH CARBON DIOXIDE (CO<sub>2</sub>)  
GAS CONCENTRATION  
IN THIS AREA  
CAN CAUSE ASPHYXIATION.

**5307.4.6 Seismic and structural design.** Carbon dioxide system containers and piping shall comply with the seismic design requirements in Chapter 16 of the *International Building Code* and shall not exceed the floor loading limitation of the building.

**5307.4.7 Container refilling.** Carbon dioxide containers located indoors shall not be refilled unless filled from a remote connection located outdoors.

## CHAPTER 54

# CORROSIVE MATERIALS

### User note:

**About this chapter:** Chapter 54 addresses the hazards of corrosive materials that have a destructive effect on living tissues. Though corrosive gases exist, most corrosive materials are solid or liquid and classified as either acids or bases (alkalis). These materials may pose a wide range of hazards other than corrosivity, such as combustibility, reactivity or oxidizing hazards, and must conform to the requirements of this code with respect to all of their known hazards. The focus of this chapter is on materials whose primary hazard is corrosivity; that is, the ability to destroy or irreparably damage living tissue on contact.

### SECTION 5401 GENERAL

**5401.1 Scope.** The storage and use of *corrosive* materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

#### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Stationary storage battery systems in accordance with Section 1207.
3. This chapter shall not apply to R-717 (ammonia) where used as a refrigerant in a refrigeration system (see Section 608).

**5401.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 5402 DEFINITION

**5402.1 Definition.** The following term is defined in Chapter 2:

**CORROSIVE.**

### SECTION 5403 GENERAL REQUIREMENTS

**5403.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of *corrosive* materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5401.

**5403.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with this chapter and Chapter 50.

### SECTION 5404 STORAGE

**5404.1 Indoor storage.** Indoor storage of *corrosive* materials in amounts exceeding the *maximum allowable quantity*

*per control area* indicated in Table 5003.1.1(2), shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

**5404.1.1 Liquid-tight floor.** In addition to the provisions of Section 5004.12, floors in storage areas for *corrosive* liquids shall be of liquid-tight construction.

**5404.2 Outdoor storage.** Outdoor storage of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

**5404.2.1 Above-ground outside storage tanks.** Above-ground outside storage tanks exceeding an aggregate quantity of 1,000 gallons (3785 L) of *corrosive* liquids shall be provided with secondary containment in accordance with Section 5004.2.2.

**5404.2.2 Distance from storage to exposures.** Outdoor storage of *corrosive* materials shall not be within 20 feet (6096 mm) of buildings not associated with the manufacturing or distribution of such materials, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. A 2-hour *fire barrier* without openings or penetrations, and extending not less than 30 inches (762 mm) above and to the sides of the storage area, is allowed in lieu of such distance. The wall shall either be an independent structure, or the *exterior wall* of the building adjacent to the storage area.

### SECTION 5405 USE

**5405.1 Indoor use.** The indoor use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 5005 and this chapter.

**5405.1.1 Liquid transfer.** *Corrosive* liquids shall be transferred in accordance with Section 5005.1.10.

**5405.1.2 Ventilation.** Where *corrosive* materials are dispensed or used, mechanical exhaust ventilation in accordance with Section 5005.2.1.1 shall be provided.

**5405.2 Outdoor use.** The outdoor use of *corrosive* materials in amounts exceeding the *maximum allowable quantity per*



## CORROSIVE MATERIALS

*control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 5005 and this chapter.

**5405.2.1 Distance from use to exposures.** Outdoor use of *corrosive* materials shall be located in accordance with Section 5404.2.2.

## CHAPTER 55

# CRYOGENIC FLUIDS

### User note:

**About this chapter:** Chapter 55 regulates the hazards associated with the storage, use and handling of cryogenic fluids through regulation of such things as pressure relief mechanisms and proper container storage. These hazards are in addition to the code requirements that address the other hazards of cryogenic fluids such as flammability and toxicity. These other characteristics are dealt with in Chapter 50 and other chapters, such as Chapter 58 and its content about flammable gases. Cryogens are hazardous because they are held at extremely low temperatures and high pressures. Many cryogenic fluids, however, are actually inert gases and would not be regulated elsewhere in this code. Cryogens are used for many applications but specifically have had widespread use in the biomedical field and in space programs.

### SECTION 5501 GENERAL

**5501.1 Scope.** Storage, use and handling of *cryogenic fluids* shall comply with this chapter and NFPA 55. *Cryogenic fluids* classified as hazardous materials shall also comply with the general requirements of Chapter 50. Partially full containers containing residual *cryogenic fluids* shall be considered as full for the purposes of the controls required.

#### Exceptions:

1. Fluids used as refrigerants in refrigeration systems (see Section 608).
2. Liquefied natural gas (LNG), which shall comply with NFPA 59A.

Oxidizing *cryogenic fluids*, including oxygen, shall comply with Chapter 63, as applicable.

Flammable *cryogenic fluids*, including hydrogen, methane and carbon monoxide, shall comply with Chapters 23 and 58, as applicable.

Inert *cryogenic fluids*, including argon, helium and nitrogen, shall comply with ANSI/CGA P-18.

**5501.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 5502 DEFINITIONS

**5502.1 Definitions.** The following terms are defined in Chapter 2.

**CRYOGENIC CONTAINER.**

**CRYOGENIC FLUID.**

**CRYOGENIC VESSEL.**

**FLAMMABLE CRYOGENIC FLUID.**

**LOW-PRESSURE TANK.**

### SECTION 5503 GENERAL REQUIREMENTS

**5503.1 Containers.** Containers employed for storage or use of *cryogenic fluids* shall comply with Sections 5503.1.1 through 5503.1.3.2 and Chapter 50.

**5503.1.1 Nonstandard containers.** Containers, equipment and devices that are not in compliance with recognized standards for design and construction shall be *approved* upon presentation of satisfactory evidence that they are designed and constructed for safe operation.

**5503.1.1.1 Data submitted for approval.** The following data shall be submitted to the *fire code official* with reference to the deviation from the recognized standard with the application for approval.

1. Type and use of container, equipment or device.
2. Material to be stored, used or transported.
3. Description showing dimensions and materials used in construction.
4. Design pressure, maximum operating pressure and test pressure.
5. Type, size and setting of pressure relief devices.
6. Other data requested by the *fire code official*.

**5503.1.2 Concrete containers.** Concrete containers shall be built in accordance with the *International Building Code*. Barrier materials and membranes used in connection with concrete, but not functioning structurally, shall be compatible with the materials contained.

**5503.1.3 Foundations and supports.** Containers shall be provided with substantial concrete or masonry foundations, or structural steel supports on firm concrete or masonry foundations. Containers shall be supported to prevent the concentration of excessive loads on the supporting portion of the shell. Foundations for horizontal containers shall be constructed to accommodate expansion and contraction of the container. Foundations shall be provided to support the weight of vaporizers or heat exchangers.

**5503.1.3.1 Temperature effects.** Where container foundations or supports are subject to exposure to temperatures below -130°F (-90°C), the foundations or supports shall be constructed of materials to withstand the low-temperature effects of *cryogenic fluid* spillage.

**5503.1.3.2 Corrosion protection.** Portions of containers in contact with foundations or saddles shall be painted to protect against corrosion.

## CRYOGENIC FLUIDS

**5503.2 Pressure relief devices.** Pressure relief devices shall be provided in accordance with Sections 5503.2.1 through 5503.2.7 to protect containers and systems containing *cryogenic fluids* from rupture in the event of overpressure. Pressure relief devices shall be designed in accordance with CGA S-1.1, CGA S-1.2 and CGA S-1.3.

**5503.2.1 Containers.** Containers shall be provided with pressure relief devices.

**5503.2.2 Vessels or equipment other than containers.** Heat exchangers, vaporizers, insulation casings surrounding containers, vessels and coaxial piping systems in which liquefied *cryogenic fluids* could be trapped because of leakage from the primary container shall be provided with a pressure relief device.

**5503.2.3 Sizing.** Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. The relief device shall have sufficient capacity to prevent the maximum design pressure of the container or system from being exceeded.

**5503.2.4 Access.** Pressure relief devices shall be located such that they are provided with *ready access* for inspection and repair.

**5503.2.5 Arrangement.** Pressure relief devices shall be arranged to discharge unobstructed to the open air in such a manner as to prevent impingement of escaping gas on personnel, containers, equipment and adjacent structures or to enter enclosed spaces.

**Exception:** DOTn-specified containers with an internal volume of 2 cubic feet (0.057 m<sup>3</sup>) or less.

**5503.2.6 Shutoffs between pressure relief devices and containers.** Shutoff valves shall not be installed between pressure relief devices and containers.

**Exceptions:**

1. A shutoff valve is allowed on containers equipped with multiple pressure relief device installations where the arrangement of the valves provides the full required flow through the minimum number of required relief devices at all times.
2. A locking-type shutoff valve is allowed to be used upstream of the pressure relief device for service-related work performed by the supplier when in accordance with the requirements of the *ASME Boiler and Pressure Vessel Code*.

**5503.2.7 Temperature limits.** Pressure relief devices shall not be subjected to *cryogenic fluid* temperatures except when operating.

**5503.3 Pressure relief vent piping.** Pressure relief vent-piping systems shall be constructed and arranged so as to remain functional and direct the flow of gas to a safe location in accordance with Sections 5503.3.1 and 5503.3.2.

**5503.3.1 Sizing.** Pressure relief device vent piping shall have a cross-sectional area not less than that of the pressure relief device vent opening and shall be arranged so as not to restrict the flow of escaping gas.

**5503.3.2 Arrangement.** Pressure relief device vent piping and drains in vent lines shall be arranged so that escaping gas will discharge unobstructed to the open air and not impinge on personnel, containers, equipment and adjacent structures or enter enclosed spaces. Pressure relief device vent lines shall be installed in such a manner to exclude or remove moisture and condensation and prevent malfunction of the pressure relief device because of freezing or ice accumulation.

**5503.4 Marking.** Cryogenic containers and systems shall be marked in accordance with Sections 5503.4.1 through 5503.4.6.

**5503.4.1 Identification signs.** Visible hazard identification signs in accordance with NFPA 704 shall be provided at entrances to buildings or areas in which *cryogenic fluids* are stored, handled or used.

**5503.4.2 Identification of contents.** Stationary and portable containers shall be marked with the name of the gas contained. Stationary above-ground containers shall be placarded in accordance with Sections 5003.5 and 5003.6. Portable containers shall be identified in accordance with CGA C-7.

**5503.4.3 Identification of containers.** Stationary containers shall be identified with the manufacturing specification and maximum allowable working pressure with a permanent nameplate. The nameplate shall be installed on the container in a location provided with *ready access*. The nameplate shall be marked in accordance with the *ASME Boiler and Pressure Vessel Code* or DOTn 49 CFR Parts 100–185.

**5503.4.4 Identification of container connections.** Container inlet and outlet connections, liquid-level limit controls, valves and pressure gauges shall be identified with one of the following:

1. A permanent tag or label identifying the function.
2. A schematic drawing that portrays the function and designates whether the connection is to the vapor or liquid space of the container.

Where a schematic drawing is provided, it shall be attached to the container and maintained in a legible condition.

**5503.4.5 Identification of piping systems.** Piping systems shall be identified in accordance with ASME A13.1.

**5503.4.6 Identification of emergency shutoff valves.** Emergency shutoff valves shall be identified and the location shall be clearly visible and indicated by means of a sign.

**5503.5 Security.** Cryogenic containers and systems shall be secured against accidental dislodgement and against access by unauthorized personnel in accordance with Sections 5503.5.1 through 5503.5.4.

**5503.5.1 Security of areas.** Containers and systems shall be secured against unauthorized entry and safeguarded in an *approved* manner.

**5503.5.2 Securing of containers.** Stationary containers shall be secured to foundations in accordance with the

*International Building Code.* Portable containers subject to shifting or upset shall be secured. Nesting shall be an acceptable means of securing containers.

**5503.5.3 Securing of vaporizers.** Vaporizers, heat exchangers and similar equipment shall be anchored to a suitable foundation and its connecting piping shall be sufficiently flexible to provide for the effects of expansion and contraction due to temperature changes.

**5503.5.4 Physical protection.** Containers, piping, valves, pressure relief devices, regulating equipment and other appurtenances shall be protected against physical damage and tampering.

**5503.6 Electrical wiring and equipment.** Electrical wiring and equipment shall comply with NFPA 70 and Sections 5503.6.1 and 5503.6.2.

**5503.6.1 Location.** Containers and systems shall not be located where they could become part of an electrical circuit.

**5503.6.2 Electrical grounding and bonding.** Containers and systems shall not be used for electrical grounding. Where electrical grounding and bonding is required, the system shall comply with NFPA 70. The grounding system shall be protected against corrosion, including corrosion caused by stray electric currents.

**5503.7 Service and repair.** Service, repair, modification or removal of valves, pressure relief devices or other container appurtenances shall comply with Sections 5503.7.1 and 5503.7.2 and the *ASME Boiler and Pressure Vessel Code*, Section VIII or DOTn 49 CFR Parts 100–185.

**5503.7.1 Containers.** Containers that have been removed from service shall be handled in an *approved* manner.

**5503.7.2 Systems.** Service and repair of systems shall be performed by trained personnel.

**5503.8 Unauthorized use.** Containers shall not be used for any purpose other than to serve as a vessel for containing the product that it is designed to contain.

**5503.9 Leaks, damage and corrosion.** Leaking, damaged or corroded containers shall be removed from service. Leaking, damaged or corroded systems shall be replaced, repaired or removed in accordance with Section 5503.7.

**5503.10 Lighting.** Where required, lighting, including emergency lighting, shall be provided for fire appliances and operating facilities such as walkways, control valves and gates ancillary to stationary containers.

## SECTION 5504 STORAGE

**5504.1 General.** Storage of containers shall comply with this section.

**5504.2 Indoor storage.** Indoor storage of containers shall be in accordance with Sections 5504.2.1 through 5504.2.2.3.

**5504.2.1 Stationary containers.** Stationary containers shall be installed in accordance with the provisions applicable to the type of fluid stored and this section.

**5504.2.1.1 Containers.** Stationary containers shall comply with Section 5503.1.

**5504.2.1.2 Construction of indoor areas.** *Cryogenic fluids* in stationary containers stored indoors shall be located in buildings, rooms or areas constructed in accordance with the *International Building Code*.

**5504.2.1.3 Ventilation.** Storage areas for stationary containers shall be ventilated in accordance with the *International Mechanical Code*.

**5504.2.2 Portable containers.** Indoor storage of portable containers shall comply with the provisions applicable to the type of fluid stored and Sections 5504.2.2.1 through 5504.2.2.3.

**5504.2.2.1 Containers.** Portable containers shall comply with Section 5503.1.

**5504.2.2.2 Construction of indoor areas.** *Cryogenic fluids* in portable containers stored indoors shall be stored in buildings, rooms or areas constructed in accordance with the *International Building Code*.

**5504.2.2.3 Ventilation.** Storage areas shall be ventilated in accordance with the *International Mechanical Code*.

**5504.3 Outdoor storage.** Outdoor storage of containers shall be in accordance with Sections 5504.3.1 through 5504.3.1.2.3.

**5504.3.1 Separation from hazardous conditions.** Cryogenic containers and systems in outdoor storage shall be separated from materials and conditions that pose exposure hazards to or from each other in accordance with Sections 5504.3.1.1 through 5504.3.1.1.5.

**5504.3.1.1 Stationary containers.** Stationary containers shall be separated from exposure hazards in accordance with the provisions applicable to the type of fluid contained and the minimum separation distances indicated in Table 5504.3.1.1.

TABLE 5504.3.1.1  
SEPARATION OF STATIONARY CONTAINERS  
FROM EXPOSURE HAZARDS

EXPOSURE	MINIMUM DISTANCE (feet)
Air intakes	10
Building exits	10
Buildings, regardless of construction type	1
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Lot lines	5
Nonambulatory patient areas	50
Other hazardous materials	In accordance with Chapter 50
Places of public assembly	50
Wall openings	1

For SI: 1 foot = 304.8 mm.



## CRYOGENIC FLUIDS

**5504.3.1.1.1 Point-of-fill connections.** Remote transfer points and fill connection points shall not be positioned closer to exposures than the minimum distances required for stationary containers.

**5504.3.1.1.2 Surfaces beneath containers.** Containers shall be placed on surfaces that are compatible with the fluid in the container.

**5504.3.1.1.3 Location.** Containers of *cryogenic fluids* shall not be located within diked areas containing other hazardous materials.

**5504.3.1.1.4 Areas subject to flooding.** Stationary containers located in areas subject to flooding shall be securely anchored or elevated to prevent the containers from separating from foundations or supports.

**5504.3.1.1.5 Drainage.** The area surrounding stationary containers shall be provided with a means to prevent accidental discharge of fluids from endangering personnel, containers, equipment and adjacent structures or to enter enclosed spaces. The stationary container shall not be placed where spilled or discharged fluids will be retained around the container.

**Exception:** These provisions shall not apply where it is determined by the *fire code official* that the container does not constitute a hazard, after consideration of special features such as crushed rock utilized as a heat sink, topographical conditions, nature of occupancy, proximity to structures on the same or adjacent property, and the capacity and construction of containers and character of fluids to be stored.

**5504.3.1.2 Outdoor storage of portable containers.** Outdoor storage of portable containers shall comply with Section 5503 and Sections 5504.3.1.2.1 through 5504.3.1.2.3.

**5504.3.1.2.1 Exposure hazard separation.** Portable containers in outdoor storage shall be separated from exposure hazards in accordance with Table 5504.3.1.2.1.

**TABLE 5504.3.1.2.1  
SEPARATION OF PORTABLE CONTAINERS  
FROM EXPOSURE HAZARDS**

EXPOSURE	MINIMUM DISTANCE (feet)
Air intakes	10
Building exits	10
Combustible materials such as paper, leaves, weeds, dry grass or debris	15
Lot lines	5
Other hazardous materials	In accordance with Chapter 50
Wall openings	1

For SI: 1 foot = 304.8 mm.

**5504.3.1.2.2 Surfaces beneath containers.** The surface of the area on which stationary containers are placed, including the surface of the area located below the point where connections are made for the purpose of filling such containers, shall be compatible with the fluid in the container.

**5504.3.1.2.3 Drainage.** The area surrounding portable containers shall be provided with a means to prevent accidental discharge of fluids from endangering adjacent containers, buildings, equipment or adjoining property.

**Exception:** These provisions shall not apply where it is determined by the *fire code official* that the container does not constitute a hazard.

## SECTION 5505 USE AND HANDLING

**5505.1 General.** Use and handling of *cryogenic fluid* containers and systems shall comply with Sections 5505.1.1 through 5505.5.2.

**5505.1.1 Cryogenic fluid systems.** *Cryogenic fluid* systems shall be suitable for the use intended and designed by persons competent in such design. Equipment, machinery and processes shall be *listed* or *approved*.

**5505.1.2 Piping systems.** Piping, tubing, valves and joints and fittings conveying *cryogenic fluids* shall be installed in accordance with the material-specific provisions of Section 5501.1 and Sections 5505.1.2.1 through 5505.1.2.6.

**5505.1.2.1 Design and construction.** Piping systems shall be suitable for the use intended through the full range of pressure and temperature to which they will be subjected. Piping systems shall be designed and constructed to provide adequate allowance for expansion, contraction, vibration, settlement and fire exposure.

**5505.1.2.2 Joints.** Joints on container piping and tubing shall be threaded, welded, silver brazed or flanged.

**5505.1.2.3 Valves and accessory equipment.** Valves and accessory equipment shall be suitable for the intended use at the temperatures of the application and shall be designed and constructed to withstand the maximum pressure at the minimum temperature to which they will be subjected.

**5505.1.2.3.1 Shutoff valves on containers.** Shutoff valves shall be provided on all container connections except for pressure relief devices. Shutoff valves shall be provided with access thereto and located as close as practical to the container.

**5505.1.2.3.2 Shutoff valves on piping.** Shutoff valves shall be installed in piping containing *cryogenic fluids* where needed to limit the volume of liquid discharged in the event of piping or equipment failure. Pressure relief valves shall be installed

where liquid is capable of being trapped between shutoff valves in the piping system (see Section 5503.2).

**5505.1.2.4 Physical protection and support.** Piping systems shall be supported and protected from physical damage. Piping passing through walls shall be protected from mechanical damage.

**5505.1.2.5 Corrosion protection.** Above-ground piping that is subject to corrosion because of exposure to corrosive atmospheres, shall be constructed of materials to resist the corrosive environment or otherwise protected against corrosion. Below-ground piping shall be protected against corrosion.

**5505.1.2.6 Testing.** Piping systems shall be tested and proven free of leaks after installation as required by the standards to which they were designed and constructed. Test pressures shall be not less than 150 percent of the maximum allowable working pressure where hydraulic testing is conducted or 110 percent where testing is conducted pneumatically.

**5505.2 Indoor use.** Indoor use of *cryogenic fluids* shall comply with the material-specific provisions of Section 5501.1.

**5505.3 Outdoor use.** Outdoor use of *cryogenic fluids* shall comply with the material specific provisions of Sections 5501.1, 5505.3.1 and 5505.3.2.

**5505.3.1 Separation.** Distances from *lot lines*, buildings and exposure hazards shall comply with Section 5504.3 and the material-specific provisions of Section 5501.1.

**5505.3.2 Emergency shutoff valves.** Manual or automatic emergency shutoff valves shall be provided to shut off the *cryogenic fluid* supply in case of emergency. An emergency shutoff valve shall be located at the source of supply and at the point where the system enters the building.

**5505.4 Filling and dispensing.** Filling and dispensing of *cryogenic fluids* shall comply with Sections 5505.4.1 through 5505.4.3.

**5505.4.1 Dispensing areas.** Dispensing of *cryogenic fluids* with physical or *health hazards* shall be conducted in *approved* locations. Dispensing indoors shall be conducted in areas constructed in accordance with the *International Building Code*.

**5505.4.1.1 Ventilation.** Indoor areas where *cryogenic fluids* are dispensed shall be ventilated in accordance with the requirements of the *International Mechanical Code* in a manner that captures any vapor at the point of generation.

**Exception:** *Cryogenic fluids* that can be demonstrated not to create harmful vapors.

**5505.4.1.2 Piping systems.** Piping systems utilized for filling or dispensing of *cryogenic fluids* shall be designed and constructed in accordance with Section 5505.1.2.

**5505.4.2 Vehicle loading and unloading areas.** Loading or unloading areas shall be conducted in an *approved* manner in accordance with the standards referenced in Section 5501.1.

**5505.4.3 Limit controls.** Limit controls shall be provided to prevent overfilling of stationary containers during filling operations.

**5505.5 Handling.** Handling of cryogenic containers shall comply with Sections 5505.5.1 and 5505.5.2.

**5505.5.1 Carts and trucks.** Cryogenic containers shall be moved using an *approved* method. Where cryogenic containers are moved by hand cart, hand truck or other mobile device, such carts, trucks or devices shall be designed for the secure movement of the container.

Carts and trucks used to transport cryogenic containers shall be designed to provide a stable base for the commodities to be transported and shall have a means of restraining containers to prevent accidental dislodgement.

**5505.5.2 Closed containers.** Pressurized containers shall be transported in a closed condition. Containers designed for use at atmospheric conditions shall be transported with appropriate loose-fitting covers in place to prevent spillage.



## CHAPTER 56

# EXPLOSIVES AND FIREWORKS

### User note:

**About this chapter:** Chapter 56 prescribes minimum requirements for the safe manufacture, storage, handling and use of explosives, ammunition and blasting agents for commercial and industrial occupancies. These provisions are intended to protect the general public, emergency responders and individuals who handle explosives. It also regulates the manufacturing, retail sale, display and wholesale distribution of fireworks; establishes the requirements for obtaining approval to manufacture, store, sell, discharge or conduct a public display; and references national standards for regulations governing manufacture, storage and public displays.

### SECTION 5601 GENERAL

**5601.1 Scope.** The provisions of this chapter shall govern the possession, manufacture, storage, handling, sale and use of *explosives*, *explosive materials*, fireworks and small arms ammunition.

#### Exceptions:

1. The Armed Forces of the United States, Coast Guard or National Guard.
2. *Explosives* in forms prescribed by the official United States Pharmacopoeia.
3. The possession, storage and use of small arms ammunition where packaged in accordance with DOTn packaging requirements.
4. The possession, storage and use of not more than 1 pound (0.454 kg) of commercially manufactured sporting black powder, 20 pounds (9 kg) of smokeless powder and 10,000 small arms primers for hand loading of small arms ammunition for personal consumption.
5. The use of *explosive materials* by federal, state and local regulatory, law enforcement and fire agencies acting in their official capacities.
6. Special industrial *explosive* devices that in the aggregate contain less than 50 pounds (23 kg) of *explosive materials*.
7. The possession, storage and use of blank industrial-power load cartridges where packaged in accordance with DOTn packaging regulations.
8. Transportation in accordance with DOTn 49 CFR Parts 100–185.
9. Items preempted by federal regulations.

**5601.1.1 Explosive material standard.** In addition to the requirements of this chapter, NFPA 495 shall govern the manufacture, transportation, storage, sale, handling and use of *explosive materials*.

**5601.1.2 Explosive material terminals.** In addition to the requirements of this chapter, the operation of *explosive material* terminals shall conform to the provisions of NFPA 498.

**5601.1.3 Fireworks.** The possession, manufacture, storage, sale, handling and use of fireworks are prohibited.

#### Exceptions:

1. Storage and handling of fireworks as allowed in Section 5604.
2. Manufacture, assembly and testing of fireworks as allowed in Section 5605.
3. The use of fireworks for fireworks displays as allowed in Section 5608.
4. The possession, storage, sale, handling and use of specific types of Division 1.4G fireworks where allowed by applicable laws, ordinances and regulations, provided that such fireworks and facilities comply with the 2006 edition of NFPA 1124, CPSC 16 CFR Parts 1500 and 1507, and DOTn 49 CFR Parts 100–185, as applicable for consumer fireworks.

**5601.1.4 Rocketry.** The storage, handling and use of model and high-power rockets shall comply with the requirements of NFPA 1122, NFPA 1125 and NFPA 1127.

**5601.1.5 Ammonium nitrate.** The storage and handling of ammonium nitrate shall comply with the requirements of NFPA 400 and Chapter 63.

**Exception:** Storage of ammonium nitrate in magazines with blasting agents shall comply with the requirements of NFPA 495.

**5601.2 Permit required.** Permits shall be required as set forth in Section 105.5 and regulated in accordance with this section.

**5601.2.1 Residential uses.** Persons shall not keep or store, nor shall any permit be issued to keep or store, any *explosives* at any place of habitation, or within 100 feet (30 480 mm) thereof.

**Exception:** Storage of smokeless propellant, black powder and small arms primers for personal use and not for resale in accordance with Section 5606.

**5601.2.2 Sale and retail display.** Persons shall not construct a retail display nor offer for sale *explosives*, *explosive materials* or fireworks on highways, sidewalks, public property or in Group A or E occupancies.



## EXPLOSIVES AND FIREWORKS

**5601.2.3 Permit restrictions.** The *fire code official* is authorized to limit the quantity of *explosives*, *explosive materials* or fireworks permitted at a given location. Persons possessing a permit for storage of *explosives* at any place, shall not keep or store an amount greater than authorized in such permit. Only the kind of *explosive* specified in such a permit shall be kept or stored.

**5601.2.4 Financial responsibility.** Before a permit is issued, as required by Section 5601.2, the applicant shall file with the jurisdiction a corporate surety bond in the principal sum of \$100,000 or a public liability insurance policy for the same amount, for the purpose of the payment of all damages to persons or property that arise from, or are caused by, the conduct of any act authorized by the permit upon which any judicial judgment results. The *fire code official* is authorized to specify a greater or lesser amount when, in his or her opinion, conditions at the location of use indicate a greater or lesser amount is required. Government entities shall be exempt from this bond requirement.

**5601.2.4.1 Blasting.** Before approval to do blasting is issued, the applicant for approval shall file a bond or submit a certificate of insurance in such form, amount and coverage as determined by the legal department of the jurisdiction to be adequate in each case to indemnify the jurisdiction against any and all damages arising from permitted blasting.

**5601.2.4.2 Fireworks display.** The permit holder shall furnish a bond or certificate of insurance in an amount deemed adequate by the *fire code official* for the payment of all potential damages to a person or persons or to property by reason of the permitted display, and arising from any acts of the permit holder, the agent, employees or subcontractors.

**5601.3 Prohibited explosives.** Permits shall not be issued or renewed for possession, manufacture, storage, handling, sale or use of the following materials and such materials currently in storage or use shall be disposed of in an *approved* manner.

1. Liquid nitroglycerin.
2. Dynamite containing more than 60-percent liquid *explosive* ingredient.
3. Dynamite having an unsatisfactory absorbent or one that permits leakage of a liquid *explosive* ingredient under any conditions liable to exist during storage.
4. Nitrocellulose in a dry and uncompressed condition in a quantity greater than 10 pounds (4.54 kg) of net weight in one package.
5. Fulminate of mercury in a dry condition and fulminate of all other metals in any condition except as a component of manufactured articles not hereinafter forbidden.
6. *Explosive* compositions that ignite spontaneously or undergo marked decomposition, rendering the products of their use more hazardous, when subjected for 48 consecutive hours or less to a temperature of 167°F (75°C).

7. New *explosive materials* until *approved* by DOTn, except that permits are allowed to be issued to educational, governmental or industrial laboratories for instructional or research purposes.
8. *Explosive materials* forbidden for transport by DOTn.
9. *Explosive materials* containing an ammonium salt and a chlorate.
10. *Explosives* not packed or marked as required by DOTn 49 CFR Parts 100–185.

**Exception:** Gelatin dynamite.

**5601.4 Qualifications.** Persons in charge of magazines, blasting, fireworks display or pyrotechnic special effect operations shall not be under the influence of alcohol or drugs that impair sensory or motor skills, shall be not less than 21 years of age and shall demonstrate knowledge of all safety precautions related to the storage, handling or use of *explosives*, *explosive materials* or fireworks.

**5601.5 Supervision.** The *fire code official* is authorized to require operations permitted under the provisions of Section 5601.2 to be supervised at any time by the *fire code official* in order to determine compliance with all safety and fire regulations.

**5601.6 Notification.** Whenever a new *explosive material* storage or manufacturing site is established, including a temporary job site, the local law enforcement agency, fire department and local emergency planning committee shall be notified 48 hours in advance, not including Saturdays, Sundays and holidays, of the type, quantity and location of *explosive materials* at the site.

**5601.7 Seizure.** The *fire code official* is authorized to remove or cause to be removed or disposed of in an *approved* manner, at the expense of the *owner*, *explosives*, *explosive materials* or fireworks offered or exposed for sale, stored, possessed or used in violation of this chapter.

**5601.8 Establishment of quantity of explosives and distances.** The quantity of *explosives* and distances shall be in accordance with Sections 5601.8.1 through 5601.8.1.4.

**5601.8.1 Quantity of explosives.** The quantity-distance (Q-D) tables in Sections 5604.5 and 5605.3 shall be used to provide the minimum separation distances from potential explosion sites as set forth in Tables 5601.8.1(1) through 5601.8.1(3). The classification and the weight of the *explosives* are primary characteristics governing the use of these tables. The net *explosive* weight shall be determined in accordance with Sections 5601.8.1.1 through 5601.8.1.4.

**5601.8.1.1 Mass-detonating explosives (Division 1.1, 1.2 or 1.5).** The total net *explosive* weight of mass-detonating *explosives* (Division 1.1, 1.2 or 1.5) shall be used. See Table 5604.5.2(1) or Table 5605.3, as appropriate.

**Exception:** Where the TNT equivalence of the *explosive material* has been determined, the equivalence is allowed to be used to establish the net *explosive* weight.

**TABLE 5601.8.1(1)**  
**APPLICATION OF QUANTITY-DISTANCE (Q-D) TABLES—DIVISION 1.1, 1.2 AND 1.5 EXPLOSIVES<sup>a, b, c</sup>**

ITEM	MAGAZINE	OPERATING BUILDING	INHABITED BUILDING	PUBLIC TRAFFIC ROUTE
Inhabited building	IBD in Table 5604.5.2(1)	IBD in Table 5604.5.2(1)	Not Applicable	Not Applicable
Magazine	IMD in Table 5604.5.2(1)	ILD or IPD in Table 5605.3	IBD in Table 5604.5.2(1)	PTR in Table 5604.5.2(1)
Operating building	ILD or IPD in Table 5604.5.2(1)	ILD or IPD in Table 5605.3	IBD in Table 5604.5.2(1)	PTR in Table 5604.5.2(1)
Public traffic route	PTR in Table 5604.5.2(1)	PTR in Table 5604.5.2(1)	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- The minimum separation distance shall be 60 feet. Where a building or magazine containing explosives is barricaded, the minimum distance shall be 30 feet.
- Linear interpolation between tabular values in the referenced Q-D tables shall not be allowed. Nonlinear interpolation of the values shall be allowed subject to an approved technical opinion and report prepared in accordance with Section 104.8.2.
- For definitions of quantity-distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.

**TABLE 5601.8.1(2)**  
**APPLICATION OF QUANTITY-DISTANCE (Q-D) TABLES—DIVISION 1.3 EXPLOSIVES<sup>a, b, c</sup>**

ITEM	MAGAZINE	OPERATING BUILDING	INHABITED BUILDING	PUBLIC TRAFFIC ROUTE
Inhabited building	IBD in Table 5604.5.2(2)	IBD in Table 5604.5.2(2)	Not Applicable	Not Applicable
Magazine	IMD in Table 5604.5.2(2)	ILD or IPD in Table 5604.5.2(2)	IBD in Table 5604.5.2(2)	PTR in Table 5604.5.2(2)
Operating building	ILD or IPD in Table 5604.5.2(2)	ILD or IPD in Table 5604.5.2(2)	IBD in Table 5604.5.2(2)	PTR in Table 5604.5.2(2)
Public traffic route	PTR in Table 5604.5.2(2)	PTR in Table 5604.5.2(2)	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- The minimum separation distance shall be not less than 50 feet.
- Linear interpolation between tabular values in the referenced Q-D table shall be allowed.
- For definitions of quantity-distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.

**TABLE 5601.8.1(3)**  
**APPLICATION OF QUANTITY-DISTANCE (Q-D) TABLES—DIVISION 1.4 EXPLOSIVES<sup>a, b, c</sup>**

ITEM	MAGAZINE	OPERATING BUILDING	INHABITED BUILDING	PUBLIC TRAFFIC ROUTE
Inhabited building	IBD in Table 5604.5.2(3)	IBD in Table 5604.5.2(3)	Not Applicable	Not Applicable
Magazine	IMD in Table 5604.5.2(3)	ILD or IPD in Table 5604.5.2(3)	IBD in Table 5604.5.2(3)	PTR in Table 5604.5.2(3)
Operating building	ILD or IPD in Table 5604.5.2(3)	ILD or IPD in Table 5604.5.2(3)	IBD in Table 5604.5.2(3)	PTR in Table 5604.5.2(3)
Public traffic route	PTR in Table 5604.5.2(3)	PTR in Table 5604.5.2(3)	Not Applicable	Not Applicable

For SI: 1 foot = 304.8 mm.

- The minimum separation distance shall be not less than 50 feet.
- Linear interpolation between tabular values in the referenced Q-D table shall not be allowed.
- For definitions of quantity-distance abbreviations IBD, ILD, IMD, IPD and PTR, see Chapter 2.

#### **5601.8.1.2 Nonmass-detonating explosives (excluding Division 1.4).** Nonmass-detonating *explosives* (excluding Division 1.4) shall be as follows:

- Division 1.3 propellants. The total weight of the propellants alone shall be the net *explosive* weight. The net weight of propellant shall be used. See Table 5604.5.2(2).
- Combinations of bulk metal powder and pyrotechnic compositions. The sum of the net weights of metal powders and pyrotechnic compositions in the containers shall be the net *explosive* weight. See Table 5604.5.2(2).

#### **5601.8.1.3 Combinations of mass-detonating and nonmass-detonating explosives (excluding Division 1.4).** Combination of mass-detonating and nonmass-detonating *explosives* (excluding Division 1.4) shall be as follows:

- Where Division 1.1 and 1.2 *explosives* are located in the same site, determine the distance for the total quantity considered first as 1.1 and then as 1.2. The required distance is the greater of the two. Where the Division 1.1 requirements are controlling and the TNT equivalence of the 1.2 is known, the TNT equivalent weight of the 1.2 items shall be allowed to be added to

## EXPLOSIVES AND FIREWORKS

the total *explosive* weight of Division 1.1 items to determine the net *explosive* weight for Division 1.1 distance determination. See Table 5604.5.2(2) or Table 5605.3, as appropriate.

2. Where Division 1.1 and 1.3 *explosives* are located in the same site, determine the distances for the total quantity considered first as 1.1 and then as 1.3. The required distance is the greater of the two. Where the Division 1.1 requirements are controlling and the TNT equivalence of the 1.3 is known, the TNT equivalent weight of the 1.3 items shall be allowed to be added to the total *explosive* weight of Division 1.1 items to determine the net *explosive* weight for Division 1.1 distance determination. See Table 5604.5.2(1), 5604.5.2(2) or 5605.3, as appropriate.
3. Where Division 1.1, 1.2 and 1.3 *explosives* are located in the same site, determine the distances for the total quantity considered first as 1.1, next as 1.2 and finally as 1.3. The required distance is the greatest of the three. As allowed by Items 1 and 2, TNT equivalent weights for 1.2 and 1.3 items are allowed to be used to determine the net weight of *explosives* for Division 1.1 distance determination. Table 5604.5.2(1) or Table 5605.3 shall be used where TNT equivalency is used to establish the net *explosive* weight.
4. For composite pyrotechnic items Division 1.1 and Division 1.3, the sum of the net weights of the pyrotechnic composition and the *explosives* involved shall be used. See Tables 5604.5.2(1) and 5604.5.2(2).

**5601.8.1.4 Moderate fire—no blast hazards (Division 1.4).** For Division 1.4 *explosives*, the total weight of the *explosive material* alone is the net weight. The net weight of the *explosive material* shall be used.

## SECTION 5602

### DEFINITIONS

**5602.1 Definitions.** The following terms are defined in Chapter 2:

**AMMONIUM NITRATE.**

**BARRICADE.**

Artificial barricade.

Natural barricade.

**BARRICADED.**

**BLAST AREA.**

**BLAST SITE.**

**BLASTER.**

**BLASTING AGENT.**

**BULLET RESISTANT.**

**DETONATING CORD.**

**DETONATION.**

**DETONATOR.**

**DISCHARGE SITE.**

**DISPLAY SITE.**

**EXPLOSIVE.**

High explosive.

Low explosive.

Mass-detonating explosives.

UN/DOtn Class 1 explosives.

Division 1.1.

Division 1.2.

Division 1.3.

Division 1.4.

Division 1.5.

Division 1.6.

**EXPLOSIVE MATERIAL.**

**FALLOUT AREA.**

**FIREWORKS.**

Fireworks, 1.3G.

Fireworks, 1.4G.

**FIREWORKS DISPLAY.**

**HIGHWAY.**

**INHABITED BUILDING.**

**MAGAZINE.**

Indoor.

Type 1.

Type 2.

Type 3.

Type 4.

Type 5.

**MORTAR.**

**NET EXPLOSIVE WEIGHT (net weight).**

**OPERATING BUILDING.**

**OPERATING LINE.**

**PLOSOPHORIC MATERIAL.**

**PROXIMATE AUDIENCE.**

**PUBLIC TRAFFIC ROUTE (PTR).**

**PYROTECHNIC ARTICLE.**

**PYROTECHNIC COMPOSITION.**

**PYROTECHNIC SPECIAL EFFECT.**

**PYROTECHNIC SPECIAL-EFFECT MATERIAL.**

**PYROTECHNICS.**

**QUANTITY-DISTANCE (Q-D).**

Inhabited building distance (IBD).

Intermagazine distance (IMD).

Intraline distance (ILD) or Intraplant distance (IPD).

RAILWAY.

READY BOX.

SMALL ARMS AMMUNITION.

SMALL ARMS PRIMERS.

SMOKELESS PROPELLANTS.

SPECIAL INDUSTRIAL EXPLOSIVE DEVICE.

THEFT RESISTANT.

### SECTION 5603 RECORD KEEPING AND REPORTING

**5603.1 General.** Records of the receipt, handling, use or disposal of *explosive materials*, and reports of any accidents, thefts or unauthorized activities involving *explosive materials* shall conform to the requirements of this section.

**5603.2 Transaction record.** The permittee shall maintain a record of all transactions involving receipt, removal, use or disposal of *explosive materials*. Such records shall be maintained for a period of 5 years.

**Exception:** Where only Division 1.4G (consumer fireworks) are handled, records need only be maintained for a period of 3 years.

**5603.3 Loss, theft or unauthorized removal.** The loss, theft or unauthorized removal of *explosive materials* from a magazine or permitted facility shall be reported to the *fire code official*, local law enforcement authorities and the US Department of Treasury, Bureau of Alcohol, Tobacco, Firearms and Explosives within 24 hours.

**Exception:** Loss of Division 1.4G (consumer fireworks) need not be reported to the Bureau of Alcohol, Tobacco, Firearms and Explosives.

**5603.4 Accidents.** Accidents involving the use of *explosives*, *explosive materials* and fireworks that result in injuries or property damage shall be reported to the *fire code official* immediately.

**5603.5 Misfires.** The pyrotechnic display operator or blaster in charge shall keep a record of all aerial shells that fail to fire or charges that fail to detonate.

**5603.6 Hazard communication.** Manufacturers of *explosive materials* and fireworks shall maintain records of chemicals, chemical compounds and mixtures required by DOL 29 CFR Part 1910.1200 and Section 407.

**5603.7 Safety rules.** Current safety rules covering the operation of magazines, as described in Section 5604.7, shall be posted on the interior of the magazine in a visible location.

### SECTION 5604 EXPLOSIVE MATERIALS STORAGE AND HANDLING

**5604.1 General.** Storage of *explosives* and *explosive materials*, small arms ammunition, small arms primers, propellant-actuated cartridges and smokeless propellants in magazines shall comply with the provisions of this section.

**5604.2 Magazine required.** *Explosives* and *explosive materials*, and Division 1.3G fireworks shall be stored in magazines constructed, located, operated and maintained in accordance with the provisions of Section 5604 and NFPA 495 or NFPA 1124.

#### Exceptions:

1. Storage of fireworks at display sites in accordance with Section 5608.5 and NFPA 1123 or NFPA 1126.
2. Portable or mobile magazines not exceeding 120 square feet (11 m<sup>2</sup>) in area shall not be required to comply with the requirements of the *International Building Code*.

**5604.3 Magazines.** The storage of *explosives* and *explosive materials* in magazines shall comply with Table 5604.3.

**5604.3.1 High explosives.** *Explosive materials* classified as Division 1.1 or 1.2 or formerly classified as Class A by the US Department of Transportation shall be stored in Type 1, 2 or 3 magazines.

#### Exceptions:

1. Black powder shall be stored in a Type 1, 2, 3 or 4 magazine.
2. Cap-sensitive *explosive material* that is demonstrated not to be bullet sensitive shall be stored in a Type 1, 2, 3, 4 or 5 magazine.

**5604.3.2 Low explosives.** *Explosive materials* that are not cap sensitive shall be stored in a Type 1, 2, 3, 4 or 5 magazine.

**5604.3.3 Detonating cord.** For quantity and distance purposes, detonating cord of 50 grains per foot shall be calculated as equivalent to 8 pounds (4 kg) of high *explosives* per 1,000 feet (305 m). Heavier or lighter core loads shall be rated proportionally.

**5604.4 Prohibited storage.** Detonators shall be stored in a separate magazine for blasting supplies and shall not be stored in a magazine with other *explosive materials*.

**5604.5 Location.** The use of magazines for storage of *explosives* and *explosive materials* shall comply with Sections 5604.5.1 through 5604.5.3.3.

**5604.5.1 Indoor magazines.** The use of indoor magazines for storage of *explosives* and *explosive materials* shall comply with the requirements of Sections 5604.5.1.1 through 5604.5.1.7.

**5604.5.1.1 Use.** The use of indoor magazines for storage of *explosives* and *explosive materials* shall be limited to occupancies of Group F, H, M or S, and research and development laboratories.

**5604.5.1.2 Construction.** Indoor magazines shall comply with the following construction requirements:

1. Construction shall be fire resistant and theft resistant.
2. Exterior shall be painted red.



## EXPLOSIVES AND FIREWORKS

**TABLE 5604.3**  
**STORAGE AMOUNTS AND MAGAZINE REQUIREMENTS FOR EXPLOSIVES, EXPLOSIVE MATERIALS**  
**AND FIREWORKS, 1.3G MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA**

NEW UN/DOTn DIVISION	OLD DOTn CLASS	ATF/OSHA CLASS	INDOOR <sup>a</sup> (pounds)				OUTDOOR (pounds)	MAGAZINE TYPE REQUIRED				
			Unprotected	Cabinet	Sprinklers	Sprinklers & cabinet		1	2	3	4	5
1.1 <sup>b</sup>	A	High	0	0	1	2	1	X	X	X	—	—
1.2	A	High	0	0	1	2	1	X	X	X	—	—
1.2	B	Low	0	0	1	1	1	X	X	X	X	—
1.3	B	Low	0	0	5	10	1	X	X	X	X	—
1.4	B	Low	0	0	50	100	1	X	X	X	X	—
1.5	C	Low	0	0	1	2	1	X	X	X	X	—
1.5	Blasting Agent	Blasting Agent	0	0	1	2	1	X	X	X	X	X
1.6	Not Applicable	Not Applicable	0	0	1	2	1	X	X	X	X	X

For SI: 1 pound = 0.454 kg, 1 pound per gallon = 0.12 kg per liter, 1 ounce = 28.35 g.

a. A factor of 10 pounds per gallon shall be used for converting pounds (solid) to gallons (liquid) in accordance with Section 5003.1.2.

b. Black powder shall be stored in a Type 1, 2, 3 or 4 magazine as provided for in Section 5604.3.1.

3. Base shall be fitted with wheels, casters or rollers to facilitate removal from the building in an emergency.
4. Lid or door shall be marked with conspicuous white lettering not less than 3 inches (76 mm) high and minimum  $\frac{1}{2}$  inch (12.7 mm) stroke, reading "EXPLOSIVES—KEEP FIRE AWAY."
5. The least horizontal dimension shall not exceed the clear width of the entrance door.

**5604.5.1.3 Quantity limit.** Not more than 50 pounds (23 kg) of *explosives* or *explosive materials* shall be stored within an indoor magazine.

**Exception:** Day boxes used for the storage of in-process material in accordance with Section 5605.6.4.1.

**5604.5.1.4 Prohibited use.** Indoor magazines shall not be used within buildings containing Group R occupancies.

**5604.5.1.5 Location.** Indoor magazines shall be located within 10 feet (3048 mm) of an entrance and only on floors at or having *ramp* access to the exterior grade level.

**5604.5.1.6 Number.** Not more than two indoor magazines shall be located in the same building. Where two such magazines are located in the same building, one magazine shall be used solely for the storage of not more than 5,000 detonators.

**5604.5.1.7 Separation distance.** Where two magazines are located in the same building, they shall be separated by a distance of not less than 10 feet (3048 mm).

**5604.5.2 Outdoor magazines.** Outdoor magazines other than Type 3 shall be located so as to comply with Table 5604.5.2(2) or 5604.5.2(3) as set forth in Tables 5601.8.1(1) through 5601.8.1(3). Where a magazine or

group of magazines, as described in Section 5604.5.2.2, contains different classes of *explosive materials*, and Division 1.1 materials are present, the required separations for the magazine or magazine group as a whole shall comply with Table 5604.5.2(2).

**5604.5.2.1 Separation.** Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, public transportation routes and operating buildings. Magazines shall be separated from each other by not less than the intermagazine distances (IMD) shown for the separation of magazines.

**5604.5.2.2 Grouped magazines.** Where two or more magazines are separated from each other by less than the intermagazine distances (IMD), such magazines as a group shall be considered as one magazine and the total quantity of *explosive materials* stored in the group shall be treated as if stored in a single magazine. The location of the group of magazines shall comply with the intermagazine distances (IMD) specified from other magazines or magazine groups, inhabited buildings (IBD), public transportation routes (PTR) and operating buildings (ILD or IPD) as required.

**5604.5.3 Special requirements for Type 3 magazines.** Type 3 magazines shall comply with Sections 5604.5.3.1 through 5604.5.3.3.

**5604.5.3.1 Location.** Wherever practicable, Type 3 magazines shall be located away from neighboring inhabited buildings, railways, highways and other magazines in accordance with Table 5604.5.2(2) or 5604.5.2(3), as applicable.

**5604.5.3.2 Supervision.** Type 3 magazines shall be attended when *explosive materials* are stored within. *Explosive materials* shall be removed to appropriate storage magazines for unattended storage at the end of the workday.

## EXPLOSIVES AND FIREWORKS

**TABLE 5604.5.2(1)**  
**AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES AS**  
**APPROVED BY THE INSTITUTE OF MAKERS OF EXPLOSIVES AND REVISED JUNE 1991<sup>a</sup>**

QUANTITY OF EXPLOSIVE MATERIALS <sup>c</sup>		DISTANCES IN FEET							
		Inhabited buildings		Public highways with traffic volume less than 3,000 vehicles per day		Public highways with traffic volume greater than 3,000 vehicles per day and passenger railways		Separation of magazines <sup>d</sup>	
Pounds over	Pounds not over	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded
0	5	70	140	30	60	51	102	6	12
5	10	90	180	35	70	64	128	8	16
10	20	110	220	45	90	81	162	10	20
20	30	125	250	50	100	93	186	11	22
30	40	140	280	55	110	103	206	12	24
40	50	150	300	60	120	110	220	14	28
50	75	170	340	70	140	127	254	15	30
75	100	190	380	75	150	139	278	16	32
100	125	200	400	80	160	150	300	18	36
125	150	215	430	85	170	159	318	19	38
150	200	235	470	95	190	175	350	21	42
200	250	255	510	105	210	189	378	23	46
250	300	270	540	110	220	201	402	24	48
300	400	295	590	120	240	221	442	27	54
400	500	320	640	130	260	238	476	29	58
500	600	340	680	135	270	253	506	31	62
600	700	355	710	145	290	266	532	32	64
700	800	375	750	150	300	278	556	33	66
800	900	390	780	155	310	289	578	35	70
900	1,000	400	800	160	320	300	600	36	72
1,000	1,200	425	850	165	330	318	636	39	78
1,200	1,400	450	900	170	340	336	672	41	82
1,400	1,600	470	940	175	350	351	702	43	86
1,600	1,800	490	980	180	360	366	732	44	88
1,800	2,000	505	1,010	185	370	378	756	45	90
2,000	2,500	545	1,090	190	380	408	816	49	98
2,500	3,000	580	1,160	195	390	432	864	52	104
3,000	4,000	635	1,270	210	420	474	948	58	116
4,000	5,000	685	1,370	225	450	513	1,026	61	122
5,000	6,000	730	1,460	235	470	546	1,092	65	130
6,000	7,000	770	1,540	245	490	573	1,146	68	136
7,000	8,000	800	1,600	250	500	600	1,200	72	144
8,000	9,000	835	1,670	255	510	624	1,248	75	150
9,000	10,000	865	1,730	260	520	645	1,290	78	156
10,000	12,000	875	1,750	270	540	687	1,374	82	164
12,000	14,000	885	1,770	275	550	723	1,446	87	174
14,000	16,000	900	1,800	280	560	756	1,512	90	180
16,000	18,000	940	1,880	285	570	786	1,572	94	188

(continued)

## EXPLOSIVES AND FIREWORKS

**TABLE 5604.5.2(1)—continued**  
**AMERICAN TABLE OF DISTANCES FOR STORAGE OF EXPLOSIVES AS**  
**APPROVED BY THE INSTITUTE OF MAKERS OF EXPLOSIVES AND REVISED JUNE 1991<sup>a</sup>**

QUANTITY OF EXPLOSIVE MATERIALS <sup>c</sup>		DISTANCES IN FEET							
		Inhabited buildings		Public highways with traffic volume less than 3,000 vehicles per day		Public highways with traffic volume greater than 3,000 vehicles per day and passenger railways		Separation of magazines <sup>d</sup>	
Pounds over	Pounds not over	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded	Barricaded	Unbarricaded
18,000	20,000	975	1,950	290	580	813	1,626	98	196
20,000	25,000	1,055	2,000	315	630	876	1,752	105	210
25,000	30,000	1,130	2,000	340	680	933	1,866	112	224
30,000	35,000	1,205	2,000	360	720	981	1,962	119	238
35,000	40,000	1,275	2,000	380	760	1,026	2,000	124	248
40,000	45,000	1,340	2,000	400	800	1,068	2,000	129	258
45,000	50,000	1,400	2,000	420	840	1,104	2,000	135	270
50,000	55,000	1,460	2,000	440	880	1,140	2,000	140	280
55,000	60,000	1,515	2,000	455	910	1,173	2,000	145	290
60,000	65,000	1,565	2,000	470	940	1,206	2,000	150	300
65,000	70,000	1,610	2,000	485	970	1,236	2,000	155	310
70,000	75,000	1,655	2,000	500	1,000	1,263	2,000	160	320
75,000	80,000	1,695	2,000	510	1,020	1,293	2,000	165	330
80,000	85,000	1,730	2,000	520	1,040	1,317	2,000	170	340
85,000	90,000	1,760	2,000	530	1,060	1,344	2,000	175	350
90,000	95,000	1,790	2,000	540	1,080	1,368	2,000	180	360
95,000	100,000	1,815	2,000	545	1,090	1,392	2,000	185	370
100,000	110,000	1,835	2,000	550	1,100	1,437	2,000	195	390
110,000	120,000	1,855	2,000	555	1,110	1,479	2,000	205	410
120,000	130,000	1,875	2,000	560	1,120	1,521	2,000	215	430
130,000	140,000	1,890	2,000	565	1,130	1,557	2,000	225	450
140,000	150,000	1,900	2,000	570	1,140	1,593	2,000	235	470
150,000	160,000	1,935	2,000	580	1,160	1,629	2,000	245	490
160,000	170,000	1,965	2,000	590	1,180	1,662	2,000	255	510
170,000	180,000	1,990	2,000	600	1,200	1,695	2,000	265	530
180,000	190,000	2,010	2,010	605	1,210	1,725	2,000	275	550
190,000	200,000	2,030	2,030	610	1,220	1,755	2,000	285	570
200,000	210,000	2,055	2,055	620	1,240	1,782	2,000	295	590
210,000	230,000	2,100	2,100	635	1,270	1,836	2,000	315	630
230,000	250,000	2,155	2,155	650	1,300	1,890	2,000	335	670
250,000	275,000	2,215	2,215	670	1,340	1,950	2,000	360	720
275,000	300,000 <sup>b</sup>	2,275	2,275	690	1,380	2,000	2,000	385	770

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

- This table applies only to the manufacture and permanent storage of commercial explosive materials. It is not applicable to transportation of explosives or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles or other heavily encased explosives.
- Storage in excess of 300,000 pounds of explosive materials in one magazine is not allowed.
- Where a manufacturing building on an explosive materials plant site is designed to contain explosive materials, such building shall be located with respect to its proximity to inhabited buildings, public highways and passenger railways based on the maximum quantity of explosive materials permitted to be in the building at one time.
- Where two or more storage magazines are located on the same property, each magazine shall comply with the minimum distances specified from inhabited buildings, railways and highways, and, in addition, they should be separated from each other by not less than the distances shown for separation of magazines, except that the quantity of explosives in detonator magazines shall govern in regard to the spacing of said detonator magazines from magazines containing other explosive materials. Where any two or more magazines are separated from each other by less than the specified separation of magazines distances, then two or more such magazines, as a group, shall be considered as one magazine, and the total quantity of explosive materials stored in such group shall be treated as if stored in a single magazine located on the site of any magazine in the group and shall comply with the minimum distances specified from other magazines, inhabited buildings, railways and highways.

## EXPLOSIVES AND FIREWORKS

**TABLE 5604.5.2(2)**  
**TABLE OF DISTANCES (Q-D) FOR BUILDINGS AND MAGAZINES CONTAINING EXPLOSIVES—DIVISION 1.3 MASS-FIRE HAZARD<sup>a, b, c</sup>**

QUANTITY OF DIVISION 1.3 EXPLOSIVES (NET EXPLOSIVES WEIGHT)		DISTANCES IN FEET			
Pounds Over	Pounds Not Over	Inhabited Building Distance (IBD)	Distance to Public Traffic Route (PTR)	Intermagazine Distance (IMD)	Intraline Distance (ILD) or Intraplant Distance (IPD)
0	1,000	75	75	50	50
1,000	5,000	115	115	75	75
5,000	10,000	150	150	100	100
10,000	20,000	190	190	125	125
20,000	30,000	215	215	145	145
30,000	40,000	235	235	155	155
40,000	50,000	250	250	165	165
50,000	60,000	260	260	175	175
60,000	70,000	270	270	185	185
70,000	80,000	280	280	190	190
80,000	90,000	295	295	195	195
90,000	100,000	300	300	200	200
100,000	200,000	375	375	250	250
200,000	300,000	450	450	300	300

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

- Black powder, where stored in magazines, is defined as low explosive by the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF).
- For quantities less than 1,000 pounds, the required distances are those specified for 1,000 pounds. The use of lesser distances is allowed where supported by approved test data or analysis.
- Linear interpolation of explosive quantities between table entries is allowed.

**TABLE 5604.5.2(3)**  
**TABLE OF DISTANCES (Q-D) FOR BUILDINGS AND MAGAZINES CONTAINING EXPLOSIVES—DIVISION 1.4<sup>c</sup>**

QUANTITY OF DIVISION 1.4 EXPLOSIVES (NET EXPLOSIVES WEIGHT)		DISTANCES IN FEET			
Pounds Over	Pounds Not Over	Inhabited Building Distance (IBD)	Distance to Public Traffic Route (PTR)	Intermagazine Distance <sup>a, b</sup> (IMD)	Intraline Distance (ILD) or Intraplant Distance <sup>a</sup> (IPD)
50	Not Limited	100	100	50	50

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

- A separation distance of 100 feet is required for buildings of other than Type I or Type II construction as defined in the *International Building Code*.
- For earth-covered magazines, specific separation is not required.
  - Earth cover material used for magazines shall be relatively cohesive. Solid or wet clay and similar types of soil are too cohesive and shall not be used. Soil shall be free from unsanitary organic matter, trash, debris and stones heavier than 10 pounds or larger than 6 inches in diameter. Compaction and surface preparation shall be provided, as necessary, to maintain structural integrity and avoid erosion. Where cohesive material cannot be used, as in sandy soil, the earth cover over magazines shall be finished with a suitable material to ensure structural integrity.
  - The earth fill or earth cover between earth-covered magazines shall be either solid or sloped, in accordance with the requirements of other construction features, but not less than 2 feet of earth cover shall be maintained over the top of each magazines. To reduce erosion and facilitate maintenance operations, the cover shall have a slope of 1 unit vertical to 2 units horizontal (50-percent slope).
- Restricted to articles, including articles packaged for shipment, that are not regulated as an explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpacked articles used in process operations that do not propagate a detonation or deflagration between articles.

**5604.5.3.3 Use.** Not more than two Type 3 magazines shall be located at the same blasting site. Where two Type 3 magazines are located at the same blasting site, one magazine shall be used solely for the storage of detonators.

**5604.6 Construction.** Magazines shall be constructed in accordance with Sections 5604.6.1 through 5604.6.5.2.

**5604.6.1 Drainage.** The ground around a magazine shall be graded so that water drains away from the magazine.

**5604.6.2 Heating.** Magazines requiring heat shall be heated as prescribed in NFPA 495 by either hot water radiant heating within the magazine or by indirect warm air heating.



## EXPLOSIVES AND FIREWORKS

**5604.6.3 Lighting.** Where lighting is necessary within a magazine, electric safety flashlights or electric safety lanterns shall be used, except as provided in NFPA 495.

**5604.6.4 Nonsparking materials.** In other than Type 5 magazines, there shall not be exposed ferrous metal on the interior of a magazine containing packages of *explosives*.

**5604.6.5 Signs and placards.** Property on which Type 1 magazines and outdoor magazines of Types 2, 4 and 5 are located shall be posted with signs stating: “NO SMOKING” and “EXPLOSIVES—KEEP OFF.” These signs shall be of contrasting colors with a minimum letter height of 3 inches (76 mm) with a minimum brush stroke of  $\frac{1}{2}$  inch (12.7 mm). The signs shall be located to minimize the possibility of a bullet shot at the sign hitting the magazine.

**5604.6.5.1 Access road signs.** At the entrance to *explosive* material manufacturing and storage sites, all access roads shall be posted with the following warning sign or other *approved* sign:

DANGER!

NEVER FIGHT EXPLOSIVE FIRES.  
EXPLOSIVES ARE STORED ON THIS SITE  
CALL \_\_\_\_\_

The sign shall be weather resistant with a reflective surface and have lettering not less than 2 inches (51 mm) high.

**5604.6.5.2 Placards.** Type 5 magazines containing Division 1.5 blasting agents shall be prominently placarded as required during transportation by DOTn 49 CFR Part 172 and DOTy 27 CFR Part 555.

**5604.7 Operation.** Magazines shall be operated in accordance with Sections 5604.7.1 through 5604.7.9.

**5604.7.1 Security.** Magazines shall be kept locked in the manner prescribed in NFPA 495 at all times except during placement or removal of *explosives* or inspection.

**5604.7.2 Open flames and lights.** Smoking, matches, flame-producing devices, open flames, firearms and firearms cartridges shall not be allowed inside of or within 50 feet (15 240 mm) of magazines.

**5604.7.3 Brush.** The area located around a magazine shall be kept clear of brush, dried grass, leaves, trash, debris and similar combustible materials for a distance of 25 feet (7620 mm).

**5604.7.4 Combustible storage.** Combustible materials shall not be stored within 50 feet (15 240 mm) of magazines.

**5604.7.5 Unpacking and repacking explosive materials.** Containers of *explosive materials*, except fiberboard containers, and packages of damaged or deteriorated *explosive materials* or fireworks shall not be unpacked or repacked inside or within 50 feet (15 240 mm) of a magazine or in close proximity to other *explosive materials*.

**5604.7.5.1 Storage of opened packages.** Packages of *explosive materials* that have been opened shall be closed before being placed in a magazine.

**5604.7.5.2 Nonsparking tools.** Tools used for the opening and closing of packages of *explosive materials*, other than metal slitters for opening paper, plastic or fiberboard containers, shall be made of nonsparking materials.

**5604.7.5.3 Disposal of packaging.** Empty containers and paper and fiber packaging materials that previously contained *explosive materials* shall be disposed of or reused in an *approved* manner.

**5604.7.6 Tools and equipment.** Metal tools, other than nonferrous transfer conveyors and ferrous metal conveyor stands protected by a coat of paint, shall not be stored in a magazine containing *explosive materials* or detonators.

**5604.7.7 Contents.** Magazines shall be used exclusively for the storage of *explosive materials*, blasting materials and blasting accessories.

**5604.7.8 Compatibility.** Corresponding grades and brands of *explosive materials* shall be stored together and in such a manner that the grade and brand marks are visible. Stocks shall be stored so as to be easily counted and checked. Packages of *explosive materials* shall be stacked in a stable manner not exceeding 8 feet (2438 mm) in height.

**5604.7.9 Stock rotation.** When *explosive material* is removed from a magazine for use, the oldest usable stocks shall be removed first.

**5604.8 Maintenance.** Maintenance of magazines shall comply with Sections 5604.8.1 through 5604.8.3.

**5604.8.1 Housekeeping.** Magazine floors shall be regularly swept and be kept clean, dry and free of grit, paper, empty packages and rubbish. Brooms and other cleaning utensils shall not have any spark-producing metal parts. Sweepings from magazine floors shall be disposed of in accordance with the manufacturer's *approved* instructions.

**5604.8.2 Repairs.** *Explosive materials* shall be removed from the magazine before making repairs to the interior of a magazine. *Explosive materials* shall be removed from the magazine before making repairs to the exterior of the magazine where there is a possibility of causing a fire. *Explosive materials* removed from a magazine under repair shall either be placed in another magazine or placed a safe distance from the magazine, where they shall be properly guarded and protected until repairs have been completed. Upon completion of repairs, the *explosive materials* shall be promptly returned to the magazine. Floors shall be cleaned before and after repairs.

**5604.8.3 Floors.** Magazine floors stained with liquid shall be dealt with in accordance with instructions obtained from the manufacturer of the *explosive material* stored in the magazine.

**5604.9 Inspection.** Magazines containing *explosive materials* shall be opened and inspected at maximum seven-day intervals. The inspection shall determine whether there has been an unauthorized or attempted entry into a magazine or an unauthorized removal of a magazine or its contents.

**5604.10 Disposal of explosive materials.** *Explosive materials* shall be disposed of in accordance with Sections 5604.10.1 through 5604.10.7.

**5604.10.1 Notification.** The *fire code official* shall be notified immediately where deteriorated or leaking *explosive materials* are determined to be dangerous or unstable and in need of disposal.

**5604.10.2 Deteriorated materials.** Where an *explosive material* has deteriorated to an extent that it is in an unstable or dangerous condition, or when a liquid has leaked from an *explosive material*, the person in possession of such material shall immediately contact the material's manufacturer to obtain disposal and handling instructions.

**5604.10.3 Qualified person.** The work of destroying explosive materials shall be directed by persons experienced in the destruction of *explosive materials*.

**5604.10.4 Storage of misfires.** *Explosive materials* and fireworks recovered from blasting or display misfires shall be placed in a magazine until an experienced person has determined the proper method for disposal.

**5604.10.5 Disposal sites.** Sites for the destruction of *explosive materials* and fireworks shall be *approved* and located at the maximum practicable safe distance from inhabited buildings, public highways, operating buildings and all other exposures to ensure keeping air blast and ground vibration to a minimum. The location of disposal sites shall not be closer to magazines, inhabited buildings, railways, highways and other rights-of-way than is allowed by Tables 5604.5.2(1), 5604.5.2(2) and 5604.5.2(3). Where possible, *barricades* shall be utilized between the destruction site and inhabited buildings. Areas where *explosives* are detonated or burned shall be posted with adequate warning signs.

**5604.10.6 Reuse of site.** Unless an *approved* burning site has been thoroughly saturated with water and has passed a safety inspection, 48 hours shall elapse between the completion of a burn and the placement of scrap *explosive materials* for a subsequent burn.

**5604.10.7 Personnel safeguards.** Once an *explosive* burn operation has been started, personnel shall relocate to a safe location where adequate protection from air blast and flying debris is provided. Personnel shall not return to the burn area until the person in charge has inspected the burn site and determined that it is safe for personnel to return.

## SECTION 5605 MANUFACTURE, ASSEMBLY AND TESTING OF EXPLOSIVES, EXPLOSIVE MATERIALS AND FIREWORKS

**5605.1 General.** The manufacture, assembly and testing of *explosives*, ammunition, blasting agents and fireworks shall

comply with the requirements of this section and NFPA 495 or NFPA 1124.

### Exceptions:

1. The hand loading of small arms ammunition prepared for personal use and not offered for resale.
2. The mixing and loading of blasting agents at blasting sites in accordance with NFPA 495.
3. The use of binary *explosives* or phosphoric materials in blasting or pyrotechnic special effects applications in accordance with NFPA 495 or NFPA 1126.

**5605.2 Emergency planning and preparedness.** Emergency plans, emergency drills, employee training and hazard communication shall conform to the provisions of this section and Sections 404, 405, 406 and 407.

**5605.2.1 Hazardous Materials Management Plans and Inventory Statements required.** Detailed Hazardous Materials Management Plans (HMMP) and Hazardous Materials Inventory Statements (HMIS) complying with the requirements of Section 407 shall be prepared and submitted to the local emergency planning committee, the *fire code official* and the local fire department.

**5605.2.2 Maintenance of plans.** A copy of the required HMMP and HMIS shall be maintained on site and furnished to the *fire code official* on request.

**5605.2.3 Employee training.** Workers who handle *explosives* or *explosive* charges or dispose of *explosives* shall be trained in the hazards of the materials and processes in which they are to be engaged and with the safety rules governing such materials and processes.

**5605.2.4 Emergency procedures.** *Approved* emergency procedures shall be formulated for each plant and shall include personal instruction in any anticipated emergency. Personnel shall be made aware of an emergency warning signal.

**5605.3 Intraplant separation of operating buildings.** *Explosives* manufacturing buildings and fireworks manufacturing buildings, including those where *explosive* charges are assembled, manufactured, prepared or loaded utilizing Division 1.1, 1.2, 1.3, 1.4 or 1.5 *explosives*, shall be separated from all other buildings, including magazines, within the confines of the manufacturing plant, at a distance not less than those shown in Table 5604.5.2(3) or Table 5605.3, as appropriate.

The quantity of *explosives* in an operating building shall be the net weight of all *explosives* contained therein. Distances shall be based on the hazard division requiring the greatest separation, unless the aggregate *explosive* weight is divided by *approved* walls or shields designed for that purpose. Where dividing a quantity of *explosives* into smaller stacks, a suitable barrier or adequate separation distance shall be provided to prevent propagation from one stack to another.

Where distance is used as the sole means of separation within a building, such distance shall be established by test-

## EXPLOSIVES AND FIREWORKS

ing. Testing shall demonstrate that propagation between stacks will not result. Barriers provided to protect against explosive effects shall be designed and installed in accordance with *approved* standards.

**Exception:** Fireworks manufacturing buildings separated in accordance with NFPA 1124.

**TABLE 5605.3**  
**MINIMUM INTRALINE (INTRAPLANT) SEPARATION DISTANCES**  
**(ILD OR IPD) BETWEEN BARRICADED OPERATING BUILDINGS**  
**CONTAINING EXPLOSIVES—DIVISION 1.1, 1.2 OR 1.5**  
**MASS-EXPLOSION HAZARD<sup>a</sup>**

NET EXPLOSIVE WEIGHT		
Pounds Over	Pounds Not Over	Intraline Distance (ILD) or Intraplant Distance (IPD) (feet)
0	50	30
50	100	40
100	200	50
200	300	60
300	400	65
400	500	70
500	600	75
600	700	80
700	800	85
800	900	90
900	1,000	95
1,000	1,500	105
1,500	2,000	115
2,000	3,000	130
3,000	4,000	140
4,000	5,000	150
5,000	6,000	160
6,000	7,000	170
7,000	8,000	180
8,000	9,000	190
9,000	10,000	200
10,000	15,000	225
15,000	20,000	245
20,000	25,000	265
25,000	30,000	280
30,000	35,000	295
35,000	40,000	310
40,000	45,000	320
45,000	50,000	330
50,000	55,000	340
55,000	60,000	350
60,000	65,000	360
65,000	70,000	370

(continued)

**TABLE 5605.3—continued**  
**MINIMUM INTRALINE (INTRAPLANT) SEPARATION DISTANCES**  
**(ILD OR IPD) BETWEEN BARRICADED OPERATING BUILDINGS**  
**CONTAINING EXPLOSIVES—DIVISION 1.1, 1.2 OR 1.5**  
**MASS-EXPLOSION HAZARD<sup>a</sup>**

NET EXPLOSIVE WEIGHT		
Pounds Over	Pounds Not Over	Intraline Distance (ILD) or Intraplant Distance (IPD) (feet)
70,000	75,000	385
75,000	80,000	390
80,000	85,000	395
85,000	90,000	400
90,000	95,000	410
95,000	100,000	415
100,000	125,000	450
125,000	150,000	475
150,000	175,000	500
175,000	200,000	525
200,000	225,000	550
225,000	250,000	575
250,000	275,000	600
275,000	300,000	635

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

a. Where a building or magazine containing explosives is not barricaded, the intraline distances shown in this table shall be doubled.

**5605.4 Separation of manufacturing operating buildings from inhabited buildings, public traffic routes and magazines.** Where an operating building on an *explosive materials* plant site is designed to contain *explosive materials*, such a building shall be located away from inhabited buildings, public traffic routes and magazines in accordance with Table 5604.5.2(2) or 5604.5.2(3) as appropriate, based on the maximum quantity of *explosive materials* permitted to be in the building at one time (see Section 5601.8).

**Exception:** Fireworks manufacturing buildings constructed and operated in accordance with NFPA 1124.

**5605.4.1 Determination of net explosive weight for operating buildings.** In addition to the requirements of Section 5601.8 to determine the net *explosive* weight for materials stored or used in operating buildings, quantities of *explosive materials* stored in magazines located at distances less than intraline distances from the operating building shall be added to the contents of the operating building to determine the net *explosive* weight for the operating building.

**5605.4.1.1 Indoor magazines.** The storage of *explosive materials* located in indoor magazines in operating buildings shall be limited to a net *explosive* weight not to exceed 50 pounds (23 kg).

**5605.4.1.2 Outdoor magazines with a net explosive weight less than 50 pounds.** The storage of *explosive materials* in outdoor magazines located at less than intraline distances from operating buildings shall be



limited to a net explosive weight not to exceed 50 pounds (23 kg).

**5605.4.1.3 Outdoor magazines with a net explosive weight greater than 50 pounds.** The storage of *explosive materials* in outdoor magazines in quantities exceeding 50 pounds (23 kg) net *explosive* weight shall be limited to storage in outdoor magazines located not less than intraline distances from the operating building in accordance with Section 5604.5.2.

**5605.4.1.4 Net explosive weight of materials stored in combination indoor and outdoor magazines.** The aggregate quantity of *explosive materials* stored in any combination of indoor magazines or outdoor magazines located at less than the intraline distances from an operating building shall not exceed 50 pounds (23 kg).

**5605.5 Buildings and equipment.** Buildings or rooms that exceed the *maximum allowable quantity per control area* of *explosive materials* shall be operated in accordance with this section and constructed in accordance with the requirements of the *International Building Code* for Group H occupancies.

**Exception:** Fireworks manufacturing buildings constructed and operated in accordance with NFPA 1124.

**5605.5.1 Explosives dust.** *Explosives* dust shall not be exhausted to the atmosphere.

**5605.5.1.1 Wet collector.** When collecting *explosives* dust, a wet collector system shall be used. Wetting agents shall be compatible with the *explosives*. Collector systems shall be interlocked with process power supplies so that the process cannot continue without the collector systems operating.

**5605.5.1.2 Waste disposal and maintenance.** *Explosives* dust shall be removed from the collection chamber as often as necessary to prevent overloading. The entire system shall be cleaned at a frequency that will eliminate hazardous concentrations of *explosives* dust in pipes, tubing and ducts.

**5605.5.2 Exhaust fans.** Squirrel cage blowers shall not be used for exhausting hazardous fumes, vapors or gases. Only nonferrous fan blades shall be used for fans located within the ductwork and through which hazardous materials are exhausted. Motors shall be located outside the duct.

**5605.5.3 Work stations.** Work stations shall be separated by distance, barrier or other *approved* alternatives so that fire in one station will not ignite material in another work station. Where necessary, the operator shall be protected by a personnel shield located between the operator and the *explosive* device or *explosive material* being processed. This shield and its support shall be capable of withstanding a blast from the maximum amount of *explosives* allowed behind it.

**5605.6 Operations.** Operations involving *explosives* shall comply with Sections 5605.6.1 through 5605.6.10.

**5605.6.1 Isolation of operations.** Where the type of material and processing warrants, mechanical operations involving *explosives* in excess of 1 pound (0.454 kg) shall be carried on at isolated stations or at intraplant distances, and machinery shall be controlled from remote locations behind *barricades* or at separations so that workers will be at a safe distance while machinery is operating.

**5605.6.2 Static controls.** The work area where the screening, grinding, blending and other processing of static-sensitive *explosives* or pyrotechnic materials is done shall be provided with *approved* static controls.

**5605.6.3 Approved containers.** Bulk *explosives* shall be kept in *approved*, nonsparking containers when not being used or processed. *Explosives* shall not be stored or transported in open containers.

**5605.6.4 Quantity limits.** The quantity of *explosives* at any particular work station shall be limited to that posted on the load limit signs for the individual work station. The total quantity of *explosives* for multiple work stations shall not exceed that established by the intraplant distances in Table 5604.5.2(3) or Table 5605.3, as appropriate.

**5605.6.4.1 Magazines.** Magazines used for storage in processing areas shall be in accordance with the requirements of Section 5604.5.1. *Explosive materials* shall be removed to appropriate storage magazines for unattended storage at the end of the workday. The contents of indoor magazines shall be added to the quantity of *explosives* contained at individual work stations and the total quantity of material stored, processed or used shall be utilized to establish the intraplant separation distances indicated by Table 5604.5.2(3) or Table 5605.3, as appropriate.

**5605.6.5 Waste disposal.** *Approved* receptacles with covers shall be provided for each location for disposing of waste material and debris. These waste receptacles shall be emptied and cleaned as often as necessary but not less than once each day or at the end of each shift.

**5605.6.6 Safety rules.** General safety rules and operating instructions governing the particular operation or process conducted at that location shall be available at each location.

**5605.6.7 Personnel limits.** The number of occupants in each process building and in each magazine shall not exceed the number necessary for proper conduct of production operations.

**5605.6.8 Pyrotechnic and explosive composition quantity limits.** Not more than 500 pounds (227 kg) of pyrotechnic or *explosive* composition, including not more than 10 pounds (5 kg) of salute powder shall be allowed at one time in any process building or area. Compositions not in current use shall be kept in covered nonferrous containers.

**Exception:** Composition that has been loaded or pressed into tubes or other containers as consumer fireworks.



## EXPLOSIVES AND FIREWORKS

**5605.6.9 Posting limits.** The maximum number of occupants and maximum weight of pyrotechnic and *explosive* composition permitted in each process building shall be posted in a conspicuous location in each process building or magazine.

**5605.6.10 Heat sources.** Fireworks, *explosives* or *explosive* charges in *explosive materials* manufacturing, assembly or testing shall not be stored near any source of heat.

**Exception:** *Approved* drying or curing operations.

**5605.7 Maintenance.** Maintenance and repair of *explosives*-manufacturing facilities and areas shall comply with Section 5604.8.

**5605.8 Explosive materials testing sites.** *Detonation* of *explosive materials* or ignition of fireworks for testing purposes shall be done only in isolated areas at sites where distance, protection from missiles, shrapnel or flyrock, and other safeguards provides protection against injury to personnel or damage to property.

**5605.8.1 Protective clothing and equipment.** Protective clothing and equipment shall be provided to protect persons engaged in the testing, ignition or *detonation* of *explosive materials*.

**5605.8.2 Site security.** Where tests are being conducted or *explosives* are being detonated, only authorized persons shall be present. Areas where *explosives* are regularly or frequently detonated or burned shall be *approved* and posted with adequate warning signs. Warning devices shall be activated before burning or detonating *explosives* to alert persons approaching from any direction that they are approaching a danger zone.

**5605.9 Waste disposal.** Disposal of *explosive materials* waste from manufacturing, assembly or testing operations shall be in accordance with Section 5604.10.

### SECTION 5606 SMALL ARMS AMMUNITION AND SMALL ARMS AMMUNITION COMPONENTS

**5606.1 General.** Indoor storage and display of black powder, smokeless propellants, small arms primers, small arms ammunition and commercial reloading shall comply with this section and NFPA 495.

**5606.2 Prohibited storage.** Small arms ammunition shall not be stored together with Division 1.1, Division 1.2 or Division 1.3 *explosives* unless the storage facility is suitable for the storage of *explosive materials*.

**5606.3 Packages.** Smokeless propellants shall be stored in *approved* shipping containers conforming to DOTn 49 CFR Part 173.

**5606.3.1 Repackaging.** The bulk repackaging of smokeless propellants, black powder and small arms primers shall not be performed in retail establishments.

**5606.3.2 Damaged packages.** Damaged containers shall not be repackaged.

**Exception:** *Approved* repackaging of damaged containers of smokeless propellant into containers of the same type and size as the original container.

**5606.4 Storage in Group R occupancies.** The storage of small arms ammunition components in Group R occupancies shall comply with Sections 5606.4.1 through 5606.4.3.

**5606.4.1 Black powder.** Black powder for personal use in quantities not exceeding 20 pounds (9 kg) shall be stored in original containers in occupancies limited to Group R-3. Quantities exceeding 20 pounds (9 kg) shall not be stored in any Group R occupancy.

**5606.4.2 Smokeless propellants.** Smokeless propellants for personal use in quantities not exceeding 20 pounds (9 kg) shall be stored in original containers in occupancies limited to Group R-3. Smokeless propellants in quantities exceeding 20 pounds (9 kg) but not exceeding 50 pounds (23 kg) and kept in a wooden box or cabinet having walls of not less than 1 inch (25 mm) nominal thickness shall be allowed to be stored in occupancies limited to Group R-3. Quantities exceeding these amounts shall not be stored in any Group R occupancy.

**5606.4.3 Small arms primers.** Not more than 10,000 small arms primers shall be stored in occupancies limited to Group R-3.

**5606.5 Display and storage in Group M occupancies.** The display and storage of small arms ammunition components in Group M occupancies shall comply with Sections 5606.5.1 through 5606.5.2.3.

**5606.5.1 Display.** Display of small arms ammunition components in Group M occupancies shall comply with Sections 5606.5.1.1 through 5606.5.1.3.

**5606.5.1.1 Smokeless propellant.** Not more than 20 pounds (9 kg) of smokeless propellants, in containers of 1 pound (0.454 kg) or less capacity each, shall be displayed in Group M occupancies.

**5606.5.1.2 Black powder.** Not more than 1 pound (0.454 kg) of black powder shall be displayed in Group M occupancies.

**5606.5.1.3 Small arms primers.** Not more than 10,000 small arms primers shall be displayed in Group M occupancies.

**5606.5.2 Storage.** Storage of small arms ammunition components shall comply with Sections 5606.5.2.1 through 5606.5.2.3.

**5606.5.2.1 Smokeless propellant.** Commercial stocks of smokeless propellants shall be stored as follows:

1. Quantities exceeding 20 pounds (9 kg), but not exceeding 100 pounds (45 kg) shall be stored in portable wooden boxes having walls of not less than 1 inch (25 mm) nominal thickness.

2. Quantities exceeding 100 pounds (45 kg), but not exceeding 800 pounds (363 kg), shall be stored in nonportable storage cabinets having walls not less than 1 inch (25 mm) nominal thickness. Not more than 400 pounds (182 kg) shall be stored in any one cabinet, and cabinets shall be separated by a distance of not less than 25 feet (7620 mm) or by a *fire partition* having a *fire-resistance rating* of not less than 1 hour.
3. Storage of quantities exceeding 800 pounds (363 kg), but not exceeding 5,000 pounds (2270 kg) in a building shall comply with all of the following:
  - 3.1. The warehouse or storage room is not open to unauthorized personnel.
  - 3.2. Smokeless propellant shall be stored in nonportable storage cabinets having wood walls not less than 1 inch (25 mm) nominal thickness and having shelves with not more than 3 feet (914 mm) of separation between shelves.
  - 3.3. Not more than 400 pounds (182 kg) is stored in any one cabinet.
  - 3.4. Cabinets shall be located against walls of the storage room or warehouse with not less than 40 feet (12 192 mm) between cabinets.
  - 3.5. The minimum required separation between cabinets shall be 20 feet (6096 mm) provided that *barricades* twice the height of the cabinets are attached to the wall, midway between each cabinet. The *barricades* must extend not less than 10 feet (3048 mm) outward, be firmly attached to the wall and be constructed of steel not less than  $\frac{1}{4}$  inch thick (6.4 mm), 2-inch (51 mm) nominal thickness wood, brick or concrete block.
  - 3.6. Smokeless propellant shall be separated from materials classified as *combustible liquids*, *flammable liquids*, flammable solids or oxidizing materials by a distance of 25 feet (7620 mm) or by a *fire partition* having a *fire-resistance rating* of 1 hour.
  - 3.7. The building shall be equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
4. Smokeless propellants not stored in accordance with Item 1, 2, or 3 shall be stored in a Type 2 or 4 magazine in accordance with Section 5604 and NFPA 495.

**5606.5.2.2 Black powder.** Commercial stocks of black powder in quantities less than 50 pounds (23 kg) shall be allowed to be stored in Type 2 or 4 indoor or

outdoor magazines. Quantities greater than 50 pounds (23 kg) shall be stored in outdoor Type 2 or 4 magazines. Where black powder and smokeless propellants are stored together in the same magazine, the total quantity shall not exceed that permitted for black powder.

**5606.5.2.3 Small arms primers.** Commercial stocks of small arms primers shall be stored as follows:

1. Quantities not to exceed 750,000 small arms primers stored in a building shall be arranged such that not more than 100,000 small arms primers are stored in any one pile and piles are not less than 15 feet (4572 mm) apart.
2. Quantities exceeding 750,000 small arms primers stored in a building shall comply with all of the following:
  - 2.1. The warehouse or storage building is not open to unauthorized personnel.
  - 2.2. Small arms primers shall be stored in cabinets. Not more than 200,000 small arms primers shall be stored in any one cabinet.
  - 2.3. Shelves in cabinets shall have vertical separation of not less than 2 feet (610 mm).
  - 2.4. Cabinets shall be located against walls of the warehouse or storage room with not less than 40 feet (12 192 mm) between cabinets. The minimum required separation between cabinets shall be allowed to be reduced to 20 feet (6096 mm) provided that *barricades* twice the height of the cabinets are attached to the wall, midway between each cabinet. The *barricades* shall be firmly attached to the wall and shall be constructed of steel not less than  $\frac{1}{4}$  inch thick (6.4 mm), 2-inch (51 mm) nominal thickness wood, brick or concrete block.
  - 2.5. Small arms primers shall be separated from materials classified as *combustible liquids*, *flammable liquids*, flammable solids or oxidizing materials by a distance of 25 feet (7620 mm) or by a *fire partition* having a *fire-resistance rating* of 1 hour.
  - 2.6. The building shall be protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
3. Small arms primers not stored in accordance with Item 1 or 2 of this section shall be stored in a magazine meeting the requirements of Section 5604 and NFPA 495.

## EXPLOSIVES AND FIREWORKS

**5606.6 Commercial reloading.** Commercial reloading of small arms ammunition shall comply with Sections 5606.6.1 through 5606.6.8.

**5606.6.1 Electrical.** Areas within 3 feet (914 mm) of reloading equipment shall be Class I, Division 2, Group A type.

**5606.6.2 Exhaust fans.** Squirrel cage blowers shall not be used for exhausting hazardous fumes, vapors or gases. Only nonferrous fan blades shall be used for fans located within the ductwork and through which hazardous materials are exhausted. Motors shall be located outside the duct.

**5606.6.3 Work stations.** Work stations shall be separated by distance, barrier or other *approved* alternatives so that fire in one station will not ignite material in another work station.

**5606.6.4 Personnel limits.** The number of occupants in each process building and in each magazine shall not exceed the number necessary for proper conduct of production operations.

**5606.6.5 Approved containers.** Smokeless powder shall be kept in its original container.

**5606.6.6 Static controls.** The work area shall be provided with *approved* static controls.

**5606.6.7 Waste disposal.** *Approved* receptacles with covers shall be provided for each location for disposing of waste material and debris. These waste receptacles shall be emptied and cleaned as often as necessary but not less than once each day or at the end of each shift.

**5606.6.8 Safety rules.** General safety rules and operating instructions governing the particular operation or process conducted at that location shall be available at each location.

## SECTION 5607 BLASTING

**5607.1 General.** Blasting operations shall be conducted only by *approved*, competent operators familiar with the required safety precautions and the hazards involved and in accordance with the provisions of NFPA 495.

**5607.2 Manufacturer's instructions.** Blasting operations shall be performed in accordance with the instructions of the manufacturer of the *explosive materials* being used.

**5607.3 Blasting in congested areas.** Where blasting is done in a congested area or in close proximity to a structure, railway or highway, or any other installation, precautions shall be taken to minimize earth vibrations and air blast effects. Blasting mats or other protective means shall be used to prevent fragments from being thrown.

**5607.4 Restricted hours.** Surface-blasting operations shall only be conducted during daylight hours between sunrise and sunset. Other blasting shall be performed during daylight hours unless otherwise *approved* by the *fire code official*.

**5607.5 Utility notification.** Where blasting is being conducted in the vicinity of utility lines or rights-of-way, the blaster shall notify the appropriate representatives of the utilities not less than 24 hours in advance of blasting, specifying the location and intended time of such blasting. Verbal notices shall be confirmed with written notice.

**Exception:** In an emergency situation, the time limit shall not apply where *approved*.

**5607.6 Electric detonator precautions.** Precautions shall be taken to prevent accidental discharge of electric detonators from currents induced by radar and radio transmitters, lightning, adjacent power lines, dust and snowstorms, or other sources of extraneous electricity.

**5607.7 Nonelectric detonator precautions.** Precautions shall be taken to prevent accidental initiation of nonelectric detonators from stray currents induced by lightning or static electricity.

**5607.8 Blasting area security.** During the time that holes are being loaded or are loaded with *explosive materials*, blasting agents or detonators, only authorized persons engaged in drilling and loading operations or otherwise authorized to enter the site shall be allowed at the blast site. The blast site shall be guarded or barricaded and posted. Blast site security shall be maintained until after the post-blast inspection has been completed.

**5607.9 Drill holes.** Holes drilled for the loading of *explosive* charges shall be made and loaded in accordance with NFPA 495.

**5607.10 Removal of excess explosive materials.** After loading for a blast is completed and before firing, excess *explosive materials* shall be removed from the area and returned to the proper storage facilities.

**5607.11 Initiation means.** The initiation of blasts shall be by means conforming to the provisions of NFPA 495.

**5607.12 Connections.** The blaster shall supervise the connecting of the blastholes and the connection of the load-line to the power source or initiation point. Connections shall be made progressively from the blasthole back to the initiation point.

Blasting lead lines shall remain shunted (shorted) and shall not be connected to the blasting machine or other source of current until the blast is to be fired.

**5607.13 Firing control.** A blast shall not be fired until the blaster has made certain that all surplus *explosive materials* are in a safe place in accordance with Section 5607.10, all persons and equipment are at a safe distance or under sufficient cover and that an adequate warning signal has been given.

**5607.14 Post-blast procedures.** After the blast, the following procedures shall be observed.

1. Persons shall not return to the blast area until allowed to do so by the blaster in charge.
2. The blaster shall allow sufficient time for smoke and fumes to dissipate and for dust to settle before returning to or approaching the blast area.

3. The blaster shall inspect the entire blast site for misfires before allowing other personnel to return to the blast area.

**5607.15 Misfires.** Where a misfire is suspected, all initiating circuits shall be traced and a search made for unexploded charges. Where a misfire is found, the blaster shall provide proper safeguards for excluding all personnel from the blast area. Misfires shall be reported to the blasting supervisor immediately. Misfires shall be handled under the direction of the person in charge of the blasting operation in accordance with NFPA 495.

## SECTION 5608 FIREWORKS DISPLAY

**5608.1 General.** Outdoor fireworks displays, use of pyrotechnics before a *proximate audience* and pyrotechnic special effects in motion picture, television, theatrical and group entertainment productions shall comply with Sections 5608.2 through 5608.10 and NFPA 1123 or NFPA 1126.

**5608.2 Permit application.** Prior to issuing permits for a fireworks display, plans for the fireworks display, inspections of the display site and demonstrations of the display operations shall be *approved*. A plan establishing procedures to follow and actions to be taken in the event that a shell fails to ignite in, or discharge from, a mortar or fails to function over the fallout area or other malfunctions shall be provided to the *fire code official*.

**5608.2.1 Outdoor fireworks displays.** In addition to the requirements of Section 403, permit applications for outdoor fireworks displays using Division 1.3G fireworks shall include a diagram of the location at which the fireworks display will be conducted, including the site from which fireworks will be discharged; the location of buildings, highways, overhead obstructions and utilities; and the lines behind which the audience will be restrained.

**5608.2.2 Use of pyrotechnics before a proximate audience.** Where the separation distances required in Section 5608.4 and NFPA 1123 are unavailable or cannot be secured, fireworks displays shall be conducted in accordance with NFPA 1126 for *proximate audiences*. Applications for use of pyrotechnics before a *proximate audience* shall include plans indicating the required clearances for spectators and combustibles, crowd control measures, smoke control measures and requirements for standby personnel and equipment where provision of such personnel or equipment is required by the *fire code official*.

**5608.3 Approved fireworks displays.** *Approved* fireworks displays shall include only the *approved* fireworks 1.3G, fireworks 1.4G, fireworks 1.4S and pyrotechnic articles 1.4G, which shall be handled by an *approved*, competent operator. The *approved* fireworks shall be arranged, located, discharged and fired in a manner that will not pose a hazard to property or endanger any person.

**5608.4 Clearance.** Spectators, spectator parking areas, and *dwelling*s, buildings or structures shall not be located within the display site.

### Exceptions:

1. This provision shall not apply to pyrotechnic special effects and fireworks displays using Division 1.4G materials before a *proximate audience* in accordance with NFPA 1126.
2. This provision shall not apply to unoccupied *dwelling*s, buildings and structures with the approval of the building owner and the *fire code official*.

**5608.5 Storage of fireworks at display site.** The storage of fireworks at the display site shall comply with the requirements of this section and NFPA 1123 or NFPA 1126.

**5608.5.1 Supervision and weather protection.** Beginning as soon as fireworks have been delivered to the display site, they shall not be left unattended.

**5608.5.2 Weather protection.** Fireworks shall be kept dry after delivery to the display site.

**5608.5.3 Inspection.** Shells shall be inspected by the operator or assistants after delivery to the display site. Shells having tears, leaks, broken fuses or signs of having been wet shall be set aside and shall not be fired. Aerial shells shall be checked for proper fit in mortars prior to discharge. Aerial shells that do not fit properly shall not be fired. After the fireworks display, damaged, deteriorated or dud shells shall either be returned to the supplier or destroyed in accordance with the supplier's instructions and Section 5604.10.

**Exception:** Minor repairs to fuses shall be allowed. For electrically ignited displays, attachment of electric matches and similar tasks shall be allowed.

**5608.5.4 Sorting and separation.** After delivery to the display site and prior to the fireworks display, all shells shall be separated according to their size and their designation as salutes.

**Exception:** For electrically fired displays, or displays where all shells are loaded into mortars prior to the show, separation of shells according to their size or their designation as salutes is not required.

**5608.5.5 Ready boxes.** Display fireworks, 1.3G, that will be temporarily stored at the site during the fireworks display shall be stored in ready boxes located upwind and not less than 25 feet (7620 mm) from the mortar placement and separated according to their size and their designation as salutes.

**Exception:** For electrically fired fireworks displays, or fireworks displays where all shells are loaded into mortars prior to the show, separation of shells according to their size, their designation as salutes or for the use of ready boxes is not required.



## EXPLOSIVES AND FIREWORKS

**5608.6 Installation of mortars.** Mortars for firing fireworks shells shall be installed in accordance with NFPA 1123 and shall be positioned so that shells are propelled away from spectators and over the fallout area. Mortars shall not be angled toward the spectator viewing area. Prior to placement, mortars shall be inspected for defects, such as dents, bent ends, damaged interiors and damaged plugs. Defective mortars shall not be used.

**5608.7 Handling.** Aerial shells shall be carried to mortars by the shell body. For the purpose of loading mortars, aerial shells shall be held by the thick portion of the fuse and carefully loaded into mortars.

**5608.8 Fireworks display supervision.** Whenever in the opinion of the *fire code official* or the operator a hazardous condition exists, the fireworks display shall be discontinued immediately until such time as the dangerous situation is corrected.

**5608.9 Post-fireworks display inspection.** After the fireworks display, the firing crew shall conduct an inspection of the fallout area for the purpose of locating unexploded aerial shells or live components. This inspection shall be conducted before public access to the site shall be allowed. Where fireworks are displayed at night and it is not possible to inspect the site thoroughly, the operator or designated assistant shall inspect the entire site at first light.

A report identifying any shells that fail to ignite in, or discharge from, a mortar or fail to function over the fallout area or otherwise malfunction, shall be filed with the *fire code official*.

**5608.10 Disposal.** Any shells found during the inspection required in Section 5608.9 shall not be handled until not less than 15 minutes have elapsed from the time the shells were fired. The fireworks shall then be doused with water and allowed to remain for not less than 5 additional minutes before being placed in a plastic bucket or fiberboard box. The disposal instructions of the manufacturer as provided by the fireworks supplier shall then be followed in disposing of the fireworks in accordance with Section 5604.10.

## SECTION 5609 TEMPORARY STORAGE OF CONSUMER FIREWORKS

**5609.1 General.** Where the display or temporary storage of fireworks 1.4G (consumer fireworks) is allowed by Section 5601.1.3, Exception 4, such display or storage shall comply with the applicable requirements of NFPA 1124.

## CHAPTER 57

# FLAMMABLE AND COMBUSTIBLE LIQUIDS

### User note:

**About this chapter:** Chapter 57 provides requirements that are intended to reduce the likelihood of fires involving the storage, handling, use or transportation of flammable and combustible liquids. Adherence to these practices may also limit damage in the event of an accidental fire involving these materials. These liquids are used for fuel, lubricants, cleaners, solvents, medicine and even drinking. The danger associated with flammable and combustible liquids is that the vapors from these liquids, when combined with air in their flammable range, will burn or explode at temperatures near normal living and working environments. The regulations herein are intended to prevent the flammable and combustible liquids from being ignited and provide mitigating requirements for when a fire does occur.

### SECTION 5701 GENERAL

**5701.1 Scope and application.** Prevention, control and mitigation of dangerous conditions related to storage, use, dispensing, mixing and handling of *flammable* and *combustible liquids* shall be in accordance with Chapter 50 and this chapter.

**5701.2 Nonapplicability.** This chapter shall not apply to liquids as otherwise provided in other laws or regulations or chapters of this code, including:

1. Specific provisions for *flammable liquids* in motor fuel-dispensing facilities, repair garages, airports and marinas in Chapter 23.
2. Medicines, foodstuffs, cosmetics and commercial or institutional products containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solution not being flammable, provided that such materials are packaged in individual containers not exceeding 1.3 gallons (5 L).
3. Quantities of alcoholic beverages in retail or wholesale sales or storage occupancies, provided that the liquids are packaged in individual containers not exceeding 1.3 gallons (5 L).
4. Storage and use of fuel oil in tanks and containers connected to oil-burning equipment. Such storage and use shall be in accordance with Section 605. For abandonment of fuel oil tanks, this chapter applies.
5. Refrigeration systems (see Section 608).
6. Storage and display of aerosol products complying with Chapter 51.
7. Storage and use of liquids that do not have a fire point when tested in accordance with ASTM D92.
8. Liquids with a *flash point* greater than 95°F (35°C) in a water-miscible solution or dispersion with a water and inert (noncombustible) solids content of more than 80 percent by weight, which do not sustain combustion.
9. Liquids without *flash points* that can be flammable under some conditions, such as certain halogenated hydrocarbons and mixtures containing halogenated hydrocarbons.

10. The storage of beer, distilled spirits and wines in barrels and casks.
11. Commercial cooking oil storage tank systems located within a building and designed and installed in accordance with Section 607 and NFPA 30.
12. Application and release of pesticide and agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications where applied in accordance with the manufacturer's instructions and label directions.
13. The off-site transportation of *flammable* or *combustible liquids* where in accordance with Department of Transportation (DOTn) regulation.

**5701.3 Referenced documents.** The applicable requirements of Chapter 50, other chapters of this code, the *International Building Code* and the *International Mechanical Code* pertaining to *flammable liquids* shall apply.

**5701.4 Permits.** Permits shall be required as set forth in Sections 105.5 and 105.6.

**5701.5 Material classification.** *Flammable* and *combustible liquids* shall be classified in accordance with the definitions in Chapter 2.

When mixed with lower flash-point liquids, Class II or III liquids are capable of assuming the characteristics of the lower flash-point liquids. Under such conditions, the appropriate provisions of this chapter for the actual *flash point* of the mixed liquid shall apply.

When heated above their *flash points*, Class II and III liquids assume the characteristics of Class I liquids. Under such conditions, the appropriate provisions of this chapter for *flammable liquids* shall apply.

### SECTION 5702 DEFINITIONS

**5702.1 Definitions.** The following terms are defined in Chapter 2:

**ALCOHOL-BASED HAND RUB.**

**BULK PLANT OR TERMINAL.**

**BULK TRANSFER.**

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

### COMBUSTIBLE LIQUID.

Class II.

Class IIIA.

Class IIIB.

### FIRE POINT.

### FLAMMABLE LIQUID.

Class IA.

Class IB.

Class IC.

### FLASH POINT.

### FUEL LIMIT SWITCH.

### LIQUID STORAGE ROOM.

### LIQUID STORAGE WAREHOUSE.

### MOBILE FUELING.

### PROCESS TRANSFER.

### REFINERY.

### REMOTE EMERGENCY SHUTOFF DEVICE.

### REMOTE SOLVENT RESERVOIR.

### SOLVENT DISTILLATION UNIT.

### TANK, PRIMARY.

## SECTION 5703 GENERAL REQUIREMENTS

**5703.1 Electrical.** Electrical wiring and equipment shall be installed and maintained in accordance with Section 603 and NFPA 70.

**5703.1.1 Classified locations for flammable liquids.** Areas where *flammable liquids* are stored, handled, dispensed or mixed shall be in accordance with Table 5703.1.1. A classified area shall not extend beyond an unpierced floor, roof or other solid partition.

The extent of the classified area is allowed to be reduced, or eliminated, where sufficient technical justification is provided to the *fire code official* that a concentration in the area in excess of 25 percent of the lower flammable limit (LFL) cannot be generated.

**5703.1.2 Classified locations for combustible liquids.** Areas where Class II or III liquids are heated above their *flash points* shall have electrical installations in accordance with Section 5703.1.1.

**Exception:** Solvent distillation units in accordance with Section 5705.4.

**5703.1.3 Other applications.** The *fire code official* is authorized to determine the extent of the Class I electrical equipment and wiring location where a condition is not specifically covered by these requirements or NFPA 70.

**5703.2 Fire protection.** Fire protection for the storage, use, dispensing, mixing, handling and on-site transportation of

*flammable and combustible liquids* shall be in accordance with this chapter and applicable sections of Chapter 9.

### **5703.2.1 Portable fire extinguishers and hose lines.**

Portable fire extinguishers shall be provided in accordance with Section 906. Hose lines shall be provided in accordance with Section 905.

**5703.3 Site assessment.** In the event of a spill, leak or discharge from a tank system, a site assessment shall be completed by the *owner* or operator of such tank system if the *fire code official* determines that a potential fire or explosion hazard exists. Such site assessments shall be conducted to ascertain potential fire hazards and shall be completed and submitted to the fire department within a time period established by the *fire code official*, not to exceed 60 days.

**5703.4 Spill control and secondary containment.** Where the *maximum allowable quantity per control area* is exceeded, and where required by Section 5004.2, rooms, buildings or areas used for storage, dispensing, use, mixing or handling of Class I, II and IIIA liquids shall be provided with spill control and secondary containment in accordance with Section 5004.2.

**5703.5 Labeling and signage.** The *fire code official* is authorized to require warning signs for the purpose of identifying the hazards of storing or using *flammable liquids*. Signage for identification and warning such as for the inherent hazard of flammable liquids or smoking shall be provided in accordance with this chapter and Sections 5003.5 and 5003.6.

**5703.5.1 Style.** Warning signs shall be of a durable material. Signs warning of the hazard of *flammable liquids* shall have white lettering on a red background and shall read: "DANGER—FLAMMABLE LIQUIDS." Letters shall be not less than 3 inches (76 mm) in height and  $\frac{1}{2}$  inch (12.7 mm) in stroke.

**5703.5.2 Location.** Signs shall be posted in locations as required by the *fire code official*. Piping containing *flammable liquids* shall be identified in accordance with ASME A13.1.

**5703.5.3 Warning labels.** Individual containers, packages and cartons shall be identified, marked, labeled and placarded in accordance with federal regulations and applicable state laws.

**5703.5.4 Identification.** Color coding or other *approved* identification means shall be provided on each loading and unloading riser for *flammable or combustible liquids* to identify the contents of the tank served by the riser.

**5703.6 Piping systems.** Piping systems, and their component parts, for *flammable and combustible liquids* shall be in accordance with Sections 5703.6.1 through 5703.6.11.

**5703.6.1 Nonapplicability.** The provisions of Section 5703.6 shall not apply to gas or oil well installations; piping that is integral to stationary or portable engines, including aircraft, watercraft and motor vehicles; and piping in connection with boilers and pressure vessels regulated by the *International Mechanical Code*.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**TABLE 5703.1.1**  
**CLASS I ELECTRICAL EQUIPMENT LOCATIONS<sup>a</sup>**

LOCATION	GROUP D DIVISION	EXTENT OF CLASSIFIED AREA
<b>Underground tank fill opening</b>	1	Pits, boxes or spaces below grade level, any part of which is within the Division 1 or 2 classified area.
	2	Up to 18 inches above grade level within a horizontal radius of 10 feet from a loose-fill connection and within a horizontal radius of 5 feet from a tight-fill connection.
<b>Vent—Discharging upward</b>	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 5 feet of open end of vent, extending in all directions.
<b>Drum and container filling</b>		
Outdoor or indoor with adequate ventilation	1	Within 3 feet of vent and fill opening, extending in all directions.
	2	Area between 3 feet and 5 feet from vent of fill opening, extending in all directions. Also up to 18 inches above floor or grade level within a horizontal radius of 10 feet from vent or fill opening.
<b>Pumps, bleeders, withdrawal fittings, meters and similar devices</b>		
Indoor	2	Within 5 feet of any edge of such devices, extending in all directions, and up to 3 feet above floor or grade level within 25 feet horizontally from any edge of such devices.
Outdoor	2	Within 3 feet of any edge of such devices, extending in all directions, and up to 18 inches above floor or grade level within 10 feet horizontally from an edge of such devices.
<b>Pits</b>		
Without mechanical ventilation	1	Entire area within pit if any part is within a Division 1 or 2 classified area.
With mechanical ventilation	2	Entire area within pit if any part is within a Division 1 or 2 classified area.
Containing valves, fittings or piping, and not within a Division 1 or 2 classified area	2	Entire pit.
<b>Drainage ditches, separators, impounding basins</b>		
Indoor	1 or 2	Same as pits.
Outdoor	2	Area up to 18 inches above ditch, separator or basin, and up to 18 inches above grade within 15 feet horizontal from any edge.
<b>Tank vehicle and tank car<sup>b</sup></b>		
Loading through open dome	1	Within 3 feet of edge of dome, extending in all directions.
	2	Area between 3 feet and 15 feet from edge of dome, extending in all directions.
Loading through bottom connections with atmospheric venting	1	Within 3 feet of point of venting to atmosphere, extending in all directions.
	2	Area between 3 feet and 15 feet from point of venting to atmosphere, extending in all directions. Also up to 18 inches above grade within a horizontal radius of 10 feet from point of loading connection.
Loading through closed dome with atmospheric venting	1	Within 3 feet of open end of vent, extending in all directions.
	2	Area between 3 feet and 15 feet from open end of vent, extending in all directions, and within 3 feet of edge of dome, extending in all directions.
Loading through closed dome with vapor control	2	Within 3 feet of point of connection of both fill and vapor lines, extending in all directions.
Bottom loading with vapor control or any bottom unloading	2	Within 3 feet of point of connection, extending in all directions, and up to 18 inches above grade within a horizontal radius of 10 feet from point of connection.

(continued)



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**TABLE 5703.1.1—continued**  
**CLASS I ELECTRICAL EQUIPMENT LOCATIONS<sup>a</sup>**

LOCATION	GROUP D DIVISION	EXTENT OF CLASSIFIED AREA
Storage and repair garage for tank vehicles	1	Pits or spaces below floor level.
	2	Area up to 18 inches above floor or grade level for entire storage or repair garage.
Garages for other than tank vehicles	Ordinary	Where there is an opening to these rooms within the extent of an outdoor classified area, the entire room shall be classified the same as the area classification at the point of the opening.
Outdoor drum storage	Ordinary	—
Indoor warehousing where there is no flammable liquid transfer	Ordinary	Where there is an opening to these rooms within the extent of an indoor classified area, the room shall be classified the same as if the wall, curb or partition did not exist.
Indoor equipment where flammable vapor/air mixtures could exist under normal operations	1	Area within 5 feet of any edge of such equipment, extending in all directions.
	2	Area within 5 feet of any edge of such equipment, extending in all directions. Area between 5 feet and 8 feet of any edge of such equipment, extending in all directions, and the area up to 3 feet above floor or grade level within 5 feet to 25 feet horizontally from any edge of such equipment. <sup>c</sup>
Outdoor equipment where flammable vapor/air mixtures could exist under normal operations	1	Area within 3 feet of any edge of such equipment, extending in all directions.
	2	Area between 3 feet and 8 feet of any edge of such equipment extending in all directions, and the area up to 3 feet above floor or grade level within 3 feet to 10 feet horizontally from any edge of such equipment.
Tank—Above ground		
Shell, ends or roof and dike area	1	Area inside dike where dike height is greater than the distance from the tank to the dike for more than 50 percent of the tank circumference.
	2	Area within 10 feet from shell, ends or roof of tank. Area inside dikes to level of top of dike.
Vent	1	Area within 5 feet of open end of vent, extending in all directions.
	2	Area between 5 feet and 10 feet from open end of vent, extending in all directions.
Floating roof	1	Area above the roof and within the shell.
Office and restrooms	Ordinary	Where there is an opening to these rooms within the extent of an indoor classified location, the room shall be classified the same as if the wall, curb or partition did not exist.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- Locations as classified in NFPA 70.
- When classifying extent of area, consideration shall be given to the fact that tank cars or tank vehicles can be spotted at varying points. Therefore, the extremities of the loading or unloading positions shall be used.
- The release of Class I liquids can generate vapors to the extent that the entire building, and possibly a zone surrounding it, are considered a Class I, Division 2, location.

**5703.6.2 Design and fabrication of piping systems and components.** Piping system components shall be designed and fabricated in accordance with the applicable standard listed in Table 5703.6.2 and Chapter 27 of NFPA 30, except as modified by Section 5703.6.2.1.

**5703.6.2.1 Special materials.** Low-melting-point materials (such as aluminum, copper or brass), materials that soften on fire exposure (such as nonmetallic materials) and nonductile material (such as cast iron) shall be acceptable for use underground in accordance with the applicable standard listed in Table 5703.6.2. Where such materials are used outdoors in above-ground piping systems or within buildings, they shall

**TABLE 5703.6.2**  
**PIPING STANDARDS**

PIPING USE	STANDARD
Power piping	ASME B31.1
Process piping	ASME B31.3
Pipeline transportation systems for liquid hydrocarbons and other liquids	ASME B31.4
Building services piping	ASME B31.9
Double containment piping	UL 971A, UL 1369

be in accordance with the applicable standard listed in Table 5703.6.2 and one of the following:

1. Suitably protected against fire exposure.
2. Located where leakage from failure would not unduly expose people or structures.
3. Located where leakage can be readily controlled by operation of remotely located valves in a location provided with *ready access*.

In all cases, nonmetallic piping shall be used in accordance with Section 27.4.6 of NFPA 30.

**5703.6.3 Testing.** Unless tested in accordance with the applicable section of ASME B31.9, piping, before being covered, enclosed or placed in use, shall be hydrostatically tested to 150 percent of the maximum anticipated pressure of the system, or pneumatically tested to 110 percent of the maximum anticipated pressure of the system, but not less than 5 pounds per square inch gauge (psig) (34.47 kPa) at the highest point of the system. This test shall be maintained for a sufficient time period to complete visual inspection of joints and connections. For not less than 10 minutes, there shall be no leakage or permanent distortion. Care shall be exercised to ensure that these pressures are not applied to vented storage tanks. Such storage tanks shall be tested independently from the piping.

**5703.6.3.1 Existing piping.** Existing piping shall be tested in accordance with this section where the *fire code official* has reasonable cause to believe that a leak exists. Piping that could contain flammable or *combustible liquids* shall not be tested pneumatically. Such tests shall be at the expense of the *owner* or operator.

**Exception:** Vapor-recovery piping is allowed to be tested using an inert gas.

**5703.6.4 Protection from vehicles.** Guard posts or other *approved* means shall be provided to protect piping, valves or fittings subject to vehicular damage in accordance with Section 312.

**5703.6.5 Protection from external corrosion and galvanic action.** Where subject to external corrosion, piping, related fluid-handling components and supports for both underground and above-ground applications shall be fabricated from noncorrosive materials, and coated or provided with corrosion protection. Dissimilar metallic parts that promote galvanic action shall not be joined.

**5703.6.6 Valves.** Piping systems shall contain a sufficient number of manual control valves and check valves to operate the system properly and to protect the plant under both normal and emergency conditions. Piping systems in connection with pumps shall contain a sufficient number of such valves to control properly the flow of liquids in normal operation and in the event of physical damage or fire exposure.

**5703.6.6.1 Backflow protections.** Connections to pipelines or piping by which equipment (such as tank

cars, tank vehicles or marine vessels) discharges liquids into storage tanks shall be provided with check valves or block valves for automatic protection against backflow where the piping arrangement is such that backflow from the system is possible. Where loading and unloading is done through a common pipe system, a check valve is not required. However, a block valve, located in an area where it is provided with *ready access* or remotely operable, shall be provided.

**5703.6.6.2 Manual drainage.** Manual drainage-control valves shall be located at *approved* locations remote from the tanks, diked area, drainage system and impounding basin to ensure their operation in a fire condition.

**5703.6.7 Connections.** Above-ground tanks with connections located below normal liquid level shall be provided with internal or external isolation valves located as close as practical to the shell of the tank. Except for liquids whose chemical characteristics are incompatible with steel, such valves, where external, and their connections to the tank shall be of steel.

**5703.6.8 Piping supports.** Piping systems shall be substantially supported and protected against physical damage and excessive stresses arising from settlement, vibration, expansion, contraction or exposure to fire. The supports shall be protected against exposure to fire by one of the following:

1. Draining liquid away from the piping system at a minimum slope of not less than 1 percent.
2. Providing protection with a *fire-resistance rating* of not less than 2 hours.
3. Other *approved* methods.

**5703.6.9 Flexible joints.** Flexible joints shall be *listed* and *approved* and shall be installed on underground liquid, vapor and vent piping at all of the following locations:

1. Where piping connects to underground tanks.
2. Where piping ends at pump islands and vent risers.
3. At points where differential movement in the piping can occur.

**5703.6.9.1 Fiberglass-reinforced plastic piping.** Fiberglass-reinforced plastic (FRP) piping is not required to be provided with flexible joints in locations where both of the following conditions are present:

1. Piping does not exceed 4 inches (102 mm) in diameter.
2. Piping has a straight run of not less than 4 feet (1219 mm) on one side of the connection where such connections result in a change of direction.

In lieu of the minimum 4-foot (1219 mm) straight run length, *approved* and *listed* flexible joints are allowed to be used under dispensers and suction pumps, at submerged pumps and tanks, and where vents extend above ground.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5703.6.10 Pipe joints.** Joints shall be liquid tight and shall be welded, flanged or threaded except that *listed* flexible connectors are allowed in accordance with Section 5703.6.9. Threaded or flanged joints shall fit tightly by using *approved* methods and materials for the type of joint. Joints in piping systems used for Class I liquids shall be welded where located in concealed spaces within buildings.

Nonmetallic joints shall be *approved* and shall be installed in accordance with the manufacturer's instructions.

Pipe joints that are dependent on the friction characteristics or resiliency of combustible materials for liquid tightness of piping shall not be used in buildings. Piping shall be secured to prevent disengagement at the fitting.

**5703.6.11 Bends.** Pipe and tubing shall be bent in accordance with ASME B31.9.

### SECTION 5704 STORAGE

**5704.1 General.** The storage of *flammable* and *combustible liquids* in containers and tanks shall be in accordance with this section and the applicable sections of Chapter 50.

**5704.2 Tank storage.** The provisions of this section shall apply to:

1. The storage of *flammable* and *combustible liquids* in fixed above-ground and underground tanks.
2. The storage of *flammable* and *combustible liquids* in fixed above-ground tanks inside of buildings.
3. The storage of *flammable* and *combustible liquids* in portable tanks whose capacity exceeds 660 gallons (2498 L).
4. The installation of such tanks and portable tanks.

**5704.2.1 Change of tank contents.** Tanks subject to change in contents shall be in accordance with Section 5704.2.7. Prior to a change in contents, the *fire code official* is authorized to require testing of a tank.

Tanks that have previously contained Class I liquids shall not be loaded with Class II or Class III liquids until such tanks and all piping, pumps, hoses and meters connected thereto have been completely drained and flushed.

**5704.2.2 Use of tank vehicles and tank cars as storage tanks.** Tank cars and tank vehicles shall not be used as storage tanks.

**5704.2.3 Labeling and signs.** Labeling and signs for storage tanks and storage tank areas shall comply with Sections 5704.2.3.1 and 5704.2.3.2.

**5704.2.3.1 Smoking and open flame.** Signs shall be posted in storage areas prohibiting open flames and smoking. Signs shall comply with Section 5703.5.

**5704.2.3.2 Label or placard.** Tanks more than 100 gallons (379 L) in capacity, which are permanently installed or mounted and used for the storage of Class

I, II or III liquids, shall bear a label and placard identifying the material therein. Placards shall be in accordance with NFPA 704.

#### Exceptions:

1. Tanks of 300-gallon (1136 L) capacity or less located on private property and used for heating and cooking fuels in single-family *dwellings*.
2. Tanks located underground.

**5704.2.4 Sources of ignition.** Smoking and open flames are prohibited in storage areas in accordance with Section 5003.7.

**Exception:** Areas designated as smoking and hot work areas, and areas where hot work permits have been issued in accordance with this code.

**5704.2.5 Explosion control.** Explosion control shall be provided in accordance with Section 911 for indoor tanks.

**5704.2.6 Separation from incompatible materials.** Storage of *flammable* and *combustible liquids* shall be separated from *incompatible materials* in accordance with Section 5003.9.8.

Grass, weeds, combustible materials and waste Class I, II or IIIA liquids shall not be accumulated in an unsafe manner at a storage site.

**5704.2.7 Design, fabrication and construction requirements for tanks.** The design, fabrication and construction of tanks shall comply with NFPA 30. Each tank shall bear a permanent nameplate or marking indicating the standard used as the basis of design.

**5704.2.7.1 Materials used in tank construction.** The materials used in tank construction shall be in accordance with NFPA 30. The materials of construction for tanks and their appurtenances shall be compatible with the liquids to be stored.

**5704.2.7.2 Pressure limitations for tanks.** Tanks shall be designed for the pressures to which they will be subjected in accordance with NFPA 30.

**5704.2.7.3 Tank vents for normal venting.** Tank vents for normal venting shall be installed and maintained in accordance with Sections 5704.2.7.3.1 through 5704.2.7.3.5.3.

**5704.2.7.3.1 Vent lines.** Vent lines from tanks shall not be used for purposes other than venting unless *approved*.

**5704.2.7.3.2 Vent-line flame arresters and pressure-vacuum vents.** *Listed* or *approved* flame arresters or pressure-vacuum (PV) vents that remain closed unless venting under pressure or vacuum conditions shall be installed in normal vents of tanks containing Class IB and IC liquids.

Vent-line flame arresters shall be installed in accordance with their listing or API 2000 and maintained in accordance with Section 21.8.6 of NFPA 30 or API 2000. In-line flame arresters in piping systems shall be installed and maintained in accor-

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

dance with their listing or API 2028. Pressure-vacuum vents shall be installed in accordance with Section 21.4.3 of NFPA 30 or API 2000 and maintained in accordance with Section 21.8.6 of NFPA 30 or API 2000.

**Exception:** Where determined by the *fire code official* that the use of these devices can result in damage to the tank.

**5704.2.7.3.3 Vent pipe outlets.** Vent pipe outlets for tanks storing Class I, II or IIIA liquids shall be located such that the vapors are released at a safe point outside of buildings and not less than 12 feet (3658 mm) above the finished ground level. Vapors shall be discharged upward or horizontally away from adjacent walls to assist in vapor dispersion. Vent outlets shall be located such that flammable vapors will not be trapped by eaves or other obstructions and shall be not less than 5 feet (1524 mm) from building openings or *lot lines* of properties that can be built on. Vent outlets on atmospheric tanks storing Class IIIB liquids are allowed to discharge inside a building where the vent is a normally closed vent.

**Exception:** Vent pipe outlets on tanks storing Class IIIB liquid inside buildings and connected to fuel-burning equipment shall be located such that the vapors are released to a safe location outside of buildings.

**5704.2.7.3.4 Installation of vent piping.** Vent piping shall be designed, sized, constructed and installed in accordance with Section 5703.6. Vent pipes shall be installed such that they will drain toward the tank without sags or traps in which liquid can collect. Vent pipes shall be installed in such a manner so as not to be subject to physical damage or vibration.

**5704.2.7.3.5 Manifolding.** Tank vent piping shall not be manifolded unless required for special purposes such as vapor recovery, vapor conservation or air pollution control.

**5704.2.7.3.5.1 Above-ground tanks.** For above-ground tanks, manifolded vent pipes shall be adequately sized to prevent system pressure limits from being exceeded where manifolded tanks are subject to the same fire exposure.

**5704.2.7.3.5.2 Underground tanks.** For underground tanks, manifolded vent pipes shall be sized to prevent system pressure limits from being exceeded when manifolded tanks are filled simultaneously.

**5704.2.7.3.5.3 Tanks storing Class I liquids.** Vent piping for tanks storing Class I liquids shall not be manifolded with vent piping for tanks storing Class II and III liquids unless positive means are provided to prevent the vapors from Class I liquids from entering tanks storing Class II and III liquids, to prevent contamination and

possible change in classification of less volatile liquid.

**5704.2.7.4 Emergency venting.** Stationary, above-ground tanks shall be equipped with additional venting that will relieve excessive internal pressure caused by exposure to fires. Emergency vents for Class I, II and IIIA liquids shall not discharge inside buildings. The venting shall be installed and maintained in accordance with Section 22.7 of NFPA 30.

**Exceptions:**

1. Tanks larger than 12,000 gallons (45 420 L) in capacity storing Class IIIB liquids that are not within the diked area or the drainage path of Class I or II liquids do not require emergency relief venting.
2. Emergency vents on protected above-ground tanks complying with UL 2085 containing Class II or IIIA liquids are allowed to discharge inside the building.

**5704.2.7.5 Tank openings other than vents.** Tank openings for other than vents shall comply with Sections 5704.2.7.5.1 through 5704.2.7.5.8.

**5704.2.7.5.1 Connections below liquid level.** Connections for tank openings below the liquid level shall be liquid tight.

**5704.2.7.5.2 Filling, emptying and vapor recovery connections.** Filling, emptying and vapor recovery connections to tanks containing Class I, II or IIIA liquids shall be located outside of buildings in accordance with Section 5704.2.7.5.6 at a location free from sources of ignition and not less than 5 feet (1524 mm) away from building openings or *lot lines* of property that can be built on. Such openings shall be properly identified and provided with a liquid-tight cap that shall be closed when not in use.

Filling and emptying connections to indoor tanks containing Class IIIB liquids and connected to fuel-burning equipment shall be located at a finished ground level location outside of buildings. Such openings shall be provided with a liquid-tight cap that shall be closed when not in use. A sign in accordance with Section 5003.6 that displays the following warning shall be permanently attached at the filling location:

TRANSFERRING FUEL OTHER THAN  
CLASS IIIB COMBUSTIBLE LIQUID TO  
THIS TANK CONNECTION IS A VIOLATION  
OF THE FIRE CODE AND IS STRICTLY  
PROHIBITED

**5704.2.7.5.3 Piping, connections and fittings.** Piping, connections, fittings and other appurtenances shall be installed in accordance with Section 5703.6.

**5704.2.7.5.4 Manual gauging.** Openings for manual gauging, if independent of the fill pipe, shall be provided with a liquid-tight cap or cover. Covers



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

shall be kept closed when not gauging. If inside a building, such openings shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other *approved* device.

**5704.2.7.5.5 Fill pipes and discharge lines.** For top-loaded tanks, a metallic fill pipe shall be designed and installed to minimize the generation of static electricity by terminating the pipe within 6 inches (152 mm) of the bottom of the tank, and it shall be installed in a manner that avoids excessive vibration.

**5704.2.7.5.5.1 Class I liquids.** For Class I liquids other than crude oil, gasoline and asphalt, the fill pipe shall be designed and installed in a manner that will minimize the possibility of generating static electricity by terminating within 6 inches (152 mm) of the bottom of the tank.

**5704.2.7.5.5.2 Underground tanks.** For underground tanks, fill pipe and discharge lines shall enter only through the top. Fill lines shall be sloped toward the tank. Underground tanks for Class I liquids having a capacity greater than 1,000 gallons (3785 L) shall be equipped with a tight fill device for connecting the fill hose to the tank.

**5704.2.7.5.6 Location of connections that are made or broken.** Filling, withdrawal and vapor-recovery connections for Class I, II and IIIA liquids that are made and broken shall be located outside of buildings, not more than 5 feet (1524 mm) above the finished ground level, in an *approved* location in close proximity to the parked delivery vehicle. Such location shall be away from sources of ignition and not less than 5 feet (1524 mm) away from building openings. Such connections shall be closed and liquid tight when not in use and shall be properly identified.

**5704.2.7.5.7 Protection against vapor release.** Tank openings provided for purposes of vapor recovery shall be protected against possible vapor release by means of a spring-loaded check valve or dry-break connections, or other *approved* device, unless the opening is a pipe connected to a vapor processing system. Openings designed for combined fill and vapor recovery shall be protected against vapor release unless connection of the liquid delivery line to the fill pipe simultaneously connects the vapor recovery line. Connections shall be vapor tight.

**5704.2.7.5.8 Overfill prevention.** An *approved* means or method in accordance with Section 5704.2.9.7.5 shall be provided to prevent the overfill of all Class I, II and IIIA liquid storage tanks. Storage tanks in refineries, bulk plants or terminals regulated by Section 5706.4 or 5706.7 shall have overfill protection in accordance with API 2350.

An *approved* means or method in accordance with Section 5704.2.9.7.5 shall be provided to prevent the overfilling of Class IIIB liquid storage tanks connected to fuel-burning equipment inside buildings.

**Exception:** Outside above-ground tanks with a capacity of 1,320 gallons (5000 L) or less.

**5704.2.7.6 Repair, alteration or reconstruction of tanks and piping.** The repair, alteration or reconstruction, including welding, cutting and hot tapping of storage tanks and piping that have been placed in service, shall be in accordance with NFPA 30. Hot work, as defined in Section 202, on such tanks shall be conducted in accordance with Section 3510.

**5704.2.7.7 Design of supports.** The design of the supporting structure for tanks shall be in accordance with the *International Building Code* and NFPA 30.

**5704.2.7.8 Locations subject to flooding.** Where a tank is located in an area where it is subject to buoyancy because of a rise in the water table, flooding or accumulation of water from fire suppression operations, uplift protection shall be provided in accordance with Sections 22.14 and 23.14 of NFPA 30.

**5704.2.7.9 Corrosion protection.** Where subject to external corrosion, tanks shall be fabricated from corrosion-resistant materials, coated or provided with corrosion protection in accordance with Section 23.3.5 of NFPA 30.

**5704.2.7.10 Leak reporting.** A consistent or accidental loss of liquid, or other indication of a leak from a tank system, shall be reported immediately to the fire department, the *fire code official* and other authorities having jurisdiction.

**5704.2.7.10.1 Leaking tank disposition.** Leaking tanks shall be promptly emptied, repaired and returned to service, abandoned or removed in accordance with Section 5704.2.13 or 5704.2.14.

**5704.2.7.11 Tank lining.** Steel tanks are allowed to be lined only for the purpose of protecting the interior from corrosion or providing compatibility with a material to be stored. Only those liquids tested for compatibility with the lining material are allowed to be stored in lined tanks.

**5704.2.8 Vaults.** Vaults shall be allowed to be either above or below grade and shall comply with Sections 5704.2.8.1 through 5704.2.8.18.

**5704.2.8.1 Listing required.** Vaults shall be *listed* in accordance with UL 2245.

**Exception:** Where *approved* by the *fire code official*, below-grade vaults are allowed to be constructed on site, provided that the design is in accordance with the *International Building Code* and that special inspections are conducted to verify structural strength and compliance of the installation with the *approved* design in accordance with Section 1707 of the *International Building Code*.

Installation plans for below-grade vaults that are constructed on site shall be prepared by, and the design shall bear the stamp of, a professional engineer. Consideration shall be given to soil and hydrostatic loading on the floors, walls and lid; anticipated seismic forces; uplifting by groundwater or flooding; and to loads imposed from above such as traffic and equipment loading on the vault lid.

**5704.2.8.2 Design and construction.** The vault shall completely enclose each tank. There shall not be openings in the vault enclosure except those necessary for access to, inspection of, and filling, emptying and venting of the tank. The walls and floor of the vault shall be constructed of reinforced concrete not less than 6 inches (152 mm) thick. The top of an above-grade vault shall be constructed of noncombustible material and shall be designed to be weaker than the walls of the vault, to ensure that the thrust of an explosion occurring inside the vault is directed upward before significantly high pressure can develop within the vault.

The top of an at-grade or below-grade vault shall be designed to relieve safely or contain the force of an explosion occurring inside the vault. The top and floor of the vault and the tank foundation shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. The walls and floor of a vault installed below grade shall be designed to withstand anticipated soil and hydrostatic loading.

Vaults shall be designed to be wind and earthquake resistant, in accordance with the *International Building Code*.

**5704.2.8.3 Secondary containment.** Vaults shall be substantially liquid tight and there shall not be backfill around the tank or within the vault. The vault floor shall drain to a sump. For premanufactured vaults, liquid tightness shall be certified as part of the listing provided by a nationally recognized testing laboratory. For field-erected vaults, liquid tightness shall be certified in an *approved* manner.

**5704.2.8.4 Internal clearance.** There shall be sufficient clearance between the tank and the vault to allow for visual inspection and maintenance of the tank and its appurtenances. Dispensing devices are allowed to be installed on tops of vaults.

**5704.2.8.5 Anchoring.** Vaults and their tanks shall be suitably anchored to withstand uplifting by ground water or flooding, including when the tank is empty.

**5704.2.8.6 Vehicle impact protection.** Vaults shall be resistant to damage from the impact of a motor vehicle, or vehicle impact protection shall be provided in accordance with Section 312.

**5704.2.8.7 Arrangement.** Tanks shall be *listed* for above-ground use, and each tank shall be in its own vault. Compartmentalized tanks shall be allowed and shall be considered as a single tank. Adjacent vaults shall be allowed to share a common wall. The common

wall shall be liquid and vapor tight and shall be designed to withstand the load imposed when the vault on either side of the wall is filled with water.

**5704.2.8.8 Connections.** Connections shall be provided to permit venting of each vault to dilute, disperse and remove vapors prior to personnel entering the vault.

**5704.2.8.9 Ventilation.** Vaults that contain tanks of Class I liquids shall be provided with an exhaust ventilation system installed in accordance with Section 5004.3. The ventilation system shall operate continuously or be designed to operate upon activation of the vapor or liquid detection system. The system shall provide ventilation at a rate of not less than 1 cubic foot per minute (cfm) per square foot of floor area [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ], but not less than 150 cfm (4  $\text{m}^3/\text{min}$ ). The exhaust system shall be designed to provide air movement across all parts of the vault floor. Supply and exhaust ducts shall extend to within 3 inches (76 mm), but not more than 12 inches (305 mm), of the floor. The exhaust system shall be installed in accordance with the *International Mechanical Code*.

**5704.2.8.10 Liquid detection.** Vaults shall be equipped with a detection system capable of detecting liquids, including water, and activating an alarm.

**5704.2.8.11 Monitoring and detection.** Vaults shall be provided with *approved* vapor and liquid detection systems and equipped with on-site audible and visual warning devices with battery backup. Vapor detection systems shall sound an alarm when the system detects vapors that reach or exceed 25 percent of the lower explosive limit (LEL) of the liquid stored. Vapor detectors shall be located not higher than 12 inches (305 mm) above the lowest point in the vault. Liquid detection systems shall sound an alarm upon detection of any liquid, including water. Liquid detectors shall be located in accordance with the manufacturer's instructions. Activation of either vapor or liquid detection systems shall cause a signal to be sounded at an *approved*, constantly attended location within the facility serving the tanks or at an *approved* location. Activation of vapor detection systems shall shut off dispenser pumps.

**5704.2.8.12 Liquid removal.** Means shall be provided to recover liquid from the vault. Where a pump is used to meet this requirement, the pump shall not be permanently installed in the vault. Electric-powered portable pumps shall be suitable for use in Class I, Division 1, or Zone 0 locations, as defined in NFPA 70.

**5704.2.8.13 Normal vents.** Vent pipes that are provided for normal tank venting shall terminate not less than 12 feet (3658 mm) above ground level.

**5704.2.8.14 Emergency vents.** Emergency vents shall be vapor tight and shall be allowed to discharge inside the vault. Long-bolt manhole covers shall not be allowed for this purpose.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5704.2.8.15 Accessway.** Vaults shall be provided with an *approved* personnel accessway with a minimum dimension of 30 inches (762 mm) and with a permanently affixed, nonferrous ladder. Accessways shall be designed to be nonsparking. Travel distance from any point inside a vault to an accessway shall not exceed 20 feet (6096 mm). At each entry point, a warning sign indicating the need for procedures for safe entry into confined spaces shall be posted. Entry points shall be secured against unauthorized entry and vandalism.

**5704.2.8.16 Fire protection.** Vaults shall be provided with a suitable means to admit a fire suppression agent.

**5704.2.8.17 Classified area.** The interior of a vault containing a tank that stores a Class I liquid shall be designated a Class I, Division 1, or Zone 0 location, as defined in NFPA 70.

**5704.2.8.18 Overfill protection.** Overfill protection shall be provided in accordance with Section 5704.2.9.7.5. The use of a float vent valve shall be prohibited.

**5704.2.9 Above-ground tanks.** Above-ground storage of *flammable* and *combustible liquids* in tanks shall comply with Section 5704.2 and Sections 5704.2.9.1 through 5704.2.9.7.9.

**5704.2.9.1 Existing noncompliant installations.** Existing above-ground tanks shall be maintained in accordance with the code requirements that were applicable at the time of installation. Above-ground tanks that were installed in violation of code requirements applicable at the time of installation shall be made code compliant or shall be removed in accordance with Section 5704.2.14, regardless of whether such tank has been previously inspected (see Section 108.4).

**5704.2.9.2 Fire protection.** Fire protection for above-ground tanks shall comply with Sections 5704.2.9.2.1 through 5704.2.9.2.4.

**5704.2.9.2.1 Required foam fire protection systems.** Where required by the *fire code official*, foam fire protection shall be provided for above-ground tanks, other than pressure tanks operating at or above 1 pound per square inch gauge (psig) (6.89 kPa) where such tank, or group of tanks spaced less than 50 feet (15 240 mm) apart measured shell to shell, has a liquid surface area in excess of 1,500 square feet (139 m<sup>2</sup>), and is in accordance with one of the following:

1. Used for the storage of Class I or II liquids.
2. Used for the storage of crude oil.
3. Used for in-process products and is located within 100 feet (30 480 mm) of a fired still, heater, related fractioning or processing apparatus or similar device at a processing plant or petroleum refinery as herein defined.

4. Considered by the *fire code official* as posing an unusual exposure hazard because of topographical conditions; nature of occupancy, proximity on the same or adjoining property, and height and character of liquids to be stored; degree of private fire protection to be provided; and facilities of the fire department to cope with *flammable liquid* fires.

**5704.2.9.2.2 Foam fire protection system installation.** Where foam fire protection is required, it shall be installed in accordance with NFPA 11.

**5704.2.9.2.2.1 Foam storage.** Where foam fire protection is required, foam-producing materials shall be stored on the premises.

**Exception:** Storage of foam-producing materials off the premises is allowed as follows:

1. Such materials stored off the premises shall be of the proper type suitable for use with the equipment at the installation where required.
2. Such materials shall be readily available at the storage location at all times.
3. Adequate loading and transportation facilities shall be provided.
4. The time required to deliver such materials to the required location in the event of fire shall be consistent with the hazards and fire scenarios for which the foam supply is intended.
5. At the time of a fire, these off-premises supplies shall be accumulated in sufficient quantities before placing the equipment in operation to ensure foam production at an adequate rate without interruption until extinguishment is accomplished.

**5704.2.9.2.3 Fire protection of supports.** Supports or pilings for above-ground tanks storing Class I, II or IIIA liquids elevated more than 12 inches (305 mm) above grade shall have a *fire-resistance rating* of not less than 2 hours in accordance with the fire exposure criteria specified in ASTM E1529.

**Exceptions:**

1. Structural supports tested as part of a protected above-ground tank in accordance with UL 2085.
2. Stationary tanks located outside of buildings where protected by an *approved* water-spray system designed in accordance with Chapter 9 and NFPA 15.
3. Stationary tanks located inside of buildings equipped throughout with an *approved automatic sprinkler system*



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

designed in accordance with Section 903.3.1.1.

**5704.2.9.2.4 Inerting of tanks storing boilover liquids.** Liquids with boilover characteristics shall not be stored in fixed roof tanks larger than 150 feet (45 720 mm) in diameter unless an *approved* gas enrichment or inerting system is provided on the tank.

**Exception:** Crude oil storage tanks in production fields with no other exposures adjacent to the storage tank.

**5704.2.9.3 Supports, foundations and anchorage.** Supports, foundations and anchorages for above-ground tanks shall be designed and constructed in accordance with NFPA 30 and the *International Building Code*.

**5704.2.9.4 Stairways, platforms and walkways.** Stairways, platforms and walkways shall be of noncombustible construction and shall be designed and constructed in accordance with NFPA 30 and the *International Building Code*.

**5704.2.9.5 Above-ground tanks inside of buildings.** Above-ground tanks inside of buildings shall comply with Sections 5704.2.9.5.1 and 5704.2.9.5.2.

**5704.2.9.5.1 Overfill prevention.** Above-ground tanks storing Class I, II and IIIA liquids inside buildings shall be equipped with a device or other means to prevent overflow into the building including, but not limited to: a float valve; a preset meter on the fill line; a valve actuated by the weight of the tank's contents; a low-head pump that is incapable of producing overflow; or a liquid-tight overflow pipe not less than one pipe size larger than the fill pipe and discharging by gravity back to the outside source of liquid or to an *approved* location. Tanks containing Class IIIB liquids and connected to fuel-burning equipment shall be provided with a means to prevent overflow into buildings in accordance with Section 5704.2.7.5.8.

**5704.2.9.5.2 Fill pipe connections.** Fill pipe connections for tanks storing Class I, II and IIIA liquids and Class IIIB liquids connected to fuel-burning equipment shall be in accordance with Section 5704.2.9.7.6.

**5704.2.9.6 Above-ground tanks outside of buildings.** Above-ground tanks outside of buildings shall comply with Sections 5704.2.9.6.1 through 5704.2.9.6.3.

**5704.2.9.6.1 Locations where above-ground tanks are prohibited.** Storage of Class I and II liquids in above-ground tanks outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited [JURISDICTION TO SPECIFY].

**5704.2.9.6.1.1 Location of tanks with pressures 2.5 psig or less.** Above-ground tanks operating at pressures not exceeding 2.5 psig

(17.2 kPa) for storage of Class I, II or IIIA liquids, which are designed with a floating roof, a weak roof-to-shell seam or equipped with emergency venting devices limiting pressure to 2.5 psig (17.2 kPa), shall be located in accordance with Table 22.4.1.1(a) of NFPA 30.

**Exceptions:**

1. Vertical tanks having a weak roof-to-shell seam and storing Class IIIA liquids are allowed to be located at one-half the distances specified in Table 22.4.1.1(a) of NFPA 30, provided that the tanks are not within a diked area or drainage path for a tank storing Class I or II liquids.
2. Liquids with boilover characteristics and unstable liquids in accordance with Sections 5704.2.9.6.1.3 and 5704.2.9.6.1.4.
3. For protected above-ground tanks in accordance with Section 5704.2.9.7 and tanks in at-grade or above-grade vaults in accordance with Section 5704.2.8, the distances in Table 22.4.1.1(b) of NFPA 30 shall apply and shall be reduced by one-half, but not to less than 5 feet (1524 mm).

**5704.2.9.6.1.2 Location of tanks with pressures exceeding 2.5 psig.** Above-ground tanks for the storage of Class I, II or IIIA liquids operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting allowing pressures to exceed 2.5 psig (17.2 kPa) shall be located in accordance with Table 22.4.1.3 of NFPA 30.

**Exception:** Liquids with boilover characteristics and unstable liquids in accordance with Sections 5704.2.9.6.1.3 and 5704.2.9.6.1.4.

**5704.2.9.6.1.3 Location of tanks storing boilover liquids.** Above-ground tanks for storage of liquids with boilover characteristics shall be located in accordance with Table 22.4.1.4 of NFPA 30.

**5704.2.9.6.1.4 Location of tanks storing unstable liquids.** Above-ground tanks for the storage of unstable liquids shall be located in accordance with Table 22.4.1.5 of NFPA 30.

**5704.2.9.6.1.5 Location of tanks storing Class IIIB liquids.** Above-ground tanks for the storage of Class IIIB liquids, excluding unstable liquids, shall be located in accordance with Table 22.4.1.6 of NFPA 30, except where located within a diked area or drainage path for a tank or tanks storing Class I or II liquids. Where a Class IIIB liquid storage tank is within the diked area or drainage path for a Class I or II



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

liquid, distances required by Section 5704.2.9.6.1.1 shall apply.

**5704.2.9.6.1.6 Reduction of separation distances to adjacent property.** Where two tank properties of diverse ownership have a common boundary, the *fire code official* is authorized to, with the written consent of the *owners* of the two properties, apply the distances in Sections 5704.2.9.6.1.2 through 5704.2.9.6.1.5 assuming a single property.

**5704.2.9.6.2 Separation between adjacent stable or unstable liquid tanks.** The separation between tanks containing stable liquids shall be in accordance with Table 22.4.2.1 of NFPA 30. Where tanks are in a diked area containing Class I or II liquids, or in the drainage path of Class I or II liquids, and are compacted in three or more rows or in an irregular pattern, the *fire code official* is authorized to require greater separation than specified in Table 22.4.2.1 of NFPA 30 or other means to make tanks in the interior of the pattern open for fire-fighting purposes.

The separation between tanks containing unstable liquids shall be not less than one-half the sum of their diameters.

**Exception:** Tanks used for storing Class IIIB liquids are allowed to be spaced 3 feet (914 mm) apart unless within a diked area or drainage path for a tank storing Class I or II liquids.

**5704.2.9.6.3 Separation between adjacent tanks containing flammable or combustible liquids and LP-gas.** The minimum horizontal separation between an LP-gas container and a Class I, II or IIIA liquid storage tank shall be 20 feet (6096 mm) except in the case of Class I, II or IIIA liquid tanks operating at pressures exceeding 2.5 psig (17.2 kPa) or equipped with emergency venting allowing pressures to exceed 2.5 psig (17.2 kPa), in which case the provisions of Section 5704.2.9.6.2 shall apply.

An *approved* means shall be provided to prevent the accumulation of Class I, II or IIIA liquids under adjacent LP-gas containers such as by dikes, diversion curbs or grading. Where *flammable* or *combustible liquid* storage tanks are within a diked area, the LP-gas containers shall be outside the diked area and not less than 10 feet (3048 mm) away from the centerline of the wall of the diked area.

### Exceptions:

1. Liquefied petroleum gas containers of 125 gallons (473 L) or less in capacity installed adjacent to fuel-oil supply tanks of 660 gallons (2498 L) or less in capacity.
2. Horizontal separation is not required between above-ground LP-gas containers and underground *flammable* and *combustible liquid* tanks.

**5704.2.9.7 Additional requirements for protected above-ground tanks.** In addition to the requirements of this chapter for above-ground tanks, the installation of protected above-ground tanks shall be in accordance with Sections 5704.2.9.7.1 through 5704.2.9.7.9.

**5704.2.9.7.1 Tank construction.** The construction of a protected above-ground tank and its primary tank shall be in accordance with Section 5704.2.7.

**5704.2.9.7.2 Normal and emergency venting.** Normal and emergency venting for protected above-ground tanks shall be provided in accordance with Sections 5704.2.7.3 and 5704.2.7.4. The vent capacity reduction factor shall not be allowed.

**5704.2.9.7.3 Secondary containment.** Protected above-ground tanks shall be provided with secondary containment, drainage control or diking in accordance with Section 5004.2. A means shall be provided to establish the integrity of the secondary containment in accordance with NFPA 30.

**5704.2.9.7.4 Vehicle impact protection.** Where protected above-ground tanks, piping, electrical conduit or dispensers are subject to vehicular impact, they shall be protected therefrom, either by having the impact protection incorporated into the system design in compliance with the impact test protocol of UL 2085, or by meeting the provisions of Section 312, or where necessary, a combination of both. Where guard posts or other *approved* barriers are provided, they shall be independent of each above-ground tank.

**5704.2.9.7.5 Overfill prevention.** Protected above-ground tanks shall not be filled in excess of 95 percent of their capacity. An overfill prevention system shall be provided for each tank. During tank-filling operations, the system shall comply with one of the following:

1. The overfill prevention system shall include the following:
  - 1.1. An independent means of notifying the person filling the tank that the fluid level has reached 90 percent of tank capacity by providing an audible or visual alarm signal, providing a tank level gauge marked at 90 percent of tank capacity, or other *approved* means.
  - 1.2. Automatic shut off of the flow of fuel to the tank when the quantity of liquid in the tank reaches 95 percent of tank capacity. For rigid hose fuel-delivery systems, an *approved* means shall be provided to empty the fill hose into the tank after the automatic shutoff device is activated.
2. The system shall reduce the flow rate to not more than 15 gallons per minute (0.95

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

L/s) so that at the reduced flow rate, the tank will not overfill for 30 minutes, and automatically shut off flow into the tank so that none of the fittings on the top of the tank are exposed to product because of overfilling.

**5704.2.9.7.5.1 Information signs.** A permanent sign shall be provided at the fill point for the tank, documenting the filling procedure and the tank calibration chart.

**Exception:** Where climatic conditions are such that the sign may be obscured by ice or snow, or weathered beyond readability or otherwise impaired, said procedures and chart shall be located in the office window, lock box or other area available to the person filling the tank.

**5704.2.9.7.5.2 Determination of available tank capacity.** The filling procedure shall require the person filling the tank to determine the gallonage (literage) required to fill it to 90 percent of capacity before commencing the fill operation.

**5704.2.9.7.6 Fill pipe connections.** The fill pipe shall be provided with a means for making a direct connection to the tank vehicle's fuel delivery hose so that the delivery of fuel is not exposed to the open air during the filling operation. Where any portion of the fill pipe exterior to the tank extends below the level of the top of the tank, a check valve shall be installed in the fill pipe not more than 12 inches (305 mm) from the fill hose connection.

**5704.2.9.7.7 Spill containers.** A spill container having a capacity of not less than 5 gallons (19 L) shall be provided for each fill connection. For tanks with a top fill connection, spill containers shall be noncombustible and shall be fixed to the tank and equipped with a manual drain valve that drains into the primary tank. For tanks with a remote fill connection, a portable spill container shall be allowed.

**5704.2.9.7.8 Tank openings.** Tank openings in protected above-ground tanks shall be through the top only.

**5704.2.9.7.9 Antisiphon devices.** *Approved* antisiphon devices shall be installed in each external pipe connected to the protected above-ground tank where the pipe extends below the level of the top of the tank.

**5704.2.10 Drainage and diking.** The area surrounding a tank or group of tanks shall be provided with drainage control or shall be diked to prevent accidental discharge of liquid from endangering adjacent tanks, adjoining property or reaching waterways.

**Exceptions:**

1. The *fire code official* is authorized to alter or waive these requirements based on a technical

report that demonstrates that such tank or group of tanks does not constitute a hazard to other tanks, waterways or adjoining property, after consideration of special features such as topographical conditions, nature of occupancy and proximity to buildings on the same or adjacent property, capacity, and construction of proposed tanks and character of liquids to be stored, and nature and quantity of private and public fire protection provided.

2. Drainage control and diking is not required for *listed* secondary containment tanks.

**5704.2.10.1 Volumetric capacity.** The volumetric capacity of the diked area shall be not less than the greatest amount of liquid that can be released from the largest tank within the diked area. The capacity of the diked area enclosing more than one tank shall be calculated by deducting the volume of the tanks other than the largest tank below the height of the dike.

**5704.2.10.2 Diked areas containing two or more tanks.** Diked areas containing two or more tanks shall be subdivided in accordance with NFPA 30.

**5704.2.10.3 Protection of piping from exposure fires.** Piping shall not pass through adjacent diked areas or impounding basins, unless provided with a sealed sleeve or otherwise protected from exposure to fire.

**5704.2.10.4 Combustible materials in diked areas.** Diked areas shall be kept free from combustible materials, drums and barrels.

**5704.2.10.5 Equipment, controls and piping in diked areas.** Pumps, manifolds and fire protection equipment or controls shall not be located within diked areas or drainage basins or in a location where such equipment and controls would be endangered by fire in the diked area or drainage basin. Piping above ground shall be minimized and located as close as practical to the shell of the tank in diked areas or drainage basins.

**Exceptions:**

1. Pumps, manifolds and piping integral to the tanks or equipment being served, which is protected by intermediate diking, berms, drainage or fire protection such as water spray, monitors or resistive coating.
2. Fire protection equipment or controls that are appurtenances to the tanks or equipment being protected, such as foam chambers or foam piping and water or foam monitors and hydrants, or hand and wheeled extinguishers.

**5704.2.11 Underground tanks.** Underground storage of *flammable* and *combustible liquids* in tanks shall comply with Section 5704.2 and Sections 5704.2.11.1 through 5704.2.11.4.2.1.

**5704.2.11.1 Location.** *Flammable* and *combustible liquid* storage tanks located underground, either

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

outside or under buildings, shall be in accordance with all of the following:

1. Tanks shall be located with respect to existing foundations and supports such that the loads carried by the latter cannot be transmitted to the tank.
2. The distance from any part of a tank storing liquids to the nearest wall of a *basement*, pit, cellar or *lot line* shall be not less than 3 feet (914 mm).
3. A minimum distance of 1 foot (305 mm), shell to shell, shall be maintained between underground tanks.

**5704.2.11.2 Depth and cover.** Excavation for underground storage tanks shall be made with due care to avoid undermining of foundations of existing structures. Underground tanks shall be set on firm foundations and surrounded with not less than 6 inches (152 mm) of noncorrosive inert material, such as clean sand.

**5704.2.11.3 Overfill protection and prevention systems.** Fill pipes shall be equipped with a spill container and an overfill prevention system in accordance with NFPA 30.

**5704.2.11.4 Leak prevention.** Leak prevention for underground tanks shall comply with Sections 5704.2.11.4.1 and 5704.2.11.4.2.

**5704.2.11.4.1 Inventory control.** Daily inventory records for underground storage tank systems shall be maintained.

**5704.2.11.4.2 Leak detection.** Underground storage tank systems shall be provided with an *approved* method of leak detection from any component of the system that is designed and installed in accordance with NFPA 30.

**5704.2.11.4.2.1 Location.** The leak detection panel status shall be annunciated at an *approved* on-site location.

**5704.2.12 Testing.** Tank testing shall comply with Sections 5704.2.12.1 and 5704.2.12.2.

**5704.2.12.1 Acceptance testing.** Prior to being placed into service, tanks shall be tested in accordance with Section 21.5 of NFPA 30.

**5704.2.12.2 Testing of underground tanks.** Before being covered or placed in use, tanks and piping connected to underground tanks shall be tested for tightness. Piping shall be tested in accordance with Section 5703.6.3. The system shall not be covered until it has been *approved*.

**5704.2.13 Abandonment and status of tanks.** Tanks taken out of service shall be removed in accordance with Section 5704.2.14, or safeguarded in accordance with Sections 5704.2.13.1 through 5704.2.13.2.3 and API 1604.

**5704.2.13.1 Underground tanks.** Underground tanks taken out of service shall comply with Sections 5704.2.13.1.1 through 5704.2.13.1.5.

**5704.2.13.1.1 Temporarily out of service.** Underground tanks temporarily out of service shall have the fill line, gauge opening, vapor return and pump connection secure against tampering. Vent lines shall remain open and be maintained in accordance with Sections 5704.2.7.3 and 5704.2.7.4.

**5704.2.13.1.2 Out of service for 90 days.** Underground tanks not used for a period of 90 days shall be safeguarded in accordance with all the following or be removed in accordance with Section 5704.2.14:

1. *Flammable* or *combustible liquids* shall be removed from the tank.
2. All piping, including fill line, gauge opening, vapor return and pump connection, shall be capped or plugged and secured from tampering.
3. Vent lines shall remain open and be maintained in accordance with Sections 5704.2.7.3 and 5704.2.7.4.

**5704.2.13.1.3 Out of service for one year.** Underground tanks that have been out of service for a period of one year shall be removed from the ground in accordance with Section 5704.2.14 or abandoned in place in accordance with Section 5704.2.13.1.4.

**5704.2.13.1.4 Tanks abandoned in place.** Tanks abandoned in place shall be as follows:

1. *Flammable* and *combustible liquids* shall be removed from the tank and connected piping.
2. The suction, inlet, gauge, vapor return and vapor lines shall be disconnected.
3. The tank shall be filled completely with an *approved* inert solid material.
4. Remaining underground piping shall be capped or plugged.
5. A record of tank size, location and date of abandonment shall be retained.
6. All exterior above-grade fill piping shall be permanently removed when tanks are abandoned or removed.

**5704.2.13.1.5 Reinstallation of underground tanks.** Tanks that are to be reinstalled for *flammable* or *combustible liquid* service shall be in accordance with this chapter, *ASME Boiler and Pressure Vessel Code* (Section VIII), API 1615, UL 58 and UL 1316.

**5704.2.13.2 Above-ground tanks.** Above-ground tanks taken out of service shall comply with Sections 5704.2.13.2.1 through 5704.2.13.2.3.

**5704.2.13.2.1 Temporarily out of service.** Above-ground tanks temporarily out of service shall have

all connecting lines isolated from the tank and be secured against tampering.

**Exception:** In-place fire protection (foam) system lines.

**5704.2.13.2.2 Out of service for 90 days.** Above-ground tanks not used for a period of 90 days shall be safeguarded in accordance with Section 5704.2.13.1.2 or removed in accordance with Section 5704.2.14.

**Exceptions:**

1. Tanks and containers connected to oil burners that are not in use during the warm season of the year or are used as a backup heating system to gas.
2. In-place, active fire protection (foam) system lines.
3. Farm tanks used for irrigation wells or other farm uses.

**5704.2.13.2.3 Out of service for one year.** Above-ground tanks that have been out of service for a period of one year shall be removed in accordance with Section 5704.2.14.

**Exception:** Tanks within operating facilities.

**5704.2.14 Removal and disposal of tanks.** Removal and disposal of tanks shall comply with Sections 5704.2.14.1 and 5704.2.14.2.

**5704.2.14.1 Removal.** Removal of above-ground and underground tanks shall be in accordance with all of the following:

1. *Flammable* and *combustible liquids* shall be removed from the tank and connected piping.
2. Piping at tank openings that is not to be used further shall be disconnected.
3. Piping shall be removed from the ground.

**Exception:** Piping is allowed to be abandoned in place where the *fire code official* determines that removal is not practical. Abandoned piping shall be capped and safeguarded as required by the *fire code official*.

4. Tank openings shall be capped or plugged, leaving a  $\frac{1}{8}$ -inch to  $\frac{1}{4}$ -inch-diameter (3.2 mm to 6.4 mm) opening for pressure equalization.
5. Tanks shall be purged of vapor and inerted prior to removal.
6. All exterior above-grade fill and vent piping shall be permanently removed.

**Exception:** Piping associated with bulk plants, terminal facilities and refineries.

**5704.2.14.2 Disposal.** Tanks shall be disposed of in accordance with federal, state and local regulations.

**5704.2.15 Maintenance.** Above-ground tanks, connected piping and ancillary equipment shall be maintained in a safe operating condition. Tanks shall be maintained in accordance with their listings. Damage to above-ground

tanks, connected piping or ancillary equipment shall be repaired using materials having equal or greater strength and *fire resistance* or the equipment shall be replaced or taken out of service.

**5704.3 Container and portable tank storage.** Storage of *flammable* and *combustible liquids* in closed containers that do not exceed 60 gallons (227 L) in individual capacity and portable tanks that do not exceed 660 gallons (2498 L) in individual capacity, and limited transfers incidental thereto, shall comply with Sections 5704.3.1 through 5704.3.8.5.

**5704.3.1 Design, construction and capacity of containers and portable tanks.** The design, construction and capacity of containers for the storage of Class I, II and IIIA liquids shall be in accordance with this section and Section 9.4 of NFPA 30.

**5704.3.1.1 Approved containers.** Only *approved* containers and portable tanks shall be used.

**5704.3.2 Liquid storage cabinets.** Where other sections of this code require that liquid containers be stored in storage cabinets, such cabinets and storage shall be in accordance with Sections 5704.3.2.1 through 5704.3.2.2.

**5704.3.2.1 Design and construction of storage cabinets.** Design and construction of liquid storage cabinets shall be in accordance with Sections 5704.3.2.1.1 through 5704.3.2.1.4.

**5704.3.2.1.1 Materials.** Cabinets shall be *listed* in accordance with UL 1275, or constructed of *approved* wood or metal in accordance with the following:

1. Unlisted metal cabinets shall be constructed of steel having a thickness of not less than 0.044 inch (1.12 mm) (18 gage). The cabinet, including the door, shall be double walled with  $1\frac{1}{2}$ -inch (38 mm) airspace between the walls. Joints shall be riveted or welded and shall be tight fitting.
2. Unlisted wooden cabinets, including doors, shall be constructed of not less than 1-inch (25 mm) exterior grade plywood. Joints shall be rabbeted and shall be fastened in two directions with wood screws. Door hinges shall be of steel or brass. Cabinets shall be painted with an intumescent-type paint.

**5704.3.2.1.2 Labeling.** Cabinets shall be provided with a conspicuous label in red letters on contrasting background that reads: "FLAMMABLE—KEEP FIRE AWAY."

**5704.3.2.1.3 Doors.** Doors shall be well fitted, self-closing and equipped with a three-point latch.

**5704.3.2.1.4 Bottom.** The bottom of the cabinet shall be liquid tight to a height of not less than 2 inches (51 mm).

**5704.3.2.2 Capacity.** The combined total quantity of liquids in a cabinet shall not exceed 120 gallons (454 L).



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5704.3.3 Indoor storage.** Storage of *flammable* and *combustible liquids* inside buildings in containers and portable tanks shall be in accordance with Sections 5704.3.3.1 through 5704.3.3.10.

### Exceptions:

1. Liquids in the fuel tanks of motor vehicles, aircraft, boats or portable or stationary engines.
2. The storage of distilled spirits and wines in wooden barrels or casks.

**5704.3.3.1 Portable fire extinguishers.** *Approved* portable fire extinguishers shall be provided in accordance with specific sections of this chapter and Section 906.

**5704.3.3.2 Incompatible materials.** Materials that will react with water or other liquids to produce a hazard shall not be stored in the same room with *flammable* and *combustible liquids* except where stored in accordance with Section 5003.9.8.

**5704.3.3.3 Clear means of egress.** Storage of any liquids, including stock for sale, shall not be stored near or be allowed to obstruct physically the route of egress.

**5704.3.3.4 Empty containers or portable tank storage.** The storage of empty tanks and containers previously used for the storage of *flammable* or *combustible liquids*, unless free from explosive vapors, shall be stored as required for filled containers and portable tanks. Portable tanks and containers, when emptied, shall have the covers or plugs immediately replaced in openings.

**5704.3.3.5 Shelf storage.** Shelving shall be of *approved* construction, adequately braced and anchored. Seismic requirements shall be in accordance with the *International Building Code*.

**5704.3.3.5.1 Use of wood.** Wood of not less than 1 inch (25 mm) nominal thickness is allowed to be used as shelving, racks, dunnage, scuffboards, floor overlay and similar installations.

**5704.3.3.5.2 Displacement protection.** Shelves shall be of sufficient depth and provided with a lip or guard to prevent individual containers from being displaced.

**Exception:** Shelves in storage cabinets or on laboratory furniture specifically designed for such use.

**5704.3.3.5.3 Orderly storage.** Shelf storage of *flammable* and *combustible liquids* shall be maintained in an orderly manner.

**5704.3.3.6 Rack storage.** Where storage on racks is allowed elsewhere in this code, a minimum 4-foot-wide (1219 mm) aisle shall be provided between adjacent rack sections and any adjacent storage of liquids. Main aisles shall be not less than 8 feet (2438 mm) wide.

**5704.3.3.7 Pile or palletized storage.** Solid pile and palletized storage in liquid warehouses shall be arranged so that piles are separated from each other by not less than 4 feet (1219 mm). Aisles shall be provided and arranged so that containers or portable tanks are not more than 20 feet (6096 mm) from an aisle. Main aisles shall be not less than 8 feet (2438 mm) wide.

**5704.3.3.8 Limited combustible storage.** Limited quantities of combustible commodities are allowed to be stored in liquid storage areas where the ordinary combustibles, other than those used for packaging the liquids, are separated from the liquids in storage by not less than 8 feet (2438 mm) horizontally, either by open aisles or by open racks, and where protection is provided in accordance with Chapter 9.

**5704.3.3.9 Idle combustible pallets.** Storage of empty or idle combustible pallets inside an unprotected liquid storage area shall be limited to a maximum pile size of 2,500 square feet (232 m<sup>2</sup>) and to a maximum storage height of 6 feet (1829 mm). Storage of empty or idle combustible pallets inside a protected liquid storage area shall comply with NFPA 13. Pallet storage shall be separated from liquid storage by aisles that are not less than 8 feet (2438 mm) wide.

**5704.3.3.10 Containers in piles.** Containers in piles shall be stacked in such a manner as to provide stability and to prevent excessive stress on container walls. Portable tanks stored more than one tier high shall be designed to nest securely, without dunnage. Material-handling equipment shall be suitable to handle containers and tanks safely at the upper tier level.

**5704.3.4 Quantity limits for storage.** Liquid storage quantity limitations shall comply with Sections 5704.3.4.1 through 5704.3.4.4.

**5704.3.4.1 Maximum allowable quantity per control area.** For occupancies other than Group M wholesale and retail sales uses, indoor storage of *flammable* and *combustible liquids* shall not exceed the *maximum allowable quantities per control area* indicated in Table 5003.1.1(1) and shall not exceed the additional limitations set forth in this section.

For Group M occupancy wholesale and retail sales uses, indoor storage of *flammable* and *combustible liquids* shall not exceed the *maximum allowable quantities per control area* indicated in Table 5704.3.4.1.

Storage of hazardous production material *flammable* and *combustible liquids* in Group H-5 occupancies shall be in accordance with Chapter 27.

**5704.3.4.2 Occupancy quantity limits.** The following limits for quantities of stored *flammable* or *combustible liquids* shall not be exceeded:

1. Group A occupancies: Quantities in Group A occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equip-

**TABLE 5704.3.4.1**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF**  
**FLAMMABLE AND COMBUSTIBLE LIQUIDS IN WHOLESALE AND RETAIL SALES OCCUPANCIES<sup>a</sup>**

TYPE OF LIQUID	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA (gallons)		
	Sprinklered <sup>b</sup> in accordance with footnote densities and arrangements	Sprinklered in accordance with Tables 5704.3.6.3(4) through 5704.3.6.3(8) and Table 5704.3.7.5.1	Nonsprinklered
Class IA	60	60	30
Class IB, IC, II and IIIA	7,500 <sup>c</sup>	15,000 <sup>c</sup>	1,600
Class IIIB	Unlimited	Unlimited	13,200

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon = 3.785 L, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

- a. Control areas shall be separated from each other by not less than a 1-hour fire barrier.
- b. To be considered as sprinklered, a building shall be equipped throughout with an approved automatic sprinkler system with a design providing minimum densities as follows:
1. For uncartoned commodities on shelves 6 feet or less in height where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of Ordinary Hazard Group 2.
  2. For cartoned, palletized or racked commodities where storage is 4 feet 6 inches or less in height and where the ceiling height does not exceed 18 feet, quantities are those allowed with a minimum sprinkler design density of 0.21 gallon per minute per square foot over the most remote 1,500-square-foot area.
- c. Where wholesale and retail sales or storage areas exceed 50,000 square feet in area, the maximum allowable quantities are allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to not more than 100 percent of the table amounts. A control area separation is not required. The cumulative amounts, including amounts attained by having an additional control area, shall not exceed 30,000 gallons.

ment, and shall not exceed quantities set forth in Table 5003.1.1(1).

2. Group B occupancies: Quantities in drinking, dining, office and school uses within Group B occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
3. Group E occupancies: Quantities in Group E occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
4. Group F occupancies: Quantities in dining, office, and school uses within Group F occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
5. Group I occupancies: Quantities in Group I occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
6. Group M occupancies: Quantities in dining, office, and school uses within Group M occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1). The maximum allowable quantities for storage in wholesale and retail sales

areas shall be in accordance with Section 5704.3.4.1.

7. Group R occupancies: Quantities in Group R occupancies shall not exceed that necessary for maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
8. Group S occupancies: Quantities in dining and office uses within Group S occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

**5704.3.4.3 Quantities exceeding limits for control areas.** Quantities exceeding those allowed in *control areas* set forth in Section 5704.3.4.1 shall be in liquid storage rooms or liquid storage warehouses in accordance with Sections 5704.3.7 and 5704.3.8.

**5704.3.4.4 Liquids for maintenance and operation of equipment.** In all occupancies, quantities of *flammable* and *combustible liquids* in excess of 10 gallons (38 L) used for maintenance purposes and the operation of equipment shall be stored in liquid storage cabinets in accordance with Section 5704.3.2. Quantities not exceeding 10 gallons (38 L) are allowed to be stored outside of a cabinet where in *approved* containers located in private garages or other *approved* locations.

**5704.3.5 Storage in control areas.** Storage of *flammable* and *combustible liquids* in *control areas* shall be in accordance with Sections 5704.3.5.1 through 5704.3.5.4.

**5704.3.5.1 Basement storage.** Class I liquids shall be allowed to be stored in *basements* in amounts not exceeding the *maximum allowable quantity per control area* for use-open systems in Table 5003.1.1(1), provided that *fire protection systems* are

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

provided in accordance with Chapter 9. Class II and IIIA liquids shall be allowed to be stored in *basements*, provided that automatic suppression and other fire protection are provided in accordance with Chapter 9.

**5704.3.5.2 Storage pile heights.** Containers having less than a 30-gallon (114 L) capacity that contain Class I or II liquids shall not be stacked more than 3 feet (914.4 mm) or two containers high, whichever is greater, unless stacked on fixed shelving or otherwise satisfactorily secured. Containers of Class I or II liquids having a capacity of 30 gallons (114 L) or more shall not be stored more than one container high. Containers shall be stored in an upright position.

**5704.3.5.3 Storage distance from ceilings and roofs.** Piles of containers or portable tanks shall not be stored closer than 3 feet (914 mm) to the nearest beam, chord, girder or other obstruction, and shall be 3 feet (914 mm) below sprinkler deflectors or discharge orifices of water spray or other overhead *fire protection system*.

**5704.3.5.4 Combustible materials.** In areas that are not open to the public, Class I, II and IIIA liquids shall not be stored in the same pile or rack section as ordinary combustible commodities unless such materials are packaged together as kits.

**5704.3.6 Wholesale and retail sales uses.** *Flammable and combustible liquids* in Group M occupancy wholesale and retail sales uses shall be in accordance with Sections 5704.3.6.1 through 5704.3.6.5, or Sections 10.10.2, 12.3.6, 16.4.1 through 16.4.3, 16.5.1 through 16.5.2.12, Figures 16.4.1(a) through 16.4.1(c) and Tables 16.5.2.1 through 16.5.2.12, of NFPA 30.

**5704.3.6.1 Container type.** Containers for Class I liquids shall be metal.

**Exception:** In sprinklered buildings, an aggregate quantity of 120 gallons (454 L) of water-miscible Class IB and Class IC liquids is allowed in non-metallic containers, each having a capacity of 16 ounces (0.473 L) or less.

**5704.3.6.2 Container capacity.** Containers for Class I liquids shall not exceed a capacity of 5 gallons (19 L).

**Exception:** Metal containers not exceeding 55 gallons (208 L) are allowed to store up to 240 gallons (908 L) of the *maximum allowable quantity per control area* of Class IB and IC liquids in a *control area*. The building shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Table 5704.3.4.1. The containers shall be provided with plastic caps without cap seals and shall be stored upright. Containers shall not be stacked or stored in racks and shall not be located in areas open to the public.

**5704.3.6.3 Fire protection and storage arrangements.** Fire protection and container storage arrangements shall be in accordance with Table 5704.3.6.3(1) or the following:

1. Storage on shelves shall not exceed 6 feet (1829 mm) in height, and shelving shall be metal.
2. Storage on pallets or in piles greater than 4 feet 6 inches (1372 mm) in height, or where the ceiling exceeds 18 feet (5486 mm) in height, shall be protected in accordance with Table 5704.3.6.3(4), and the storage heights and arrangements shall be limited to those specified in Table 5704.3.6.3(2).
3. Storage on racks greater than 4 feet 6 inches (1372 mm) in height, or where the ceiling exceeds 18 feet (5486 mm) in height shall be protected in accordance with Tables 5704.3.6.3(5), 5704.3.6.3(6), and 5704.3.6.3(7) as appropriate, and the storage heights and arrangements shall be limited to those specified in Table 5704.3.6.3(3).

Combustible commodities shall not be stored above *flammable and combustible liquids*.

**TABLE 5704.3.6.3(1)**  
**MAXIMUM STORAGE HEIGHT IN CONTROL AREA**

TYPE OF LIQUID	NONSPRINKLERED AREA (feet)	SPRINKLERED AREA <sup>a</sup> (feet)	SPRINKLERED WITH IN-RACK PROTECTION <sup>a, b</sup> (feet)
Flammable liquids:			
Class IA	4	4	4
Class IB	4	8	12
Class IC	4	8	12
Combustible liquids:			
Class II	6	8	12
Class IIIA	8	12	16
Class IIIB	8	12	20

For SI: 1 foot = 304.8 mm.

a. In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.

b. In-rack protection shall be in accordance with Table 5704.3.6.3(5), 5704.3.6.3(6) or 5704.3.6.3(7).

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**TABLE 5704.3.6.3(2)**  
**STORAGE ARRANGEMENTS FOR PALLETIZED OR SOLID-PILE STORAGE IN LIQUID STORAGE ROOMS AND WAREHOUSES**

CLASS	STORAGE LEVEL	MAXIMUM STORAGE HEIGHT			MAXIMUM QUANTITY PER PILE (gallons)		MAXIMUM QUANTITY PER ROOM <sup>a</sup> (gallons)	
		Drums	Containers <sup>b</sup> (feet)	Portable tanks <sup>b</sup> (feet)	Containers	Portable tanks	Containers	Portable tanks
IA	Ground floor	1	5	Not Allowed	3,000	Not Allowed	12,000	Not Allowed
	Upper floors	1	5	Not Allowed	2,000	Not Allowed	8,000	Not Allowed
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
IB	Ground floor	1	6.5	7	5,000	20,000	15,000	40,000
	Upper floors	1	6.5	7	3,000	10,000	12,000	20,000
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
IC	Ground floor <sup>d</sup>	1	6.5 <sup>c</sup>	7	5,000	20,000	15,000	40,000
	Upper floors	1	6.5 <sup>c</sup>	7	3,000	10,000	12,000	20,000
	Basements	0	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed	Not Allowed
II	Ground floor <sup>d</sup>	3	10	14	10,000	40,000	25,000	80,000
	Upper floors	3	10	14	10,000	40,000	25,000	80,000
	Basements	1	5	7	7,500	20,000	7,500	20,000
III	Ground floor	5	20	14	15,000	60,000	50,000	100,000
	Upper floors	5	20	14	15,000	60,000	50,000	100,000
	Basements	3	10	7	10,000	20,000	25,000	40,000

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- See Section 5704.3.8.1 for unlimited quantities in liquid storage warehouses.
- In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.
- These height limitations are allowed to be increased to 10 feet for containers having a capacity of 5 gallons or less.
- For palletized storage of unsaturated polyester resins (UPR) in relieving-style metal containers with 50 percent or less by weight Class IC or II liquid and no Class IA or IB liquid, height and pile quantity limits shall be permitted to be 10 feet and 15,000 gallons, respectively, provided that such storage is protected by sprinklers in accordance with NFPA 30 and that the UPR storage area is not located in the same containment area or drainage path for other Class I or II liquids.

**TABLE 5704.3.6.3(3)**  
**STORAGE ARRANGEMENTS FOR RACK STORAGE IN LIQUID STORAGE ROOMS AND WAREHOUSES**

CLASS	TYPE RACK	STORAGE LEVEL	MAXIMUM STORAGE HEIGHT <sup>b</sup> (feet)	MAXIMUM QUANTITY PER ROOM <sup>a</sup> (gallons)
			Containers	Containers
IA	Double row or Single row	Ground floor	25	7,500
		Upper floors	15	4,500
		Basements	Not Allowed	Not Allowed
IB	Double row or Single row	Ground floor	25	15,000
		Upper floors	15	9,000
		Basements	Not Allowed	Not Allowed
II	Double row or Single row	Ground floor	25	24,000
		Upper floors	25	24,000
		Basements	15	9,000
III	Multirow	Ground floor	40	48,000
	Double row	Upper floors	20	48,000
	Single row	Basements	20	24,000

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.

- See Section 5704.3.8.1 for unlimited quantities in liquid storage warehouses.
- In buildings protected by an automatic sprinkler system, the storage height for containers and portable tanks shall not exceed the maximum storage height permitted for the fire protection scheme set forth in NFPA 30 or the maximum storage height demonstrated in a full-scale fire test, whichever is greater. NFPA 30 criteria and fire test results for metallic containers and portable tanks shall not be applied to nonmetallic containers and portable tanks.



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**TABLE 5704.3.6.3(4)**  
**AUTOMATIC SPRINKLER PROTECTION FOR SOLID-PILE AND PALLETIZED STORAGE**  
**OF LIQUIDS IN METAL CONTAINERS AND PORTABLE TANKS<sup>a</sup>**

STORAGE CONDITIONS		CEILING SPRINKLER DESIGN AND DEMAND				MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLERS AND HOSE STREAMS (hours)
Class liquid	Container size and arrangement	Density (gpm/ft²)	Area (square feet)		Maximum spacing (square feet)		
			High-temperature sprinklers	Ordinary temperature sprinklers			
IA	5 gallons or less, with or without cartons, palletized or solid pile <sup>b</sup>	0.30	3,000	5,000	100	750	2
	Containers greater than 5 gallons, on end or side, palletized or solid pile	0.60	5,000	8,000	80	750	
IB, IC and II	5 gallons or less, with or without cartons, palletized or solid pile <sup>b</sup>	0.30	3,000	5,000	100	500	2
	Containers greater than 5 gallons on pallets or solid pile, one high	0.25	5,000	8,000	100		
II	Containers greater than 5 gallons on pallets or solid pile, more than one high, on end or side	0.60	5,000	8,000	80	750	2
IB, IC and II	Portable tanks, one high	0.30	3,000	5,000	100	500	2
II	Portable tanks, two high	0.60	5,000	8,000	80	750	2
III	5 gallons or less, with or without cartons, palletized or solid pile	0.25	3,000	5,000	120	500	1
	Containers greater than 5 gallons on pallets or solid pile, on end or sides, up to three high	0.25	3,000	5,000	120	500	1
	Containers greater than 5 gallons, on pallets or solid pile, on end or sides, up to 18 feet high	0.35	3,000	5,000	100	750	2
	Portable tanks, one high	0.25	3,000	5,000	120	500	1
	Portable tanks, two high	0.50	3,000	5,000	80	750	2

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

- a. The design area contemplates the use of Class II standpipe systems. Where Class I standpipe systems are used, the area of application shall be increased by 30 percent without revising density.
- b. For storage heights above 4 feet or ceiling heights greater than 18 feet, an approved engineering design shall be provided in accordance with Section 104.8.2.

**5704.3.6.4 Warning for containers.** Cans, containers and vessels containing *flammable liquids* or *flammable liquid* compounds or mixtures offered for sale shall be provided with a warning indicator, painted or printed on the container and stating that the liquid is flammable, and shall be kept away from heat and an open flame.

**5704.3.6.5 Storage plan.** Where required by fire the code official, *aisle* and storage plans shall be submitted in accordance with Chapter 50.

**5704.3.7 Liquid storage rooms.** Liquid storage rooms shall comply with Sections 5704.3.7.1 through 5704.3.7.5.2.

**5704.3.7.1 General.** Quantities of liquids exceeding those set forth in Section 5704.3.4.1 for storage in *control areas* shall be stored in a liquid storage room complying with this section and constructed and separated as required by the *International Building Code*.

#### **5704.3.7.2 Quantities and arrangement of storage.**

The quantity limits and storage arrangements in liquid storage rooms shall be in accordance with Tables 5704.3.6.3(2) and 5704.3.6.3(3) and Sections 5704.3.7.2.1 through 5704.3.7.2.3.

**5704.3.7.2.1 Mixed storage.** Where two or more classes of liquids are stored in a pile or rack section, both of the following shall apply:

1. The quantity in that pile or rack shall not exceed the smallest of the maximum quantities for the classes of liquids stored in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(3).
2. The height of storage in that pile or rack shall not exceed the smallest of the maximum heights for the classes of liquids stored in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(3).

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**TABLE 5704.3.6.3(5)**  
**AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS FOR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS OF 5-GALLON CAPACITY OR LESS WITH OR WITHOUT CARTONS ON CONVENTIONAL WOOD PALLETS<sup>a</sup>**

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND					MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLER AND HOSE STREAM (hours)
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Maximum spacing	Racks up to 9 feet deep	Racks more than 9 feet to 12 feet deep	30 psi (standard orifice)			
		High-temperature sprinklers	Ordinary temperature sprinklers				14 psi (large orifice)	Number of sprinklers operating		
I  (maximum 25-foot height)  Option 1	0.40	3,000	5,000	80 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. One line sprinklers above each level of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multiple-level	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. One line sprinklers above each level of storage 3. Locate in transverse flue spaces, staggered vertical and within 20 inches of aisle 4. Shields required where multiple-level	30 psi (0.5-inch orifice)	1. Eight sprinklers if only one level 2. Six sprinklers each on two levels if only two levels 3. Six sprinklers each on top three levels, if three or more levels 4. Hydraulically most remote	750	2
I  (maximum 25-foot height)  Option 2	0.55	2,000 <sup>b</sup>	Not Applicable	100 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. See 2 above 3. See 3 above 4. See 4 above	14 psi (0.53-inch orifice)	See 1 through 4 above	500	2
I and II  (maximum 14-foot storage height) (maximum three tiers)	0.55 <sup>c</sup>	2,000 <sup>d</sup>	Not Applicable	100 ft <sup>2</sup> /head	Not Applicable  None for maximum 6-foot-deep racks	Not Applicable	Not Applicable	Not Applicable	500	2
II  (maximum 25-foot height)	0.30	3,000	5,000	100 ft <sup>2</sup> /head	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers between levels at nearest 10-foot vertical intervals 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multiple-level	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. Two lines between levels at nearest 10-foot vertical intervals 3. Locate in transverse flue spaces, staggered vertical and within 20 inches of aisle 4. Shields required where multiple-level	30 psi	Hydraulically most remote—six sprinklers at each level, up to a maximum of three levels	750	2
III  (40-foot height)	0.25	3,000	5,000	120 ft <sup>2</sup> /head	Same as for Class II liquids	Same as for Class II liquids	30 psi	Same as for Class II liquids	500	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

a. The design area contemplates the use of Class II standpipe systems. Where Class I standpipe systems are used, the area of application shall be increased by 30 percent without revising density.

b. Using listed or approved extra-large orifices, high-temperature quick-response or standard element sprinklers under a maximum 30-foot ceiling with minimum 7.5-foot aisles.

c. For friction lid cans and other metal containers equipped with plastic nozzles or caps, the density shall be increased to 0.65 gpm per square foot using listed or approved extra-large orifice, high-temperature quick-response sprinklers.

d. Using listed or approved extra-large orifice, high-temperature quick-response or standard element sprinklers under a maximum 18-foot ceiling with minimum 7.5-foot aisles and metal containers.

**FLAMMABLE AND COMBUSTIBLE LIQUIDS**

**TABLE 5704.3.6.3(6) AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS FOR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS GREATER THAN 5-GALLON CAPACITY<sup>a</sup>**

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND					MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLER AND HOSE STREAM (hours)
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Maximum spacing	On-side storage racks up to 9-foot-deep racks	On-end storage (on pallets) up to 9-foot-deep racks	Minimum nozzle pressure	Number of sprinklers operating		
		High-temperature sprinklers	Ordinary temperature sprinklers							
IA  (maximum 25-foot height)	0.60	3,000	5,000	80 ft <sup>2</sup> /head	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers above each tier of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multiple-level	1. Ordinary temperature sprinklers 8 feet apart horizontally 2. One line sprinklers above each tier of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multiple-level	30 psi	Hydraulically most remote—six sprinklers at each level	1,000	2
IB, IC and II  (maximum 25-foot height)	0.60	3,000	5,000	100 ft <sup>2</sup> /head	1. See 1 above 2. One line sprinklers every three tiers of storage 3. See 3 above 4. See 4 above	1. See 1 above 2. See 2 above 3. See 3 above 4. See 4 above	30 psi	Hydraulically most remote—six sprinklers at each level	750	2
III  (maximum 40-foot height)	0.25	3,000	5,000	120 ft <sup>2</sup> /head	1. See 1 above 2. One line sprinklers every sixth level (maximum) 3. See 3 above 4. See 4 above	1. See 1 above 2. One line sprinklers every third level (maximum) 3. See 3 above 4. See 4 above	15 psi	Hydraulically most remote—six sprinklers at each level	500	1

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

a. The design assumes the use of Class I standpipe systems. Where a Class I standpipe system is used, the area of application shall be increased by 30 percent without revising density.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

TABLE 5704.3.6.3(7) AUTOMATIC AFF WATER PROTECTION REQUIREMENTS FOR RACK STORAGE OF LIQUIDS IN METAL CONTAINERS GREATER THAN 5-GALLON CAPACITY<sup>a, b</sup>

CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND			IN-RACK SPRINKLER ARRANGEMENT AND DEMAND <sup>c</sup>					DURATION AFFX SUPPLY (minimum)	DURATION WATER SUPPLY (hours)
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		On-end storage of drumson pallets, up to 25 feet	Minimum nozzle pressure (psi)	Number of sprinklers operating	Hose stream demand <sup>d</sup> (gpm)			
		High-temperature sprinklers	Ordinary temperature sprinklers							
IA, IB, IC and II	0.30	1,500	2,500	1. Ordinary temperature sprinkler up to 10 feet apart horizontally 2. One line sprinklers above each level of storage 3. Locate in longitudinal flue space, staggered vertically 4. Shields required for multiple-level	30	Three sprinklers per level	500	15	2	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

a. System shall be a closed-head wet system with approved devices for proportioning aqueous film-forming foam.

b. Except as modified herein, in-rack sprinklers shall be installed in accordance with NFPA 13.

c. The height of storage shall not exceed 25 feet.

d. Hose stream demand includes 1 1/2-inch inside hose connections, where required.

TABLE 5704.3.6.3(8) AUTOMATIC SPRINKLER PROTECTION REQUIREMENTS FOR CLASS I LIQUID STORAGE IN METAL CONTAINERS OF 1-GALLON CAPACITY OR LESS WITH UNCARTONED OR CASE-CUT SHELF DISPLAY UP TO 6.5 FEET, AND PALLETIZED STORAGE ABOVE IN A DOUBLE-ROW RACK ARRAY<sup>a</sup>

STORAGE HEIGHT	CEILING SPRINKLER DESIGN AND DEMAND				IN-RACK SPRINKLER ARRANGEMENT AND DEMAND				MINIMUM HOSE STREAM DEMAND (gpm)	MINIMUM DURATION SPRINKLERS AND HOSE STREAM (hours)
	Density (gpm/ft <sup>2</sup> )	Area (square feet)		Maximum spacing	Racks up to 9 feet deep	Racks 9 to 12 feet	Minimum nozzle pressure	Number of sprinklers operating		
		High temperature	Ordinary temperature							
Maximum 20-foot storage height	0.60	2,000 <sup>b</sup>	Not Applicable	100 ft <sup>2</sup> /head	1. Ordinary temperature, quick-response sprinklers, maximum 8 feet 3 inches horizontal spacing 2. One line of sprinklers at the 6-foot level and the 11.5-foot level of storage 3. Locate in longitudinal flue space, staggered vertical 4. Shields required where multiple-level	Not Applicable	30 psi (standard orifice) or 14 psi (large orifice)	1. Six sprinklers each on two levels 2. Hydraulically most remote 12 sprinklers	500	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch = 6.895 kPa, 1 gallon = 3.785 L, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

a. This table shall not apply to racks with solid shelves.

b. Using extra-large orifice sprinklers under a ceiling 30 feet or less in height. Minimum aisle width is 7.5 feet.



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5704.3.7.2.2 Separation and aisles.** Piles shall be separated from each other by not less than 4-foot (1219 mm) aisles. Aisles shall be provided so that all containers are 20 feet (6096 mm) or less from an aisle. Where the storage of liquids is on racks, a minimum 4-foot-wide (1219 mm) aisle shall be provided between adjacent rows of racks and adjacent storage of liquids. Main aisles shall be not less than 8 feet (2438 mm) wide.

Additional aisles shall be provided for access to doors, required windows and ventilation openings, standpipe connections, mechanical equipment and switches. Such aisles shall be not less than 3 feet (914 mm) in width, unless greater widths are required for separation of piles or racks, in which case the greater width shall be provided.

**5704.3.7.2.3 Stabilizing and supports.** Containers and piles shall be separated by pallets or dunnage to provide stability and to prevent excessive stress to container walls. Portable tanks stored over one tier shall be designed to nest securely without dunnage.

Requirements for portable tank design shall be in accordance with Chapters 9 and 12 of NFPA 30. Shelving, racks, dunnage, scuffboards, floor overlay and similar installations shall be of noncombustible construction or of wood not less than a 1-inch (25 mm) nominal thickness. Adequate material-handling equipment shall be available to handle tanks safely at upper tier levels.

**5704.3.7.3 Spill control and secondary containment.** Liquid storage rooms shall be provided with spill control and secondary containment in accordance with Section 5004.2.

**5704.3.7.4 Ventilation.** Liquid storage rooms shall be ventilated in accordance with Section 5004.3.

**5704.3.7.5 Fire protection.** Fire protection for liquid storage rooms shall comply with Sections 5704.3.7.5.1 and 5704.3.7.5.2.

**5704.3.7.5.1 Fire-protection systems.** Liquid storage rooms shall be protected by *automatic sprinkler systems* installed in accordance with Chapter 9 and

Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1. In-rack sprinklers shall also comply with NFPA 13.

Automatic foam-water systems and automatic aqueous film-forming foam (AFFF) water sprinkler systems shall not be used except where *approved*.

Protection criteria developed from fire modeling or full-scale fire testing conducted at an *approved* testing laboratory are allowed in lieu of the protection as shown in Tables 5704.3.6.3(2) through 5704.3.6.3(7) and Table 5704.3.7.5.1 where *approved*.

**5704.3.7.5.2 Portable fire extinguishers.** Not less than one *approved* portable fire extinguisher complying with Section 906 and having a rating of not less than 20-B shall be located not less than 10 feet (3048 mm) or more than 50 feet (15 240 mm) from any Class I or II liquid storage area located outside of a liquid storage room.

Not less than one portable fire extinguisher having a rating of not less than 20-B shall be located outside of, but not more than 10 feet (3048 mm) from, the door opening into a liquid storage room.

**5704.3.8 Liquid storage warehouses.** Buildings used for storage of *flammable or combustible liquids* in quantities exceeding those set forth in Section 5704.3.4 for *control areas* and Section 5704.3.7 for liquid storage rooms shall comply with Sections 5704.3.8.1 through 5704.3.8.5 and shall be constructed and separated as required by the *International Building Code*.

**5704.3.8.1 Quantities and storage arrangement.** The total quantities of liquids in a liquid storage warehouse shall not be limited. The arrangement of storage shall be in accordance with Table 5704.3.6.3(2) or 5704.3.6.3(4).

**5704.3.8.1.1 Mixed storage.** Mixed storage shall be in accordance with Section 5704.3.7.2.1.

**5704.3.8.1.2 Separation and aisles.** Separation and aisles shall be in accordance with Section 5704.3.7.2.2.

**TABLE 5704.3.7.5.1**  
**AUTOMATIC AFFF-WATER PROTECTION REQUIREMENTS FOR SOLID-PILE AND**  
**PALLETIZED STORAGE OF LIQUIDS IN METAL CONTAINERS OF 5-GALLON CAPACITY OR LESS<sup>a, b</sup>**

PACKAGE TYPE	CLASS LIQUID	CEILING SPRINKLER DESIGN AND DEMAND					STORAGE HEIGHT (feet)	HOSE DEMAND (gpm) <sup>c</sup>	DURATION AFFF SUPPLY (minimum)	DURATION WATER SUPPLY (hours)
		Density (gpm/ft <sup>2</sup> )	Area (square feet)	Temperature rating	Maximum spacing	Orifice size (inch)				
Cartoned	IB, IC, II and III	0.40	2,000	286°F	100 ft <sup>2</sup> /head	0.531	11	500	15	2
Uncartoned	IB, IC, II and III	0.30	2,000	286°F	100 ft <sup>2</sup> /head	0.5 or 0.531	12	500	15	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>, °C = [(°F) – 32]/1.8.

a. System shall be a closed-head wet system with approved devices for proportioning aqueous film-forming foam.

b. Maximum ceiling height of 30 feet.

c. Hose stream demand includes 1½-inch inside hose connections, where required.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5704.3.8.2 Spill control and secondary containment.** Liquid storage warehouses shall be provided with spill control and secondary containment as set forth in Section 5004.2.

**5704.3.8.3 Ventilation.** Liquid storage warehouses storing containers greater than 5 gallons (19 L) in capacity shall be ventilated at a rate of not less than 0.25 cfm per square foot ( $0.00127 \text{ m}^3/\text{s} \times \text{m}^2$ ) of floor area over the storage area.

**5704.3.8.4 Automatic sprinkler systems.** Liquid storage warehouses shall be protected by *automatic sprinkler systems* installed in accordance with Chapter 9 and Tables 5704.3.6.3(4) through 5704.3.6.3(7) and Table 5704.3.7.5.1, or Sections 16.4.1 through 16.4.3, 16.5.1 through 16.5.2.12, and Figures 16.4.1(a) through 16.4.1(c) and Tables 16.5.2.1 through 16.5.2.12 of NFPA 30. In-rack sprinklers shall also comply with NFPA 13.

Automatic foam-water systems and automatic AFFF water sprinkler systems shall not be used except where *approved*.

Protection criteria developed from fire modeling or full-scale fire testing conducted at an *approved* testing laboratory are allowed in lieu of the protection as shown in Tables 5704.3.6.3(2) through 5704.3.6.3(7) and Table 5704.3.7.5.1 where *approved*.

**5704.3.8.5 Warehouse hose lines.** In liquid storage warehouses, either  $1\frac{1}{2}$ -inch (38 mm) lined or 1-inch (25 mm) hard rubber hose lines shall be provided in sufficient number to reach all liquid storage areas and shall be in accordance with Section 903 or 905.

#### 5704.4 Outdoor storage of containers and portable tanks.

Storage of *flammable* and *combustible liquids* in closed containers and portable tanks outside of buildings shall be in accordance with Section 5703 and Sections 5704.4.1 through 5704.4.8. Capacity limits for containers and portable tanks shall be in accordance with Section 5704.3.

**5704.4.1 Plans.** Storage shall be in accordance with *approved* plans.

**5704.4.2 Location on property.** Outdoor storage of liquids in containers and portable tanks shall be in accordance with Table 5704.4.2. Storage of liquids near buildings located on the same lot shall be in accordance with this section.

**5704.4.2.1 Mixed liquid piles.** Where two or more classes of liquids are stored in a single pile, the quantity in the pile shall not exceed the smallest of maximum quantities for the classes of material stored.

**5704.4.2.2 Access.** Storage of containers or portable tanks shall be provided with fire apparatus access roads in accordance with Chapter 5.

**5704.4.2.3 Security.** The storage area shall be protected against tampering or trespassers where necessary and shall be kept free from weeds, debris and other combustible materials not necessary to the storage.

**5704.4.2.4 Storage adjacent to buildings.** Not more than 1,100 gallons (4163 L) of liquids stored in closed containers and portable tanks is allowed adjacent to a building located on the same premises and under the same management, provided that one of the following requirements is met:

1. The building does not exceed one story in height. Such building shall be of *fire-resistance-rated* construction with noncombustible exterior surfaces or noncombustible construction and shall be used principally for the storage of liquids.
2. The exterior building wall adjacent to the storage area shall have a *fire-resistance rating* of not less than 2 hours, having no openings to above-grade areas within 10 feet (3048 mm) horizontally of such storage and no openings to below-grade areas within 50 feet (15 240 mm) horizontally of such storage.

TABLE 5704.4.2  
OUTDOOR LIQUID STORAGE IN CONTAINERS AND PORTABLE TANKS

CLASS OF LIQUID	CONTAINER STORAGE— MAXIMUM PER PILE		PORTABLE TANK STORAGE— MAXIMUM PER PILE		MINIMUM DISTANCE BETWEEN PILES OR RACKS (feet)	MINIMUM DISTANCE TO LOT LINE OF PROPERTY THAT CAN BE BUILT ON <sup>c, d</sup> (feet)	MINIMUM DISTANCE TO PUBLIC STREET, PUBLIC ALLEY OR PUBLIC WAY <sup>d</sup> (feet)
	Quantity <sup>a, b</sup> (gallons)	Height (feet)	Quantity <sup>a, b</sup> (gallons)	Height (feet)			
IA	1,100	10	2,200	7	5	50	10
IB	2,200	12	4,400	14	5	50	10
IC	4,400	12	8,800	14	5	50	10
II	8,800	12	17,600	14	5	25	5
III	22,000	18	44,000	14	5	10	5

For SI: 1 foot = 304.8 mm, 1 gallon 3.785 L.

a. For mixed class storage, see Section 5704.4.2.

b. For storage in racks, the quantity limits per pile do not apply, but the rack arrangement shall be limited to not more than 50 feet in length and two rows or 9 feet in depth.

c. If protection by a public fire department or private fire brigade capable of providing cooling water streams is not available, the distance shall be doubled.

d. Where the total quantity stored does not exceed 50 percent of the maximum allowed per pile, the distances are allowed to be reduced 50 percent, but not less than 3 feet.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

The quantity of liquids stored adjacent to a building protected in accordance with Item 2 is allowed to exceed 1,100 gallons (4163 L), provided that the maximum quantity per pile does not exceed 1,100 gallons (4163 L) and each pile is separated by a 10-foot-minimum (3048 mm) clear space along the common wall.

Where the quantity stored exceeds 1,100 gallons (4163 L) adjacent to a building complying with Item 1, or the provisions of Item 1 cannot be met, a minimum distance in accordance with Table 5704.4.2, column 7 ("Minimum Distance to Lot Line of Property That Can Be Built On") shall be maintained between buildings and the nearest container or portable tank.

**5704.4.3 Spill control and secondary containment.** Storage areas shall be provided with spill control and secondary containment in accordance with Section 5703.4.

**Exception:** Containers stored on *approved* containment pallets in accordance with Section 5004.2.3 and containers stored in cabinets and lockers with integral spill containment.

**5704.4.4 Security.** Storage areas shall be protected against tampering or trespassers by fencing or other *approved* control measures.

**5704.4.5 Protection from vehicles.** Guard posts or other means shall be provided to protect exterior storage tanks from vehicular damage. Where guard posts are installed, the posts shall be installed in accordance with Section 312.

**5704.4.6 Clearance from combustibles.** The storage area shall be kept free from weeds, debris and combustible materials not necessary to the storage. The area surrounding an exterior storage area shall be kept clear of such materials for a minimum distance of 15 feet (4572 mm).

**5704.4.7 Weather protection.** Weather protection for outdoor storage shall be in accordance with Section 5004.13.

**5704.4.8 Empty containers and tank storage.** The storage of empty tanks and containers previously used for the storage of *flammable* or *combustible liquids*, unless free from explosive vapors, shall be stored as required for filled containers and tanks. Tanks and containers when emptied shall have the covers or plugs immediately replaced in openings.

### SECTION 5705 DISPENSING, USE, MIXING AND HANDLING

**5705.1 Scope.** Dispensing, use, mixing and handling of *flammable liquids* shall be in accordance with Section 5703 and this section. Tank vehicle and tank car loading and unloading and other special operations shall be in accordance with Section 5706.

**Exception:** Containers of organic coatings having no fire point and which are opened for pigmentation are not required to comply with this section.

**5705.2 Liquid transfer.** Liquid transfer equipment and methods for transfer of Class I, II and IIIA liquids shall be *approved* and be in accordance with Sections 5705.2.1 through 5705.2.6.

**5705.2.1 Pumps.** Where positive-displacement pumps are used, they shall be provided with pressure relief discharging back to the tank, pump suction or other *approved* location, or shall be provided with interlocks to prevent over-pressure.

**5705.2.2 Pressured systems.** Where gases are introduced to provide for transfer of Class I liquids, or Class II and III liquids transferred at temperatures at or above their *flash points* by pressure, only inert gases shall be used. Controls, including pressure relief devices, shall be provided to limit the pressure so that the maximum working pressure of tanks, containers and piping systems cannot be exceeded. Where devices operating through pressure within a tank or container are used, the tank or container shall be a pressure vessel *approved* for the intended use. Air or oxygen shall not be used for pressurization.

**Exception:** Air transfer of Class II and III liquids at temperatures below their *flash points*.

**5705.2.3 Piping, hoses and valves.** Piping, hoses and valves used in liquid transfer operations shall be *approved* or *listed* for the intended use.

**5705.2.4 Class I, II and III liquids.** Class I liquids or, when heated to or above their *flash points*, Class II and Class III liquids, shall be transferred by one of the following methods:

1. From safety cans complying with UL 30.
2. Through an *approved* closed piping system.
3. From containers or tanks by an *approved* pump taking suction through an opening in the top of the container or tank.
4. For Class IB, IC, II and III liquids, from containers or tanks by gravity through an *approved* self-closing or automatic-closing valve where the container or tank and dispensing operations are provided with spill control and secondary containment in accordance with Section 5703.4. Class IA liquids shall not be dispensed by gravity from tanks.
5. *Approved* engineered liquid transfer systems.

**Exception:** Liquids in original shipping containers not exceeding a 5.3-gallon (20 L) capacity.

**5705.2.5 Manual container filling operations.** Class I liquids or Class II and Class III liquids that are heated up to or above their *flash points* shall not be transferred into containers unless the nozzle and containers are electrically interconnected. Acceptable methods of electrical interconnection include either of the following:

1. Metallic floor plates on which containers stand while filling, where such floor plates are electrically connected to the fill stem.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

2. Where the fill stem is bonded to the container during filling by means of a bond wire.

**5705.2.6 Automatic container-filling operations for Class I liquids.** Container-filling operations for Class I liquids involving conveyor belts or other automatic-feeding operations shall be designed to prevent static accumulations.

**5705.3 Use, dispensing and mixing inside of buildings.** Indoor use, dispensing and mixing of *flammable* and *combustible liquids* shall be in accordance with Section 5705.2 and Sections 5705.3.1 through 5705.3.5.3.

**5705.3.1 Closure of mixing or blending vessels.** Vessels used for mixing or blending of Class I liquids and Class II or III liquids heated up to or above their *flash points* shall be provided with self-closing, tight-fitting, noncombustible lids that will control a fire within such vessel.

**Exception:** Where such devices are impractical, *approved* automatic or manually controlled fire-extinguishing devices shall be provided.

**5705.3.2 Bonding of vessels.** Where differences of potential could be created, vessels containing Class I liquids or liquids handled at or above their *flash points* shall be elec-

trically connected by bond wires, ground cables, piping or similar means to a static grounding system to maintain equipment at the same electrical potential to prevent sparking.

**5705.3.3 Heating, lighting and cooking appliances.** Heating, lighting and cooking appliances that utilize Class I liquids shall not be operated within a building or structure.

**Exception:** Operation in single-family *dwelling*s.

**5705.3.4 Location of processing vessels.** Processing vessels shall be located with respect to distances to *lot lines* of adjoining property that can be built on, in accordance with Tables 5705.3.4(1) and 5705.3.4(2).

**Exception:** Where the exterior wall facing the adjoining *lot line* is a blank wall having a *fire-resistance rating* of not less than 4 hours, the *fire code official* is authorized to modify the distances. The distance shall be not less than that set forth in the *International Building Code*, and where Class IA or unstable liquids are involved, explosion control shall be provided in accordance with Section 911.

TABLE 5705.3.4(1)  
SEPARATION OF PROCESSING VESSELS FROM LOT LINES

PROCESSING VESSELS WITH EMERGENCY RELIEF VENTING	LOCATION <sup>a</sup>	
	Stable liquids	Unstable liquids
Not in excess of 2.5 psig	Table 5705.3.4(2)	2.5 times Table 5705.3.4(2)
Over 2.5 psig	1.5 times Table 5705.3.4(2)	4 times Table 5705.3.4(2)

For SI: 1 pound per square inch gauge = 6.895 kPa.

- a. Where protection of exposures by a public fire department or private fire brigade capable of providing cooling water streams on structures is not provided, distances shall be doubled.

TABLE 5705.3.4(2)  
REFERENCE TABLE FOR USE WITH TABLE 5705.3.4(1)

TANK CAPACITY (gallons)	MINIMUM DISTANCE FROM LOT LINE OF A LOT THAT IS OR CAN BE BUILT ON, INCLUDING THE OPPOSITE SIDE OF A PUBLIC WAY (feet)	MINIMUM DISTANCE FROM NEAREST SIDE OF ANY PUBLIC WAY OR FROM NEAREST IMPORTANT BUILDING ON THE SAME PROPERTY (feet)
275 or less	5	5
276 to 750	10	5
751 to 12,000	15	5
12,001 to 30,000	20	5
30,001 to 50,000	30	10
50,001 to 100,000	50	15
100,001 to 500,000	80	25
500,001 to 1,000,000	100	35
1,000,001 to 2,000,000	135	45
2,000,001 to 3,000,000	165	55
3,000,001 or more	175	60

For SI: 1 foot = 304.8 mm, 1 gallon = 3.785 L.



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5705.3.5 Quantity limits for use.** Liquid use quantity limitations shall comply with Sections 5705.3.5.1 through 5705.3.5.3.

**5705.3.5.1 Maximum allowable quantity per control area.** Indoor use, dispensing and mixing of *flammable* and *combustible liquids* shall not exceed the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) and shall not exceed the additional limitations set forth in Section 5705.3.5.

Use of hazardous production material *flammable* and *combustible liquids* in Group H-5 occupancies shall be in accordance with Chapter 27.

**Exception:** Cleaning with Class I, II and IIIA liquids shall be in accordance with Section 5705.3.6.

**5705.3.5.2 Occupancy quantity limits.** The following limits for quantities of *flammable* and *combustible liquids* used, dispensed or mixed based on occupancy classification shall not be exceeded:

1. Group A occupancies: Quantities in Group A occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
2. Group B occupancies: Quantities in drinking, dining, office and school uses within Group B occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
3. Group E occupancies: Quantities in Group E occupancies shall not exceed that necessary for demonstration, treatment, laboratory work, maintenance purposes and operation of equipment and shall not exceed quantities set forth in Table 5003.1.1(1).
4. Group F occupancies: Quantities in dining, office and school uses within Group F occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
5. Group I occupancies: Quantities in Group I occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).
6. Group M occupancies: Quantities in dining, office and school uses within Group M occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

7. Group R occupancies: Quantities in Group R occupancies shall not exceed that necessary for maintenance purposes and operation of equipment, and shall not exceed quantities set forth in Table 5003.1.1(1).

8. Group S occupancies: Quantities in dining and office uses within Group S occupancies shall not exceed that necessary for demonstration, laboratory work, maintenance purposes and operation of equipment and shall not exceed quantities set forth in Table 5003.1.1(1).

**Exception:** Cleaning with Class I, II, or IIIA liquids shall be in accordance with Section 5705.3.6.

**5705.3.5.3 Quantities exceeding limits for control areas.** Quantities exceeding the *maximum allowable quantity per control area* indicated in Sections 5705.3.5.1 and 5705.3.5.2 shall be in accordance with the following:

1. For *open systems*, indoor use, dispensing and mixing of *flammable* and *combustible liquids* shall be within a room or building complying with the *International Building Code* and Sections 5705.3.7.1 through 5705.3.7.5.3.
2. For *closed systems*, indoor use, dispensing and mixing of *flammable* and *combustible liquids* shall be within a room or building complying with the *International Building Code* and Sections 5705.3.7 through 5705.3.7.4 and Section 5705.3.7.6.

**5705.3.6 Cleaning with flammable and combustible liquids.** Cleaning with Class I, II and IIIA liquids shall be in accordance with Sections 5705.3.6.1 through 5705.3.6.2.7.

### Exceptions:

1. Dry cleaning shall be in accordance with Chapter 21.
2. Spray-nozzle cleaning shall be in accordance with Section 2403.3.5.

**5705.3.6.1 Cleaning operations.** Class IA liquids shall not be used for cleaning. Cleaning with Class IB, IC or II liquids shall be conducted as follows:

1. In a room or building, Section 5705.3.7; or
2. In a parts cleaner *listed, labeled and approved* for the purpose, Section 5705.3.6.2.

**Exception:** Materials used in commercial and industrial process-related cleaning operations in accordance with other provisions of this code and not involving facilities maintenance cleaning operations.

**5705.3.6.2 Listed and approved machines.** Parts cleaning and degreasing conducted in *listed* and *approved* machines in accordance with Section 5705.3.6.1 shall be in accordance with Sections 5705.3.6.2.1 through 5705.3.6.2.7.

**5705.3.6.2.1 Solvents.** Solvents shall be classified and shall be compatible with the machines within which they are used.

**5705.3.6.2.2 Machine capacities.** The quantity of solvent shall not exceed the *listed* design capacity of the machine for the solvent being used with the machine.

**5705.3.6.2.3 Solvent quantity limits.** Solvent quantities shall be limited as follows:

1. Machines without remote solvent reservoirs shall be limited to quantities set forth in Section 5705.3.5.
2. Machines with remote solvent reservoirs using Class I liquids shall be limited to quantities set forth in Section 5705.3.5.
3. Machines with remote solvent reservoirs using Class II liquids shall be limited to 35 gallons (132 L) per machine. The total quantities shall not exceed an aggregate of 240 gallons (908 L) per *control area* in buildings not equipped throughout with an *approved automatic sprinkler system* and an aggregate of 480 gallons (1817 L) per *control area* in buildings equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.
4. Machines with remote solvent reservoirs using Class IIIA liquids shall be limited to 80 gallons (303 L) per machine.

**5705.3.6.2.4 Immersion soaking of parts.** Work areas of machines with remote solvent reservoirs shall not be used for immersion soaking of parts.

**5705.3.6.2.5 Separation.** Multiple machines shall be separated from each other by a distance of not less than 30 feet (9144 mm) or by a *fire barrier* with a minimum 1-hour *fire-resistance rating*.

**5705.3.6.2.6 Ventilation.** Machines shall be located in areas adequately ventilated to prevent accumulation of vapors.

**5705.3.6.2.7 Installation.** Machines shall be installed in accordance with their listings.

**5705.3.7 Rooms or buildings for quantities exceeding the maximum allowable quantity per control area.** Where required by Section 5705.3.5.3 or 5705.3.6.1, rooms or buildings used for the use, dispensing or mixing of *flammable* and *combustible liquids* in quantities exceeding the *maximum allowable quantity per control area* shall be in accordance with Sections 5705.3.7.1 through 5705.3.7.6.3.

**5705.3.7.1 Construction, location and fire protection.** Rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3 occupancies based on use, dispensing or mixing of *flammable* or *combustible liquids* shall be constructed in accordance with the *International Building Code*.

**5705.3.7.2 Basements.** In rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3, dispensing or mixing of *flammable* or *combustible liquids* shall not be conducted in *basements*.

**5705.3.7.3 Fire protection.** Rooms or buildings classified in accordance with the *International Building Code* as Group H-2 or H-3 occupancies shall be equipped with an *approved* automatic fire-extinguishing system in accordance with Chapter 9.

**5705.3.7.4 Doors.** Interior doors to rooms or portions of such buildings shall be self-closing fire doors in accordance with the *International Building Code*.

**5705.3.7.5 Open systems.** Use, dispensing and mixing of *flammable* and *combustible liquids* in *open systems* shall be in accordance with Sections 5705.3.7.5.1 through 5705.3.7.5.3.

**5705.3.7.5.1 Ventilation.** Continuous mechanical ventilation shall be provided at a rate of not less than 1 cfm per square foot [ $0.00508 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of floor area over the design area. Provisions shall be made for introduction of makeup air in such a manner to include all floor areas or pits where vapors can collect. Local or spot ventilation shall be provided where needed to prevent the accumulation of hazardous vapors. Ventilation system design shall comply with the *International Building Code* and *International Mechanical Code*.

**Exception:** Where natural ventilation can be shown to be effective for the materials used, dispensed or mixed.

**5705.3.7.5.2 Explosion control.** Explosion control shall be provided in accordance with Section 911.

**5705.3.7.5.3 Spill control and secondary containment.** Spill control shall be provided in accordance with Section 5703.4 where Class I, II or IIIA liquids are dispensed into containers exceeding a 1.3-gallon (5 L) capacity or mixed or used in open containers or systems exceeding a 5.3-gallon (20 L) capacity. Spill control and secondary containment shall be provided in accordance with Section 5703.4 where the capacity of an individual container exceeds 55 gallons (208 L) or the aggregate capacity of multiple containers or tanks exceeds 100 gallons (378.5 L).

**5705.3.7.6 Closed systems.** Use or mixing of *flammable* or *combustible liquids* in *closed systems* shall be in accordance with Sections 5705.3.7.6.1 through 5705.3.7.6.3.

**5705.3.7.6.1 Ventilation.** *Closed systems* designed to be opened as part of normal operations shall be provided with ventilation in accordance with Section 5705.3.7.5.1.

**5705.3.7.6.2 Explosion control.** Explosion control shall be provided where an explosive environment can occur as a result of the mixing or use process. Explosion control shall be designed in accordance with Section 911.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**Exception:** Where process vessels are designed to contain fully the worst-case explosion anticipated within the vessel under process conditions considering the most likely failure.

**5705.3.7.6.3 Spill control and secondary containment.** Spill control shall be provided in accordance with Section 5703.4 where *flammable* or *combustible liquids* are dispensed into containers exceeding a 1.3-gallon (5 L) capacity or mixed or used in open containers or systems exceeding a 5.3-gallon (20 L) capacity. Spill control and secondary containment shall be provided in accordance with Section 5703.4 where the capacity of an individual container exceeds 55 gallons (208 L) or the aggregate capacity of multiple containers or tanks exceeds 1,000 gallons (3785 L).

**5705.3.8 Use, dispensing and handling outside of buildings.** Outside use, dispensing and handling shall be in accordance with Sections 5705.3.8.1 through 5705.3.8.4.

Dispensing of liquids into motor vehicle fuel tanks at motor fuel-dispensing facilities shall be in accordance with Chapter 23.

**5705.3.8.1 Spill control.** Outside use, dispensing and handling areas shall be provided with spill control as set forth in Section 5703.4.

**5705.3.8.2 Location on property.** Dispensing activities that exceed the quantities set forth in Table 5705.3.8.2 shall not be conducted within 15 feet (4572 mm) of buildings or combustible materials or within 25 feet (7620 mm) of building openings, *lot lines*, public streets, public alleys or *public ways*. Dispensing activities that exceed the quantities set forth in Table 5705.3.8.2 shall not be conducted within 15 feet (4572 mm) of storage of Class I, II or III liquids unless such liquids are stored in tanks that are *listed* and *labeled* as 2-hour protected tank assemblies in accordance with UL 2085.

### Exceptions:

1. The requirements shall not apply to areas where only the following are dispensed: Class III liquids; liquids that are heavier than water; water-miscible liquids; and liquids with viscosities greater than 10,000 centipoise (cp) (10 Pa × s).
2. *Flammable* and *combustible liquid* dispensing in refineries, chemical plants, process facilities, gas and crude oil production facilities and oil-blending and packaging facilities, terminals and bulk plants.

**TABLE 5705.3.8.2  
MAXIMUM ALLOWABLE QUANTITIES FOR  
DISPENSING FLAMMABLE AND COMBUSTIBLE  
LIQUIDS IN OUTDOOR CONTROL AREAS<sup>a, b</sup>**

CLASS OF LIQUID	QUANTITY (gallons)
Flammable	
Class IA	10
Class IB	15
Class IC	20
Combination Class IA, IB and IC	30 <sup>c</sup>
Combustible	
Class II	30
Class IIIA	80
Class IIIB	3,300

For SI: 1 gallon = 3.785 L.

- a. For definition of “Outdoor Control Area,” see Section 202.
- b. The fire code official is authorized to impose special conditions regarding locations, types of containers, dispensing units, fire control measures and other factors involving fire safety.
- c. Containing not more than the maximum allowable quantity per control area of each individual class.

**5705.3.8.3 Location of processing vessels.** Processing vessels shall be located with respect to distances to *lot lines* that can be built on in accordance with Table 5705.3.4(1).

**Exception:** In refineries and distilleries.

**5705.3.8.4 Weather protection.** Weather protection for outdoor use shall be in accordance with Section 5005.3.9.

**5705.4 Solvent distillation units.** Solvent distillation units shall comply with Sections 5705.4.1 through 5705.4.9.

**5705.4.1 Unit with a capacity of 60 gallons or less.** Solvent distillation units used to recycle Class I, II or IIIA liquids having a distillation chamber capacity of 60 gallons (227 L) or less shall be *listed*, *labeled* and installed in accordance with Section 5705.4 and UL 2208.

### Exceptions:

1. Solvent distillation units used in continuous through-put industrial processes where the source of heat is remotely supplied using steam, hot water, oil or other heat transfer fluids, the temperature of which is below the auto-ignition point of the solvent.
2. *Approved* research, testing and experimental processes.

**5705.4.2 Units with a capacity exceeding 60 gallons.** Solvent distillation units used to recycle Class I, II or IIIA liquids, having a distillation chamber capacity exceeding 60 gallons (227 L) shall be used in locations that comply with the use and mixing requirements of Section 5705 and other applicable provisions in this chapter.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5705.4.3 Prohibited processing.** Class I, II and IIIA liquids that are classified as unstable (reactive) shall not be processed in solvent distillation units.

**Exception:** Appliances *listed* for the distillation of unstable (reactive) solvents.

**5705.4.4 Labeling.** A permanent label shall be affixed to the unit by the manufacturer. The label shall indicate the capacity of the distillation chamber, and the distance the unit shall be placed away from sources of ignition. The label shall indicate the products for which the unit has been *listed* for use or refer to the instruction manual for a list of the products.

**5705.4.5 Manufacturer's instruction manual.** An instruction manual shall be provided. The manual shall be readily available for the user and the *fire code official*. The manual shall include installation, use and servicing instructions. It shall identify the liquids for which the unit has been *listed* for distillation purposes along with each liquid's *flash point* and auto-ignition temperature. For units with adjustable controls, the manual shall include directions for setting the heater temperature for each liquid to be instilled.

**5705.4.6 Location.** Solvent distillation units shall be used in locations in accordance with the listing. Solvent distillation units shall not be used in *basements*.

**5705.4.7 Storage of liquids.** Distilled liquids and liquids awaiting distillation shall be stored in accordance with Section 5704.

**5705.4.8 Storage of residues.** Hazardous residue from the distillation process shall be stored in accordance with Section 5704 and Chapter 50.

**5705.4.9 Portable fire extinguishers.** *Approved* portable fire extinguishers shall be provided in accordance with Section 906. Not less than one portable fire extinguisher having a rating of not less than 40-B shall be located not less than 10 feet (3048 mm) or more than 30 feet (9144 mm) from any solvent distillation unit.

**5705.5 Alcohol-based hand rubs classified as Class I or II liquids.** The use of wall-mounted dispensers containing alcohol-based hand rubs classified as Class I or II liquids shall be in accordance with all of the following:

1. The maximum capacity of each dispenser shall be 68 ounces (2 L).
2. The minimum separation between dispensers shall be 48 inches (1219 mm).
3. The dispensers shall not be installed above, below, or closer than 1 inch (25 mm) to an electrical receptacle, switch, appliance, device or other ignition source. The wall space between the dispenser and the floor or intervening counter top shall be free of electrical receptacles, switches, appliances, devices or other ignition sources.
4. Dispensers shall be mounted so that the bottom of the dispenser is not less than 42 inches (1067 mm) and not more than 48 inches (1219 mm) above the finished floor.

5. Dispensers shall not release their contents except when the dispenser is manually activated. Facilities shall be permitted to install and use automatically activated "touch free" alcohol-based hand-rub dispensing devices with the following requirements:

- 5.1. The facility or persons responsible for the dispensers shall test the dispensers each time a new refill is installed in accordance with the manufacturer's care and use instructions.
- 5.2. Dispensers shall be designed and must operate in a manner that ensures accidental or malicious activations of the dispensing device are minimized. At a minimum, all devices subject to or used in accordance with this section shall have the following safety features:
  - 5.2.1. Any activations of the dispenser shall only occur when an object is placed within 4 inches (98 mm) of the sensing device.
  - 5.2.2. The dispenser shall not dispense more than the amount required for hand hygiene consistent with label instructions as regulated by the United States Food and Drug Administration (USFDA).
  - 5.2.3. An object placed within the activation zone and left in place will cause only one activation.
6. Storage and use of alcohol-based hand rubs shall be in accordance with the applicable provisions of Sections 5704 and 5705.
7. Dispensers installed in occupancies with carpeted floors shall only be allowed in *smoke compartments* or *fire areas* equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.

**5705.5.1 Corridor installations.** In addition to the provisions of Section 5705.5, where wall-mounted dispensers containing alcohol-based hand rubs are installed in *corridors* or rooms and areas open to the *corridor*, they shall be in accordance with all of the following:

1. Level 2 and 3 aerosol containers shall not be allowed in *corridors*.
2. The maximum capacity of each Class I or II liquid dispenser shall be 41 ounces (1.21 L) and the maximum capacity of each Level 1 aerosol dispenser shall be 18 ounces (0.51 kg).
3. The maximum quantity allowed in a *corridor* within a *control area* shall be 10 gallons (37.85 L) of Class I or II liquids or 1135 ounces (32.2 kg) of Level 1 aerosols, or a combination of Class I or II liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gallons (37.85 L) or 1,135 ounces (32.2 kg) such that the sum of the ratios of the liquid and aerosol quantities divided by the



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

allowable quantity of liquids and aerosols, respectively, shall not exceed one.

4. The minimum *corridor* width shall be 72 inches (1829 mm).
5. Projections into a *corridor* shall be in accordance with Section 1003.3.3.

### SECTION 5706 SPECIAL OPERATIONS

**5706.1 General.** This section shall cover the provisions for special operations that include, but are not limited to, storage, use, dispensing, mixing or handling of *flammable* and *combustible liquids*. The following special operations shall be in accordance with Sections 5701, 5703, 5704 and 5705, except as provided in Section 5706.

1. Storage and dispensing of *flammable* and *combustible liquids* on farms and construction sites.
2. Well drilling and operating.
3. Bulk plants or terminals.
4. Bulk transfer and process transfer operations utilizing tank vehicles and tank cars.
5. Tank vehicles and tank vehicle operation.
6. Refineries.
7. Vapor recovery and vapor-processing systems.

**5706.2 Storage and dispensing of flammable and combustible liquids on farms and construction sites.** Permanent and temporary storage and dispensing of Class I and II liquids for private use on farms and rural areas and at construction sites, earth-moving projects, gravel pits or borrow pits shall be in accordance with Sections 5706.2.1 through 5706.2.8.1.

**Exception:** Storage and use of fuel oil and containers connected with oil-burning equipment regulated by Section 605 and the *International Mechanical Code*.

**5706.2.1 Combustibles and open flames near tanks.** Storage areas shall be kept free from weeds and extraneous combustible material. Open flames and smoking are prohibited in *flammable* or *combustible liquid* storage areas.

**5706.2.2 Marking of tanks and containers.** Tanks and containers for the storage of liquids above ground shall be conspicuously marked with the name of the product that they contain and the words: "FLAMMABLE—KEEP FIRE AND FLAME AWAY." Tanks shall bear the additional marking: "KEEP 50 FEET FROM BUILDINGS."

**5706.2.3 Containers for storage and use.** Metal containers used for storage of Class I or II liquids shall be in accordance with DOTn requirements or shall be of an *approved* design.

Discharge devices shall be of a type that do not develop an internal pressure on the container. Pumping devices or *approved* self-closing faucets used for dispensing liquids shall not leak and shall be well-maintained.

Individual containers shall not be interconnected and shall be kept closed when not in use.

Containers stored outside of buildings shall be in accordance with Section 5704 and the *International Building Code*.

**5706.2.4 Permanent and temporary tanks.** The capacity of permanent above-ground tanks containing Class I or II liquids shall not exceed 1,100 gallons (4164 L). The capacity of temporary above-ground tanks containing Class I or II liquids shall not exceed 10,000 gallons (37 854 L). Tanks shall be of the single-compartment design.

**Exception:** Permanent above-ground tanks of greater capacity that meet the requirements of Section 5704.2.

**5706.2.4.1 Fill-opening security.** Fill openings shall be equipped with a locking closure device. Fill openings shall be separate from vent openings.

**5706.2.4.2 Vents.** Tanks shall be provided with a method of normal and emergency venting. Normal vents shall be in accordance with Section 5704.2.7.3.

Emergency vents shall be in accordance with Section 5704.2.7.4. Emergency vents shall be arranged to discharge in a manner that prevents localized overheating or flame impingement on any part of the tank in the event that vapors from such vents are ignited.

**5706.2.4.3 Location.** Tanks containing Class I or II liquids shall be kept outside and not less than 50 feet (15 240 mm) from buildings and combustible storage. Additional distance shall be provided where necessary to ensure that vehicles, equipment and containers being filled directly from such tanks will not be less than 50 feet (15 240 mm) from structures, haystacks or other combustible storage.

**5706.2.4.4 Locations where above-ground tanks are prohibited.** The storage of Class I and II liquids in above-ground tanks is prohibited within the limits established by law as the limits of districts in which such storage is prohibited [JURISDICTION TO SPECIFY].

**5706.2.5 Type of tank.** Tanks shall be provided with top openings only or shall be elevated for gravity discharge.

**5706.2.5.1 Tanks with top openings only.** Tanks with top openings shall be mounted in accordance with either of the following:

1. On well-constructed metal legs connected to shoes or runners designed so that the tank is stabilized and the entire tank and its supports can be moved as a unit.
2. For stationary tanks, on a stable base of timbers or blocks approximately 6 inches (152 mm) in height that prevents the tank from contacting the ground.

**5706.2.5.1.1 Pumps and fittings.** Tanks with top openings only shall be equipped with a tightly and permanently attached, *approved* pumping device having an *approved* hose of sufficient length for filling vehicles, equipment or containers to be served from the tank. Either the pump or the hose shall be

equipped with a padlock to its hanger to prevent tampering. An effective antisiphoning device shall be included in the pump discharge unless a self-closing nozzle is provided. Siphons or internal pressure discharge devices shall not be used.

**5706.2.5.2 Tanks for gravity discharge.** Tanks with a connection in the bottom or the end for gravity-dispensing liquids shall be mounted and equipped as follows:

1. Supports to elevate the tank for gravity discharge shall be designed to carry all required loads and provide stability.
2. Bottom or end openings for gravity discharge shall be equipped with a valve located adjacent to the tank shell that will close automatically in the event of fire through the operation of an effective heat-activated releasing device. Where this valve cannot be operated manually, it shall be supplemented by a second, manually operated valve.

The gravity discharge outlet shall be provided with an *approved* hose equipped with a self-closing valve at the discharge end of a type that can be padlocked to its hanger.

**5706.2.6 Spill control drainage control and diking.** Indoor storage and dispensing areas shall be provided with spill control and drainage control as set forth in Section 5703.4. Outdoor storage areas shall be provided with drainage control or diking as set forth in Section 5704.2.10.

**5706.2.7 Portable fire extinguishers.** Portable fire extinguishers with a minimum rating of 20-B:C and complying with Section 906 shall be provided where required by the *fire code official*.

**5706.2.8 Dispensing from tank vehicles.** Where *approved*, liquids used as fuels are allowed to be transferred from tank vehicles into the tanks of motor vehicles or special equipment, provided that:

1. The tank vehicle's specific function is that of supplying fuel to motor vehicle fuel tanks.
2. The dispensing hose does not exceed 100 feet (30 480 mm) in length.
3. The dispensing nozzle is an *approved* type.
4. The dispensing hose is properly placed on an *approved* reel or in a compartment provided before the tank vehicle is moved.
5. Signs prohibiting smoking or open flames within 25 feet (7620 mm) of the vehicle or the point of refueling are prominently posted on the tank vehicle.
6. Electrical devices and wiring in areas where fuel dispensing is conducted are in accordance with NFPA 70.
7. Tank vehicle-dispensing equipment is operated only by designated personnel who are trained to handle and dispense motor fuels.

8. Provisions are made for controlling and mitigating unauthorized discharges.

**5706.2.8.1 Location.** Dispensing from tank vehicles shall be conducted not less than 50 feet (15 240 mm) from structures or combustible storage.

**5706.3 Well drilling and operating.** Wells for oil and natural gas shall be drilled and operated in accordance with Sections 5706.3.1 through 5706.3.8.

**5706.3.1 Location.** The location of wells shall comply with Sections 5706.3.1.1 through 5706.3.1.3.2.

**5706.3.1.1 Storage tanks and sources of ignition.** Storage tanks or boilers, fired heaters, open-flame devices or other sources of ignition shall not be located within 25 feet (7620 mm) of well heads. Smoking is prohibited at wells or tank locations except as designated and in *approved* posted areas.

**Exception:** Engines used in the drilling, production and serving of wells.

**5706.3.1.2 Streets and railways.** Wells shall not be drilled within 75 feet (22 860 mm) of any dedicated public street, highway or nearest rail of an operating railway.

**5706.3.1.3 Buildings.** Wells shall not be drilled within 100 feet (30 480 mm) of buildings not necessary to the operation of the well.

**5706.3.1.3.1 Group A, E or I buildings.** Wells shall not be drilled within 300 feet (91 440 mm) of buildings with an occupancy in Group A, E or I.

**5706.3.1.3.2 Existing wells.** Where wells are existing, buildings shall not be constructed within the distances set forth in Section 5706.3.1 for separation of wells or buildings.

**5706.3.2 Waste control.** Control of waste materials associated with wells shall comply with Sections 5706.3.2.1 and 5706.3.2.2.

**5706.3.2.1 Discharge on a street or water channel.** Liquids containing crude petroleum or its products shall not be discharged into or on streets, highways, drainage canals or ditches, storm drains or flood control channels.

**5706.3.2.2 Discharge and combustible materials on ground.** The surface of the ground under, around or near wells, pumps, boilers, oil storage tanks or buildings shall be kept free from oil, waste oil, refuse or waste material.

**5706.3.3 Sumps.** Sumps associated with wells shall comply with Sections 5706.3.3.1 through 5706.3.3.3.

**5706.3.3.1 Maximum width.** Sumps or other basins for the retention of oil or petroleum products shall not exceed 12 feet (3658 mm) in width.

**5706.3.3.2 Backfilling.** Sumps or other basins for the retention of oil or petroleum products larger than 6 feet by 6 feet by 6 feet (1829 mm by 1829 mm by 1829 mm) shall not be maintained longer than 60 days after the cessation of drilling operations.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5706.3.3.3 Security.** Sumps, diversion ditches and depressions used as sumps shall be securely fenced or covered.

**5706.3.4 Prevention of blowouts.** Protection shall be provided to control and prevent the blowout of a well. Protection equipment shall meet federal, state and other applicable jurisdiction requirements.

**5706.3.5 Storage tanks.** Storage of *flammable* or *combustible liquids* in tanks shall be in accordance with Section 5704. Oil storage tanks or groups of tanks shall have posted in a conspicuous place, on or near such tank or tanks, an *approved* sign with the name of the *owner* or operator, or the lease number and the telephone number where a responsible person can be reached at any time.

**5706.3.6 Soundproofing.** Where soundproofing material is required during oil field operations, such material shall be noncombustible.

**5706.3.7 Signs.** Well locations shall have posted in a conspicuous place on or near such tank or tanks an *approved* sign with the name of the *owner* or operator, name of the leasee or the lease number, the well number and the telephone number where a responsible person can be reached at any time. Such signs shall be maintained on the premises from the time materials are delivered for drilling purposes until the well is abandoned.

**5706.3.8 Field-loading racks.** Field-loading racks shall be in accordance with Section 5706.5.

**5706.4 Bulk plants or terminals.** Portions of properties where *flammable* and *combustible liquids* are received by tank vessels, pipelines, tank cars or tank vehicles and stored or blended in bulk for the purpose of distribution by tank vessels, pipelines, tanks cars, tank vehicles or containers shall be in accordance with Sections 5706.4.1 through 5706.4.10.4.

**5706.4.1 Building construction.** Buildings shall be constructed in accordance with the *International Building Code*.

**5706.4.2 Means of egress.** Rooms in which liquids are stored, used or transferred by pumps shall have *means of egress* arranged to prevent occupants from being trapped in the event of fire.

**5706.4.3 Heating.** Rooms in which Class I liquids are stored or used shall be heated only by means not constituting a source of ignition, such as steam or hot water. Rooms containing heating appliances involving sources of ignition shall be located and arranged to prevent entry of flammable vapors.

**5706.4.4 Ventilation.** Ventilation shall be provided for rooms, buildings and enclosures in which Class I liquids are pumped, used or transferred. Design of ventilation systems shall consider the relatively high specific gravity of the vapors. Where natural ventilation is used, adequate openings in outside walls at floor level, unobstructed except by louvers or coarse screens, shall be provided. Where natural ventilation is inadequate, mechanical ventilation shall be provided in accordance with the *International Mechanical Code*.

**5706.4.4.1 Basements and pits.** Class I liquids shall not be stored or used within a building having a *basement* or pit into which flammable vapors can travel, unless such area is provided with ventilation designed to prevent the accumulation of flammable vapors therein.

**5706.4.4.2 Dispensing of Class I liquids.** Containers of Class I liquids shall not be drawn from or filled within buildings unless a provision is made to prevent the accumulation of flammable vapors in hazardous concentrations. Where mechanical ventilation is required, it shall be kept in operation while flammable vapors could be present.

**5706.4.5 Storage.** Storage of Class I, II and IIIA liquids in bulk plants shall be in accordance with the applicable provisions of Section 5704.

**5706.4.6 Overfill protection of Class I and II liquids.** Manual and automatic systems shall be provided to prevent overfill during the transfer of Class I and II liquids from mainline pipelines and marine vessels in accordance with API 2350.

**5706.4.7 Wharves.** This section shall apply to all wharves, piers, bulkheads and other structures over or contiguous to navigable water having a primary function of transferring liquid cargo in bulk between shore installations and tank vessels, ships, barges, lighter boats or other mobile floating craft.

**Exception:** Marine motor fuel-dispensing facilities in accordance with Chapter 23.

**5706.4.7.1 Transferring approvals.** Handling packaged cargo of liquids, including full and empty drums, bulk fuel and stores, over a wharf during cargo transfer shall be subject to the approval of the wharf supervisor and the senior deck officer on duty.

**5706.4.7.2 Transferring location.** Wharves at which liquid cargoes are to be transferred in bulk quantities to or from tank vessels shall be not less than 100 feet (30 480 mm) from any bridge over a navigable waterway; or from an entrance to, or superstructure of, any vehicular or railroad tunnel under a waterway. The termination of the fixed piping used for loading or unloading at a wharf shall be not less than 200 feet (60 960 mm) from a bridge or from an entrance to, or superstructures of, a tunnel.

**5706.4.7.3 Superstructure and decking material.** Superstructure and decking shall be designed for the intended use. Decking shall be constructed of materials that will afford the desired combination of flexibility, resistance to shock, durability, strength and *fire resistance*.

**5706.4.7.4 Tanks allowed.** Tanks used exclusively for ballast water or Class II or III liquids are allowed to be installed on suitably designed wharves.

**5706.4.7.5 Transferring equipment.** Loading pumps capable of building up pressures in excess of the safe working pressure of cargo hose or loading arms shall be provided with bypasses, relief valves or other



arrangements to protect the loading facilities against excessive pressure. Relief devices shall be tested not less than annually to determine that they function satisfactorily at their set pressure.

**5706.4.7.6 Piping, valves and fittings.** Piping valves and fittings shall be in accordance with Section 5703.6 except as modified by the following:

1. Flexibility of piping shall be ensured by appropriate layout and arrangement of piping supports so that motion of the wharf structure resulting from wave action, currents, tides or the mooring of vessels will not subject the pipe to repeated excessive strain.
2. Pipe joints that depend on the friction characteristics of combustible materials or on the grooving of pipe ends for mechanical continuity of piping shall not be used.
3. Swivel joints are allowed in piping to which hoses are connected and for articulated, swivel-joint transfer systems, provided that the design is such that the mechanical strength of the joint will not be impaired if the packing materials fail such as by exposure to fire.
4. Each line conveying Class I or II liquids leading to a wharf shall be provided with a block valve that has *ready access* and that is on shore, near the approach to the wharf and outside of any diked area. Where more than one line is involved, the valves shall be grouped in one location.
5. Means shall be provided for easy access to cargo line valves located below the wharf deck.
6. Piping systems shall contain a sufficient number of valves to operate the system properly and to control the flow of liquid in normal operation and in the event of physical damage.
7. Piping on wharves shall be bonded and grounded where Class I and II liquids are transported. Where excessive stray currents are encountered, insulating joints shall be installed. Bonding and grounding connections on piping shall be located on the wharf side of hose riser insulating flanges, where used, and shall be in a location provided with *ready access* for inspection.
8. Hose or articulated swivel-joint pipe connections used for cargo transfer shall be capable of accommodating the combined effects of change in draft and maximum tidal range, and mooring lines shall be kept adjusted to prevent surge of the vessel from placing stress on the cargo transfer system.
9. Hoses shall be supported to avoid kinking and damage from chafing.

**5706.4.7.7 Loading and unloading.** Loading or discharging shall not commence until the wharf superintendent and officer in charge of the tank vessel agree

that the tank vessel is properly moored and connections are properly made.

**5706.4.7.8 Mechanical work.** Mechanical work shall not be performed on the wharf during cargo transfer, except under special authorization by the *fire code official* based on a review of the area involved, methods to be employed and precautions necessary.

**5706.4.8 Sources of ignition.** Class I, II or IIIA liquids shall not be used, drawn or dispensed where flammable vapors can reach a source of ignition. Smoking shall be prohibited except in designated locations. “No Smoking” signs complying with Section 310 shall be conspicuously posted where a hazard from flammable vapors is normally present.

**5706.4.9 Drainage control.** Loading and unloading areas shall be provided with drainage control in accordance with Section 5704.2.10.

**5706.4.10 Fire protection.** Fire protection shall be in accordance with Chapter 9 and Sections 5706.4.10.1 through 5706.4.10.4.

**5706.4.10.1 Portable fire extinguishers.** Portable fire extinguishers with a rating of not less than 20-B and complying with Section 906 shall be located within 75 feet (22 860 mm) of hose connections, pumps and separator tanks.

**5706.4.10.2 Fire hoses.** Where piped water is available, ready-connected fire hose in a size appropriate for the water supply shall be provided in accordance with Section 905 so that manifolds where connections are made and broken can be reached by not less than one hose stream.

**5706.4.10.3 Obstruction of equipment.** Material shall not be placed on wharves in such a manner that would obstruct access to fire-fighting equipment or important pipeline control valves.

**5706.4.10.4 Fire apparatus access.** Where the wharf is designed for vehicular traffic, an unobstructed fire apparatus access road to the shore end of the wharf shall be maintained in accordance with Chapter 5.

**5706.5 Bulk transfer and process transfer operations.** Bulk transfer and process transfer operations shall be *approved* and be in accordance with Sections 5706.5.1 through 5706.5.4.5. Motor fuel-dispensing facilities shall comply with Chapter 23.

**5706.5.1 General.** The provisions of Sections 5706.5.1.1 through 5706.5.1.18 shall apply to bulk transfer and process transfer operations; Sections 5706.5.2 and 5706.5.2.1 shall apply to bulk transfer operations; Sections 5706.5.3 through 5706.5.3.3 shall apply to process transfer operations and Sections 5706.5.4 through 5706.5.4.5 shall apply to dispensing from tank vehicles and tank cars.

**5706.5.1.1 Location.** Bulk transfer and process transfer operations shall be conducted in *approved* locations. Tank cars shall be unloaded only on private sidings or railroad-siding facilities equipped for trans-



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

ferring *flammable* or *combustible liquids*. Tank vehicles and tank cars engaged in bulk transfer or process transfer operations shall be separated from buildings, above-ground tanks, combustible materials, *lot lines*, public streets, public alleys or *public ways* by a distance of 25 feet (7620 mm) for Class I liquids and 15 feet (4572 mm) for Class II and IIIA liquids measured from the nearest loading or unloading valve on the tank vehicle or tank car.

**Exception:** Buildings for pumps and shelters for personnel supporting transfer operations shall not be required to be separated from tank vehicles and tank cars engaged in bulk transfer or process transfer operations.

**5706.5.1.2 Weather protection canopies.** Where weather protection canopies are provided, they shall be constructed in accordance with Section 5004.13. Weather protection canopies shall not be located within 15 feet (4572 mm) of a building or combustible material or within 25 feet (7620 mm) of building openings, *lot lines*, public streets, public alleys or *public ways*.

**5706.5.1.3 Ventilation.** Ventilation shall be provided to prevent accumulation of vapors in accordance with Section 5705.3.7.5.1.

**5706.5.1.4 Sources of ignition.** Sources of ignition shall be controlled or eliminated in accordance with Section 5003.7.

**5706.5.1.5 Spill control and secondary containment.** Areas where transfer operations are located shall be provided with spill control and secondary containment in accordance with Section 5703.4. The spill control and secondary containment system shall have a design capacity capable of containing the capacity of the largest tank compartment located in the area where transfer operations are conducted. Containment of the rainfall volume specified in Section 5004.2.2.6 is not required.

**5706.5.1.6 Fire protection.** Fire protection shall be in accordance with Section 5703.2.

**5706.5.1.7 Static protection.** Static protection shall be provided to prevent the accumulation of static charges during transfer operations. Bonding facilities shall be provided during the transfer through open domes where Class I liquids are transferred, or where Class II and III liquids are transferred into tank vehicles or tank cars that could contain vapors from previous cargoes of Class I liquids.

Protection shall consist of a metallic bond wire permanently electrically connected to the fill stem. The fill pipe assembly shall form a continuous electrically conductive path downstream from the point of bonding. The free end of such bond wire shall be provided with a clamp or equivalent device for convenient attachment to a metallic part in electrical contact with the cargo tank of the tank vehicle or tank car. For tank vehicles, protection shall consist of a flexible

bond wire of adequate strength for the intended service and the electrical resistance shall not exceed 1 megohm. For tank cars, bonding shall be provided where the resistance of a tank car to ground through the rails is 25 ohms or greater.

Such bonding connection shall be fastened to the vehicle, car or tank before dome covers are raised and shall remain in place until filling is complete and all dome covers have been closed and secured.

### Exceptions:

1. Where vehicles and cars are loaded exclusively with products not having a static-accumulating tendency, such as asphalt, cutback asphalt, most crude oils, residual oils and water-miscible liquids.
2. Where Class I liquids are not handled at the transfer facility and the tank vehicles are used exclusively for Class II and III liquids.
3. Where vehicles and cars are loaded or unloaded through closed top or bottom connections whether the hose is conductive or nonconductive.

Filling through open domes into the tanks of tank vehicles or tank cars that contain vapor-air mixtures within the flammable range, or where the liquid being filled can form such a mixture, shall be by means of a downspout that extends to near the bottom of the tank.

**5706.5.1.8 Stray current protection.** Tank car loading facilities where Class I, II or IIIA liquids are transferred through open domes shall be protected against stray currents by permanently bonding the pipe to not less than one rail and to the transfer apparatus. Multiple pipes entering the transfer areas shall be permanently electrically bonded together. In areas where excessive stray currents are known to exist, all pipes entering the transfer area shall be provided with insulating sections to isolate electrically the transfer apparatus from the pipelines.

**5706.5.1.9 Top loading.** When top loading a tank vehicle with Class I and II liquids without vapor control, valves used for the final control of flow shall be of the self-closing type and shall be manually held open except where automatic means are provided for shutting off the flow when the tank is full. Where used, automatic shutoff systems shall be provided with a manual shutoff valve located at a safe distance from the loading nozzle to stop the flow if the automatic system fails.

When top loading a tank vehicle with vapor control, flow control shall be in accordance with Section 5706.5.1.10. Self-closing valves shall not be tied or locked in the open position.

**5706.5.1.10 Bottom loading.** When bottom loading a tank vehicle or tank car with or without vapor control, a positive means shall be provided for loading a predetermined quantity of liquid, together with an auto-

matic secondary shutoff control to prevent overflow. The connecting components between the transfer equipment and the tank vehicle or tank car required to operate the secondary control shall be functionally compatible.

**5706.5.1.10.1 Dry disconnect coupling.** When bottom loading a tank vehicle, the coupling between the liquid loading hose or pipe and the truck piping shall be a dry disconnect coupling.

**5706.5.1.10.2 Venting.** When bottom loading a tank vehicle or tank car that is equipped for vapor control and vapor control is not used, the tank shall be vented to the atmosphere to prevent pressurization of the tank. Such venting shall be at a height equal to or greater than the top of the cargo tank.

**5706.5.1.10.3 Vapor-tight connection.** Connections to the plant vapor control system shall be designed to prevent the escape of vapor to the atmosphere when not connected to a tank vehicle or tank car.

**5706.5.1.10.4 Vapor-processing equipment.** Vapor-processing equipment shall be separated from above-ground tanks, warehouses, other plant buildings, transfer facilities or nearest *lot line* of adjoining property that can be built on by a distance of not less than 25 feet (7620 mm). Vapor-processing equipment shall be protected from physical damage by remote location, guard rails, curbs or fencing.

**5706.5.1.11 Switch loading.** Tank vehicles or tank cars that have previously contained Class I liquids shall not be loaded with Class II or III liquids until such vehicles and all piping, pumps, hoses and meters connected thereto have been completely drained and flushed.

**5706.5.1.12 Loading racks.** Where provided, loading racks, *stairways* or platforms shall be constructed of noncombustible materials. Buildings for pumps or for shelter of loading personnel are allowed to be part of the loading rack. Wiring and electrical equipment located within 25 feet (7620 mm) of any portion of the loading rack shall be in accordance with Section 5703.1.1.

**5706.5.1.13 Transfer apparatus.** Bulk and process transfer apparatus shall be of an *approved* type.

**5706.5.1.14 Inside buildings.** Tank vehicles and tank cars shall not be located inside a building while transferring Class I, II or IIIA liquids, unless *approved* by the *fire code official*.

**Exception:** Tank vehicles are allowed under weather protection canopies and canopies of automobile motor vehicle fuel-dispensing stations.

**5706.5.1.15 Tank vehicle and tank car certification.** Certification shall be maintained for tank vehicles and tank cars in accordance with DOTn 49 CFR Parts 100–185.

#### **5706.5.1.16 Tank vehicle and tank car stability.**

Tank vehicles and tank cars shall be stabilized against movement during loading and unloading in accordance with Sections 5706.5.1.16.1 through 5706.5.1.16.3.

**5706.5.1.16.1 Tank vehicles.** When the vehicle is parked for loading or unloading, the cargo trailer portion of the tank vehicle shall be secured in a manner that will prevent unintentional movement.

**5706.5.1.16.2 Chock blocks.** Not less than two chock blocks not less than 5 inches by 5 inches by 12 inches (127 mm by 127 mm by 305 mm) in size and dished to fit the contour of the tires shall be used during transfer operations of tank vehicles.

**5706.5.1.16.3 Tank cars.** Brakes shall be set and the wheels shall be blocked to prevent rolling.

**5706.5.1.17 Monitoring.** Transfer operations shall be monitored by an *approved* monitoring system or by an attendant. Where monitoring is by an attendant, the operator or other competent person shall be present at all times.

**5706.5.1.18 Security.** Transfer operations shall be surrounded by a noncombustible fence not less than 5 feet (1524 mm) in height. Tank vehicles and tank cars shall not be loaded or unloaded unless such vehicles are entirely within the fenced area.

#### **Exceptions:**

1. Motor fuel-dispensing facilities complying with Chapter 23.
2. Installations where adequate public safety exists because of isolation, natural barriers or other factors as determined appropriate by the *fire code official*.
3. Facilities or properties that are entirely enclosed or protected from entry.

**5706.5.2 Bulk transfer.** Bulk transfer shall be in accordance with Sections 5706.5.1 and 5706.5.2.1.

**5706.5.2.1 Vehicle motor.** Motors of tank vehicles or tank cars shall be shut off during the making and breaking of hose connections and during the unloading operation.

**Exception:** Where unloading is performed with a pump deriving its power from the tank vehicle motor.

**5706.5.3 Process transfer.** Process transfer shall be in accordance with Section 5706.5.1 and Sections 5706.5.3.1 through 5706.5.3.3.

**5706.5.3.1 Piping, valves, hoses and fittings.** Piping, valves, hoses and fittings that are not a part of the tank vehicle or tank car shall be in accordance with Section 5703.6. Caps or plugs that prevent leakage or spillage shall be provided at all points of connection to transfer piping.

**5706.5.3.1.1 Shutoff valves.** *Approved* automatically or manually activated shutoff valves shall be provided where the transfer hose connects to the

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

process piping, and on both sides of any exterior *fire-resistance-rated* wall through which the piping passes. Manual shutoff valves shall be arranged so that they are able to be accessed from grade. Valves shall not be locked in the open position.

**5706.5.3.1.2 Hydrostatic relief.** Hydrostatic pressure-limiting or relief devices shall be provided where pressure buildup in trapped sections of the system could exceed the design pressure of the components of the system.

Devices shall relieve to other portions of the system or to another *approved* location.

**5706.5.3.1.3 Antisiphon valves.** Antisiphon valves shall be provided where the system design would allow siphonage.

**5706.5.3.2 Vents.** Normal and emergency vents shall be maintained operable at all times.

**5706.5.3.3 Motive power.** Motors of tank vehicles or tank cars shall be shut off during the making and breaking of hose connections and during the unloading operation.

**Exception:** When unloading is performed with a pump deriving its power from the tank vehicle motor.

**5706.5.4 Dispensing from tank vehicles and tank cars.** Dispensing from tank vehicles and tank cars into the fuel tanks of motor vehicles shall be prohibited unless allowed by and conducted in accordance with Sections 5706.5.4.1 through 5706.5.4.5.

**5706.5.4.1 Marine craft and special equipment.** Liquids intended for use as motor fuels are allowed to be transferred from tank vehicles into the fuel tanks of marine craft and special equipment where *approved* by the *fire code official*, and where:

1. The tank vehicle's specific function is that of supplying fuel to fuel tanks.
2. The operation is not performed where the public has access or where there is unusual exposure to life and property.
3. The dispensing line does not exceed 50 feet (15 240 mm) in length.
4. The dispensing nozzle is *approved*.

**5706.5.4.2 Emergency refueling.** Where *approved* by the *fire code official*, dispensing of motor vehicle fuel from tank vehicles into the fuel tanks of motor vehicles is allowed during emergencies. Dispensing from tank vehicles shall be in accordance with Sections 5706.2.8 and 5706.6.

**5706.5.4.3 Aircraft fueling.** Transfer of liquids from tank vehicles to the fuel tanks of aircraft shall be in accordance with Chapter 20.

**5706.5.4.4 Fueling of vehicles at farms, construction sites and similar areas.** Transfer of liquid from tank vehicles to motor vehicles for private use on farms and rural areas and at construction sites, earth-moving

projects, gravel pits and borrow pits is allowed in accordance with Section 5706.2.8.

**5706.5.4.5 Commercial, industrial, governmental or manufacturing.** Dispensing of Class II and III motor vehicle fuel from tank vehicles into the fuel tanks of motor vehicles located at commercial, industrial, governmental or manufacturing establishments is allowed where permitted, provided that such dispensing operations are conducted in accordance with the following:

1. Dispensing shall occur only at sites that have been issued a permit to conduct mobile fueling.
2. The *owner* of a mobile fueling operation shall provide to the jurisdiction a written response plan that demonstrates readiness to respond to a fuel spill and carry out appropriate mitigation measures, and describes the process to dispose properly of contaminated materials.
3. A detailed site plan shall be submitted with each application for a permit. The site plan shall indicate: all buildings, structures and appurtenances on site and their use or function; all uses adjacent to the *lot lines* of the site; the locations of all storm drain openings, adjacent waterways or wetlands; information regarding slope, natural drainage, curbing, impounding and how a spill will be retained on the site property; and the scale of the site plan.

Provisions shall be made to prevent liquids spilled during dispensing operations from flowing into buildings or off-site. Acceptable methods include, but shall not be limited to, grading driveways, raising doorsills or other *approved* means.

4. The *fire code official* is allowed to impose limits on the times and days during which mobile fueling operations is allowed to take place, and specific locations on a site where fueling is permitted.
5. Mobile fueling operations shall be conducted in areas not open to the public or shall be limited to times when the public is not present.
6. Mobile fueling shall not take place within 15 feet (4572 mm) of buildings, property lines, combustible storage or storm drains.

### Exceptions:

1. The distance to storm drains shall not apply where an *approved* storm drain cover or an *approved* equivalent that will prevent any fuel from reaching the drain is in place prior to fueling or a fueling hose being placed within 15 feet (4572 mm) of the drain. Where placement of a storm drain cover will cause the accumulation of excessive water or difficulty in conducting the fueling, such cover

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

- shall not be used and the fueling shall not take place within 15 feet (4572 mm) of a drain.
2. The distance to storm drains shall not apply for drains that direct influent to *approved* oil interceptors.
  7. The tank vehicle shall comply with the requirements of NFPA 385 and local, state and federal requirements. The tank vehicle's specific functions shall include that of supplying fuel to motor vehicle fuel tanks. The vehicle and all its equipment shall be maintained in good repair.
  8. Signs prohibiting smoking or open flames within 25 feet (7620 mm) of the tank vehicle or the point of fueling shall be prominently posted on three sides of the vehicle including the back and both sides.
  9. A portable fire extinguisher with a minimum rating of 40:BC shall be provided on the vehicle with signage clearly indicating its location.
  10. The dispensing nozzles and hoses shall be of an *approved* and *listed* type.
  11. The dispensing hose shall not be extended from the reel more than 100 feet (30 480 mm) in length.
  12. Absorbent materials, nonwater-absorbent pads, a 10-foot-long (3048 mm) containment boom, an *approved* container with lid and a nonmetallic shovel shall be provided to mitigate a minimum 5-gallon (19 L) fuel spill.
  13. Tank vehicles shall be equipped with a "fuel limit" switch such as a count-back switch, to limit the amount of a single fueling operation to not more than 500 gallons (1893 L) before resetting the limit switch.
 

**Exception:** Tank vehicles where the operator carries and can utilize a remote emergency shutoff device that, when activated, immediately causes flow of fuel from the tank vehicle to cease.
  14. Persons responsible for dispensing operations shall be trained in the appropriate mitigating actions in the event of a fire, leak or spill. Training records shall be maintained by the dispensing company.
  15. Operators of tank vehicles used for mobile fueling operations shall have in their possession at all times an emergency communications device to notify the proper authorities in the event of an emergency.
  16. The tank vehicle dispensing equipment shall be constantly attended and operated only by designated personnel who are trained to handle and dispense motor fuels.
  17. Fuel dispensing shall be prohibited within 25 feet (7620 mm) of any source of ignition.
  18. The engines of vehicles being fueled shall be shut off during dispensing operations.
  19. Nighttime fueling operations shall only take place in adequately lighted areas.
  20. The tank vehicle shall be positioned with respect to vehicles being fueled to prevent traffic from driving over the delivery hose.
  21. During fueling operations, tank vehicle brakes shall be set, chock blocks shall be in place and warning lights shall be in operation.
  22. Motor vehicle fuel tanks shall not be topped off.
  23. The dispensing hose shall be properly placed on an *approved* reel or in an *approved* compartment prior to moving the tank vehicle.
  24. The *fire code official* and other appropriate authorities shall be notified when a reportable spill or unauthorized discharge occurs.
  25. Operators shall place a drip pan or an absorbent pillow under each fuel fill opening prior to and during dispensing operations. Drip pans shall be liquid-tight. The pan or absorbent pillow shall have a capacity of not less than 3 gallons (11.36 L). Spills retained in the drip pan or absorbent pillow need not be reported. Operators, when fueling, shall have on their person an absorbent pad capable of capturing diesel fuel overfills. Except during fueling, the nozzle shall face upward and an absorbent pad shall be kept under the nozzle to catch drips. Contaminated absorbent pads or pillows shall be disposed of regularly in accordance with local, state and federal requirements.

**5706.6 Tank vehicles and vehicle operation.** Tank vehicles shall be designed, constructed, equipped and maintained in accordance with NFPA 385 and Sections 5706.6.1 through 5706.6.4.

**5706.6.1 Operation of tank vehicles.** Tank vehicles shall be utilized and operated in accordance with NFPA 385 and Sections 5706.6.1.1 through 5706.6.1.11.

**5706.6.1.1 Vehicle maintenance.** Tank vehicles shall not be operated unless they are in proper state of repair and free from accumulation of grease, oil or other flammable substance, and leaks.

**5706.6.1.2 Leaving vehicle unattended.** The driver, operator or attendant of a tank vehicle shall not remain in the vehicle cab and shall not leave the vehicle while it is being filled or discharged. The delivery hose, when attached to a tank vehicle, shall be considered to be a part of the tank vehicle.

**5706.6.1.3 Vehicle motor shutdown.** Motors of tank vehicles or tractors shall be shut down during the making or breaking of hose connections. If loading or unloading is performed without the use of a power pump, the tank vehicle or tractor motor shall be shut down throughout such operations.



## FLAMMABLE AND COMBUSTIBLE LIQUIDS

**5706.6.1.4 Outage.** A cargo tank or compartment thereof used for the transportation of *flammable* or *combustible liquids* shall not be loaded to absolute capacity. The vacant space in a cargo tank or compartment thereof used in the transportation of *flammable* or *combustible liquids* shall be not less than 1 percent. Sufficient space shall be left vacant to prevent leakage from or distortion of such tank or compartment by expansion of the contents caused by rise in temperature in transit.

**5706.6.1.5 Overfill protection.** The driver, operator or attendant of a tank vehicle shall, before making delivery to a tank, determine the unfilled capacity of such tank by a suitable gauging device. To prevent overfilling, the driver, operator or attendant shall not deliver in excess of that amount.

**5706.6.1.6 Securing hatches.** During loading, hatch covers shall be secured on all but the receiving compartment.

**5706.6.1.7 Liquid temperature.** Materials shall not be loaded into or transported in a tank vehicle at a temperature above the material's ignition temperature unless safeguarded in an *approved* manner.

**5706.6.1.8 Bonding to underground tanks.** An external bond-wire connection or bond-wire integral with a hose shall be provided for the transferring of *flammable liquids* through open connections into underground tanks.

**5706.6.1.9 Smoking.** Smoking by tank vehicle drivers, helpers or other personnel is prohibited while they are driving, making deliveries, filling or making repairs to tank vehicles.

**5706.6.1.10 Hose connections.** Delivery of *flammable liquids* to underground tanks with a capacity of more than 1,000 gallons (3785 L) shall be made by means of *approved* liquid and vapor-tight connections between the delivery hose and tank fill pipe. Where underground tanks are equipped with any type of vapor recovery system, all connections required to be made for the safe and proper functioning of the particular vapor recovery process shall be made. Such connections shall be made liquid and vapor tight and remain connected throughout the unloading process. Vapors shall not be discharged at grade level during delivery.

**5706.6.1.10.1 Simultaneous delivery.** Simultaneous delivery to underground tanks of any capacity from two or more discharge hoses shall be made by means of mechanically tight connections between the hose and fill pipe.

**5706.6.1.11 Hose protection.** Upon arrival at a point of delivery and prior to discharging any *flammable* or *combustible liquids* into underground tanks, the driver, operator or attendant of the tank vehicle shall ensure that all hoses utilized for liquid delivery and vapor recovery, where required, will be protected from physical damage by motor vehicles. Such protection shall be provided by positioning the tank vehicle to prevent

motor vehicles from passing through the area or areas occupied by hoses, or by other *approved* equivalent means.

**5706.6.2 Parking.** Parking of tank vehicles shall be in accordance with Sections 5706.6.2.1 through 5706.6.2.3.

**Exception:** In cases of accident, breakdown or other emergencies, tank vehicles are allowed to be parked and left unattended at any location while the operator is obtaining assistance.

**5706.6.2.1 Parking near residential, educational and institutional occupancies and other high-risk areas.** Tank vehicles shall not be left unattended at any time on residential streets, or within 500 feet (152 m) of a residential area, apartment or hotel complex, educational facility, hospital or care facility. Tank vehicles shall not be left unattended at any other place that would, in the opinion of the *fire chief*, pose an extreme life hazard.

**5706.6.2.2 Parking on thoroughfares.** Tank vehicles shall not be left unattended on a public street, highway, public avenue or public alley.

### Exceptions:

1. The necessary absence in connection with loading or unloading the vehicle. During actual fuel transfer, Section 5706.6.1.2 shall apply. The vehicle location shall be in accordance with Section 5706.6.2.1.
2. Stops for meals during the day or night, where the street is well lighted at the point of parking. The vehicle location shall be in accordance with Section 5706.6.2.1.

**5706.6.2.3 Duration exceeding 1 hour.** Tank vehicles parked at one point for longer than 1 hour shall be located off of public streets, highways, public avenues or alleys, and in accordance with either of the following:

1. Inside of a bulk plant and either 25 feet (7620 mm) or more from the nearest *lot line* or within a building *approved* for such use.
2. At other *approved* locations not less than 50 feet (15 240 mm) from the buildings other than those *approved* for the storage or servicing of such vehicles.

**5706.6.3 Garaging.** Tank vehicles shall not be parked or garaged in buildings other than those specifically *approved* for such use by the *fire code official*.

**5706.6.4 Portable fire extinguisher.** Tank vehicles shall be equipped with a portable fire extinguisher complying with Section 906 and having a minimum rating of 2-A:20-B:C.

During unloading of the tank vehicle, the portable fire extinguisher shall be out of the carrying device on the vehicle and shall be 15 feet (4572 mm) or more from the unloading valves.

**5706.7 Refineries.** Plants and portions of plants in which *flammable liquids* are produced on a scale from crude petroleum, natural gasoline or other hydrocarbon sources shall be in accordance with Sections 5706.7.1 through 5706.7.3. Petroleum-processing plants and facilities or portions of plants or facilities in which *flammable* or *combustible liquids* are handled, treated or produced on a commercial scale from crude petroleum, natural gasoline, or other hydrocarbon sources shall also be in accordance with API 651, API 653, API 752, API 1615, API 2001, API 2003, API 2009, API 2015, API 2023, API 2201 and API 2350.

**5706.7.1 Corrosion protection.** Above-ground tanks and piping systems shall be protected against corrosion in accordance with API 651.

**5706.7.2 Cleaning of tanks.** The safe entry and cleaning of petroleum storage tanks shall be conducted in accordance with API 2015.

**5706.7.3 Storage of heated petroleum products.** Where petroleum-derived asphalts and residues are stored in heated tanks at refineries and bulk storage facilities or in tank vehicles, such products shall be in accordance with API 2023.

**5706.8 Vapor recovery and vapor-processing systems.** Vapor-processing systems in which the vapor source operates at pressures from vacuum, up to and including 1 psig (6.9 kPa) or in which a potential exists for vapor mixtures in the flammable range, shall comply with Sections 5706.8.1 through 5706.8.5.

**Exceptions:**

1. Marine systems complying with federal transportation waterway regulations such as DOTn 33 CFR Parts 154 through 156, and CGR 46 CFR Parts 30, 32, 35 and 39.
2. Motor fuel-dispensing facility systems complying with Chapter 23.

**5706.8.1 Over-pressure/vacuum protection.** Tanks and equipment shall have independent venting for over-pressure or vacuum conditions that might occur from malfunction of the vapor recovery or processing system.

**Exception:** For tanks, venting shall comply with Section 5704.2.7.3.

**5706.8.2 Vent location.** Vents on vapor-processing equipment shall be not less than 12 feet (3658 mm) from adjacent ground level, with outlets located and directed so that flammable vapors will disperse to below the lower flammable limit (LFL) before reaching locations containing potential ignition sources.

**5706.8.3 Vapor collection systems and overfill protection.** The design and operation of the vapor collection system and overfill protection shall be in accordance with this section and Section 19.5 of NFPA 30.

**5706.8.4 Liquid-level monitoring.** A liquid knock-out vessel used in the vapor collection system shall have means to verify the liquid level and a high-liquid-level sensor that activates an alarm. For unpopulated facilities, the high-liquid-level sensor shall initiate the shutdown of

liquid transfer into the vessel and shutdown of vapor recovery or vapor-processing systems.

**5706.8.5 Overfill protection.** Storage tanks served by vapor recovery or processing systems shall be equipped with overfill protection in accordance with Section 5704.2.7.5.8.

## SECTION 5707 ON-DEMAND MOBILE FUELING OPERATIONS

**5707.1 General.** On-demand mobile fueling operations that dispense Class I, II and III liquids into the fuel tanks of motor vehicles shall comply with Sections 5707.1 through 5707.6.6.

**Exception:** Fueling from an *approved* portable container in cases of an emergency or for personal use.

**5707.1.1 Approval required.** Mobile fueling operations shall not be conducted without first obtaining a *permit* and approval from the *fire code official*. Mobile fueling operations shall occur only at *approved* locations. The *fire code official* is authorized to approve individual locations or geographic areas where mobile fueling is allowed.

**5707.2 Mobile fueling vehicle.** An on-demand mobile fueling vehicle shall be that which is utilized in on-demand fueling operations for the dispensing of Class I, II or III liquids into the fuel tanks of motor vehicles.

**5707.2.1 Mobile fueling vehicle classifications.** An on-demand mobile fueling vehicle shall be characterized as one of the following:

1. Tier 1 mobile fueling vehicle. A tank vehicle that complies with NFPA 385 and that has chassis-mounted tanks where the aggregate capacity does not exceed 1,600 gallons (6057 L).
2. Tier 2 mobile fueling vehicle. A vehicle with one or more chassis-mounted tanks or containers that do not exceed 110 gallons (416 L) in capacity with an aggregate capacity that does not exceed 800 gallons (3028 L) or the weight capacity of the vehicle in accordance with DOTn.
3. Tier 3 mobile fueling vehicle. A vehicle that carries a maximum aggregate capacity of 60 gallons (227 L) of motor fuel in metal safety cans listed in accordance with UL 30 or other approved metal containers, each not to exceed 5 gallons (19 L) in capacity.

**5707.2.2 Mobile fueling vehicle requirements.** Each mobile fueling vehicle shall comply with all local, state and federal requirements, as well as the following:

1. Mobile fueling vehicles with a chassis-mounted tank in excess of 110 gallons (416 L) shall also comply with the requirements of Section 5706.6 and NFPA 385.
2. The mobile fueling vehicle and its equipment shall be maintained in good repair.

## FLAMMABLE AND COMBUSTIBLE LIQUIDS

3. Safety cans and *approved* metal containers shall be secured to the mobile fueling vehicle except when in use.
4. Fueling a motor vehicle from tanks or containers mounted in a trailer connected to a mobile fueling vehicle shall be prohibited.

**5707.3 Required documents.** Documents developed to comply with Sections 5707.3.1 through 5707.3.3 shall be updated as necessary by the *owner* of the mobile fueling operation and shall be maintained in compliance with Section 109.3.

**5707.3.1 Safety and emergency response plan.** Mobile fueling operators shall have an *approved* written safety and emergency response plan that establishes policies and procedures for fire safety, spill prevention and control, personnel training and compliance with other applicable requirements of this code.

**5707.3.2 Training records.** Mobile fueling vehicles shall be operated only by designated personnel who are trained on proper fueling procedures and the safety and emergency response plan. Training records of operators shall be maintained.

**5707.3.3 Site plan.** Where required by the *fire code official*, a site plan shall be developed for each location or area at which mobile fueling occurs. The site plan shall be in sufficient detail to indicate the following:

1. All buildings and structures.
2. *Lot lines* or property lines.
3. Electric car chargers.
4. Solar photovoltaic parking lot canopies.
5. Appurtenances on-site and their use or function.
6. All uses adjacent to the *lot lines* of the site.
7. Fueling locations.
8. Locations of all storm drain openings and adjacent waterways or wetlands.
9. Information regarding slope, natural drainage, curbing and impounding.
10. How a spill will be kept on the site property.
11. Scale of the site plan.

**5707.4 Mobile fueling areas.** During fueling, the mobile fueling vehicle and point of connection to the vehicle shall not be located on public streets, *public ways* or inside *buildings*. Fueling on the roof level of parking structures or other *buildings* is prohibited.

**5707.4.1 Separation.** During fueling, the point of connection to the vehicle being fueled shall not take place within 25 feet (7620 mm) of buildings, *lot lines*, property lines or combustible storage. Mobile fueling vehicles shall not park within 10 feet (3048 mm) of buildings, *lot lines*, property lines or combustible storage.

**Exceptions:**

1. The *fire code official* shall be authorized to decrease the separation distance for dispensing

from metal safety cans or other *approved* metal containers in accordance with Section 5707.2.

2. The point of fueling shall not take place within 10 feet (3048 mm) of buildings, *lot lines*, property lines or combustible storage where the mobile fueling vehicle has an *approved* vapor recovery system or is servicing vehicles with onboard refueling vapor recovery.

Where dispensing operations occur within 15 feet (4572 mm) of a storm drain, an *approved* storm drain cover or an *approved* equivalent method that will prevent any fuel from reaching the drain shall be used.

**5707.4.2 Sources of ignition.** Smoking, open flames and other sources of ignition shall be prohibited within 25 feet (7620 mm) of fuel dispensing activities. Signs prohibiting smoking or open flames within 25 feet (7620 mm) of the vehicle or the point of fueling shall be prominently posted on the mobile fueling vehicle. The engines of vehicles being fueled shall be shut off during fueling.

**5707.4.3 Electrical equipment.** Mobile fueling shall not occur within 20 feet (6096 mm) of electrical equipment located within 18 inches (457 mm) of the ground unless such electrical equipment is rated for Class I, Division 2, hazardous locations in accordance with NFPA 70.

**5707.5 Equipment.** Mobile fueling equipment shall comply with Sections 5707.5.1 through 5707.5.5.

**5707.5.1 Dispensing hoses and nozzles.** Where equipped, the dispensing hose shall not exceed 50 feet (15 240 mm) in length. The dispensing nozzles and hoses shall be of an *approved* and *listed* type. Where metal-to-metal contact cannot be made between the nozzle and the fuel fill opening, a means for bonding the mobile fueling vehicle to the motor vehicle shall be provided and employed during fueling operations.

**5707.5.2 Breakaway device.** A *listed* breakaway device shall be provided at the nozzle.

**Exception:** Mobile fueling vehicles equipped with an approved brake interlock tied to the nozzle holder that prohibits movement of the mobile fueling vehicle when the nozzle is removed from its holder or tied to the delivery of fuel that prevents activation of the pumping system.

**5707.5.3 Shutoff valve and fuel limit.** Mobile fueling vehicles shall be equipped with a *listed* shutoff valve assembly and a fuel limit switch set to a maximum of 30 gallons (116 L).

**5707.5.4 Fire extinguisher.** An *approved* portable fire extinguisher complying with Section 906 with a minimum rating of 4-A:80-B:C shall be provided on the mobile fueling vehicle with signage clearly indicating its location.

**5707.5.5 Spill kit.** Mobile fueling vehicles shall contain a minimum 5-gallon (19 L) spill kit of an *approved* type.

**5707.6 Operations.** Mobile fueling vehicles shall be constantly attended during fueling operations with brakes set

and warning lights in operation. Mobile fueling vehicles shall not obstruct emergency vehicle access roads.

**5707.6.1 Dispensing hose.** Where equipped, mobile fueling vehicles shall be positioned in a manner to preclude traffic from driving over the dispensing hose. The dispensing hose shall be properly placed on an *approved* reel or in an *approved* compartment prior to moving the mobile fueling vehicle.

**5707.6.2 Drip control.** Operators shall place a drip pan or an absorbent pillow under the nozzle and each fuel fill opening prior to and during dispensing operations to catch drips.

**5707.6.3 Safety cones.** Safety cones or other visual barriers shall be employed as warning devices to highlight the vehicle fueling area.

**5707.6.4 Vehicle lights.** The mobile fueling vehicle flasher lights shall be in operation while dispensing operations are in progress.

**5707.6.5 Nighttime deliveries.** Nighttime deliveries shall be made only in areas deemed adequately lighted by the *fire code official*.

**5707.6.6 Spill reporting.** Spills shall be reported in accordance with Section 5003.3.1.





## CHAPTER 58

# FLAMMABLE GASES AND FLAMMABLE CRYOGENIC FLUIDS

### User note:

**About this chapter:** Chapter 58 sets requirements for the storage and use of flammable gases. For safety purposes, there is a limit on the quantities of flammable gas allowed per control area. Exceeding these limitations increases the possibility of damage to both property and individuals. The principal hazard posed by flammable gas is its ready ignitability, or even explosivity, when mixed with air in the proper proportions. Consequently, occupancies storing or handling large quantities of flammable gas are classified as Group H-2 (high hazard) by the International Building Code®.

### SECTION 5801 GENERAL

**5801.1 Scope.** The storage and use of flammable gases and flammable *cryogenic fluids* shall be in accordance with this chapter, NFPA 2 and NFPA 55. *Compressed gases* shall also comply with Chapter 53 and *cryogenic fluids* shall also comply with Chapter 55. Flammable *cryogenic fluids* shall comply with Section 5806. Hydrogen motor fuel-dispensing stations and repair garages and their associated above-ground hydrogen storage systems shall also be designed, constructed and maintained in accordance with Chapter 23.

#### Exceptions:

1. Gases used as refrigerants in refrigeration systems (see Section 608).
2. Liquefied petroleum gases and natural gases regulated by Chapter 61.
3. Fuel-gas systems and appliances regulated under the *International Fuel Gas Code* other than gaseous hydrogen systems and appliances.
4. Pyrophoric gases in accordance with Chapter 64.

**5801.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 5802 DEFINITIONS

**5802.1 Definitions.** The following terms are defined in Chapter 2:

**FLAMMABLE GAS.**

**FLAMMABLE LIQUEFIED GAS.**

**GAS DETECTION SYSTEM.**

**GASEOUS HYDROGEN SYSTEM.**

**HYDROGEN FUEL GAS ROOM.**

**METAL HYDRIDE.**

**METAL HYDRIDE STORAGE SYSTEM.**

### SECTION 5803 GENERAL REQUIREMENTS

**5803.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of flamma-

ble gases in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 5801 and 5803.

**5803.1.1 Special limitations for indoor storage and use.** Flammable gases shall not be stored or used in Group A, E, I or R occupancies or in offices in Group B occupancies.

#### Exceptions:

1. Cylinders of nonliquefied *compressed gases* not exceeding a capacity of 250 cubic feet (7.08 m<sup>3</sup>) or liquefied gases not exceeding a capacity of 40 pounds (18 kg) each at *normal temperature and pressure (NTP)* used for maintenance purposes, patient care or operation of equipment.
2. Food service operations in accordance with Section 6103.2.1.7.
3. Hydrogen gas systems located in a hydrogen fuel gas room constructed in accordance with Section 421 of the *International Building Code*.

**5803.1.1.1 Medical gases.** Medical gas system supply cylinders shall be located in medical gas storage rooms or gas cabinets as set forth in Section 5306.

**5803.1.1.2 Aggregate quantity.** The aggregate quantities of flammable gases used for maintenance purposes and operation of equipment shall not exceed the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1).

**5803.1.2 Storage containers.** Cylinders and pressure vessels for flammable gases shall be designed, constructed, installed, tested and maintained in accordance with Chapter 53.

**5803.1.3 Emergency shutoff.** *Compressed gas* systems conveying flammable gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

**5803.1.3.1 Shutoff at source.** A manual or automatic fail-safe emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. Manual or automatic cylinder valves are allowed to be used as the

## FLAMMABLE GASES AND FLAMMABLE CRYOGENIC FLUIDS

required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

**5803.1.3.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

**5803.1.4 Ignition source control.** Ignition sources in areas containing flammable gases in storage or in use shall be controlled in accordance with Section 5003.7.

**Exception:** Fuel gas systems connected to building service utilities in accordance with the *International Fuel Gas Code*.

**5803.1.4.1 Static-producing equipment.** Static-producing equipment located in flammable gas storage areas shall be grounded.

**5803.1.4.2 Signs.** “No Smoking” signs shall be posted at entrances to rooms and in areas containing flammable gases in accordance with Section 5003.7.1.

**5803.1.5 Electrical.** Electrical wiring and equipment shall be installed and maintained in accordance with Section 603 and NFPA 70.

**5803.1.5.1 Bonding of electrically conductive materials and equipment.** Exposed noncurrent-carrying metal parts, including metal gas piping systems, that are part of flammable gas supply systems located in a hazardous (electrically classified) location shall be bonded to a grounded conductor in accordance with the provisions of NFPA 70.

**5803.1.5.2 Static-producing equipment.** Static-producing equipment located in flammable gas storage or use areas shall be grounded.

**5803.1.6 Liquefied flammable gases and flammable gases in solution.** Containers of liquefied flammable gases and flammable gases in solution shall be positioned in the upright position or positioned so that the pressure relief valve is in direct contact with the vapor space of the container.

### Exceptions:

1. Containers of flammable gases in solution with a capacity of 1.3 gallons (5 L) or less.
2. Containers of flammable liquefied gases, with a capacity not exceeding 1.3 gallons (5 L), designed to preclude the discharge of liquid from safety relief devices.

**5803.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

## SECTION 5804 STORAGE

**5804.1 Indoor storage.** Indoor storage of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1), shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

**5804.1.1 Explosion control.** Buildings or portions thereof containing flammable gases shall be provided with explosion control in accordance with Section 911.

**5804.2 Outdoor storage.** Outdoor storage of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

## SECTION 5805 USE

**5805.1 General.** The use of flammable gases in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5005, and this chapter.

## SECTION 5806 FLAMMABLE CRYOGENIC FLUIDS

**5806.1 General.** The storage and use of flammable *cryogenic fluids* shall be in accordance with Sections 5806.2 through 5806.4.8.3 and Chapter 55.

**5806.2 Limitations.** Storage of flammable *cryogenic fluids* in stationary containers outside of buildings is prohibited within the limits established by law as the limits of districts in which such storage is prohibited [JURISDICTION TO SPECIFY].

**5806.3 Above-ground tanks for liquid hydrogen.** Above-ground tanks for the storage of liquid hydrogen shall be in accordance with Sections 5806.3.1 through 5806.3.2.1.

**5806.3.1 Construction of the inner vessel.** The inner vessel of storage tanks in liquid hydrogen service shall be designed and constructed in accordance with Section VIII, Division 1, of the *ASME Boiler and Pressure Vessel Code* and shall be vacuum jacketed in accordance with Section 5806.3.2.

**5806.3.2 Construction of the vacuum jacket (outer vessel).** The vacuum jacket used as an outer vessel for storage tanks in liquid hydrogen service shall be of welded steel construction designed to withstand the maximum internal and external pressure to which it will be subjected under operating conditions to include conditions of emergency pressure relief of the annular space between the inner and outer vessel. The jacket shall be

designed to withstand a minimum collapsing pressure differential of 30 psi (207 kPa).

**5806.3.2.1 Vacuum-level monitoring.** A connection shall be provided on the exterior of the vacuum jacket to allow measurement of the pressure within the annular space between the inner and outer vessel. The connection shall be fitted with a bellows-sealed or diaphragm-type valve equipped with a vacuum gauge tube that is shielded to protect against damage from impact.

**5806.4 Underground tanks for liquid hydrogen.** Underground tanks for the storage of liquid hydrogen shall be in accordance with Sections 5806.4.1 through 5806.4.8.3.

**5806.4.1 Construction.** Storage tanks for liquid hydrogen shall be designed and constructed in accordance with *ASME Boiler and Pressure Vessel Code* (Section VIII, Division 1) and shall be vacuum jacketed in accordance with Section 5806.4.8.

**5806.4.2 Location.** Storage tanks shall be located outside in accordance with the following:

1. Tanks and associated equipment shall be located with respect to foundations and supports of other structures such that the loads carried by the latter cannot be transmitted to the tank.
2. The distance from any part of the tank to the nearest wall of a *basement*, pit, cellar or *lot line* shall be not less than 3 feet (914 mm).
3. A minimum distance of 1 foot (305 mm), shell to shell, shall be maintained between underground tanks.

**5806.4.3 Depth, cover and fill.** The tank shall be buried such that the top of the vacuum jacket is covered with not less than 1 foot (305 mm) of earth and with concrete not less than 4 inches (102 mm) thick placed over the earthen cover. The concrete shall extend not less than 1 foot (305 mm) horizontally beyond the footprint of the tank in all directions. Underground tanks shall be set on firm foundations constructed in accordance with the *International Building Code* and surrounded with not less than 6 inches (152 mm) of noncorrosive inert material, such as sand.

**Exception:** The vertical extension of the vacuum jacket as required for service connections.

**5806.4.4 Anchorage and security.** Tanks and systems shall be secured against accidental dislodgement in accordance with this chapter.

**5806.4.5 Venting of underground tanks.** Vent pipes for underground storage tanks shall be in accordance with Section 5503.3.

**5806.4.6 Underground liquid hydrogen piping.** Underground liquid hydrogen piping shall be vacuum jacketed or protected by *approved* means and designed in accordance with Chapter 55.

**5806.4.7 Overfill protection and prevention systems.** An *approved* means or method shall be provided to prevent the overfill of all storage tanks.

**5806.4.8 Vacuum jacket construction.** The vacuum jacket shall be designed and constructed in accordance with Section VIII of *ASME Boiler and Pressure Vessel Code* and shall be designed to withstand the anticipated loading, including loading from vehicular traffic, where applicable. Portions of the vacuum jacket installed below grade shall be designed to withstand anticipated soil, seismic and hydrostatic loading.

**5806.4.8.1 Material.** The vacuum jacket shall be constructed of stainless steel or other *approved* corrosion-resistant material.

**5806.4.8.2 Corrosion protection.** The vacuum jacket shall be protected by *approved* or *listed* corrosion-resistant materials or an engineered cathodic protection system. Where cathodic protection is utilized, an *approved* maintenance schedule shall be established. Exposed components shall be inspected not less than twice a year. Records of maintenance and inspection events shall be maintained.

**5806.4.8.3 Vacuum-level monitoring.** An *approved* method shall be provided to indicate loss of vacuum within the vacuum jacket(s).

## SECTION 5807 METAL HYDRIDE STORAGE SYSTEMS

**5807.1 General requirements.** The storage and use of metal hydride storage systems shall be in accordance with Sections 5801, 5803, 5804, 5805 and 5807. Those portions of the system that are used as a means to store or supply hydrogen shall also comply with Chapters 50 and 53 as applicable.

**5807.1.1 Classification.** The hazard classification of the metal hydride storage system, as required by Section 5001.2.2, shall be based on the hydrogen stored without regard to the metal hydride content.

**5807.1.2 Listed or approved systems.** Metal hydride storage systems shall be *listed* or *approved* for the application and designed in a manner that prevents the addition or removal of the metal hydride by other than the original equipment manufacturer.

**5807.1.3 Containers, design and construction.** *Compressed gas* containers, cylinders and tanks shall be designed and constructed in accordance with Section 5303.2.

**5807.1.4 Service life and inspection of containers.** Metal hydride storage system cylinders, containers or tanks shall be inspected, tested and requalified for service at not less than 5-year intervals.

**5807.1.5 Marking and labeling.** Marking and labeling of cylinders, containers, tanks and systems shall be in accordance with Section 5303.4 and Sections 5807.1.5.1 through 5807.1.5.4.

**5807.1.5.1 System marking.** Metal hydride storage systems shall be marked with all of the following:

1. Manufacturer's name.



## FLAMMABLE GASES AND FLAMMABLE CRYOGENIC FLUIDS

2. Service life indicating the last date the system can be used.
3. A unique code or serial number specific to the unit.
4. System name or product code that identifies the system by the type of chemistry used in the system.
5. Emergency contact name, telephone number or other contact information.
6. Limitations on refilling of containers to include rated charging pressure and capacity.

**5807.1.5.2 Valve marking.** Metal hydride storage system valves shall be marked with all of the following:

1. Manufacturer's name.
2. Service life indicating the last date the valve can be used.
3. Metal hydride service in which the valve can be used, or a product code that is traceable to this information.

**5807.1.5.3 Pressure relief device marking.** Metal hydride storage system pressure relief devices shall be marked with all of the following:

1. Manufacturer's name.
2. Metal hydride service in which the device can be used, or a product code that is traceable to this information.
3. Activation parameters to include temperature, pressure or both.

**5807.1.5.3.1 Pressure relief devices integral to container valves.** The required markings for pressure relief devices that are integral components of valves used on cylinders, containers and tanks shall be allowed to be placed on the valve.

**5807.1.5.4 Pressure vessel markings.** Cylinders, containers and tanks used in metal hydride storage systems shall be marked with all of the following:

1. Manufacturer's name.
2. Design specification to which the vessel was manufactured.
3. Authorized body approving the design and initial inspection and test of the vessel.
4. Manufacturer's original test date.
5. Unique serial number for the vessel.
6. Service life identifying the last date the vessel can be used.
7. System name or product code that identifies the system by the type of chemistry used in the system.

**5807.1.6 Temperature extremes.** Metal hydride storage systems, whether full or partially full, shall not be exposed to artificially created high temperatures exceed-

ing 125°F (52°C) or subambient (low) temperatures unless designed for use under the exposed conditions.

**5807.1.7 Falling objects.** Metal hydride storage systems shall not be placed in areas where they are capable of being damaged by falling objects.

**5807.1.8 Piping systems.** Piping, including tubing, valves, fittings and pressure regulators, serving metal hydride storage systems, shall be maintained gas tight to prevent leakage.

**5807.1.8.1 Leaking systems.** Leaking systems shall be removed from service.

**5807.1.9 Refilling of containers.** The refilling of *listed* or *approved* metal hydride storage systems shall be in accordance with the listing requirements and manufacturer's instructions.

**5807.1.9.1 Industrial trucks.** The refilling of metal hydride storage systems serving powered industrial trucks shall be in accordance with Section 309.

**5807.1.9.2 Hydrogen purity.** The purity of hydrogen used for the purpose of refilling containers shall be in accordance with the listing and the manufacturer's instructions.

**5807.1.10 Electrical.** Electrical components for metal hydride storage systems shall be designed, constructed and installed in accordance with NFPA 70.

**5807.2 Portable containers or systems.** Portable containers or systems shall comply with Sections 5807.2.1 through 5807.2.2.

**5807.2.1 Securing containers.** Containers, cylinders and tanks shall be secured in accordance with Section 5303.5.3.

**5807.2.1.1 Use on mobile equipment.** Where a metal hydride storage system is used on mobile equipment, the equipment shall be designed to restrain containers, cylinders or tanks from dislodgement, slipping or rotating when the equipment is in motion.

**5807.2.1.2 Motorized equipment.** Metal hydride storage systems used on motorized equipment, shall be installed in a manner that protects valves, pressure regulators, fittings and controls against accidental impact.

**5807.2.1.2.1 Protection from damage.** Metal hydride storage systems, including cylinders, containers, tanks and fittings, shall not extend beyond the platform of the mobile equipment.

**5807.2.2 Valves.** Valves on containers, cylinders and tanks shall remain closed except when containers are connected to *closed systems* and ready for use.

## SECTION 5808 HYDROGEN FUEL GAS ROOMS

**5808.1 General.** Where required by this code, hydrogen fuel gas rooms shall be designed and constructed in accordance

with Sections 5808.1 through 5808.7 and the *International Building Code*.

**5808.2 Location.** Hydrogen fuel gas rooms shall not be located below grade.

**5808.3 Design and construction.** Hydrogen fuel gas rooms not exceeding the *maximum allowable quantity per control area* in Table 5003.1.1(1) shall be separated from other areas of the building in accordance with Section 509.1 of the *International Building Code*.

**5808.3.1 Pressure control.** Hydrogen fuel gas rooms shall be provided with a ventilation system designed to maintain the room at a negative pressure in relation to surrounding rooms and spaces.

**5808.3.2 Windows.** Operable windows in interior walls shall not be permitted. Fixed windows shall be permitted where in accordance with Section 716 of the *International Building Code*.

**5808.4 Exhaust ventilation.** Hydrogen fuel gas rooms shall be provided with mechanical exhaust ventilation in accordance with the applicable provisions of Section 2311.8.2.

**5808.5 Gas detection system.** Hydrogen fuel gas rooms shall be provided with a gas detection system that complies with Sections 916, 5808.5.1 and 5808.5.2.

**5808.5.1 System activation.** Activation of a gas detection system alarm shall result in both of the following:

1. Initiation of distinct audible and visible alarm signals both inside and outside of the hydrogen fuel gas room.
2. Automatic activation of the mechanical exhaust ventilation system.

**5808.5.2 Failure of the gas detection system.** Failure of the gas detection system shall automatically activate the mechanical exhaust ventilation system, stop hydrogen generation and cause a trouble signal to sound at an *approved* location.

**5808.6 Explosion control.** Explosion control shall be provided where required by Section 911.

**5808.7 Standby power.** Mechanical ventilation and gas detection systems shall be connected to a standby power system in accordance with Section 1203.



## CHAPTER 59

# FLAMMABLE SOLIDS

### User note:

**About this chapter:** Chapter 59 addresses general requirements for storage and handling of flammable solids, especially magnesium; however, it is important to note that several other solid materials, including such metals as titanium, zirconium, hafnium, calcium, zinc, sodium, lithium, potassium, sodium/potassium alloys, uranium, thorium and plutonium, can be explosion hazards under the right conditions. Some of these metals are almost exclusively laboratory materials but because of where they are used, fire service personnel must be trained to handle emergency situations. Because uranium, thorium and plutonium are also radioactive materials, they pose more specialized problems for fire service personnel.

### SECTION 5901 GENERAL

**5901.1 Scope.** The storage and use of flammable solids shall be in accordance with this chapter.

**5901.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 5902 DEFINITIONS

**5902.1 Definitions.** The following terms are defined in Chapter 2:

**FLAMMABLE SOLID.**

**MAGNESIUM.**

### SECTION 5903 GENERAL REQUIREMENTS

**5903.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of flammable solids in amounts not exceeding the *maximum allowable quantity per control area* as indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003 and 5901.

**5903.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of flammable solids exceeding the *maximum allowable quantity per control area* as indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

### SECTION 5904 STORAGE

**5904.1 Indoor storage.** Indoor storage of flammable solids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

**5904.1.1 Pile size limits and location.** Flammable solids stored in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated into piles each not larger than 1,000 cubic feet (28 m<sup>3</sup>).

**5904.1.2 Aisles.** Aisle widths between piles shall be not less than the height of the piles or 4 feet (1219 mm), whichever is greater.

**5904.1.3 Basement storage.** Flammable solids shall not be stored in *basements*.

**5904.2 Outdoor storage.** Outdoor storage of flammable solids in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter. Outdoor storage of magnesium shall be in accordance with Section 5906.

**5904.2.1 Distance from storage to exposures.** Outdoor storage of flammable solids shall not be located within 20 feet (6096 mm) of a building, *lot line*, public street, public alley, *public way* or *means of egress*. A 2-hour *fire barrier* without openings or penetrations and extending 30 inches (762 mm) above and to the sides of the storage area is allowed in lieu of such distance. The wall shall either be an independent structure, or the *exterior wall* of the building adjacent to the storage area.

**5904.2.2 Pile size limits.** Outdoor storage of flammable solids shall be separated into piles not larger than 5,000 cubic feet (141 m<sup>3</sup>) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height or 10 feet (3048 mm), whichever is greater.

### SECTION 5905 USE

**5905.1 General.** The use of flammable solids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter. The use of magnesium shall be in accordance with Section 5906.

### SECTION 5906 MAGNESIUM

**5906.1 General.** Storage, use, handling and processing of magnesium, including the pure metal and alloys of which the major part is magnesium, shall be in accordance with Chapter 50 and Sections 5906.2 through 5906.5.8.



## FLAMMABLE SOLIDS

**5906.2 Storage of magnesium articles.** The storage of magnesium shall comply with Sections 5906.2.1 through 5906.4.3.

**5906.2.1 Storage of greater than 50 cubic feet.** Magnesium storage in quantities greater than 50 cubic feet (1.4 m<sup>3</sup>) shall be separated from storage of other materials that are either combustible or in combustible containers by aisles. Piles shall be separated by aisles with a minimum width of not less than the pile height.

**5906.2.2 Storage of greater than 1,000 cubic feet.** Magnesium storage in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated into piles not larger than 1,000 cubic feet (28 m<sup>3</sup>) each. Piles shall be separated by aisles with a minimum width of not less than the pile height. Such storage shall not be located in nonsprinklered buildings of Type III, IV or V construction, as defined in the *International Building Code*.

**5906.2.3 Storage in combustible containers or within 30 feet of other combustibles.** Where in nonsprinklered buildings of Type III, IV or V construction, as defined in the *International Building Code*, magnesium shall not be stored in combustible containers or within 30 feet (9144 mm) of other combustibles.

**5906.2.4 Storage in foundries and processing plants.** The size of storage piles of magnesium articles in foundries and processing plants shall not exceed 1,250 cubic feet (25 m<sup>3</sup>). Piles shall be separated by aisles with a minimum width of not less than one-half the pile height.

**5906.3 Storage of pigs, ingots and billets.** The storage of magnesium pigs, ingots and billets shall comply with Sections 5906.3.1 and 5906.3.2.

**5906.3.1 Indoor storage.** Indoor storage of pigs, ingots and billets shall only be on floors of noncombustible construction. Piles shall not be larger than 500,000 pounds (226.8 metric tons) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height.

**5906.3.2 Outdoor storage.** Outdoor storage of magnesium pigs, ingots and billets shall be in piles not exceeding 1,000,000 pounds (453.6 metric tons) each. Piles shall be separated by aisles with a minimum width of not less than one-half the pile height. Piles shall be separated from combustible materials or buildings on the same or adjoining property by a distance of not less than the height of the nearest pile.

**5906.4 Storage of fine magnesium scrap.** The storage of scrap magnesium shall comply with Sections 5906.4.1 through 5906.4.3.

**5906.4.1 Separation.** Magnesium fines shall be kept separate from other combustible materials.

**5906.4.2 Storage of 50 to 1,000 cubic feet.** Storage of fine magnesium scrap in quantities greater than 50 cubic feet (1.4 m<sup>3</sup>) [six 55-gallon (208 L) steel drums] shall be separated from other occupancies by an open space of not less than 50 feet (15 240 mm) or by a *fire barrier* constructed in accordance with Section 707 of the *International Building Code*.

**5906.4.3 Storage of greater than 1,000 cubic feet.** Storage of fine magnesium scrap in quantities greater than 1,000 cubic feet (28 m<sup>3</sup>) shall be separated from all buildings other than those used for magnesium scrap recovery operations by a distance of not less than 100 feet (30 480 mm).

**5906.5 Use of magnesium.** The use of magnesium shall comply with Sections 5906.5.1 through 5906.5.8.

**5906.5.1 Melting pots.** Floors under and around melting pots shall be of noncombustible construction.

**5906.5.2 Heat-treating ovens.** *Approved* means shall be provided for control of magnesium fires in heat-treating ovens.

**5906.5.3 Dust collection.** Magnesium grinding, buffing and wire-brushing operations, other than rough finishing of castings, shall be provided with *approved* hoods or enclosures for dust collection that are connected to a liquid-precipitation type of separator that converts dust to sludge without contact (in a dry state) with any high-speed moving parts.

**5906.5.3.1 Duct construction.** Connecting ducts or suction tubes shall be completely grounded, as short as possible, and without bends. Ducts shall be fabricated and assembled with a smooth interior, with internal lap joints pointing in the direction of airflow and without unused capped side outlets, pockets or other dead-end spaces that allow an accumulation of dust.

**5906.5.3.2 Independent dust separators.** Each machine shall be equipped with an individual dust-separating unit.

### Exceptions:

1. One separator is allowed to serve two dust-producing units on multiunit machines.
2. One separator is allowed to serve not more than four portable dust-producing units in a single enclosure or stand.

**5906.5.4 Power supply interlock.** Power supply to machines shall be interlocked with exhaust airflow, and liquid pressure level or flow. The interlock shall be designed to shut down the machine it serves when the dust removal or separator system is not operating properly.

**5906.5.5 Electrical equipment.** Electric wiring, fixtures and equipment in the immediate vicinity of and attached to dust-producing machines, including those used in connection with separator equipment, shall be of *approved* types and shall be *approved* for use in Class II, Division 1 hazardous locations in accordance with NFPA 70.

**5906.5.6 Grounding.** Equipment shall be securely grounded by permanent ground wires in accordance with NFPA 70.

**5906.5.7 Fire-extinguishing materials.** Fire-extinguishing materials shall be provided for every operator performing machining, grinding or other processing oper-

ation on magnesium in accordance with either of the following:

1. Within 30 feet (9144 mm), a supply of extinguishing materials in an *approved* container with a hand scoop or shovel for applying the material.
2. Within 75 feet (22 860 mm), a portable fire extinguisher complying with Section 906.

All extinguishing materials shall be *approved* for use on magnesium fires. Where extinguishing materials are stored in cabinets or other enclosed areas, the enclosures shall be openable without the use of a key or special knowledge.

**5906.5.8 Collection of chips, turnings and fines.** Chips, turnings and other fine magnesium scrap shall be collected from the pans or spaces under machines and from other places where they collect not less than once each working day. Such material shall be placed in a covered, vented steel container and removed to an *approved* location.



## CHAPTER 60

# HIGHLY TOXIC AND TOXIC MATERIALS

### User note:

**About this chapter:** Chapter 60 provides requirements to protect occupants, emergency responders and those in the immediate area of the building and facility from short-term, acute hazards associated with a release of, or general exposure to, toxic and highly toxic materials. This chapter deals with all three states of toxic and highly toxic materials: solids, liquids and gases. This code does not address long-term exposure effects of these materials, which are addressed by agencies such as the Environmental Protection Agency (EPA) and Occupational Safety and Health Administration (OSHA).

### SECTION 6001 GENERAL

**6001.1 Scope.** The storage and use of highly toxic and toxic materials shall comply with this chapter. *Compressed gases* shall also comply with Chapter 53.

#### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Conditions involving pesticides or agricultural products as follows:
  - 2.1. Application and release of pesticide, agricultural products and materials intended for use in weed abatement, erosion control, soil amendment or similar applications when applied in accordance with the manufacturer's instruction and label directions.
  - 2.2. Transportation of pesticides in compliance with the Federal Hazardous Materials Transportation Act and regulations thereunder.
  - 2.3. Storage in *dwellings* or private garages of pesticides registered by the US Environmental Protection Agency to be utilized in and around the home, garden, pool, spa and patio.

**6001.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6002 DEFINITIONS

**6002.1 Definitions.** The following terms are defined in Chapter 2:

**CONTAINMENT SYSTEM.**

**CONTAINMENT VESSEL.**

**EXCESS FLOW VALVE.**

**HIGHLY TOXIC.**

**OZONE-GAS GENERATOR.**

**PHYSIOLOGICAL WARNING THRESHOLD.**

**REDUCED FLOW VALVE.**

**TOXIC.**

### SECTION 6003 HIGHLY TOXIC AND TOXIC SOLIDS AND LIQUIDS

**6003.1 Indoor storage and use.** The indoor storage and use of highly toxic and toxic materials shall comply with Sections 6003.1.1 through 6003.1.5.3.

**6003.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic solids or liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003 and 6001.

**6003.1.2 Quantities exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic solids or liquids in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Section 6001, Sections 6003.1.3 through 6003.1.5.3 and Chapter 50.

**6003.1.3 Treatment system—highly toxic liquids.** Exhaust scrubbers or other systems for processing vapors of highly toxic liquids shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at *normal temperature and pressure (NTP)*. Treatment systems and other processing systems shall be installed in accordance with the *International Mechanical Code*.

**6003.1.4 Indoor storage.** Indoor storage of highly toxic and toxic solids and liquids shall comply with Sections 6003.1.4.1 and 6003.1.4.2.

**6003.1.4.1 Floors.** In addition to the requirements set forth in Section 5004.12, floors of storage areas where highly toxic and toxic liquids are stored shall be of liquid-tight construction.



## HIGHLY TOXIC AND TOXIC MATERIALS

**6003.1.4.2 Separation—highly toxic solids and liquids.** In addition to the requirements set forth in Section 5003.9.8, highly toxic solids and liquids in storage shall be located in *approved* hazardous material storage cabinets or isolated from other hazardous material storage by construction in accordance with the *International Building Code*.

**6003.1.5 Indoor use.** Indoor use of highly toxic and toxic solids and liquids shall comply with Sections 6003.1.5.1 through 6003.1.5.3.

**6003.1.5.1 Liquid transfer.** Highly toxic and toxic liquids shall be transferred in accordance with Section 5005.1.10.

**6003.1.5.2 Exhaust ventilation for open systems.** Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in *open systems* in accordance with Section 5005.2.1.1.

**Exception:** Liquids that do not generate highly toxic or toxic fumes, mists or vapors.

**6003.1.5.3 Exhaust ventilation for closed systems.** Mechanical exhaust ventilation shall be provided for highly toxic and toxic liquids used in *closed systems* in accordance with Section 5005.2.2.1.

**Exception:** Liquids that do not generate highly toxic or toxic fumes, mists or vapors.

**6003.2 Outdoor storage and use.** Outdoor storage and use of highly toxic and toxic materials shall comply with Sections 6003.2.1 through 6003.2.6.

**6003.2.1 Quantities not exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic solids or liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 6001.

**6003.2.2 Quantities exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic solids or liquids in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 6001 and 6003.2 and Chapter 50.

**6003.2.3 General outdoor requirements.** The general requirements applicable to the outdoor storage of highly toxic or toxic solids and liquids shall be in accordance with Sections 6003.2.3.1 and 6003.2.3.2.

**6003.2.3.1 Location.** Outdoor storage or use of highly toxic or toxic solids and liquids shall not be located within 20 feet (6096 mm) of *lot lines*, public streets, public alleys, *public ways*, *exit discharges* or *exterior wall openings*. A 2-hour *fire barrier* without openings or penetrations extending not less than 30 inches (762 mm) above and to the sides of the storage is allowed in lieu of such distance. The wall shall either be an independent structure, or the *exterior wall* of the building adjacent to the storage area.

**6003.2.3.2 Treatment system—highly toxic liquids.** Exhaust scrubbers or other systems for processing

vapors of highly toxic liquid shall be provided where a spill or accidental release of such liquids can be expected to release highly toxic vapors at *normal temperature and pressure (NTP)*. Treatment systems and other processing systems shall be installed in accordance with the *International Mechanical Code*.

**6003.2.4 Outdoor storage piles.** Outdoor storage piles of highly toxic and toxic solids and liquids shall be separated into piles not larger than 2,500 cubic feet (71 m<sup>3</sup>). Aisle widths between piles shall be not less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

**6003.2.5 Weather protection for highly toxic liquids and solids—outdoor storage or use.** Where overhead weather protection is provided for outdoor storage or use of highly toxic liquids or solids, and the weather protection is attached to a building, the storage or use area shall either be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, or storage or use vessels shall be fire resistive. Weather protection shall be provided in accordance with Section 5004.13 for storage and Section 5005.3.9 for use.

**6003.2.6 Outdoor liquid transfer.** Highly toxic and toxic liquids shall be transferred in accordance with Section 5005.1.10.

## SECTION 6004

### HIGHLY TOXIC AND TOXIC COMPRESSED GASES

**6004.1 General.** The storage and use of highly toxic and toxic *compressed gases* shall comply with this section.

**6004.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of highly toxic and toxic *compressed gases* in certain occupancies shall be subject to the limitations contained in Sections 6004.1.1.1 through 6004.1.1.3.

**6004.1.1.1 Group A, E, I or U occupancies.** Toxic and highly toxic *compressed gases* shall not be stored or used within Group A, E, I or U occupancies.

**Exception:** Cylinders not exceeding 20 cubic feet (0.566 m<sup>3</sup>) at *normal temperature and pressure (NTP)* are allowed within gas cabinets or fume hoods.

**6004.1.1.2 Group R occupancies.** Toxic and highly toxic *compressed gases* shall not be stored or used in Group R occupancies.

**6004.1.1.3 Offices, retail sales and classrooms.** Toxic and highly toxic *compressed gases* shall not be stored or used in offices, retail sales or classroom portions of Group B, F, M or S occupancies.

**Exception:** In classrooms of Group B occupancies, cylinders with a capacity not exceeding 20 cubic feet (0.566 m<sup>3</sup>) at *NTP* are allowed in gas cabinets or fume hoods.

**6004.1.2 Gas cabinets.** Gas cabinets containing highly toxic or toxic *compressed gases* shall comply with Section 5003.8.6 and the following requirements:

1. The average ventilation velocity at the face of gas cabinet access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s) at any point of the access port or window.
2. Gas cabinets shall be connected to an exhaust system.
3. Gas cabinets shall not be used as the sole means of exhaust for any room or area.
4. The maximum number of cylinders located in a single gas cabinet shall not exceed three, except that cabinets containing cylinders not exceeding 1 pound (0.454 kg) net contents are allowed to contain up to 100 cylinders.
5. Gas cabinets required by Section 6004.2 or 6004.3 shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. Alternative fire-extinguishing systems shall not be used.

**6004.1.3 Exhausted enclosures.** Exhausted enclosures containing highly toxic or toxic *compressed gases* shall comply with Section 5003.8.5 and the following requirements:

1. The average ventilation velocity at the face of the enclosure shall be not less than 200 feet per minute (1.02 m/s) with not less than 150 feet per minute (0.76 m/s).
2. Exhausted enclosures shall be connected to an exhaust system.
3. Exhausted enclosures shall not be used as the sole means of exhaust for any room or area.
4. Exhausted enclosures required by Section 6004.2 or 6004.3 shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1. Alternative fire-extinguishing systems shall not be used.

**6004.2 Indoor storage and use.** The indoor storage and use of highly toxic or toxic *compressed gases* shall be in accordance with Sections 6004.2.1 through 6004.2.2.10.3.

**6004.2.1 Applicability.** The applicability of regulations governing the indoor storage and use of highly toxic and toxic *compressed gases* shall be as set forth in Sections 6004.2.1.1 through 6004.2.1.3.

**6004.2.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic gases in amounts not exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Sections 5001, 5003, 6001 and 6004.1.

**6004.2.1.2 Quantities exceeding the maximum allowable quantity per control area.** The indoor storage or use of highly toxic and toxic gases in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(2) shall be in accordance with Sections 6001, 6004.1, 6004.2 and Chapter 50.

**6004.2.1.3 Ozone gas generators.** The indoor use of ozone gas-generating equipment shall be in accordance with Section 6005.

**6004.2.2 General indoor requirements.** The general requirements applicable to the indoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.2.2.1 through 6004.2.2.10.3.

**6004.2.2.1 Cylinder and tank location.** Cylinders shall be located within gas cabinets, exhausted enclosures or gas rooms. Portable and stationary tanks shall be located within gas rooms or exhausted enclosures.

**6004.2.2.2 Ventilated areas.** The room or area in which gas cabinets or exhausted enclosures are located shall be provided with exhaust ventilation. Gas cabinets or exhausted enclosures shall not be used as the sole means of exhaust for any room or area.

**6004.2.2.3 Leaking cylinders and tanks.** One or more gas cabinets or exhausted enclosures shall be provided to handle leaking cylinders, containers or tanks.

#### Exceptions:

1. Where cylinders, containers or tanks are located within gas cabinets or exhausted enclosures.
2. Where *approved* containment vessels or containment systems are provided in accordance with all of the following:
  - 2.1. Containment vessels or containment systems shall be capable of fully containing or terminating a release.
  - 2.2. Trained personnel shall be available at an *approved* location.
  - 2.3. Containment vessels or containment systems shall be capable of being transported to the leaking cylinder, container or tank.

**6004.2.2.3.1 Location.** Gas cabinets and exhausted enclosures shall be located in gas rooms and connected to an exhaust system.

**6004.2.2.4 Local exhaust for portable tanks.** A means of local exhaust shall be provided to capture leaks from portable tanks. The local exhaust shall consist of portable ducts or collection systems designed to be applied to the site of a leak in a valve or fitting on the tank. The local exhaust system shall be located in a gas room. Exhaust shall be directed to a

## HIGHLY TOXIC AND TOXIC MATERIALS

treatment system in accordance with Section 6004.2.2.7.

### 6004.2.2.5 Piping and controls—stationary tanks.

In addition to the requirements of Section 5003.2.2, piping and controls on stationary tanks shall comply with the following requirements:

1. Pressure relief devices shall be vented to a treatment system designed in accordance with Section 6004.2.2.7.

**Exception:** Pressure relief devices on outdoor tanks provided exclusively for relieving pressure due to fire exposure are not required to be vented to a treatment system provided that:

1. The material in the tank is not flammable.
  2. The tank is not located in a diked area with other tanks containing combustible materials.
  3. The tank is located not less than 30 feet (9144 mm) from combustible materials or structures or is shielded by a *fire barrier* complying with Section 6004.3.2.1.1.
2. Filling or dispensing connections shall be provided with a means of local exhaust. Such exhaust shall be designed to capture fumes and vapors. The exhaust shall be directed to a treatment system in accordance with Section 6004.2.2.7.
  3. Stationary tanks shall be provided with a means of excess flow control on all tank inlet or outlet connections.

#### Exceptions:

1. Inlet connections designed to prevent backflow.
2. Pressure relief devices.

**6004.2.2.6 Gas rooms.** Gas rooms shall comply with Section 5003.8.4 and both of the following requirements:

1. The exhaust ventilation from gas rooms shall be directed to an exhaust system.
2. Gas rooms shall be equipped with an *approved automatic sprinkler system*. Alternative fire-extinguishing systems shall not be used.

**6004.2.2.7 Treatment systems.** The exhaust ventilation from gas cabinets, exhausted enclosures and gas rooms, and local exhaust systems required in Sections 6004.2.2.4 and 6004.2.2.5 shall be directed to a treatment system. The treatment system shall be utilized to handle the accidental release of gas and to process exhaust ventilation. The treatment system shall be designed in accordance with Sections 6004.2.2.7.1

through 6004.2.2.7.5 and Section 510 of the *International Mechanical Code*.

#### Exceptions:

1. Highly toxic and toxic gases—storage. A treatment system is not required for cylinders, containers and tanks in storage where all of the following controls are provided:
  - 1.1. Valve outlets are equipped with gastight outlet plugs or caps.
  - 1.2. Handwheel-operated valves have handles secured to prevent movement.
  - 1.3. *Approved* containment vessels or containment systems are provided in accordance with Section 6004.2.2.3.
2. Toxic gases—use. Treatment systems are not required for toxic gases supplied by cylinders or portable tanks not exceeding 1,700 pounds (772 kg) water capacity where a gas detection system complying with Section 6004.2.2.10 and *listed* or *approved* automatic-closing fail-safe valves are provided. The gas detection system shall have a sensing interval not exceeding 5 minutes. Automatic-closing fail-safe valves shall be located immediately adjacent to cylinder valves and shall close when gas is detected at the permissible exposure limit (PEL) by a gas sensor monitoring the exhaust system at the point of discharge from the gas cabinet, exhausted enclosure, ventilated enclosure or gas room.

**6004.2.2.7.1 Design.** Treatment systems shall be capable of diluting, adsorbing, absorbing, containing, neutralizing, burning or otherwise processing the contents of the largest single vessel of *compressed gas*. Where a total containment system is used, the system shall be designed to handle the maximum anticipated pressure of release to the system when it reaches equilibrium.

**6004.2.2.7.2 Performance.** Treatment systems shall be designed to reduce the maximum allowable discharge concentrations of the gas to one-half immediate by dangerous to life and health (IDLH) at the point of discharge to the atmosphere. Where more than one gas is emitted to the treatment system, the treatment system shall be designed to handle the worst-case release based on the release rate, the quantity and the IDLH for all *compressed gases* stored or used.

**6004.2.2.7.3 Sizing.** Treatment systems shall be sized to process the maximum worst-case release of gas based on the maximum flow rate of release from

the largest vessel utilized. The entire contents of the largest *compressed gas* vessel shall be considered.

**6004.2.2.7.4 Stationary tanks.** Stationary tanks shall be labeled with the maximum rate of release for the *compressed gas* contained based on valves or fittings that are inserted directly into the tank. Where multiple valves or fittings are provided, the maximum flow rate of release for valves or fittings with the highest flow rate shall be indicated. Where liquefied *compressed gases* are in contact with valves or fittings, the liquid flow rate shall be utilized for computation purposes. Flow rates indicated on the label shall be converted to cubic feet per minute (cfm/min) ( $\text{m}^3/\text{s}$ ) of gas at *normal temperature and pressure (NTP)*.

**6004.2.2.7.5 Portable tanks and cylinders.** The maximum flow rate of release for portable tanks and cylinders shall be calculated based on the total release from the cylinder or tank within the time specified in Table 6004.2.2.7.5. Where portable tanks or cylinders are equipped with *approved* excess flow or reduced flow valves, the worst-case release shall be determined by the maximum achievable flow from the valve as determined by the valve manufacturer or compressed gas supplier. Reduced flow and excess flow valves shall be permanently marked by the valve manufacturer to indicate the maximum design flow rate. Such markings shall indicate the flow rate for air under *normal temperature and pressure (NTP)*.

**TABLE 6004.2.2.7.5  
RATE OF RELEASE FOR CYLINDERS AND PORTABLE TANKS**

VESSEL TYPE	NONLIQUEFIED (minutes)	LIQUEFIED (minutes)
Containers	5	30
Portable tanks	40	240

**6004.2.2.8 Emergency power.** Emergency power shall be provided for the following systems in accordance with Section 603:

1. Exhaust ventilation system.
2. Treatment system.
3. Gas detection system.
4. Smoke detection system.
5. Temperature control system.
6. Fire alarm system.
7. Emergency alarm system.

**6004.2.2.8.1 Fail-safe engineered systems.** Emergency power shall not be required for mechanical exhaust ventilation, treatment systems and temperature control systems where *approved* fail-safe engineered systems are installed.

**6004.2.2.9 Automatic fire detection system—highly toxic compressed gases.** An *approved* automatic fire detection system shall be installed in rooms or areas where highly toxic *compressed gases* are stored or

used. Activation of the detection system shall sound a local alarm. The fire detection system shall comply with Section 907.

**6004.2.2.10 Gas detection system.** A gas detection system complying with Section 916 shall be provided to detect the presence of gas at or below the PEL or ceiling limit of the gas for which detection is provided. The system shall be capable of monitoring the discharge from the treatment system at or below one-half the IDLH limit and shall initiate a response in accordance with Sections 6004.2.2.10.1 through 6004.2.2.10.3 if the gas detection alarm is activated.

**Exception:** A gas detection system is not required for toxic gases when the physiological warning threshold level for the gas is at a level below the accepted PEL for the gas.

**6004.2.2.10.1 Alarms.** The gas detection system shall initiate a local alarm and transmit a signal to a constantly attended control station when a short-term hazard condition is detected. The alarm shall be both audible and visible and shall provide warning both inside and outside the area where gas is detected. The audible alarm shall be distinct from all other alarms.

**Exception:** Signal transmission to a constantly attended control station is not required where not more than one cylinder of highly toxic or toxic gas is stored.

**6004.2.2.10.2 Shut off of gas supply.** The gas-detection system shall automatically close the shut-off valve at the source on gas supply piping and tubing related to the system being monitored for whichever gas is detected.

**Exception:** Automatic shutdown is not required for reactors utilized for the production of highly toxic or toxic *compressed gases* where such reactors are:

1. Operated at pressures less than 15 pounds per square inch gauge (psig) (103.4 kPa).
2. Constantly attended.
3. Provided with emergency shutoff valves that have *ready access*.

**6004.2.2.10.3 Valve closure.** Automatic closure of shutoff valves shall be in accordance with the following:

1. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas cabinet or exhausted enclosure, the shutoff valve in the gas cabinet or exhausted enclosure for the specific gas detected shall automatically close.
2. Where the gas-detection sampling point initiating the gas detection system alarm is within a gas room and *compressed gas* containers are not in gas cabinets or exhausted enclosures, the shutoff valves



## HIGHLY TOXIC AND TOXIC MATERIALS

on all gas lines for the specific gas detected shall automatically close.

- Where the gas-detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve for the compressed container of specific gas detected supplying the manifold shall automatically close.

**Exception:** Where the gas-detection sampling point initiating the gas-detection system alarm is at a use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve in the gas valve enclosure for the branch line located in the piping distribution manifold enclosure shall automatically close.

**6004.3 Outdoor storage and use.** The outdoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.3.1 through 6004.3.4.

**6004.3.1 Applicability.** The applicability of regulations governing the outdoor storage and use of highly toxic and toxic *compressed gases* shall be as set forth in Sections 6004.3.1.1 through 6004.3.1.3.

**6004.3.1.1 Quantities not exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic gases in amounts not exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 5001, 5003 and 6001.

**6004.3.1.2 Quantities exceeding the maximum allowable quantity per control area.** The outdoor storage or use of highly toxic and toxic gases in amounts exceeding the *maximum allowable quantity per control area* set forth in Table 5003.1.1(4) shall be in accordance with Sections 6001 and 6004.3 and Chapter 50.

**6004.3.1.3 Ozone gas generators.** The outdoor use of ozone gas-generating equipment shall be in accordance with Section 6005.

**6004.3.2 General outdoor requirements.** The general requirements applicable to the outdoor storage and use of highly toxic and toxic *compressed gases* shall be in accordance with Sections 6004.3.2.1 through 6004.3.2.4.

**6004.3.2.1 Location.** Outdoor storage or use of highly toxic or toxic *compressed gases* shall be located in accordance with Sections 6004.3.2.1.1 through 6004.3.2.1.3.

**Exception:** *Compressed gases* located in gas cabinets complying with Sections 5003.8.6 and 6004.1.2 and located 5 feet (1524 mm) or more from buildings and 25 feet (7620 mm) or more from an *exit discharge*.

**6004.3.2.1.1 Distance limitation to exposures.** Outdoor storage or use of highly toxic or toxic

*compressed gases* shall not be located within 75 feet (22 860 mm) of a *lot line*, public street, public alley, *public way*, *exit discharge* or building not associated with the manufacture or distribution of such gases, unless all of the following conditions are met:

- Storage is shielded by a 2-hour *fire barrier* that interrupts the line of sight between the storage and the exposure.
- The 2-hour *fire barrier* shall be located not less than 5 feet (1524 mm) from any exposure.
- The 2-hour *fire barrier* shall not have more than two sides at approximately 90-degree (1.57 rad) directions, or three sides with connecting angles of approximately 135 degrees (2.36 rad).

### 6004.3.2.1.2 Openings in exposed buildings.

Where the storage or use area is located closer than 75 feet (22 860 mm) to a building not associated with the manufacture or distribution of highly toxic or toxic *compressed gases*, openings into a building other than for piping are not allowed above the height of the top of the 2-hour *fire barrier* or within 50 feet (15 240 mm) horizontally from the storage area whether or not shielded by a *fire barrier*.

**6004.3.2.1.3 Air intakes.** The storage or use area shall not be located within 75 feet (22 860 mm) of air intakes.

**6004.3.2.2 Leaking cylinders and tanks.** The requirements of Section 6004.2.2.3 shall apply to outdoor cylinders and tanks. Gas cabinets and exhausted enclosures shall be located within or immediately adjacent to outdoor storage or use areas.

**6004.3.2.3 Local exhaust for portable tanks.** Local exhaust for outdoor portable tanks shall be provided in accordance with the requirements set forth in Section 6004.2.2.4.

**6004.3.2.4 Piping and controls—stationary tanks.** Piping and controls for outdoor stationary tanks shall be in accordance with the requirements set forth in Section 6004.2.2.5.

**6004.3.3 Outdoor storage weather protection for portable tanks and cylinders.** Weather protection in accordance with Section 5004.13 shall be provided for portable tanks and cylinders located outdoors and not within gas cabinets or exhausted enclosures. The storage area shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**Exception:** An *automatic sprinkler system* is not required where:

- All materials under the weather protection structure, including hazardous materials and the containers in which they are stored, are noncombustible.
- The weather protection structure is located not less than 30 feet (9144 mm) from combustible

materials or structures or is separated from such materials or structures using a *fire barrier* complying with Section 6004.3.2.1.1.

**6004.3.4 Outdoor use of cylinders, containers and portable tanks.** Cylinders, containers and portable tanks in outdoor use shall be located in gas cabinets or exhausted enclosures and shall comply with Sections 6004.3.4.1 through 6004.3.4.3.

**6004.3.4.1 Treatment systems.** The treatment system requirements set forth in Section 6004.2.2.7 shall apply to highly toxic or toxic gases located outdoors.

**6004.3.4.2 Emergency power.** The requirements for emergency power set forth in Section 6004.2.2.8 shall apply to highly toxic or toxic gases located outdoors.

**6004.3.4.3 Gas detection system.** The gas detection system requirements set forth in Section 6004.2.2.10 shall apply to highly toxic or toxic gases located outdoors.

## SECTION 6005 OZONE GAS GENERATORS

**6005.1 Scope.** Ozone gas generators having a maximum ozone-generating capacity of 0.5 pound (0.23 kg) or more over a 24-hour period shall be in accordance with Sections 6005.2 through 6005.6.

### Exceptions:

1. Ozone-generating equipment used in Group R-3 occupancies.
2. Ozone-generating equipment where used in Group H-5 occupancies where in compliance with Chapters 27 and 50 and the other provisions in this chapter for highly toxic gases.

**6005.2 Design.** Ozone gas generators shall be designed, fabricated and tested in accordance with NEMA 250.

**6005.3 Location.** Ozone generators shall be located in *approved* cabinets or ozone generator rooms in accordance with Section 6005.3.1 or 6005.3.2.

**Exception:** An ozone gas generator within an *approved* pressure vessel where located outside of buildings.

**6005.3.1 Cabinets.** Ozone cabinets shall be constructed of *approved* materials and compatible with ozone. Cabinets shall display an *approved* sign stating: “OZONE GAS GENERATOR—HIGHLY TOXIC—OXIDIZER.”

Cabinets shall be braced for seismic activity in accordance with the *International Building Code*.

Cabinets shall be mechanically ventilated in accordance with the *International Mechanical Code* with not less than six air changes per hour.

The average velocity of ventilation at makeup air openings with cabinet doors closed shall be not less than 200 feet per minute (1.02 m/s).

**6005.3.2 Ozone gas generator rooms.** Ozone gas generator rooms shall be mechanically ventilated in accordance with the *International Mechanical Code* with not less

than six air changes per hour. Ozone gas generator rooms shall be equipped with a gas detection system complying with Section 916 that will shut off the generator and sound a local alarm when concentrations above the permissible exposure limit (PEL) occur.

Ozone gas generator rooms shall not be normally occupied, and such rooms shall be kept free of combustible and hazardous material storage. Room access doors shall display an *approved* sign stating: “OZONE GAS GENERATOR—HIGHLY TOXIC—OXIDIZER.”

**6005.4 Piping, valves and fittings.** Piping, valves, fittings and related components used to convey ozone shall be in accordance with Sections 6005.4.1 through 6005.4.3.

**6005.4.1 Piping.** Piping shall be welded stainless steel piping or tubing.

### Exceptions:

1. Double-walled piping.
2. Piping, valves, fittings and related components located in exhausted enclosures.

**6005.4.2 Materials.** Materials shall be compatible with ozone and shall be rated for the design operating pressures.

**6005.4.3 Identification.** Piping shall be identified with the following: “OZONE GAS—HIGHLY TOXIC—OXIDIZER.”

**6005.5 Automatic shutdown.** Ozone gas generators shall be designed to shut down automatically under the following conditions:

1. When the dissolved ozone concentration in the water being treated is above saturation when measured at the point where the water is exposed to the atmosphere.
2. When the process using generated ozone is shut down.
3. Failure of the ventilation system for the cabinet or ozone generator room.
4. Failure of the gas detection system in an ozone gas generator room.

**6005.6 Manual shutdown.** Manual shutdown controls shall be provided at the generator and, where in a room, within 10 feet (3048 mm) of the main *exit* or *exit access* door.



## CHAPTER 61

# LIQUEFIED PETROLEUM GASES

*Deleted in its entirety. Refer to the Arkansas Liquefied Petroleum Gas Code.*







## CHAPTER 62

# ORGANIC PEROXIDES

### User note:

**About this chapter:** Chapter 62 addresses the hazards associated with the storage, handling and use of organic peroxides and is intended to manage the fire and oxidation hazards of organic peroxides by preventing their uncontrolled release. These chemicals possess the characteristics of flammable or combustible liquids and are also strong oxidizers. This unusual combination of properties requires special storage and handling precautions to prevent uncontrolled release, contamination, hazardous chemical reactions, fires or explosions. The requirements of this chapter pertain to industrial applications in which significant quantities of organic peroxides are stored or used; however, smaller quantities of organic peroxides still pose a significant hazard and, therefore, must be stored and used in accordance with the applicable provisions of this chapter and Chapter 50.

### SECTION 6201 GENERAL

**6201.1 Scope.** The storage and use of organic peroxides shall be in accordance with this chapter and Chapter 50.

Unclassified detonable organic peroxides that are capable of *detonation* in their normal shipping containers under conditions of fire exposure shall be stored in accordance with Chapter 56.

**6201.2 Permits.** Permits shall be required for organic peroxides as set forth in Section 105.5.

### SECTION 6202 DEFINITION

**6202.1 Definition.** The following term is defined in Chapter 2:

#### ORGANIC PEROXIDE.

Class I.

Class II.

Class III.

Class IV.

Class V.

Unclassified detonable.

### SECTION 6203 GENERAL REQUIREMENTS

**6203.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of organic peroxides in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6201 and 6203.

**6203.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of organic peroxides shall be in accordance with Sections 6203.1.1.1 through 6203.1.1.4.

**6203.1.1.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of unclassified

detonable and Class I organic peroxides shall be stored in accordance with the following:

1. Unclassified detonable and Class I organic peroxides shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. The hazardous materials storage cabinets shall not contain other storage.

**6203.1.1.2 Group R occupancies.** Unclassified detonable and Class I organic peroxides shall not be stored or used within Group R occupancies.

**6203.1.1.3 Group B, F, M or S occupancies.** Unclassified detonable and Class I organic peroxides shall not be stored or used in offices, or retail sales areas of Group B, F, M or S occupancies.

**6203.1.1.4 Classrooms.** In classrooms in Group B, F or M occupancies, any amount of unclassified detonable and Class I organic peroxides shall be stored in accordance with the following:

1. Unclassified detonable and Class I organic peroxides shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. The hazardous materials storage cabinets shall not contain other storage.

**6203.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

### SECTION 6204 STORAGE

**6204.1 Indoor storage.** Indoor storage of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

## ORGANIC PEROXIDES

Indoor storage of unclassified detonable organic peroxides that are capable of *detonation* in their normal shipping containers under conditions of fire exposure shall be stored in accordance with Chapter 56.

**6204.1.1 Detached storage.** Storage of organic peroxides shall be in detached buildings where required by Section 5003.8.2.

**6204.1.2 Distance from detached buildings to exposures.** In addition to the requirements of the *International Building Code*, detached storage buildings for Class I, II, III, IV and V organic peroxides shall be located in accordance with Table 6204.1.2. Detached buildings containing quantities of unclassified detonable organic peroxides in excess of those set forth in Table 5003.8.2 shall be located in accordance with Table 5604.5.2(1).

**6204.1.3 Liquid-tight floor.** In addition to the requirements of Section 5004.12, floors of storage areas shall be of liquid-tight construction.

**6204.1.4 Electrical wiring and equipment.** In addition to the requirements of Section 5003.9.4, electrical wiring and equipment in storage areas for Class I or II organic peroxides shall comply with the requirements for electrical Class I, Division 2, locations.

**6204.1.5 Smoke detection.** An *approved* supervised smoke detection system in accordance with Section 907

shall be provided in rooms or areas where Class I, II or III organic peroxides are stored. Activation of the smoke detection system shall sound a local alarm.

**Exception:** A smoke detection system shall not be required in detached storage buildings equipped throughout with an *approved* automatic fire-extinguishing system complying with Chapter 9.

**6204.1.6 Maximum quantities.** Maximum allowable quantities per building in a mixed occupancy building shall not exceed the amounts set forth in Table 5003.8.2. Maximum allowable quantities per building in a detached storage building shall not exceed the amounts specified in Table 6204.1.2.

**6204.1.7 Storage arrangement.** Storage arrangements for organic peroxides shall be in accordance with Table 6204.1.7 and shall comply with all of the following:

1. Containers and packages in storage areas shall be closed.
2. Bulk storage shall not be in piles or bins.
3. A minimum 2-foot (610 mm) clear space shall be maintained between storage and uninsulated metal walls.
4. Fifty-five-gallon (208 L) drums shall not be stored more than one drum high.

**TABLE 6204.1.2**  
**ORGANIC PEROXIDES—DISTANCE TO EXPOSURES FROM DETACHED STORAGE BUILDINGS OR OUTDOOR STORAGE AREAS**

ORGANIC PEROXIDE CLASS	MAXIMUM STORAGE QUANTITY (POUNDS) AT MINIMUM SEPARATION DISTANCE					
	Distance to buildings, lot lines, public streets, public alleys, public ways or means of egress			Distance between individual detached storage buildings or individual outdoor storage areas		
	50 feet	100 feet	150 feet	20 feet	75 feet	100 feet
I	2,000	20,000	175,000	2,000	20,000	175,000
II	100,000	200,000	No Limit	100,000 <sup>a</sup>	No Limit	No Limit
III	200,000	No Limit	No Limit	200,000 <sup>a</sup>	No Limit	No Limit
IV	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit
V	No Limit	No Limit	No Limit	No Limit	No Limit	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg.

a. Where the amount of organic peroxide stored exceeds this amount, the minimum separation shall be 50 feet.

**TABLE 6204.1.7**  
**STORAGE OF ORGANIC PEROXIDES**

ORGANIC PEROXIDE CLASS	PILE CONFIGURATION				MAXIMUM QUANTITY PER BUILDING
	Maximum width (feet)	Maximum height (feet)	Minimum distance to next pile (feet)	Minimum distance to walls (feet)	
I	6	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
II	10	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
III	10	8	4 <sup>a</sup>	4 <sup>b</sup>	Note c
IV	16	10	3 <sup>a, d</sup>	4 <sup>b</sup>	No Requirement
V	No Requirement	No Requirement	No Requirement	No Requirement	No Requirement

For SI: 1 foot = 304.8 mm.

- Not less than one main aisle with a minimum width of 8 feet shall divide the storage area.
- Distance to noncombustible walls is allowed to be reduced to 2 feet.
- See Table 6204.1.2 for maximum quantities.
- The distance shall be not less than one-half the pile height.

**6204.1.8 Location in building.** The storage of Class I or II organic peroxides shall be on the ground floor. Class III organic peroxides shall not be stored in *basements*.

**6204.1.9 Contamination.** Organic peroxides shall be stored in their original DOTn shipping containers. Organic peroxides shall be stored in a manner to prevent contamination.

**6204.1.10 Explosion control.** Indoor storage rooms, areas and buildings containing unclassified detonable and Class I organic peroxides shall be provided with explosion control in accordance with Section 911.

**6204.1.11 Standby power.** Standby power shall be provided in accordance with Section 1203 for the following systems used to protect Class I and unclassified detonable organic peroxides:

1. Exhaust ventilation system.
2. Treatment system.
3. Smoke detection system.
4. Temperature control system.
5. Fire alarm system.
6. Emergency alarm system.

**6204.1.11.1 Fail-safe engineered systems.** Standby power shall not be required for mechanical exhaust ventilation, treatment systems and temperature control systems where *approved* fail-safe engineered systems are installed.

**6204.2 Outdoor storage.** Outdoor storage of organic peroxides in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

**6204.2.1 Distance from storage to exposures.** Outdoor storage areas for organic peroxides shall be located in accordance with Table 6204.1.2.

**6204.2.2 Electrical wiring and equipment.** In addition to the requirements of Section 5003.9.4, electrical wiring and equipment in outdoor storage areas containing unclassified detonable, Class I or Class II organic peroxides shall comply with the requirements for electrical Class I, Division 2, locations.

**6204.2.3 Maximum quantities.** Maximum quantities of organic peroxides in outdoor storage shall be in accordance with Table 6204.1.2.

**6204.2.4 Storage arrangement.** Storage arrangements shall be in accordance with Table 6204.1.7.

**6204.2.5 Separation.** In addition to the requirements of Section 5003.9.8, outdoor storage areas for organic peroxides in amounts exceeding those specified in Table 5003.8.2 shall be located a minimum distance of 50 feet (15 240 mm) from other hazardous material storage.

## SECTION 6205 USE

**6205.1 General.** The use of organic peroxides in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.





# CHAPTER 63

## OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS

### User note:

**About this chapter:** Chapter 63 addresses the hazards associated with solid, liquid, gaseous and cryogenic fluid oxidizing materials, including oxygen in home use, and establishes criteria for their safe storage and protection in indoor and outdoor storage facilities, minimizing the potential for uncontrolled releases and contact with fuel sources. Although oxidizers themselves do not burn, they pose unique fire hazards because of their ability to support combustion by breaking down and giving off oxygen.

### SECTION 6301 GENERAL

**6301.1 Scope.** The storage and use of oxidizing materials shall be in accordance with this chapter and Chapter 50. Oxidizing gases shall also comply with Chapter 53. Oxidizing *cryogenic fluids* shall also comply with Chapter 55.

#### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Bulk oxygen systems at industrial and institutional consumer sites shall be in accordance with NFPA 55.
3. Liquid oxygen stored or used in home health care in Group I-1, I-4 and R occupancies in accordance with Section 6306.

**6301.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6302 DEFINITIONS

**6302.1 Definitions.** The following terms are defined in Chapter 2:

**BULK OXYGEN SYSTEM.**

**LIQUID OXYGEN AMBULATORY CONTAINER.**

**LIQUID OXYGEN HOME CARE CONTAINER.**

**OXIDIZER.**

Class 4.

Class 3.

Class 2.

Class 1.

**OXIDIZING CRYOGENIC FLUID.**

**OXIDIZING GAS.**

### SECTION 6303 GENERAL REQUIREMENTS

**6303.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of oxidizing materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6301 and 6303. Oxidizing gases shall also comply with Chapter 53.

**6303.1.1 Special limitations for indoor storage and use by occupancy.** The indoor storage and use of oxidizing materials shall be in accordance with Sections 6303.1.1.1 through 6303.1.1.2.

**6303.1.1.1 Class 4 liquid and solid oxidizers.** The storage and use of Class 4 liquid and solid oxidizers shall comply with Sections 6303.1.1.1.1 through 6303.1.1.1.4.

**6303.1.1.1.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of Class 4 liquid and solid oxidizers shall be stored in accordance with the following:

1. Class 4 liquid and solid oxidizers shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. The hazardous materials storage cabinets shall not contain other storage.

**6303.1.1.1.2 Group R occupancies.** Class 4 liquid and solid oxidizers shall not be stored or used within Group R occupancies.

**6303.1.1.1.3 Offices and retail sales areas.** Class 4 liquid and solid oxidizers shall not be stored or used in offices or retail sales areas of Group B, F, M or S occupancies.

**6303.1.1.1.4 Classrooms.** In classrooms of Group B, F or M occupancies, any amount of Class 4 liquid and solid oxidizers shall be stored in accordance with the following:

1. Class 4 liquid and solid oxidizers shall be stored in hazardous materials storage cabinets complying with Section 5003.8.7.
2. Hazardous materials storage cabinets shall not contain other storage.

## OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS

- \* **6303.1.1.2 Oxidizing gases.** Except for cylinders of nonliquefied *compressed gases* not exceeding a capacity of 250 cubic feet (7 m<sup>3</sup>) or liquefied *compressed gases* not exceeding a capacity of 46 pounds (21 kg) each used for maintenance purposes, patient care or operation of equipment, oxidizing gases shall not be stored or used in Group A, E, I or R occupancies or in offices in Group B occupancies.

The aggregate quantities of gases used for maintenance purposes and operation of equipment shall not exceed the *maximum allowable quantity per control area* listed in Table 5003.1.1(1).

Medical gas systems and medical gas supply cylinders shall also be in accordance with Section 5306.

**6303.1.2 Emergency shutoff.** *Compressed gas* systems conveying oxidizing gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

**6303.1.2.1 Shutoff at source.** A manual or automatic fail-safe emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

**6303.1.2.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

**6303.1.3 Ignition source control.** Ignition sources in areas containing oxidizing gases shall be controlled in accordance with Section 5003.7.

**6303.1.4 Class 1, 2 and 3 oxidizer storage configuration.** The storage configuration of Class 1, 2 and 3 liquid and solid oxidizers shall be as set forth in Table 6303.1.4.

- \*\* **6303.1.5 Class 3 liquid and solid oxidizers.** Not more than 220 pounds (99 kg) of solid or 22 gallons (83 L) of liquid Class 3 oxidizer is allowed in storage and use where such materials are necessary for maintenance purposes or operation of equipment. The oxidizers shall be stored in *approved* containers and in an *approved* manner.

## SECTION 6304 STORAGE

**6304.1 Indoor storage.** Indoor storage of oxidizing materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

**6304.1.1 Explosion control.** Indoor storage rooms, areas and buildings containing Class 4 liquid or solid oxidizers shall be provided with explosion control in accordance with Section 911.

**TABLE 6303.1.4  
STORAGE OF CLASS 1, 2 AND 3  
OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS (feet)		
	Class 1	Class 2	Class 3
Piles			
Maximum width	24	16	12
Maximum height	20	Note c	Note c
Maximum distance to aisle	12	8	8
Minimum distance to next pile	4 <sup>a</sup>	Note a	Note a
Minimum distance to walls	2 <sup>b</sup>	2	4
Maximum quantity per pile	200 tons	MAQ	NA
Maximum quantity per building	No Limit	Note d	Note d

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton. MAQ = Maximum Allowable Quantity.

NA = Not Applicable.

- The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.
- There shall not be a minimum distance from the pile to a wall for amounts less than 9,000 pounds.
- Maximum storage height in nonsprinklered buildings is limited to 6 feet. In sprinklered buildings, see NFPA 400 for storage heights based on ceiling sprinkler protection.
- Maximum quantity per building varies. See Chapter 50 for control areas and MAQs.

**6304.1.2 Automatic sprinkler system.** The *automatic sprinkler system* for oxidizer storage shall be designed in accordance with NFPA 400.

**6304.1.3 Liquid-tight floor.** In addition to Section 5004.12, floors of storage areas for liquid and solid oxidizers shall be of liquid-tight construction.

**6304.1.4 Smoke detection.** An *approved* supervised smoke detection system in accordance with Section 907 shall be installed in liquid and solid oxidizer storage areas. Activation of the smoke detection system shall sound a local alarm.

**Exception:** Detached storage buildings protected by an *approved* automatic fire-extinguishing system.

**6304.1.5 Storage conditions.** The maximum quantity of oxidizers per building in storage buildings shall not exceed those quantities set forth in Tables 6304.1.5(1) through 6304.1.5(3).

The storage configuration for liquid and solid oxidizers shall be as set forth in Table 6303.1.4 and Tables 6304.1.5(1) through 6304.1.5(3).

Class 2 oxidizers shall not be stored in *basements* except where such storage is in stationary tanks.

Class 3 and 4 oxidizers in amounts exceeding the *maximum allowable quantity per control area* set forth in Section 5003.1 shall be stored on the ground floor only.

## OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS

**TABLE 6304.1.5(1)**  
**STORAGE OF CLASS 2 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS	
	Group H occupancy storage	Detached storage
Piles		
Maximum width	25 feet	25 feet
Maximum height	Note a	Note a
Maximum distance to aisle	12 feet	12 feet
Minimum distance to next pile	Note b	Note b
Minimum distance to walls	2 feet <sup>c</sup>	2 feet <sup>c</sup>
Maximum quantity per pile	100 tons	100 tons
Maximum quantity per building	2000 tons	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton.

- a. Maximum storage height in nonsprinklered buildings is limited to 6 feet. In sprinklered buildings see NFPA 400 for storage heights based on ceiling sprinkler protection.
- b. The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.
- c. For protection level and detached storage under 4,500 pounds, there shall not be a minimum separation distance between the pile and any wall.

**TABLE 6304.1.5(2)**  
**STORAGE OF CLASS 3 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS	
	Group H occupancy storage	Detached storage
Piles		
Maximum width	16 feet	20 feet
Maximum height	Note a	Note a
Maximum distance to aisle	10 feet	10 feet
Minimum distance to next pile	Note b	Note b
Minimum distance to walls	4 feet <sup>c</sup>	4 feet <sup>c</sup>
Maximum quantity per pile	30 tons	100 tons
Maximum quantity per building	1200 tons	No Limit

For SI: 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 ton = 0.907185 metric ton.

- a. Maximum storage height in nonsprinklered buildings is limited to 6 feet. In sprinklered buildings see NFPA 400 for storage heights based on ceiling sprinkler protection.
- b. The minimum aisle width shall be equal to the pile height, but not less than 4 feet and not greater than 8 feet.
- c. For protection level and detached storage under 2,300 pounds, there shall not be a minimum separation distance between the pile and any wall.

**TABLE 6304.1.5(3)**  
**STORAGE OF CLASS 4 OXIDIZER LIQUIDS AND SOLIDS**

STORAGE CONFIGURATION	LIMITS (feet)
Piles	
Maximum length	10
Maximum width	4
Maximum height	8
Minimum distance to next pile	8
Maximum quantity per building	No Limit

For SI: 1 foot = 304.8 mm.

**6304.1.6 Separation of Class 4 oxidizers from other materials.** In addition to the requirements in Section 5003.9.8, Class 4 oxidizer liquids and solids shall be separated from other hazardous materials by not less than a 1-hour *fire barrier* or stored in hazardous materials storage cabinets.

**6304.1.7 Contamination.** Liquid and solid oxidizers shall not be stored on or against combustible surfaces. Liquid and solid oxidizers shall be stored in a manner to prevent contamination.

**6304.1.8 Detached storage.** Storage of liquid and solid oxidizers shall be in detached buildings where required by Section 5003.8.2.

**6304.1.8.1 Separation distance.** Detached storage buildings for Class 4 oxidizer liquids and solids shall be located not less than 50 feet (15 240 mm) from other hazardous materials storage.

**6304.2 Outdoor storage.** Outdoor storage of oxidizing materials in amounts exceeding the *maximum allowable quantities per control area* set forth in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter. Oxidizing gases shall also comply with Chapter 53.

**6304.2.1 Distance from storage to exposures for oxidizing gases.** Outdoor storage areas for oxidizing gases shall be located in accordance with Table 6304.2.1.

**6304.2.1.1 Oxidizing cryogenic fluids.** Outdoor storage areas for oxidizing *cryogenic fluids* shall be located in accordance with Chapter 55.

**TABLE 6304.2.1**  
**OXIDIZER GASES—DISTANCE FROM STORAGE TO EXPOSURES<sup>a</sup>**

QUANTITY OF GAS STORED (cubic feet at NTP)	DISTANCE TO A BUILDING NOT ASSOCIATED WITH THE MANUFACTURE OR DISTRIBUTION OF OXIDIZING GASES OR PUBLIC WAY OR LOT LINE THAT CAN BE BUILT ON (feet)	DISTANCE BETWEEN STORAGE AREAS (feet)
0–50,000	5	5
50,001–100,000	10	10
100,001 or greater	15	10

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. The minimum required distances shall not apply where fire barriers without openings or penetrations having a minimum fire-resistance rating of 2 hours interrupt the line of sight between the storage and the exposure. The configuration of the fire barrier shall be designed to allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

**6304.2.2 Storage configuration for liquid and solid oxidizers.** Storage configuration for liquid and solid oxidizers shall be in accordance with Table 6303.1.4 and Tables 6304.1.5(1) through 6304.1.5(3).

**6304.2.3 Storage configuration for oxidizing gases.** Storage configuration for oxidizing gases shall be in accordance with Table 6304.2.1.



## SECTION 6305 USE

**6305.1 Scope.** The use of oxidizers in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter. Oxidizing gases shall also comply with Chapter 53.

## SECTION 6306 LIQUID OXYGEN IN HOME HEALTH CARE

**6306.1 General.** The storage and use of liquid oxygen (LOX) in home health care in Group I-1, I-4 and R occupancies shall comply with Sections 6306.2 through 6306.6, or shall be stored and used in accordance with Chapter 50.

**6306.2 Information and instructions to be provided.** The seller of liquid oxygen shall provide the user with information in written form that includes, but is not limited to, the following:

1. Manufacturer's instructions and labeling for safe storage and use of the containers.
2. Locating containers away from ignition sources, *exits*, electrical hazards and high-temperature devices in accordance with Section 6306.3.3.
3. Restraint of containers to prevent falling in accordance with Section 6306.3.4.
4. Requirements for handling containers in accordance with Section 6306.3.5.
5. Safeguards for refilling containers in accordance with Section 6306.3.6.
6. Signage requirements in accordance with Section 6306.6.

**6306.3 Liquid oxygen home care containers.** Containers of liquid oxygen in home health care shall be in accordance with Sections 6306.3.1 through 6306.3.6.3.

**6306.3.1 Maximum individual container capacity.** Liquid oxygen home care containers shall not exceed an individual capacity of 15.8 gallons (60 L) in Group I-1, I-4 and R occupancies. Liquid oxygen ambulatory containers are allowed in Group I-1, I-4 and R occupancies. Containers of liquid oxygen in home health care shall also be stored, used and filled in accordance with Section 6306 and Sections 5503.1 and 5503.2.

**6306.3.2 Manufacturer's instructions and labeling.** Containers shall be stored, used and operated in accordance with the manufacturer's instructions and labeling.

**6306.3.3 Locating containers.** Containers shall not be located in areas where any of the following conditions exist:

1. They can be overturned due to operation of a door.
2. They are in the direct path of egress.
3. They are subject to falling objects.
4. They can become part of an electrical circuit.
5. Open flames and high-temperature devices can cause a hazard.

**6306.3.4 Restraining containers.** Liquid oxygen home care containers shall be restrained while in storage or use to prevent falling caused by contact, vibration or seismic activity. Containers shall be restrained by one of the following methods:

1. Restraining containers to a fixed object with one or more restraints.
2. Restraining containers within a framework, stand or assembly designed to secure the container.
3. Restraining containers by locating a container against two points of contact such as the walls of a corner of a room or a wall and a secure furnishing or object such as a desk.

**6306.3.5 Container handling.** Containers shall be handled by use of a cart or hand truck designed for such use.

### Exceptions:

1. Liquid oxygen home care containers equipped with a roller base.
2. Liquid oxygen ambulatory containers are allowed to be hand carried.

**6306.3.6 Filling of containers.** The filling of containers shall be in accordance with Sections 6306.3.6.1 through 6306.3.6.3.

**6306.3.6.1 Filling location.** Liquid oxygen home care containers and ambulatory containers shall be filled outdoors.

**Exception:** Liquid oxygen ambulatory containers are allowed to be filled indoors where the supply container is specifically designed for filling such containers and written instructions are provided by the container manufacturer.

**6306.3.6.2 Incompatible surfaces.** A drip pan compatible with liquid oxygen shall be provided under home care container fill and vent connections during the filling process in order to protect against liquid oxygen spillage from coming into contact with combustible surfaces, including asphalt.

**6306.3.6.3 Open flames and high-temperature devices.** The use of open flames and high-temperature devices shall be in accordance with Section 5003.7.2.

**6306.4 Maximum aggregate quantity.** The maximum aggregate quantity of liquid oxygen allowed in storage and in use in each *dwelling unit* shall be 31.6 gallons (120 L).

### Exceptions:

1. The maximum aggregate quantity of liquid oxygen allowed in Group I-4 occupancies shall be limited by the maximum allowable quantity set forth in Table 5003.1.1(1).
2. Where individual sleeping rooms are separated from the remainder of the *dwelling unit* by *fire barriers* constructed in accordance with Section 707 of the *International Building Code*, and *horizontal assemblies* constructed in accordance with Section 711 of the *International Building Code*, or

## OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS

both, having a minimum *fire-resistance rating* of 1 hour, the maximum aggregate quantity per *dwelling unit* shall be increased to allow not more than 31.6 gallons (120 L) of liquid oxygen per sleeping room.

**6306.5 Smoking prohibited.** Smoking shall be prohibited in rooms or areas where liquid oxygen is in use.

**6306.6 Signs.** Warning signs for occupancies using home health care liquid oxygen shall be in accordance with Sections 6306.6.1 and 6306.6.2.

**6306.6.1 No smoking sign.** A sign stating “OXYGEN—NO SMOKING” shall be posted in each room or area where liquid oxygen containers are stored, used or filled.

**6306.6.2 Premises signage.** Where required by the *fire code official*, each *dwelling unit* or *sleeping unit* shall have an *approved* sign indicating that the unit contains liquid oxygen home care containers.

**6306.7 Fire department notification.** Where required by the *fire code official*, the liquid oxygen seller shall notify the fire department of the locations of liquid oxygen home care containers.



## CHAPTER 64

# PYROPHORIC MATERIALS

### User note:

**About this chapter:** Chapter 64 regulates the hazards associated with pyrophoric materials, which are capable of spontaneously igniting in the air at or below a temperature of 130°F (54°C). Many pyrophoric materials also pose severe flammability or reactivity hazards. This chapter addresses only the hazards associated with pyrophoric materials. Materials that pose multiple hazards must conform to the requirements of this code with respect to all hazards.

### SECTION 6401 GENERAL

**6401.1 Scope.** The storage and use of pyrophoric materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

**6401.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6402 DEFINITION

**6402.1 Definition.** The following term is defined in Chapter 2:

**PYROPHORIC.**

### SECTION 6403 GENERAL REQUIREMENTS

**6403.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of pyrophoric materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6401 and 6403.

**6403.1.1 Emergency shutoff.** *Compressed gas* systems conveying pyrophoric gases shall be provided with *approved* manual or automatic emergency shutoff valves that can be activated at each point of use and at each source.

**6403.1.1.1 Shutoff at source.** An automatic emergency shutoff valve shall be installed on supply piping at the cylinder or bulk source. The shutoff valve shall be operated by a remotely located manually activated shutdown control located not less than 15 feet (4572 mm) from the source of supply. Manual or automatic cylinder valves are allowed to be used as the required emergency shutoff valve where the source of supply is limited to unmanifolded cylinder sources.

**6403.1.1.2 Shutoff at point of use.** A manual or automatic emergency shutoff valve shall be installed on the supply piping at the point of use or at a point where the equipment using the gas is connected to the supply system.

**6403.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

### SECTION 6404 STORAGE

**6404.1 Indoor storage.** Indoor storage of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003 and 5004 and this chapter.

The storage of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with ANSI/CGA G-13.

**6404.1.1 Liquid-tight floor.** In addition to the requirements of Section 5004.12, floors of storage areas containing pyrophoric liquids shall be of liquid-tight construction.

**6404.1.2 Pyrophoric solids and liquids.** Storage of pyrophoric solids and liquids shall be limited to a maximum area of 100 square feet (9.3 m<sup>2</sup>) per pile. Storage shall not exceed 5 feet (1524 mm) in height. Individual containers shall not be stacked.

Aisles between storage piles shall be not less than 10 feet (3048 mm) in width.

Individual tanks or containers shall not exceed 500 gallons (1893 L) in capacity.

**6404.1.3 Pyrophoric gases.** Storage of pyrophoric gases shall be in detached buildings where required by Section 5003.8.2.

**6404.1.4 Separation from incompatible materials.** In addition to the requirements of Section 5003.9.8, indoor storage of pyrophoric materials shall be isolated from incompatible hazardous materials by 1-hour *fire barriers* with openings protected in accordance with the *International Building Code*.

**Exception:** Storage in *approved* hazardous materials storage cabinets constructed in accordance with Section 5003.8.7.



## PYROPHORIC MATERIALS

**6404.2 Outdoor storage.** Outdoor storage of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003 and 5004, and this chapter.

The storage of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with ANSI/CGA G-13.

**6404.2.1 Distance from storage to exposures.** The separation of pyrophoric solids, liquids and gases from buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress* shall be in accordance with the following:

1. Solids and liquids. Two times the separation required by Chapter 57 for Class IB *flammable liquids*.
2. Gases. The location and maximum amount of pyrophoric gas per storage area shall be in accordance with Table 6404.2.1.

**6404.2.2 Weather protection.** Where overhead construction is provided for sheltering outdoor storage areas of pyrophoric materials, the storage areas shall be provided with *approved* automatic fire-extinguishing system protection.

## SECTION 6405 USE

**6405.1 General.** The use of pyrophoric materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

**6405.2 Weather protection.** Where overhead construction is provided for sheltering of outdoor use areas of pyrophoric materials, the use areas shall be provided with *approved* automatic fire-extinguishing system protection.

**6405.3 Silane gas.** The use of silane gas, and gas mixtures with a silane concentration of 1.37 percent or more by volume, shall be in accordance with ANSI/CGA G-13.

TABLE 6404.2.1  
PYROPHORIC GASES—DISTANCE FROM STORAGE TO EXPOSURES<sup>a</sup>

MAXIMUM AMOUNT PER STORAGE AREA (cubic feet)	MINIMUM DISTANCE BETWEEN STORAGE AREAS (feet)	MINIMUM DISTANCE TO LOT LINES OF PROPERTY THAT CAN BE BUILT ON (feet)	MINIMUM DISTANCE TO PUBLIC STREETS, PUBLIC ALLEYS OR PUBLIC WAYS (feet)	MINIMUM DISTANCE TO BUILDINGS ON THE SAME PROPERTY		
				Nonrated construction or openings within 25 feet	Two-hour construction and no openings within 25 feet	Four-hour construction and no openings within 25 feet
250	5	25	5	5	0	0
2,500	10	50	10	10	5	0
7,500	20	100	20	20	10	0

For SI: 1 foot = 304.8 mm, 1 cubic foot = 0.02832 m<sup>3</sup>.

- a. The minimum required distances shall be reduced to 5 feet where protective structures having a minimum fire resistance of 2 hours interrupt the line of sight between the container and the exposure. The protective structure shall be not less than 5 feet from the exposure. The configuration of the protective structure shall allow natural ventilation to prevent the accumulation of hazardous gas concentrations.

## CHAPTER 65

# PYROXYLIN (CELLULOSE NITRATE) PLASTICS

### User note:

**About this chapter:** Chapter 65 addresses the significant hazards associated with pyroxylin (cellulose nitrate) plastics, which are the most dangerous and unstable of all plastic compounds. The chemically bound oxygen in their structure permits them to burn vigorously in the absence of atmospheric oxygen at a rate 15 times greater than comparable common combustibles. Strict compliance with the provisions of this chapter, along with proper housekeeping and storage arrangements, helps to reduce the hazards associated with pyroxylin (cellulose nitrate) plastics in a fire or other emergencies.

### SECTION 6501 GENERAL

**6501.1 Scope.** This chapter shall apply to the storage and handling of plastic substances, materials or compounds with cellulose nitrate (pyroxylin) as a base, by whatever name known, in the form of blocks, sheets, tubes or fabricated shapes.

Cellulose nitrate (pyroxylin) motion picture film shall comply with the requirements of Section 306.

**6501.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6502 DEFINITIONS

**6502.1 Terms defined in Chapter 2.** Words and terms used in this chapter and defined in Chapter 2 shall have the meanings ascribed to them as defined therein.

### SECTION 6503 GENERAL REQUIREMENTS

**6503.1 Displays.** Cellulose nitrate (pyroxylin) plastic articles are allowed to be placed on tables not more than 3 feet (914 mm) wide and 10 feet (3048 mm) long. Tables shall be spaced not less than 3 feet (914 mm) apart. Where articles are displayed on counters, they shall be arranged in a like manner.

**6503.2 Space under tables.** Spaces underneath tables shall be kept free from storage of any kind and accumulation of paper, refuse and other combustible material.

**6503.3 Location.** Sales or display tables shall be so located that in the event of a fire at the table, the table will not interfere with free *means of egress* from the room in not less than one direction.

**6503.4 Lighting.** Lighting shall not be located directly above cellulose nitrate (pyroxylin) plastic material, unless provided with a suitable guard to prevent heated particles from falling.

### SECTION 6504 STORAGE AND HANDLING

**6504.1 Raw material.** Raw cellulose nitrate (pyroxylin) plastic material in a Group F building shall be stored and handled in accordance with Sections 6504.1.1 through 6504.1.7.

**6504.1.1 Storage of incoming material.** Where raw material in excess of 25 pounds (11 kg) is received in a building or *fire area*, an *approved* vented cabinet or *approved* vented vault equipped with an *approved automatic sprinkler system* shall be provided for the storage of material.

**6504.1.2 Capacity limitations.** Cabinets in any one workroom shall not contain more than 1,000 pounds (454 kg) of raw material. Each cabinet shall not contain more than 500 pounds (227 kg). Each compartment shall not contain more than 250 pounds (114 kg).

**6504.1.3 Storage of additional material.** Raw material in excess of that allowed by Section 6504.1.2 shall be kept in vented vaults not exceeding 1,500-cubic-foot capacity (43 m<sup>3</sup>) of total vault space, and with *approved* construction, venting and sprinkler protection.

**6504.1.4 Heat sources.** Cellulose nitrate (pyroxylin) plastic shall not be stored within 2 feet (610 mm) of heat-producing appliances, steam pipes, radiators or chimneys.

**6504.1.5 Accumulation of material.** In factories manufacturing articles of cellulose nitrate (pyroxylin) plastics, *approved* sprinklered and vented cabinets, vaults or storage rooms shall be provided to prevent the accumulation in workrooms of raw stock in process or finished articles.

**6504.1.6 Operators.** In workrooms of cellulose nitrate (pyroxylin) plastic factories, operators shall not be stationed closer together than 3 feet (914 mm), and the amount of material per operator shall not exceed one shift's supply and shall be limited to the capacity of three tote boxes, including material awaiting removal or use.

**6504.1.7 Waste material.** Waste cellulose nitrate (pyroxylin) plastic materials such as shavings, chips, turnings, sawdust, edgings and trimmings shall be kept under water in metal receptacles until removed from the premises.

**PYROXYLIN (CELLULOSE NITRATE) PLASTICS**

**6504.2 Fire protection.** The manufacture or storage of articles of cellulose nitrate (pyroxylin) plastic in quantities exceeding 100 pounds (45 kg) shall be located in a building or portion thereof equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**6504.3 Sources of ignition.** Sources of ignition shall not be located in rooms in which cellulose nitrate (pyroxylin) plastic in excess of 25 pounds (11 kg) is handled or stored.

**6504.4 Heating.** Rooms in which cellulose nitrate (pyroxylin) plastic is handled or stored shall be heated by low-pressure steam or hot water radiators.

## CHAPTER 66

# UNSTABLE (REACTIVE) MATERIALS

### User note:

**About this chapter:** Chapter 66 addresses the hazards of unstable (reactive) liquid and solid materials as well as unstable (reactive) compressed gases. In addition to their unstable reactivity, these materials may pose other hazards, such as toxicity, corrosivity, explosivity, flammability or oxidizing potential. This chapter, however, is intended to address those materials whose primary hazard is unstable reactivity. Materials that pose multiple hazards must conform to the requirements of the code with respect to all hazards. Strict compliance with the provisions of this chapter, along with proper housekeeping and storage arrangements, helps to reduce the exposure hazards associated with unstable (reactive) materials in a fire or other emergency.

### SECTION 6601 GENERAL

**6601.1 Scope.** The storage and use of unstable (reactive) materials shall be in accordance with this chapter. *Compressed gases* shall also comply with Chapter 53.

#### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Detonable unstable (reactive) materials shall be stored in accordance with Chapter 56.

**6601.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6602 DEFINITION

**6602.1 Definition.** The following term is defined in Chapter 2:

#### UNSTABLE (REACTIVE) MATERIAL.

- Class 4.
- Class 3.
- Class 2.
- Class 1.

### SECTION 6603 GENERAL REQUIREMENTS

**6603.1 Quantities not exceeding the maximum allowable quantity per control area.** Quantities of unstable (reactive) materials not exceeding the *maximum allowable quantity per control area* shall be in accordance with Sections 6603.1.1 through 6603.1.2.5.

**6603.1.1 General.** The storage and use of unstable (reactive) materials in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6601 and 6603.

**6603.1.2 Limitations for indoor storage and use by occupancy.** The indoor storage of unstable (reactive) materials shall be in accordance with Sections 6603.1.2.1 through 6603.1.2.5.

**6603.1.2.1 Group A, E, I or U occupancies.** In Group A, E, I or U occupancies, any amount of Class 3 and 4 unstable (reactive) materials shall be stored in accordance with the following:

1. Class 3 and 4 unstable (reactive) materials shall be stored in hazardous material storage cabinets complying with Section 5003.8.7.
2. The hazardous material storage cabinets shall not contain other storage.

**6603.1.2.2 Group R occupancies.** Class 3 and 4 unstable (reactive) materials shall not be stored or used within Group R occupancies.

**6603.1.2.3 Group M occupancies.** Class 4 unstable (reactive) materials shall not be stored or used in retail sales portions of Group M occupancies.

**6603.1.2.4 Offices.** Class 3 and 4 unstable (reactive) materials shall not be stored or used in offices of Group B, F, M or S occupancies.

**6603.1.2.5 Classrooms.** In classrooms in Group B, F or M occupancies, any amount of Class 3 and 4 unstable (reactive) materials shall be stored in accordance with the following:

1. Class 3 and 4 unstable (reactive) materials shall be stored in hazardous material storage cabinets complying with Section 5003.8.7.
2. The hazardous material storage cabinets shall not contain other storage.

**6603.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.



## UNSTABLE (REACTIVE) MATERIALS

SECTION 6604  
STORAGE

**6604.1 Indoor storage.** Indoor storage of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

In addition, Class 3 and 4 unstable (reactive) detonable materials shall be stored in accordance with the *International Building Code* requirements for *explosives*.

**6604.1.1 Detached storage.** Storage of unstable (reactive) materials shall be in detached buildings where required in Section 5003.8.2.

**6604.1.2 Explosion control.** Indoor storage rooms, areas and buildings containing Class 3 or 4 unstable (reactive) materials shall be provided with explosion control in accordance with Section 911.

**6604.1.3 Liquid-tight floor.** In addition to Section 5004.12, floors of storage areas for liquids and solids shall be of liquid-tight construction.

**6604.1.4 Storage configuration.** Unstable (reactive) materials stored in quantities greater than 500 cubic feet (14 m<sup>3</sup>) shall be separated into piles, each not larger than 500 cubic feet (14 m<sup>3</sup>). Aisle width shall be not less than the height of the piles or 4 feet (1219 mm), whichever is greater.

**Exception:** Materials stored in tanks.

**6604.1.5 Location in building.** Unstable (reactive) materials shall not be stored in *basements*.

**6604.2 Outdoor storage.** Outdoor storage of unstable (reactive) materials in amounts exceeding the *maximum allowable quantities per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

**6604.2.1 Distance from storage to exposures Class 4 and 3 (detonable) materials.** Outdoor storage of Class 4 or 3 (detonable) unstable (reactive) material shall be in accordance with Table 5604.5.2(2). The number of pounds of material listed in the table shall be the net weight of the material present. Alternatively, the number of pounds of material shall be based on a trinitrotoluene (TNT) equivalent weight.

**6604.2.2 Distance from storage to exposures Class 3 (deflagratable) materials.** Outdoor storage of deflagratable Class 3 unstable (reactive) materials shall be in accordance with Table 5604.5.2(3). The number of pounds of material listed shall be the net weight of the material present.

**6604.2.3 Distance from storage to exposures Class 2 and 1 materials.** Outdoor storage of Class 2 or 1 unstable (reactive) materials shall not be located within 20 feet (6096 mm) of buildings not associated with the manufacture or distribution of such materials, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. The minimum required distance shall not apply where *fire barriers* without openings or penetrations having a mini-

mum *fire-resistance rating* of 2 hours interrupt the line of sight between the storage and the exposure. The *fire barrier* shall either be an independent structure or the exterior wall of the building adjacent to the storage area.

**6604.2.4 Storage configuration.** Piles of unstable (reactive) materials shall not exceed 1,000 cubic feet (28 m<sup>3</sup>).

**6604.2.5 Aisle widths.** Aisle widths between piles shall be not less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

SECTION 6605  
USE

**6605.1 General.** The use of unstable (reactive) materials in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

## CHAPTER 67

# WATER-REACTIVE SOLIDS AND LIQUIDS

### User note:

**About this chapter:** Chapter 67 addresses the hazards associated with water-reactive materials that are solid or liquid at normal temperatures and pressures. In addition to their water reactivity, these materials may pose a wide range of other hazards, such as toxicity, flammability, corrosiveness or oxidizing potential. This chapter addresses only those materials whose primary hazard is water reactivity. Materials that pose multiple hazards must conform to the requirements of this code with respect to all hazards. Strict compliance with the requirements of this chapter, along with proper housekeeping and storage arrangements, helps to reduce the exposure to hazards associated with water-reactive materials in a fire or other emergency.

### SECTION 6701 GENERAL

**6701.1 Scope.** The storage and use of water-reactive solids and liquids shall be in accordance with this chapter.

#### Exceptions:

1. Display and storage in Group M and storage in Group S occupancies complying with Section 5003.11.
2. Detonable water-reactive solids and liquids shall be stored in accordance with Chapter 56.

**6701.2 Permits.** Permits shall be required as set forth in Section 105.5.

### SECTION 6702 DEFINITION

**6702.1 Definition.** The following term is defined in Chapter 2:

#### WATER-REACTIVE MATERIAL.

- Class 3.
- Class 2.
- Class 1.

### SECTION 6703 GENERAL REQUIREMENTS

**6703.1 Quantities not exceeding the maximum allowable quantity per control area.** The storage and use of water-reactive solids and liquids in amounts not exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Sections 5001, 5003, 6701 and 6703.

**6703.2 Quantities exceeding the maximum allowable quantity per control area.** The storage and use of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Section 5003.1 shall be in accordance with Chapter 50 and this chapter.

### SECTION 6704 STORAGE

**6704.1 Indoor storage.** Indoor storage of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1), shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

**6704.1.1 Detached storage.** Storage of water-reactive solids and liquids shall be in detached buildings where required by Section 5003.8.2.

**6704.1.2 Liquid-tight floor.** In addition to the provisions of Section 5004.12, floors in storage areas for water-reactive solids and liquids shall be of liquid-tight construction.

**6704.1.3 Waterproof room.** Rooms or areas used for the storage of water-reactive solids and liquids shall be constructed in a manner that resists the penetration of water through the use of waterproof materials. Piping carrying water for other than *approved automatic sprinkler systems* shall not be within such rooms or areas.

**6704.1.4 Watertight containers.** Where Class 3 water-reactive solids and liquids are stored in areas equipped with an *automatic sprinkler system*, the materials shall be stored in closed watertight containers.

**6704.1.5 Storage configuration.** Water-reactive solids and liquids stored in quantities greater than 500 cubic feet (14 m<sup>3</sup>) shall be separated into piles, each not larger than 500 cubic feet (14 m<sup>3</sup>). Aisle widths between piles shall be not less than the height of the pile or 4 feet (1219 mm), whichever is greater.

**Exception:** Water-reactive solids and liquids stored in tanks.

Class 2 water-reactive solids and liquids shall not be stored in *basements* unless such materials are stored in closed watertight containers or tanks.

Class 3 water-reactive solids and liquids shall not be stored in *basements*.

Class 2 or 3 water-reactive solids and liquids shall not be stored with *flammable liquids*.

**6704.1.6 Explosion control.** Indoor storage rooms, areas and buildings containing Class 2 or 3 water-reactive

## WATER-REACTIVE SOLIDS AND LIQUIDS

solids and liquids shall be provided with explosion control in accordance with Section 911.

**6704.2 Outdoor storage.** Outdoor storage of water-reactive solids and liquids in quantities exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5004 and this chapter.

**6704.2.1 General.** Outdoor storage of water-reactive solids and liquids shall be within tanks or closed water-tight containers and shall be in accordance with Sections 6704.2.2 through 6704.2.5.

**6704.2.2 Class 3 distance to exposures.** Outdoor storage of Class 3 water-reactive solids and liquids shall not be within 75 feet (22 860 mm) of buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress*.

**6704.2.3 Class 2 distance to exposures.** Outdoor storage of Class 2 water-reactive solids and liquids shall not be within 20 feet (6096 mm) of buildings, *lot lines*, public streets, public alleys, *public ways* or *means of egress*. A 2-hour *fire barrier* without openings or penetrations, and extending not less than 30 inches (762 mm) above and to the sides of the storage area, is allowed in lieu of such distance. The wall shall either be an independent structure, or the exterior wall of the building adjacent to the storage area.

**6704.2.4 Storage conditions.** Class 3 water-reactive solids and liquids shall be limited to piles not greater than 500 cubic feet (14 m<sup>3</sup>).

Class 2 water-reactive solids and liquids shall be limited to piles not greater than 1,000 cubic feet (28 m<sup>3</sup>).

Aisle widths between piles shall be not less than one-half the height of the pile or 10 feet (3048 mm), whichever is greater.

**6704.2.5 Containment.** Secondary containment shall be provided in accordance with the provisions of Section 5004.2.2.

## SECTION 6705 USE

**6705.1 General.** The use of water-reactive solids and liquids in amounts exceeding the *maximum allowable quantity per control area* indicated in Table 5003.1.1(1) or 5003.1.1(3) shall be in accordance with Sections 5001, 5003, 5005 and this chapter.

# CHAPTERS 68 through 79 RESERVED





## Part VI—Referenced Standards

### CHAPTER 80 REFERENCED STANDARDS

---

#### User note:

**About this chapter:** This code contains numerous references to standards promulgated by other organizations that are used to provide requirements for materials and methods of construction. This chapter contains a comprehensive list of all standards that are referenced in this code. These standards, in essence, are part of this code to the extent of the reference to the standard.

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 102.7.

---

#### AASHTO

American Association of State Highway and Transportation Officials  
444 North Capitol Street, NW, Suite 249  
Washington, DC 20001

**HB-17—2002: Specification for Highway Bridges, 17th Edition 2002**  
503.2.6

---

#### AFSI

Architectural Fabric Structures Institute  
c/o Industrial Fabric Association International  
1801 County Road B West  
Roseville, MN 55113

**ASI—77: Design and Standards Manual**  
3103.10.2

---

#### ANSI

American National Standards Institute  
25 West 43rd Street, 4th Floor  
New York, NY 10036

**ANSI E1.21—2013: Entertainment Technology: Temporary Structures Used for Technical Production of Outdoor Entertainment Events**  
3105.1, 3105.4, 3105.5

---

#### API

American Petroleum Institute  
1220 L Street, NW  
Washington, DC 20005

**Publ 2009—7th Edition (2002, R2012): Safe Welding and Cutting Practices in Refineries, Gas Plants and Petrochemical Plants**  
5706.7

**Publ 2028 3rd Edition—(2002, R2010): Flame Arrestors in Piping Systems**  
5704.2.7.3.2

**Publ 2201 5th Edition—(2003, R2010): Procedures for Welding or Hot Tapping on Equipment in Service**  
5706.7

**RP 651—4th Edition (2014): Cathodic Protection of Aboveground Petroleum Storage Tanks**  
5706.7, 5706.7.1

**RP 752—3rd Edition (2009): Management of Hazards Associated with Location of Process Plant Buildings, CMA Managers Guide**  
5706.7

**RP 1604—3rd Edition (1996 R2010): Closure of Underground Petroleum Storage Tanks**  
5704.2.13

**RP 1615—(1996) 6th Edition (2011): Installation of Underground-petroleum Storage Systems**  
5704.2.13.1.5, 5706.7

## REFERENCED STANDARDS

### API—continued

**RP 2001—9th Edition (2012): Fire Protection in Refineries, 8th Edition**  
5706.7

**RP 2003—8th Edition (2015): Protection Against Ignitions Arising out of Static, Lightning and Stray Currents**  
5706.7

**RP 2023—3rd Edition (2001, R2006): Guide for Safe Storage and Handling of Heated Petroleum-derived Asphalt Products and Crude-oil Residue**  
5706.7, 5706.7.3

**Std 653—5th Edition (2018): Tank Inspection, Repair, Alteration and Reconstruction**  
5706.7

**Std 2000—7th Edition (2014): Venting Atmosphere and Low-pressure Storage Tanks: Nonrefrigerated and Refrigerated**  
5704.2.7.3.2

**Std 2015—8th Edition 2001 (2018): Requirements for Safe Entry and Clearing of Petroleum Storage Tanks**  
5706.7, 5706.7.2

**Std 2350—4th Edition (2012): Overfill Protection for Storage Tanks in Petroleum Facilities, 3rd Edition**  
5704.2.7.5.8, 5706.4.6, 5706.7

---

## ASCE/SEI

American Society of Civil Engineers  
Structural Engineering Institute  
Reston, VA 20191-4400

**ASCE/SEI 24—20: Flood Resistant Design and Construction**  
1203.1.8

---

## ASHRAE

ASHRAE  
1791 Tullie Circle NE  
Atlanta, GA 30329

**15—2019: Safety Standard for Refrigeration Systems**  
608.1.1, 608.18.2

**170—2017: Ventilation of Health Care Facilities**  
1020.6

---

## ASME

American Society of Mechanical Engineers  
Two Park Avenue  
New York, NY 10016-5990

**A13.1—2020: Scheme for the Identification of Piping Systems**  
3509.3, 5003.2.2.1, 5303.4.3, 5503.4.5, 5703.5.2

**A17.1—2019/CSA B44—19: Safety Code for Elevators and Escalators**  
508.1.6, 604.2, 907.3.3, 1009.4.1

**A17.3—2017: Safety Code for Existing Elevators and Escalators**  
1103.3.1, 1103.3.2

**B16.18—2018: Cast Copper-alloy Solder-joint Pressure Fittings**  
909.13.1

**B16.22—2018: Wrought Copper and Copper-alloy Solder-joint Pressure Fittings**  
909.13.1

**B31.1—2020: Power Piping**  
5003.2.2, Table 5703.6.2

**B31.3—2020: Process Piping**  
5003.2.2.2, Table 5703.6.2

**B31.4—2019: Pipeline Transportation Systems for Liquids and Slurries**  
Table 5703.6.2

**B31.9—2020: Building Services Piping**  
Table 5703.6.2, 5703.6.3, 5703.6.11

**BPVC—2019: ASME Boiler and Pressure Vessel Code (Sections I, II, IV, V & VI, VIII)**  
5003.2.1, 5303.2, 5303.3.2, 5503.2.6, 5503.4.3, 5503.7, 5704.2.13.1.5, 5806.3.1, 5806.4.1, 5806.4.8

## ASSP

American Society of Safety Professionals  
520 N. Northwest Highway  
Park Ridge, IL 60068

**ANSI/ASSP Z359.1—2020: The Fall Protection Code**  
1015.6, 1015.7

## ASTM

ASTM International  
100 Barr Harbor Drive, P.O. Box C700  
West Conshohocken, PA 19428-2959

- B42—15a: Specification for Seamless Copper Pipe, Standard Sizes**  
909.13.1
- B43—15: Specification for Seamless Red Brass Pipe, Standard Sizes**  
909.13.1
- B68/B68M—11: Specification for Seamless Copper Tube, Bright Annealed (Metric)**  
909.13.1
- B88—16: Specification for Seamless Copper Water Tube**  
909.13.1
- B251/B251M—2017: Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube**  
909.13.1
- B280—18: Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service**  
909.13.1
- D56—16a: Test Method for Flash Point by Tag Closed Cup Tester**  
202
- D86—17: Test Method for Distillation of Petroleum Products at Atmospheric Pressure**  
202
- D92—2018: Test Method for Flash and Fire Points by Cleveland Open Cup Tester**  
202, 2401.2, 5001.1, 5104.1.1, 5104.1.2, 5701.2
- D93—18: Test Method for Flash Point by Pensky-Martens Closed Up Tester**  
202
- D323—15A: Test Method for Vapor Pressure of Petroleum Products (Reid Method)**  
202
- D2859—16: Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials**  
804.3.3.1, 804.3.3.2
- D3278—96(2011): Test Methods for Flash Point of Liquids by Small Scale Closed-cup Apparatus**  
202
- E84—18b: Standard Test Method for Surface Burning Characteristics of Building Materials**  
202, 803.1, 803.1.2, 803.3, 803.5.2, 803.10, 803.12, 803.13, 804.1.1, 804.1.2, 804.2.4, 3305.9
- E108—17: Standard Test Methods for Fire Tests of Roof Coverings**  
317.2, 317.3
- E648—17a: Standard Test Method for Critical Radiant Flux of Floor-covering Systems Using a Radiant Heat Energy Source**  
804.3.1, 804.3.2, 804.4
- E681—09(2015): Test Method for Concentration Limits of Flammability of Chemicals (Vapors and Gases)**  
202
- E1354—17: Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter**  
304.3.2, 304.3.4, 318.1, 808.1, 808.2, 2310.5.3, 3305.2.3, 3305.9, 3603.4
- E1529—16e1: Standard Test Method for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies**  
5704.2.9.2.3
- E1537—16: Test Method for Fire Testing of Upholstered Furniture**  
805.1.1.2, 805.2.1.2, 805.3.1.2, 805.4.1.2
- E1590—17: Test Method for Fire Testing of Mattresses**  
805.1.2.2, 805.2.2.2, 805.3.2.2.1, 805.4.2.2



## REFERENCED STANDARDS

### ASTM—continued

- E1966—15: Standard Test Method for Fire-resistant Joint Systems**  
202
- E2072—14: Standard Specification for Photoluminescent (Phosphorescent) Safety Markings**  
1025.4
- E2404—17: Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facing and Veneers to Assess Surface Burning Characteristics**  
803.5.1, 803.5.2, 803.12
- E2573—17: Standard Practice for Specimen Preparation and Mounting of Site-fabricated Stretch Systems to Assess Surface Burning Characteristics**  
803.10
- E2579—15: Standard Practice for Specimen Preparation and Mounting of Wood Products to Assess Surface Burning Characteristics**  
803.13
- E3082—17: Standard Test Methods for Determining the Effectiveness of Fire-retardant Treatments for Natural Christmas Trees**  
806.1.4
- F1085—14: Standard Specification for Mattress and Box Springs for Use in Berths in Marine Vessels**  
805.3.2.2.2
- F2006—17: Standard/Safety Specification for Window Fall Prevention Devices for Non-emergency Escape (Egress) and Rescue (Ingress) Windows**  
1015.8
- F2090—17: Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms**  
1015.8, 1015.8.1, 1031.2.1
- F2200—17: Standard Specification for Automated Vehicular Gate Construction**  
503.5, 503.6

## BHMA

Builders Hardware Manufacturers' Association  
355 Lexington Avenue, 15th Floor  
New York, NY 10017

- A156.10—2017: Power-operated Pedestrian Doors**  
1010.3.2
- A156.19—2019: Power Assist and Low-energy Power-operated Doors**  
1010.3.2
- A156.27—2019: Power- and Manual-operated Revolving Pedestrian Doors**  
1010.3.1, 1010.3.1.1
- A156.38—2019: Low-energy Power-operated Sliding and Folding Doors**  
1010.3.2

## CA

State of California Department of Consumer Affairs  
Bureau of Household Goods and Services  
4244 South Market Court, Suite D  
Sacramento, CA 95834-1243

- California Technical Bulletin 129—1992: Flammability Test Procedure for Mattresses for Use in Public Buildings**  
805.1.2.2, 805.2.2.2, 805.3.2.2.1, 805.4.2.2
- California Technical Bulletin 133—1991: Flammability Test Procedure for Seating Furniture for Use in Public Occupancies**  
805.1.1.2, 805.2.1.2, 805.4.1.2

## CGA

Compressed Gas Association  
14501 George Carter Way, Suite 103  
Chantilly, VA 20151

- ANSI/CGA G-13—(2015): Storage and Handling of Silane and Silane Mixtures**  
6404.1, 6404.2, 6405.3
- ANSI/CGA P-18—(2013): Standard for Bulk Inert Gas Systems**  
5501.1

## REFERENCED STANDARDS

### CGA—continued

**C-7—(2014): Guide to Classification and Labeling of Compressed Gases**

5303.4.2, 5503.4.2

**P-1—(2015): Standard for Safe Handling of Compressed Gases in Containers**

5305.7

**S-1.1—(2011): Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases**

5303.3.2, 5503.2

**S-1.2—(2009): Pressure Relief Device Standards—Part 2—Portable Tanks for Compressed Gases**

5303.3.2, 5503.2

**S-1.3—(2008): Pressure Relief Device Standards—Part 3—Stationary Storage Containers for Compressed Gases**

5303.3.2, 5503.2

**V-1—(2013): Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections**

3505.2.1

---

## CGR

Coast Guard Regulations  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

**46 CFR Parts 30, 32, 35 & 39—1999: Shipping**

5706.8

---

## CPSC

Consumer Product Safety Commission  
4330 East-West Highway  
Bethesda, MD 20814

**16 CFR Part 1500—2009: Hazardous Substances and Articles; Administration and Enforcement Regulations**

202, 5601.1.3

**16 CFR Part 1500.41—2009: Method for Testing Primary Irritant Substances**

202

**16 CFR Part 1500.42—2009: Test for Eye Irritants**

202

**16 CFR Part 1500.44—2009: Method for Testing Extremely Flammable and Flammable Solids**

202

**16 CFR Part 1507—2002: Fireworks Devices**

202, 5601.1.3

**16 CFR Part 1630—2007: Standard for the Surface Flammability of Carpets and Rugs**

804.3.3.1, 804.3.3.2

---

## CSA

CSA Group  
8501 East Pleasant Valley Road  
Cleveland, OH 44131

**ANSI Z21.69/CSA 6.16—2015: Connectors for Movable Gas Appliances**

319.5, 606.4

**ANSI Z83.26/CSA 2.37—2014: Gas-fired Outdoor Infrared Patio Heaters**

605.5.2.2.1

**CSA FC1—2012: Stationary Fuel Cell Power Systems**

1206.3

**CSA/ANSI NGV 2—2016: Compressed Natural Gas Vehicle Fuel Containers**

319.9.1.3

**CSA/ANSI NGV 5.1—2016: Residential Fueling Appliances**

2308.2.3

**CSA/ANSI NGV 5.2—2017: Vehicle Fueling Appliances**

2308.2.4

## REFERENCED STANDARDS

### DOC

U.S. Department of Commerce  
1401 Constitution Avenue, NW  
Washington, DC 20230

**16 CFR Part 1632—2015: Standard for the Flammability of Mattress and Mattress Pads (FF 4-72, Amended)**  
805.1.2.1, 805.2.2.1, 805.3.2.1, 805.4.2.1

### DOL

U.S. Department of Labor  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20402-9325

**29 CFR Part 1910.1000—2015: Air Contaminants**  
202, 2104.2.1

**29 CFR Part 1910.1200—2015: Hazard Communication**  
202, 5603.6

### DOTn

U.S. Department of Transportation  
Office of Hazardous Material Safety  
1200 New Jersey Avenue SE  
East Building 2nd Floor  
Washington, DC 20590

**33 CFR Part 154—2015: Facilities Transferring Oil or Hazardous Material in Bulk**  
5706.8

**33 CFR Part 155—2015: Oil or Hazardous Material Pollution Prevention Regulations for Vessels**  
5706.8

**33 CFR Part 156—2015: Oil and Hazardous Material Transfer Operations**  
5706.8

**49 CFR Part 172—2015: Hazardous Materials Tables, Special Provisions, Hazardous Materials Communications, Emergency Response Information and Training Requirements**  
5604.6.5.2

**49 CFR Part 173—2009: Shippers—General Requirements for Shipments and Packagings**  
5104.1.1, 5104.1.2, 5606.3

**49 CFR Part 173.137—2009: Shippers—General Requirements for Shipments and Packagings: Class 8—Assignment of Packing Group**  
202

**49 CFR Part 173.192—2006: Packaging for Certain Toxic Gases in Hazard Zone A**  
Table 5003.8.2

**49 CFR Part 178—2015: Specifications for Packagings**  
3505.4

**49 CFR Parts 100—185—2015: Hazardous Materials Regulations**  
202, 3505.4, 5303.2, 5503.4.3, 5503.7, 5601.1, 5601.1.3, 5601.3, 5706.5.1.15

### DOTy

U.S. Department of Treasury  
c/o Superintendent of Documents  
Washington, DC 20402-9325

**27 CFR Part 555—2015: Commerce in Explosives, as amended through April 1, 1998**  
202, 5604.6.5.2

### EN

European Committee for Standardization (EN)  
Central Secretariat  
Rue de Stassart 36  
B-10 50 Brussels

**European Standard EN 1081—1998: Resilient Floor Coverings—Determination of the Electrical Resistance**  
2309.5.1.1

# FCC

Federal Communications Commission  
Wireless Telecommunications Bureau (WTB)  
445 12th Street SW  
Washington, DC 20554

## 47 CFR Part 90.219—2014: Private Land Mobile Radio Services—Use of Signal Boosters

510.5.5

# FM

FM Approvals  
Headquarters Office  
1151 Boston-Providence Turnpike  
P.O. Box 9102  
Norwood, MA 02062

## 4430—2012: Approval Standard for Heat and Smoke Vents

910.3.1

## ANSI/FM 4996—2019: Approval Standard for Classification of Pallets and Other Material Handling Products as Equivalent to Wood Pallets

315.7.5, 3206.4.1.1

# ICC

International Code Council, Inc.  
500 New Jersey Avenue, NW  
6th Floor  
Washington, DC 20001

## IBC—21: International Building Code®

201.3, 202, 304.1.3, 306.1, 311.1.1, 311.3, 313.1, 317.1, 403.7.3.4, 403.10.4, 404.2.1, 504.1, 508.1, 508.1.2, 510.5.1, 603.1, 604.1, 604.4, 604.5, 604.5.1, 604.5.2, 604.5.3, 604.5.4, 605.2.1.1, 605.3, 605.4.2.6, 605.6.2, 605.8, 701.1, 701.6, 801.1, 803.1, Table 803.3, 803.11.1, 803.11.2, 803.15, 807.2, 807.5.1.2, 808.1, 808.2, 808.5, 901.4, 901.4.1, 901.4.2, 901.4.3, 901.4.4, 903.2, 903.2.5.2, 903.2.9.1, 903.2.10, 903.3.1.1.1, 903.3.1.2, 903.3.1.2.1, 903.3.1.2.3, 903.3.2, 904.14, 907.1.1, 907.2.1, 907.2.6.2, 907.2.6.3.3, 907.2.7, 907.2.13, 907.2.18, 907.2.21, 907.5.2.1, 907.6.6, 909.1, 909.2, 909.3, 909.4.3, 909.5, 909.5.3, 909.5.3.1, 909.5.3.2, 909.6.3, 909.10.5, 909.11.1, 909.18.8, 909.20.2, 909.20.2.1, 909.20.3.1, 909.20.3.2, 909.20.6.1, 909.21.1, 910.4.5, Table 911.1, 911.2, 913.2.1, 914.1, 914.2.1, 914.3.1, 914.3.2, 914.4.1, 914.5.3, Table 914.8.3, 914.8.3.2, 914.10, 915.1.6, 1003.2, 1003.5, Table 1004.5, 1004.6, 1005.7.2, 1006.2.1, Table 1006.2.1, 1008.3.4, 1009.2, 1009.4.1, 1009.4.2, 1009.5, 1009.6.4, 1009.7.2, 1010.1.4, 1010.1.6, 1010.2.2, 1010.2.7, 1010.3.1, 1010.3.3, 1011.7, 1011.10, 1011.11, 1011.12.2, 1012.6.3, 1012.6.4, 1014.1, 1015.2, 1015.2.1, 1016.2, Table 1017.2, 1018.3, 1018.5, 1019.3, 1019.4, 1020.2, Table 1020.2, 1020.2.1, 1021.4, 1023.2, 1023.3.1, 1023.4, 1023.5, 1023.6, 1023.7, 1023.12, 1023.12.1, 1023.12.2, 1024.3, 1024.5, 1024.6, 1024.7, 1024.8, 1026.2, 1026.3, 1026.4.1, 1027.5, 1028.2, 1030.1.1.1, 1030.14.1, 1030.16.4, 1031.5.3, 1101.2, 1101.3, 1103.3.2, 1103.4.1, 1103.4.8, 1103.4.9.1, 1103.4.9.2.1, 1103.4.9.2.2, 1103.4.9.4, 1103.4.9.5, 1103.4.10, 1103.5.4, 1104.5, 1104.17, 1104.17.1, 1104.18, Table 1104.18, 1105.4.1, 1105.4.3.1, 1105.4.3.2, 1105.5.7, 1105.7.2, 1105.7.3, 1105.7.4, 1105.7.5, 1105.7.6, 1105.8, 1203.1, 1203.1.3, 1203.1.8, 1203.2.1, 1203.2.8, 1203.2.9, 1203.2.11, 1203.2.16, 1203.2.19, 1205.1, 1206.6.2, 1207.4.4, 1207.7.4, 1207.9.2, 1207.11.3, 2004.6, 2006.17, 2007.1, 2007.4, 2103.3, 2107.1, 2301.1, 2301.4, 2303.1, 2307.4, 2308.3, 2308.3.1, 2309.3.1.5.1, 2309.3.2, 2310.1, 2311.1, 2311.3.1, 2311.4.1, 2311.8.3, 2404.2, 2404.3.1, 2404.3.3.6, 2404.3.4, 2405.2, 2701.1, 2701.4, 2703.2.2, 2703.3.1, 2703.3.2, 2703.3.4, 2703.3.8, 2703.14, 2703.14.1, 2703.14.2, 2703.15.1, 2704.3.1, 2705.2.3.2, 2705.3.1, 2705.3.2.1, 2705.3.3, 2803.1, 2905.1, 2909.2, 2909.4, 2909.6, 3101.1, 3103.1, 3103.3.1, 3103.8.2, 3103.8.4, 3103.9.1, 3103.9.2, 3103.9.3, 3104.1, 3105.5, 3201.3, 3206.3.2, 3206.9, 3207.2, 3208.1.1, 3208.2, 3315.1, 3403.1, 3704.3, 3704.4, 3704.5, 3801.1, 3801.2, 3804.1, 3804.1.1.1, Table 3805.4, Table 3806.2.1, 3901.1, 3903.1, 3904.1, 5003.2.2.2, 5003.2.8, 5003.8.1, Table 5003.8.2, 5003.8.3, 5003.8.3.1, 5003.8.4.1, 5003.9.9, 5004.13, 5005.2, 5005.3.9, 5101.1, 5303.16.1, 5303.16.2, 5306.1, 5306.2, 5306.2.1, 5306.2.2, 5307.4.6, 5503.1.2, 5503.5.2, 5504.2.1.2, 5504.2.2.2, 5505.4.1, 5604.2, Table 5604.5.2(3), 5605.5, 5701.3, 5704.2.7.7, 5704.2.8.1, 5704.2.8.2, 5704.2.9.3, 5704.2.9.4, 5704.3.3.5, 5704.3.7.1, 5704.3.8, 5705.3.4, 5705.3.5.3, 5705.3.7.1, 5705.3.7.2, 5705.3.7.3, 5705.3.7.4, 5705.3.7.5.1, 5706.2.3, 5706.4.1, 5803.1.1, 5806.4.3, 5808.1, 5808.3, 5808.3.2, 5906.2.2, 5906.2.3, 5906.4.2, 6003.1.4.2, 6005.3.1, 6109.11.2, 6204.1.2, 6306.4, 6404.1.4, 6604.1



## REFERENCED STANDARDS

### ICC—continued

#### ICC 300—17: Standard on Bleachers, Folding and Telescopic Seating and Grandstands

1030.1.1, 1030.17

#### ICC 500—20: ICC/NSSA Standard on the Design and Construction of Storm Shelters

1031.2

#### ICC A117.1—17: Accessible and Usable Buildings and Facilities

907.5.2.3.3, 1009.8.2, 1009.9, 1009.11, 1010.2.13.1, 1012.1, 1012.6.5, 1012.10, 1013.4, 1023.11

#### IEBC—21: International Existing Building Code®

102.3, 1011.5.2, 1103.1, 1104.18, 1105.5.2

#### IFGC—21: International Fuel Gas Code®

201.3, 605.1, 605.2.1.3, 605.3, 605.6.2, 605.8, 610.1.1, 1206.9, 2301.1, 2301.6, 2308.1, 2309.3.1.2, 2309.3.1.5, 2504.5, 3001.1, 3003.1, 3004.1, 3004.2, 3107.12.1, 3107.12.2, 3107.13.1, 3304.3, 3307.2.1, Table 5003.1.1(1), 5301.1, 5801.1, 5803.1.4, 6103.1, 6103.2.1.7, 6103.3

#### IMC—21: International Mechanical Code®

201.3, 308.3, 605.1, 605.2.1.1, 605.2.1.2, 605.2.1.3, 605.2.1.4, 605.2.1.5, 605.3, 605.4, 605.4.2.3, 605.4.2.5, 605.6.2, 605.8, 606.1, 606.2, 608.1, 608.3, 608.4, 608.5, 608.8, 608.9.1, 608.10, 608.17, 610.1.1, 903.2.11.4, 904.13, 907.3.1, 909.1, 909.10.2, 909.13.1, 910.4.7, 915.6.1, 1006.2.2.3, 1011.16, 1020.6.1, 1207.4.7, 1207.6.1, 1207.6.1.2.2, 1207.11.7, 2104.2.1, 2105.3, 2301.1, 2301.6, 2309.3.1.2, 2311.3.1, 2311.4.3, 2311.8.2, 2311.8.8, 2311.8.10, 2404.7, 2404.7.2, 2504.5, 2703.2.2, 2703.10.4, 2703.14, 2803.2, 2803.3, 3001.1, 3003.1, 3004.2, 3107.12.1, 3107.12.2, 3703.5, 3804.1.1.7, 3904.1, Table 5003.1.1(1), 5003.8.4.2, 5003.8.5.2, 5003.8.6.2, 5004.3.1, 5303.7.6, 5303.16.9, 5305.5, 5306.2.2, 5306.2.3, 5307.4.4, 5504.2.1.3, 5504.2.2.3, 5505.4.1.1, 5701.3, 5703.6.1, 5704.2.8.9, 5705.3.7.5.1, 5706.2, 5706.4.4, 6003.1.3, 6003.2.3.2, 6004.2.2.7, 6005.3.1, 6005.3.2, 6103.2.1.7

#### IPC—21: International Plumbing Code®

201.3, 903.3.5, 904.11.1.3, 912.6, 2311.2.3, 5004.2.2.6

#### IPMC—21: International Property Maintenance Code®

311.1.1

#### IRC—21: International Residential Code®

102.5, 202, 913.1, 1001.1, 1205.1, 1205.2.1

#### IWUIC—21: International Wildland-Urban Interface Code®

304.1.2

## IIAR

International Institute of Ammonia Refrigeration  
1001 N. Fairfax Street, Suite 503  
Alexandria, VA 22314

#### ANSI/IIAR 2—2014, including Addendum A: Safe Design of Closed-circuit Ammonia Refrigeration Systems

608.1.2, 608.9

#### ANSI/IIAR 6—2019: Standard for Inspection, Testing, and Maintenance of Closed-circuit Ammonia Refrigeration Systems

608.1.2

#### ANSI/IIAR 7—2019: Developing Operating Procedures for Closed-circuit Ammonia Refrigeration Systems

608.1.2

#### ANSI/IIAR 8—2020: Decommissioning of Closed-circuit Ammonia Refrigeration Systems

608.1.2

#### ANSI/IIAR 9—2020: Standard for Minimum System Safety Requirements for Existing Closed-circuit Ammonia Refrigeration Systems

608.1.2

## IKECA

International Kitchen Exhaust Cleaning Association  
100 North 20th Street, Suite 400  
Philadelphia, PA 19103

#### ANSI/IKECA C10—2016: Standard for the Methodology for Cleaning Commercial Kitchen Exhaust Systems

606.3.3.2

---

# ISO

International Organization for Standardization (ISO)  
ISO Central Secretariat 1 ch, de la Voie-Creuse, Case postale 56  
CH-1211 Geneva 20, Switzerland

**ISO 8115—86: Cotton Bales—Dimensions and Density**  
Table 2704.2.2.1, Table 5003.1.1(1)

---

# NEMA

National Electrical Manufacturer's Association  
1300 North 17th Street Suite 900  
Arlington, VA 22209

**250—2018: Enclosures for Electrical Equipment (1,000 Volt Maximum)**  
6005.2

---

# NFPA

National Fire Protection Association  
1 Batterymarch Park  
Quincy, MA 02169-7471

- 02—20: Hydrogen Technologies Code**  
1206.3, 1206.4, 2309.1, 2309.3.1.1, 2309.3.1.2, 2309.4, 2309.6, 2311.8, 2311.8.2, 2311.8.10, 2311.8.11, 5301.1, 5801.1
- 04—21: Standard for Integrated Fire Protection and Life Safety System Testing**  
901.6.2.1, 901.6.2.2
- 10—18: Standard for Portable Fire Extinguishers**  
Table 901.6.1, 906.2, Table 906.3(1), Table 906.3(2), 906.3.2, 906.3.4, 3006.3
- 11—16: Standard for Low-, Medium-, and High-expansion Foam**  
904.7, 5704.2.9.2.2
- 12—18: Standard on Carbon Dioxide Extinguishing Systems**  
Table 901.6.1, 904.8, 904.13, 1207.5.5
- 12A—18: Standard on Halon 1301 Fire Extinguishing Systems**  
Table 901.6.1, 904.9
- 13—19: Standard for the Installation of Sprinkler Systems**  
903.3.1.1, 903.3.2, 903.3.8.2, 903.3.8.5, 904.13, 905.3.4, 907.6.4, 914.3.2, 1019.3, 1019.3, 1103.4.8, 3201.1, 3204.2, 3205.5, Table 3206.2, 3206.4.1, 3206.10, 3207.2, 3207.2.1, 3208.2.2, 3208.2.2.1, 3208.4, 3210.1, 3401.1, 5104.1, 5104.1.1, 5106.5.7, 5704.3.3.9, Table 5704.3.6.3(7), 5704.3.7.5.1, 5704.3.8.4
- 13D—19: Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes**  
903.3.1.3
- 13R—19: Standard for the Installation of Sprinkler Systems in Low-rise Residential Occupancies**  
903.3.1.2, 903.3.5.2, 903.4
- 14—19: Standard for the Installation of Standpipe and Hose Systems**  
905.2, 905.3.4, 905.4.2, 905.6.2, 905.8
- 15—17: Standard for Water Spray Fixed Systems for Fire Protection**  
1207.5.5, 5704.2.9.2.3
- 16—19: Standard for the Installation of Foam-water Sprinkler and Foam-water Spray Systems**  
904.7, 904.13
- 17—21: Standard for Dry Chemical Extinguishing Systems**  
Table 901.6.1, 904.6, 904.13
- 17A—21: Standard for Wet Chemical Extinguishing Systems**  
Table 901.6.1, 904.5, 904.13
- 20—19: Standard for the Installation of Stationary Pumps for Fire Protection**  
913.1, 913.2, 913.5.1
- 22—18: Standard for Water Tanks for Private Fire Protection**  
507.2.2
- 24—19: Standard for Installation of Private Fire Service Mains and Their Appurtenances**  
507.2.1, 2809.5

## REFERENCED STANDARDS

### NFPA—continued

#### 25—20: Standard for the Inspection, Testing and Maintenance of Water-based Fire Protection Systems

507.5.3, Table 901.6.1, 901.7, 904.7.1, 912.7, 913.5

#### 30—21: Flammable and Combustible Liquids Code

607.1, 5001.1, 5701.2, 5703.6.2, 5703.6.2.1, 5704.2.7, 5704.2.7.1, 5704.2.7.2, 5704.2.7.3.2, 5704.2.7.4, 5704.2.7.6, 5704.2.7.7, 5704.2.7.8, 5704.2.7.9, 5704.2.9.3, 5704.2.9.4, 5704.2.9.6.1.1, 5704.2.9.6.1.2, 5704.2.9.6.1.3, 5704.2.9.6.1.4, 5704.2.9.6.1.5, 5704.2.9.6.2, 5704.2.9.7.3, 5704.2.10.2, 5704.2.11.3, 5704.2.11.4.2, 5704.2.12.1, 5704.3.1, 5704.3.6, Table 5704.3.6.3(1), Table 5704.3.6.3(2), Table 5704.3.6.3(3), 5704.3.7.2.3, 5704.3.8.4, 5706.8.3

#### 30A—21: Code for Motor Fuel-dispensing Facilities and Repair Garages

2301.4, 2301.5, 2301.6, 2306.6.3, 2310.1

#### 30B—19: Code for the Manufacture and Storage of Aerosol Products

5101.1, 5103.1, 5104.1, Table 5104.3.1, Table 5104.3.2, Table 5104.3.2.2, 5104.3.3, 5104.4.1, 5104.5.2, 5104.6, 5104.8.2, 5106.2.2, 5106.2.4, 5106.3.2, Table 5106.4, 5106.5.1, 5106.5.6, 5107.1

#### 31—20: Standard for the Installation of Oil-burning Equipment

605.1.6, 605.4.1, 605.4.3

#### 32—16: Standard for Dry Cleaning Facilities

2107.1, 2107.3

#### 33—18: Standard for Spray Application Using Flammable or Combustible Materials

2403.3.3

#### 34—18: Standard for Dipping, Coating and Printing Processes Using Flammable or Combustible Liquids

2405.3, 2405.4.1.1

#### 35—16: Standard for the Manufacture of Organic Coatings

2901.3, 2905.4

#### 40—19: Standard for the Storage and Handling of Cellulose Nitrate Film

306.2

#### 45—19: Standard on Fire Protection for Laboratories Using Chemicals (2015 Edition)

3803.1.5, 3804.1.1.7, 3805.2.1, 3805.2.2

#### 51—18: Design and Installation of Oxygen-fuel Gas Systems for Welding, Cutting and Allied Processes

3501.5, 3507.1, 3509.1

#### 52—19: Vehicular Gaseous Fuel System Code

319.9.2, 5301.1

#### 55—20: Compressed Gases and Cryogenic Fluids Code

3508.1, 5301.1, 5307.4.2, 5501.1, 5801.1, 6301.1

#### 56—20: Standard for Fire and Explosion Prevention during Cleaning and Purging of Flammable Gas Piping Systems

3307.2.1

#### 58—20: Liquefied Petroleum Gas Code

319.8.3, 2311.5, 3903.6, 6101.1, 6103.1, 6103.2.1, 6103.2.1.2, 6103.2.1.7, 6103.2.2, 6104.1, 6104.3.2, 6104.4, 6105.2, 6106.2, 6106.3, 6107.2, 6107.4, 6108.1, 6108.2, 6109.11.2, 6111.3

#### 59A—19: Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)

5301.1, 5501.1

#### 61—20: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities

Table 2205.1

#### 68—13: Standard on Explosion Protection by Deflagration Venting

911.1, 911.4, Table 2205.1

#### 69—19: Standard on Explosion Prevention Systems

911.1, 911.3, Table 2205.1

**NFPA—continued****70—20: National Electrical Code**

309.2, 603.1, 603.1.1, 603.2.1, 603.4, 603.4.1, 603.5, 603.8, 605.1.2, 605.1.6, 605.6.2, 607.6, 607.7, 608.17, 608.18, 904.3.1, 907.6.1, 909.12.2, 909.16.3, 910.4.6, 1006.2.2.4, 1010.2.9.2, 1201.2, 1203.1.3, 1205.1, 1206.4, 1206.14, 1207.4.1, 1207.4.2, 1207.4.8, 1207.5.3, 1207.10.6, 1207.10.7.4, 1207.11.5, 1207.11.10, 2006.3.4, 2104.2.3, 2108.2, 2203.4.1, 2203.5, Table 2205.1, 2301.5, 2305.4, 2308.8.1.2.4, 2309.2.3, 2311.3.1, 2311.8.10, 2403.2.1, 2403.2.1.1, 2403.2.1.4, 2403.2.5, 2404.6.1.2.2, 2404.9.4, 2504.5, 2603.2.1, 2703.7.1, 2703.7.2, 2703.7.3, 2803.4, 2904.1, 3103.12.6.1, 3106.6, 3107.12.7, 3305.7, 3506.4, 4003.3.3, 4003.4, 5003.8.7.1, 5003.9.4, 5303.7.6, 5303.8, 5303.16.11, 5303.16.14, 5503.6, 5503.6.2, 5703.1, Table 5703.1.1, 5703.1.3, 5704.2.8.12, 5704.2.8.17, 5706.2.8, 5803.1.5, 5803.1.5.1, 5807.1.10, 5906.5.5, 5906.5.6, 6109.15.1

**72—19: National Fire Alarm and Signaling Code**

508.1.6, Table 901.6.1, 903.4.1, 904.3.5, 907.1.2, 907.2, 907.2.6, 907.2.9.3, 907.2.11, 907.2.13.2, 907.3, 907.3.3, 907.3.4, 907.5.2.1.2, 907.5.2.1.3, 907.5.2.1.3.2, 907.5.2.2, 907.5.2.2.5, 907.6, 907.6.1, 907.6.2, 907.6.6, 907.7, 907.7.1, 907.7.2, 907.8, 907.8.2, 907.8.4, 917.1, 1103.3.2, 1203.2.4, 1207.5.4, 1207.6.1.2.3, 1207.6.1.2.4, Table 1207.7, 2810.11

**76—16: Standard for the Fire Protection of Telecommunications Facilities**

1207.1.2.1, 1207.2.1, 1207.3.1, 1207.3.7.1, 1207.4.1, 1207.5.1, 1207.5.2, 1207.5.3, 1207.5.5, Table 1207.6, 1207.6.2.3, Table 1207.7

**77—14: Recommended Practice on Static Electricity**

Table 2205.1

**80—19: Standard for Fire Doors and Other Opening Protectives**

705.2, 706.1, 1010.3.3, 1032.2.2

**85—19: Boiler and Combustion System Hazards Code**

Table 2205.1

**86—19: Standard for Ovens and Furnaces**

3001.1

**92—18: Standard for Smoke Control Systems**

909.7, 909.8

**96—21: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations**

606.2, 904.13

**99—21: Health Care Facilities Code**

603.1.2, 603.5.1.1, 609.1, 1105.11.1, 1105.11.2, 1203.4.1, 1203.5.1, 5003.7.4, 5306.4, 5306.5

**101—21: Life Safety Code**

1030.6.2

**105—19: Standard for Smoke Door Assemblies and Other Opening Protectives**

705.2, 706.1, 909.20.4.1

**110—19: Standard for Emergency and Standby Power Systems**

913.5.2, 913.5.3, 1203.1.3, 1203.4, 1203.5

**111—19: Standard on Stored Electrical Energy Emergency and Standby Power Systems**

1203.1.3, 1203.4, 1203.5

**120—20: Standard for Fire Prevention and Control in Coal Mines**

Table 2205.1

**160—21: Standard for the Use of Flame Effects Before an Audience**

308.3.2

**170—18: Standard for Fire Safety and Emergency Symbols**

1025.2.6.1

**204—18: Standard for Smoke and Heat Venting**

Table 901.6.1, 910.5.1, 910.5.2

**232—17: Standard for the Protection of Records**

3210.1.1

**241—19: Standard for Safeguarding Construction, Alteration and Demolition Operations**

3301.1, 3303.2

**253—19: Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source**

804.3.1, 804.3.2, 804.4



## REFERENCED STANDARDS

### NFPA—continued

- 260—19: Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture**  
805.1.1.1, 805.2.1.1, 805.3.1.1, 805.4.1.1
- 261—18: Standard Method of Test for Determining Resistance of Mock-up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes**  
805.1.1.1, 805.2.1.1, 805.3.1.1, 805.4.1.1
- 265—19: Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile Wall Coverings in Full Height Panels and Walls**  
803.5.1, 803.5.1.1
- 286—19: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth**  
803.1, 803.1.1, 803.1.1.1, 803.3, 803.12, 803.13, 804.1.1, 804.2.4
- 289—19: Standard Method of Fire Test for Individual Fuel Packages**  
807.3, 807.4.1, 807.5.1.1, 808.3
- 303—21: Fire Protection Standard for Marinas and Boatyards**  
3603.5, 3603.6, 3604.2
- 318—18: Standard for the Protection of Semiconductor Fabrication Facilities**  
2703.16
- 326—20: Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning or Repair**  
3510.1
- 385—17: Standard for Tank Vehicles for Flammable and Combustible Liquids**  
5706.5.4.5, 5706.6, 5706.6.1, 5707.2
- 400—19: Hazardous Materials Code**  
5601.1.5, Table 6303.1.4, 6304.1.2, Table 6304.1.5(1), Table 6304.1.5(2)
- 407—17: Standard for Aircraft Fuel Servicing**  
2006.2, 2006.3
- 409—16: Standard for Aircraft Hangars**  
914.8.3, Table 914.8.3, 914.8.3.1, 914.8.6
- 410—20: Standard on Aircraft Maintenance**  
2004.7
- 484—19: Standard for Combustible Metals**  
320.3.4, 320.3.6, Table 2205.1
- 495—18: Explosive Materials Code**  
202, 911.1, 911.5, 5601.1.1, 5601.1.5, 5604.2, 5604.6.2, 5604.6.3, 5604.7.1, 5605.1, 5605.2.3, 5606.1, 5606.5.2.1, 5607.1, 5607.9, 5607.11, 5607.15
- 498—18: Standard for Safe Havens and Interchange Lots for Vehicles Transporting Explosives**  
5601.1.2
- 505—18: Fire Safety Standard for Powered Industrial Trucks, Including Type Designations, Areas of Use, Maintenance and Operation**  
309.2, 4003.3.3
- 652—19: The Fundamentals of Combustible Dust**  
320.3.5, 2203.4.8, 2203.5, 2204.1, 2204.2, 2205.1.1
- 654—20: Standard for Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids**  
320.3.5, 2203.1, 2203.5, Table 2205.1
- 655—17: Standard for the Prevention of Sulfur Fires and Explosions**  
Table 2205.1
- 664—20: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities**  
2203.1, 2203.5, Table 2205.1, 2805.3
- 701—19: Standard Methods of Fire Tests for Flame-propagation of Textiles and Films**  
807.3, 807.4.1, 807.5.1.2, 2603.5, 3104.2
- 703—21: Standard for Fire Retardant-treated Wood and Fire-retardant Coatings for Building Materials**  
803.4
- 704—17: Standard System for Identification of the Hazards of Materials for Emergency Response**  
202, 608.8, 5003.2.2.2, 5003.5, 5003.10.2, 5005.1.10, 5005.1.12, 5005.2.1.1, 5005.4.4, 5503.4.1, 5704.2.3.2

## REFERENCED STANDARDS

## NFPA—continued

- 720—15: Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment**  
915.5.1, 915.5.2, 915.6
- 750—19: Standard on Water Mist Fire Protection Systems**  
202, Table 901.6.1, 904.11.1.1, 904.13, 1207.5.5
- 780—17: Standard for the Installation of Lightning Protection Systems**  
4003.4
- 853—20: Installation of Stationary Fuel Cell Power Systems**  
1206.3, 1206.4, 1206.6.2, 1206.11, 1206.12
- 914—19: Code for Fire Protection of Historic Structures**  
1103.1.1
- 1122—18: Code for Model Rocketry**  
5601.1.4
- 1123—18: Code for Fireworks Display**  
202, 5604.2, 5608.1, 5608.2.2, 5608.5, 5608.6
- 1124—06: Code for the Manufacture, Transportation, Storage and Retail Sales of Fireworks and Pyrotechnic Articles**  
5601.1.3
- 1124—17: Code for the Manufacture, Transportation, and Storage of Fireworks and Pyrotechnic Articles**  
202, 5604.2, 5605.1, 5605.3, 5605.4, 5605.5, 5609.1
- 1125—17: Code for the Manufacture of Model Rocket and High-power Rocket Motors**  
5601.1.4
- 1126—21: Standard for the Use of Pyrotechnics Before a Proximate Audience**  
5604.2, 5605.1, 5608.1, 5608.2.2, 5608.4, 5608.5
- 1127—18: Code for High-power Rocketry**  
5601.1.4
- 1142—17: Standard on Water Supplies for Suburban and Rural Fire Fighting**  
B103.3
- 1221—19: Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems**  
510.4.2, 510.5
- 2001—18: Standard on Clean Agent Fire Extinguishing Systems**  
Table 901.6.1, 904.10, 1207.5.5
- 2010—20: Standard for Fixed Aerosol Fire-extinguishing Systems**  
Table 901.6.1, 904.12, 1207.5.5

---

**UL**

Underwriters Laboratories LLC  
333 Pfingsten Road  
Northbrook, IL 60062

- 10C—2016: Positive Pressure Fire Tests of Door Assemblies**  
1010.2.9.3
- 30—1995: Metal Safety Cans—with revisions through June 2014**  
5003.9.10, 5005.1.10, 5705.2.4, 5707.2
- 58—2018: Steel Underground Tanks for Flammable and Combustible Liquids**  
5704.2.13.1.5
- 80—2007: Steel Tanks for Oil-burner Fuels and Other Combustible Liquids—with revisions through January 2014**  
319.7.1, 605.4.2.1, 605.4.2.2, 607.2
- 87A—2015: Power-operated Dispensing Devices for Gasoline and Gasoline/Ethanol Blends with Nominal Ethanol Concentrations up to 85 Percent—with revisions through June 2017**  
2306.8.1
- 142—2006: Steel Aboveground Tanks for Flammable and Combustible Liquids—with revisions through August 2014**  
319.7.1, 605.4.1.1, 605.4.2.1, 605.4.2.2, 607.2, 2306.2.3
- 199E—2004: Outline of Investigation for Fire Testing of Sprinklers and Water Spray Nozzles for Protection of Deep Fat Fryers**  
904.13.4.1

## REFERENCED STANDARDS

### UL—continued

- 217—2015: Single and Multiple Station Smoke Alarms—with revisions through November 2016**  
907.2.11, 915.4.4
- 268—2016: Smoke Detectors for Fire Alarm Systems—with revisions through July 2016**  
907.2.6.2, 907.2.11.7, 915.5.3
- 294—2018: Access Control System Units—with revisions through October 2018**  
1010.2.11, 1010.2.12, 1010.2.13.1, 1010.2.14
- 300—2005: Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment—with revisions through December 2014**  
904.13
- 300A—2006: Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces**  
904.14.1.1
- 305—2012: Panic Hardware—with revisions through March 2017**  
1010.2.9.3
- 325—2017: Standard for Door, Drapery, Gate, Louver and Window Operators and Systems**  
503.5, 503.6
- 498A—2008: Current Taps and Adaptors—with revisions through June 2016**  
603.5.1
- 499—2014: Standard for Electrical Heating Appliances—with revisions through February 2017**  
607.6
- 647—1993: Standard for Unvented Kerosene-fired Room Heaters and Portable Heaters—with revisions through April 2010**  
605.5
- 710—2012: Exhaust Hoods for Commercial Cooking Equipment—with revisions through June 2018**  
606.2
- 710B—2011: Recirculating Systems—with revisions through August 2014**  
606.2, 904.13
- 723—2018: Standard for Test for Surface Burning Characteristics of Building Materials**  
202, 803.1, 803.1.2, 803.3, 803.5.2, 803.10, 803.12, 803.13, 804.1.1, 804.1.2, 804.2.4, 3305.9
- 790—2004: Standard Test Methods for Fire Tests of Roof Coverings—with revisions through October 2018**  
317.2, 317.3, 1207.9.5
- 791—2006: Standard for Residential Incinerators—with revisions through November 2014**  
605.8.1
- 793—2008: Automatically Operated Roof Vents for Smoke and Heat—with revisions through March 2017**  
910.3.1
- 817—2015: Standard for Cord Sets and Power-supply Cords—with revisions through August 2018**  
603.6
- 864—2014: Control Units and Accessories for Fire Alarm Systems—with revisions through March 2018**  
909.12
- 900—2015: Air Filter Units**  
2404.7.8
- 924—2016: Standard for Safety Emergency Lighting and Power Equipment—with revisions through May 2018**  
1013.5, 3103.12.6.1
- 971A—2006: Outline of Investigation for Metallic Underground Fuel Pipe**  
Table 5703.6.2
- 1037—2016: Antitheft Alarms and Devices—with revisions through September 2017**  
506.1
- 1046—2010: Grease Filters for Exhaust Ducts—with revisions through April 2017**  
606.3.1
- 1275—2014: Flammable Liquid Storage Cabinets—with revisions through February 2018**  
5003.8.7.1, 5704.3.2.1.1
- 1313—2015: Nonmetallic Safety Cans for Petroleum Products**  
5003.9.10

## UL—continued

- 1315—2017: Safety for Metal Waste Paper Containers**  
808.1, 808.2
- 1316—1994: Glass Fiber Reinforced Plastic Underground Storage Tanks for Petroleum Products, Alcohols and Alcohol-gasoline Mixtures—with revisions through May 2006**  
5704.2.13.1.5
- 1363—2018: Relocatable Power Taps**  
603.5.1
- 1363A—2014: Outline of Investigation for Special Purpose Relocatable Power Taps**  
603.5.1.1
- 1369—2018: Aboveground Piping Requirements**  
Table 5703.6.2
- 1389—2019: Plant Oil Extraction Equipment for Installation and Use in Ordinary (Unclassified) Locations and Hazardous (Classified) Locations**  
3904.2.1
- 1489—2016: Fire Resistant Pipe Protection Systems Carrying Combustible Liquids**  
1203.1.2
- 1741—2010: Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources—with revisions through February 2018**  
1207.3.3, 1207.11.5
- 1805—2002: Laboratory Hoods and Cabinets—with revisions through June 2006**  
3805.2.2
- 1973—2018: Batteries for Use in Stationary, Vehicle Auxilliary Power and Light Electric Rail (LER) Applications and Stationary Applications**  
Table 1207.6
- 1974—2017: Standard for Evaluation for Repurposing Batteries**  
1207.3.9
- 1975—2006: Fire Tests for Foamed Plastics Used for Decorative Purpose**  
807.5.1.1, 808.3
- 1994—2015: Standard for Luminous Egress Path Marking Systems**  
1008.2.1, 1025.2.1, 1025.2.3, 1025.2.4, 1025.2.5, 1025.4
- 2011—2019: Outline for Machinery**  
320.2.1, 320.3.2
- 2017—2008: General-purpose Signaling Devices and Systems—with revisions through January 2016**  
3905.1.2
- 2034—2017: Single and Multiple Station Carbon Monoxide Alarms—with revisions through September 2018**  
915.4.2, 915.4.4
- 2075—2013: Standard for Gas and Vapor Detectors and Sensors—with revisions through December 2017**  
915.5.1, 915.5.3
- 2079—2015: Tests for Fire Resistance of Building Joint Systems**  
202
- 2085—1997: Protected Aboveground Tanks for Flammable and Combustible Liquids—with revisions through September 2010**  
202, 605.4.1.1, 605.4.2.1, 605.4.2.2, 2306.2.2, 2306.2.3, 5704.2.7.4, 5704.2.9.2.3, 5704.2.9.7.4, 5705.3.8.2
- 2152—2016: Outline of Investigation for Special Purpose Nonmetallic Containers and Tanks for Specific Combustible or Noncombustible Liquids**  
607.3
- 2196—2017: Standard for Fire Test for Circuit Integrity of Fire-resistive Power, Instrumentation, Control and Data Cables**  
913.2.2, 1203.3
- 2200—2012: Stationary Engine Generator Assemblies—with revisions through October 2015**  
1203.1.1
- 2201—2018: Standard for Carbon Monoxide (CO) Emission Rate of Portable Generators**  
1204.2



REFERENCED STANDARDS

- UL—continued
- 2208—2010: Solvent Distillation Units—with revisions through September 2015

5705.4.1
- 2245—2006: Below-grade Vaults for Flammable Liquid Storage Tanks

5704.2.8.1
- 2335—2010: Fire Tests of Storage Pallets—with revisions through August 2017

315.7.5, 3206.4.1.1
- 2360—2000: Test Methods for Determining the Combustibility Characteristics of Plastics Used in Semi-conductor Tool Construction—with revisions through October 2017

2703.10.1.2
- 2524—2019: Standard for In-building 2-way Emergency Radio Communication Enhancement Systems

510.4
- 9540—2016: Standard for Energy Storage Systems and Equipment

1207.3.1, 1207.3.2, 1207.3.7, 1207.10.6, 1207.10.7.4, 1207.11.1, 1207.11.5
- 9540A—2017: Standard for Safety Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

1207.1.5 , 1207.6.3
- 60601-1—2003: Medical Electrical Equipment, Part I: General Requirements for Safety

603.5.1.1
- 60950-1—2014: Information Technology Equipment—Safety Requirements

320.2.1
- 62368-1—2014: Audio/video, Information and Communication Technology Equipment—Safety Requirements

320.2.1

USC	
	United States Code c/o Superintendent of Documents U.S. Government Printing Office Washington, DC 20402-9325
18 USC Part 1, Chapter 40: Importation, Manufacture, Distribution and Storage of Explosive Materials	
	202
21 USC Chapter 9: United States Food, Drug and Cosmetic Act	
	202

## ***Part VII—Appendices***

### **APPENDIX A BOARD OF APPEALS**

*Deleted in its entirety.*





## APPENDIX B

# FIRE-FLOW REQUIREMENTS FOR BUILDINGS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix B provides a tool for the use of jurisdictions in establishing a policy for determining fire-flow requirements in accordance with Section 507.3. The determination of required fire flow is not an exact science, but having some level of information provides a consistent way of choosing the appropriate fire flow for buildings throughout a jurisdiction. The primary tool used in this appendix is a table that presents fire flow based on construction type and building area based on the correlation of the Insurance Services Office (ISO) method and the construction types used in the International Building Code®.

### SECTION B101 GENERAL

**B101.1 Scope.** The procedure for determining fire-flow requirements for buildings or portions of buildings hereafter constructed shall be in accordance with this appendix. This appendix does not apply to structures other than buildings.

### SECTION B102 DEFINITIONS

**B102.1 Definitions.** For the purpose of this appendix, certain terms are defined as follows:

**FIRE FLOW.** The flow rate of a water supply, measured at 20 pounds per square inch (psi) (138 kPa) residual pressure, that is available for fire fighting.

**FIRE-FLOW CALCULATION AREA.** The floor area, in square feet (m<sup>2</sup>), used to determine the required fire flow.

### SECTION B103 MODIFICATIONS

**B103.1 Decreases.** The *fire code official* is authorized to reduce the *fire-flow* requirements for isolated buildings or a group of buildings in rural areas or small communities where the development of full *fire-flow* requirements is impractical.

**B103.2 Increases.** The *fire code official* is authorized to increase the *fire-flow* requirements where conditions indicate an unusual susceptibility to group fires or conflagrations. An increase shall be not more than twice that required for the building under consideration.

**B103.3 Areas without water supply systems.** For information regarding water supplies for fire-fighting purposes in rural and suburban areas in which adequate and reliable water supply systems do not exist, the *fire code official* is authorized to utilize NFPA 1142 or the *International Wild-land-Urban Interface Code*.

### SECTION B104 FIRE-FLOW CALCULATION AREA

**B104.1 General.** The *fire-flow calculation area* shall be the total floor area of all floor levels within the *exterior walls*, and under the horizontal projections of the roof of a building, except as modified in Section B104.3.

**B104.2 Area separation.** Portions of buildings that are separated by *fire walls* without openings, constructed in accordance with the *International Building Code*, are allowed to be considered as separate *fire-flow calculation areas*.

**B104.3 Type IA and Type IB construction.** The *fire-flow calculation area* of buildings constructed of Type IA and Type IB construction shall be the area of the three largest successive floors.

**Exception:** *Fire-flow calculation area* for open parking garages shall be determined by the area of the largest floor.

### SECTION B105 FIRE-FLOW REQUIREMENTS FOR BUILDINGS

**B105.1 One- and two-family dwellings, Group R-3 and R-4 buildings and townhouses.** The minimum *fire-flow* and flow duration requirements for one- and two-family *dwellings*, Group R-3 and R-4 buildings and *townhouses* shall be as specified in Tables B105.1(1) and B105.1(2).

**B105.2 Buildings other than one- and two-family dwellings, Group R-3 and R-4 buildings and townhouses.** The minimum *fire-flow* and flow duration for buildings other than one- and two-family *dwellings*, Group R-3 and R-4 buildings and *townhouses* shall be as specified in Tables B105.1(2) and B105.2.

**B105.3 Water supply for buildings equipped with an automatic sprinkler system.** For buildings equipped with an *approved automatic sprinkler system*, the water supply shall be capable of providing the greater of:

1. The *automatic sprinkler system* demand, including hose stream allowance.
2. The required *fire flow*.



# APPENDIX B—FIRE-FLOW REQUIREMENTS FOR BUILDINGS

**TABLE B105.1(1)**  
**REQUIRED FIRE FLOW FOR ONE- AND TWO-FAMILY DWELLINGS, GROUP R-3 AND R-4 BUILDINGS AND TOWNHOUSES**

FIRE-FLOW CALCULATION AREA (square feet)	AUTOMATIC SPRINKLER SYSTEM (Design Standard)	MINIMUM FIRE FLOW (gallons per minute)	FLOW DURATION (hours)
0–3,600	No automatic sprinkler system	1,000	1
3,601 and greater	No automatic sprinkler system	Value in Table B105.1(2)	Duration in Table B105.1(2) at the required fire-flow rate
0–3,600	Section 903.3.1.3 of the <i>International Fire Code</i> or Section P2904 of the <i>International Residential Code</i>	500	$\frac{1}{2}$
3,601 and greater	Section 903.3.1.3 of the <i>International Fire Code</i> or Section P2904 of the <i>International Residential Code</i>	$\frac{1}{2}$ value in Table B105.1(2)	1

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m.

**TABLE B105.1(2)**  
**REFERENCE TABLE FOR TABLES B105.1(1) AND B105.2**

FIRE-FLOW CALCULATION AREA (square feet)					FIRE FLOW (gallons per minute) <sup>b</sup>	FLOW DURATION (hours)
Type IA and IB <sup>a</sup>	Type IIA and IIIA <sup>a</sup>	Type IV and V-A <sup>a</sup>	Type IIB and IIIB <sup>a</sup>	Type V-B <sup>a</sup>		
0–22,700	0–12,700	0–8,200	0–5,900	0–3,600	1,500	2
22,701–30,200	12,701–17,000	8,201–10,900	5,901–7,900	3,601–4,800	1,750	
30,201–38,700	17,001–21,800	10,901–12,900	7,901–9,800	4,801–6,200	2,000	
38,701–48,300	21,801–24,200	12,901–17,400	9,801–12,600	6,201–7,700	2,250	
48,301–59,000	24,201–33,200	17,401–21,300	12,601–15,400	7,701–9,400	2,500	
59,001–70,900	33,201–39,700	21,301–25,500	15,401–18,400	9,401–11,300	2,750	3
70,901–83,700	39,701–47,100	25,501–30,100	18,401–21,800	11,301–13,400	3,000	
83,701–97,700	47,101–54,900	30,101–35,200	21,801–25,900	13,401–15,600	3,250	
97,701–112,700	54,901–63,400	35,201–40,600	25,901–29,300	15,601–18,000	3,500	
112,701–128,700	63,401–72,400	40,601–46,400	29,301–33,500	18,001–20,600	3,750	
128,701–145,900	72,401–82,100	46,401–52,500	33,501–37,900	20,601–23,300	4,000	4
145,901–164,200	82,101–92,400	52,501–59,100	37,901–42,700	23,301–26,300	4,250	
164,201–183,400	92,401–103,100	59,101–66,000	42,701–47,700	26,301–29,300	4,500	
183,401–203,700	103,101–114,600	66,001–73,300	47,701–53,000	29,301–32,600	4,750	
203,701–225,200	114,601–126,700	73,301–81,100	53,001–58,600	32,601–36,000	5,000	
225,201–247,700	126,701–139,400	81,101–89,200	58,601–65,400	36,001–39,600	5,250	
247,701–271,200	139,401–152,600	89,201–97,700	65,401–70,600	39,601–43,400	5,500	
271,201–295,900	152,601–166,500	97,701–106,500	70,601–77,000	43,401–47,400	5,750	
295,901–Greater	166,501–Greater	106,501–115,800	77,001–83,700	47,401–51,500	6,000	
—	—	115,801–125,500	83,701–90,600	51,501–55,700	6,250	
—	—	125,501–135,500	90,601–97,900	55,701–60,200	6,500	
—	—	135,501–145,800	97,901–106,800	60,201–64,800	6,750	
—	—	145,801–156,700	106,801–113,200	64,801–69,600	7,000	
—	—	156,701–167,900	113,201–121,300	69,601–74,600	7,250	
—	—	167,901–179,400	121,301–129,600	74,601–79,800	7,500	
—	—	179,401–191,400	129,601–138,300	79,801–85,100	7,750	
—	—	191,401–Greater	138,301–Greater	85,101–Greater	8,000	

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895 kPa.

a. Types of construction are based on the *International Building Code*.

b. Measured at 20 psi residual pressure.

## APPENDIX B—FIRE-FLOW REQUIREMENTS FOR BUILDINGS

**TABLE B105.2**  
**REQUIRED FIRE FLOW FOR BUILDINGS OTHER THAN ONE- AND**  
**TWO-FAMILY DWELLINGS, GROUP R-3 AND R-4 BUILDINGS AND TOWNHOUSES**

<b>AUTOMATIC SPRINKLER SYSTEM (Design Standard)</b>	<b>MINIMUM FIRE FLOW (gallons per minute)</b>	<b>FLOW DURATION (hours)</b>
No automatic sprinkler system	Value in Table B105.1(2)	Duration in Table B105.1(2)
Section 903.3.1.1 of the <i>International Fire Code</i>	25% of the value in Table B105.1(2) <sup>a</sup>	Duration in Table B105.1(2) at the reduced flow rate
Section 903.3.1.2 of the <i>International Fire Code</i>	25% of the value in Table B105.1(2) <sup>b</sup>	Duration in Table B105.1(2) at the reduced flow rate

For SI: 1 gallon per minute = 3.785 L/m.

a. The reduced fire flow shall be not less than 1,000 gallons per minute.

b. The reduced fire flow shall be not less than 1,500 gallons per minute.

## SECTION B106 REFERENCED STANDARDS

**B106.1 General.** See Table B106.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE B106.1**  
**REFERENCED STANDARDS**

<b>STANDARD ACRONYM</b>	<b>STANDARD NAME</b>	<b>SECTIONS HEREIN REFERENCED</b>
IBC—21	<i>International Building Code</i>	B104.2
IRC—21	<i>International Residential Code</i>	Table B105.1(1)
IWUIC—21	<i>International Wildland-Urban Interface Code</i>	B103.3
NFPA 1142—17	<i>Standard on Water Supplies for Suburban and Rural Fire Fighting</i>	B103.3



## APPENDIX C

# FIRE HYDRANT LOCATIONS AND DISTRIBUTION

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix C focuses on the location and spacing of fire hydrants, which is important to the success of fire-fighting operations. The difficulty with determining the spacing of fire hydrants is that every situation is unique and has unique challenges. Finding one methodology for determining hydrant spacing is difficult. This particular appendix gives one methodology based on the required fire flow that fire departments can work with to set a policy for hydrant distribution around new buildings and facilities in conjunction with Section 507.5.

### SECTION C101 GENERAL

**C101.1 Scope.** In addition to the requirements of Section 507.5.1, fire hydrants shall be provided in accordance with this appendix for the protection of buildings, or portions of buildings, hereafter constructed or moved into the jurisdiction.

### SECTION C102 NUMBER OF FIRE HYDRANTS

**C102.1 Minimum number of fire hydrants for a building.** The number of fire hydrants available to a building shall be not less than the minimum specified in Table C102.1.

### SECTION C103 FIRE HYDRANT SPACING

**C103.1 Hydrant spacing.** Fire apparatus access roads and public streets providing required access to buildings in accordance with Section 503 shall be provided with one or

**TABLE C102.1  
REQUIRED NUMBER AND SPACING OF FIRE HYDRANTS<sup>h</sup>**

FIRE-FLOW REQUIREMENT (gpm)	MINIMUM NUMBER OF HYDRANTS	AVERAGE SPACING BETWEEN HYDRANTS <sup>a, b, c, f, g</sup> (feet)	MAXIMUM DISTANCE FROM ANY POINT ON STREET OR ROAD FRONTAGE TO A HYDRANT <sup>d, f, g</sup>
1,750 or less	1	500	250
1,751–2,250	2	450	225
2,251–2,750	3	450	225
2,751–3,250	3	400	225
3,251–4,000	4	350	210
4,001–5,000	5	300	180
5,001–5,500	6	300	180
5,501–6,000	6	250	150
6,001–7,000	7	250	150
7,001 or more	8 or more <sup>e</sup>	200	120

For SI: 1 foot = 304.8 mm, 1 gallon per minute = 3.785 L/m.

- a. Reduce by 100 feet for dead-end streets or roads.
- b. Where streets are provided with median dividers that cannot be crossed by fire fighters pulling hose lines, or where arterial streets are provided with four or more traffic lanes and have a traffic count of more than 30,000 vehicles per day, hydrant spacing shall average 500 feet on each side of the street and be arranged on an alternating basis.
- c. Where new water mains are extended along streets where hydrants are not needed for protection of structures or similar fire problems, fire hydrants shall be provided at spacing not to exceed 1,000 feet to provide for transportation hazards.
- d. Reduce by 50 feet for dead-end streets or roads.
- e. One hydrant for each 1,000 gallons per minute or fraction thereof.
- f. A 50-percent spacing increase shall be permitted where the building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1 of the *International Fire Code*.
- g. A 25-percent spacing increase shall be permitted where the building is equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.2 or 903.3.1.3 of the *International Fire Code* or Section P2904 of the *International Residential Code*.
- h. The fire code official is authorized to modify the location, number and distribution of fire hydrants based on site-specific constraints and hazards.



## APPENDIX C—FIRE HYDRANT LOCATIONS AND DISTRIBUTION

more fire hydrants, as determined by Section C102.1. Where more than one fire hydrant is required, the distance between required fire hydrants shall be in accordance with Sections C103.2 and C103.3.

**C103.2 Average spacing.** The average spacing between fire hydrants shall be in accordance with Table C102.1.

**Exception:** The average spacing shall be permitted to be increased by 10 percent where existing fire hydrants provide all or a portion of the required number of fire hydrants.

**C103.3 Maximum spacing.** The maximum spacing between fire hydrants shall be in accordance with Table C102.1.

### SECTION C104 CONSIDERATION OF EXISTING FIRE HYDRANTS

**C104.1 Existing fire hydrants.** Existing fire hydrants on public streets are allowed to be considered as available to meet the requirements of Sections C102 and C103. Existing fire hydrants on adjacent properties are allowed to be considered as available to meet the requirements of Sections C102 and C103 provided that a fire apparatus access road extends between properties and that an easement is established to prevent obstruction of such roads.

### SECTION C105 REFERENCED STANDARD

**C105.1 General.** See Table C105.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE C105.1  
REFERENCED STANDARD**

STANDARD ACRONYM	STANDARD NAME	SECTION HEREIN REFERENCED
IRC—21	<i>International Residential Code</i>	Table C102.1

APPENDIX D

FIRE APPARATUS ACCESS ROADS

The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.

User note:

**About this appendix:** Appendix D contains more detailed elements for use with the basic access requirements found in Section 503, which gives some minimum criteria, such as a maximum length of 150 feet and a minimum width of 20 feet, but in many cases does not state specific criteria. This appendix, like Appendices B and C, is a tool for jurisdictions looking for guidance in establishing access requirements and includes criteria for multiple-family residential developments, large one- and two-family subdivisions, specific examples for various types of turnarounds for fire department apparatus and parking regulatory signage.

SECTION D101  
GENERAL

- D101.1 Scope.** Fire apparatus access roads shall be in accordance with this appendix and all other applicable requirements of the *Arkansas Fire Prevention Code*.
- Requests for exceptions to Appendix D may be appealed to the State Fire Marshal.

SECTION D102  
REQUIRED ACCESS

**D102.1 Access and loading.** Facilities, buildings or portions of buildings hereafter constructed shall be accessible to fire department apparatus by way of an *approved* fire apparatus access road with an asphalt, concrete or other *approved* driving surface capable of supporting the imposed load of fire apparatus weighing up to 75,000 pounds (34 050 kg).

SECTION D103  
MINIMUM SPECIFICATIONS

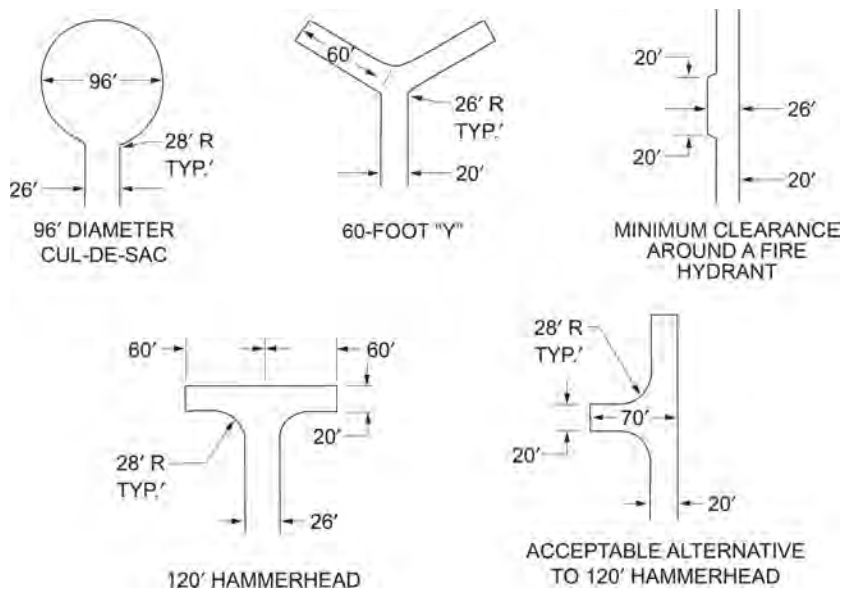
**D103.1 Access road width with a hydrant.** Where a fire hydrant is located on a fire apparatus access road, the minimum road width shall be 26 feet (7925 mm), exclusive of shoulders (see Figure D103.1).

**D103.2 Grade.** Fire apparatus access roads shall not exceed 10 percent in grade.

**Exception:** Grades steeper than 10 percent as *approved* by the *fire code official*.

**D103.3 Turning radius.** The minimum turning radius shall be determined by the *fire code official*.

**D103.4 Dead ends.** Dead-end fire apparatus access roads in excess of 150 feet (45 720 mm) shall be provided with width and turnaround provisions in accordance with Table D103.4.



For SI: 1 foot = 304.8 mm.

FIGURE D103.1  
DEAD-END FIRE APPARATUS ACCESS ROAD TURNAROUND

APPENDIX D—FIRE APPARATUS ACCESS ROADS

TABLE D103.4  
REQUIREMENTS FOR DEAD-END  
FIRE APPARATUS ACCESS ROADS

LENGTH (feet)	WIDTH (feet)	TURNAROUNDS REQUIRED
0–150	20	None required
151–500	20	120-foot Hammerhead, 60-foot “Y” or 96-foot-diameter cul-de-sac in accordance with Figure D103.1
501–750	26	120-foot Hammerhead, 60-foot “Y” or 96-foot-diameter cul-de-sac in accordance with Figure D103.1
Over 750		Special approval required

For SI: 1 foot = 304.8 mm.

**D103.5 Fire apparatus access road gates.** Gates securing the fire apparatus access roads shall comply with all of the following criteria:

1. Where a single gate is provided, the gate width shall be not less than 20 feet (6096 mm). Where a fire apparatus road consists of a divided roadway, the gate width shall be not less than 12 feet (3658 mm).
2. Gates shall be of the horizontal swing, horizontal slide, vertical lift or vertical pivot type.
3. Construction of gates shall be of materials that allow manual operation by one person.
4. Gate components shall be maintained in an operative condition at all times and replaced or repaired when defective.
5. Electric gates shall be equipped with a means of opening the gate by fire department personnel for emergency access. Emergency opening devices shall be *approved* by the *fire code official*.
6. Methods of locking shall be submitted for approval by the *fire code official*.
7. Electric gate operators, where provided, shall be *listed* in accordance with UL 325.
8. Gates intended for automatic operation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

**D103.6 Signs.** Where required by the *fire code official*, fire apparatus access roads shall be marked with permanent “NO PARKING—FIRE LANE” signs complying with Figure D103.6. Signs shall have a minimum dimension of 12 inches

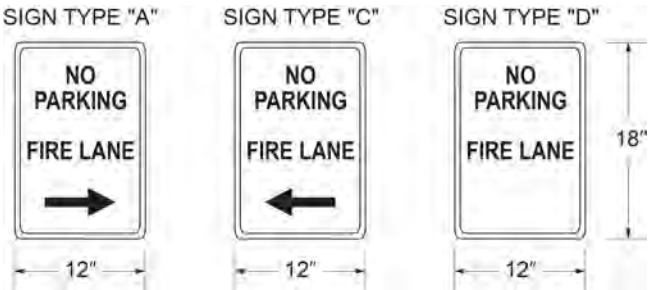


FIGURE D103.6  
FIRE LANE SIGNS

(305 mm) wide by 18 inches (457 mm) high and have red letters on a white reflective background. Signs shall be located at each end of a painted curb and additionally in between so that the maximum separation between the signs is 100 feet (30 m) as measured along the centerline of the fire apparatus access road, or as approved by the fire code official or the authority having jurisdiction. Signs shall be posted on one or both sides of the fire apparatus road as required by Section D103.6.1 or D103.6.2.

**D103.6.1 Roads 20 to 26 feet in width.** *Fire lane* signs as specified in Section D103.6 shall be posted on both sides of fire apparatus access roads that are 20 to 26 feet wide (6096 to 7925 mm).

**D103.6.2 Roads more than 26 feet in width.** *Fire lane* signs as specified in Section D103.6 shall be posted on one side of fire apparatus access roads more than 26 feet wide (7925 mm) and less than 32 feet wide (9754 mm).

SECTION D104  
COMMERCIAL AND INDUSTRIAL DEVELOPMENTS

**D104.1 Buildings exceeding three stories or 30 feet in height.** Buildings or facilities exceeding 30 feet (9144 mm) or three stories in height shall have not fewer than two means of fire apparatus access for each structure.

**D104.2 Buildings exceeding 62,000 square feet in area.** Buildings or facilities having a gross *building area* of more than 62,000 square feet (5760 m<sup>2</sup>) shall be provided with two separate and *approved* fire apparatus access roads.

**Exception:** Projects having a gross *building area* of up to 124,000 square feet (11 520 m<sup>2</sup>) that have a single *approved* fire apparatus access road where all buildings are equipped throughout with *approved automatic sprinkler systems*.

**D104.3 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one half of the length of the maximum overall diagonal dimension of the lot or area to be served, measured in a straight line between accesses.

SECTION D105  
AERIAL FIRE APPARATUS ACCESS ROADS

**D105.1 Where required.** Where the vertical distance between the *grade plane* and the highest roof surface exceeds 30 feet (9144 mm), *approved* aerial fire apparatus access roads shall be provided. For purposes of this section, the highest roof surface shall be determined by measurement to the eave of a pitched roof, the intersection of the roof to the exterior wall, or the top of parapet walls, whichever is greater.

**Exception:** Where *approved* by the *fire code official*, buildings of Type IA, Type IB or Type IIA construction equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and having fire fighter access through an enclosed *stairway* with a Class I standpipe from the lowest level of fire department vehicle access to all roof surfaces.

## APPENDIX D—FIRE APPARATUS ACCESS ROADS

**D105.2 Width.** Aerial fire apparatus access roads shall have a minimum unobstructed width of 26 feet (7925 mm), exclusive of shoulders, in the immediate vicinity of the building or portion thereof.

**D105.3 Proximity to building.** One or more of the required access routes meeting this condition shall be located not less than 15 feet (4572 mm) and not greater than 30 feet (9144 mm) from the building, and shall be positioned parallel to one entire side of the building. The side of the building on which the aerial fire apparatus access road is positioned shall be *approved* by the *fire code official*.

**D105.4 Obstructions.** Overhead utility and power lines shall not be located over the aerial fire apparatus access road or between the aerial fire apparatus road and the building. Other obstructions shall be permitted to be placed with the approval of the *fire code official*.

### SECTION D106 MULTIPLE-FAMILY RESIDENTIAL DEVELOPMENTS

**D106.1 Projects having more than 100 dwelling units.** Multiple-family residential projects having more than 100 *dwelling units* shall be equipped throughout with two separate and *approved* fire apparatus access roads.

**Exception:** Projects having up to 200 *dwelling units* shall have not fewer than one *approved* fire apparatus access road where all buildings, including nonresidential occupancies, are equipped throughout with *approved automatic sprinkler systems* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**D106.2 Projects having more than 200 dwelling units.** Multiple-family residential projects having more than 200 *dwelling units* shall be provided with two separate and *approved* fire apparatus access roads regardless of whether they are equipped with an *approved automatic sprinkler system*.

**D106.3 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the property or area to be served, measured in a straight line between accesses.

### SECTION D107 ONE- OR TWO-FAMILY RESIDENTIAL DEVELOPMENTS

**D107.1 One- or two-family dwelling residential developments.** Developments of one- or two-family *dwelling units* where the number of *dwelling units* exceeds 30 shall be provided with two separate and *approved* fire apparatus access roads.

#### Exceptions:

1. Where there are more than 30 *dwelling units* accessed from a single public or private fire apparatus access road and all *dwelling units* are equipped throughout with an *approved automatic*

*sprinkler system* in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3, access from two directions shall not be required.

2. The number of *dwelling units* accessed from a single fire apparatus access road shall not be increased unless fire apparatus access roads will connect with future development, as determined by the *fire code official*.

**D107.2 Remoteness.** Where two fire apparatus access roads are required, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the property or area to be served, measured in a straight line between accesses.

### SECTION D108 REFERENCED STANDARDS

**D108.1 General.** See Table D108.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

TABLE D108.1  
REFERENCED STANDARDS

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
ASTM F2200—14	<i>Standard Specification for Automated Vehicular Gate Construction</i>	D103.5
UL 325—02	<i>Door, Drapery, Gate, Louver, and Window Operators and Systems, with Revisions through May 2015</i>	D103.5





## APPENDIX E

# HAZARD CATEGORIES

*This appendix is for information purposes and is not intended for adoption.*

---

### User note:

**About this appendix:** Appendix E contains guidance for designers, engineers, architects, code officials, plans reviewers and inspectors in the classifying of hazardous materials so that proposed designs can be evaluated intelligently and accurately. The descriptive materials and explanations of hazardous materials and how to report and evaluate them on a Safety Data Sheet (SDS) are intended to be instructional as well as informative. Note that Safety Data Sheets also include the concept known as Material Safety Data Sheets (MSDS).

---

### SECTION E101 GENERAL

**E101.1 Scope.** This appendix provides information, explanations and examples to illustrate and clarify the hazard categories contained in Chapter 50 of the *International Fire Code*. The hazard categories are based on the DOL 29 CFR. Where numerical classifications are included, they are in accordance with nationally recognized standards.

This appendix should not be used as the sole means of hazardous materials classification.

### SECTION E102 HAZARD CATEGORIES

**E102.1 Physical hazards.** Materials classified in this section pose a *physical hazard*.

**E102.1.1 Explosives and blasting agents.** The current UN/DOT classification system recognized by international authorities, the Department of Defense and others classifies all *explosives* as Class 1 materials. They are then divided into six separate divisions to indicate their relative hazard. There is not a direct correlation between the designations used by the old DOT system and those used by the current system nor is there correlation with the system (high and low) established by the Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF). Table 5604.3 provides some guidance with regard to the current categories and their relationship to the old categories. Some items appear in more than one division, depending on factors such as the degree of confinement or separation, type of packaging, storage configuration or state of assembly.

In order to determine the level of hazard presented by *explosive materials*, testing to establish quantitatively their explosive nature is required. There are numerous test methods that have been used to establish the character of an explosive material. Standardized tests, required for finished goods containing *explosives* or *explosive materials* in a packaged form suitable for shipment or storage, have been established by UN/DOT and BATF. However, these tests do not consider key elements that should be examined in a manufacturing situation. In manufacturing operations, the condition and/or the state of a material may vary within the process. Potentially, material classi-

fication and the requirements used to determine that classification during manufacturing will differ from the classification of the same material found in finished goods. A classification methodology must be used that recognizes the hazards commensurate with the application to the variable physical conditions as well as potential variations of physical character and type of *explosive* under consideration.

Test methods or guidelines for hazard classification of energetic materials used for in-process operations shall be *approved* by the *fire code official*. Test methods used shall be DOD, BATF, UN/DOT or other *approved* criteria. The results of such testing shall become a portion of the files of the jurisdiction and be included as an independent section of any Hazardous Materials Management Plan (HMMP) required by Section 5605.2.1. Also see Section 104.8.2.

Examples of materials in various Divisions are as follows:

1. Division 1.1 (High *Explosives*). Consists of *explosives* that have a mass explosion hazard. A mass explosion is one that affects almost the entire pile of material instantaneously. Includes substances that, where tested in accordance with *approved* methods, can be caused to detonate by means of a blasting cap where unconfined or will transition from *deflagration* to a *detonation* where confined or unconfined. Examples: dynamite, TNT, nitroglycerine, C-3, HMX, RDX, encased *explosives*, military ammunition.
2. Division 1.2 (Low *Explosives*). Consists of *explosives* that have a projection hazard, but not a mass explosion hazard. Examples: nondetonating encased *explosives*, military ammunition and the like.
3. Division 1.3 (Low *Explosives*). Consists of *explosives* that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. The major hazard is radiant heat or violent burning, or both. Can be deflagrated where confined. Examples: smokeless powder, propellant *explosives*, display fireworks.

## APPENDIX E—HAZARD CATEGORIES

4. Division 1.4. Consists of *explosives* that pose a minor explosion hazard. The *explosive* effects are largely confined to the package and no projection of fragments of appreciable size or range is expected. An internal fire must not cause virtually instantaneous explosion of almost the entire contents of the package. Examples: squibs (nondetonating igniters), *explosive* actuators, *explosive* trains (low-level detonating cord).
5. Division 1.5 (Blasting Agents). Consists of very insensitive *explosives*. This division comprises substances that have a mass explosion hazard, but are so insensitive that there is very little probability of initiation or of transition from burning to *detonation* under normal conditions of transport. Materials are not cap sensitive; however, they are mass detonating where provided with sufficient input. Examples: oxidizer and liquid fuel slurry mixtures and gels, ammonium nitrate combined with fuel oil.
6. Division 1.6. Consists of extremely insensitive articles that do not have a mass *explosive* hazard. This division comprises articles that contain only extremely insensitive detonating substances and that demonstrate a negligible probability of accidental initiation or propagation. Although this category of materials has been defined, the primary application is currently limited to military uses. Examples: Low vulnerability military weapons.

*Explosives* in each division are assigned a compatibility group letter by the Associate Administrator for Hazardous Materials Safety (DOT) based on criteria specified by DOTn 49 CFR. Compatibility group letters are used to specify the controls for the transportation and storage related to various materials to prevent an increase in hazard that might result if certain types of *explosives* were stored or transported together. Altogether, there are 35 possible classification codes for *explosives*, for example, 1.1A, 1.3C, 1.4S.

### E102.1.2 Compressed gases. Examples include:

1. Flammable: acetylene, carbon monoxide, ethane, ethylene, hydrogen, methane. Ammonia will ignite and burn although its flammable range is too narrow for it to fit the definition of “Flammable gas.”  
For binary mixtures where the hazardous component is diluted with a nonflammable gas, the mixture shall be categorized in accordance with CGA P-23.
2. Oxidizing: oxygen, ozone, oxides of nitrogen, chlorine and fluorine. Chlorine and fluorine do not contain oxygen but reaction with flammables is similar to that of oxygen.
3. *Corrosive*: ammonia, hydrogen chloride, fluorine.

4. Highly toxic: arsine, cyanogen, fluorine, germane, hydrogen cyanide, nitric oxide, phosphine, hydrogen selenide, stibine.
5. Toxic: chlorine, hydrogen fluoride, hydrogen sulfide, phosgene, silicon tetrafluoride.
6. Inert (chemically unreactive): argon, helium, krypton, neon, nitrogen, xenon.
7. Pyrophoric: diborane, dichloroborane, phosphine, silane.
8. Unstable (reactive): butadiene (unstabilized), ethylene oxide, vinyl chloride.

### E102.1.3 Flammable and combustible liquids. Examples include:

#### 1. Flammable liquids.

Class IA liquids shall include those having *flash points* below 73°F (23°C) and having a *boiling point* at or below 100°F (38°C).

Class IB liquids shall include those having *flash points* below 73°F (23°C) and having a *boiling point* at or above 100°F (38°C).

Class IC liquids shall include those having *flash points* at or above 73°F (23°C) and below 100°F (38°C).

#### 2. Combustible liquids.

Class II liquids shall include those having *flash points* at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA liquids shall include those having *flash points* at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB liquids shall include those liquids having *flash points* at or above 200°F (93°C).

### E102.1.4 Flammable solids. Examples include:

1. Organic solids: camphor, cellulose nitrate, naphthalene.
2. Inorganic solids: decaborane, lithium amide, phosphorous heptasulfide, phosphorous sesquisulfide, potassium sulfide, anhydrous sodium sulfide, sulfur.
3. Combustible metals (except dusts and powders): cesium, magnesium, zirconium.

### E102.1.5 Combustible dusts and powders. Finely divided solids that could be dispersed in air as a dust cloud: wood sawdust, plastics, coal, flour, powdered metals (few exceptions).

### E102.1.6 Combustible fibers. See the definition of *combustible fibers* in Section 202.

### E102.1.7 Oxidizers. Examples include:

1. Gases: oxygen, ozone, oxides of nitrogen, fluorine and chlorine (reaction with flammables is similar to that of oxygen).
2. Liquids: bromine, hydrogen peroxide, nitric acid, perchloric acid, sulfuric acid.

3. Solids: chlorates, chromates, chromic acid, iodine, nitrates, nitrites, perchlorates, peroxides.

**E102.1.7.1 Examples of liquid and solid oxidizers according to hazard.** Examples include:

Class 4: ammonium perchlorate (particle size greater than 15 microns), ammonium permanganate, guanidine nitrate, hydrogen peroxide solutions more than 91 percent by weight, perchloric acid solutions more than 72.5 percent by weight, potassium superoxide, tetranitromethane.

Class 3: ammonium dichromate, calcium hypochlorite (over 50 percent by weight), chloric acid (10 percent maximum concentration), hydrogen peroxide solutions (greater than 52 percent up to 91 percent), mono-(trichloro)-tetra-(monopotassium dichloro)-penta-s-triazinetriane, nitric acid, (fuming—more than 86 percent concentration), perchloric acid solutions (60 percent to 72 percent by weight), potassium bromate, potassium chlorate, potassium dichloro-s-triazinetriane (potassium dichloro-isocyanurate), potassium perchlorate (99 percent), potassium permanganate (greater than 97.5 percent), sodium bromate, sodium chlorate and sodium chlorite (over 40 percent by weight).

Class 2: barium bromate, barium chlorate, barium hypochlorite, barium perchlorate, barium permanganate, 1-bromo-3-chloro-5, 5-dimethylhydantoin, calcium chlorate, calcium chlorite, calcium hypochlorite (50 percent or less by weight), calcium perchlorate, calcium permanganate, calcium peroxide (75 percent), chromium trioxide (chromic acid), copper chlorate, halane (1, 3-dichloro-5, 5-dimethylhydantoin), hydrogen peroxide (greater than 27.5 percent up to 52 percent), lead perchlorate, lithium chlorate, lithium hypochlorite (more than 39 percent available chlorine), lithium perchlorate, magnesium bromate, magnesium chlorate, magnesium perchlorate, mercurous chlorate, nitric acid (more than 40 percent but less than 86 percent), perchloric acid solutions (more than 50 percent but less than 60 percent), potassium peroxide, potassium superoxide, silver peroxide, sodium chlorite (40 percent or less by weight), sodium dichloro-s-triazinetriane anhydrous (sodium dichloroisocyanurate anhydrous), sodium perchlorate, sodium perchlorate monohydrate, sodium permanganate, sodium peroxide, sodium persulfate (99 percent), strontium chlorate, strontium perchlorate, thallium chlorate, urea hydrogen peroxide, zinc bromate, zinc chlorate and zinc permanganate.

Class 1: all inorganic nitrates (unless otherwise classified), all inorganic nitrites (unless otherwise classified), ammonium persulfate, barium peroxide, hydrogen peroxide solutions (greater than 8 percent up to 27.5 percent), lead dioxide, lithium hypochlorite (39 percent or less available chlorine), lithium peroxide, magnesium peroxide, manganese dioxide, nitric acid (40 percent concentration or less).

perchloric acid solutions (less than 50 percent by weight), potassium dichromate, potassium monopersulfate (45 percent  $\text{KHSO}_5$  or 90 percent triple salt), potassium percarbonate, potassium persulfate, sodium carbonate peroxide, sodium dichloro-s-triazinetriene dihydrate, sodium dichromate, sodium perborate (anhydrous), sodium perborate monohydrate, sodium perborate tetra-hydrate, sodium percarbonate, strontium peroxide, trichloro-s-triazinetriene (trichloroisocyanuric acid) and zinc peroxide.

**E102.1.8 Organic peroxides.** Organic peroxides contain the double oxygen or peroxy (-o-o) group. Some are flammable compounds and subject to explosive decomposition. They are available as:

1. Liquids.
2. Pastes.
3. Solids (usually finely divided powders).

**E102.1.8.1 Classification of organic peroxides according to hazard.** Examples include:

Unclassified: Unclassified organic peroxides are capable of *detonation* and are regulated in accordance with Chapter 56.

Class I: acetyl cyclohexane sulfonyl 60-65 percent concentration by weight, fulfonyl peroxide, benzoyl peroxide over 98 percent concentration, t-butyl hydroperoxide 90 percent, t-butyl peroxyacetate 75 percent, t-butyl peroxyisopropylcarbonate 92 percent, diisopropyl peroxydicarbonate 100 percent, di-n-propyl peroxydicarbonate 98 percent, and di-n-propyl peroxydicarbonate 85 percent.

Class II: acetyl peroxide 25 percent, t-butyl hydroperoxide 70 percent (with DTBP and t-BuOH diluents), t-butyl peroxybenzoate 98 percent, t-butyl peroxy-2-ethylhexanoate 97 percent, t-butyl peroxyisobutyrate 75 percent, t-butyl peroxyisopropyl-carbonate 75 percent, t-butyl peroxy-pivalate 75 percent, dibenzoyl peroxydicarbonate 85 percent, di-sec-butyl peroxydicarbonate 98 percent, di-secbutyl peroxydicarbonate 75 percent, 1,1-di-(t-butylperoxy)-3,5,5-trimethy cyclohexane 95 percent, di-(2-ethylhexyl) peroxydicarbonate 97 percent, 2,5-dimethyl-2-5 di (benzoylperoxy) hexane 92 percent, and peroxyacetic acid 43 percent.

Class III: acetyl cyclohexane sulfonal peroxide 29 percent, benzoyl peroxide 78 percent, benzoyl peroxide paste 55 percent, benzoyl peroxide paste 50 percent peroxide/50 percent butylbenzylphthalate diluent, cumene hydroperoxide 86 percent, di-(4-butylcyclohexyl) peroxydicarbonate 98 percent, t-butyl peroxy-2-ethylhexanoate 97 percent, t-butyl peroxyneodecanoate 75 percent, decanoyl peroxide 98.5 percent, di-t-butyl peroxide 99 percent, 1,1-di-(t-butylperoxy)3,5,5-trimethylcyclohexane 75 percent, 2,4-dichlorobenzoyl peroxide 50 percent, di-isopropyl peroxydicarbonate 30 percent, 2,5-di-



## APPENDIX E—HAZARD CATEGORIES

methyl-2,5-di-(2-ethylhexanolyperoxy)-hexane 90 percent, 2,5-dimethyl-2,5-di-(t-butylperoxy) hexane 90 percent and methyl ethyl ketone peroxide 9 percent active oxygen diluted in dimethyl phthalate.

Class IV: benzoyl peroxide 70 percent, benzoyl peroxide paste 50 percent peroxide/15 percent water/35 percent butylphthalate diluent, benzoyl peroxide slurry 40 percent, benzoyl peroxide powder 35 percent, t-butyl hydroperoxide 70 percent, (with water diluent), t-butyl peroxy-2-ethylhexanoate 50 percent, decumyl peroxide 98 percent, di-(2-ethylhexal) peroxydicarbonate 40 percent, laurel peroxide 98 percent, p-methane hydroperoxide 52.5 percent, methyl ethyl ketone peroxide 5.5 percent active oxygen and methyl ethyl ketone peroxide 9 percent active oxygen diluted in water and glycols.

Class V: benzoyl peroxide 35 percent, 1,1-di-t-butyl peroxy 3,5,5-trimethylcyclohexane 40 percent, 2,5-di-(t-butyl peroxy) hexane 47 percent and 2,4-pentanedione peroxide 4 percent active oxygen.

#### E102.1.9 Pyrophoric materials. Examples include:

1. Gases: diborane, phosphine, silane.
2. Liquids: diethylaluminum chloride, di-ethylberyllium, diethylphosphine, diethylzinc, dimethylarsine, triethylaluminum etherate, triethylbismuthine, triethylboron, trimethylaluminum, trimethylgallium.
3. Solids: cesium, hafnium, lithium, white or yellow phosphorous, plutonium, potassium, rubidium, sodium, thorium.

#### E102.1.10 Unstable (reactive) materials. Examples include:

Class 4: acetyl peroxide, dibutyl peroxide, dinitrobenzene, ethyl nitrate, peroxyacetic acid and picric acid (dry) trinitrobenzene.

Class 3: hydrogen peroxide (greater than 52 percent), hydroxylamine, nitromethane, paranitroaniline, perchloric acid and tetrafluoroethylene monomer.

Class 2: acrolein, acrylic acid, hydrazine, methacrylic acid, sodium perchlorate, styrene and vinyl acetate.

Class 1: acetic acid, hydrogen peroxide 35 percent to 52 percent, paraldehyde and tetrahydrofuran.

#### E102.1.11 Water-reactive materials. Examples include:

Class 3: aluminum alkyls such as triethylaluminum, isobutylaluminum and trimethylaluminum; bromine pentafluoride, bromine trifluoride, chlorodiethylaluminum and diethylzinc.

Class 2: calcium carbide, calcium metal, cyanogen bromide, lithium hydride, methyldichlorosilane, potassium metal, potassium peroxide, sodium metal, sodium peroxide, sulfuric acid and trichlorosilane.

Class 1: acetic anhydride, sodium hydroxide, sulfur monochloride and titanium tetrachloride.

**E102.1.12 Cryogenic fluids.** The cryogenics listed will exist as *compressed gases* where they are stored at ambient temperatures.

1. Flammable: carbon monoxide, deuterium (heavy hydrogen), ethylene, hydrogen, methane.
2. Oxidizing: fluorine, nitric oxide, oxygen.
3. *Corrosive*: fluorine, nitric oxide.
4. Inert (chemically unreactive): argon, helium, krypton, neon, nitrogen, xenon.
5. Highly toxic: fluorine, nitric oxide.

**E102.2 Health hazards.** Materials classified in this section pose a *health hazard*.

#### E102.2.1 Highly toxic materials. Examples include:

1. Gases: arsine, cyanogen, diborane, fluorine, germane, hydrogen cyanide, nitric oxide, nitrogen dioxide, ozone, phosphine, hydrogen selenide, stibine.
2. Liquids: acrolein, acrylic acid, 2-chloroethanol (ethylene chlorohydrin), hydrazine, hydrocyanic acid, 2-methylaziridine (propylenimine), 2-methyl-acetonitrile (acetone cyanohydrin), methyl ester isocyanic acid (methyl isocyanate), nicotine, tetranitromethane and tetraethylstannane (tetraethyltin).
3. Solids: (aceto) phenylmercury (phenyl mercuric acetate), 4-aminopyridine, arsenic pentoxide, arsenic trioxide, calcium cyanide, 2-chloroacetophenone, aflatoxin B, decaborane(14), mercury (II) bromide (mercuric bromide), mercury (II) chloride (*corrosive* mercury chloride), pentachlorophenol, methyl parathion, phosphorus (white) and sodium azide.

#### E102.2.2 Toxic materials. Examples include:

1. Gases: boron trichloride, boron trifluoride, chlorine, chlorine trifluoride, hydrogen fluoride, hydrogen sulfide, phosgene, silicon tetrafluoride.
2. Liquids: acrylonitrile, allyl alcohol, alpha-chlorotoluene, aniline, 1-chloro-2,3-epoxypropane, chloroformic acid (allyl ester), 3-chloropropene (allyl chloride), o-cresol, crotonaldehyde, dibromomethane, diisopropylamine, diethyl ester sulfuric acid, dimethyl ester sulfuric acid, 2-furaldehyde (furfural), furfural alcohol, phosphorus chloride, phosphoryl chloride (phosphorus oxychloride) and thionyl chloride.
3. Solids: acrylamide, barium chloride, barium (II) nitrate, benzidine, p-benzoquinone, beryllium chloride, cadmium chloride, cadmium oxide, chloroacetic acid, chlorophenylmercury (phenyl mercuric chloride), chromium (VI) oxide (chromic acid, solid), 2,4-dinitrotoluene, hydroquinone, mercury chloride (calomel), mercury (II) sulfate (mercuric sulfate), osmium tetroxide, oxalic acid, phenol, P-phenylenediamine, phenylhydrazine, 4-phenylmorpholine, phosphorus sulfide, potassium

fluoride, potassium hydroxide, selenium (IV) disulfide and sodium fluoride.

#### E102.2.3 Corrosives. Examples include:

1. Acids: Examples: chromic, formic, hydrochloric (muriatic) greater than 15 percent, hydrofluoric, nitric (greater than 6 percent, perchloric, sulfuric (4 percent or more).
2. Bases (alkalis): hydroxides-ammonium (greater than 10 percent), calcium, potassium (greater than 1 percent), sodium (greater than 1 percent); certain carbonates-potassium.
3. Other *corrosives*: bromine, chlorine, fluorine, iodine, ammonia.

**Note:** *Corrosives* that are oxidizers (for example, nitric acid, chlorine, fluorine), *compressed gases* (for example, ammonia, chlorine, fluorine), or water-reactive (for example, concentrated sulfuric acid, sodium hydroxide) are *physical hazards* in addition to being *health hazards*.

### SECTION E103 EVALUATION OF HAZARDS

**E103.1 Degree of hazard.** The degree of hazard present depends on many variables that should be considered individually and in combination. Some of these variables are as shown in Sections E103.1.1 through E103.1.5.

**E103.1.1 Chemical properties of the material.** Chemical properties of the material determine self reactions and reactions that could occur with other materials. Generally, materials within subdivisions of hazard categories will exhibit similar chemical properties. However, materials with similar chemical properties could pose very different hazards. Each individual material should be researched to determine its hazardous properties and then considered in relation to other materials that it might contact and the surrounding environment.

**E103.1.2 Physical properties of the material.** Physical properties, such as whether a material is a solid, liquid or gas at ordinary temperatures and pressures, considered along with chemical properties will determine requirements for containment of the material. Specific gravity (weight of a liquid compared to water) and vapor density (weight of a gas compared to air) are both physical properties that are important in evaluating the hazards of a material.

**E103.1.3 Amount and concentration of the material.** The amount of material present and its concentration must be considered along with physical and chemical properties to determine the magnitude of the hazard. Hydrogen peroxide, for example, is used as an antiseptic and a hair bleach in low concentrations (approximately 8 percent in water solution). Over 8 percent, hydrogen peroxide is classed as an oxidizer and is toxic. Above 90 percent, it is a Class 4 oxidizer “that can undergo an explosive reaction when catalyzed or exposed to heat, shock or friction,” a definition that, incidentally, places

hydrogen peroxide over 90-percent concentration in the unstable (reactive) category. Small amounts at high concentrations could pose a greater hazard than large amounts at low concentrations.

**E103.1.3.1 Mixtures.** Gases—toxic and highly toxic gases include those gases that have an  $LC_{50}$  of 2,000 parts per million (ppm) or less when rats are exposed for a period of 1 hour or less. To maintain consistency with the definitions for these materials, exposure data for periods other than 1 hour must be normalized to 1 hour. To classify mixtures of *compressed gases* that contain one or more toxic or highly toxic components, the  $LC_{50}$  of the mixture must be determined. Mixtures that contain only two components are binary mixtures. Those that contain more than two components are multicomponent mixtures. Where two or more hazardous substances (components) having an  $LC_{50}$  below 2,000 ppm are present in a mixture, their combined effect, rather than that of the individual substance components, must be considered. The effects of the hazards present must be considered as additive, except where there is a good reason to believe that the principal effects of the different harmful substances (components) are not additive.

For binary mixtures where the hazardous component is diluted with a nontoxic gas such as an inert gas, the  $LC_{50}$  of the mixture is estimated by use of the methodology contained in CGA P-20. The hazard zones specified in CGA P-20 are applicable for DOTn purposes and shall not be used for hazard classification.

**E103.1.4 Actual use, activity or process involving the material.** The definition of handling, storage and use in *closed systems* refers to materials in packages or containers. Dispensing and use in open containers or systems describes situations where a material is exposed to ambient conditions or vapors are liberated to the atmosphere. Dispensing and use in *open systems*, then, are generally more hazardous situations than handling, storage or use in *closed systems*. The actual use or process could include heating, electric or other sparks, catalytic or reactive materials and many other factors that could affect the hazard and must therefore be thoroughly analyzed.

**E103.1.5 Surrounding conditions.** Conditions such as other materials or processes in the area, type of construction of the structure, fire protection features (for example, *fire walls*, sprinkler systems, alarms), occupancy (use) of adjoining areas, normal temperatures, exposure to weather, etc., must be taken into account in evaluating the hazard.

**E103.2 Evaluation questions.** The following are sample evaluation questions:

1. What is the material? Correct identification is important; exact spelling is vital. Checking labels and SDS and asking responsible persons should be among the highest priorities.
2. What are the concentration and strength?

## APPENDIX E—HAZARD CATEGORIES

3. What is the physical form of the material? Liquids, gases and finely divided solids have differing requirements for spill and leak control and containment.
4. How much material is present? Consider in relation to permit amounts, *maximum allowable quantity per control area* (from Group H occupancy requirements), amounts that require detached storage and overall magnitude of the hazard.
5. What other materials (including furniture, equipment and building components) are close enough to interact with the material?
6. What are the likely reactions?
7. What is the activity involving the material?
8. How does the activity impact the hazardous characteristics of the material? Consider vapors released or hazards otherwise exposed.
9. What must the material be protected from? (For example, other materials, temperature, shock, pressure.)
10. What effects of the material must people and the environment be protected from?
11. How can protection be accomplished? Consider:
  - 11.1. Proper containers and equipment.
  - 11.2. Separation by distance or construction.
  - 11.3. Enclosure in cabinets or rooms.
  - 11.4. Spill control, drainage and containment.
  - 11.5. Control system ventilation, special electrical, detection and alarm, extinguishment, explosion venting, limit controls, exhaust scrubbers and excess flow control.
  - 11.6. Administrative (operational) control signs, ignition source control, security, personnel training, established procedures, storage plans and emergency plans.

Evaluation of the hazard is a strongly subjective process; therefore, the person charged with this responsibility must gather as much relevant data as possible so that the decision will be objective and within the limits prescribed in laws, policies and standards.

It could be necessary to cause the responsible persons in charge to have tests made by qualified persons or testing laboratories to support contentions that a particular material or process is or is not hazardous. See Section 104.8.2.

## SECTION E104 REFERENCED STANDARDS

**E104.1 General.** See Table E104.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE E104.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
CGA P-20—2009	<i>Standard for Classification of Toxic Mixtures</i>	E103.1.3.1
CGA P-23—2008	<i>Standard for Categorizing Gas Mixtures Containing Flammable and Nonflammable Components</i>	E102.1.2

## APPENDIX F

# HAZARD RANKING

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

---

### User note:

**About this appendix:** Appendix F is intended to be a companion to the specific requirements of Chapters 51 through 67, which regulate the storage, handling and use of all hazardous materials classified as either physical or health hazards. These materials pose diverse hazards, including instability, reactivity, flammability, oxidizing potential or toxicity; therefore, identifying them by hazard ranking is essential. This appendix lists the various hazardous material categories that are defined in this code, along with the NFPA 704 hazard ranking for each.

---

### SECTION F101 GENERAL

**F101.1 Scope.** Assignment of levels of hazards to be applied to specific hazard classes as required by NFPA 704 shall be in accordance with this appendix. The appendix is based on application of the degrees of hazard as defined in NFPA 704 arranged by hazard class as for specific categories defined in Chapter 2 of the *International Fire Code* and used throughout.

**F101.2 General.** The hazard rankings shown in Table F101.2 have been established by using guidelines found within NFPA 704. As noted in Section 4.2 of NFPA 704, there could be specific reasons to alter the degree of hazard assigned to a specific material; for example, ignition temperature, flammable range or susceptibility of a container to rupture by an internal combustion explosion or to metal failure while under pressure or because of heat from external fire. As a result, the degree of hazard assigned for the same material can vary when assessed by different people of equal competence.

The hazard rankings assigned to each class represent reasonable minimum hazard levels for a given class based on the use of criteria established by NFPA 704. Specific cases of use or storage may dictate the use of higher degrees of hazard in certain cases.

### SECTION F102 REFERENCED STANDARDS

**F102.1 General.** See Table F102.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE F102.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
NFPA 70—20	<i>National Electrical Code</i>	Table F101.2
NFPA 704—17	<i>Identification of the Hazards of Materials for Emergency Response</i>	F101.1, F101.2



## APPENDIX F—HAZARD RANKING

**TABLE F101.2**  
**FIRE FIGHTER WARNING PLACARD DESIGNATIONS BASED ON HAZARD CLASSIFICATION CATEGORIES**

HAZARD CATEGORY	DESIGNATION
Combustible liquid II	F2
Combustible liquid IIIA	F2
Combustible liquid IIIB	F1
Combustible dust	F3 or F2 <sup>a</sup>
Combustible fiber	F3
Cryogenic flammable	F4, H3
Cryogenic oxidizing	OX, H3
Explosive	R4
Flammable solid	F2
Flammable gas (gaseous)	F4
Flammable gas (liquefied)	F4
Flammable liquid IA	F4
Flammable liquid IB	F3
Flammable liquid IC	F3
Organic peroxide, UD	R4
Organic peroxide I	F4, R3
Organic peroxide II	F3, R3
Organic peroxide III	F2, R2
Organic peroxide IV	F1, R1
Organic peroxide V	None
Oxidizing gas (gaseous)	OX
Oxidizing gas (liquefied)	OX
Oxidizer 4	OX4
Oxidizer 3	OX3
Oxidizer 2	OX2
Oxidizer 1	OX1
Pyrophoric gases	F4
Pyrophoric solids, liquids	F3
Unstable reactive 4D	R4
Unstable reactive 3D	R4
Unstable reactive 3N	R2
Unstable reactive 2	R2
Unstable reactive 1	None
Water reactive 3	W3
Water reactive 2	W2
Corrosive	H3, COR
Toxic	H3
Highly toxic	H4

a. F3 = Finely divided solids, typically less than 75 micrometers (µm) (200 mesh), that pose an elevated risk of forming an ignitable dust cloud, such as finely divided sulfur, NFPA 70 Group E dusts (for example, aluminum, zirconium and titanium) and bisphenol A. F2 = Finely divided solids less than 420 µm (40 mesh) that pose an ordinary risk of forming an ignitable dust cloud.

F—Flammable category.

R—Reactive category.

H—Health category.

W—Special hazard: water reactive.

OX—Special hazard: oxidizing properties.

COR—Corrosive.

UD—Unclassified detonable material.

4D—Class 4 detonable material.

3D—Class 3 detonable material.

3N—Class 3 nondetonable material.

## APPENDIX G

# CRYOGENIC FLUIDS—WEIGHT AND VOLUME EQUIVALENTS

*This appendix is for information purposes and is not intended for adoption.*

---

### User note:

**About this appendix:** Appendix G gives the fire code official and registered design professional a ready reference tool for the conversion of the liquid weight and volume of cryogenic fluid to their corresponding volume of gas and vice versa and is a companion to the provisions of Chapter 55 of this code.

---

### SECTION G101 GENERAL

**G101.1 Scope.** This appendix is used to convert from liquid to gas for *cryogenic fluids*.

**G101.2 Conversion.** Table G101.2 shall be used to determine the equivalent amounts of *cryogenic fluids* in either the liquid or gas phase.

**G101.2.1 Use of the table.** To use Table G101.2, read horizontally across the line of interest. For example, to determine the number of cubic feet of gas contained in 1.0 gallon (3.785 L) of liquid argon, find 1.000 in the column entitled “Volume of Liquid at Normal *Boiling Point*.” Reading across the line under the column entitled “Volume of Gas at NTP” (70°F and 1 atmosphere/14.7 psia), the value of 112.45 cubic feet (3.184 m<sup>3</sup>) is found.

**G101.2.2 Other quantities.** If other quantities are of interest, the numbers can be multiplied or divided to obtain the quantity of interest. For example, to determine the number of cubic feet of argon gas contained in a volume of 1,000 gallons (3785 L) of liquid argon at its normal *boiling point*, multiply 112.45 by 1,000 to obtain 112,450 cubic feet (3184 m<sup>3</sup>).

## APPENDIX G—CRYOGENIC FLUIDS—WEIGHT AND VOLUME EQUIVALENTS

**TABLE G101.2**  
**WEIGHT AND VOLUME EQUIVALENTS FOR COMMON CRYOGENIC FLUIDS**

CRYOGENIC FLUID	WEIGHT OF LIQUID OR GAS		VOLUME OF LIQUID AT NORMAL BOILING POINT		VOLUME OF GAS AT NTP	
	Pounds	Kilograms	Liters	Gallons	Cubic feet	Cubic meters
Argon	1.000	0.454	0.326	0.086	9.67	0.274
	2.205	1.000	0.718	0.190	21.32	0.604
	3.072	1.393	1.000	0.264	29.71	0.841
	11.628	5.274	3.785	1.000	112.45	3.184
	10.340	4.690	3.366	0.889	100.00	2.832
	3.652	1.656	1.189	0.314	35.31	1.000
Helium	1.000	0.454	3.631	0.959	96.72	2.739
	2.205	1.000	8.006	2.115	213.23	6.038
	0.275	0.125	1.000	0.264	26.63	0.754
	1.042	0.473	3.785	1.000	100.82	2.855
	1.034	0.469	3.754	0.992	100.00	2.832
	0.365	0.166	1.326	0.350	35.31	1.000
Hydrogen	1.000	0.454	6.409	1.693	191.96	5.436
	2.205	1.000	14.130	3.733	423.20	11.984
	0.156	0.071	1.000	0.264	29.95	0.848
	0.591	0.268	3.785	1.000	113.37	3.210
	0.521	0.236	3.339	0.882	100.00	2.832
	0.184	0.083	1.179	0.311	35.31	1.000
Oxygen	1.000	0.454	0.397	0.105	12.00	0.342
	2.205	1.000	0.876	0.231	26.62	0.754
	2.517	1.142	1.000	0.264	30.39	0.861
	9.527	4.321	3.785	1.000	115.05	3.250
	8.281	3.756	3.290	0.869	100.00	2.832
	2.924	1.327	1.162	0.307	35.31	1.000
Nitrogen	1.000	0.454	0.561	0.148	13.80	0.391
	2.205	1.000	1.237	0.327	30.43	0.862
	1.782	0.808	1.000	0.264	24.60	0.697
	6.746	3.060	3.785	1.000	93.11	2.637
	7.245	3.286	4.065	1.074	100.00	2.832
	2.558	1.160	1.436	0.379	35.31	1.000
LNG <sup>a</sup>	1.000	0.454	1.052	0.278	22.968	0.650
	2.205	1.000	2.320	0.613	50.646	1.434
	0.951	0.431	1.000	0.264	21.812	0.618
	3.600	1.633	3.785	1.000	82.62	2.340
	4.356	1.976	4.580	1.210	100.00	2.832
	11.501	5.217	1.616	0.427	35.31	1.000

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 cubic foot = 0.02832 m<sup>3</sup>, °C = [(°F) – 32]/1.8, 1 pound per square inch atmosphere = 6.895 kPa.

a. The values listed for liquefied natural gas (LNG) are “typical” values. LNG is a mixture of hydrocarbon gases, and no two LNG streams have exactly the same composition.

## APPENDIX H

# HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix H is intended to assist businesses in establishing a Hazardous Materials Management Plan (HMMP) and Hazardous Materials Inventory Statement (HMIS) based on the classification and quantities of materials that would be found on-site in storage or use. The sample forms and available Safety Data Sheets (SDS) provide the basis for the evaluations. It is also a companion to Sections 407.5 and 407.6, which provide the requirement that the HMIS and HMMP be submitted where required by the fire code official.

### SECTION H101 HMMP

#### H101.1 Part A (see Example Format in Figure H101.1).

1. Fill out items and sign the declaration.
2. Part A of this section is required to be updated and submitted annually, or within 30 days of a process or management change.

#### H101.2 Part B—General Facility Description/Site Plan (see Example Format in Figure H101.2).

1. Provide a site plan on 8<sup>1</sup>/<sub>2</sub>-inch by 11-inch (215 mm by 279 mm) paper, showing the locations of all buildings, structures, outdoor chemical control or storage and use areas, parking lots, internal roads, storm and sanitary sewers, wells and adjacent property uses. Indicate the approximate scale, northern direction and date the drawing was completed.

#### H101.3 Part C—Facility Storage Map—Confidential Information (see Example Format in Figure H101.3).

1. Provide a floor plan of each building identified on the site plan as containing hazardous materials on 8<sup>1</sup>/<sub>2</sub>-inch by 11-inch (215 mm by 279 mm) paper, identifying the northern direction and showing the location of each storage and use area.
2. Identify storage and use areas, including hazard waste storage areas.
3. Show the following:
  - 3.1. Accesses to each storage and use area.
  - 3.2. Location of emergency equipment.
  - 3.3. Location where liaison will meet emergency responders.
  - 3.4. Facility evacuation meeting point locations.
  - 3.5. The general purpose of other areas within the building.
  - 3.6. Location of all above-ground and under-ground tanks to include sumps, vaults, below-grade treatment systems, piping, etc.

- 3.7. Hazard classes in each area.

- 3.8. Locations of all Group H occupancies, *control areas*, and exterior storage and use areas.

- 3.9. Emergency *exits*.

### SECTION H102 HMIS

#### H102.1 Inventory statement contents.

1. HMIS Summary Report (see Example Format in Table H102.1).
  - 1.1. Complete a summary report for each *control area* and Group H occupancy.
  - 1.2. The storage summary report includes the HMIS Inventory Report amounts in storage, use-closed and use-open conditions.
  - 1.3. Provide separate summary reports for storage, use-closed and use-open conditions.
  - 1.4. IBC/IFC Hazard Class.
  - 1.5. Inventory Amount [Solid (lb), Liquid (gal), Gas (cu ft, gal or lb)].
  - 1.6. IBC/IFC *maximum allowable quantity per control area* (MAQ). (If applicable, double MAQ for sprinkler protection and/or storage in cabinets. For wholesale and retail sales occupancies, go to Tables 5003.11.1 and 5704.3.4.1 of the *International Fire Code* for MAQs.)
2. HMIS Inventory Report (see Example Format in Figure H102.1).
  - 2.1. Complete an inventory report by listing products by location.
  - 2.2. Product name.
  - 2.3. Components. (For mixtures specify percentages of major components if available.)



## APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS

- 2.4. Chemical Abstract Service (CAS) Number. (For mixtures list CAS Numbers of major components if available.)
- 2.5. Location. (Identify the *control area* or, if it is a Group H occupancy, provide the classification, such as H-2 or H-3.)
- 2.6. Container with a capacity of greater than 55 gallons (208 L). (If product container, vessel or tank could exceed 55 gallons, indicate yes in column.)
- 2.7. Hazard Classification. (List applicable classifications for each product.)
- 2.8. Stored. (Amount of product in storage conditions.)
- 2.9. Closed. (Amount of product in use-*closed systems*.)
- 2.10. Open. (Amount of product in use-*open systems*.)

Facilities that have prepared, filed and submitted a Tier II Inventory Report required by the US Environmental Protection Agency (USEPA) or required by a state that has secured USEPA approval for a similar form shall be deemed to have complied with this section.

### SECTION H103 EMERGENCY PLAN

**H103.1 Emergency notification** (see Example Format in Figure H103.1). Where OSHA or state regulations require a facility to have either an Emergency Action Plan (EAP) or an Emergency Response Plan (ERP), the EAP or ERP shall be included as part of the HMMP.

### SECTION H104 SECURITY

**H104.1 General.** Hazardous materials storage, dispensing, use and handling areas shall be secured against unauthorized entry and safeguarded in a manner *approved* by the *fire code official*.

**H104.2 Chemical Facility Anti-Terrorism Standards (CFATS).** Chemical facilities deemed to be high risk by the US Department of Homeland Security shall be required to develop and implement security plans in accordance with the Chemical Facility Anti-Terrorism Standards set forth in DHS CFATS 6 CFR Part 27.

### SECTION H105 REFERENCED STANDARDS

**H105.1 General.** See Table H105.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE H105.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
DHS CFATS 6 CFR Part 27—2007	<i>Chemical Facility Anti-Terrorism Standards</i>	H104.2
IBC—21	<i>International Building Code</i>	H102.1

**APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND  
HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS**

1. Business Name: \_\_\_\_\_ Phone: \_\_\_\_\_  
Address: \_\_\_\_\_

2. Person Responsible for the Business  
Name: \_\_\_\_\_ Title: \_\_\_\_\_ Phone: \_\_\_\_\_

3. Emergency Contacts:

Name:	Title:	Home Number:	Work Number:
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

4. Person Responsible for the Application/Principal Contact:  
Name: \_\_\_\_\_ Title: \_\_\_\_\_ Phone: \_\_\_\_\_

5. Principal Business Activity:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

6. Number of Employees: \_\_\_\_\_

7. Number of Shifts: \_\_\_\_\_  
a. Number of Employees per Shift:  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

8. Hours of Operation: \_\_\_\_\_

**FIGURE H101.1  
HAZARDOUS MATERIALS MANAGEMENT PLAN  
SECTION I: FACILITY DESCRIPTION**



## APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS

[illegible]

<b>Business Name</b>	<b>Date</b>
<b>Address</b>	<b>Page of</b>

**FIGURE H101.3**  
**HAZARDOUS MATERIALS MANAGEMENT PLAN**  
**SECTION I: FACILITY DESCRIPTION PART C—FACILITY MAP**



**APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND  
HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS**

Product Name (Components) <sup>c</sup>	CAS Number	Location <sup>a</sup>	Container > 55 gal <sup>b</sup>	Haz Class 1	Haz Class 2	Haz Class 3	Stored (lbs)	Stored (gal)	Stored (gas) <sup>d</sup>	Closed (lbs)	Closed (gal)	Closed gas <sup>d</sup>	Open (lbs)	Open (gal)
<b>ACETYLENE</b> (Acetylene gas)	74-86-2	Control Area 1		FLG	UR2				150					
<b>BLACK AEROSOL SPRAY PAINT</b> (Mixture)	Mixture	Control Area 1		A-L3			24							
<b>GASOLINE, UNLEADED</b> (Gasoline-Mixture) Methyl-t-Butyl-Ether-15% Diisopropyl Ether-7% Ethanol-11% Toluene-12% Xylene-11%	8006-61-9 1634-04-4 108-20-3 64-17-5 108-88-3 1330-20-7	Control Area 1		F1B				5						
<b>MOTOR OIL-10W40</b> (Hydrotreated Heavy Paraffinic Distillate-85%; Additives-20%)	64742-54-7 Mixture	Control Area 1		C3B				3						
<b>DIESEL</b> (Diesel-99-100%; Additives)	68476-34-6 Proprietary	Control Area 2	Yes	C2				225						
<b>TRANSMISSION FLUID</b> (Oil-Solvent-Neutral; Performance Additives)	64742-65-0	Control Area 2		C3B				3						
<b>OXYGEN, GAS</b> (Oxygen)	7782-44-7	H-3		OXG					5,000					

a. Identify the control area or, if it is a Group H occupancy, provide the classification, such as H-2, H-3, etc.

b. If the product container, vessel or tank could exceed 55 gallons, indicate yes in the column.

c. Specify percentages of main components if available.

d. In cubic feet, gallons or pounds.

(This is an example; add additional hazard classes as needed.)

**FIGURE H102.1**

**SECTION II—HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INVENTORY REPORT**  
(Sort Products Alphabetically by Location of Product and Then Alphabetically by Product Name)

**APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND  
HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS**

**TABLE H102.1  
SECTION II—HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) SUMMARY REPORT<sup>a</sup> (Storage<sup>b</sup> Conditions)<sup>c</sup>**

IBC/IFC HAZARD CLASS	HAZARD CLASS (Abbrev)	INVENTORY AMOUNT			IBC/IFC MAXIMUM ALLOWABLE QUANTITY <sup>d</sup>		
		Solid (lb)	Liquid (gal)	Gas (cu ft, gal, lb)	Solid (lb)	Liquid (gal)	Gas (cu ft, gal, lb)
Combustible Liquids	C2		5			120	
	C3A					330	
	C3B		6			13,200	
Combustible Fiber	Loose/Baled						
Cryogenics, Flammable	Cryo-Flam					45	
Cryogenic, Oxidizing	Cryo-OX					45	
Flammable Gas	FLG						
(Gaseous)				150			1,000
(Liquefied)						30	
Flammable Liquid	F1A					30	
	F1B & F1C		5			120	
Combination (1A, 1B, 1C)			5			120	
Flammable Solid	FLS				125		
Organic Peroxide	OPU				0		
	OP1				5		
	OP2				50		
	OP3				125		
	OP4				NL		
	OP5				NL		
Oxidizer	OX4				0		
	OX3				10		
	OX2				250		
	OX1				4,000		

a. Complete a summary report for each control area and Group H occupancy.

b. Storage = storage + use-closed + use-open systems.

c. Separate reports are required for use-closed and use-open systems.

d. Include increases for sprinklers or storage in cabinets, if applicable.

(This is an example; add additional hazard classes as needed.)

**APPENDIX H—HAZARDOUS MATERIALS MANAGEMENT PLAN (HMMP) AND  
HAZARDOUS MATERIALS INVENTORY STATEMENT (HMIS) INSTRUCTIONS**

1. In the event of an emergency, the following shall be notified:
- a. Facility Liaison

Name	Title	Home Number	Work Number
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

- b. Agency

Agency	Contact	Phone Number
Fire Department	_____	_____
LEPC	_____	_____
Other	_____	_____

**FIGURE H103.1  
HAZARDOUS MATERIALS MANAGEMENT PLAN  
SECTION III: EMERGENCY PLAN**

## APPENDIX I

## FIRE PROTECTION SYSTEMS—NONCOMPLIANT CONDITIONS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

**User note:**

**About this appendix:** Appendix I, which was developed by the ICC Hazard Abatement in Existing Buildings Committee, is intended to provide the fire code official with a list of conditions that are readily identifiable by the inspector during the course of an inspection utilizing this code. The specific conditions identified in this appendix are primarily derived from applicable NFPA standards and pose a hazard to the proper operation of the respective systems. While these do not represent all of the conditions that pose a hazard or otherwise may impair the proper operation of fire protection systems, their identification in this adoptable appendix will provide a more direct path for enforcement by the fire code official.

### SECTION I101 NONCOMPLIANT CONDITIONS

**I101.1 General.** This appendix is intended to identify conditions that can occur where *fire protection systems* are not properly maintained or components have been damaged. This appendix is not intended to provide comprehensive inspection, testing and maintenance requirements, which are found in NFPA 10, 25 and 72. Rather, it is intended to identify problems that are readily observable during fire inspections.

**I101.2 Noncompliant conditions requiring component replacement.** The following conditions shall be deemed noncompliant and shall cause the related component(s) to be replaced to comply with the provisions of this code:

1. Sprinkler heads having any of the following conditions:
  - 1.1. Signs of leakage.
  - 1.2. Paint or other ornamentation that is not factory applied.
  - 1.3. Evidence of corrosion including, but not limited to, discoloration or rust.
  - 1.4. Deformation or damage of any part.
  - 1.5. Improper orientation of sprinkler head.
  - 1.6. Empty glass bulb.
  - 1.7. Sprinkler heads manufactured prior to 1920.
  - 1.8. Replacement sprinkler heads that do not match existing sprinkler heads in orifice size, K-factor temperature rating, coating or deflector type.
  - 1.9. Sprinkler heads for the protection of cooking equipment that have not been replaced within one year.
2. Water pressure and air pressure gauges that have been installed for more than 5 years and have not been tested to within 3 percent accuracy.

**I101.3 Noncompliant conditions requiring component repair or replacement.** The following shall be deemed noncompliant conditions and shall cause the related compo-

nent(s) to be repaired or replaced to comply with the provisions of this code:

1. Sprinkler and standpipe system piping and fittings having any of the following conditions:
  - 1.1. Signs of leakage.
  - 1.2. Evidence of corrosion.
  - 1.3. Misalignment.
  - 1.4. Mechanical damage.
2. Sprinkler piping support having any of the following conditions:
  - 2.1. Materials resting on or hung from sprinkler piping.
  - 2.2. Damaged or loose hangers or braces.
3. Class II and Class III standpipe systems having any of the following conditions:
  - 3.1. No hose or nozzle, where required.
  - 3.2. Hose threads incompatible with fire department hose threads.
  - 3.3. Hose connection cap missing.
  - 3.4. Mildew, cuts, abrasions and deterioration evident.
  - 3.5. Coupling damaged.
  - 3.6. Gaskets missing or deteriorated.
  - 3.7. Nozzle missing or obstructed.
4. Hose racks and cabinets having any of the following conditions:
  - 4.1. Difficult to operate or damaged.
  - 4.2. Hose improperly racked or rolled.
  - 4.3. Inability of rack to swing 90 degrees (1.57 rad) out of the cabinet.
  - 4.4. Cabinet locked, except as permitted by this code.
  - 4.5. Cabinet door will not fully open.
  - 4.6. Door glazing cracked or broken.



## APPENDIX I—FIRE PROTECTION SYSTEMS—NONCOMPLIANT CONDITIONS

5. Portable fire extinguishers having any of the following conditions:
  - 5.1. Broken seal or tamper indicator.
  - 5.2. Expired maintenance tag.
  - 5.3. Pressure gauge indicator in “red.”
  - 5.4. Signs of leakage or corrosion.
  - 5.5. Mechanical damage, denting or abrasion of tank.
  - 5.6. Presence of repairs such as welding, soldering or brazing.
  - 5.7. Damaged threads.
  - 5.8. Damaged hose assembly, couplings or swivel joints.
6. Fire alarm and detection control equipment, initiating devices and notification appliances having any of the following conditions:
  - 6.1. Corroded or leaking batteries or terminals.
  - 6.2. Smoke detectors having paint or other ornamentation that is not factory applied.
  - 6.3. Mechanical damage to heat or smoke detectors.
  - 6.4. Tripped fuses.
7. Fire department connections having any of the following conditions:
  - 7.1. Fire department connections are not visible or able to be accessed from the fire apparatus access road.
  - 7.2. Couplings or swivels are damaged.
  - 7.3. Plugs and caps are missing or damaged.
  - 7.4. Gaskets are deteriorated.
  - 7.5. Check valve is leaking.
  - 7.6. Identification signs are missing.
8. Fire pumps having any of the following conditions:
  - 8.1. Pump room temperature is less than 40°F (4.4°C).
  - 8.2. Ventilating louvers are not freely operable.
  - 8.3. Corroded or leaking system piping.
  - 8.4. Diesel fuel tank is less than two-thirds full.
  - 8.5. Battery readings, lubrication oil or cooling water levels are abnormal.

## SECTION I102 REFERENCED STANDARDS

**I102.1 General.** See Table I102.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE I102.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
NFPA 10—21	<i>Portable Fire Extinguishers</i>	I101.1
NFPA 25—20	<i>Inspection, Testing and Maintenance of Water-based Fire Protection Systems</i>	I101.1
NFPA 72—19	<i>National Fire Alarm and Signaling Code</i>	I101.1

## APPENDIX J

# BUILDING INFORMATION SIGN

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix J provides design, installation and maintenance requirements for a Building Information Sign (BIS), a fire service tool to be utilized in the crucial, initial response of fire fighters to a structure fire. The BIS placard is designed to be utilized within the initial response time frame of an incident to assist fire fighters in their tactical sizing up of a situation as soon as possible after arrival on the scene of a fire emergency. The BIS design is in the shape of a fire service Maltese cross and includes five spaces (the four wings plus the centerpiece of the cross symbol) in which information is placed about the tactical considerations of construction type and hourly rating, fire protection systems, occupancy type, content hazards and special features that could affect tactical decisions and operations.

### SECTION J101 GENERAL

**J101.1 Scope.** New buildings shall have a building information sign(s) that shall comply with Sections J101.1.1 through J101.7. Existing buildings shall be brought into compliance with Sections J101.1 through J101.9 when one of the following occurs:

1. The fire department conducts an annual inspection intended to verify compliance with this section, or any required inspection.
2. A change in use or occupancy has occurred.

#### Exceptions:

1. Group U occupancies.
2. One- and two-family dwellings.

**J101.1.1 Sign location.** The building information sign shall be placed at one of the following locations:

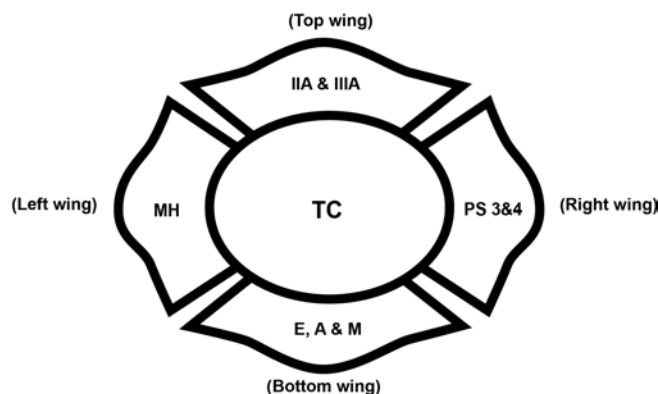
1. On the entry door or sidelight at a minimum height of 42 inches (1067 mm) above the walking surface on the address side of the building or structure.
2. On the exterior surface of the building or structure on either side of the entry door, not more than 3 feet (914 mm) from the entrance door, at a minimum height of 42 inches (1067 mm) above the walking surface on the address side of the building or structure.
3. Conspicuously placed inside an enclosed entrance lobby, on any vertical surface within 10 feet (3048 mm) of the entrance door at a minimum height of 42 inches (1067 mm) above the walking surface.
4. Inside the building's fire command center.
5. On the exterior of the fire alarm control unit or on the wall immediately adjacent to the fire alarm control unit door where the alarm panel is located in the enclosed main lobby.

**J101.1.2 Sign features.** The building information sign shall consist of all of the following:

1. White reflective background with red letters.

2. Durable material.
3. Numerals shall be Roman or Latin numerals, as required, or alphabet letters.
4. Permanently affixed to the building or structure in an approved manner.

**J101.1.3 Sign shape.** The building information sign shall be a Maltese cross as shown in Figure J101.1.3.



**FIGURE J101.1.3  
EXAMPLE OF COMPLETED BUILDING INFORMATION SIGN**

**J101.1.4 Sign size and lettering.** The minimum size of the building information sign and lettering shall be in accordance with the following:

1. The width and height shall be 6 inches by 6 inches (152 mm by 152 mm).
2. The height or width of each Maltese cross wing area shall be  $1\frac{1}{8}$  inches (29 mm) and have a stroke width of  $\frac{1}{2}$  inch (12.7 mm).
3. The center of the Maltese cross, a circle or oval, shall be 3 inches (76 mm) in diameter and have a stroke width of  $\frac{1}{2}$  inch (12.7 mm).
4. All Roman numerals and alphabetic designations, shall be  $1\frac{1}{4}$  inch (32 mm) in height and have a stroke width of  $\frac{1}{4}$  inch (6.4 mm).

**J101.2 Sign designations.** Designations shall be made based on the construction type, content, hazard, fire protection

## APPENDIX J—BUILDING INFORMATION SIGN

systems, life safety and occupancy. Where multiple designations occur within a classification category, the designation used shall be based on the greatest potential risk.

**J101.3 Construction type (top wing).** The construction types shall be designated by assigning the appropriate Roman numeral and letter, placed inside the top wing of the Maltese cross. The hourly rating provided is for the structural framing in accordance with Table 601 of the *International Building Code*,

CONSTRUCTION TYPE	FIRE-RESISTANCE RATING
IA—Noncombustible	3 hours
IB—Noncombustible	2 hours
IIA—Noncombustible	1 hour
IIB—Noncombustible	0 hours
IIIA—Noncombustible/combustible	1 hour
IIIB—Noncombustible/combustible	0 hours
IV—Heavy timber (HT)	HT
VA—Combustible	1 hour
VB—Combustible	0 hours

**J101.4 Fire protection systems (right wing).** The fire protection system shall be designated by determining its level of protection and assigning the appropriate designation to the right wing of the Maltese cross. Where multiple systems are provided, all shall be listed:

AS	Automatic sprinkler system installed throughout
CES	Chemical-extinguishing system and designated area
CS	Combination sprinkler and standpipe system
DS	Dry sprinkler system and designated areas
FA	Fire alarm system
FP	Fire pump
FW	Fire wall and designated areas
PAS	Pre-action sprinkler system and designated floor
PS	Partial automatic sprinkler system, and designated floor
S	Standpipe system
NS	No system installed

**J101.5 Occupancy type (bottom wing).** The occupancy of a building or structure shall be designated in accordance with the occupancy classification found in Section 302.1 of the *International Building Code* and the corresponding designation shall be placed in the bottom wing of the Maltese cross. Where a building or structure contains a mixture of uses and occupancies, all uses and occupancies shall be identified.

A	Assembly
B	Business
E	Educational
F	Factory or Industrial
H	High Hazard
I	Institutional

M	Mercantile
R	Residential

**J101.6 Hazards of content (left wing).** The hazards of building contents shall be designated by one of the following classifications as defined in NFPA 13 and the appropriate designation shall be placed inside the left wing of the Maltese cross:

LH	Light hazard
MH	Moderate hazard
HH	High hazard

**J101.7 Tactical considerations (center circle).** The center circle shall include the name of the local fire service and, where required, the letters “TC” for “tactical considerations.” Where fire fighters conduct preplan operations, a unique situation(s) for tactical considerations shall be identified and the information provided to the fire dispatch communications center to further assist fire fighters in identifying that there is special consideration(s) for this occupancy. Special consideration designations include, but are not limited to:

1. Impact-resistant drywall.
2. Impact-resistant glazing, such as blast or hurricane-type glass.
3. All types of roof and floor structural members including but not limited to post-tension concrete, bar joists, solid wood joists, rafters, trusses, cold-formed galvanized steel, I-joists and I-beams; green roof with vegetation, soil and plants.
4. Hazardous materials (such as *explosives*, chemicals, plastics).
5. Solar panels and DC electrical energy.
6. HVAC system; and smoke management system for pressurization and exhaust methods.
7. Other unique characteristic(s) within the building that are ranked according to a potential risk to occupants and fire fighters.

**J101.8 Sign classification maintenance, building information.** Sign maintenance shall comply with each of the following:

1. Fire departments in the jurisdiction shall define the designations to be placed within the sign.
2. Fire departments in the jurisdiction shall conduct annual inspections to verify compliance with this section of the code and shall notify the *owner*, or the *owner's* agent, of any required updates to the sign in accordance with fire department designations and the *owner*, or the *owner's* agent, shall comply within 30 days.
3. The owner of a building shall be responsible for the maintenance and updates to the sign in accordance with fire department designations.

**J101.9 Training.** Jurisdictions shall train fire department personnel on Sections J101.1 through J101.8.

## SECTION J102

### REFERENCED STANDARDS

**J102.1 General.** See Table J102.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE J102.1**  
**REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
IBC—21	<i>International Building Code</i>	J101.3, J101.5
NFPA 13—19	<i>Installation of Sprinkler Systems</i>	J101.6





## APPENDIX K

# CONSTRUCTION REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix K was created with the intent to provide jurisdictions with an option for assessing minimum fire and life safety requirements for buildings containing ambulatory care facilities. While this appendix is written with the intent to apply retroactive minimum standards, it is recognized that the ambulatory care requirements are relatively recent additions to the International Building Code®. For that reason, these requirements are presented as an appendix so that the adopting authority can exercise judgment in the adoption and application of this section. This appendix would also be useful for those local and state jurisdictions that are specifically focused on ensuring the safety of existing ambulatory care facilities by providing minimum criteria that could be used to bring older facilities into compliance with the current standards at the discretion of the adopting jurisdiction. The technical requirements are based on the current International Building Code language, which is consistent with the overall concept of the current federal requirements.

### SECTION K101 GENERAL

**K101.1 Scope.** The provisions of this chapter shall apply to existing buildings containing ambulatory care facilities in addition to the requirements of Chapter 11. Where the provisions of this chapter conflict with either the construction requirements in Chapter 11 or the construction requirements that applied at the time of construction, the most restrictive provision shall apply.

**K101.2 Intent.** The intent of this appendix is to provide a minimum degree of fire and life safety to persons occupying existing buildings containing ambulatory care facilities where such buildings do not comply with the minimum requirements of the *International Building Code*.

### SECTION K102 FIRE SAFETY REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

**K102.1 Separation.** Ambulatory care facilities where the potential exists for four or more care recipients to be incapable of self-preservation at any time, whether rendered incapable by staff or staff has accepted responsibility for a care recipient already incapable, shall be separated from adjacent spaces, *corridors* or tenants with a *fire partition* installed in accordance with Section 708 of the *International Building Code*.

**K102.2 Smoke compartments.** Where the aggregate area of one or more ambulatory care facilities is greater than 10,000 square feet (929 m<sup>2</sup>) on one story, the story shall be provided with a *smoke barrier* to subdivide the story into not fewer than two *smoke compartments*. The area of any one such *smoke compartment* shall be not greater than 22,500 square feet (2092 m<sup>2</sup>). The travel distance from any point in a *smoke compartment* to a *smoke barrier* door shall be not greater than 200 feet (60 960 mm). The *smoke barrier* shall be installed in accordance with Section 709 of the *International*

*Building Code* with the exception that *smoke barriers* shall be continuous from an outside wall to an outside wall, a floor to a floor, or from a *smoke barrier* to a *smoke barrier* or a combination thereof.

**K102.2.1 Refuge area.** Not less than 30 net square feet (2.8 m<sup>2</sup>) for each nonambulatory care recipient shall be provided within the aggregate area of *corridors*, care recipient rooms, treatment rooms, lounge or dining areas and other low-hazard areas within each *smoke compartment*. Each occupant of an ambulatory care facility shall be provided with access to a refuge area without passing through or utilizing adjacent tenant spaces.

**K102.2.2 Smoke barriers.** *Smoke barriers* shall be constructed in accordance with Sections 422 and 709 of the *International Building Code*.

#### Exceptions:

1. *Smoke barriers* shall be permitted to terminate at an atrium enclosure in accordance with Section 404.6 of the *International Building Code*.
2. *Smoke barriers* shall be continuous from an outside wall to an outside wall, a floor to a floor, a *smoke barrier* to a *smoke barrier* or a combination thereof.

**K102.2.3 Opening protectives.** Openings in *smoke barriers* shall be protected in accordance with Section 716 of the *International Building Code*. Opening protectives shall have a minimum *fire protection rating* of  $\frac{1}{3}$  hour.

**Exception:** Existing wired glass vision panels in doors shall be permitted to remain.

**K102.2.4 Penetrations.** Penetrations of *smoke barriers* shall comply with the *International Building Code*.

**Exception:** *Approved* existing materials and methods of construction.

## APPENDIX K—CONSTRUCTION REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

**K102.2.5 Joints.** Joints made in or between *smoke barriers* shall comply with the *International Building Code*.

**Exception:** *Approved* existing materials and methods of construction.

**K102.2.6 Duct and air transfer openings.** Penetrations in a *smoke barrier* by duct and air-transfer openings shall comply with Section 717 of the *International Building Code*.

**Exception:** Where existing duct and air-transfer openings in *smoke barriers* exist without smoke dampers, they shall be permitted to remain. Any changes to existing smoke dampers shall be submitted for review and *approved* in accordance with Section 717 of the *International Building Code*.

**K102.2.7 Independent egress.** A *means of egress* shall be provided from each *smoke compartment* created by *smoke barriers* without having to return through the *smoke compartment* from which *means of egress* originated.

**K102.3 Automatic sprinkler system.** An *automatic sprinkler system* shall be provided in ambulatory care facilities where required by Sections K102.3.1 and K102.3.2.

**K102.3.1 Types IIB, IIIB and VB construction.** An *automatic sprinkler system* shall be provided throughout the entire floor containing an ambulatory care facility in Types IIB, IIIB and VB construction where either of the following conditions exist at any time:

1. Four or more care recipients are rendered incapable of self-preservation.
2. One or more care recipients that are rendered incapable of self-preservation are located at other than the *level of exit discharge* serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor where such care is provided, all floors below and all floors between the level of ambulatory care and the nearest *level of exit discharge*, including the *level of exit discharge*.

**K102.3.2 High-rise buildings.** In high-rise buildings containing ambulatory care facilities, an *automatic sprinkler system* shall be provided throughout the entire floor containing an ambulatory care facility where either of the following conditions exist at any time:

1. Four or more care recipients are rendered incapable of self-preservation.
2. One or more care recipients that are rendered incapable of self-preservation are located at other than the *level of exit discharge* serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor where such care is provided, all floors below and all floors between the level of ambulatory care and the nearest *level of exit discharge*, including the *level of exit discharge*.

**K102.4 Automatic fire alarm system.** *Fire areas* containing ambulatory care facilities shall be provided with an electronically supervised automatic smoke detection system installed within the ambulatory care facility and in public use areas outside of tenant spaces, including *public corridors* and elevator lobbies.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, provided that the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

**K102.5 Waste and linen chutes.** In ambulatory care facilities, existing waste and linen chutes shall comply with Sections K102.5.1 through K102.5.5.

**K102.5.1 Enclosures.** Chutes shall be enclosed with 1-hour *fire-resistance-rated* construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**K102.5.2 Chute intakes.** Chute intakes shall comply with Section K102.5.2.1 or K102.5.2.2.

**K102.5.2.1 Chute intake direct from corridor.** Where intake to chutes is direct from a *corridor*, the intake opening shall be equipped with a chute-intake door in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**K102.5.2.2 Chute intake via a chute-intake room.** Where the intake to chutes is accessed through a chute-intake room, the room shall be enclosed with 1-hour *fire-resistance-rated* construction. Opening protectives for the intake room shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than  $\frac{3}{4}$  hour. Opening protectives for the chute enclosure shall be in accordance with Section K102.5.1.

**K102.5.3 Automatic sprinkler system.** Chutes shall be equipped with an *approved automatic sprinkler system* in accordance with Section 903.2.11.2.

**K102.5.4 Chute discharge rooms.** Chutes shall terminate in a dedicated chute discharge room. Such rooms shall be separated from the remainder of the building by not less than 1-hour *fire-resistance-rated* construction. Opening protectives shall be in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

**K102.5.5 Chute discharge protection.** Chute discharges shall be equipped with a self-closing or automatic-closing opening protective in accordance with Section 716 of the *International Building Code* and have a *fire protection rating* of not less than 1 hour.

## APPENDIX K—CONSTRUCTION REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

### SECTION K103 INCIDENTAL USES IN EXISTING AMBULATORY CARE FACILITIES

**K103.1 General.** Incidental uses associated with and located within existing ambulatory care facilities required to be separated by Section 422 of the *International Building Code*, and that generally pose a greater level of risk to such occupancies, shall comply with the provisions of Sections K103.2 through K103.4.2.1. Incidental uses in ambulatory care facilities required to be separated by Section 422 of the *International Building Code* are limited to those listed in Table K103.1.

**K103.2 Occupancy classification.** Incidental uses shall not be individually classified in accordance with Section 302.1 of the *International Building Code*. Incidental uses shall be included in the building occupancies in which they are located.

**K103.3 Area limitations.** Incidental uses shall not occupy more than 10 percent of the *building area* of the story in which they are located.

**K103.4 Separation and protection.** The incidental uses listed in Table K103.1 shall be separated from the remainder of the building or be equipped with an *automatic sprinkler system*, or both, in accordance with the provisions of that table.

**K103.4.1 Separation.** Where Table K103.1 specifies a *fire-resistance-rated* separation, the incidental uses shall be separated from the remainder of the building in accordance with Section 509.4.1 of the *International Building Code*.

**K103.4.2 Protection.** Where Table K103.1 permits an *automatic sprinkler system* without a *fire-resistance-rated* separation, the incidental uses shall be separated from the remainder of the building by construction capa-

ble of resisting the passage of smoke in accordance with Section 509.4.2 of the *International Building Code*.

**K103.4.2.1 Protection limitation.** Except as otherwise specified in Table K103.1 for certain incidental uses, where an *automatic sprinkler system* is provided in accordance with Table K103.1, only the space occupied by the incidental use need be equipped with such a system.

### SECTION K104 MEANS OF EGRESS REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

**K104.1 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear opening width of 28 inches (711 mm). Where this section requires a minimum clear opening width of 28 inches (711 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a minimum clear opening width of 28 inches (711 mm). In ambulatory care facilities, doors serving as *means of egress* from patient treatment rooms shall provide a minimum clear opening width of 32 inches (813 mm). The maximum width of a swinging door leaf shall be 48 inches (1219 mm) nominal. The minimum clear opening height of doors shall be 80 inches (2032 mm).

#### Exceptions:

1. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum clear opening width.
2. The width of door leaves in revolving doors that comply with Section 1010.3.1 shall not be limited.
3. The maximum width of door leaves in revolving doors that comply with Section 1010.3.2 shall not be limited.

TABLE K103.1  
INCIDENTAL USES IN EXISTING AMBULATORY CARE FACILITIES

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen fuel gas rooms, not classified as Group H	1 hour
Incinerator rooms	2 hours and provide automatic sprinkler system
Laboratories not classified as Group H	1 hour or provide automatic sprinkler system
Laundry rooms over 100 square feet	1 hour or provide automatic sprinkler system
Waste and linen collection rooms with containers with total volume of 10 cubic feet or greater	1 hour or provide automatic sprinkler system
Storage rooms greater than 100 square feet	1 hour or provide automatic sprinkler system
Stationary storage battery systems having a liquid electrolyte capacity of more than 50 gallons for flooded lead-acid, nickel cadmium or VRLA, or more than 1,000 pounds for lithium-ion and lithium metal polymer used for facility standby power, emergency power or uninterruptible power supplies	1 hour

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch (psi) = 6.9 kPa, 1 British thermal unit (Btu) per hour = 0.293 watts, 1 horsepower = 746 watts, 1 gallon = 3.785 L.



## APPENDIX K—CONSTRUCTION REQUIREMENTS FOR EXISTING AMBULATORY CARE FACILITIES

4. *Exit access* doors serving a room not larger than 70 square feet (6.5 m<sup>2</sup>) shall have a door leaf width of not less than 24 inches (610 mm).
5. Door closers and door stops shall be permitted to be 78 inches (1981 mm) minimum above the floor.

**K104.2 Corridor and aisle width.** *Corridor* width shall be as determined in Section 1005.1 and this section. The minimum width of *corridors* and *aisles* that serve gurney traffic in areas where patients receive care that causes them to be incapable of self-preservation shall be not less than 72 inches (1829 mm).

**K104.3 Existing elevators.** Existing elevators, escalators, dumbwaiters and moving walks shall comply with the requirements of Sections K104.3.1 and K104.3.2.

**K104.3.1 Elevators, escalators, dumbwaiters and moving walks.** Existing elevators, escalators, dumbwaiters and moving walks in ambulatory care facilities required to be separated by Section 422 of the *International Building Code* shall comply with ASME A17.3.

**K104.3.2 Elevator emergency operation.** Existing elevators with a travel distance of 25 feet (7620 mm) or more above or below the main floor or other level of a building and intended to serve the needs of emergency personnel for fire-fighting or rescue purposes shall be provided with emergency operation in accordance with ASME A17.3.

### SECTION K105 REFERENCED STANDARDS

**K105.1 General.** See Table K105.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE K105.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
IBC—21	<i>International Building Code</i>	K101.2, K102.1, K102.2, K102.2.2, K102.2.3, K102.2.4, K102.2.5, K102.2.6, K102.5.1, K102.5.2.1, K102.5.2.2, K102.5.4, K102.5.5, K103.1, K103.2, K103.4.1, K103.4.2, K104.3.1
ASME A17.3—2020	<i>Safety Code for Existing Elevators and Escalators</i>	K104.3.1, K104.3.2

## APPENDIX L

# REQUIREMENTS FOR FIRE FIGHTER AIR REPLENISHMENT SYSTEMS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix L provides for the design, installation and maintenance of permanently installed fire fighter breathing air systems in buildings designated by the jurisdiction. Breathing air is critical for fire-fighting operations. Historically, fire departments have supplied air bottles by means of a “bottle brigade,” whereby fire fighters manually transport air bottles up stairways, which is an extraordinarily fire fighter-intensive process and takes fire fighters away from their primary mission of rescue and fire fighting. Technology now exists to address the issue using in-building air supply systems. Fire fighter breathing air systems were introduced in the late 1980s and are now required in a number of communities throughout the United States. The system has been called a “standpipe for air” and consists of stainless steel, high-pressure piping that is supplied by on-site air storage or fire department air supply units. Air-filling stations are then strategically located throughout the building, allowing fire fighters to refill breathing air cylinders inside the fire building, negating the required “bottle brigade,” and making more fire fighters available for search, rescue and fire suppression operations.

### SECTION L101 GENERAL

**L101.1 Scope.** Fire fighter air replenishment systems (FARS) shall be provided in accordance with this appendix. The adopting ordinance shall specify building characteristics or special hazards that establish thresholds triggering a requirement for the installation of a FARS. The requirement shall be based on the fire department’s capability of replenishing fire fighter breathing air during sustained emergency operations. Considerations shall include:

1. Building characteristics, such as number of stories above or below *grade plane*, floor area, type of construction and fire resistance of the primary structural *frame* to allow sustained fire-fighting operations based on a rating of not less than 2 hours.
2. Special hazards, other than buildings, that require unique accommodations to allow the fire department to replenish fire fighter breathing air.
3. Fire department staffing level.
4. Availability of a fire department breathing air replenishment vehicle.

### SECTION L102 DEFINITIONS

**L102.1 Definitions.** For the purpose of this appendix, certain terms are defined as follows:

**FIRE FIGHTER AIR REPLENISHMENT SYSTEM (FARS).** A permanently installed arrangement of piping, valves, fittings and equipment to facilitate the replenishment of breathing air in self-contained breathing apparatus (SCBA) for fire fighters engaged in emergency operations.

### SECTION L103 PERMITS

**L103.1 Permits.** Permits shall be required to install and maintain a FARS. Permits shall be in accordance with Sections L103.2 and L103.3.

**L103.2 Construction permit.** A construction permit is required for installation of or modification to a FARS. The construction permit application shall include documentation of an acceptance and testing plan as specified in Section L105.

**L103.3 Operational permit.** An operational permit is required to maintain a FARS.

### SECTION L104 DESIGN AND INSTALLATION

**L104.1 Design and installation.** A FARS shall be designed and installed in accordance with Sections L104.2 through L104.15.3.

**L104.2 Standards.** Fire fighter air replenishment systems shall be in accordance with Sections L104.2.1 and L104.2.2.

**L104.2.1 Pressurized system components.** Pressurized system components shall be designed and installed in accordance with ASME B31.3.

**L104.2.2 Air quality.** The system shall be designed to convey breathing air complying with NFPA 1989.

**L104.3 Design and operating pressure.** The minimum design pressure shall be 110 percent of the fire department’s normal SCBA fill pressure. The system design pressure shall be marked in an *approved* manner at the supply connections, and adjacent to pressure gauges on any fixed air supply components. Pressure shall be maintained in the system within 5 percent of the design pressure.

**L104.4 Cylinder refill rate.** The FARS shall be capable of refilling breathing air cylinders of a size and pressure used

## APPENDIX L—REQUIREMENTS FOR FIRE FIGHTER AIR REPLENISHMENT SYSTEMS

by the fire department at a rate of not less than two empty cylinders in 2 minutes.

**L104.5 Breathing air supply.** Where a fire department mobile air unit is available, the FARS shall be supplied by an external mobile air connection in accordance with Section L104.14. Where a fire department mobile air unit is not available, a stored pressure air supply shall be provided in accordance with Section L104.5.1. A stored pressure air supply shall be permitted to be added to a system supplied by an external mobile air connection provided that a means to bypass the stored pressure air supply is located at the external mobile air connection.

**L104.5.1 Stored pressure air supply.** A stored pressure air supply shall be designed based on Chapter 24 of NFPA 1901 except that provisions applicable only to mobile apparatus or not applicable to system design shall not apply. A stored pressure air supply shall be capable of refilling not less than 50 empty breathing air cylinders of a size and pressure used by the fire department.

**L104.5.2 Retrofit of external mobile air connection.** A FARS not initially provided with an external mobile air connection due to the lack of a mobile air unit shall be retrofitted with an external mobile air connection where a mobile air unit becomes available. Where an external mobile air connection is provided, a means to bypass the stored pressure air supply shall be located at the external mobile air connection. The retrofit shall be completed not more than 12 months after notification by the *fire code official*.

**L104.6 Isolation valves.** System isolation valves that are accessible to the fire department shall be installed on the system riser to allow piping beyond any air cylinder refill panel to be blocked.

**L104.7 Pressure relief valve.** Pressure relief valves shall be installed at each point of supply and at the top or end of every riser. The relief valve shall meet the requirements of CGA S-1.3 and shall not be field adjustable. Pressure relief valves shall discharge in a manner that does not endanger personnel who are in the area. Valves, plugs or caps shall not be installed in the discharge of a pressure relief valve. Where discharge piping is used the end shall not be threaded.

**L104.8 Materials and equipment.** Pressurized system components shall be *listed* or *approved* for their intended use and rated for the maximum allowable design pressure in the system. Piping and fittings shall be stainless steel.

**L104.9 Welded connections.** Piping connections that are concealed shall be welded.

**L104.10 Protection of piping.** System piping shall be protected from physical damage in an *approved* manner.

**L104.11 Compatibility.** Fittings and connections intended to be used by the fire department shall be compatible with the fire department's equipment.

**L104.12 Security.** Connections to a FARS shall be safeguarded from unauthorized access in an *approved* manner.

**L104.13 Fill stations.** Fire fighter air replenishment fill stations shall comply with Section L104.13.1 through L104.13.3.

**L104.13.1 Location.** Fill stations for refilling breathing air cylinders shall be located as follows:

1. Fill stations shall be provided at the fifth floor above and below the ground level floor and every third floor level thereafter.
2. On floor levels requiring fill stations, one fill station shall be provided adjacent to a required exit stair at a location designated by the *fire code official*. In buildings required to have three or more exit stairs, additional fill stations shall be provided at a ratio of one fill station for every three *stairways*.

**L104.13.2 Design.** Fill stations for breathing air cylinders shall be designed to meet the following requirements:

1. A pressure gauge and pressure-regulating devices and controls shall be provided to allow the operator to control the fill pressure and fill rate on each cylinder fill hose.
2. Valves controlling cylinder fill hoses shall be slow-operating valves.
3. A separate flow restriction device shall be provided on each fill hose.
4. A method shall be provided to bleed each cylinder fill hose.
5. The fill station shall be designed to provide a containment area that fully encloses any cylinder being filled and flexible cylinder fill hoses, and directs the energy from a failure away from personnel. Fill stations shall be designed to prohibit filling of cylinders that are not enclosed within the containment area.

**Exception:** Where required or *approved* by the *fire chief*, fill stations providing for the direct refilling of the fire fighters' breathing air cylinders using Rapid Intervention Crew/Company Universal Air Connection (RIC/UAC) fittings shall be used in lieu of cylinder fill stations that utilize containment areas.

**L104.13.3 Cylinder refill rate.** Fill stations shall be capable of simultaneously filling two or more empty breathing air cylinders equivalent to those used by the fire department to the cylinders' design pressure within 2 minutes.

**L104.14 External mobile air connection.** An external mobile air connection shall be provided for fire department mobile air apparatus where required by Section L104.5 to supply the system with breathing air.

**L104.14.1 Location.** The location of the external mobile air connection shall be accessible to mobile air apparatus and *approved* by the *fire code official*.

**L104.14.2 Protection from vehicles.** A means of vehicle impact protection in accordance with Section 312 shall be provided to protect mobile air connections that are subject to vehicular impact.

## APPENDIX L—REQUIREMENTS FOR FIRE FIGHTER AIR REPLENISHMENT SYSTEMS

**L104.14.3 Clear space around connections.** A working space of not less than 36 inches (914 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided and maintained in front of and to the sides of external mobile air connections.

**L104.15 Air-monitoring system.** An *approved* air-monitoring system shall be provided. The system shall automatically monitor air quality, moisture and pressure on a continual basis. The air-monitoring system shall be equipped with not less than two content analyzers capable of detecting carbon monoxide, carbon dioxide, nitrogen, oxygen, moisture and hydrocarbons.

**L104.15.1 Alarm conditions.** The air-monitoring system shall transmit a supervisory signal when any of the following levels are detected:

1. Carbon monoxide exceeds 5 ppm.
2. Carbon dioxide exceeds 1,000 ppm.
3. An oxygen level below 19.5 percent or above 23.5 percent.
4. A nitrogen level below 75 percent or above 81 percent.
5. Hydrocarbon (condensed) content exceeds 5 milligrams per cubic meter of air.
6. The moisture concentration exceeds 24 ppm by volume.
7. The pressure falls below 90 percent of the maintenance pressure specified in Section L104.3.

**L104.15.2 Alarm supervision, monitoring and notification.** The air-monitoring system shall be electrically supervised and monitored by an *approved* supervising station, or where *approved*, shall initiate audible and visual supervisory signals at a constantly attended location.

**L104.15.3 Air quality status display.** Air quality status shall be visually displayed at the external mobile air connection required by Section L104.14.

### SECTION L105 ACCEPTANCE TESTS

**L105.1 Acceptance tests.** Upon completion of the installation, a FARS shall be acceptance tested to verify compliance with equipment manufacturer's instructions and design documents. Oversight of the acceptance tests shall be provided by a *registered design professional*. Acceptance testing shall include all of the following:

1. A pneumatic test in accordance with ASME B31.3 of the complete system at a minimum test pressure of 110 percent of the system design pressure using oil-free dry air, nitrogen or argon shall be conducted. Test pressure shall be maintained for not less than 24 hours. During this test, all fittings, joints and system components shall be inspected for leaks. Defects in the system or leaks detected shall be documented and repaired.

2. A cylinder-filling performance test shall be conducted to verify compliance with the required breathing air cylinder refill rate from the exterior mobile air connection and, where provided, a stored air pressure supply system.
3. The air quality monitoring system shall be tested to verify both of the following conditions:
  - 3.1. Visual indicators required by Section L104.15.1 function properly.
  - 3.2. Supervisory signals are transmitted as required by Section L104.15.2 for each sensor based on a sensor function test.
4. Connections intended for fire department use shall be confirmed as compatible with the fire department's mobile air unit, SCBA cylinders and, where provided, RIC/UAC connections.
5. Air samples shall be taken from not less than two fill stations and submitted to an *approved* gas analysis laboratory to verify compliance with NFPA 1989. The FARS shall not be placed into service until a written report verifying compliance with NFPA 1989 has been provided to the *fire code official*.

### SECTION L106 INSPECTION, TESTING AND MAINTENANCE

**L106.1 Periodic inspection, testing and maintenance.** A FARS shall be continuously maintained in an operative condition and shall be inspected not less than annually. Not less than quarterly, an air sample shall be taken from the system and tested to verify compliance with NFPA 1989. The laboratory test results shall be maintained on site and readily available for review by the *fire code official*.

### SECTION L107 REFERENCED STANDARDS

**L107.1 General.** See Table L107.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

TABLE L107.1  
REFERENCED STANDARDS

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
ASME B31.3—2020	<i>Process Piping</i>	L104.2.1, L105.1
CGA S-1.3—2008	Pressure Relief Device Standards—Part 3 <i>Stationary Storage Containers for Compressed Gases</i>	L104.7
NFPA 1901—16	<i>Standard for Automotive Fire Apparatus</i>	L104.5.1
NFPA 1989—13	<i>Breathing Air Quality for Fire Emergency Services Respiratory Protection</i>	L104.2.2, L105.1, L106.1





## APPENDIX M

# HIGH-RISE BUILDINGS—RETROACTIVE AUTOMATIC SPRINKLER REQUIREMENT

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

---

**User note:**

**About this appendix:** Appendix M was created with the intent to provide an option for adoption by jurisdictions that choose to require existing high-rise buildings to be retrofitted with automatic sprinklers. Modern fire and building codes require complete automatic fire sprinkler protection and a variety of other safety features in new high-rise construction. Many older high-rise buildings lack automatic sprinkler protection and other basic fire protection features necessary to protect the occupants, emergency responders and the structure itself. Without complete automatic sprinkler protection, fire departments cannot provide the level of protection that high-rise buildings demand. Existing high-rise buildings that are not protected with automatic sprinklers represent a significant hazard to occupants and fire fighters, and can significantly impact a community's infrastructure and economic viability in the event of a fire loss.

---

### SECTION M101 SCOPE

**M101.1 Scope.** An automatic sprinkler system shall be installed in all existing high-rise buildings in accordance with the requirements and compliance schedule of this appendix.

### SECTION M102 WHERE REQUIRED

**M102.1 High-rise buildings.** An automatic sprinkler system installed in accordance with Section 903.3.1.1 shall be provided throughout existing high-rise buildings.

**Exceptions:**

1. Airport traffic control towers.
2. Open parking structures.
3. Group U occupancies.
4. Occupancies in Group F-2.

### SECTION M103 COMPLIANCE

**M103.1 Compliance schedule.** Building owners shall file a compliance schedule with the *fire code official* not later than 365 days after receipt of a written notice of violation. The compliance schedule shall not exceed 12 years for an *automatic sprinkler system* retrofit.



## APPENDIX N

# INDOOR TRADE SHOWS AND EXHIBITIONS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance or legislation of the jurisdiction.*

### User note:

**About this appendix:** Appendix N was created to address the hazards that are associated with larger, more complex trade shows and exhibitions. Although many of these requirements are already included in various locations in this code, some of the more important items, such as requirements for covered booths and multiple-level booths, are not. The intent is to have the requirements covering these events in a single location with pointers to other locations within this code, which makes it easier for those organizing exhibitions and individual exhibitors who are unfamiliar with the fire code to locate the requirements that are applicable to them.

### SECTION N101 GENERAL

**N101.1 Scope.** Indoor trade shows and exhibitions with temporary vendor displays or booths within any indoor occupancy classification shall be in accordance with this appendix and all other applicable requirements of this code.

Compliance with this appendix is not required where Section N101.1.1 or N101.1.2 is applicable.

**N101.1.1 Nonsprinklered buildings.** In a building that is not equipped throughout with an *automatic sprinkler system*, the aggregate exhibit area must be less than 1,500 square feet (139 m<sup>2</sup>) of floor area and meet both of the following conditions:

1. The exhibit area does not include any covered or multiple-level exhibits or booths.
2. Not fewer than two remote *exits* or *exit access* doors in compliance with Chapter 10 are provided.

**N101.1.2 Sprinklered buildings.** In a building that is equipped throughout with an *automatic sprinkler system* with a minimum design density of ordinary hazard Group 1, the aggregate exhibit area must be less than 4,500 square feet (418 m<sup>2</sup>) of floor area and meet both of the following conditions:

1. The exhibit area does not include any covered or multiple-level exhibits or booths.
2. Not fewer than two remote *exits* or *exit access* doors in compliance with Chapter 10 are provided.

**N101.2 Permit required.** An operational permit for trade shows and exhibitions shall be required as set forth in Section 105.5.15.

**N101.3 Application.** A permit application for a trade show or exhibition shall be submitted to the *fire code official* prior to the start of the event in a time frame established by the jurisdiction. The application shall include documentation that identifies all of the following:

1. The *means of egress*.
2. The locations and widths of *exits* and *aisles*.
3. The locations of *exit* signs.

4. The total square footage (square meters) of spaces.
5. The location and arrangement of all booths and cooking equipment.
6. The location of all fire protection equipment.
7. The type and location of any heating and electrical equipment, where applicable.
8. The location of any covered or multiple-level booths.
9. *Construction documents* for any covered or multiple-level booths.
10. The storage locations and quantities of any highly combustible goods.
11. The location and type of any vehicle displays, where applicable.

### SECTION N102 DEFINITIONS

**N102.1 Definitions.** For the purpose of this appendix, certain terms are defined as follows:

**COOKING.** Heating food products to a temperature of 145°F (63°C) or higher by baking, braising, boiling, frying or grilling.

**COVERED BOOTH.** An exhibit that has an obstruction placed over the exhibit above floor level that resembles a roof, canopy, tent or other obstruction, other than vertical signs or banners.

**MULTIPLE-LEVEL BOOTH.** An exhibit that has a second level or tier constructed on top of the exhibit or portion of the exhibit that is accessible to the public, or includes a live load above the exhibit area floor level.

### SECTION N103 PUBLIC SAFETY FOR EVENTS

**N103.1 Fire safety and evacuation plan.** A fire safety and evacuation plan shall be provided in accordance with Section 404.2.

**Exception:** Where the *fire code official* determines that the nature of the exhibition, display or the activities therein does not pose an increased hazard to public safety.



## APPENDIX N—INDOOR TRADE SHOWS AND EXHIBITIONS

**N103.2 Fire watch personnel.** Where, in the opinion of the *fire code official*, it is essential for public safety in a trade show or exhibition, either because of the number or persons present or because of the nature of the performance, exhibition, display or activity, the *owner* or *owner's* authorized agent shall provide one or more *fire watch* personnel in accordance with Section 403.11.1.

**N103.3 Crowd managers.** Where events involve a gathering of more than 1,000 people, trained crowd managers shall be provided in accordance with Section 403.11.3.

### SECTION N104

#### INTERIOR FINISH AND DECORATIVE MATERIALS

**N104.1 General.** Interior finish, interior trim, furniture, furnishings and decorative materials, including decorative vegetation, used in exhibition areas shall comply with the requirements of this section and Chapter 8.

**N104.2 Interior wall and ceiling finish.** The materials used for interior wall and ceiling finish of exhibit booths and displays in exhibition areas shall comply with one of the following:

1. Where the building is not equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the wall and ceiling finish materials are required to be Class A in accordance with Section 803.
2. Where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the wall and ceiling finish materials are required to be not less than Class B in accordance with Section 803.

### SECTION N105

#### MULTIPLE-LEVEL BOOTHS

**N105.1 Construction documents.** *Construction documents* for all multiple-level booths shall be stamped by a *registered design professional* and shall be submitted with the permit application to the *fire code official* or the *building code official*, as appropriate.

**N105.2 Structural design.** Multiple-level booths shall be designed and constructed in accordance with Chapter 16 of the *International Building Code*.

**N105.3 Means of egress.** Upper levels of multiple-level booths with an *occupant load* greater than 10 persons shall have not fewer than two *exits* or *exit access* that are separated in accordance with Section 1007.1.1.

**N105.4 Automatic sprinkler systems.** An *approved automatic sprinkler system* in accordance with Section 903.3.1.1 shall be provided in multiple-level booths exceeding 400 square feet (37.2 m<sup>2</sup>) in floor area per level.

**N105.5 Inspection.** Inspection to verify that multiple-level booths are constructed in accordance with the *construction documents* and structural design details required by this section shall be *approved by the building code official*.

**N105.6 Fire alarm and detection.** Each multiple-level booth with a floor area exceeding 120 square feet (11.1 m<sup>2</sup>) on any level shall be provided with an *approved* fire alarm system in accordance with Section 907.2.

### SECTION N106

#### COVERED BOOTHS

**N106.1 Automatic sprinkler systems.** An *approved automatic sprinkler system* in accordance with Section 903.3.1.1 shall be provided in covered booths exceeding 100 square feet (9.3 m<sup>2</sup>) in floor area per level.

**N106.2 Fire alarm and detection.** Each covered booth with a floor area exceeding 120 square feet (11.1 m<sup>2</sup>) on any level shall be provided with an *approved fire alarm system* in accordance with Section 907.2.

### SECTION N107

#### DISPLAY AND STORAGE OF HAZARDOUS AND COMBUSTIBLE MATERIALS

**N107.1 Hazardous materials.** The display of hazardous materials shall comply with Section 314 and Chapters 50 through 67. The storage of hazardous materials in indoor trade shows and exhibition areas shall be prohibited.

**N107.1.1 Display near exit.** The display of hazardous materials within 5 feet (1524 mm) of an *exit* shall be prohibited.

**N107.2 Storage of combustible materials.** Storage of combustible materials shall comply with Section 315.

**N107.3 Vehicles.** The display of liquid- or gas-fueled vehicles, boats or other motor craft in indoor trade shows and exhibition areas shall comply with Sections 314.4 and N107.3.1 through N107.3.3.

**N107.3.1 Batteries in vehicles.** Vehicle batteries shall be rendered inoperable. Batteries in liquid- and gas-fueled vehicles shall be disconnected. Batteries in electric vehicles shall be rendered inoperable by the removal of fuses or other *approved* methods but shall not be required to be disconnected.

**N107.3.2 Vehicle fuel.** Vehicle fuel shall comply with Sections N107.3.2.1 through N107.3.2.4.

**N107.3.2.1 Fueling within the structure.** Vehicles shall not be fueled or defueled within the structure.

**N107.3.2.2 Vehicle fuel tanks.** Vehicle fuel tanks shall contain not more than one quarter of the tank capacity or 5 gallons (18.93 L) of fuel, whichever is less.

**N107.3.2.3 Vehicle fuel systems.** Vehicle fuel systems shall be inspected for leaks prior to the vehicle being brought into the structure.

**N107.3.2.4 Vehicle fuel tank openings.** Vehicle fuel tank openings shall be locked and sealed to prevent the escape of vapors.

## APPENDIX N—INDOOR TRADE SHOWS AND EXHIBITIONS

**N107.3.3 Obstruction by vehicles.** Vehicles shall not be located in such a manner that they obstruct a *means of egress*.

**N107.3.4 Gas-powered vehicles.** Compressed natural gas (CNG), liquefied petroleum gas (LPG) or hydrogen-powered vehicles present in indoor trade shows and exhibition areas shall comply with Sections N107.3.4.1 through N107.3.4.3.

**N107.3.4.1 Shutoff valves.** Shutoff valves shall be closed and the engine shall be operated until it stops. Valves shall remain closed until the vehicle is removed.

**N107.3.4.2 Battery hot lead.** The hot lead of the battery shall be disconnected.

**N107.3.4.3 Dual-fuel vehicles equipped to operate on gasoline.** Dual-fuel vehicles equipped to operate on gasoline as well as on CNG, LPG or hydrogen shall comply with Section 3107.15.

**N107.3.5 Competitions or demonstrations.** Competitions or demonstrations using any type of vehicle shall comply with Section 3107.15.5.

**N107.4 Fueled equipment other than vehicles.** Fueled equipment other than vehicles shall comply with Section 313.

**N107.5 LP-gas containers.** Liquefied petroleum (LP) gas containers shall comply with Sections N107.5.1 through N107.5.5 and Chapter 61.

**N107.5.1 LP-gas containers exceeding 12 pounds (5 kg) of water capacity.** The use of LP-gas containers exceeding 12 pounds (5 kg) of water capacity shall be prohibited.

**N107.5.2 Where more than one LP-gas container is present in the same area.** Where more than one LP-gas container is present in the same area, cylinders shall be separated from each other by a minimum of 20 feet (6096 mm).

**N107.5.3 Equipment for LP-gas containers.** Equipment for LP-gas containers, including tanks, piping, hoses, fittings, valves, tubing and other related components, shall be *approved* and shall comply with Chapter 61 and with the applicable requirements of the *International Fuel Gas Code*.

**N107.5.4 Securing of LP-gas containers.** Portable LP-gas containers shall be securely fastened in place to prevent unauthorized movement.

**N107.5.5 Spare LP-gas containers.** Spare LP-gas containers not connected to an *approved* appliance shall be stored in a location and manner *approved* by the *fire code official*.

**N107.6 Cooking and open-flame devices.** All cooking equipment and any open-flame devices shall comply with the requirements of Section 308 of this code and with Chapter 5 of the *International Mechanical Code*. Cooking equipment shall be separated from combustible material

display or storage by a horizontal distance of not less than 5 feet (1524 mm).

## SECTION N108 MEANS OF EGRESS

**N108.1 Means of egress from the indoor trade show or exhibition area.** *Means of egress* from the indoor trade show or exhibition area shall comply with Chapter 10 and with Sections N108.2 and N108.3.

**N108.2 Design of means of egress.** The design of *means of egress* shall take into consideration the exhibit layout and the anticipated crowd movement during the event.

**N108.3 Aisles and corridors.** *Aisles* and *corridors* within the exhibit area shall be kept free from obstructions when the public is present. Storage of any kind in *aisles* or *corridors* within the exhibit area is not permitted.

## SECTION N109 REFERENCED STANDARDS

**N109.1 General.** See Table N109.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

TABLE N109.1  
REFERENCED STANDARDS

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
IBC—21	<i>International Building Code</i>	N105.2
IFGC—21	<i>International Fuel Gas Code</i>	N107.5.3
IMC—21	<i>International Mechanical Code</i>	N107.6



## APPENDIX O

# DAY CARE FACILITIES COMPILATION

### SECTION O101 GENERAL

**O101.1 General.** This appendix is a compilation of sections from Volumes I and II of the *Arkansas Fire Prevention Code*. They have been brought together here as a reference guide. Every effort was made to ensure a complete reference; however, this section exists as an aid and is not intended as a substitute for the applicable provisions of the *Arkansas Fire Prevention Code*, Volumes I, II and III.

**O101.2 Paragraph notation.** All of the following sections will retain their original paragraph designation in order to provide their location within the code and avoid any confusion associated with renumbering these requirements.

**O101.3 Applicability.** This is a summarized portion of the 2021 *Arkansas Fire Prevention Code* covering the basic requirements for Day Care Facilities. It should be understood that some systems, components, structures and/or conditions may need to be specifically evaluated for their compliance to the *Arkansas Fire Prevention Code* and/or its referenced standards. There are conditions that warrant evaluation on a case-by-case basis for code compliance.

**IBC 305.1 Educational Group E.** Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade. Rooms normally occupied by preschool, kindergarten or first-grade students shall be located on a level of exit discharge. Rooms normally occupied by second-grade students shall not be located more than one level above the level of exit discharge unless provided with a dedicated and independent means of egress.

**IBC 305.1.1 Accessory to places of religious worship.** Religious educational rooms and religious auditoriums, which are accessory to *places of religious worship* in accordance with Section 303.1.4 and have *occupant loads* of less than 100 per room or space, shall be classified as Group A-3 occupancies.

**IBC 305.2 Group E, day care facilities.** This group includes buildings and structures, or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or *personal care services* for fewer than 24 hours per day.

**IBC 305.2.1 Within places of religious worship.** Rooms and spaces within *places of religious worship* providing such day care during religious functions shall be classified as part of the primary occupancy.

**IBC 305.2.2 Five or fewer children.** A facility having five or fewer children receiving such day care shall be classified as part of the primary occupancy.

**IBC 305.2.3 Five or fewer children in a dwelling unit.** A facility such as the above within a *dwelling unit* and

having five or fewer children receiving such day care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

**IBC 305.3 Storm shelters in Group E occupancies.** *Storm shelters* shall be provided for Group E occupancies where required by Section 423.5.

**IBC 308.5 Institutional Group I-4, day care facilities.** Institutional Group I-4 occupancy shall include buildings and structures occupied by more than five persons of any age who receive *custodial care* for fewer than 24 hours per day by persons other than parents or guardians; relatives by blood, marriage or adoption; and in a place other than the home of the person cared for. Rooms normally occupied by preschool, kindergarten or first-grade students shall be located on a level of exit discharge. Rooms normally occupied by second-grade students shall not be located more than one level above the level of exit discharge unless provided with a dedicated and independent means of egress. This group shall include, but not be limited to, the following:

Adult day care

Child day care

**IBC 308.5.1 Classification as Group E.** A child day care facility that provides care for more than five but not more than 100 children 2½ years or less of age, where the rooms in which the children are cared for are located on a *level of exit discharge* serving such rooms and each of these child care rooms has an *exit* door directly to the exterior, shall be classified as Group E.

**IBC 308.5.2 Within a place of religious worship.** Rooms and spaces within *places of religious worship* providing such care during religious functions shall be classified as part of the primary occupancy.

**IBC 308.5.3 Five or fewer persons receiving care.** A facility having five or fewer persons receiving *custodial care* shall be classified as part of the primary occupancy.

**IBC 308.5.4 Five or fewer persons receiving care in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer persons receiving *custodial care* shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

### AUTOMATIC SPRINKLER SYSTEM

**IFC 903.2.3 Group E.** An *automatic sprinkler system* shall be provided for Group E occupancies as follows:

1. Throughout all Group E *fire areas* greater than 12,000 square feet (1115 m<sup>2</sup>) in area.



## APPENDIX O—DAY CARE FACILITIES COMPILATION

2. The Group E *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**Exception:** In buildings where every classroom has not fewer than one exterior exit door at ground level, an *automatic sprinkler system* is not required in any area below the lowest *level of exit discharge* serving that area.

3. The Group E *fire area* has an *occupant load* of 300 or more.

**IFC 903.2.6 Group I.** An *automatic sprinkler system* shall be provided throughout buildings with a Group I *fire area*.

**Exceptions:**

1. An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group I-1, Condition 1 facilities.
2. An *automatic sprinkler system* is not required where Group I-4-day care facilities are at the *level of exit discharge* and where every room where care is provided has not fewer than one exterior *exit door*.
3. In buildings where Group I-4 day care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be installed on the entire floor where care is provided, all floors between the level of care and the *level of exit discharge* and all floors below the *level of exit discharge* other than areas classified as an open parking garage.

## MANUAL FIRE ALARM

**IFC 907.2.3 Group E.** A manual fire alarm system that initiates the occupant notification signal utilizing an emergency voice/alarm communication system meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall be installed in Group E occupancies. Where *automatic sprinkler systems* or smoke detectors are installed, such systems or detectors shall be connected to the building fire alarm system. The provisions of Section 907.2.3.1 shall apply in rooms normally occupied by preschool or kindergarten students when used for sleeping.

**Exceptions:**

1. A manual fire alarm system shall not be required in Group E occupancies with an *occupant load* of 50 or less.
2. Emergency voice/alarm communication systems meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall not be required in Group E occupancies with occupant loads of 100 or less, provided that activation of the manual fire alarm system initiates an *approved* occupant notification signal in accordance with Section 907.5.

3. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:

- 3.1. Interior *corridors* are protected by smoke detectors.
- 3.2. Auditoriums, cafeterias, gymnasiums and similar areas are protected by *heat detectors* or other *approved* detection devices.
- 3.3. Shops and laboratories involving dusts or vapors are protected by *heat detectors* or other *approved* detection devices.
- 3.4. Manual activation is provided from a normally occupied location.

4. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:

- 4.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
- 4.2. The emergency voice/alarm communication system will activate on sprinkler water flow.
- 4.3. Manual activation is provided from a normally occupied location.

**IFC 907.2.3.1 Day care facilities.** Day care facilities with an occupant load of 30 or less shall be protected with single- or multiple-station smoke alarms in the following places:

1. On the ceiling or wall outside of each day care room used for sleeping (in the immediate vicinity of the room).
2. In each day care room used for sleeping.

**IFC 907.2.3.2 Interconnection.** Where more than one smoke alarm is required to be installed, the smoke detectors shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

**IFC 907.2.3.3 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch, other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system.

**IFC 907.2.6 Group I.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group I occupancies. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in accordance with Sections 907.2.6.1, 907.2.6.2 and 907.2.6.3.3.

**Exceptions:**

1. Manual fire alarm boxes in *sleeping units* of Group I-1 and I-2 occupancies shall not be required at *exits* if located at all care providers' control stations or other constantly attended staff locations, provided that such manual fire alarm boxes are visible and provided with *ready access*, and the distances of travel required in Section 907.4.2.1 are not exceeded.
2. Occupant notification systems are not required to be activated where private mode signaling installed in accordance with NFPA 72 is *approved* by the *fire code official* and staff evacuation responsibilities are included in the fire safety and evacuation plan required by Section 404.

## AUTOMATIC SMOKE DETECTION

**907.2.3.1 Day care facilities.** Day care facilities with an occupant load of 30 or less shall be protected with single- or multiple-station smoke alarms in the following places:

1. On the ceiling or wall outside of each day care room used for sleeping (in the immediate vicinity of the room).
2. In each day care room used for sleeping.

**907.2.3.2 Interconnection.** Where more than one smoke alarm is required to be installed, the smoke detectors shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

**907.2.3.3 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch, other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system.

## FIRE ALARM MONITORING

**907.6.6 Monitoring.** Fire alarm systems required by this chapter or by the *Arkansas Fire Prevention Code*, Volume II shall be monitored by an approved supervising station in accordance with NFPA 72.

**Exception:** Monitoring by a supervising station is not required for:

1. Single- and multiple-station smoke alarms required by Section 907.2.11.
2. Smoke detectors in Group I-3 occupancies.
3. Automatic sprinkler systems in one- and two-family dwellings.

## COOKING

**IFC 606.1 General.** Commercial kitchen exhaust hoods shall comply with the requirements of the *International Mechanical Code*.

**IFC 606.2 Where required.** A Type I hood shall be installed at or above all commercial cooking appliances and domestic cooking appliances used for commercial purposes that produce grease vapors. A residential hood is allowed for protection of domestic cooking appliances in day care facilities that meet requirements of AFPC 904.14.

**Exceptions:**

1. Factory-built commercial exhaust hoods that are *listed* and *labeled* in accordance with UL 710, and installed in accordance with Section 304.1 of the *International Mechanical Code*, shall not be required to comply with Sections 507.1.5, 507.2.3, 507.2.5, 507.2.8, 507.3.1, 507.3.3, 507.4 and 507.5 of the *International Mechanical Code*.
2. Factory-built commercial cooking recirculating systems that are *listed* and *labeled* in accordance with UL 710B, and installed in accordance with Section 304.1 of the *International Mechanical Code*, shall not be required to comply with Sections 507.1.5, 507.2.3, 507.2.5, 507.2.8, 507.3.1, 507.3.3, 507.4 and 507.5 of the *International Mechanical Code*. Spaces in which such systems are located shall be considered to be kitchens and shall be ventilated in accordance with Table 403.3.1.1 of the *International Mechanical Code*. For the purpose of determining the floor area required to be ventilated, each individual appliance shall be considered as occupying not less than 100 square feet (9.3 m<sup>2</sup>).
3. Where cooking appliances are equipped with integral down-draft exhaust systems and such appliances and exhaust systems are *listed* and *labeled* for the application in accordance with NFPA 96, a hood shall not be required at or above them.
4. A Type I hood shall not be required for an electric cooking appliance where an *approved* testing agency provides documentation that the appliance effluent contains 5 mg/m<sup>3</sup> or less of grease when

## APPENDIX O—DAY CARE FACILITIES COMPILATION

tested at an exhaust flow rate of 500 cfm (0.236 m<sup>3</sup>/s) in accordance with UL 710B.

**IFC 606.2.1 Where required—retroactive in existing buildings or structures.** A residential hood shall be installed in all day care and Group I-4 occupancies serving 16 or more persons.

**IFC 606.3 Operations and maintenance.** Commercial cooking systems shall be operated and maintained in accordance with Sections 606.3.1 through 606.3.4.

**606.3.1 Ventilation system.** The ventilation system in connection with hoods shall be operated at the required rate of air movement, and grease filters *listed* and *labeled* in accordance with UL 1046 shall be in place where equipment under a kitchen grease hood is used.

**IFC 904.2.2 Commercial hood and duct systems.** Each required commercial kitchen exhaust hood and duct system required by Section 606 to have a Type I hood shall be protected with an *approved* automatic fire-extinguishing system installed in accordance with this code.

**904.13 Commercial cooking systems.** The automatic fire-extinguishing system for commercial cooking systems shall be of a type recognized for protection of commercial cooking equipment and exhaust systems of the type and arrangement protected. Pre-engineered automatic dry- and wet-chemical extinguishing systems shall be tested in accordance with UL 300 and *listed* and *labeled* for the intended application. Other types of automatic fire-extinguishing systems shall be *listed* and *labeled* for specific use as protection for commercial cooking operations. The system shall be installed in accordance with this code, NFPA 96, its listing and the manufacturer's installation instructions. Automatic fire extinguishing systems of the following types shall be installed in accordance with the referenced standard indicated, as follows:

1. Carbon dioxide extinguishing systems, NFPA 12.
2. *Automatic sprinkler systems*, NFPA 13.
3. Automatic water mist systems, NFPA 750.
4. Foam-water sprinkler system or foam-water spray systems, NFPA 16.
5. Dry-chemical extinguishing systems, NFPA 17.
6. Wet-chemical extinguishing systems, NFPA 17A.

**Exception:** Factory-built commercial cooking recirculating systems that are tested in accordance with UL 710B and *listed*, *labeled* and installed in accordance with Section 304.1 of the *International Mechanical Code*.

**IFC 904.13.1 Manual system operation.** A manual actuation device shall be located at or near a *means of egress* from the cooking area not less than 10 feet (3048 mm) and not more than 20 feet (6096 mm) from the kitchen exhaust system. The manual actuation device shall be installed not more than 48 inches (1200 mm) nor less than 42 inches (1067 mm) above the floor and shall clearly identify the hazard protected. The manual actuation shall require a maximum force of 40 pounds (178 N) and a

maximum movement of 14 inches (356 mm) to actuate the fire suppression system.

**Exception:** *Automatic sprinkler systems* shall not be required to be equipped with manual actuation means.

**IFC 904.13.2 System interconnection.** The actuation of the fire extinguishing system shall automatically shut down the fuel or electrical power supply to the cooking equipment. The fuel and electrical supply reset shall be manual.

**904.14 Domestic cooking facilities.** Cooktops and ranges installed in the following occupancies shall be protected in accordance with Section 904.14.1:

1. In Group I-1 occupancies where domestic cooking facilities are installed in accordance with Section 420.9 of the *International Building Code*.
2. In Group I-2 occupancies where domestic cooking facilities are installed in accordance with Section 407.2.7 of the *International Building Code*.
3. In Group R-2 college dormitories where domestic cooking facilities are installed in accordance with Section 420.11 of the *International Building Code*.
4. New and existing day care facilities shall be provided with automatic fire-extinguishing systems for cooking appliances utilizing a cooking surface. Automatic fire-extinguishing systems designed for residential use are allowed for protection of domestic cooking appliances.

**Exception:** In-home day care licensed for 16 or fewer children and all the following requirements are met.

1. The licensed holder resides in the home.
2. The licensed caregiver resides in the home.
3. A signed agreement to not conduct cooking that produces grease-laden vapors during the hours of day care operation is provided.

## DOORS, GATES, TURNSTILES

**IFC 1010.1 Doors.** Doors in the *means of egress* shall comply with the requirements of Sections 1010.1.1 through 1010.3.4. Exterior exit doors shall also comply with the requirements of Section 1022.2. Gates in the *means of egress* shall comply with the requirements of Sections 1010.4 and 1010.4.1. Turnstiles in the *means of egress* shall comply with the requirements of Sections 1010.5 through 1010.5.4.

Doors, gates and turnstiles provided for egress purposes in numbers greater than required by this code shall comply with the requirements of this section.

Doors in the *means of egress* shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Mirrors or similar reflecting materials shall not be used on *means of egress* doors. *Means of egress* doors shall not be concealed by curtains, drapes, decorations or similar materials.

**IFC 1010.1.1 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear opening width of 32 inches (813 mm). The clear opening width of



doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). Where this section requires a minimum clear opening width of 32 inches (813 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a minimum clear opening width of 32 inches (813 mm). In Group I-2, doors serving as *means of egress* doors where used for the movement of beds shall provide a minimum clear opening width of 41 $\frac{1}{2}$  inches (1054 mm). The minimum clear opening height of doors shall be not less than 80 inches (2032 mm).

#### Exceptions:

1. In Group R-2 and R-3 *dwelling and sleeping units* that are not required to be an Accessible unit, Type A unit or Type B unit, the minimum width shall not apply to door openings that are not part of the required *means of egress*.
2. Group I-3 door openings to resident *sleeping units* that are not required to be an Accessible unit shall have a minimum clear opening width of 28 inches (711 mm).
3. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum clear opening width.
4. The maximum width of door leaves in revolving doors that comply with Section 1010.3.1 shall not be limited.
5. The maximum width of door leaves in power-operated doors that comply with Section 1010.3.2 shall not be limited.
6. Door openings within a *dwelling unit* or *sleeping unit* shall have a minimum clear opening height of 78 inches (1981 mm).
7. In *dwelling and sleeping units* that are not required to be Accessible, Type A or Type B units, exterior door openings, other than the required *exit* door, shall have a minimum clear opening height of 76 inches (1930 mm).
8. In Groups I-1, R-2, R-3 and R-4, in *dwelling and sleeping units* that are not required to be Accessible, Type A or Type B units, the minimum clear opening widths shall not apply to interior egress doors.
9. Door openings required to be *accessible* within Type B units intended for user passage shall have a minimum clear opening width of 31.75 inches (806 mm).
10. Doors to walk-in freezers and coolers less than 1,000 square feet (93 m<sup>2</sup>) in area shall have a maximum width of 60 inches (1524 mm) nominal.
11. Doors serving nonaccessible single-user shower or sauna compartments; toilet stalls; or dressing, fitting or changing rooms shall have a minimum clear opening width of 20 inches (508 mm).

**IFC 1010.1.1.1 Projections into clear opening.** There shall not be projections into the required clear opening width lower than 34 inches (864 mm) above the floor or ground. Projections into the clear opening width between 34 inches (864 mm) and 80 inches (2032 mm) above the floor or ground shall not exceed 4 inches (102 mm).

**Exception:** Door closers, overhead door stops, power door operators and electromagnetic door locks shall be permitted to be 78 inches (1980 mm) minimum above the floor.

**IFC 1010.1.2 Egress door types.** Egress doors shall be of the side-hinged swinging door, pivoted door or balanced door types.

#### Exceptions:

1. Private garages, office areas, factory and storage areas with an *occupant load* of 10 or less.
2. Group I-3 occupancies used as a place of detention.
3. Critical or intensive care patient rooms within suites of health care facilities.
4. Doors within or serving a single *dwelling unit* in Groups R-2 and R-3.
5. In other than Group H occupancies, revolving doors complying with Section 1010.3.1.
6. In other than Group H occupancies, special purpose horizontal sliding, accordion or folding door assemblies complying with Section 1010.3.3.
7. Power-operated doors in accordance with Section 1010.3.2.
8. Doors serving a bathroom within an individual *sleeping unit* in Group R-1.
9. In other than Group H occupancies, manually operated horizontal sliding doors are permitted in a *means of egress* from spaces with an *occupant load* of 10 or less.

**IFC 1010.1.2.1 Direction of swing.** Side-hinged swinging doors, pivoted doors and balanced doors shall swing in the direction of egress travel where serving a room or area containing an occupant load of 50 or more persons or a Group H occupancy.

**IFC 1010.1.3 Forces to unlatch and open doors.** The forces to unlatch doors shall comply with the following:

1. Where door hardware operates by push or pull, the operational force to unlatch the door shall not exceed 15 pounds (66.7 N).
2. Where door hardware operates by rotation, the operational force to unlatch the door shall not exceed 28 inch-pounds (315 N-cm).

The force to open doors shall comply with the following:

1. For interior swinging egress doors that are manually operated, other than doors required to be fire



## APPENDIX O—DAY CARE FACILITIES COMPILATION

rated, the force for pushing or pulling open the door shall not exceed 5 pounds (22 N).

2. For other swinging doors, sliding doors or folding doors, and doors required to be fire rated, the door shall require not more than a 30-pound (133 N) force to be set in motion and shall move to a full-open position when subjected to not more than a 15-pound (67 N) force.

**IFC 1010.1.3.1 Location of applied forces.** Forces shall be applied to the latch side of the door.

**IFC 1010.1.3.2 Manual horizontal sliding doors.** Where a manual horizontal sliding door is required to latch, the latch or other mechanism shall prevent the door from rebounding into a partially open position when the door is closed.

**IFC 1010.2.12 Sensor release of electrically locked egress doors.** Sensor release of electric locking systems shall be permitted on doors located in the *means of egress* in any occupancy except Group H where installed and operated in accordance with all of the following criteria:

1. The sensor shall be installed on the egress side, arranged to detect an occupant approaching the doors and shall cause the electric locking system to unlock.
2. The electric locks shall be arranged to unlock by a signal from or loss of power to the sensor.
3. Loss of power to the lock or locking system shall automatically unlock the electric locks.
4. The doors shall be arranged to unlock from a manual unlocking device located 40 inches to 48 inches (1016 mm to 1219 mm) vertically above the floor and within 5 feet (1524 mm) of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign that reads "PUSH TO EXIT." When operated, the manual unlocking device shall result in direct interruption of power to the electric lock—independent of other electronics—and the electric lock shall remain unlocked for not less than 30 seconds.
5. Activation of the building fire alarm system, where provided, shall automatically unlock the electric lock, and the electric lock shall remain unlocked until the fire alarm system has been reset.
6. Activation of the building *automatic sprinkler system* or fire detection system, where provided, shall automatically unlock the electric lock. The electric lock shall remain unlocked until the fire alarm system has been reset.
7. Emergency lighting shall be provided on the egress side of the door.
8. The door locking system units shall be *listed* in accordance with UL 294.

**[BE] 1010.2.13 Delayed egress.** Delayed egress locking systems shall be permitted to be installed on doors serving the following occupancies in buildings that are

equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved* automatic smoke or heat detection system installed in accordance with Section 907:

1. Group B, F, I, M, R, S and U occupancies.
2. Group E classrooms with an *occupant load* of less than 50.
3. In courtrooms in Group A-3 and B occupancies, delayed egress locking systems shall be permitted to be installed on *exit* or *exit access* doors, other than the main *exit* or *exit access* door, in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**IFC 1010.2.13.1 Delayed egress locking system.** The delayed egress locking system shall be installed and operated in accordance with all of the following:

1. The delay electronics of the delayed egress locking system shall deactivate upon actuation of the *automatic sprinkler system* or automatic fire detection system, allowing immediate free egress.
2. The delay electronics of the delayed egress locking system shall deactivate upon loss of power controlling the lock or lock mechanism, allowing immediate free egress.
3. The delayed egress locking system shall have the capability of being deactivated at the *fire command center* and other *approved* locations.
4. An attempt to egress shall initiate an irreversible process that shall allow such egress in not more than 15 seconds when a physical effort to exit is applied to the egress side door hardware for not more than 3 seconds. Initiation of the irreversible process shall activate an audible signal in the vicinity of the door. Once the delay electronics have been deactivated, rearming the delay electronics shall be by manual means only.

**Exception:** Where *approved*, a delay of not more than 30 seconds is permitted on a delayed egress door.

5. The egress path from any point shall not pass through more than one delayed egress locking system.

**Exceptions:**

1. In Group I-1, Condition 2, Group I-2 or I-3 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided that the combined delay does not exceed 30 seconds.
2. In Group I-1, Condition 1 or Group I-4 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided that the combined

delay does not exceed 30 seconds and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

6. A sign shall be provided on the door and shall be located above and within 12 inches (305 mm) of the door exit hardware:

**Exception:** Where *approved*, in Group I occupancies, the installation of a sign is not required where care recipients who, because of clinical needs, require restraint or containment as part of the function of the treatment area.

- 6.1. For doors that swing in the direction of egress, the sign shall read: "PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS."
- 6.2. For doors that swing in the opposite direction of egress, the sign shall read: "PULL UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS."
- 6.3. The sign shall comply with the visual character requirements in ICC A117.1.
7. Emergency lighting shall be provided on the egress side of the door.
8. The delayed egress locking system units shall be *listed* in accordance with UL 294.

**IFC 1010.2.9 Panic and fire exit hardware.** Swinging doors serving a Group H occupancy and swinging doors serving rooms or spaces with an *occupant load* of 50 or more in a Group A or E occupancy shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*.

**Exceptions:**

1. A main *exit* of a Group A occupancy shall be permitted to have locking devices in accordance with Section 1010.2.4, Item 3.
2. Doors provided with *panic hardware* or *fire exit hardware* and serving a Group A or E occupancy shall be permitted to be electrically locked in accordance with Section 1010.2.12 or 1010.2.11.
3. *Exit access doors* serving occupied exterior areas shall be permitted to be locked in accordance with Section 1010.2.4, Item 8.
4. Courtrooms shall be permitted to be locked in accordance with Section 1010.2.13, Item 3.

**IFC 1010.2.9.3 Installation.** Where *panic* or *fire exit hardware* is installed, it shall comply with the following:

1. *Panic hardware* shall be *listed* in accordance with UL 305.
2. *Fire exit hardware* shall be *listed* in accordance with UL 10C and UL 305.

3. The actuating portion of the releasing device shall extend not less than one-half of the door leaf width.
4. The maximum unlatching force shall not exceed 15 pounds (67 N).

## MEANS OF EGRESS

**IFC 1008.2 Illumination required.** The *means of egress* serving a room or space shall be illuminated at all times that the room or space is occupied.

**Exceptions:**

1. Occupancies in Group U.
2. *Aisle accessways* in Group A.
3. *Dwelling units* and *sleeping units* in Groups R-1, R-2 and R-3.
4. *Sleeping units* of Group I occupancies.

**IFC 1008.2.1 Illumination level under normal power.**

The *means of egress* illumination level shall be not less than 1 footcandle (11 lux) at the walking surface. Along *exit access stairways*, *exit stairways* and at their required landings, the illumination level shall be not less than 10 footcandles (108 lux) at the walking surface when the *stairway* is in use.

**Exception:** For auditoriums, theaters, concert or opera halls and similar assembly occupancies, the illumination at the walking surface is permitted to be reduced during performances by one of the following methods provided that the required illumination is automatically restored upon activation of a premises' fire alarm system:

1. Externally illuminated walking surfaces shall be permitted to be illuminated to not less than 0.2 footcandle (2.15 lux).
2. Steps, landings and the sides of *ramps* shall be permitted to be marked with self-luminous materials in accordance with Sections 1025.2.1, 1025.2.2 and 1025.2.4 by systems listed in accordance with UL 1994.

**IFC 1008.3 Emergency power for illumination.** The power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply.

**IFC 1008.3.1 General.** In the event of power supply failure in rooms and spaces that require two or more *exits* or *access to exits*, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Aisles*.
2. *Corridors*.
3. *Exit access stairways* and *ramps*.

**IFC 1008.3.2 Buildings.** In the event of power supply failure, in buildings that require two or more *exits* or *access to exits*, an emergency electrical system shall automatically illuminate all of the following areas:

1. Interior *exit access stairways* and *ramps*.

## APPENDIX O—DAY CARE FACILITIES COMPILATION

2. Interior and exterior exit stairways and ramps.
3. Exit passageways.
4. Vestibules and areas on the level of discharge used for exit discharge in accordance with Section 1028.2.
5. Exterior landings as required by Section 1010.1.5 for exit doorways that lead directly to the exit discharge.

**IFC 1008.3.3 Rooms and spaces.** In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:

1. Electrical equipment rooms.
2. Fire command centers.
3. Fire pump rooms.
4. Generator rooms.
5. Public restrooms with an area greater than 300 square feet (27.87 m<sup>2</sup>).

**IFC 1008.3.4 Duration.** The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Section 2702 of the *International Building Code*.

**IFC 1008.3.5 Illumination level under emergency power.** Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 footcandle (11 lux) and a minimum at any point of 0.1 footcandle (1 lux) measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle (6 lux) average and a minimum at any point of 0.06 footcandle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded. In Group I-2 occupancies, failure of a single lamp in a luminaire shall not reduce the illumination level to less than 0.2 footcandle (2.2 lux).

## EXIT SIGNS

**IFC 1013.1 Where required.** Exits and exit access doors shall be marked by an approved exit sign readily visible from any direction of egress travel. The path of egress travel to exits and within exits shall be marked by readily visible exit signs to clearly indicate the direction of egress travel in cases where the exit or the path of egress travel is not immediately visible to the occupants. Intervening means of egress doors within exits shall be marked by exit signs. Exit sign placement shall be such that any point in an exit access corridor or exit passageway is within 100 feet (30 480 mm) or the listed viewing distance of the sign, whichever is less, from the nearest visible exit sign.

### Exceptions:

1. Exit signs are not required in rooms or areas that require only one exit or exit access.

2. Main exterior exit doors or gates that are obviously and clearly identifiable as exits need not have exit signs where approved by the fire code official.
3. Exit signs are not required in occupancies in Group U and individual sleeping units or dwelling units in Group R-1, R-2 or R-3.
4. Exit signs are not required in dayrooms, sleeping rooms or dormitories in occupancies in Group I-3.
5. In occupancies in Groups A-4 and A-5, exit signs are not required on the seating side of vomitories or openings into seating areas where exit signs are provided in the concourse that are readily apparent from the vomitories. Egress lighting is provided to identify each vomitory or opening within the seating area in an emergency.

**IFC 1006.1 General.** The number of exits or exit access doorways required within the means of egress system shall comply with the provisions of Section 1006.2 for spaces, including mezzanines, and Section 1006.3 for stories or occupied roofs.

**IFC 1006.2 Egress from spaces.** Rooms, areas or spaces, including mezzanines, within a story or basement shall be provided with the number of exits or access to exits in accordance with this section.

**IFC 1006.2.1 Egress based on occupant load and common path of egress travel distance.** Two exits or exit access doorways from any space shall be provided where the design occupant load or the common path of egress travel distance exceeds the values listed in Table 1006.2.1. The cumulative occupant load from adjacent rooms, areas or spaces shall be determined in accordance with Section 1004.2.

### Exceptions:

1. The number of exits from foyers, lobbies, vestibules or similar spaces need not be based on cumulative occupant loads for areas discharging through such spaces, but the capacity of the exits from such spaces shall be based on applicable cumulative occupant loads.
2. Care suites in Group I-2 occupancies complying with Section 407.4 of the *International Building Code*.
3. Unoccupied mechanical rooms and penthouses are not required to comply with the common path of egress travel distance measurement.

**IFC 1006.2.1.1 Three or more exits or exit access doorways.** Three exits or exit access doorways shall be provided from any space with an occupant load of 501 to 1,000. Four exits or exit access doorways shall be provided from any space with an occupant load greater than 1,000.

## APPENDIX O—DAY CARE FACILITIES COMPILATION

**[BE] TABLE 1006.2.1**  
**SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY**

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)		With Sprinkler System (feet)
		Occupant Load		
		OL ≤ 30	OL > 30	
A <sup>c</sup> , E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	3	NP	NP	25 <sup>b</sup>
H-4, H-5	10	NP	NP	75 <sup>b</sup>
I-1, I-2 <sup>d</sup> , I-4	10	NP	NP	75 <sup>a</sup>
I-3	10	NP	NP	100 <sup>a</sup>
R-1	10	NP	NP	75 <sup>a</sup>
R-2	20	NP	NP	125 <sup>a</sup>
R-3 <sup>e</sup>	20	NP	NP	125 <sup>a,g</sup>
R-4 <sup>e</sup>	20	NP	NP	125 <sup>a, g</sup>
S <sup>f</sup>	29	100	75	100 <sup>a</sup>
U	49	100	75	75 <sup>a</sup>

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

- Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.
- Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.
- For a room or space used for assembly purposes having fixed seating, see Section 1030.8.
- For the travel distance limitations in Group I-2, see Section 407.4 of the *International Building Code*.
- The common path of egress travel distance shall apply only in a Group R-3 occupancy located in a mixed occupancy building.
- The length of common path of egress travel distance in a Group S-2 open parking garage shall be not more than 100 feet.
- For the travel distance limitations in Groups R-3 and R-4 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3, see Section 1006.2.2.6.

**[BE] TABLE 1006.3.4(2)**  
**STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR OTHER OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM OCCUPANT LOAD PER STORY	MAXIMUM EXIT ACCESS TRAVEL DISTANCE (feet)
First story above or below grade plane	A, B <sup>b</sup> , E, F <sup>b</sup> , M, U	49	75
	H-2, H-3	3	25
	H-4, H-5, I, R-1, R-2 <sup>a, c</sup>	10	75
	S <sup>b, d</sup>	29	75
Second story above grade plane	B, F, M, S <sup>d</sup>	29	75
Third story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

- Buildings classified as Group R-2 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with emergency escape and rescue openings in accordance with Section 1031.
- Group B, F and S occupancies in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 shall have a maximum exit access travel distance of 100 feet.
- This table is used for R-2 occupancies consisting of sleeping units. For R-2 occupancies consisting of dwelling units, use Table 1006.3.4(1).
- The length of exit access travel distance in a Group S-2 open parking garage shall be not more than 100 feet.



## APPENDIX O—DAY CARE FACILITIES COMPILATION

**CARBON MONOXIDE ALARMS**

**IFC 915.1 General.** Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Section 1103.9.

**IFC 915.1.1 Where required.** Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

**IFC 915.1.2 Fuel-burning appliances and fuel-burning fireplaces.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms that contain a fuel-burning appliance or a fuel-burning fireplace.

**IFC 915.1.3 Fuel-burning forced-air furnaces.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms served by a fuel-burning, forced-air furnace.

**Exception:** Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in the first room or area served by each main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an *approved* location.

**IFC 915.1.4 Fuel-burning appliances outside of dwelling units, sleeping units and classrooms.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms located in buildings that contain fuel-burning appliances or fuel-burning fireplaces.

**Exceptions:**

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in one of the following locations:
  - 2.1. In an *approved* location between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
  - 2.2. On the ceiling of the room containing the fuel-burning appliance or fuel-burning fireplace.

**IFC 915.2 Locations.** Where required by Section 915.1.1, carbon monoxide detection shall be installed in the locations specified in Sections 915.2.1 through 915.2.3.

**IFC 915.2.1 Dwelling units.** Carbon monoxide detection shall be installed in *dwelling units* outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

**IFC 915.2.2 Sleeping units.** Carbon monoxide detection shall be installed in *sleeping units*.

**Exception:** Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the *sleeping unit* where the *sleeping unit* or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced-air furnace.

**IFC 915.2.3 Group E occupancies.** Carbon monoxide detectors shall be installed in classrooms in Group E occupancies. Carbon monoxide alarm signals shall be automatically transmitted to an on-site location that is staffed by school personnel.

**Exception:** Carbon monoxide alarm signals shall not be required to be automatically transmitted to an on-site location that is staffed by school personnel in Group E occupancies with an *occupant load* of 30 or less.

**INTERIOR FINISH**

**IFC 803.3 Interior finish requirements based on occupancy.** Interior wall and ceiling finish shall have a flame spread index not greater than that specified in Table 803.3 for the group and location designated. Interior wall and ceiling finish materials tested in accordance with NFPA 286, and meeting the acceptance criteria of Section 803.1.1.1, shall be used where a Class A classification in accordance with ASTM E84 or UL 723 is required.

**803.3.1 Interior finish requirements—day care occupancies.** Interior finish requirements shall apply to all areas used for day care and that are part of the means of egress in day care facilities serving 10 or fewer clients, located in the caregiver's home.

**IFC 803.4 Fire-retardant coatings.** The required flame spread or smoke-developed index of surfaces in existing buildings shall be allowed to be achieved by application of *approved* fire-retardant coatings, paints or solutions to surfaces having a flame spread index exceeding that allowed. Such applications shall comply with NFPA 703 and the required fire-retardant properties shall be maintained or renewed in accordance with the manufacturer's instructions. The fire-retardant paint, coating or solution shall have been assessed by testing over the same substrate to be used in the application.

**IFC 807.2 Combustible decorative materials.** In Groups A, B, E, I, M and R-1 and in dormitories in Group R-2, curtains, draperies, fabric hangings and other similar combustible decorative materials suspended from walls or ceilings shall comply with Section 807.3 and shall not

**TABLE 803.3**  
**INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY<sup>k</sup>**

GROUP	SPRINKLERED <sup>l</sup>			NONSPRINKLERED		
	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>
A-1 and A-2	B	B	C	A	A <sup>d</sup>	B <sup>e</sup>
A-3 <sup>f</sup> , A-4, A-5	B	B	C	A	A <sup>d</sup>	C
B, E, M, R-1, R-4	B	C <sup>m</sup>	C	A	B <sup>m</sup>	C
F	C	C	C	B	C	C
H	B	B	C <sup>g</sup>	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B <sup>h, i</sup>	A	A	B
I-3	A	A <sup>j</sup>	C	A	A	B
I-4	B	B	B <sup>h, i</sup>	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No Restrictions			No Restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- Class C interior finish materials shall be allowed for wainscoting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.11 of the *International Building Code*.
- In exit enclosures of buildings less than three stories in height of other than Group I-3, Class B interior finish for nonsprinklered buildings and Class C for sprinklered buildings shall be permitted.
- Requirements for rooms and enclosed spaces shall be based on spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered as enclosing spaces and the rooms or spaces on both sides shall be considered as one. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor, regardless of the group classification of the building or structure.
- Lobby areas in Group A-1, A-2 and A-3 occupancies shall be not less than Class B materials.
- Class C interior finish materials shall be allowed in Group A occupancies with an occupant load of 300 persons or less.
- In places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be allowed.
- Class B material is required where the building exceeds two stories.
- Class C interior finish materials shall be allowed in administrative spaces.
- Class C interior finish materials shall be allowed in rooms with a capacity of four persons or less.
- Class B materials shall be allowed as wainscoting extending not more than 48 inches above the finished floor in corridors.
- Finish materials as provided for in other sections of this code.
- Applies where the vertical exits, exit passageways, corridors or rooms and spaces are protected by an approved automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
- Corridors in ambulatory care facilities shall have a Class B or better interior finish material.

exceed 10 percent of the specific wall or ceiling area to which such materials are attached.

#### Exceptions:

- In auditoriums in Group A, the permissible amount of curtains, draperies, fabric hangings and similar combustible decorative material suspended from walls or ceilings shall not exceed 75 percent of the aggregate wall area where the building is equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, and where the material is installed in accordance with Section 803.15 of the *International Building Code*.
- In Group R-2 dormitories, within *sleeping units* and *dwelling units*, the permissible amount of curtains, draperies, fabric hangings and similar decorative materials suspended from walls or ceilings shall not exceed 50 percent of the aggregate wall areas where the building is equipped through-out with an

*approved automatic sprinkler system* installed in accordance with Section 903.3.1.

- In Group B and M occupancies, the amount of combustible fabric partitions suspended from the ceiling and not supported by the floor shall comply with Section 807.3 and shall not be limited.
- The 10-percent limit shall not apply to curtains, draperies, fabric hangings and similar combustible decorative materials used as window coverings.

**IFC 807.5.2 Group E.** Group E occupancies shall comply with Sections 807.5.2.1 through 807.5.2.3.

**IFC 807.5.2.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

#### Exceptions:

- Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

## APPENDIX O—DAY CARE FACILITIES COMPILATION

2. *Corridors* protected by an *approved* fire alarm system installed in accordance with Section 907.
3. Storage in metal lockers, provided the minimum required egress width is maintained.

**IFC 807.5.2.2 Artwork in corridors.** Artwork and teaching materials shall be limited on the walls of *corridors* to not more than 20 percent of the wall area.

**IFC 807.5.2.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of *classrooms* to not more than 50 percent of the specific wall area to which they are attached.

**IFC 807.5.5 Group I-4.** Group I-4 occupancies shall comply with the requirements in Sections 807.5.5.1 through 807.5.5.3.

**IFC 807.5.5.1 Storage in corridors and lobbies.** Clothing and personal effects shall not be stored in *corridors* and lobbies.

**Exceptions:**

1. *Corridors* protected by an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. *Corridors* protected by an *approved* fire alarm system installed in accordance with Section 907.
3. Storage in metal lockers, provided the minimum required egress width is maintained.

**IFC 807.5.5.2 Artwork in corridors.** Artwork and teaching materials shall be limited on walls of *corridors* to not more than 20 percent of the wall area.

**IFC 807.5.5.3 Artwork in classrooms.** Artwork and teaching materials shall be limited on walls of *classrooms* to not more than 50 percent of the specific wall area to which they are attached.

## CORRIDORS

**IFC 1020.2 Construction.** *Corridors* shall be *fire-resistance rated* in accordance with Table 1020.2. The corridor walls required to be *fire-resistance rated* shall comply with Section 708 of the *International Building Code* for *fire partitions*.

**Exceptions:**

1. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group E where each room that is used for instruction has not less than one door opening directly to the exterior and rooms for assembly purposes have not less than one-half of the required *means of egress* doors opening directly to the exterior. Exterior doors specified in this exception are required to be at ground level.
2. A *fire-resistance rating* is not required for *corridors* contained within a *dwelling unit* or *sleeping unit* in an occupancy in Groups I-1 and R.
3. A *fire-resistance rating* is not required for *corridors* in open parking garages.
4. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group B that is a space requiring only a single *means of egress* complying with Section 1006.2.
5. *Corridors* adjacent to the *exterior walls* of buildings shall be permitted to have unprotected openings on unrated *exterior walls* where unrated walls are permitted by Table 705.5 of the *International Building Code* and unprotected openings are permitted by Table 705.8 of the *International Building Code*.

**IFC 1020.4 Obstruction.** The minimum width or required capacity of *corridors* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

[BE] TABLE 1020.2  
CORRIDOR FIRE-RESISTANCE RATING

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system
H-1, H-2, H-3	All	Not Permitted	1 <sup>c</sup>
H-4, H-5	Greater than 30	Not Permitted	1 <sup>c</sup>
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5 <sup>c</sup> /1 <sup>d</sup>
I-2 <sup>a</sup>	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 <sup>b,c</sup>
I-4	All	1	0

a. For requirements for occupancies in Group I-2, see Sections 407.2 and 407.3 of the *International Building Code*.

b. For a reduction in the fire-resistance rating for occupancies in Group I-3, see Section 408.8 of the *International Building Code*.

c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 where allowed.

d. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

[BE] TABLE 1020.3  
MINIMUM CORRIDOR WIDTH

OCCUPANCY	MINIMUM WIDTH (inches)
Any facility not listed below	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36
Within a dwelling unit	36
In Group E with a corridor having an occupant load of 100 or more	72
In corridors and areas serving stretcher traffic in ambulatory care facilities	72
Group I-2 in areas where required for bed movement	96

For SI: 1 foot = 304.8 mm.

**IFC 1020.5 Dead ends.** Where more than one *exit* or *exit access doorway* is required, the exit access shall be arranged such that dead-end *corridors* do not exceed 20 feet (6096 mm) in length.

**Exceptions:**

1. In Group I-3, Condition 2, 3 or 4 occupancies, the dead end in a *corridor* shall not exceed 50 feet (15 240 mm).
2. In occupancies in Groups B, E, F, I-1, M, R-1, R-2, S and U, where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the length of the dead-end *corridors* shall not exceed 50 feet (15 240 mm).
3. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.
4. In Group I-2, Condition 2 occupancies, the length of dead-end *corridors* that do not serve patient rooms or patient treatment spaces shall not exceed 30 feet (9144 mm).

**EXIT ACCESS TRAVEL DISTANCE**

**IFC 1017.1 General.** Travel distance within the *exit access* portion of the *means of egress* system shall be in accordance with this section.

**IFC 1017.2 Limitations.** *Exit access* travel distance shall not exceed the values given in Table 1017.2.

**IFC 1017.2.1 Exterior egress balcony increase.** *Exit access* travel distances specified in Table 1017.2 shall be increased up to an additional 100 feet (30 480 mm) provided that the last portion of the *exit access* leading to the exit occurs on an exterior egress balcony constructed in accordance with Section 1021. The length of such balcony shall be not less than the amount of the increase taken.

**IFC 1017.3 Measurement.** *Exit access* travel distance shall be measured from the most remote point of each room, area or space along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an *exit*. Where

more than one *exit* is required, *exit access* travel distance shall be measured to the nearest *exit*.

**Exceptions:**

1. In open parking garages, *exit access* travel distance is permitted to be measured to the closest riser of an *exit access stairway* or the closest slope of an *exit access ramp*.
2. In smoke-protected seating and open-air assembly seating, *exit access* travel distance shall be measured in accordance with Section 1030.7.

**FIRE EXTINGUISHERS**

**IFC 906.1 Where required.** Portable fire extinguishers shall be installed in all of the following locations:

1. In new and existing Group A, B, E, F, H, I, M, R-1, R-2, R-4 and S occupancies.

**Exceptions:**

1. In Group R-2 occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each dwelling unit is provided with a portable fire extinguisher having a minimum rating of 1-A:10-B: C.
2. In Group E occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each classroom is provided with a portable fire extinguisher having a minimum rating of 2-A:20-B: C.
3. In storage areas of Group S occupancies where forklift, powered industrial truck or powered cart operators are the primary occupants, fixed extinguishers, as specified in NFPA 10, shall not be required where in accordance with all of the following:
  - 3.1. Use of vehicle-mounted extinguishers shall be *approved* by the *fire code official*.
  - 3.2. Each vehicle shall be equipped with a 10-pound, 40A:80B:C extinguisher affixed to the vehicle using a mounting bracket



## APPENDIX O—DAY CARE FACILITIES COMPILATION

**[BE] TABLE 1017.2  
EXIT ACCESS TRAVEL DISTANCE<sup>a</sup>**

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200	250 <sup>b, c</sup>
I-1	Not Permitted	250 <sup>b</sup>
B	200	300 <sup>c</sup>
F-2, S-2, U	300	400 <sup>c</sup>
H-1	Not Permitted	75 <sup>d</sup>
H-2	Not Permitted	100 <sup>d</sup>
H-3	Not Permitted	150 <sup>d</sup>
H-4	Not Permitted	175 <sup>d</sup>
H-5	Not Permitted	200 <sup>c</sup>
I-2, I-3	Not Permitted	200 <sup>c</sup>
I-4	150	200 <sup>c</sup>

For SI: 1 foot = 304.8 mm.

- a. See the following sections for modifications to exit access travel distance requirements:
- Section 402.8 of the *International Building Code*: For the distance limitation in malls.
  - Section 407.4 of the *International Building Code*: For the distance limitation in Group I-2.
  - Sections 408.6.1 and 408.8.1 of the *International Building Code*: For the distance limitations in Group I-3.
  - Section 411.2 of the *International Building Code*: For the distance limitation in special amusement areas.
  - Section 412.6 of the *International Building Code*: For the distance limitations in aircraft manufacturing facilities.
  - Section 1006.2.2.2: For the distance limitation in refrigeration machinery rooms.
  - Section 1006.2.2.3: For the distance limitation in refrigerated rooms and spaces.
  - Section 1006.3.4: For buildings with one exit.
  - Section 1017.2.2: For increased distance limitation in Groups F-1 and S-1.
  - Section 1030.7: For increased limitation in assembly seating.
  - Section 3103.4 of the *International Building Code*: For temporary structures.
  - Section 3104.9 of the *International Building Code*: For pedestrian walkways.
- b. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.
- c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
- d. Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.1.
- e. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

approved by the extinguisher manufacturer or the *fire code official* for vehicular use.

- 3.3. Not less than two spare extinguishers of equal or greater rating shall be available on-site to replace a discharged extinguisher.
- 3.4. Vehicle operators shall be trained in the proper operation, use and inspection of extinguishers.
- 3.5. Inspections of vehicle-mounted extinguishers shall be performed daily.
2. Within 30 feet (9144 mm) distance of travel from commercial cooking equipment and from domestic cooking equipment in Group I-1; I-2, Condition 1; and R-2 college dormitory occupancies.
3. In areas where *flammable* or *combustible liquids* are stored, used or dispensed.
4. On each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3316.1.

5. Where required by the sections indicated in Table 906.1.

6. Special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the *fire code official*.

**Exception:** Portable fire extinguishers are not required at normally unmanned Group U occupancy buildings or structures where a portable fire extinguisher suitable to the hazard of the location is provided on the vehicle of visiting personnel.

**IFC 906.2 General requirements.** Portable fire extinguishers shall be selected, installed and maintained in accordance with this section and NFPA 10.

**Exceptions:**

1. The distance of travel to reach an extinguisher shall not apply to the spectator seating portions of Group A-5 occupancies.
2. Thirty-day inspections shall not be required and maintenance shall be allowed to be once every 3 years for dry-chemical or halogenated agent por-

table fire extinguishers that are supervised by a *listed* and *approved* electronic monitoring device, provided that all of the following conditions are met:

- 2.1. Electronic monitoring shall confirm that extinguishers are properly positioned, properly charged and unobstructed.
  - 2.2. Loss of power or circuit continuity to the electronic monitoring device shall initiate a trouble signal.
  - 2.3. The extinguishers shall be installed inside of a building or cabinet in a noncorrosive environment.
  - 2.4. Electronic monitoring devices and supervisory circuits shall be tested every 3 years when extinguisher maintenance is performed.
  - 2.5. A written log of required hydrostatic test dates for extinguishers shall be maintained by the *owner* to verify that hydrostatic tests are conducted at the frequency required by NFPA 10.
3. In Group I-3, portable fire extinguishers shall be permitted to be located at staff locations.

## DAY CARE FACILITY CODE REFERENCE GUIDE

**Note:** This is a summarized portion of the 2021 *Arkansas Fire Prevention Code* covering the basic requirements for Day Care Facilities. It should be understood that some systems, components, structures and/or conditions may need to be specifically evaluated for their compliance to the *Arkansas Fire Prevention Code* and/or its referenced standards. There are conditions that warrant evaluation on a case-by-case basis for code compliance.

## OCCUPANCY CLASSIFICATION LISTINGS IN VOLUME II OF ARKANSAS FIRE PREVENTION CODE

### SECTION 305 EDUCATIONAL GROUP E

**305.1 Educational Group E.** Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade.

**305.1.1 Accessory to places of religious worship.** Religious educational rooms and religious auditoriums, which are accessory to places of religious worship in accordance with Section 303.1.4 and have occupant loads of less than 100 per room or space, shall be classified as Group A-3 occupancies.

**305.2 Group E, day care facilities.** This group includes buildings and structures, or portions thereof occupied by more than five children older than 2½ years of age who

receive educational, supervision or personal care services for fewer than 24 hours per day.

**305.2.1 Within places of religious worship.** Rooms and spaces within places of religious worship providing such day care during religious functions shall be classified as part of the primary occupancy.

**305.2.2 Five or fewer children.** A facility having five or fewer children receiving such day care shall be classified as part of the primary occupancy.

**305.2.3 Five or fewer children in a dwelling unit.** A facility such as the above within a dwelling unit and having five or fewer children receiving such day care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

**305.3 Storm shelters in Group E occupancies.** Storm shelters shall be provided for Group E occupancies where required by Section 423.5.

### SECTION 308 INSTITUTIONAL GROUP I

**308.1 Institutional Group I.** Institutional Group I occupancy includes, among others, the use of a building or structure, or a portion thereof, in which care or supervision is provided to persons who are or are incapable of self-preservation without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted. Institutional occupancies shall be classified as Group I-1, I-2, I-3 or I-4.

**308.5 Institutional Group I-4, day care facilities.** Institutional Group I-4 occupancy shall include buildings and structures occupied by more than five persons of any age who receive custodial care for fewer than 24 hours per day by persons other than parents or guardians; relatives by blood, marriage or adoption; and in a place other than the home of the person cared for. This group shall include, but not be limited to, the following:

Adult day care

Child day care

**308.5.1 Classification as Group E.** A child day care facility that provides care for more than five but not more than 100 children 2½ years or less of age, where the rooms in which the children are cared for are located on a level of exit discharge serving such rooms and each of these child care rooms has an exit door directly to the exterior, shall be classified as Group E.

## APPENDIX O—DAY CARE FACILITIES COMPILATION

**308.5.2 Within a place of religious worship.** Rooms and spaces within places of religious worship providing such care during religious functions shall be classified as part of the primary occupancy.

**308.5.3 Five or fewer persons receiving care.** A facility having five or fewer persons receiving custodial care shall be classified as part of the primary occupancy.

**308.5.4 Five or fewer persons receiving care in a dwelling unit.** A facility such as the above within a dwelling unit and having five or fewer persons receiving custodial care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

### Egress IBC/IFC Chapter 10

_____ (B) Table 1004	Occupant Load
_____ (B) 1006	Number of Exits
_____ (B) 1008	Means of Egress Illumination
_____ (B) 1009	Accessible Means of Egress
_____ (B) 1010	Doors and Gates
_____ (B) 1010.1.2.1	Door Swing
_____ (B) 1010.1.3	Door Opening Force
_____ (B) 1010.2	Door Operation
_____ (B) 1010.2.5	Bolt Locks
_____ (B) 1010.2.1	Unlatching
_____ (B) 1010.2.13	Delayed Egress Locks
_____ (B) 1010.2.14	Access-controlled Egress Locks
_____ (B) 1010.2.9	Panic Hardware
_____ (B) 1012	Ramps
_____ (B) 1013	Exit Signs
_____ (B) 1016	Exit Access
_____ (B) 1017	Exit Access Travel Distance (see Table 1017.2)
_____ (B) 1020	Corridor Fire-resistance Rating
_____ (B) 1020.3	Minimum Corridor Width
_____ (B) 1026	Horizontal Exit (separations)
_____ (B) 1028	Exit Discharge
_____ (B) 1031	Emergency Escape and Rescue

## Sprinkler Requirements IBC/IFC Chapter 9

### General:

_____ (F) 901	General Requirements
_____ (F) 901.6	Inspection Testing and Maintenance
_____ (F) 901.6.1	Fire Protection Maintenance Standards

### Sprinkler System:

_____ (F) 903.2.3	Group E
_____ (F) 903.2.6	Group I
_____ (F) 903.2.8	Group R
_____ (F) 903.4	Sprinkler System Supervision and Alarms
_____ (F) 903.4.1	Monitoring
_____ (F) 903.4.2	Alarms
_____ (F) 903.5	Testing and Maintenance
_____ (F) 912	Fire Department Connections

### Cooking Operations:

_____ (F) 606	Commercial Kitchen Hoods
_____ (F) 904.2.2	Commercial Hood and Duct Systems
_____ (F) 904.14	Residential Cooking Appliances

### Fire Extinguishers:

_____ (F) 906	Where Required
_____ (F) 906.3	Size and Distribution
_____ (F) 906.5	Conspicuous Location
_____ (F) 906.6	Unobstructed and Unobscured
_____ (F) 906.7	Hangers and Brackets
_____ (F) 906.8	Cabinets
_____ (F) 906.9	Extinguisher Installation (height)

### Fire Alarm System:

_____ (F) 907	General Requirements
_____ (F) 907.2.3	Group E (30 or more)
_____ (F) 907.2.6	Group I
_____ (F) 907.2.3.1	Smoke Detection (Day Care Facilities)
_____ (F) 907.6.6	Monitoring
_____ (F) 907.8	Inspection Testing and Maintenance
_____ (F) 1103.9	Carbon Monoxide Alarms



## APPENDIX O—DAY CARE FACILITIES COMPILATION

### Emergency Planning IFC Chapter 4

_____ (F) 401.7	Unplanned Evacuation
_____ (F) 405	Evacuation Drill Frequency
_____ (F) 404	Fire Safety, Lockdown and Evacuation Plans
_____ (F) 406	Employee Training and Response Procedures
_____ (F) 403.4	Group E Evacuation Drill Frequency
_____ (F) 403.7	Group I

### Fire Service Features IFC Chapter 5

_____ (F) 503	Fire Apparatus Access Roads
_____ (F) 505	Premises Identification
_____ (F) 506	Key Boxes
_____ (F) 507	Fire Protection Water Supplies
_____ (F) Appendix B	Fire-flow Requirements
_____ (F) Appendix C	Fire Hydrant Locations and Distribution
_____ (F) Appendix D	Fire Apparatus Access Roads

### Building Services and Systems IFC Chapter 6

_____ (F) 603.9	Portable Unvented Heaters
_____ (F) 605.5	Fuel-fired Heating Appliances
_____ (F) 603.4	Electrical Service Equipment Clearance
_____ (F) 603.4.1	Electrical Room Doors Labeling
_____ (F) 603.5	Relocatable Power Taps
_____ (F) 603.6	Extension Cords
_____ (F) 603.2	Unapproved Conditions (open wiring/splices/boxes)

### Interior Finish, Decorative Materials and Furnishings IFC Chapter 8

_____ (F) 803.1.1	Classification of Materials
_____ (F) Table 803.3	Interior Wall and Ceiling Finish Requirements by Occupancy
_____ (F) 803.5	Textiles
_____ (F) 803.6	Newly Introduced Textile Wall and Ceiling Coverings
_____ (F) 806	Natural Decorative Vegetation, New and Existing Buildings
_____ (F) 807	Decorative Materials and Artificial Decorative Vegetation, New and Existing Buildings
_____ (F) 807.5.2	Occupancy Based Requirements (Decorative Materials)
_____ (F) 807.5.2.2	Group E Storage in Corridors and Lobbies/Artwork
_____ (F) 807.5.2.3	Group E Storage in Classrooms/Artwork
_____ (F) 807.5.5.2	Group I Storage in Corridors and Lobbies/Artwork
_____ (F) 807.5.5.3	Group I Storage in Classrooms/Artwork
_____ (F) 808.4	Combustible Lockers

# INDEX

## A

### 24-HOUR BASIS

Defined . . . . . 202

### ABANDONED PREMISES (see VACANT PREMISES)

### ABANDONMENT

Flammable and combustible

liquid tanks . . . . . 5704.2.13

### ACCEPTANCE TESTING

Fire protection system

installations . . . . . 901.5, 904.4, 907.7

Fire pumps . . . . . 913.5.1

Flammable and combustible

liquid tanks . . . . . 5704.2.12.1

Single- and multiple-station smoke alarms . . . 907.7.1

Smoke control systems . . . . . 909.18

### ACCESS, FIRE DEPARTMENT

Aviation facilities . . . . . 2003.4

Construction and demolition sites . . . . . 3311.1

Doors for . . . . . 504.2, 3205.5, 3206.7

Equipment to . . . . . 509

High-piled storage buildings . . . . . 3206.6

Tire storage . . . . . 3406

### ACCESS ROADS, FIRE APPARATUS. . . . . 503

Aviation facilities . . . . . 2003.4

Bridges . . . . . 503.2.6

Building openings and roofs . . . . . 504

Defined . . . . . 202

High-piled storage . . . . . 3206.6

Lumber yards . . . . . 2803.6, 2809.3

Obstructions . . . . . 503.4

Tents and membrane structures . . . . . 3103.8.1

### ACCESSIBLE MEANS OF EGRESS . . . . . 1009

Defined . . . . . 202

Standby power . . . . . 1203.2.2

### ACCESSIBLE ROUTE

Defined . . . . . 202

### ACETYLENE (see WELDING AND OTHER HOT WORK)

Gas . . . . . 3505.4

Generators . . . . . 3508

### ADDITIVE MANUFACTURING (3D PRINTING) . . . 320

Definition . . . . . 202

Permits . . . . . 105.5.1

### ADDRESS NUMBER (see PREMISES IDENTIFICATION)

### ADMINISTRATION

Alternative methods and materials . . . . 104.10, 501.4

Applicability . . . . . 102

Approval . . . . . 104.6.1, 401.2, 2307.2, 2308.2,  
3103.2, 5706.4.7.1

Approved materials and equipment . . . . . 104.8

Emergencies . . . . . 104.12

General . . . . . 101

Inspections . . . . . 104.6.2, 108

Maintenance . . . . . 109

Means of appeals . . . . . 111.1

Permits . . . . . 104.2, 105

Right of entry . . . . . 104.3

Unsafe buildings . . . . . 114

Violations . . . . . 112

### AEROSOL CONTAINER

Defined . . . . . 202

Glass . . . . . 5101.4

Plastic . . . . . 5101.4, 5104.1.1

### AEROSOL FIRE-EXTINGUISHING SYSTEMS . . 904.12

### AEROSOL PRODUCT WAREHOUSE. . . . . 5104.4

Defined . . . . . 202

### AEROSOLS . . . . . Chapter 51

Classification levels . . . . . 5103.1

Classification of products . . . . . Table 5103.1

Defined . . . . . 202

Inside storage . . . . . 5104

Manufacturing facilities . . . . . 5107

Nonsegregated storage . . . . 5104.3.1, Table 5104.3.1

Outside storage . . . . . 5105

Permit required . . . . . 105.5.2

Retail display . . . . . 5106

Segregated storage . . . . . 5104.3.2, Table 5104.3.2

### AGENCY

Defined . . . . . 202

### AGENT

Defined . . . . . 202

### AGRICULTURAL BUILDING

#### (Occupancy Group U)

Defined . . . . . 202

Occupant load . . . . . Table 1004.5

### AGRICULTURAL PRODUCTS . . . . . 3703.4, 6001.1

### AGRO-INDUSTRIAL

Byproducts . . . . . 2801.1

Defined . . . . . 202

Facilities . . . . . 2804.1, 2808.1

### AIRCRAFT

Defueling . . . . . 2006.5, 2006.18

Fueling . . . . . 2006

## INDEX

Hangars . . . . .	914.8.3
Maintenance . . . . .	2004
<b>AIRCRAFT MOTOR-VEHICLE FUEL-DISPENSING FACILITY</b> . . . . .	2006.1, 2301.1
Defined . . . . .	202
<b>AIRCRAFT OPERATION AREA (AOA)</b>	
Defined . . . . .	202
Housekeeping in . . . . .	2003.3
Smoking prohibited . . . . .	2003.2
<b>AIRCRAFT-RELATED OCCUPANCIES, FIRE PROTECTION FOR</b> . . . . .	914.8
<b>AIR-INFLATED STRUCTURES (see TENTS AND OTHER MEMBRANE STRUCTURES)</b>	
Defined . . . . .	202
Permit . . . . .	105.5.49
<b>AIRPORT</b>	
Defined . . . . .	202
<b>AIRPORT TRAFFIC CONTROL TOWERS</b> . . . . .	907.2.22, 914.8.1, 914.8.2
<b>AIR-SUPPORTED STRUCTURES (see TENTS AND OTHER MEMBRANE STRUCTURES)</b> . . . . .	Chapter 31
Defined . . . . .	202
Permit . . . . .	105.5.49
<b>aisle(s)</b> . . . . .	308.1.7.1, 1018
Assembly . . . . .	1030
Cross . . . . .	1030.17.2
Defined . . . . .	202
Fixed seating . . . . .	1004.6
Hazardous materials . . . . .	5003.11.3.9
High-piled combustible storage . . . . .	3205.5, 3206.10
Obstruction of . . . . .	1032.3, 1032.5
Tents . . . . .	3103.12.5
Travel distance . . . . .	1030.7
Walking surface . . . . .	1003.4
Width . . . . .	1018.3, 1030.9.1, 1104.22, 3206.10.1, 5904.1.2
<b>aisle accessway</b> . . . . .	1018.4
Defined . . . . .	202
<b>ALARM</b> . . . . .	903.4.2, 2405.9.3, 2703.13.2.1, 6004.2.2.10.1
Activations . . . . .	401.3.2
Audible . . . . .	907.5.2.1
Coded signals . . . . .	405.5
Signals . . . . .	903.4.1, 2703.12.3
Testing . . . . .	901.5, 901.6, 904.4.2
Visible . . . . .	907.5.2.3
Warning signs . . . . .	904.3.4
<b>ALARM, NUISANCE</b>	
Defined . . . . .	202
<b>ALARM, SMOKE</b>	
Defined . . . . .	202

<b>ALARM NOTIFICATION APPLIANCE</b> . . . . .	907.5.2
Defined . . . . .	202
<b>ALARM SIGNAL</b>	
Defined . . . . .	202
<b>ALARM VERIFICATION FEATURE</b>	
Defined . . . . .	202
<b>ALCOHOL-BASED HAND RUB</b> . . . . .	5001.1, 5705.5
Defined . . . . .	202
<b>ALCOHOL-BLENDED FUELS</b>	
Compatibility of components . . . . .	2306.8.2
Defined . . . . .	202
Dispensing . . . . .	2306.8
Listed equipment . . . . .	2306.8.1
<b>ALTERATION</b>	
Defined . . . . .	202
Fire protection and life safety systems . . . . .	901.4.3
<b>ALTERNATING TREAD DEVICE</b> . . . . .	1011.14
Defined . . . . .	202
<b>ALTERNATIVE AUTOMATIC FIRE-EXTINGUISHING SYSTEMS</b> . . . . .	904
<b>ALTERNATIVE MATERIALS AND METHODS</b> . . . . .	104.10
<b>AMBULATORY CARE FACILITY (Occupancy Group B)</b>	
Automatic sprinklers . . . . .	903.2.2
Defined . . . . .	202
Fire alarm systems . . . . .	907.2.2.1
<b>AMMONIA</b>	
Diffusion systems . . . . .	608.13.7
Flaring system . . . . .	608.13.6
Refrigerant . . . . .	608.13.4
Treatment System . . . . .	608.13.5
<b>AMMONIUM NITRATE</b> . . . . .	5601.1.5
Defined . . . . .	202
<b>AMMUNITION, SMALL ARMS</b> . . . . .	5606
Defined . . . . .	202
Storage and handling . . . . .	105.5.16, 5601.2.1, 5604
<b>AMUSEMENT BUILDING, SPECIAL (see SPECIAL AMUSEMENT BUILDING)</b>	
<b>AMUSEMENT PARK STRUCTURES (Assembly, Group A-5)</b>	
Defined . . . . .	202
<b>ANNUNCIATOR</b>	
Defined . . . . .	202
<b>APPEALS, BOARD OF</b> . . . . .	111
<b>APPENDICES</b> . . . . .	101.2.1
<b>APPLIANCES</b> . . . . .	608.8
Chimneys . . . . .	605.2.1
Commercial kitchen hoods . . . . .	606
Cooking . . . . .	5705.3.3
Fuel-fired . . . . .	605
Gas piping connection . . . . .	606.4
Heating . . . . .	605.6, 603.9, 5705.3.3

## INDEX

Heat-producing . . . . .	2301.6	Pyroxylin plastic motion picture film storage . . . . .	306.1
Lighting . . . . .	5705.3.3	Pyroxylin-coated fabric . . . . .	807.5.1.4
Unsafe . . . . .	605.2	Seating . . . . .	1030
<b>APPLICABILITY (of the code)</b> . . . . .	102	Seating plan . . . . .	403.2.1
<b>APPROVED</b>		Standpipe systems . . . . .	905
Defined . . . . .	202	Storage, flammable liquids . . . . .	5704.3.4.2
<b>ARC WELDING (see WELDING AND OTHER HOT WORK)</b>		Tents . . . . .	Chapter 31
<b>AREA, BUILDING</b>		Vehicles in . . . . .	3107.15.4
Defined . . . . .	202	<b>ASSISTED RESCUE AREAS, EXTERIOR</b> . . . . .	1009.7
<b>AREA OF REFUGE</b> . . . . .	1009.6	<b>ATRIUM</b>	
Defined . . . . .	202	Defined . . . . .	202
<b>ARRAY (storage)</b> . . . . .	3205.8, 3207.4	Sprinklers . . . . .	914.4.1
Defined . . . . .	202	<b>ATRIUM FIRE PROTECTION</b> . . . . .	907.2.15, 914.4
<b>ARRAY, CLOSED (storage)</b> . . . . .	3205.8, 3207.4	<b>ATTIC</b>	
Defined . . . . .	202	Defined . . . . .	202
<b>ARTIFICIAL BARRICADE (see BARRICADE)</b>		<b>ATTIC STORAGE</b> . . . . .	315.3.4, 903.3.1.2.3
<b>ARTIFICIAL COMBUSTIBLE VEGETATION</b> . . . . .	321	<b>AUDIBLE ALARM NOTIFICATION</b>	
<b>ASH TRAYS</b> . . . . .	310.6	<b>APPLIANCE</b> . . . . .	907.5.2.1
<b>ASHES, HOT</b> . . . . .	305.2	Defined . . . . .	202
<b>ASPHALT (TAR) KETTLES</b> . . . . .	303, 3318.2	<b>AUTOMATED RACK STORAGE</b>	
<b>ASPHYXIAN GASES</b> . . . . .	5004.7.1, 5307.1	Defined . . . . .	202
<b>ASSEMBLY OCCUPANCIES (Group A)</b>		Emergency shutdown . . . . .	3209.4
Aisles . . . . .	1030	<b>AUTOMATIC</b>	
Announcements . . . . .	403.2.2	Defined . . . . .	202
Automatic sprinklers . . . . .	903.2	<b>AUTOMATIC FIRE-EXTINGUISHING SYSTEM (see FIRE-EXTINGUISHING SYSTEMS, ALTERNATIVE)</b>	
Candles . . . . .	308	<b>AUTOMATIC SMOKE DETECTION SYSTEM</b>	
Cellulose nitrate film . . . . .	105.5.6, 306	Defined . . . . .	202
Decorative materials . . . . .	806, 807	<b>AUTOMATIC SPRINKLER SYSTEM</b> . . . . .	2108.2, 2703.10, 2804.4, 3206.4, 3209.2, 3315, 6304.1.2
Defined (Occupancy classification) . . . . .	202	Aerosol product warehouses . . . . .	5104.4.1
Doors . . . . .	1010	Alarms . . . . .	903.4.2, 2703.10.5
Egress . . . . .	Chapter 10	Attics . . . . .	903.3.1.2.3
Emergency evacuation drill . . . . .	405	Basements . . . . .	903.2.11.1.3
Employee training . . . . .	406	Chutes . . . . .	1103.4.9.3
Evacuation plans . . . . .	404	Defined . . . . .	202
Fire alarm systems . . . . .	907.2.1	Dip-tank operations . . . . .	2405.4
Fire safety plans . . . . .	404	Gas rooms . . . . .	5003.8.4.1
Furnishings . . . . .	807.5.1	Group A . . . . .	903.2.1, 1103.5.1
Interior finish . . . . .	803	Group B . . . . .	903.2.2
LP-gas installations . . . . .	Chapter 61	Group E . . . . .	903.2.3
Motion picture projection rooms . . . . .	306.1	Group F-1 . . . . .	903.2.4
Multiple fire areas . . . . .	903.2.1.7	Group H . . . . .	903.2.5
Obstruction of exits . . . . .	1032.3	Group I . . . . .	903.2.6, 1103.5.2, 1103.5.3
Occupant load calculation . . . . .	1004	Group M . . . . .	903.2.7
On roofs . . . . .	903.2.1.6	Group R . . . . .	903.2.8
Open-flame devices . . . . .	308.3	Group S-1 . . . . .	903.2.9
Panic hardware . . . . .	1010.2.9	Group S-2 . . . . .	903.2.10
Permits required . . . . .	105.5.38	Hazardous exhaust ducts . . . . .	903.2.11.4
Portable fire extinguishers . . . . .	906	High-piled storage . . . . .	903.2.7.1
Posting maximum occupant load . . . . .	1004.3		
Prohibit smoking . . . . .	310		



## INDEX

Hose threads . . . . .	903.3.6
Installation requirements . . . . .	903.3
Kitchen exhaust hood and ducts systems . . . . .	903.2.11.5
Limited area . . . . .	903.3.8
Monitoring . . . . .	903.4
NFPA 13 sprinkler systems . . . . .	903.3.1.1
NFPA 13D sprinkler systems . . . . .	903.3.1.3
NFPA 13R sprinkler systems . . . . .	903.3.1.2
Open-ended corridors . . . . .	903.3.1.2.2
Pyroxylin plastics . . . . .	903.2.5.3, 1103.5.5
Repair garages . . . . .	903.2.9.1
Riser rooms . . . . .	901.4.7
Rubbish and linen chutes . . . . .	903.2.11.2
Secondary water supply . . . . .	914.3.2
Spray rooms . . . . .	2404.4
Water supplies . . . . .	903.3.5
Windowless stories . . . . .	903.2.11.1
Woodworking operations . . . . .	903.2.4.1
Zones . . . . .	907.6.4
<b>AUTOMATIC SPRINKLERS</b>	
Defined . . . . .	202
Early Suppression Fast Response (ESFR) . . . . .	910.2, Table 3206.2, Table 3208.3, Table 5104.3.2.2, 5104.4.3
Obstructions to discharge . . . . .	315.3.1, 903.3.3
Quick response (QR) . . . . .	903.3.2, Table 5704.3.6.3(5)
Residential . . . . .	903.3.2
<b>AUTOMATIC WATER MIST SYSTEM</b> . . . . .	904.11
Defined . . . . .	202
<b>AUTOMOBILE UNDERCOATING (see SPRAY FINISHING)</b>	
<b>AUTOMOTIVE MOTOR FUEL-DISPENSING FACILITY</b> . . . . .	Chapter 23
Defined . . . . .	202
<b>AVERAGE AMBIENT SOUND LEVEL</b> . . . . .	907.5.2.1.1
Defined . . . . .	202
<b>AVIATION FACILITIES (see also AIRCRAFT-RELATED OCCUPANCIES, FIRE PROTECTION FOR)</b> . . . . .	Chapter 20
Cleaning parts . . . . .	2004.3
Combustible storage . . . . .	2003.6
Dispensing hoses and nozzles . . . . .	2006.3.3
Dispensing of flammable and combustible liquids . . . . .	2003.5
Fire protection . . . . .	914.8
Fueling and defueling . . . . .	2006
Portable fire extinguishers . . . . .	2005
Radar equipment . . . . .	2006.21
<b>AWNING</b>	
Defined . . . . .	202

**B**

<b>BACKFLOW PREVENTION</b> . . . . .	903.3.5, 912.6
<b>BALCONIES</b> . . . . .	308.1.4, 903.3.1.2.1, 1021
<b>BARRICADE</b>	
Artificial defined (for explosives) . . . . .	202
Defined (for explosives) . . . . .	202
Fire apparatus access road . . . . .	503.5, 503.5.1
Natural defined (for explosives) . . . . .	202
Placement at fire scene . . . . .	104.12.1
<b>BARRICADED (explosives)</b>	
Defined . . . . .	202
<b>BASEMENT</b> . . . . .	605.4.2.8, 903.2.11.1.3, 905.3.1, 1006.2, 1031.2, 2311.4.3, 3003.1, 5704.3.5.1, 5705.3.7.2, 5706.4.4.1, 5904.1.3, 6103.2.1.1, 6204.1.8, 6304.1.5, 6704.1.5
Defined . . . . .	202
<b>BATTERY CHARGING (see POWERED INDUSTRIAL TRUCKS)</b>	
<b>BATTERY SYSTEM, STATIONARY LEAD-ACID</b>	
Defined . . . . .	202
<b>BATTERY SYSTEM, STATIONARY STORAGE</b> . . . . .	1207
Dedicated-use buildings . . . . .	1207.7.1
Defined . . . . .	202
Explosion control . . . . .	1207.6.3
Fire-resistance-rated separations . . . . .	1207.7.4
Group R-3 and R-4 occupancies . . . . .	1207.11
Indoor installations . . . . .	1207.7
Nondedicated-use buildings . . . . .	1207.7.2
Outdoor installations . . . . .	1207.8
Permit . . . . .	105.5.14, 105.6.5
Signage . . . . .	1207.4.8
Special installations . . . . .	1207.9
Spill control and neutralization . . . . .	1207.6.2
Ventilation . . . . .	1207.6.1
<b>BATTERY TYPES—Defined</b>	
Flow . . . . .	202
Lead Acid . . . . .	202
Lithium metal polymer . . . . .	202
Lithium-ion	
Nickel cadmium . . . . .	202
Stationary storage . . . . .	202
<b>BIN BOX</b> . . . . .	3208.1
Defined . . . . .	202
<b>BIOFUEL, SOLID (see SOLID BIOFUEL)</b>	
<b>BIOMASS</b>	
Defined . . . . .	202
<b>BIOMASS FEEDSTOCK, SOLID (see SOLID BIOMASS FEEDSTOCK)</b>	

<b>BLAST AREA</b>	
Defined . . . . .	202
<b>BLAST SITE</b>	
Defined . . . . .	202
<b>BLASTER</b>	
Defined . . . . .	202
<b>BLASTING AGENT (see also EXPLOSIVES AND FIREWORKS)</b>	
Defined . . . . .	202
<b>BLEACHERS</b> . . . . .	1030.1.1
Defined . . . . .	202
Occupant load . . . . .	1004.4
<b>BOARDING HOUSE (Occupancy Group R)</b>	
Defined . . . . .	202
<b>BOILING POINT</b>	
Defined . . . . .	202
<b>BOND</b>	
For explosives . . . . .	5601.2.4.1
For fireworks display . . . . .	5601.2.4.2
<b>BONDING AND GROUNDING</b> . . . . .	2104.2.4, 2106.3.4
Aircraft fueling . . . . .	2006.3.7.1, 2006.5.2
CNG motor fuel-dispensing facilities . . . . .	2308.8.1.2.4
Cryogenic fluids . . . . .	5503.6.2
Organic coating . . . . .	2904.3
Piping, valves and fittings . . . . .	5706.4.7.6
Powdered coating . . . . .	2406.6.4
Roll-coating operations . . . . .	2405.11
Underground tanks . . . . .	5706.6.1.8
Vessels . . . . .	5705.3.2
<b>BONFIRES</b> . . . . .	307.4.1
Defined . . . . .	202
Permit . . . . .	105.5.34, 307.2
<b>BREAKAWAY PROTECTION (see EMERGENCY BREAKAWAY DEVICES)</b>	
<b>BREAKOUT</b> . . . . .	1010.3
Defined . . . . .	202
<b>BREATHING APPARATUS</b> . . . . .	2603.3.2
<b>BRIDGES (see ACCESS ROADS, FIRE APPARATUS)</b>	
<b>BRITISH THERMAL UNIT (BTU)</b>	
Defined . . . . .	202
<b>BUILDING</b>	
Defined . . . . .	202
Unsafe . . . . .	114
Vacant (see Vacant premises)	
<b>BUILDING INFORMATION CARD</b> . . . . .	508.1.6
<b>BUILDING OFFICIAL</b> . . . . .	403.10.1.4, 510.1, 3105.2, 3105.5
Defined . . . . .	202
<b>BUILDING SERVICES AND SYSTEMS</b> . . . . .	Chapter 6
<b>BULK OXYGEN SYSTEM</b> . . . . .	Chapter 63
Defined . . . . .	202
<b>BULK PLANT OR TERMINAL</b> . . . . .	5706.4
Defined . . . . .	202
<b>BULK TRANSFER</b> . . . . .	5706.5
Defined . . . . .	202
<b>BULLET RESISTANT</b>	
Defined . . . . .	202
<b>BURNING (see OPEN BURNING)</b>	
<b>BUTANE (see LIQUEFIED PETROLEUM GAS)</b>	
<b>BUTYLENE (see LIQUEFIED PETROLEUM GAS)</b>	
<b>C</b>	
<b>CABINETS</b>	
Fire equipment . . . . .	905.7, 906.8, 2005.7.1
Flammable liquid . . . . .	5704.3.2
Hazardous material . . . . .	5003.8.7
Ozone . . . . .	6005.3.1
<b>CABINETS, GAS</b> . . . . .	2703.10.2, 2703.13.1.3, 5003.8.6, 5306.2.3, 6004.2.2.3, 6004.3.4
<b>CANDLES</b> . . . . .	105.5.36, 308, 806.3
<b>CANOPY</b>	
Defined . . . . .	202
<b>CANOPY, TEMPORARY STAGE (see TEMPORARY STAGE CANOPY)</b>	
<b>CAPTIONS, EMERGENCY VOICE/ALARM COMMUNICATION SYSTEM</b> . . . . .	907.5.2.2.4
<b>CARBON DIOXIDE ENRICHMENT SYSTEMS</b> . . . . .	5307.4
<b>CARBON DIOXIDE EXTINGUISHING SYSTEM</b>	
Commercial cooking systems . . . . .	904.13.3
Defined . . . . .	202
Permit required . . . . .	105.6.1
<b>CARBON DIOXIDE SYSTEMS USED IN BEVERAGE DISPENSING</b> . . . . .	5307.3
<b>CARBON MONOXIDE ALARMS AND DETECTION SYSTEMS</b> . . . . .	915, 1103.9
<b>CARE, 24-HOUR (Occupancy Group I)</b>	
Defined . . . . .	202
<b>CARE FACILITY</b> . . . . .	903.2.8.4
<b>CARE SUITE</b>	
Defined . . . . .	202
<b>CARNIVALS AND FAIRS</b>	
Permit required . . . . .	105.5.5
Place of assembly tent . . . . .	3103.3
<b>CARTON</b>	
Combustible . . . . .	5106.2.4
Defined . . . . .	202
<b>CEILING LIMIT</b>	
Defined . . . . .	202
<b>CELLULOSE NITRATE MOTION PICTURE FILM</b> . . . . .	105.5.6, 306

## INDEX

**CELLULOSE NITRATE PLASTICS [see PYROXYLIN (CELLULOSE NITRATE) PLASTICS]****CERTIFICATION OF SERVICE PERSONNEL**

- Automatic fire-extinguishing systems . . . . . 904.1.1
- Portable fire extinguishers . . . . . 906.2.1

**CHANGE OF OCCUPANCY . . . . . 102.3**

- Defined . . . . . 202

**CHANGE OF USE . . . . . 102.3****CHEMICAL**

- Defined . . . . . 202

**CHEMICAL NAME**

- Defined . . . . . 202

**CHIMNEY . . . . . 605.3, 605.2.1**

- Defined . . . . . 202
- Factory-built . . . . . 605.2.1.4
- Masonry . . . . . 605.2.1.1
- Metal . . . . . 605.2.1.2

**CHRISTMAS TREE (see DECORATIVE VEGETATION)****CHUTES, RUBBISH AND LINEN . . . . . 903.2.11.2****CLASSIFICATION**

- Aerosols . . . . . 5103
- Commodity . . . . . 3203
- Dry cleaning plants and systems . . . . . 2103.2
- Dry cleaning solvent or liquid . . . . . 202, 2103.1
- Flammable and combustible liquids . . . . . 202
- Floor finish materials . . . . . 804.3.1
- Hazardous materials . . . . . 5001.2
- Occupancy . . . . . 202
- Refrigerant . . . . . 608.4

**CLEAN AGENT**

- Defined . . . . . 202

**CLEANING**

- Cooking equipment . . . . . 606.3.3
- Flammable liquids used for . . . . . 2004.3
- Piping . . . . . 3307.2
- Powder coating . . . . . 2406.5.1
- Repair garages . . . . . 2311.2.1
- Tanks . . . . . 5706.7.2
- Tire rebuilding buffing areas . . . . . 3403.3

**CLEARANCE**

- Storage to ceiling or sprinklers . . . . . 315.3.1, 903.3.3, 5704.3.5.3

**CLINIC, OUTPATIENT (Occupancy Group B)**

- Defined . . . . . 202

**CLOSED CONTAINER . . . . . 5505.5.2**

- Defined . . . . . 202

**CLOSED SYSTEM . . . . . 5705.3.7.6**

- Defined . . . . . 202

**CLOTHES DRYER EXHAUST DUCTS . . . . . 610****CNG MOTOR FUEL-DISPENSING**

- FACILITIES . . . . . 2308

**CODE COMPLIANCE AGENCY . . . . . 103****COLD DECK . . . . . 2806.2**

- Defined . . . . . 202

**COLLEGE AND UNIVERSITY BUILDINGS, GROUP R-2 . . . . . 403.9.2.1, Table 405.3, 907.2.9.3****COMBUSTIBLE DUST . . . . . Chapter 22**

- Defined . . . . . 202

**COMBUSTIBLE DUST-PRODUCING****OPERATIONS . . . . . Chapter 22**

- Dust collection systems . . . . . 2203.3.1
- Dust explosion prevention . . . . . 2203
- Dust explosion screening test . . . . . 2204
- Housekeeping . . . . . 2203.5
- Permit . . . . . 105.5.7
- Sources of ignition . . . . . 2203.4
- Standards . . . . . 2205
- Training . . . . . 2203.8

**COMBUSTIBLE FIBERS . . . . . Chapter 37**

- Defined . . . . . 202
- General precautions . . . . . 3703
- Permit . . . . . 105.5.8
- Portable fire extinguishers . . . . . 3703.6

**COMBUSTIBLE GAS DETECTOR . . . . . 3510.2**

- Defined . . . . . 202

**COMBUSTIBLE LIQUID . . . . . 2306, 3107.4, 3107.14, Chapter 57**

- Classified locations . . . . . 5703.1.2
- Defined . . . . . 202
- Dispensing, use, mixing and handling . . . . . 5705.3, 5705.3.8
- Heated . . . . . 5701.5
- Indoor storage . . . . . 5704.3.3
- Mixtures . . . . . 5701.5
- Outdoor storage . . . . . 5704.4
- Permit . . . . . 105.5.18, 105.6.8
- Portable fire extinguisher . . . . . 5706.2.7
- Special operations . . . . . 5706
- Tank storage . . . . . 5704.2
- Waste control . . . . . 5706.3.2
- Wholesale and resale use . . . . . 5704.3.6

**COMBUSTIBLE MATERIAL****STORAGE . . . . . 105.5.31, 315, 2003.6****COMBUSTIBLE WASTE MATERIAL . . . . . 304, 2505**

- At construction sites . . . . . 3305.2
- Containers . . . . . 304.3
- Storage . . . . . 304.2

**COMMERCIAL COOKING APPLIANCES**

- Defined . . . . . 202

**COMMERCIAL COOKING OIL STORAGE****TANK SYSTEMS . . . . . 607****COMMERCIAL KITCHEN HOODS . . . . . 606**

<b>COMMERCIAL MOTOR VEHICLE</b> . . . . .	903.2.9, 903.2.9.1, 903.2.10.1
Defined . . . . .	202
<b>COMMODITY</b> . . . . .	
Classifications . . . . .	3203
Defined . . . . .	202
<b>COMMON PATH OF EGRESS TRAVEL</b> . . . . .	1006.2.1, 1018.4, 1030.8, Table 1104.18
Defined . . . . .	202
<b>COMMON USE AREAS</b> . . . . .	907.5.2.3.1
Defined . . . . .	202
<b>COMPATIBILITY (Hazardous materials) (see INCOMPATIBLE MATERIALS)</b> . . . . .	
<b>COMPRESSED GAS</b> . . . . .	Chapter 53
Containers, cylinders, tanks . . . . .	5303.1
Defined . . . . .	202
Medical gas . . . . .	5306
Not otherwise regulated . . . . .	5307
Permit required . . . . .	105.5.9
Requirements . . . . .	5303
Storage . . . . .	5304
Use and handling . . . . .	5305
Wiring . . . . .	5303.8
<b>COMPRESSED GAS CONTAINER</b> . . . . .	
Defined . . . . .	202
<b>COMPRESSED GAS SYSTEM</b> . . . . .	
Defined . . . . .	202
Motor fuel-dispensing facilities . . . . .	2308
<b>COMPRESSED NATURAL GAS (CNG)</b> . . . . .	5301.1
<b>CONFLICTING PROVISIONS</b> . . . . .	102.10
<b>CONGREGATE CARE FACILITY (Occupancy Group I)</b> . . . . .	
Defined . . . . .	202
<b>CONGREGATE LIVING FACILITY (Occupancy Group R)</b> . . . . .	
Defined . . . . .	202
<b>CONSTANTLY ATTENDED LOCATION</b> . . . . .	903.4.1, 907.2.1.1, 907.2.6, 907.2.7.1, 907.2.12.1, 907.2.13, 907.2.18.2, 907.3, 907.3.1, 913.4, 5704.2.8.11
Defined . . . . .	202
<b>CONSTRUCTION AND DEMOLITION FIRE SAFETY</b> . . . . .	Chapter 33
<b>CONSTRUCTION DOCUMENTS</b> . . . . .	106
Defined . . . . .	202
<b>CONSTRUCTION EQUIPMENT, MOTORIZED (see MOTORIZED CONSTRUCTION EQUIPMENT)</b> . . . . .	
<b>CONTAINER</b> . . . . .	
Defined . . . . .	202
<b>CONTAINER AND PORTABLE TANK STORAGE</b> . . . . .	5704.3, Table 5704.3.6.3(4), Table 5704.4.2
<b>CONTAINMENT PALLETS</b> . . . . .	
Flammable and combustible liquids . . . . .	5704.4.3
Hazardous materials . . . . .	5004.2.3
<b>CONTAINMENT SYSTEM</b> . . . . .	
Defined . . . . .	202
<b>CONTAINMENT VESSEL</b> . . . . .	
Defined . . . . .	202
<b>CONTINUOUS GAS DETECTION SYSTEM (see GAS DETECTION SYSTEM, CONTINUOUS)</b> . . . . .	
<b>CONTROL AREAS</b> . . . . .	5003.8.3
Defined . . . . .	202
<b>COOKING</b> . . . . .	
Appliances, commercial, defined . . . . .	202
Commercial, automatic sprinkler systems . . . . .	903.2.11.5
Commercial, fire-extinguishing systems . . . . .	904.13
Commercial, hoods . . . . .	606
Commercial, oil storage tank systems . . . . .	607
Commercial, portable fire extinguishers . . . . .	906.4
Devices, open-flame . . . . .	308.1.4
Domestic . . . . .	904.14
Group I-2 . . . . .	904.14
On balconies . . . . .	308.1.4
<b>CORRIDOR</b> . . . . .	1020, 1104.17
Defined . . . . .	202
Open-ended (see OPEN-ENDED CORRIDOR) . . . . .	
<b>CORROSION PROTECTION</b> . . . . .	
Cryogenic fluid containers . . . . .	5503.1.3.2
Cryogenic fluid piping . . . . .	5505.1.2.5
General . . . . .	5703.6.5
Tanks and piping . . . . .	5704.2.7.9, 5706.7.1
<b>CORROSIVE</b> . . . . .	
Defined . . . . .	202
<b>CORROSIVE MATERIALS</b> . . . . .	Chapter 54
Indoor storage . . . . .	5404.1
Indoor use . . . . .	5405.1
Outdoor storage . . . . .	5404.2
Outdoor use . . . . .	5405.2
Requirements . . . . .	5403
<b>COTTON, BALED</b> . . . . .	Table 5003.1.1(1), 3705
Defined . . . . .	202
<b>COTTON, DENSELY PACKED BALED</b> . . . . .	Table 5003.1.1(1)
Defined . . . . .	202
<b>COTTON, SEED</b> . . . . .	3703.4
Defined . . . . .	202
<b>COURT</b> . . . . .	
Defined . . . . .	202
<b>COURT, EGRESS</b> . . . . .	1029.1
Defined . . . . .	202



**COVERED AND OPEN MALL BUILDINGS**  
Automatic sprinkler system . . . . . 914.2.1  
Defined . . . . . 202  
Emergency planning . . . . . 403.10.1  
Emergency voice/alarm  
communication system . . . . . 907.2.20, 914.2.3  
Permit . . . . . 105.5. 9  
Standpipe system . . . . . 905.3.3, 914.2.2  
Tenant identification . . . . . 403.10.1.5  
Unoccupied tenant spaces . . . . . 311.6, 403.10.1.6

**CRANKCASE OIL (see WASTE OIL)**

**CRITICAL AREAS**  
Definition . . . . . 202  
System coverage. . . . . 510.4.1

**CRITICAL CIRCUIT** . . . . . 1203.3  
Defined . . . . . 202

**CROP-RIPENING AND COLORING PROCESSES (see FRUIT AND CROP RIPENING)**

**CROWD MANAGERS** . . . 403.11.3, 3106.4.3, 3107.17.2

**CRYOGENIC CONTAINER**  
Defined . . . . . 202  
Handling . . . . . 5505.5  
Marking . . . . . 5503.4  
Security . . . . . 5503.5

**CRYOGENIC FLUIDS** . . . . . Chapter 55  
Containers . . . . . 5503.1  
Defined . . . . . 202  
Filling . . . . . 5505.4  
Flammable. . . . . 5806  
Indoor storage . . . . . 5504.2  
Indoor use . . . . . 5505.2  
Outdoor storage . . . . . 5504.3  
Outdoor use. . . . . 5505.3  
Permit . . . . . 105.5.11  
Requirements . . . . . 5503  
Underground storage tanks. . . . . 5806.4.5

**CRYOGENIC VESSEL**  
Defined . . . . . 202

**CURRENT TAPS** . . . . . 603.5.2

**CUSTODIAL CARE (Occupancy Group I)**  
Defined . . . . . 202

**CUTTING AND WELDING (see WELDING AND OTHER HOT WORK)**

**CYLINDER**  
Defined . . . . . 202

**D**

**DAMPER**  
Defined . . . . . 202

**DANGER, IMMINENT** . . . . . 114.2

**DAY BOX (Magazine, Type 3)** . . . . . 202  
Defined. . . . . 202

**DEAD END** . . . . . 1020.5

**DECORATIONS** . . . . . 807  
Exit obstruction. . . . . 1032.6

**DECORATIVE MATERIALS** . . . . . 807  
Defined. . . . . 202

**DECORATIVE VEGETATION**  
Artificial. . . . . 807.4  
Natural . . . . . 806

**DEFLAGRATION**  
Defined. . . . . 202

**DEFUELING**  
Aircraft . . . . . 2006.5  
Hydrogen fuel tanks . . . . . 2309.6

**DELAYED EGRESS LOCKS** . . . 1010.2.13.1, 1032.2.1

**DELUGE SYSTEM** . . . . . 903.4, 2805.2  
Defined. . . . . 202

**DEMOLITION OF BUILDINGS**  
**FIRE SAFETY** . . . . . Chapter 33

**DESIGN PRESSURE**  
Defined. . . . . 202

**DETACHED BUILDING**  
Defined. . . . . 202  
Group H occupancies. . . . . 5003.8.2  
Storage. . . . . 6204.1.1, 6304.1.1, Table 6204.1.2

**DETEARING**  
Defined. . . . . 202

**DETECTOR, HEAT**  
Defined. . . . . 202

**DETONATING CORD**  
Defined. . . . . 202

**DETONATION**  
Defined. . . . . 202

**DETONATOR**  
Defined. . . . . 202

**DETOXIFICATION FACILITY (Group I-2)**  
Defined. . . . . 202

**DIP TANK** . . . . . 2405  
Defined. . . . . 202  
Permit. . . . . 105.6.22

**DIPPING OPERATIONS** . . . . . 2405

**DISCHARGE, EXIT (see EXIT DISCHARGE)**

**DISCHARGE OF HAZARDOUS MATERIAL (see RELEASE OF HAZARDOUS MATERIAL)**

**DISCHARGE SITE**  
Defined. . . . . 202

**DISPENSING**  
Aircraft fueling . . . . . 2006  
Defined. . . . . 202  
Fire extinguishers. . . . . 2305.5

# E

## INDEX

**ELEVATOR GROUP**

Defined ..... 202

Emergency voice/alarm communication  
system in ..... 907.5.2.2**ELEVATOR HOISTWAYS** ..... 704.1, 1103.4

Pressurization ..... 909.21

Water protection ..... 604.5.4

**ELEVATOR KEYS, FIRE SERVICE (see KEYS, FIRE  
SERVICE ELEVATOR)****ELEVATOR KEYS, NONSTANDARDIZED FIRE  
SERVICE**

Key boxes for ..... 506.1.2

**ELEVATOR RECALL/EMERGENCY  
OPERATION** ..... 604**EMERGENCY ALARM****SYSTEM** ..... 908, 5004.9, 5005.4.4

Defined ..... 202

**EMERGENCY BREAKAWAY****DEVICES** ..... 2306.7.5.1, 2307.6.3**EMERGENCY CONTROL STATION** ..... 2703.1

Defined ..... 202

**EMERGENCY ESCAPE AND****RESCUE OPENING** ..... 1031

Defined ..... 202

Maintenance ..... 1032.7

**EMERGENCY EVACUATION DRILL** ..... 405

Defined ..... 202

Frequency ..... 405.3, Table 405.3

**EMERGENCY LIGHTING EQUIPMENT**

Inspection and testing ..... 1032.10

**EMERGENCY PLANNING AND****PREPAREDNESS** ..... Chapter 4**EMERGENCY POWER SYSTEMS** ..... 603

Defined ..... 202

**EMERGENCY RELIEF****VENTING** ..... 2306.6.2.5, 5704.2.7.4**EMERGENCY REPAIRS** ..... 105.1.4**EMERGENCY RESPONDER****RADIO COVERAGE** ..... 510

In existing buildings ..... 1103.2

Permit ..... 105.6.4

**EMERGENCY SHUTOFF****VALVE** ..... 5003.2.2.1, 5503.4.6, 5505.3.2,  
6303.1.2, 6403.1.1

Defined ..... 202

**EMERGENCY SHUTOFF VALVE,****AUTOMATIC** ..... 2305.2.4, 2306.7.4, 5003.2.9.1,  
5505.3.2, 5803.1.3, 6303.1.2,  
6303.1.2.2, 6403.1.1.1

Defined ..... 202

**EMERGENCY SHUTOFF VALVE,****MANUAL** .. 2309.5.2, 2309.5.2.1, 5505.3.2, 5803.1.3,  
6303.1.2, 6303.1.2.2, 6403.1.1.2

Defined ..... 202

**EMERGENCY VENTING FOR****TANKS** ..... 607.5, 2306.5, 5704.2.7.4,  
5704.2.9.6.1.2, 5704.2.9.7.2**EMERGENCY VOICE/ALARM****COMMUNICATIONS** ..... 907.5.2.2

Atriums ..... 907.2.14

Captions ..... 907.5.2.2.4

Covered mall buildings ..... 907.2.20

Deep underground buildings ..... 907.2.19

Defined ..... 202

Group A ..... 907.2.1.1

High-rise building ..... 907.2.13

Special amusement buildings ..... 907.2.12.3

**EMPLOYEE TRAINING** ..... 406**EMPLOYEE WORK AREA**

Defined ..... 202

**ENERGY SYSTEMS** ..... Chapter 12, 1201.1, 1201.2

Electrical energy storage systems ..... 1201.3, 1207

Emergency and standby power systems ..... 1203

Permits ..... 105.5.14, 105.6.5, 105.6.9, 105.6.20

Portable generators ..... 1204, 3309

Solar and photovoltaic systems ..... 1205

Stationary fuel cell power systems ..... 1206

**ENTRY, RIGHT OF** ..... 104.3**EQUIPMENT, FUELED** ..... 313**EQUIPMENT PLATFORM**

Defined ..... 202

Guards required ..... 1015.2

**ESCALATOR OPENINGS (see FLOOR OPENINGS  
AND SHAFTS)****ESCAPE OPENINGS** ..... 1031**ESFR SPRINKLERS (see AUTOMATIC SPRINKLERS)****ETHYLENE**

Gas ..... 2503

Generators ..... 2506

**EVACUATION** ..... 114.2, 405, 2603.3.4, 2603.3.5**EVACUATION DIAGRAMS** ..... 403.9.1.1, 403.9.2.3**EVACUATION DRILLS** ..... 405

Frequency ..... 405.3, Table 405.3

Notification ..... 405.7

Recall and reentry ..... 405.10

**EVACUATION PLANS** ..... 404**EXCESS FLOW CONTROL**

Defined ..... 202

<b>EXCESS FLOW VALVE</b>		
Defined	202	
<b>EXHAUSTED ENCLOSURE</b>	5003.8.5	
Defined	202	
<b>EXHIBIT GALLERY</b>		
Occupancy load	Table 1004.5	
<b>EXHIBITION HALLS (Occupancy Group A-3)</b>	202	
<b>EXHIBITS AND TRADE SHOWS</b>	105.5.15	
<b>EXISTING</b>		
Defined	202	
<b>EXISTING BUILDINGS</b>	Chapter 11	
Group I-2	1105	
Outdoor occupancies	1106	
<b>EXIT</b>	1022	
Defined	202	
Enclosure	1023	
Horizontal	1026	
Number required	1006	
Passageways	1024	
<b>EXIT, HORIZONTAL</b>	1026	
Defined	202	
<b>EXIT ACCESS</b>	1016	
Defined	202	
Doorway	202	
Ramp	202	
Stairway	202	
<b>EXIT DISCHARGE</b>	1028	
Defined	202	
<b>EXIT DISCHARGE, LEVEL OF</b>		
Defined	202	
<b>EXIT DOORS, EXTERIOR</b>	1022	
<b>EXIT PASSAGEWAY</b>	1024	
Defined	202	
<b>EXIT RAMP, EXTERIOR</b>	1006.3, 1008.3.2, 1027	
Defined	202	
<b>EXIT STAIRWAY, EXTERIOR</b>	1027	
Defined	202	
<b>EXPANDED PLASTIC</b>	Figure 3203.9(1), Figure 3203.9(2)	
Defined	202	
<b>EXPANDED VINYL WALL OR CEILING COVERINGS</b>	803.7, 803.8	
<b>EXPLOSION</b>		
Defined	202	
<b>EXPLOSION CONTROL</b>	.911, 2204.1, 2803.2, 2803.2.1, 2905.4, 5004.6, 5005.2.1.2, 5005.2.2.2, 5704.2.5, 5705.3.7.5.2, 5705.3.7.6.2, 5808.6, 6204.1.10, 6304.1.1, 6704.1.6	
<b>EXPLOSIVE MATERIAL</b>	Chapter 56	
Buildings under construction or demolition	3308	
Defined	202	
<b>EXPLOSIVES AND FIREWORKS</b>	Chapter 56	
Defined	202	
Manufacture, assembly and testing	5605	
Permits	105.5.16	
Temporary storage of consumer fireworks	5609	
<b>EXTENSION CORDS</b>	603.6	
<b>EXTERIOR ASSISTED RESCUE AREAS</b>	1009.7	
<b>EXTERIOR WALL</b>		
Defined	202	
<b>EXTINGUISHERS (see FIRE EXTINGUISHERS, PORTABLE)</b>		
<b>EXTRA-HIGH-RACK COMBUSTIBLE STORAGE</b>		
Approval	3208.5	
Defined	202	
Fire protection	3208.5.1	
<b>F</b>		
<b>FABRICATION AREA</b>	2705.2	
Construction	2703.3.1	
Defined	202	
Electrical wiring and equipment	2703.7.1	
Existing	2701.4	
Gas detection	2703.13.1.1	
Storage	2704.2	
<b>FACILITY</b>		
Defined	202	
<b>FAIL-SAFE</b>	5003.2.2.1, 5004.7.2, 5005.1.5.1, 5005.1.11, 6004.2.2.7, 6204.1.11.1	
Defined	202	
<b>FAIRS</b>	105.5.5	
<b>FALLOUT AREA</b>		
Defined	202	
<b>FALSE ALARM</b>		
Defined	202	
<b>FEES</b>	107	
<b>FILL PIPE CONNECTIONS</b>	5704.2.9.5.2	
<b>FILM, CELLULOSE NITRATE MOTION PICTURE</b>	306	
Projection rooms	306.1	
Storage	306.2	
<b>FINES (in woodworking operations) (see also VIOLATION PENALTIES)</b>		
Defined (in woodworking operations)	202	
Storage and processing (in woodworking operations)	2808	
<b>FINISHED PRODUCTS</b>	2909.6	
<b>FIRE, RECREATIONAL (see RECREATIONAL FIRE)</b>		
<b>FIRE, REPORTING OF UNWANTED</b>	401.3.1, 3310	
<b>FIRE, UNWANTED (see UNWANTED FIRE)</b>		



## INDEX

**FIRE ALARM**

- Defined ..... 202
- Reporting ..... 401.3.2, 3310

**FIRE ALARM BOX (see MANUAL FIRE ALARM BOX)****FIRE ALARM CONTROL UNIT**

- Alarm activation ..... 907.5.1
- Defined ..... 202
- Emergency alarm interface ..... 908.3
- Fire safety function ..... 907.3
- Protection of control unit ..... 907.4.1
- Sprinkler system supervision ..... 903.4

**FIRE ALARM SIGNAL**

- Defined ..... 202

**FIRE ALARM SYSTEM**

- Annunciation ..... 907.6.3.1, 907.6.4.1
- Defined ..... 202
- Existing buildings ..... 907.9, 1103.7
- Maintenance ..... 907.8
- Monitoring ..... 907.6.6
- Notification appliances ..... 907.5
- Out of service ..... 901.7
- Permit ..... 105.6.6
- Power supply ..... 907.6.2
- Presignal feature
- Telephone dialing devices ..... 907.6.6.1
- Testing ..... 907.8
- Where required, existing buildings ..... 1103.7
- Where required, new buildings ..... 907.2
- Zones ..... 907.6.4

**FIRE AND SMOKE**

- PROTECTION FEATURES** ..... Chapter 7

**FIRE APPARATUS ACCESS ROAD** ..... 503

- Defined ..... 202
- Gates and barricades ..... 503.5, 503.6
- Obstructions ..... 503.4

**FIRE AREA** ..... 901.4.4

- Defined ..... 202

**FIRE BARRIER**

- Defined ..... 202
- Maintenance ..... 704.1

**FIRE CHIEF** ..... 104.12, 907.6.6.1, 2603.3, 3303.4, 5706.6.2.1

- Defined ..... 202

**FIRE CODE OFFICIAL**

- Defined ..... 202
- Duties and powers ..... 104

**FIRE COMMAND CENTER** ..... 508

- Defined ..... 202
- Required features ..... 508.1.6
- Separation ..... 508.1.2
- Size ..... 508.1.3
- Storage prohibited ..... 315.3.3, 508.1.5

**FIRE DAMPER**

- Defined ..... 202

**FIRE DEPARTMENT COMMUNICATION SYSTEM** ..... 907.2.13.2**FIRE DEPARTMENT CONNECTIONS** ..... 903.3.7, 905.2, 912**FIRE DEPARTMENT MASTER KEY**

- Defined ..... 202

**FIRE DEPARTMENT NOTIFICATION [see NOTIFICATION (of fire department)]****FIRE DEPARTMENT OPERATIONS** .... 104.12, 401.4**FIRE DETECTOR, AUTOMATIC**

- Defined ..... 202

**FIRE DOOR**

- Defined ..... 202

**FIRE DOOR ASSEMBLY**

- Defined ..... 202

**FIRE DRILL (see EMERGENCY EVACUATION DRILL)****FIRE EQUIPMENT, TAMPERING WITH** ..... 901.8**FIRE ESCAPE STAIRWAYS** ..... 1104.16**FIRE EXIT HARDWARE** ..... 1010.2.9

- Defined ..... 202

**FIRE EXTINGUISHERS, PORTABLE** ..... 906

- Asphalt kettles ..... 303.5
- Aviation facilities ..... 2005
- Buildings under construction or demolition ..... 3316
- Commercial cooking equipment ..... 906.4
- Dry cleaning plants ..... 2108.4
- Flammable finishes .... 2404.4.1, 2405.4.2, 2406.4.2
- Lumber yards ..... 2804.2, 2808.8

**FIRE FIGHTERS**

- Hazards to ..... 316
- In-building, two-way communication ..... 510
- Pitfalls ..... 316.3
- Safety ..... 101.3

**FIRE HYDRANT**

- Obstruction ..... 507.5.4
- Permit ..... 105.5.17, 105.5.41, 105.6.18
- Standpipe system ..... 507.5.1.1
- Tampering ..... 901.8
- Testing ..... 507.5.2, 901.5

**FIRE INVESTIGATIONS** ..... 104.11**FIRE LANE**

- Defined ..... 202

**FIRE PARTITION**

- Defined ..... 202
- Maintenance ..... 701.2

**FIRE POINT**

- Defined ..... 202

**FIRE PROTECTION EQUIPMENT** ..... 509**FIRE PROTECTION RATING**

- Defined ..... 202

<b>FIRE PROTECTION SYSTEM</b> . . . . .	Chapter 9
Defined . . . . .	202
Nonrequired . . . . .	901.4.2
Out of service . . . . .	901.7
Owner's responsibility during construction or demolition . . . . .	3303
Permit . . . . .	105.6.1, 105.6.4, 105.6.6, 105.6.7, 105.6.19, 105.6.23
<b>FIRE PUMP ROOMS</b> . . . . .	901.4.7, 913.2.1, 1008.3.3
<b>FIRE PUMPS</b> . . . . .	105.6.7, 913
<b>FIRE RECORDS</b> . . . . .	104.6.3
<b>FIRE RESISTANCE</b>	
Defined . . . . .	202
<b>FIRE SAFETY DURING CONSTRUCTION AND DEMOLITION</b> . . . . .	Chapter 33
Access for fire fighting . . . . .	3311
Automatic sprinkler systems . . . . .	3315
Cooking . . . . .	3305.8
Explosive materials . . . . .	3308
Fire reporting . . . . .	3310
Fire watch . . . . .	3305.5
Flammable gas . . . . .	3307
Owner's responsibility . . . . .	3303
Portable fire extinguishers . . . . .	3316
Precautions against fire . . . . .	3305
Safeguarding roofing operations . . . . .	3318
Standpipes . . . . .	3314
Temporary heating . . . . .	3304
<b>FIRE SAFETY FUNCTIONS</b> . . . . .	907.3
Defined . . . . .	202
<b>FIRE SAFETY PLANS</b> . . . . .	404, 3404.5
<b>FIRE SEPARATION DISTANCE</b>	
Defined . . . . .	202
<b>FIRE SERVICE ELEVATOR KEYS (see KEYS, FIRE SERVICE ELEVATOR)</b>	
<b>FIRE SERVICE FEATURES</b> . . . . .	Chapter 5
<b>FIRE WALL</b>	
Defined . . . . .	202
Maintenance . . . . .	701.2
<b>FIRE WATCH (see also STANDBY PERSONNEL)</b>	
Construction/demolition sites . . . . .	3305.5
Defined . . . . .	202
During construction . . . . .	3305.5.1
Fire protection impairments . . . . .	901.7
Hot work . . . . .	3504.2.2
Location and records . . . . .	3305.5.3
Personnel . . . . .	3305.5.2
Places of assembly . . . . .	403.11.1
<b>FIREBLOCKING</b>	
Defined . . . . .	202
Maintenance . . . . .	707.1
<b>FIRE-EXTINGUISHING SYSTEMS, ALTERNATIVE</b> . . . . .	904
Commercial cooking . . . . .	904.13
Fire alarm system interconnection . . . . .	904.3.5, 907.6
Flammable and combustible liquids . . . . .	5704.3.7.5.1, 5704.3.8.4
Flammable finishing . . . . .	2404.4, 2405.4.1, 2406.4, 2407.4
Hazardous materials . . . . .	5005.1.8
Monitoring . . . . .	904.3.5
Permit . . . . .	105.6.1
Required . . . . .	904.2
<b>FIRE-FLOW REQUIREMENTS</b> . . . . .	507.3
<b>FIREPLACES, PORTABLE OUTDOOR (see PORTABLE OUTDOOR FIREPLACES)</b>	
<b>FIRE-RESISTANCE RATING</b>	
Defined . . . . .	202
<b>FIRE-RESISTANCE-RATED CONSTRUCTION</b> . . . . .	701.2
<b>FIRE-RESISTANT JOINT SYSTEM</b>	
Defined . . . . .	202
<b>FIRE-RETARDANT COATINGS</b> . . . . .	803.4
Treatments for natural cut trees . . . . .	806.1.4
<b>FIREWORKS (see EXPLOSIVES AND FIREWORKS)</b>	
Defined . . . . .	202
Prohibited . . . . .	5601.1.3
Retail display and sale . . . . .	5609.1
<b>FIREWORKS DISPLAY</b>	
Damage from . . . . .	5601.2.4.2
Defined . . . . .	202
<b>FIXED BASE OPERATOR</b>	
Defined . . . . .	202
<b>FIXED SEATING</b> . . . . .	1004.6
Defined . . . . .	202
Occupant load factor . . . . .	1004.5
<b>FLAME ARRESTORS</b> . . . . .	5704.2.7.3.2
<b>FLAME RETARDANT (see also FIRE-RETARDANT COATINGS)</b>	
Tents, air-supported, air-inflated and tensioned membrane structures . . . . .	3104.2
<b>FLAME SPREAD</b>	
Defined . . . . .	202
<b>FLAME SPREAD INDEX</b>	
Defined . . . . .	202
<b>FLAMING FOODS AND BEVERAGES</b> . . . . .	308.1.8
<b>FLAMMABLE CRYOGENIC FLUID</b>	
Defined . . . . .	202
<b>FLAMMABLE FINISHES</b> . . . . .	Chapter 24
Defined . . . . .	202
Dipping operations . . . . .	2405
Electrostatic apparatus . . . . .	2407
Floor surfacing . . . . .	2410

## INDEX

Powder coating . . . . .	2406	<b>FLASH POINT</b>	
Protection of operations . . . . .	2403	Defined. . . . .	202
Spray finishing. . . . .	2404	<b>FLEET VEHICLE MOTOR FUEL-DISPENSING FACILITY</b>	
Ventilation . . . . . 2404.7, 2405.7, 2406.7, 2407.7, 2409.6, 2410.5		Defined. . . . .	202
<b>FLAMMABLE GAS</b> . . . . . Chapter 58		Tanks . . . . .	2306.2.4.2
Buildings under construction or demolition . . . . .	3307	<b>FLEXIBLE JOINTS</b> . . . . .	2306.7.9.1.4, 5703.6.9
Defined . . . . .	202	<b>FLIGHT (stairs)</b>	
Nonodorized . . . . .	2311.8.9	Defined. . . . .	202
Prohibited for pipe cleaning. . . . .	3307.2	<b>FLOOR AREA, GROSS</b>	
Requirements . . . . .	5803	Defined. . . . .	202
Storage . . . . .	3307.1, 5804	<b>FLOOR AREA, NET</b>	
Use . . . . .	3307.1, 5805	Defined. . . . .	202
<b>FLAMMABLE LIQUEFIED GAS</b>		<b>FLOOR CONSTRUCTION</b> . . . . .	2404.3.2, 2404.3.3.3, 2404.3.4.1, 5004.12, 6304.1.3
Defined . . . . .	202	<b>FLOOR COVERING (interior finish)</b> . . . . .	804.3
<b>FLAMMABLE LIQUIDS</b> . . . . . Chapter 57		<b>FLOOR FINISHING</b> . . . . .	2410
Buildings under construction or demolition . . . . .	3306	Permit. . . . .	105.5.19
Classified locations . . . . .	5703.1.1	<b>FLOOR IDENTIFICATION SIGNS</b> . . . . .	1023.9, 1032.9, 1104.24
Defined . . . . .	202	<b>FLOOR OPENINGS AND SHAFTS</b> . . . . .	704, 1103.4
Dispensing, use, mixing and handling . . . . .	5705.3, 5705.3.8	<b>FLUE SPACES</b> . . . . .	3208.3
In construction and demolition operations. . . . .	3306	Defined. . . . .	202
Indoor storage . . . . .	5704.3.3	<b>FLUIDIZED BED</b>	
Labeling and signage . . . . .	5703.5	Defined. . . . .	202
Motor fuel . . . . .	2306	<b>FOAM PLASTICS</b> . . . . .	803.11.1, 803.11.2, 807.5.1.1
Outdoor storage . . . . .	5704.4	<b>FOAM-EXTINGUISHING SYSTEMS</b> . . . . .	904.7
Permit . . . . .	105.5.18, 105.6.8	Defined. . . . .	202
Portable fire extinguisher. . . . .	5706.2.7	<b>FOGGING, INSECTICIDAL (see FUMIGATION AND INSECTICIDAL FOGGING)</b>	
Special operations. . . . .	5706	<b>FOLDING AND TELESCOPIC SEATING</b>	
Tank storage . . . . .	5704.2	Defined. . . . .	202
Tents, air-supported, air-inflated and tensioned membrane structures . . . . .	3107.14	<b>FOSTER CARE FACILITIES (Occupancy Group I)</b>	
Waste control . . . . .	5706.3.3	Defined. . . . .	202
Wholesale and resale use. . . . .	5704.3.6	<b>FRUIT AND CROP RIPENING</b> . . . . .	Chapter 25
<b>FLAMMABLE MATERIAL</b>		Ethylene gas . . . . .	2503
Defined . . . . .	202	Heating. . . . .	2504.5
<b>FLAMMABLE SOLID</b> . . . . . Chapter 59		Permit. . . . .	105.5.20
Defined . . . . .	202	Sources of ignition . . . . .	2504
Indoor storage . . . . .	5904.1	Warning signs . . . . .	2507
Magnesium . . . . .	5906	<b>FUEL CELL SYSTEMS</b> . . . . .	1206
Outdoor storage . . . . .	5906	Indoor installations . . . . .	1206.6
Requirements . . . . .	5903	Outdoor installations . . . . .	1206.8
Use . . . . .	5905	Permits. . . . .	105.6.9
<b>FLAMMABLE VAPOR AREA</b>		<b>FUEL LIMIT SWITCH</b>	
Alarms . . . . .	2404.8.1.1	Defined. . . . .	202
Defined . . . . .	202	<b>FUEL OIL</b>	
Electrical equipment . . . . .	2403.2.1	Grade . . . . .	605.1.3
Ignition sources . . . . .	2403.2	Storage. . . . .	605.4
Ventilation . . . . .	2404.7, 2405.7	<b>FUEL-FIRED APPLIANCES</b> . . . . .	605
Warning signs . . . . .	2403.2.7	Chimneys . . . . .	605.3, 605.2.1
<b>FLAMMABLE VAPORS OR FUMES</b>		Heating. . . . .	605.6
Defined . . . . .	202		

Installation . . . . .	605.1
<b>FUMIGANT</b>	
Defined . . . . .	202
<b>FUMIGATION AND INSECTICIDAL FOGGING</b> . . . . .	Chapter 26
Breathing apparatus . . . . .	2603.3.2
Clean up . . . . .	2603.6
Defined . . . . .	202
Fire safety requirements . . . . .	2603
Notification . . . . .	2603.3
Permit . . . . .	105.5.21
Sealing of buildings . . . . .	2603.5
Warning signs . . . . .	2603.3.1
Watch personnel . . . . .	2603.3.3
<b>FURNACE CLASS A, B, C, D</b>	
Defined . . . . .	202
<b>FURNISHINGS</b> . . . . .	808, 1032.6
<b>FURNITURE, UPHOLSTERED</b> . . . . .	805, 903.2.4,
<b>FUSIBLE LINKS</b> . . . . .	705.2, 904.13.5.3, 910.5.1

## G

<b>GARAGE (see REPAIR GARAGE)</b>	
<b>GARAGING (see PARKING AND GARAGING)</b>	
<b>GAS CABINET</b> . . . . .	2703.10.2, 2703.13.1.3, 5003.8.6, 5303.7.10, 6004.1.1
Defined . . . . .	202
<b>GAS DETECTION SYSTEM</b> . . . . .	916
Carbon dioxide systems . . . . .	5307.3.2, 5307.4.3
Defined . . . . .	202
Emergency power . . . . .	1203.2.7
Energy storage systems . . . . .	1207.6.1.2.4
Highly toxic or toxic gases . . . . .	6004.2.2.10
HPM gases . . . . .	2703.13
Hydrogen fuel gas rooms . . . . .	5808.5
Hydrogen vehicles . . . . .	2311.8.9
LNG . . . . .	2311.8.9
Ozone gas . . . . .	6005.3.2
Processing and extraction . . . . .	3905.1
Stationary fuel cell power systems . . . . .	1206.13
<b>GAS DETECTOR (see COMBUSTIBLE GAS DETECTOR)</b>	
<b>GAS METERS</b> . . . . .	605.9
<b>GAS ROOM</b> . . . . .	5003.8.4, 6004.2.2.6
Defined . . . . .	202
<b>GASEOUS HYDROGEN SYSTEM</b> . . . . .	5801.1
Defined . . . . .	202
<b>GAS-FUELED OR LIQUID-FUELED VEHICLES</b> . . . . .	314.4, 3107.14
Permit . . . . .	105.5.29

## GATES

Means of egress . . . . .	1010.4
<b>GATES, FIRE APPARATUS ROAD</b> . . . . .	503.5, 503.6
Permit . . . . .	105.6.11
<b>GENERAL REQUIREMENTS</b> . . . . .	Chapter 3
<b>GENERATORS</b>	
Acetylene . . . . .	3508
Ethylene . . . . .	2506
Ozone Gas . . . . .	6005
Stationary . . . . .	1203.1.1
<b>GLASS-FIBER-REINFORCED PLASTICS</b>	
Manufacturing . . . . .	2409
Storage . . . . .	2409.4
Ventilation . . . . .	2409.6

## GRADE FLOOR OPENING

Defined . . . . .	202
-------------------	-----

## GRADE PLANE

Defined . . . . .	202
-------------------	-----

## GRANDSTAND . . . . . 1030.1.1, 1030.1.1.1

Defined . . . . .	202
-------------------	-----

## GROUP HOME (Occupancy Group R-4)

Defined . . . . .	202
-------------------	-----

## GUARD . . . . . 1015, 1030.17, 1104.6

Defined . . . . .	202
-------------------	-----

## GUEST ROOM

Defined . . . . .	202
-------------------	-----

## GYPSUM BOARD

Defined . . . . .	202
-------------------	-----

## H

### HABITABLE SPACE

Defined . . . . .	202
-------------------	-----

### HALOGENATED EXTINGUISHING SYSTEM

Defined . . . . .	202
-------------------	-----

### HAND RUB, ALCOHOL-BASED (see ALCOHOL-BASED HAND RUB)

### HANDLING

Defined . . . . .	202
-------------------	-----

### HANDRAIL . . . . . 1014

Defined . . . . .	202
-------------------	-----

### HANGARS, AIRCRAFT (see AIRCRAFT-RELATED OCCUPANCIES, FIRE PROTECTION FOR)

### HANGERS, FIRE EXTINGUISHER . . . . . 906.7

### HARDENING TANKS . . . . . 2405.9

### HARDWARE, EXIT DOOR . . . . . 1010.2

### HARDWARE, PANIC . . . . . 1010.2.9

### HAY

Combustible fiber . . . . .	202, 3703.4
-----------------------------	-------------

Combustible waste . . . . .	304.1.1
-----------------------------	---------

Storage . . . . .	3107.2, 3703.4
-------------------	----------------



## INDEX

<b>HAZARD COMMUNICATION</b> . . . . .	407	Laboratory suite construction . . . . .	3804
Hazardous Materials Inventory		Nonsprinklered laboratories . . . . .	3805
Statement . . . . .	407.5, 5001.5.2	<b>HIGHLY TOXIC AND TOXIC</b>	
Hazardous Materials Management Plan . . . . .	407.6	<b>MATERIALS</b> . . . . .	Chapter 60
Training . . . . .	407.4	Compressed gases . . . . .	6004
<b>HAZARDOUS MATERIALS</b>		Defined . . . . .	202
Defined . . . . .	202	Indoor storage and use . . . . .	6003.1
Fire-extinguishing systems . . . . .	5004.5, 5005.1.8	Outdoor storage and use . . . . .	6003.2
General . . . . .	Chapter 50	Solids and liquids . . . . .	6003
Groups M and S . . . . .	5003.11	<b>HIGH-PILED COMBUSTIBLE STORAGE</b> . . . . .	Chapter 32
Identification signs . . . . .	5003.5	Aisles . . . . .	3206.9
Mixtures . . . . .	5001.2.1	Automated storage . . . . .	3209
Outdoor control areas . . . . .	5003.12	Automatic sprinklers . . . . .	3206.4, 3209.2
Permit . . . . .	105.5.22, 105.6.12	Classifications, commodities . . . . .	3203
Personnel training . . . . .	407.4	Defined . . . . .	202
Power systems . . . . .	1203.2.10	Fire protection . . . . .	3206, Table 3206.2
Requirements . . . . .	5003	Housekeeping . . . . .	3205
Storage . . . . .	5004	Pallets . . . . .	3206.4.1
Use, dispensing and handling . . . . .	5005	Plastic pallets . . . . .	3206.4.1.1
<b>HAZARDOUS MATERIALS</b>		<b>HIGH-PILED STORAGE AREA</b>	
<b>INVENTORY STATEMENT</b> . . . . .	407.5, 5001.5.2	Defined . . . . .	202
<b>HAZARDOUS MATERIALS</b>		Designations . . . . .	3204
<b>MANAGEMENT PLAN</b> . . . . .	407.6, 5001.5.1	Permit . . . . .	105.5.24
<b>HAZARDOUS PRODUCTION MATERIAL (HPM)</b>		<b>HIGH-RISE BUILDING</b>	
Defined . . . . .	202	Automatic sprinkler system . . . . .	903.2.11.3, 914.3.1
Permit . . . . .	105.5.23	Automatic sprinkler system, floor	
<b>HAZARDS TO FIRE FIGHTERS</b> . . . . .	316	control valves required . . . . .	903.4.3
<b>HEALTH HAZARD</b> . . . . .	5001.2.2.2, Table 5003.1.1(2),	Automatic sprinkler system, secondary	
	Table 5003.1.1(4)	water supply required . . . . .	914.3.2
Defined . . . . .	202	Defined . . . . .	202
<b>HEAT VENTS (see SMOKE AND HEAT VENTS)</b>		Emergency voice/alarm communications	
<b>HEATERS, PATIO (see PORTABLE OUTDOOR GAS-</b>		system . . . . .	907.2.13, 914.3.5
<b>FIRED HEATING APPLIANCES)</b>		Fire alarm system . . . . .	907.2.13, 914.3.3
<b>HEATERS, PORTABLE ELECTRIC SPACE</b> . . . . .	603.9	Fire alarm system zoning . . . . .	907.6.4.2
<b>HEATERS, PORTABLE UNVENTED</b> . . . . .	605.5	Fire command center . . . . .	508.1, 914.3.7
<b>HEATING APPLIANCES</b> . . . . .	605.6	Fire department communications system . . . . .	907.2.13.2
<b>HEATING EQUIPMENT, TEMPORARY,</b>		Fire safety and evacuation plans . . . . .	403.10.2
<b>DURING CONSTRUCTION</b> . . . . .	3303	In-building, two-way emergency	
<b>HEIGHT, BUILDING</b>		responder communication . . . . .	914.3.6
Defined . . . . .	202	Smokeproof exit stairway enclosures . . . . .	1023.12
<b>HELIPORT</b> . . . . .	2007	Standby power system . . . . .	1203.2.11
Defined . . . . .	202	Standpipe system . . . . .	905.3.1
Permit for rooftop heliport . . . . .	105.5.46	<b>HIGH-VOLTAGE TRANSMISSION LINE</b>	
<b>HELISTOP</b> . . . . .	2007	Defined . . . . .	202
Defined . . . . .	202	Storage under . . . . .	315.5, 316.6
<b>HI-BOY</b>		<b>HIGHWAY</b>	
Construction . . . . .	303.7	Defined . . . . .	202
Defined . . . . .	202	<b>HISTORIC BUILDINGS</b> . . . . .	102.6
<b>HIGHER EDUCATION LABORATORIES</b> . . . . .	Chapter 38	Defined . . . . .	202
Existing sprinklered laboratories . . . . .	3806	<b>HOGGED MATERIALS</b> . . . . .	2807, 2808
General safety provisions . . . . .	3803	Defined . . . . .	202

<b>HOOD</b> .....	606	Hot work hazards .....	3503.6
Defined .....	202	Streets and roads .....	505.2
<b>HORIZONTAL ASSEMBLY</b>		Tenant spaces in covered malls .....	403.10.1.5
Defined .....	202	Utilities .....	509.1.1
<b>HORIZONTAL PROJECTIONS</b> .....	1003.3.3	Vacant premises .....	311.5.4
<b>HOSE</b> .....	2307.6.2, 2310.3.3	<b>IGNITION SOURCES</b> .....	305, 3703.7
Aircraft fueling .....	2006	<b>IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH)</b>	
Conductive .....	2006.5.2.1	Defined .....	202
Connections for standpipes .....	905.3.4.1, 905.4, 905.5, 905.6	<b>IMPACT PROTECTION, VEHICLE</b> .....	312, 6107.4, 6109.13
Dispensing .....	2006.3.3, 2306.7.5	<b>IMPAIRMENT COORDINATOR</b> .....	901.7.1
Protection .....	2006.7, 5706.6.1.11	Defined .....	202
Removal of occupant hose lines .....	901.8.2	<b>IN-BUILDING, TWO-WAY EMERGENCY RESPONDER COMMUNICATION</b> .....	510
System .....	904.8.4, 904.9.3, 904.10.3	Existing buildings .....	1103.2
Threads .....	903.3.6, 912.3	High-rise buildings .....	914.3.6
<b>HOSPITALS AND PSYCHIATRIC HOSPITALS (Group I-2)</b>		<b>INCAPABLE OF SELF-PRESERVATION (Occupancy Group I)</b>	
Defined .....	202	Defined .....	202
<b>HOT WORK (see WELDING AND OTHER HOT WORK)</b>		<b>INCINERATORS</b> .....	605.8, 1103.4.10
Defined .....	202	Room egress .....	1006.2.2.1
Permit .....	105.5.25	<b>INCOMPATIBLE MATERIALS</b> ....	2704.3.3, 5003.9.8, 5003.10.3.6, 5004.2.2.2, 5004.4, 5005.1.1, 5303.7.11.1, 5704.2.6, 6404.1.4
<b>HOT WORK AREA</b>		Defined .....	202
Defined .....	202	<b>INCOMPATIBLE SURFACES</b> .....	6306.3.6.2
<b>HOT WORK EQUIPMENT</b>		<b>INDOOR TRADE SHOWS</b> .....	Appendix N
Defined .....	202	Covered booths .....	N106
<b>HOT WORK PERMITS</b>		Display and storage of hazardous and combustible materials .....	N107
Defined .....	202	Interior finish and decorative materials .....	N104
<b>HOT WORK PROGRAM</b>		Means of egress .....	N108
Defined .....	202	Multiple-level booths .....	N105
<b>HPM FACILITY (see SEMICONDUCTOR FABRICATION FACILITY)</b>		Public safety for events .....	N103
<b>HPM ROOM</b>		<b>INDUSTRIAL OVENS</b> .....	Chapter 30
Defined .....	202	Fire protection .....	3006
<b>HYDRANTS (see FIRE HYDRANT)</b>		Fuel piping .....	3004
<b>HYDROGEN</b> .....	5501.1, 5801.1	Interlocks .....	3005
<b>HYDROGEN FUEL GAS ROOMS</b> .....	5808	Location .....	3003
Defined .....	202	Operation and maintenance .....	3007
<b>HYDROGEN MOTOR FUEL-DISPENSING FACILITIES</b> .....	2309	Permit .....	105.5.26, 105.6.14
<b>HYPERBARIC FACILITIES</b> .....	609	<b>INERT GAS</b> .....	2501.1, 2906.4, Table 5003.1.1(1), Table 5003.1.1(3), 5305.8, 5703.6.3.1, 5705.2.2
		Defined .....	202
<b>I</b>		<b>INHABITED BUILDING</b>	
<b>IDENTIFICATION</b>		Defined .....	202
Alcohol-blended fuel-dispensing facilities ....	2306.8.4	<b>INITIATING DEVICE</b>	
Building (address) .....	505.1	Defined .....	202
Elevator lobby .....	1023.10	Identification .....	907.6.3
Exit discharge .....	1023.8, 1104.21	<b>INSECTICIDAL FOGGING (see FUMIGATION AND INSECTICIDAL FOGGING)</b>	
Fire protection equipment .....	509.1, 905.7.1		
Floor level .....	1023.9, 1032.9		
Hazardous materials .....	5003.5, 5503.4, 5703.5.4, 6005.4.3		

INDEX

**INSPECTION** . . . . 104.6.2, 105.2.2, 108, 108.2.1, 901.6  
Emergency and standby power system . . . . . 1203.4  
Fire department connections. . . . . 912.7  
Fire hydrant. . . . . 507.5.2  
Fireworks display. . . . . 5608.5.3, 5608.9  
Hose . . . . . 3509.7  
Magazines. . . . . 5604.9  
Masonry chimneys . . . . . 605.2.1.1  
Tents . . . . . 3103.7

**INSTITUTIONAL OCCUPANCIES**  
Defined . . . . . 202

**INTEGRATED TESTING** . . . . . 901.6.2

**INTERCONNECTION**  
Fire-extinguishing systems with  
cooking appliances . . . . . 904.13.2  
Smoke alarms . . . . . 907.2.11.5, 1103.8.2  
Standpipe risers . . . . . 905.4.2

**INTERIOR EXIT RAMP**  
Defined . . . . . 202

**INTERIOR EXIT STAIRWAY**  
Defined . . . . . 202

**INTERIOR FINISH** . . . . . Chapter 8  
Defined . . . . . 202

**INTERIOR FLOOR-WALL BASE** . . . . . 804.4  
Defined . . . . . 202

**INTERIOR WALL AND CEILING FINISH** . . . . 803, 804  
Defined . . . . . 202

**INTERIOR WALL AND CEILING FINISH  
AND TRIM.** . . . . . 803, 804

**INTUMESCENT FIRE-RESISTANT MATERIALS** . . 708

**INVESTIGATIONS, FIRE** . . . . . 104.11

**IRRITANT**  
Defined . . . . . 202  
Gases . . . . . 5004.7.1, 5307.1

**ISO-BUTANE (see LIQUEFIED PETROLEUM GAS)**

J

**JURISDICTION**  
Defined . . . . . 202

K

**KETTLES [see ORGANIC COATING or ASPHALT  
(TAR) KETTLES]**

**KEY BOXES** . . . . . 506  
Defined . . . . . 202  
Maintenance . . . . . 506.2  
Nonstandard fire service elevator keys . . . . 506.1.2  
Required . . . . . 506.1

**KEYS, FIRE SERVICE ELEVATOR** . . . . . 604.6

L

**LABELED**  
Defined. . . . . 202

**LADDERS** . . . . . 1006.2.2.1, 1006.2.2.2, 1011.15,  
1031.5.2, 1104.16.6, 5704.2.8.15

**LANDING**  
Ramps . . . . . 1012.6, 1012.10  
Stairs and stairways. . . . . 1010.1.4, 1010.1.5,  
1011.6, 1025.2.4

**LANDSCAPED ROOFS (see also  
ROOFTOP GARDENS)** . . . . . 317

**LAUNDRY CARTS** . . . . . 318.1

**LEAD-ACID BATTERY SYSTEM, STATIONARY (see  
BATTERY SYSTEMS, STATIONARY STORAGE)**

**LEAD-ACID BATTERY SYSTEM, VALVE-  
REGULATED (see BATTERY SYSTEMS,  
STATIONARY STORAGE)**

**LEAKS**  
Compressed gases . . . . . 5303.12  
Cryogenic fluids . . . . . 5503.9  
Explosive materials . . . . . 5604.10  
Flammable and combustible  
liquids . . . . . 2006.11, 2305.2.3, 2306.7.7.1, 3306.6,  
5703.6.3.1, 5704.2.7.10, 5706.6.1.1  
Highly toxic and toxic  
materials. . . . . 6004.2.2.3, 6004.2.2.4, 6004.3.2.2

**LEVEL OF EXIT DISCHARGE (see EXIT DISCHARGE,  
LEVEL OF)**

**LIABILITY** . . . . . 104.7

**LIFE SAFETY SYSTEMS** . . . . . 901, 907.8.4  
Defined. . . . . 202

**LIMITED SPRAYING SPACE**  
Defined. . . . . 202

**LINEN CHUTES** . . . . . 903.2.11.2

**LINEN CONTAINERS** . . . . . 808.1

**LIQUEFIED NATURAL GAS (LNG)** . . . . 2311.6, 5501.1  
Defined. . . . . 202

**LIQUEFIED PETROLEUM GAS (LP-gas)** . . Chapter 61  
Container defined. . . . . 202  
Containers not in service . . . . . 6110  
Cooking devices. . . . . 308.1.4  
Cylinder exchange . . . . . 6109  
Defined. . . . . 202  
Dispensing and overfilling . . . . . 6106  
Fire protection . . . . . 6108  
Installation of equipment . . . . . 6103  
Location of containers . . . . . 6104, Table 6104.3  
Motor fuel-dispensing facilities. . . . . 2307  
Parking and garaging of LPG-fueled vehicles . . 6111  
Parking and garaging of tank vehicles. . . . . 6111  
Permit. . . . . 105.5.29, 105.6.15  
Prohibited use . . . . . 6105

Safety precautions and devices . . . . .	6107	Permit . . . . .	105.5.27
Storage . . . . .	6109	Size of piles . . . . .	2807.2, 2808.3
<b>LIQUID</b>		Waste removal . . . . .	2803.3
Defined . . . . .	202	<b>LUMINOUS EGRESS PATH MARKINGS</b> . . . . .	1025
<b>LIQUID LEVEL LIMIT CONTROL</b> . . . . .	5003.2.7, 5005.1.4.1, 5005.1.4.2		
<b>LIQUID OXYGEN AMBULATORY CONTAINER</b> . . . . .	6306.3.1, 6306.3.5, 6306.3.6.1	<b>M</b>	
Defined . . . . .	202	<b>MAGAZINE</b>	
<b>LIQUID OXYGEN HOME CARE CONTAINER</b> . . .	6306.3	Defined . . . . .	202
Defined . . . . .	202	<b>MAGNESIUM</b>	
<b>LIQUID OXYGEN IN HOME HEALTH CARE</b> . . . .	6306	Defined . . . . .	202
<b>LIQUID STORAGE ROOM</b> . . . . .	5704.3.7	Permit . . . . .	105.5.30
Defined . . . . .	202	Storage . . . . .	5906.2, 5906.3, 5906.4
<b>LIQUID STORAGE WAREHOUSE</b> . . . . .	5704.3.8	Use . . . . .	5906.5
Defined . . . . .	202	<b>MAINTENANCE</b> . . . . .	109
<b>LIQUID-FUELED OR GAS-FUELED VEHICLES</b> . . . . .	314.4, 3107.15	<b>MALL (see COVERED MALL BUILDING)</b>	
Permit . . . . .	105.5.28	<b>MANIFOLDS</b>	
<b>LISTED</b>		Cylinders . . . . .	3509.4
Defined . . . . .	202	Identification . . . . .	3509.5
<b>LOADING RACKS</b> . . . . .	5706.3.8, 5706.5.1.12	Piping . . . . .	3509
<b>LOCKDOWN</b> . . . . .	404	<b>MANUAL FIRE ALARM BOX</b> . . . . .	907.4.2
Defined . . . . .	202	Defined . . . . .	202
Plans . . . . .	404.2.3	<b>MANUAL STOCKING METHODS</b>	
<b>LOCKERS, COMBUSTIBLE</b> . . . . .	808.4	Defined . . . . .	202
<b>LODGING HOUSE</b>		<b>MANUFACTURE OF ORGANIC COATINGS</b> . . . . .	Chapter 29
Defined . . . . .	202	<b>MARINAS</b> . . . . .	Chapter 36
Occupancy group . . . . .	202	<b>MARINE MOTOR FUEL-DISPENSING FACILITY</b> . . . . .	2310, 3605
<b>LONGITUDINAL FLUE SPACE (see FLUE SPACES)</b>		Defined . . . . .	202
<b>LOT</b>		Fire protection . . . . .	2310.6
Defined . . . . .	202	Fueling . . . . .	2310.4
<b>LOT LINE</b>		General . . . . .	2310.1
Defined . . . . .	202	Nozzles . . . . .	2310.3.3
<b>LOWER EXPLOSIVE LIMIT (LEL)</b>		<b>MARKING (see also PLACARDS; PLACARDING)</b> . . . . .	503.3, 909.14, 5003.5.1
Defined . . . . .	202	Compressed gas . . . . .	5303.2
<b>LOWER FLAMMABLE LIMIT (LFL)</b>		Cryogenic containers . . . . .	5503.4
Defined . . . . .	202	Shaftway . . . . .	316.2
<b>LOW-PRESSURE TANK</b>		Tank . . . . .	5706.2.2
Defined . . . . .	202	Warnings . . . . .	5003.8.7.2
<b>LP-GAS (see LIQUEFIED PETROLEUM GAS)</b>		<b>MASS NOTIFICATION SYSTEMS</b> . . . . .	917
<b>LUMBER YARDS, AGRO-INDUSTRIAL, SOLID BIOMASS AND WOODWORKING FACILITIES</b> . . . . .	Chapter 28	<b>MATERIAL SAFETY DATA SHEET (MSDS) (see SAFETY DATA SHEET)</b>	
Access plan . . . . .	2803.7	<b>MATTRESSES (in Groups I and R)</b> . . . . .	805
Emergency plan . . . . .	2808.10	<b>MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA</b> . . . . .	5003.1.1(1), Table 5003.1.1(2), Table 5003.1.1(3), Table 5003.1.1(4), 5003.11
Fire alarms . . . . .	2804.2	Defined . . . . .	202
Fire protection . . . . .	2804	<b>MEANS OF APPEALS</b> . . . . .	111
General . . . . .	2803		
Log storage areas . . . . .	2806		
Open yards . . . . .	2803.1		



## INDEX

<b>MEANS OF EGRESS</b> . . . . .	Chapter 10, 1104, 3312	<b>Plywood</b> . . . . .	2805
Accessible means of egress . . . . .	1009	<b>Process</b> . . . . .	2806
Assembly . . . . .	1030	<b>Veneer</b> . . . . .	2805
Bleachers . . . . .	1030.1.1	<b>MIRRORS</b> . . . . .	1010.1, 1032.6
Buildings under construction or demolition . . . . .	3312	<b>MIXTURES (Hazardous materials)</b> . . . . .	5001.2.1
Corridors . . . . .	1020, 1104.17	<b>MOBILE FOOD PREPARATION VEHICLES</b> . . . . .	319
Defined . . . . .	202	Permit . . . . .	105.5.32
Egress court . . . . .	202, 1029.1	<b>MOBILE FUELING</b> . . . . .	5706.5.4.5
Elevators, escalators and moving walks . . . . .	1003.7, 1104.2	Defined . . . . .	202
Emergency escape and rescue . . . . .	1031	<b>MOBILE FUELING OPERATIONS (see ON-DEMAND MOBILE FUELING OPERATIONS) MODIFICATIONS (of code requirements)</b> . . . . .	104.9
Existing buildings . . . . .	1104	<b>MONITORING (sprinkler and fire alarm systems)</b> . . . . .	903.4.1, 907.6.6
Exit access . . . . .	1016	Hazardous materials . . . . .	5004.2.2.5
Exit discharge . . . . .	1028	Termination of . . . . .	907.6.6.3
Exits . . . . .	1006	<b>MORTAR</b> . . . . .	
Guards . . . . .	1015, 1104.6	Defined . . . . .	202
Handrails . . . . .	1014	<b>MOTION PICTURE PROJECTION ROOMS AND FILM</b> . . . . .	306
Illumination . . . . .	1008, 1104.3	Film storage . . . . .	306.2
Locks, latches . . . . .	1010.2.4	<b>MOTOR FUEL-DISPENSING FACILITIES (see also by type of fuel)</b> . . . . .	105.5.33, Chapter 23
Maintenance of . . . . .	1032	<b>MOTOR VEHICLE REPAIR BOOTHS</b> . . . . .	2311.8.4
Membrane structures . . . . .	3103.12	<b>MOTORIZED CONSTRUCTION EQUIPMENT</b> . . . . .	3317
Monitoring and recording of . . . . .	1010.2.10	<b>MOVING WALKS</b> . . . . .	1103.3
Obscuration of . . . . .	316.4, 1032.4, 1032.6	<b>MSDS (see SAFETY DATA SHEET)</b> . . . . .	
Obstructions . . . . .	1032.3, 1032.3.1	<b>MULTIPLE-STATION ALARM DEVICE</b> . . . . .	
Outdoor assembly events . . . . .	3106.3	Defined . . . . .	202
Ramps . . . . .	1012	<b>MULTIPLE-STATION SMOKE ALARM</b> . . . . .	907.2.11, 1103.8
Signs . . . . .	1013	Defined . . . . .	202
Sizing . . . . .	1005	<b>MUSEUMS (Occupancy Group A-3)</b> . . . . .	
Stairways . . . . .	1023, 1027	Occupant load . . . . .	Table 1004.5
Tents . . . . .	3103.12		
<b>MECHANICAL REFRIGERATION (see REFRIGERATION SYSTEM)</b> . . . . .			
<b>MECHANICAL STOCKING METHODS</b> . . . . .	3206.10.1.1		
Defined . . . . .	202		
<b>MEDICAL CARE (Occupancy Group I)</b> . . . . .			
Defined . . . . .	202		
<b>MEDICAL GAS SYSTEMS</b> . . . . .	5306.5		
<b>MEDICAL GASES</b> . . . . .	5306		
<b>MEMBRANE STRUCTURE</b> . . . . .	Chapter 31		
Defined . . . . .	202		
<b>MERCHANDISE PAD</b> . . . . .	1018.4		
Defined . . . . .	202		
<b>METAL HYDRIDE AND METAL HYDRIDE STORAGE SYSTEMS</b> . . . . .	5807		
Defined . . . . .	202		
<b>METERS, GAS</b> . . . . .	605.9		
<b>MEZZANINE</b> . . . . .	1004.2.2		
Ceiling height . . . . .	1003.2		
Defined . . . . .	202		
<b>MILLS</b> . . . . .			
Composite board . . . . .	2805		

## N

<b>NATURAL BARRICADE (see BARRICADE)</b> . . . . .	
<b>NATURAL CUT TREES</b> . . . . .	806.1, 806.3
<b>NESTING</b> . . . . .	
Defined . . . . .	202
<b>NET EXPLOSIVE WEIGHT</b> . . . . .	
Defined . . . . .	202
<b>NITROCELLULOSE</b> . . . . .	2908.1, 2909.4
<b>NORMAL TEMPERATURE AND PRESSURE (NTP)</b> . . . . .	
Defined . . . . .	202
<b>NOSING</b> . . . . .	
Defined . . . . .	202
<b>NOTICE OF VIOLATION</b> . . . . .	112.3
<b>NOTIFICATION (of Fumigation)</b> . . . . .	2603.3

<b>NOTIFICATION (of Fire department/ Fire code official)</b> . . . . .	401.3, 2006.11.5, 2304.3.6, 5003.3.1
<b>NOTIFICATION APPLIANCE (see ALARM NOTIFICATION APPLIANCE)</b>	
<b>NOTIFICATION ZONE (see ZONE, NOTIFICATION)</b>	
<b>NOZZLES</b>	
Fuel delivery . . . . .	2306.7.6
Fuel transfer . . . . .	2006.3.3
Marine craft . . . . .	2310.3.3
<b>NUISANCE ALARM</b>	
Defined . . . . .	202
<b>NURSING HOME (Occupancy Group I-2)</b>	
Defined . . . . .	202
<b>O</b>	
<b>OBSTRUCTIONS</b>	
Fire apparatus access roads . . . . .	503.4
Fire department connections . . . . .	912.4
Fire hydrants . . . . .	507.5.4
Fire protection equipment . . . . .	509.2, 2310.6.2
Fuel-dispensing view . . . . .	2304.2.4
Manual fire alarm boxes . . . . .	907.4.2.6
Means of egress . . . . .	806.2, 1003.6, 1030.9.6, 1032.2, 1032.3, 1032.3.1, 1032.6
On rooftops . . . . .	316.4
Portable fire extinguishers . . . . .	906.6
Spraying operation ventilation . . . . .	2404.7.4
Sprinkler discharge . . . . .	315.3.1, 903.3.3
<b>OCCUPANCY, CHANGE OF (see CHANGE OF OCCUPANCY)</b>	
<b>OCCUPANCY CLASSIFICATION</b>	
<b>Group A, Assembly</b>	
Defined . . . . .	202
<b>Group B, Business</b>	
Defined . . . . .	202
<b>Group E, Educational</b>	
Defined . . . . .	202
<b>Group F, Factory Industrial</b>	
Defined . . . . .	202
<b>Group H, High-hazard</b>	
Defined . . . . .	202
<b>Group I, Institutional</b>	
Defined . . . . .	202
<b>Group M, Mercantile</b>	
Defined . . . . .	202
<b>Group R, Residential</b>	
Defined . . . . .	202
<b>Group S, Storage</b>	
Defined . . . . .	202
<b>Group U, Miscellaneous</b>	
Defined . . . . .	202
<b>OCCUPANT LOAD</b>	
Defined . . . . .	202
Posting . . . . .	1004.3
<b>OIL, COOKING . . . . .</b>	<b>607</b>
<b>OIL, FUEL (see FUEL OIL and COMBUSTIBLE LIQUID)</b>	
<b>OIL, MOTOR (see COMBUSTIBLE LIQUID)</b>	
<b>OIL, WASTE (see WASTE OIL)</b>	
<b>OIL-BURNING EQUIPMENT (see FUEL-FIRED APPLIANCES)</b>	
<b>ON-DEMAND MOBILE FUELING OPERATIONS . . . . .</b>	<b>5707</b>
<b>OPEN BURNING . . . . .</b>	<b>307</b>
Defined . . . . .	202
Permit . . . . .	105.5.34, 307.2
Precautions in tire storage areas . . . . .	3404.1
<b>OPEN FLAMES . . . . .</b>	<b>308, 806.3, 2903.6, 5003.7.2, 5604.7.2, 5706.2.1</b>
Devices . . . . .	308.1.6
Group A occupancies . . . . .	308.3
Permit . . . . .	105.5.35, 105.5.36, 308.2
<b>OPEN MALL AND OPEN MALL BUILDING (see COVERED MALL BUILDING)</b>	
Defined . . . . .	202
<b>OPEN PARKING GARAGE</b>	
Defined . . . . .	202
<b>OPEN SYSTEM (hazardous materials)</b>	
Defined . . . . .	202
<b>OPEN-ENDED CORRIDOR . . . . .</b>	<b>903.3.1.2.2, 1027.6, 1104.22</b>
Defined . . . . .	202
<b>OPERATING BUILDING</b>	
Defined . . . . .	202
Separation distances . . . . .	5605.3
<b>OPERATING PRESSURE</b>	
Defined . . . . .	202
<b>ORDERS AND NOTICES . . . . .</b>	<b>104.5, 112.3.2</b>
<b>ORGANIC COATINGS . . . . .</b>	<b>Chapter 29</b>
Defined . . . . .	202
Electrical equipment and protection . . . . .	2904
General . . . . .	2903
Kettles . . . . .	2906
Manufacture . . . . .	Chapter 29
Permit . . . . .	105.5.37
Process structures . . . . .	2905
<b>ORGANIC PEROXIDE . . . . .</b>	<b>2408, Chapter 62</b>
Defined . . . . .	202
Indoor storage . . . . .	6204.1
Outdoor storage . . . . .	6204.2, Table 6204.1.2, Table 6204.1.7

## INDEX

Requirements .....	6203
Use .....	6205
<b>OUTDOOR ASSEMBLY EVENT</b>	
Electrical equipment and wiring .....	3106.6
Occupancy and means of egress .....	3106.3
Permit .....	105.5.38
Public safety .....	3106.4.1
<b>OUTDOOR CONTROL AREA</b>	
Defined .....	202
Hazardous materials .....	5003.12
<b>OUTDOOR FIREPLACE, PORTABLE (see PORTABLE OUTDOOR FIREPLACES)</b>	
<b>OUTPATIENT CLINIC (Occupancy Group B)</b>	
Defined .....	202
<b>OVENS (see INDUSTRIAL OVENS)</b>	
<b>OVERCROWDING</b>	
Defined .....	202
Prohibited .....	109.6
<b>OVERFILL PREVENTION AND PROTECTION</b>	
.....	2006.18, 2306.6.2.3, 5704.2.7.5.8, 5704.2.8.18, 5704.2.9.7.5, 5704.2.11.4, 5706.4.6, 5706.8.3, 5706.8.5, 6106.2
<b>OWNER</b>	
Defined .....	202
<b>OXIDIZERS, OXIDIZING GASES AND OXIDIZING CRYOGENIC FLUIDS</b>	Chapter 63
Defined .....	202
Indoor storage .....	6304.1
Outdoor storage .....	6304.2
Requirements .....	6303
Use .....	6305
<b>OXIDIZING CRYOGENIC FLUID</b>	
Defined .....	202
<b>OXIDIZING GAS</b>	
Defined .....	202
<b>OXYGEN IN HOME HEALTH CARE</b>	6306
<b>OZONE-GAS GENERATOR</b>	6005
Automatic shutdown .....	6005.5
Defined .....	202
Location .....	6005.3
Manual shutdown .....	6005.6

## P

**PALLETS**

Containment pallets .....	5004.2.3
High-piled storage sprinkler protection .....	3206.4.1
Idle combustible .....	2505, Table 3203.8, 5704.3.3.9
Outdoor pallet storage .....	315.7, 2810
Plastic .....	3206.4.1.1

<b>PANIC HARDWARE</b>	1010.2.9, 1010.4.1
Defined .....	202
<b>PARKING AND GARAGING</b>	
Aircraft-fueling vehicles .....	2006.5.1.3, 2006.20
Automatic sprinkler system .....	903.2.10
Flammable- and combustible-liquid tank vehicles .....	5706.6.2, 5706.6.3
LP-gas tank vehicles .....	6111
LP-gas-fueled vehicles .....	6111.3
Mechanical-access enclosed .....	903.2.10.2
<b>PASS-THROUGH</b>	2703.3.2, 2703.10.3
Defined .....	202
<b>PATIO HEATERS (see PORTABLE OUTDOOR GAS-FIRED HEATING APPLIANCES)</b>	
<b>PENTHOUSE</b>	
Defined .....	202
<b>PERMISSIBLE EXPOSURE LIMIT (PEL)</b>	
Defined .....	202
<b>PERMITS</b>	105
Annual .....	105.1.6
Construction .....	105.6
Defined .....	202
Hot work program .....	3503.3
Operational .....	105.5
<b>PERSON</b>	
Defined .....	202
<b>PERSONAL CARE SERVICE</b>	
Defined .....	202
<b>PESTICIDE</b>	
Defined .....	202
<b>PHOTOLUMINESCENT</b>	1013.5, 1025, 1025.4, 1104.25
Defined .....	202
<b>PHYSICAL HAZARD</b>	5001.2.2.1, Table 5003.1.1(1), Table 5003.1.1(3)
Defined .....	202
<b>PIPELINES</b>	5703.6.6.1, 5706.4, 5706.4.6
<b>PIPING, VALVES AND FITTINGS</b>	
Flammable and combustible liquids .....	2306.6, 2306.7.9.1.3, 5706.4.7.6
Hazardous materials .....	5003.2.2
Highly toxic and toxic gases .....	6004.2.2.5
LP-gas in membrane structures .....	3107.13
Organic coating manufacturing .....	2907
Ozone-gas .....	6005
Protection from vehicles .....	5003.9.3
<b>PLACARDS; PLACARDING (see also SIGNS)</b>	
Cryogenic fluid containers .....	5503.4.2
Explosives .....	5604.6.5, 5604.6.5.2
Flammable and combustible liquid tanks .....	5703.5.3, 5704.2.3.2

Vacant buildings . . . . .	311.5	Permits . . . . .	105.3.5
<b>PLACE OF ASSEMBLY</b>		Tenant identification . . . . .	403.10.1.5
Permit . . . . .	105.5.39	<b>POWDER COATING</b> . . . . .	2406
<b>PLANS (see also CONSTRUCTION DOCUMENTS)</b>		<b>POWERED INDUSTRIAL TRUCKS</b> . . . . .	309
Diagrams . . . . .	403.6.1.1	Battery charging . . . . .	309.2
Evacuation . . . . .	404.2.1	Defined . . . . .	202
Facility closure . . . . .	407.7	Fire extinguishers . . . . .	309.5
Fire safety . . . . .	404.2.2	Refueling . . . . .	309.6
Hazardous materials management . . . . .	5605.2.1	Repairs . . . . .	309.7
Lockdown . . . . .	404.2.3	Ventilation . . . . .	309.4
Maintenance of . . . . .	5605.2.2	<b>PRECAUTIONS AGAINST FIRE</b> . . . . .	301.1, 3305, 3306.4, 3404
Prefire . . . . .	5608.2	<b>PREMISES IDENTIFICATION</b> . . . . .	505
Storage . . . . .	5704.4.1	<b>PRESOTTING (see DRY CLEANING)</b>	
<b>PLANT EXTRACTION SYSTEMS</b>		<b>PRESSURE VESSEL</b>	
Permit . . . . .	105.5.40	Defined . . . . .	202
<b>PLASTICS</b>		<b>PRIMARY CONTAINMENT</b>	
Cellulose nitrate . . . . .	Chapter 65	Defined . . . . .	202
Classifications of . . . . .	3203.7	<b>PRIMARY TANK</b>	
Foam . . . . .	803.8, 804.2, 808.3	Defined . . . . .	202
Manufacturing of glass-fiber-reinforced . . . . .	2409	<b>PRIVATE GARAGE</b> . . . . .	915.1.5
Pyroxylin . . . . .	105.5.43, 314.3, 807.5.1.4, 903.2.5.3, Chapter 65, 1103.5.5	Defined . . . . .	202
<b>PLENUM</b> . . . . .	315.6, 603.10	<b>PROCESS</b>	
Defined . . . . .	202	Piping . . . . .	2907
<b>PLOSOPHORIC MATERIAL</b> . . . . .	5605.1	Raw materials . . . . .	2908, 2909
Defined . . . . .	202	<b>PROCESS TRANSFER</b>	
<b>PLYWOOD AND VENEER MILLS</b>		Defined . . . . .	202
Defined . . . . .	202	Operations . . . . .	5706.5
Fire alarm system . . . . .	907.2.18, 2804.2	<b>PROCESSING AND EXTRACTION</b>	
<b>PORTABLE FIRE EXTINGUISHERS (see FIRE EXTINGUISHERS, PORTABLE)</b>		<b>FACILITIES</b> . . . . .	Chapter 39
<b>PORTABLE GENERATORS</b> . . . . .	1204, 3309	Processing and extraction of marijuana . . . . .	3903
<b>PORTABLE OUTDOOR</b>		Safety systems . . . . .	3905
<b>FIREPLACES</b> . . . . .	307.4.3, 307.5	Systems and equipment . . . . .	3904
Defined . . . . .	202	<b>PROPANE (see LIQUEFIED PETROLEUM GAS)</b>	
<b>PORTABLE OUTDOOR GAS-FIRED</b>		<b>PROPELLANT (Aerosol)</b>	
<b>HEATING APPLIANCES</b> . . . . .	605.5.2	Defined . . . . .	202
<b>PORTABLE TANKS</b>		<b>PROPELLANT, SMOKELESS (see SMOKELESS PROPELLANT)</b>	
Defined . . . . .	202	<b>PROPYLENE (see LIQUEFIED PETROLEUM GAS)</b>	
Design, construction and capacity . . . . .	5704.3.1	<b>PROTRUDING OBJECTS</b> . . . . .	1003.3
Empty . . . . .	5704.3.3.4	<b>PROXIMATE AUDIENCE</b>	
Flammable liquids . . . . .	2306.2.5	Defined . . . . .	202
Flow rate . . . . .	6004.2.2.7.5, Table 6004.2.2.7.5	Displays . . . . .	5608.2.2
Indoor storage . . . . .	5704.3.3	<b>PSYCHIATRIC HOSPITAL (see HOSPITALS AND PSYCHIATRIC HOSPITALS)</b>	
Local exhaust . . . . .	6004.2.2.4, 6004.3.2.3	<b>PUBLIC ASSEMBLAGES AND EVENTS</b> . . . . .	403.11.2
Outdoor storage . . . . .	5704.4, Table 5704.4, 6004.3.4	<b>PUBLIC USE AREAS</b> . . . . .	907.5.2.3.1
Piles . . . . .	5704.3.3.10, 5704.3.7.2.3	Defined . . . . .	202
<b>POSTING</b>		<b>PUBLIC WAY</b> . . . . .	1028.5
Evacuation diagrams (Group R-1) . . . . .	403.9.1.1	Defined . . . . .	202
Explosives and pyrotechnic amounts . . . . .	5605.6.9	<b>PYROPHORIC</b>	
No smoking signs . . . . .	310.3	Defined . . . . .	202
Occupant load . . . . .	1004.3, 5605.6.9		



## INDEX

Indoor storage .....	6404.1
Materials .....	Chapter 64
Outdoor storage .....	6404.2
Requirements .....	6403
Use .....	6405
<b>PYROTECHNIC ARTICLE</b>	
Defined .....	202
<b>PYROTECHNIC COMPOSITION</b>	
Defined .....	202
<b>PYROTECHNIC SPECIAL EFFECT</b>	
Defined .....	202
<b>PYROTECHNIC SPECIAL EFFECTS MATERIAL</b>	
Defined .....	202
Permit .....	105.5.42
<b>PYROTECHNICS</b>	
Defined .....	202
<b>PYROXYLIN (CELLULOSE NITRATE) PLASTICS</b>	
Decorative materials .....	807.5.1.4
Fire protection system . . .	903.2.5.3, 1103.5.5, 6504.2
Permit .....	105.5.43
Raw material .....	6504.1
Requirements .....	6503
Storage and handling .....	6504

## Q

<b>QUICK-RESPONSE (QR) SPRINKLERS (see AUTOMATIC SPRINKLERS)</b>	
--	--

## R

<b>RACK STORAGE</b> .....	3208, 5104.4.3, 5704.3.3.6
<b>RADIOACTIVE</b>	
Gases .....	5004.7, 5307.1
Materials .....	5004.3.1
<b>RAILWAY</b>	
Defined .....	202
<b>RAMPS</b> .....	1012, 1023, 1027
Defined .....	202
<b>RAW PRODUCT (Wood products)</b>	
Defined .....	202
Storage and processing .....	2808
<b>REACTIVE MATERIALS [see UNSTABLE (REACTIVE) MATERIALS or WATER REACTIVE MATERIALS]</b>	
<b>READY BOX</b> .....	5608.5.5
Defined .....	202
<b>RECALL, FIRE PROTECTION SYSTEM COMPONENT</b> .....	901.10
<b>RECORD DRAWINGS (fire alarm system)</b> . . .	907.7.3
Defined .....	202

<b>RECORDS/RECORD KEEPING</b> .....	104.6, 104.6.3, 108.2.1, 109.3, 405.6, 606.3.3.3, 608.7, 608.16, 901.6.3, 3210.1, 3503.5, 5603
<b>RECREATIONAL FIRE</b> .....	307.4.2
Defined .....	202
<b>RECYCLING FACILITIES</b> .....	2808
<b>REDUCED FLOW VALVE</b> .....	6004.2.2.7.5
Defined .....	202
<b>REFERENCED STANDARDS</b> .....	102.7, Chapter 80
<b>REFINERY</b>	
Defined .....	202
Petroleum .....	5706.7
<b>REFRIGERANT</b> .....	608.3
A2L Refrigerants .....	608.18
Classification .....	608.4
Defined .....	202
Detector .....	608.9
Discharge .....	608.15
Records .....	608.16
Storage .....	608.12
Type .....	608.5
<b>REFRIGERATION MACHINERY ROOMS</b> .....	608.14, 1006.2.2.2
<b>REFRIGERATION SYSTEM</b> .....	608.10.1
Defined .....	202
Permit .....	105.5.44
Refrigeration detection .....	608.9
<b>REFUGE, AREA OF (see AREA OF REFUGE)</b>	
<b>REFUGE AREA ASSOCIATED WITH SMOKE BARRIERS AND HORIZONTAL EXITS</b> . . . .	404.2.2
<b>REGISTERED DESIGN</b>	
<b>PROFESSIONAL</b> . . .	104.8.2, 106.1, 909.9, 909.18.8.3
Defined .....	202
<b>RELEASE OF HAZARDOUS MATERIAL</b> .....	5003.3
<b>RELOCATABLE POWER TAPS</b> .....	603.5.2
<b>REMOTE EMERGENCY SHUTOFF DEVICE</b>	
Defined .....	202
Use of .....	5706.5.4.5
<b>REMOTE SOLVENT RESERVOIR</b> .....	5705.3.6.2.3
Defined .....	202
<b>REPAIR GARAGES</b> .....	2311
Defined .....	202
Gas detection system .....	2311.8.9
LP-gas-fueled vehicles .....	6111.3
Motor vehicle repair booths .....	2311.8.4
Permit .....	105.5.45
Sources of ignition .....	2311.3
Sprinklers required .....	903.2.9.1
Ventilation .....	2311.4.3
<b>REPAIRS</b> .....	105.1.5
<b>REPAIRS, EMERGENCY (see EMERGENCY REPAIRS)</b>	

**REPORTING**

Aviation facilities fire extinguisher use . . . . .	2005.8
Emergencies . . . . .	401.1
Fire . . . . .	3310
Fire alarm . . . . .	3310
Leak . . . . .	5704.2.7.10
Record keeping . . . . .	5603
Research reports . . . . .	104.10.1

<b>RESIN APPLICATION AREA</b> . . . . .	2403.2.5, 2409.3, 2409.5, 2409.6
---	-------------------------------------

Defined . . . . .	202
-------------------	-----

<b>RESPONSE PROCEDURES</b> . . . . .	406
--------------------------------------	-----

**RESPONSIBLE PERSON**

Defined . . . . .	202
-------------------	-----

**RETAIL DISPLAY AREA (for aerosols)**

Defined . . . . .	202
Manufacturing facilities . . . . .	5107.1
Maximum quantities . . . . .	5106.2, Table 5106.2, Table 5106.4

<b>REVOCATION OF PERMITS</b> . . . . .	105.4
--	-------

<b>RIGHT OF ENTRY</b> . . . . .	104.3
---------------------------------	-------

<b>ROADWAYS, ACCESS FOR FIRE APPARATUS (see FIRE APPARATUS ACCESS ROAD)</b>	
---	--

<b>ROCKETS AND ROCKETRY</b> . . . . .	5601.1.4
---------------------------------------	----------

**ROLL COATING**

Defined . . . . .	202
-------------------	-----

**ROOF, LANDSCAPED (see ROOFTOP GARDENS)**

<b>ROOF VENTS</b> . . . . .	910
-----------------------------	-----

<b>ROOFING OPERATIONS SAFEGUARDS</b> . . . . .	3318
--	------

**ROOFS**

Safeguarding operations . . . . .	3318
Stairway access . . . . .	504.3, 1011.12, 1011.16

**ROOFTOP GARDENS AND**

<b>LANDSCAPED ROOFS</b> . . . . .	317, 905.3.8
-----------------------------------	--------------

**ROOFTOP HELIPORT (see HELIPORT)**

<b>RUBBISH (TRASH)</b> . . . . .	3305.2
----------------------------------	--------

Chutes, automatic sprinkler protection . . . . .	903.2.11.2
Containers . . . . .	304.3
Defined . . . . .	202

**S**

<b>SAFETY CAN</b> . . . . .	5003.9.10
Defined . . . . .	202

<b>SAFETY DATA SHEET (SDS)</b> . . . . .	5003.4
--	--------

Aerosols . . . . .	5101.3
Defined . . . . .	202
Hazard communication . . . . .	407.2

<b>SAFETY RULES (Explosives)</b> . . . . .	5603.7, 5605.6.6
--	------------------

**SCISSOR STAIRWAY**

Defined . . . . .	202
Use of . . . . .	1007.1.1

**SCOPE AND GENERAL REQUIREMENTS**

(of the code) . . . . .	101
-------------------------	-----

<b>SCREEN PORCHES AND DECKS</b> . . . . .	1015.5
---	--------

**SDS (see SAFETY DATA SHEET)**

<b>SEAT STABILITY</b> . . . . .	1030.15
---------------------------------	---------

<b>SEATING, FOLDING AND TELESCOPIC</b> . . . . .	1030.1.1
--	----------

Defined . . . . .	202
-------------------	-----

**SECONDARY CONTAINMENT**

Above-ground tanks . . . . .	2306.5
Defined . . . . .	202
Hazardous materials . . . . .	5004.2, 5004.2.2, 5005.1.3, 5005.2.1.4, 5005.2.2.4, 5005.3.5, 5005.3.7

Indoor storage . . . . .	5004.2.2.3
--------------------------	------------

Outdoor storage . . . . .	5004.2.2.4
---------------------------	------------

Type II dry cleaning systems . . . . .	2107.2.3
--	----------

Underground tanks . . . . .	5003.2.4.1
-----------------------------	------------

**SECONDARY WATER SUPPLY (see WATER SUPPLY)**

<b>SECURITY DEVICES</b> . . . . .	316.5, 1032.2.1
-----------------------------------	-----------------

**SEGREGATED**

Defined . . . . .	202
-------------------	-----

**SELF-CLOSING**

Defined . . . . .	202
-------------------	-----

<b>SELF-LUMINOUS</b> . . . . .	1013.5, 1025.4
--------------------------------	----------------

Defined . . . . .	202
-------------------	-----

**SELF-SERVICE MOTOR FUEL-DISPENSING**

<b>FACILITY</b> . . . . .	2304
---------------------------	------

Defined . . . . .	202
-------------------	-----

**SEMICONDUCTOR FABRICATION**

<b>FACILITY</b> . . . . .	Chapter 27
---------------------------	------------

Automatic sprinkler system . . . . .	2703.10
--------------------------------------	---------

Defined . . . . .	202
-------------------	-----

Emergency alarm system . . . . .	2703.12
----------------------------------	---------

Emergency power . . . . .	1203.2.17, 2703.15
---------------------------	--------------------

General safety provisions . . . . .	2703
-------------------------------------	------

Manual fire alarm system . . . . .	2703.11
------------------------------------	---------

Permit . . . . .	105.5.23
------------------	----------

Quantity limits . . . . .	Table 2704.2.2.1
---------------------------	------------------

Storage . . . . .	2704
-------------------	------

Transportation and handling . . . . .	2705.3
---------------------------------------	--------

Use and handling . . . . .	2705
----------------------------	------

<b>SERVICE CORRIDOR</b> . . . . .	2703.3.8, 2703.9, 2703.12.1.1, 2705.3.3
-----------------------------------	--

Defined . . . . .	202
-------------------	-----

**SERVICE PERSONNEL, CERTIFICATION OF (see  
CERTIFICATION OF SERVICE PERSONNEL)**

<b>SERVICE UTILITIES</b> . . . . .	110
------------------------------------	-----

<b>SHAFTS</b> . . . . .	701.2, 1103.4
-------------------------	---------------

<b>SHAFTWAY MARKINGS</b> . . . . .	316.2
------------------------------------	-------

<b>SHELF STORAGE</b> . . . . .	3207
--------------------------------	------

Defined . . . . .	202
-------------------	-----

Specialty storage . . . . .	3210
-----------------------------	------

## INDEX

<b>SHOCK PADDING</b> .....	5003.9.7
<b>SHROUDS, DECORATIVE (on chimneys)</b> . . .	605.2.1.3
<b>SIGNS (see also PLACARDS; PLACARDING)</b>	
Access roads .....	5604.6.5.1
Alarms and warning .....	904.3.4, 2507, 2305.6, 2310.5.5.1, 2603.3.1, 5703.5.1
Electrical rooms .....	603.4.1
Electrostatic apparatus .....	2407.5.2
Emergency .....	608.8, 604.4
Exit .....	1013, 1203.2.6, 3103.12.6
Fire alarm boxes .....	907.4.2.4
Fire department connection .....	912.5
Fire protection equipment rooms .....	509.1
Fire-resistance-rated construction .....	705.2.2
Foam plastic .....	808.3
Hazardous identification .....	5003.5, 5003.6, 5003.11.3.10, 5503.4.1
Illumination .....	1013.5
Marking .....	503.3
No smoking .....	310.3, 2305.6, 2308.8.1.2.6, 2403.2.6, 5003.7.1, 5704.2.3.1
Placards .....	311.5, 5604.6.5
Removal .....	310.4
Stairway exit .....	1013.5, 1013.6.2
Stationary storage battery systems .....	1207.4.8
Storage tanks .....	5704.2.3, 5706.3.7
Street or road .....	505.2
Tampering with .....	112.3.4
Vacant buildings .....	311.5
Welding .....	2403.2.7
<b>SILANE GAS</b> .....	6401.1, 6404.2, 6405.3
<b>SINGLE-STATION SMOKE</b>	
<b>ALARM</b> .....	907.2.11, 1103.8
Defined .....	202
<b>SITE</b>	
Defined .....	202
<b>SITE SAFETY PLAN</b>	
Components .....	3303.1.1
Defined .....	202
Responsibility .....	501.3.1, 3303.1
Site safety director .....	3303.2, 3303.3, 3303.4, 3303.6, 3303.7, 3303.8, 3303.9
<b>SITE-FABRICATED STRETCH SYSTEMS</b> . . . .	803.10
Defined .....	202
<b>SKY LANTERNS</b> .....	308.1.6.3
Defined .....	202
<b>SLEEPING UNIT</b>	
Defined .....	202
<b>SMALL ARMS AMMUNITION AND SMALL</b>	
<b>ARMS AMMUNITION COMPONENTS</b> .....	5606
Defined .....	202

**SMALL ARMS PRIMERS**

Defined .....	202
Group M .....	5606.5.1.3
Group R-3 .....	5606.4.3
Storage .....	5606.5.2.3
<b>SMOKE ALARM</b> .....	907.2.11, 1031.6, 1103.8
Defined .....	202
Maintenance .....	901.6, 907.10
Replacement .....	907.10
Smoke detection system as alternative to . .	907.2.11.7
<b>SMOKE AND HEAT VENTS</b> .....	910, 3206.8
<b>SMOKE BARRIERS</b>	
Construction .....	909.5
Defined .....	202
Maintenance .....	701.3, 704.1
Opening protectives in .....	705.2, 909.5.3
Pressure differential .....	909.18.6
<b>SMOKE COMPARTMENT</b>	
Defined .....	202
<b>SMOKE CONTROL SYSTEMS</b> .....	909
Permit .....	105.6.19
<b>SMOKE DAMPER</b>	
Defined .....	202
<b>SMOKE DETECTOR</b> .....	907.2.11.7, 907.2.13.1.2, 907.3.1, 907.4.1, 907.4.3
Defined .....	202
<b>SMOKE PARTITIONS</b> .....	701.4
<b>SMOKE REMOVAL</b> .....	910.4
<b>SMOKE-DEVELOPED INDEX</b>	
Defined .....	202
<b>SMOKELESS PROPELLANTS</b>	
Defined .....	202
General .....	5606
Storage and handling .....	5604
<b>SMOKEPROOF ENCLOSURE</b>	
Defined .....	202
<b>SMOKE-PROTECTED ASSEMBLY</b>	
<b>SEATING</b> .....	1030.6.2
Defined .....	202
<b>SMOKING</b> .....	310, 2003.2, 2006.3.8, 2310.5.5.1, 2403.2.6, 2803.5.3, 2903.7, 3305.1, 3404.3, 5003.7.1, 5704.2.3.1, 5706.6.1.9
Signs .....	310.3
<b>SOLAR PHOTOVOLTAIC POWER SYSTEMS</b> . .	1205
Permit .....	105.6.20
<b>SOLID (material state)</b>	
Defined .....	202
<b>SOLID BIOFUEL</b> .....	2809.4
Defined .....	202
<b>SOLID BIOMASS FEEDSTOCK</b> .....	2809.4
Defined .....	202

**SOLID SHELVING**

- Defined . . . . . 202
- Fire protection . . . . . 3208.2.2.1
- Racks . . . . . 3208.2.2

**SOLVENT DISTILLATION UNIT** . . . . . 5705.4

- Defined . . . . . 202

**SOLVENT OR LIQUID CLASSIFICATIONS,****DRY CLEANING** . . . . . 2103

- Defined . . . . . 202

**SPACE HEATERS** . . . . . 603.9, 3304**SPECIAL AMUSEMENT BUILDING**

- Defined . . . . . 202
- Exit access travel distance . . . . . Table 1017.2
- Fire alarm system . . . . . 907.2.12, 914.7.2
- Permit . . . . . 105.5.3
- Sprinklers . . . . . Table 903.2.11.6, 914.7.1

**SPECIAL INDUSTRIAL EXPLOSIVE DEVICE** . . . 5601.1

- Defined . . . . . 202

**SPILL CONTROL**

- Carts and trucks . . . . . 5003.10.3.4
- Dry cleaning . . . . . 2107.2.3
- Flammable and combustible liquids . . . . . 5703.4, 5704.3.7.3, 5704.3.8.2, 5705.3.7.5.3, 5705.3.7.6.3, 5706.2.6, 5706.5.1.5
- Hazardous materials . . . . . 5004.2, 5005.1.3, 5005.2.1.3, 5005.2.2.4, 5005.3.4, 5005.3.6
- Lead-acid battery systems . . . . . Table 1207.6, 1207.6.2
- Service stations and repair garages . . . . . 2305.3

**SPILLS** . . . . . 2004.4, 2006.11, 2310.5.2, 3107.15.5.3, 3306.6**SPONTANEOUS IGNITION**

- HAZARDS** . . . . . 304.3.1, 305.2, 3305.2.4

**SPOTTING (see DRY CLEANING)****SPRAY BOOTH**

- Areas adjacent to . . . . . 2403.2.1.3
- Construction . . . . . 2404.3.3
- Defined . . . . . 202
- Permit . . . . . 105.5.47, 105.6.22
- Ventilation . . . . . 2403.3.5.2

**SPRAY FINISHING** . . . . . 105.5.47, 105.6.22, 2404**SPRAY FIRE-RESISTANT MATERIALS** . . . . . 708**SPRAY ROOM**

- Construction . . . . . 2404.3.1
- Defined . . . . . 202
- Permit . . . . . 105.5.47, 105.6.22
- Ventilation . . . . . 2403.3.5.2

**SPRAYING SPACE**

- Defined . . . . . 202

**SPRINKLER SYSTEM (see AUTOMATIC SPRINKLER SYSTEM)****STAGE CANOPY, TEMPORARY (see TEMPORARY STAGE CANOPY)****STAGES, FIRE PROTECTION FOR** . . . . 905.3.4, 914.6**STAIR**

- Defined . . . . . 202

**STAIRWAY** . . . . . 1011

- Defined . . . . . 202
- Identification . . . . . 1023.8, 1023.9, 1104.21, 1104.24
- On flammable and combustible liquid loading racks . . . . . 5706.5.1.12
- On flammable and combustible liquid storage tanks . . . . . 5704.2.9.4

**STAIRWAY, EXTERIOR EXIT** . . . . . 1027

- Defined . . . . . 202

**STAIRWAY, SPIRAL** . . . . . 1011.10

- Defined . . . . . 202

**STANDBY PERSONNEL (see also FIRE WATCH)** . . . . . 3107.17**STANDBY POWER SYSTEM** . . . . . 1203, 5005.1.5

- Defined . . . . . 202

**STANDPIPE, TYPES OF**

- Defined . . . . . 202

**STANDPIPE SYSTEM, CLASSES OF**

- Defined . . . . . 202

**STANDPIPES** . . . . . 905

- Buildings under construction/demolition . . . . . 3314
- Dry . . . . . 905.8
- Existing buildings . . . . . 1103.6, 1103.6.1
- Heliports and helistops . . . . . 905.3.6, 1103.6.2, 2007.5
- Landscaped roofs . . . . . 905.3.8
- Permit . . . . . 105.6.23
- Rooftop gardens . . . . . 905.3.8

**STATIC PILES (wood products)**

- Defined . . . . . 202
- Protection . . . . . 2808.6

**STATIC PROTECTION** . . . . . 5706.5.1.7**STATIONARY STORAGE BATTERY SYSTEMS (see BATTERY SYSTEM, STATIONARY STORAGE)****STEEL**

- Defined . . . . . 202

**STILLS, DRY CLEANING** . . . . . 2104.2.4, 2107.1**STOP WORK ORDER** . . . . . 113**STORAGE**

- Aerosol, inside . . . . . 5104
- Ammunition . . . . . 5606
- Attics . . . . . 315.3.4
- Automated . . . . . 3209
- Boiler rooms . . . . . 315.3.3
- Calcium carbide . . . . . 3507.1
- Carousel . . . . . 3209.3
- Combustible fibers, baled . . . . . 3705
- Combustible fibers, detached structure . . . . . 3704.6



## INDEX

Combustible fibers, loose . . . . . 3704  
 Combustible liquids . . . . . 5704  
 Combustible materials . . . . . 105.5.31, 315, 2003.6  
 Compressed gas . . . . . 5304  
 Concealed spaces . . . . . 315.3.4  
 Corridors and lobbies in Group E . . . . . 807.5.2.1  
 Corrosive materials . . . . . 5404  
 Cryogenic fluids . . . . . 5504  
 Cylinder and container, welding . . . . . 3505.2  
 Distilled spirits and wines . . . . . 903.2.9.3, 4004  
 Electrical rooms . . . . . 315.3.3  
 Elevator lobbies . . . . . 604.5.1, 604.5.2, 604.5.3  
 Explosives . . . . . 5604  
 Exterior, finished lumber . . . . . 2809  
 Fire command centers . . . . . 315.3.3, 508.1.6  
 Flammable gases . . . . . 5804  
 Flammable liquids . . . . . 5704  
 Flammable solids . . . . . 5904  
 Foam . . . . . 5704.2.9.2.2.1  
 Fuel oil . . . . . 605.4  
 Hazardous materials . . . . . 5004  
 Hazardous materials storage defined . . . . . 202  
 High-piled combustible . . . . . Chapter 32  
 Hogged material . . . . . 2807, 2808  
 Indoor . . . . . 315  
 Log areas . . . . . 2806  
 Loose combustible fibers . . . . . 3704  
 LP-gas . . . . . 6109  
 Mattresses . . . . . 903.2.9.4  
 Means of egress . . . . . 315.3.2, 807.1, 807.5.2.1,  
     807.5.5.1, 1032.2, 1032.3  
 Mechanical refrigeration rooms . . . . . 608.12  
 Mechanical rooms . . . . . 315.3.3  
 Nitrocellulose . . . . . 2909.4  
 Organic peroxide . . . . . 2909.5, 6204  
 Outside . . . . . 315.4  
 Oxidizers . . . . . 6304  
 Plan . . . . . 5003.11.3.11  
 Plenums . . . . . 315.6  
 Pyrophoric materials . . . . . 6404  
 Pyroxylin (cellulose nitrate) plastics . . . . . 6504  
 Rack . . . . . 3208  
 Self-service facilities . . . . . 903.2.9.4  
 Semiconductor fabrication facilities . . . . . 2704  
 Solid-piled and shelf . . . . . 3207  
 Specialty . . . . . 3210  
 Tank . . . . . 2909.2, 5704.2  
 Tire . . . . . 3405, 3409  
 Under floors . . . . . 315.3.4  
 Under high-voltage transmission lines . . . . . 315.5  
 Unstable (reactive) materials . . . . . 6604

Upholstered furniture . . . . . 903.2.9.4  
 Water-reactive solids and liquids . . . . . 6704  
 Wood chips . . . . . 2807, 2808

**STORY**

Defined . . . . . 202

**STORY ABOVE GRADE PLANE**

Defined . . . . . 202

**STRAW** . . . . . 3107.2, 3709.4

Waste material . . . . . 304.1.1

**SUB-ATMOSPHERIC PRESSURE**

**GAS SYSTEMS (SAGS)** . . . . . 2703.16

**SUMPS** . . . . . 5706.3.3

**SUPERVISING STATION** . . . . . 903.4.1, 905.9

Defined . . . . . 202

**SUPERVISION** . . . . . 903.3.8.4, 903.4, 904.11.2,  
     905.9, 913.4

**SUPERVISORY SERVICE**

Defined . . . . . 202

**SUPERVISORY SIGNAL** . . . . . 903.4.1, 905.9

Defined . . . . . 202

**SUPERVISORY SIGNAL-INITIATING DEVICE**

Defined . . . . . 202

**SYSTEM (hazardous materials)**

Defined . . . . . 202

**T**

**TAGS** . . . . . 901.7.2, 901.7.3, 901.8.1, 904.9.2

**TANK**

Abandonment of . . . . . 5704.2.13, 5704.2.13.1.4

Above-ground . . . . . 2306.2.2, 2306.2.3, 2306.2.4,  
     5404.2.1, 5003.2.4.2, 5704.2.7.3.5.1,  
     5704.2.9, 5704.2.13.2

Anchoring . . . . . 5704.2.8.5

Capacity . . . . . 2305.1.2

Capacity, available . . . . . 5704.2.9.7.5.2

Compressed gas . . . . . 5303.1, 5303.4.2

Construction . . . . . 5704.2.9.6.1

Cooking oil storage . . . . . 607

Defective . . . . . 5003.2.6.2

Defined . . . . . 202

Design and construction . . . . . 5003.2.1, 5704.2.7,  
     5704.2.9.6.1

Diking . . . . . 5704.2.10.2

Discharge . . . . . 5704.2.7.5.5.2

Dispensing . . . . . 5706.2.8, 5706.5.4

Drainage control . . . . . 2306.5

Empty . . . . . 5003.2.5, 5704.3.3.4, 5704.4.8

Fill pipe connections . . . . . 5704.2.9.7.6

Filling operations . . . . . 2305.1, 5706.6.1.10

Hot work on . . . . . 3510, 5704.2.7.6

Inside buildings . . . . . 2306.2.2, 5704.2.9.5

Installation . . . . .	5003.2.4, 5704.2.7	Defined . . . . .	202
Lining . . . . .	5704.2.7.11	Dispensing from . . . . .	5706.2.8, 5706.5.4
Low-pressure . . . . .	202	Fire protection . . . . .	5706.6.4
Maintenance . . . . .	2903.9	Garaging . . . . .	5706.6.3, 6111.3
Manifolding . . . . .	5704.2.7.3.5	Loading racks or stations . . . . .	2909.3
Marking . . . . .	5706.2.2	Operation . . . . .	5706.6.1
Openings . . . . .	2306.6.2.1, 5704.2.7.5, 5704.2.9.7.8	Parking . . . . .	5706.6.3, 6111
Out of service . . . . .	5003.2.6.1, 5704.2.13.1.1	Smoking . . . . .	5706.6.1.9
Outside buildings . . . . .	5704.2.9.6	Stability . . . . .	5706.5.1.16
Overfill protection . . . . .	5704.2.7.5.8, 5704.2.9.7.6, 5704.2.11.3, 5706.4.6, 5706.6.1.5, 5706.8.3, 5706.8.5, 5806.4.7	Use as storage tank . . . . .	5704.2.2
Permanent and temporary . . . . .	5706.2.4	<b>TAR KETTLE [see ASPHALT (TAR) KETTLES]</b>	
Piping . . . . .	2306.6.3	<b>TELEPHONE DIALING-DEVICES,</b>	
Piping, valves and fittings . . . . .	2306.6.2	<b>AUTOMATIC . . . . .</b>	907.6.6.1
Portable . . . . .	2306.2.5, 5704.3	<b>TEMPORARY HEATING EQUIPMENT . . . .</b>	603.9, 3304
Preparation for fueling . . . . .	2310.5.6	<b>TEMPORARY SPECIAL EVENT</b>	
Pressure . . . . .	2409.3, 5704.2.7.2	<b>STRUCTURES . . . . .</b>	3105
Primary . . . . .	202	Defined . . . . .	202
Protected above-ground (see above-ground)		Permit . . . . .	105.6.24
Removal . . . . .	5704.2.14	<b>TEMPORARY WIRING . . . . .</b>	603.8, 3305.7
Repair, alteration or reconstruction . . . . .	5704.2.7.6	<b>TENANT IDENTIFICATION (see COVERED AND</b>	
Secondary containment . . . . .	5704.2.9.7.3	<b>OPEN MALL BUILDINGS)</b>	
Security . . . . .	2306.3	<b>TENANT SPACES, VACANT (see VACANT</b>	
Solvent storage . . . . .	2107.3	<b>PREMISES)</b>	
Stationary . . . . .	6004.2.2.7.4	<b>TENTS AND OTHER MEMBRANE</b>	
Storage . . . . .	2909.2, 5704, 5706.3.1.1, 5706.3.5	<b>STRUCTURES . . . . .</b>	Chapter 31
Testing . . . . .	5704.2.12	Access . . . . .	3103.8.1
Underground . . . . .	2306.2.1, 5003.2.4.1, 5704.2.7.3.5.2, 5704.2.11, 5704.2.13.1	Air-inflated structure . . . . .	3102.1
Vaults . . . . .	2306.2.4, 5704.2.8	Air-supported structure . . . . .	3102.1, 3103.10
Vehicle . . . . .	2909.3, 5706.5.1.15, 5706.5.1.16, 5706.6	Approval . . . . .	3103.2
Venting . . . . .	5704.2.7.3, 5706.2.4.2	Crowd managers . . . . .	3106.4.3, 3107.17.2
Water . . . . .	507.2.2, 507.5.3	Defined . . . . .	202
<b>TANK, ATMOSPHERIC</b>		Fire safety requirements . . . . .	3104.2
Defined . . . . .	202	Generators . . . . .	3106.6.2, 3107.16
<b>TANK, PORTABLE</b>		Heating and cooking equipment . . . .	3107.12, 3107.12.7
Defined . . . . .	202	Location . . . . .	3105.8
<b>TANK, PRIMARY</b>		LP-gas . . . . .	3107.13
Defined . . . . .	202	Means of egress . . . . .	3103.12
<b>TANK, PROTECTED ABOVE-GROUND</b>		Occupant load . . . . .	3107.11
Defined . . . . .	202	On buildings . . . . .	3103.8.4
<b>TANK, STATIONARY</b>		Operational requirements . . . . .	3107
Defined . . . . .	202	Permit . . . . .	105.5.49, 105.6.24
<b>TANK CARS (see also BULK TRANSFER) . .</b>	5706.5.1	Portable fire extinguisher . . . . .	3105.9, 3106.4.4, 3106.5.2, 3106.6.3, 3107.9
Loading racks or stations . . . . .	2909.3, 5706.5.1.12	Seating . . . . .	3103.11
Use as storage tank . . . . .	5704.2.2	Structural stability . . . . .	3103.9
<b>TANK VEHICLE . . . . .</b>	2904.3.2, 5706.5.1.16.1, 5706.6	Umbrella structures . . . . .	202
Aircraft fuel-servicing . . . . .	2005.4	Waste . . . . .	3107.19
Certification . . . . .	5706.5.1.15	<b>TESTING, ACCEPTANCE (see ACCEPTANCE</b>	
Construction . . . . .	5003.2.1	<b>TESTING)</b>	
		<b>THEFT RESISTANT . . . . .</b>	5604.5.1.2
		Defined . . . . .	202

## INDEX

## TIMBER AND LUMBER PRODUCTION

<b>FACILITIES</b> .....	2807
Defined .....	202
<b>TIRE REBUILDING</b> .....	3403
Permit .....	105.5.48
Precautions against fire .....	3404
<b>TIRE STORAGE</b> .....	Chapter 34
Access .....	3406
Fencing .....	3407
Indoor .....	3409
Outdoor .....	3405
Permit .....	105.5.48
Precautions against fire .....	3404
<b>TIRES, BULK STORAGE OF</b> .....	202
Defined .....	202
<b>TOOL (semiconductor fabrication)</b> .....	202
Defined .....	202
<b>TORCH-APPLIED ROOF SYSTEM</b> .....	202
Defined .....	202
<b>TORCHES</b> .....	308.4
Permit .....	105.5.35
<b>TOWNHOUSE</b> .....	202
Defined .....	202
<b>TOXIC</b> .....	202
Defined .....	202
Materials (see Highly toxic and toxic materials)	
<b>TRADE-OFFS FOR SPRINKLERS</b> .....	904.2.1
<b>TRAFFIC CALMING DEVICES</b> .....	503.4.1
Defined .....	202
<b>TRAINING, EMPLOYEE EMERGENCY</b> .....	406
<b>TRANSIENT</b> .....	202
Defined .....	202
<b>TRANSIENT AIRCRAFT</b> .....	914.8.3
Defined .....	202
<b>TRANSPORTATION</b> .....	
Hazardous materials .....	2705.3, 5003.10
LP-gas .....	6101.1
<b>TRANSVERSE FLUE SPACE (see FLUE SPACES)</b>	
<b>TRASH (see RUBBISH)</b>	
<b>TRAVEL DISTANCE, EXIT ACCESS</b> .....	1016
<b>TREATMENT SYSTEMS</b> .....	608.13.5, 2703.14.3, 6003.1.3, 6003.2.3.2, 6004.2.2.7, 6004.3.4.1
<b>TREES (see NATURAL CUT TREES)</b>	
<b>TROUBLE SIGNAL</b> .....	903.4.1, 906.2, 916.5, 3905.1.2, 5808.5.2
Defined .....	202
<b>TUBE TRAILERS</b> .....	5303.7.11
Defined .....	202
<b>TURNSTILES</b> .....	1010
<b>TWENTY-FOUR HOUR BASIS</b> .....	202
Defined .....	202

## U

<b>UMBRELLA STRUCTURE DEFINED</b> .....	202
<b>UNAUTHORIZED DISCHARGE</b> ....	5003.3.1, 5706.2.8
Defined .....	202
<b>UNDERGROUND BUILDINGS</b> .....	403.10.3, 905.3.5, 907.2.18, 907.2.19, 914.5, Table 1103.1, 1203.2.19
<b>UNLAWFUL ACTS</b> .....	112.1
<b>UNOCCUPIED TENANT SPACE</b> .....	311.6
<b>UNSAFE BUILDINGS (see BUILDING)</b>	
<b>UNSAFE HEATING APPLIANCES</b> .....	605.2
<b>UNSAFE STRUCTURES OR EQUIPMENT</b> .....	114
<b>UNSTABLE (REACTIVE) MATERIAL</b> .....	Chapter 66
Defined .....	202
Indoor storage .....	6604.1
Outdoor storage .....	6604.2
Requirements .....	6603
Use .....	6605.1
<b>UNVENTED HEATERS</b> .....	605.5
<b>UNWANTED FIRE</b> .....	202
Defined .....	202
Ignitions .....	305.5
Reporting .....	401.3, 3310
<b>UPHOLSTERED FURNITURE (see FURNITURE, UPHOLSTERED)</b>	
<b>USE (MATERIAL)</b> .....	202
Defined .....	202
<b>USE, CHANGE OF (see CHANGE OF USE)</b>	
<b>UTILITY IDENTIFICATION</b> .....	509.1.1

## V

<b>VACANT PREMISES</b> .....	311
Abandoned .....	311.1.1
Fire protection systems .....	311.2.2
Placarding .....	311.5
Removal of hazardous materials .....	311.4
Safeguarding .....	311.2
Tenant spaces .....	311.1.2, 311.6, 403.10.1.6
Waste removal .....	311.3
<b>VAPOR AREA, FLAMMABLE</b> .....	202
Defined .....	202
<b>VAPOR BALANCE SYSTEM</b> .....	2306.7.9.1
<b>VAPOR PRESSURE</b> .....	202
Defined .....	202
<b>VAPOR-PROCESSING SYSTEM</b> ...	2306.7.9.2, 5706.8
<b>VAPOR-RECOVERY SYSTEM</b> .....	2306.7.9, 5706.8
<b>VEHICLE IMPACT PROTECTION (see IMPACT PROTECTION, VEHICLE)</b>	
<b>VEHICLES</b> .....	314.4
Compressed natural gas powered .....	2308

W

## WARNING SIGNS

Compressed gas vaults . . . . .	5303.16.13
Explosives. . . . .	5604.10.5, 5605.8.2
Fire-extinguishing systems . . . . .	904.3.4
Flammable and combustible liquid vaults. . . . .	5704.2.8.15
Flammable finish operations. . . . .	2403.2.7
Flammable liquids storage . . . . .	5703.5
Fruit and crop ripening . . . . .	2507
Fuel dispensing. . . . .	2305.6
Fumigation and insecticidal fogging . . . . .	2603.3.1
Hazard communication (haz-mat). . . . .	407.3, 5003.5



## INDEX

<b>WIRELESS PROTECTION SYSTEM</b> . . . . .	907.6.1
Defined . . . . .	202
<b>WIRING, ELECTRICAL</b>	
Abandoned in plenums . . . . .	603.10
Hazards . . . . .	603
<b>WOOD PRODUCTS</b> . . . . .	105.5.52, 2807, 2808
<b>WOOD VENEERS</b> . . . . .	803.12
<b>WOODWORKING FACILITIES (see LUMBER YARDS AND WOODWORKING FACILITIES)</b> . . . . .	903.2.4.1
<b>WORKSTATION (semiconductor manufacturing)</b>	
Defined . . . . .	202

## Y

<b>YARD</b>	
Defined . . . . .	202

## Z

<b>ZONE, FIRE ALARM</b> . . . . .	907.6.4
Defined . . . . .	202
<b>ZONE, NOTIFICATION</b>	
Defined . . . . .	202
<b>ZONING INDICATOR PANEL</b> . . . . .	907.6.4.1

## EDITORIAL CHANGES – SECOND PRINTING

Page 2-6, definition [M] **COMMERCIAL COOKING APPLIANCES**: now reads . . . [M] **COMMERCIAL COOKING APPLIANCES**. Appliances used in a commercial food service establishment for heating or cooking food. For the purpose of this definition, a commercial food service establishment is where food is prepared for sale or is prepared on a scale that is by volume and frequency not representative of domestic household cooking.

Page 2-33, definition [BG] **SMOKE COMPARTMENT**: now reads . . . [BG] **SMOKE COMPARTMENT**. A space within a building separated from other interior areas of the building by *smoke barriers*, including interior walls and *horizontal assemblies*.

Page 3-8, **Section 315.3.3**: now reads . . . **315.3.3 Equipment rooms**. Combustible material shall not be stored in boiler rooms, mechanical rooms, elevator machine rooms, electrical equipment rooms or in *fire command centers* as specified in Section 508.1.5.

Page 3-11, **Section 317.1**: line 3, now reads . . . and Sections 1505 and 1507.15 of the *International Building*

Page 4-9, **TABLE 405.3**: column 1, row 8, now reads . . . Group I-1<sup>c</sup>

Page 4-9, **TABLE 405.3**: column 1, row 14, now reads . . . Group R-4<sup>c</sup>

Page 4-9, **TABLE 405.3**: column 2, row 6, now reads . . . Monthly

Page 4-9, **TABLE 405.3**: column 2, row 10, now reads . . . Quarterly on each shift

Page 4-9, **TABLE 405.3**: Note c added and reads . . . c. In groups I-1 and R-4, see Sections 403.7.1.4 and 403.9.3.4 for additional drills for staff.

Page 5-1, **Section 501.3.1**: line 4 now reads . . . *site safety plan* in accordance with Section 3303.

Page 6-1, **Section 603.4**: line 4 now reads . . . rated 1,000 volts or less, and Section 110.32 of NFPA 70 for

Page 6-5, **Section 605.4.1.1**: line 2 now reads . . . shall be in accordance with UL 80, UL 142 or UL

Page 9-4, **Section 903.1.1**: line 3 now reads . . . shall be permitted instead of automatic sprinkler system

Page 9-12, **Section 903.5**: now reads . . . **903.5 Testing and maintenance**. Automatic sprinkler systems shall be tested and maintained in accordance with Section 901.

Page 9-28, **Section 907.2.23**: line 4 now reads . . . energy storage systems as required in Section 1207.5.4.

Page 10-29, **Section [BE] 1013.6.3**: line 8 now reads . . . in accordance with Section 1203. Group I-2, Condition 2

Page 10-52, **Section [B] 1032.2.2**: now reads . . . [BE] **1032.2.2 Locking arrangements in educational occupancies**. In Group E occupancies, Group B educational occupancies and Group I-4 occupancies, egress doors with locking arrangements designed to keep intruders from entering the room shall comply with Section 1010.2.8.

Page 11-6, **Section 1103.5.4**: now reads . . . **1103.5.4 High-rise buildings**. Where Appendix M has not been adopted, existing high-rise buildings that do not have a previously *approved* fire sprinkler system shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where any of the following conditions apply:

1. The high-rise building has an occupied floor located more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access.
2. The high-rise building has occupied floors located more than 75 feet (22 860 mm) and not more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, and the building does not have at least two interior exit stairways complying with Section 1104.10 that are separated from the building interior by fire assemblies having a fire-resistance rating of not less than 2 hours with opening protection in accordance with Table 716.1(2) of the International Building Code.
3. The high-rise building has occupied floors located more than 75 feet (22 860 mm) and not more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, and the building does not have a fire alarm system that includes smoke detection in mechanical equipment, electrical, transformer, telephone equipment and similar rooms; corridors; elevator lobbies; and at doors penetrating interior exit stairway enclosures.

Building owners shall file a compliance schedule with the fire code official not later than 365 days after receipt of a written notice. The compliance schedule shall not exceed 12 years for completion of the automatic sprinkler system retrofit.

Page 11-12, **TABLE 1104.18**: column 3, row 13 now reads . . . 75<sup>j</sup>

Page 11-12, **TABLE 1104.18**: column 7, row 7 now reads . . . 400<sup>j</sup>

Page 11-12, **TABLE 1104.18**: column 7, row 12 now reads . . . 200<sup>j,1</sup>

Page 12-3, **Section 1204.6**: line 3 now reads . . . dance with Section 603 and shall be provided with GFCI

Page 12-6, **Section 1205.5.1**: lines 3 and 4 now read . . . of the ground-mounted photovoltaic arrays. A maintained vegetative surface or a noncombustible base, *approved* by

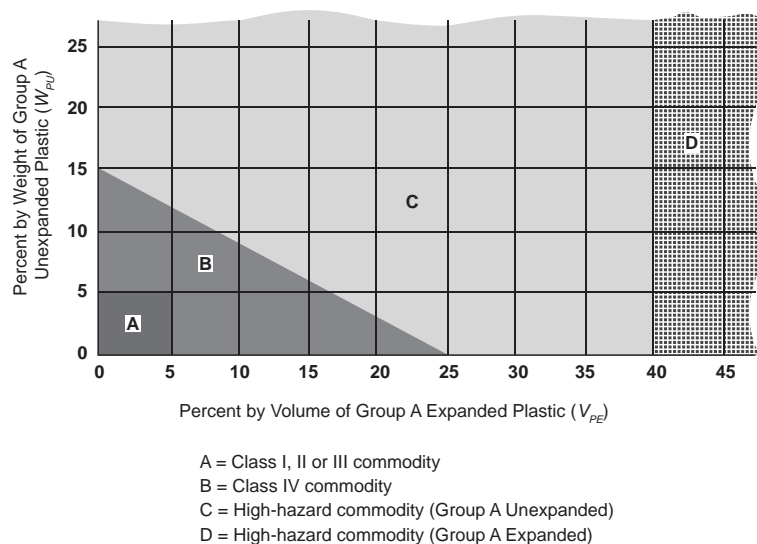
Page 12-8, **Section 1207.1.5:** line 2 now reads . . . in Section 1207, large-scale fire testing shall be

Page 12-15, **Section 1207.7.2:** line 4 now reads . . . Section 1207.7.1 dedicated-use building requirements.

Page 12-19, **Section 1207.11.6:** line 4 now reads . . . accordance with Section 907.2.11. A *heat detector listed*

Page 24-3, **Section 2402.3:** line 3 now reads . . . accordance with Sections 2404.3.1 through 2404.3.4.1.

Page 32-10, **FIGURE 3203.9(1)** now reads as shown

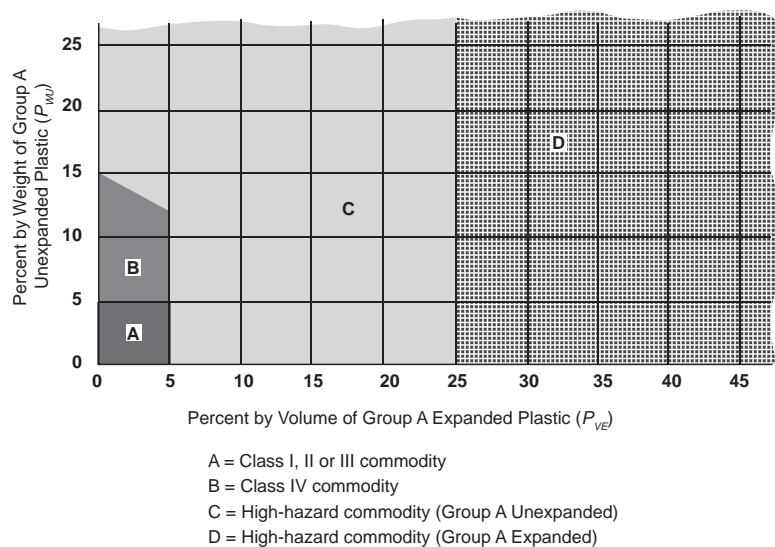


**FIGURE 3203.9(1)**  
**EVALUATION OF CARTONED COMMODITIES CONTAINING GROUP A PLASTICS<sup>a, b</sup>**

a. This figure is used to determine the commodity classification of a mixed commodity with Group A plastics in a package or crate.

b. The following is an example of how to apply Figure 3203.9(1): A pallet load consists of a Class III commodity in cardboard boxes with components of unexpanded Group A plastic and packing material of expanded Group A plastic. Using Equation 32-1, the weight of unexpanded Group A plastic is 5 percent. Using Equation 32-2, the volume of expanded Group A plastic is 15 percent. This commodity is classified as a Class IV commodity. If the volume of the expanded Group A plastic is increased to 20 percent, the classification changes to a high-hazard (Group A unexpanded) commodity. Where the load is stored on a plastic pallet, the requirements in Section 3203.10 also apply.

Page 32-10, **FIGURE 3203.9(2)** now reads as shown



**FIGURE 3203.9(2)**  
**EVALUATION OF EXPOSED COMMODITIES CONTAINING GROUP A PLASTICS<sup>a, b</sup>**

a. This figure is used to determine the commodity classification of a mixed commodity with Group A plastics where the products are exposed.

b. The following is an example of how to apply Figure 3203.9(2): A pallet load consists of an exposed Class III commodity with components of unexpanded Group A plastic and packing material of expanded Group A plastic. Using Equation 32-1, the weight of unexpanded Group A plastic is 5 percent. Using Equation 32-2, the volume of expanded Group A plastic is 6 percent. This commodity is classified as a high-hazard (Group A unexpanded) commodity. Where the load is stored on a plastic pallet, the requirements in Section 3203.10 also apply.

Page 33-1, **Section 3303.1:** now reads . . . **3303.1 Program development and maintenance.** The *owner* or *owner's* authorized agent shall be responsible for the development, implementation and maintenance of an *approved*, written *site safety plan* establishing a fire prevention program at the project site applicable throughout all phases of the construction, repair, *alteration* or demolition work. The plan addresses the requirements of this chapter and other applicable portions of this code, the duties of staff and staff training requirements. The plan shall be submitted and approved before a building permit is issued. Any changes to the plan shall be submitted for approval.

Page 34-2, **Section 3408.1:** line 3 now reads . . . 507. The water supply shall be arranged such that any part of

Page 37-1, **Section 3703.6:** line 4 now reads . . . in Table 906.1.

Page 54-1, **Section 5401.1:** Item 2, line 2 now reads . . . with Section 1207.

Page 57-25, **Section 5704.3.8.3:** line 4 now reads . . . 0.25 cfm per square foot ( $0.00127 \text{ m}^3/\text{s} \times \text{m}^2$ ) of floor

Page 80-1, Referenced Standard **AFSI** now reads . . .

#### **ASI—77: Design and Standards Manual**

Page 80-2, Referenced Standard **ASME** now reads . . .

#### **A17.3—2017: Safety Code for Existing Elevators and Escalators**

Page 80-3, Referenced Standard **ASSP** now reads . . .

#### **ANSI/ASSP Z359.1—2020: The Fall Protection Code**

Page 80-4, Referenced Standard **BHMA A156.19—2020** now reads . . .

#### **A156.19—2019: Power Assist and Low-energy Power-operated Doors**

Page 80-4, Referenced Standard **BHMA A156.38—2020** now reads . . .

#### **A156.38—2019: Low-energy Power-operated Sliding and Folding Doors**

Page 80-4, Referenced Standard **CGA ANSI/CGA G-13—(2016)** now reads . . .

#### **ANSI/CGA G-13—(2015): Storage and Handling of Silane and Silane Mixtures**

Page 80-8, Referenced Standard **IIAR ANSI/IIAR 6—2018** now reads . . .

#### **ANSI/IIAR 6—2019: Standard for Inspection, Testing, and Maintenance of Closed-circuit Ammonia Refrigeration Systems**

Page 80-8, Referenced Standard **IIAR ANSI/IIAR 7—2019** now reads . . .

#### **ANSI/IIAR 7—2019: Developing Operating Procedures for Closed-circuit Ammonia Refrigeration Systems**

Page 80-8, Referenced Standard **IIAR ANSI/IIAR 9—2018** now reads . . .

#### **ANSI/IIAR 9—2020: Standard for Minimum System Safety Requirements for Existing Closed-circuit Ammonia Refrigeration Systems**

Page 80-9, Referenced Standard **NFPA 02—19** now reads . . .

#### **02—20: Hydrogen Technologies Code**

Page 80-9, Referenced Standard **NFPA 10—21** now reads . . .

#### **10—18: Standard for Portable Fire Extinguishers**

Page 80-9, Referenced Standard **NFPA 17—20** now reads . . .

#### **17—21: Standard for Dry Chemical Extinguishing Systems**

Page 80-9, Referenced Standard **NFPA 17A—20** now reads . . .

#### **17A—21: Standard for Wet Chemical Extinguishing Systems**

Page 80-10, Referenced Standard **NFPA 55—19** now reads . . .

#### **55—20: Compressed Gases and Cryogenic Fluids Code**

Page 80-11, Referenced Standard **NFPA 96—20** now reads . . .

#### **96—21: Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations**

Page 80-15, Referenced Standard **UL 1389—2017** now reads . . .

#### **1389—2019: Plant Oil Extraction Equipment for Installation and Use in Ordinary (Unclassified) Locations and Hazardous (Classified) Locations**

For the complete errata history of this code, please visit: <https://www.iccsafe.org/errata-central/>





## RESOURCE A

# RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI)

---

### User note:

**About this resource:** *The typical process of inspecting projects by inspectors driving to job sites and performing on-site inspections has certain challenges that impacts timeliness and resource efficiencies both for building construction and safety industry and regulating jurisdictions. The time spent driving to job sites, particularly in larger cities with busy traffic patterns, takes up a substantial part of the day, reducing the number of inspections possible to complete and creating a backlog of requested inspections.*

*To address some of the challenges, many jurisdictions have implemented remote virtual inspections (RVI) for more routine and simpler inspections such as water heater replacements or other similar items. RVI is an alternative to on-site inspections using a video call with the inspector. With advances in technology and availability of sophisticated smart phones and tablets, RVI has become more common, and some jurisdictions plan to implement it for more complicated and larger inspection items or projects.*

*To assist the building construction industry and member jurisdictions in adoption of an RVI program, in May 2020, the International Code Council® (ICC®) published the Recommended Practices for Remote Virtual Inspections (RVI). This publication offers a comprehensive framework for both local jurisdictions and building industry professionals that desire to implement a remote inspection program.*

---



# Recommended Practices for Remote Virtual Inspections (RVI)





## **Recommended Practices for Remote Virtual Inspections (RVI)**

Second Printing: September 2020

ISBN: 978-1-952468-23-0

COPYRIGHT © 2020  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This publication is a copyrighted work owned by the International Code Council, Inc. ("ICC"). Without advance written permission from the ICC, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example and not limitation, photocopying, or recording by or in an information storage and retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

The information contained in this document is believed to be accurate; however, it is being provided for informational purposes only and is intended for use only as a reference for recommended practices. Publication of this document by the ICC should not be construed as the ICC engaging in or rendering engineering, legal or other professional services. Use of the information contained in this publication should not be considered by the user as a substitute for the advice of a registered professional engineer, attorney or other professional. If such advice is required, it should be sought through the services of a registered professional engineer, licensed attorney or other professional. This Recommended Practices document does not intend to overrule national building codes or local practices, but to provide a reference for minimum levels of quality to safeguard health, property and general welfare.

Trademarks: "International Code Council," the "International Code Council" logo, "ICC," the "ICC" logo and other names and trademarks appearing in this book are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission. Errata on various ICC publications may be available at [www.iccsafe.org/errata](http://www.iccsafe.org/errata).

PRINTED IN THE USA

# Table of Contents

Table of Contents . . . . .	i
Preface . . . . .	1
About the International Code Council® . . . . .	2
1.0 Introduction. . . . .	3
Purpose and Scope . . . . .	3
2.0 Definitions and Acronyms . . . . .	3
3.0 Remote Virtual Inspection Process . . . . .	3
Customer: Requesting a Remote Virtual Inspection . . . . .	4
AHJ: Scheduling Remote Virtual Inspection . . . . .	5
Customer: Prepare for Remote Virtual Inspection . . . . .	6
Customer: Prepare to Receive Remote Virtual Inspection Call . . . . .	6
What to Expect During the Inspection . . . . .	7
Inspection Results . . . . .	7
Maintaining Records of Inspections . . . . .	8
4.0 Training and Communication . . . . .	8
Staff Training. . . . .	8
Customer/Applicant. . . . .	9
Additional Considerations. . . . .	9
5.0 Appendix A (Examples of Potential Activities). . . . .	10



## Preface

Technological advances have created enormous possibilities in all aspects of life, including the building construction and safety industry. Digital and online tools for building design, construction and administrative functions, such as permit application, plan review, inspection and commissioning, have drastically increased the efficiency and accuracy of achieving safe and resilient communities. Local, state and national governments have taken advantage of advancing technologies and have incorporated various levels of digitization into their processes in order to save time and reduce costs. Examples of such efforts include online offering of permit applications, payment of permit fees, submittal of plans and digital plan review.

The speed of adoption and implementation of technology, however, varies by geographic region and depends on a number of factors, including the availability of financial resources and the infrastructure needed to support the technology. Many Authorities Having Jurisdiction (AHJs) have implemented technology at various levels with good success and have embraced greater reliance on digitization as time goes by.

The 2020 global coronavirus pandemic created an impetus in speeding the implementation of modern technologies and taking advantage of new ideas in a much shorter time frame. The spread of COVID-19 and the closing of most businesses and social activities in many parts of the world to create social distancing resulted in many sectors of the economy searching to find new solutions for conducting business.

Many AHJs needed to come up with solutions to perform all aspects of codes and standards administration from remote locations and/or home offices. One such solution using available technology is Remote Virtual Inspections (RVI).

RVI is a method of inspection that allows the needed inspections to proceed in a timely manner by the owner or contractor located on the jobsite and the inspector or inspection teams performing the inspection remotely. While this practice gained good acceptance and implementation during the weeks and months of COVID-19 social distancing, its advantages are so great that it will likely become a popular and routine tool for the foreseeable future.





The advantages and opportunities created by RVI locally, nationally and globally are enormous, allowing those with technical expertise in their specific subjects to offer their services across the globe. Building code specialists, inspectors and consultants will be able to provide services and consulting from far distances and to help building safety and resiliency anywhere needed at the local, national or global level.

*Recommended Practices for Remote Virtual Inspections* (RVI) was developed based on study, research, and discussions related to items that should be considered and addressed for an effective and consistent RVI program and to assist AHJs in implementing the readily available technologies in the adoption and implementation of their own RVI program.

ICC welcomes your comments and feedback to improve future editions of this Recommended Practices publication. Submit feedback at [www.iccsafe.org/RVI](http://www.iccsafe.org/RVI).

## About the International Code Council®

The International Code Council is a nonprofit association that provides a wide range of building safety solutions including product evaluation, accreditation, certification, codification and training. It develops model codes and standards used worldwide to construct safe, sustainable, affordable and resilient structures. The mission of the Code Council is to provide the highest quality codes, standards, products and services for all concerned with the safety and performance of the built environment. ICC Evaluation Service (ICC-ES) is the industry leader in performing technical evaluations for code compliance fostering safe and sustainable design and construction.

### Washington DC Headquarters:

500 New Jersey Avenue, NW, 6th Floor  
Washington, DC 20001-2070

### Regional Offices:

- Eastern Regional Office (BIR)
- Central Regional Office (CH)
- Western Regional Office (LA)
- Distribution Center (Lenexa, KS)

888-ICC-SAFE (888-422-7233)

[www.iccsafe.org](http://www.iccsafe.org)

### Family of Solutions:



## 1.0 Introduction

Hand-held devices such as smartphones and tablets have capabilities for real time, online communication of videos and photos. Use of advanced tools and technologies, combined with the power of such hand-held devices, has made it possible for anyone to observe the construction activities of a jobsite from any location, near or thousands of miles away. Using Remote Virtual Inspection (RVI) allows construction projects to continue without impediment and allows the Authority Having Jurisdiction (AHJ) to continue to provide the vital services needed for construction of safe buildings.

### Purpose and Scope

The purpose and scope of these Recommended Practices is to provide guidance to the Authority Having Jurisdiction (AHJ) when implementing a Remote Virtual Inspection (RVI) program as well as to the construction industry user. This document specifically addresses implementation and administration of RVI. These procedures are organized in a fashion that can be readily implemented by the AHJ as part of their inspection procedures. This document also provides recommended practices to construction industry professionals submitting to an RVI.

Until recently, Remote Virtual Inspections have been conducted only by a few AHJs at varying levels. As a result, there has not been a standardized program that addresses how to prepare for, conduct and participate in these types of inspections.

## 2.0 Definitions and Acronyms

1. **RVI: Remote Virtual Inspection:** Remote Virtual Inspection, also known as RVI, is a form of visual inspection which uses visual or electronic aids to allow an inspector or team of inspectors to observe products and/or materials from a distance because the objects are inaccessible or are in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.
2. **AHJ: Authority Having Jurisdiction.**

## 3.0 Remote Virtual Inspection Process

Remote Virtual Inspections (RVI) may provide benefits to AHJs and customers alike. In certain circumstances, an RVI may provide a better quality inspection with an increase in efficiency and cost savings. It will increase the efficiency of the inspection process utilizing modern technology. Depending on the location and complexity of a project, some limitations may impact its use. In cases where an RVI is not suitable or technology fails to provide sufficient visual clarity (i.e., poor/no service or Wi-Fi, poor lighting, etc.), an onsite inspection may be required. Subject to local approval, the AHJ may choose to use an approved third-party inspection agency or utilize staff inspectors. Where Wi-Fi and/or cellular recep-

tion are poor or not available, some AHJs may consider allowing the contractor to provide an acceptable electronic documentation of the area that needs an inspection for review by the assigned inspector or team of inspectors.

A clear understanding of the RVI requirements and communication throughout the process by both parties is paramount to the completion of a successful inspection. The inspector will check all aspects of the permitted construction project to the adopted codes and other applicable laws and regulations no differently than if it were an onsite inspection. Identification of the project jobsite location, posted address and its location within the building will be a critical part of the process.

The applicable Codes and Standards to be used for RVI are the same as the adopted codes and referenced standards of the AHJ. The implementation of the RVI is intended to achieve the same results as the typical in-person site inspection by applying the provisions of adopted codes such as the IBC®, IRC®, IPC®, IFC® and other applicable and adopted International Codes.



### Customer: Requesting a Remote Virtual Inspection

1. Ensure there is an active permit issued or certificate application filed or obtain the appropriate one prior to attempting to schedule an inspection for the project in question.
2. Electronically sign a notice indicating that the permit holder of record or representative:
  - 2.1. Consents to the use of the remote inspections.
  - 2.2. Is responsible for their own safety during the remote inspection.
  - 2.3. Allows the complete use of the videos and photos of the remote inspection by the AHJ.
  - 2.4. Certifies they are making available the site and inspection items truthfully and to the best of their ability.
  - 2.5. Is responsible for compliance with all codes and standards applicable to the project.
  - 2.6. Acknowledges that participation in the remote inspection program is voluntary (if not a mandatory program within the AHJ's jurisdiction).
  - 2.7. Acknowledges that the decision to perform an RVI is at the sole discretion of the AHJ.

3. Prior to contacting the department to schedule the inspection, confirm that the minimum criteria for a remote inspection are met. See Appendix A for examples of qualified inspection activities.
  - 3.1. Note that some types of inspections may be too complex or otherwise not compatible for remote inspections.
4. Call or go online to schedule an appointment for inspection with the AHJ.
5. Must be at least 18 years old or with an adult to perform the virtual inspection.
6. When scheduling the inspection, provide the address, permit number, and type and number of requested inspections.

### AHJ: Scheduling Remote Virtual Inspection

1. Schedule Inspection Time.
  - 1.1. All remote inspections scheduled should be requested by the customer a minimum of one business day prior to the desired inspection date.
  - 1.2. Schedule inspection either online or by telephone.
  - 1.3. Schedule sufficient time for the type of inspection requested.
  - 1.4. AHJ to send an inspection confirmation email or text to the customer with the date, approximate time of RVI and name of inspector.
  - 1.5. Send notice of customer consent and acknowledgment for electronic signature. Must be returned by customer prior to inspection scheduled time.
2. Time slots for inspections.
  - 2.1. Anticipated length of inspections per type (i.e., water heater installation, HVAC replacement, etc.) needs to be established.
  - 2.2. Each customer will be given an approximate time window for inspection.
3. Post the earliest available time for remote inspections and the latest time of the day a remote inspection may be scheduled Monday through Friday or other days selected by the AHJ.
4. Schedule after-hours or emergency inspections on a case-by-case basis.
5. Determine the types of inspections allowed for remote inspections. See Appendix A for examples of qualified inspection activities.
  - 5.1. All inspections may qualify for an RVI, depending on the AHJ's resources and policies.
6. Determine which type of videotelephony is available for use and is compatible with the AHJ's permitting software and videotelephony equipment.
  - 6.1. Videotelephony platform examples: FaceTime, Google Duo, Zoom, WhatsApp, Skype, Tango, WebEx, Microsoft Teams, GoTo-Meeting, etc.





## Customer: Prepare for Remote Virtual Inspection

1. Prior to the inspection, ensure that:
  - 1.1. The jobsite is safe at all times for the individual(s) using the device during the remote inspection including health safety.
  - 1.2. The device (smartphone, tablet, drone, etc.) is fully charged and has a suitably charged additional power supply (battery pack).
  - 1.3. The use of a noise-canceling headset is recommended.
  - 1.4. The jobsite has high-speed Wi-Fi connectivity or minimum 4G cellular service with a strong signal.
  - 1.5. The necessary tools based on type of inspection are readily available.
    - 1.5.1. For example, carry a flashlight, tape measure, level, step ladder (for close ups of ceiling), GFCI tester, etc. An extending pole for the video device, such as selfie pole, may be very helpful in taking the smartphone or other video device closer to the point of inspection in various places such as very high ceilings.
2. Have approved plans, permit card, and other necessary construction documents available onsite.
3. Make sure good lighting is available and clear the area of any unnecessary objects.
4. All features applicable to the required inspection must be visible at the time of the remote inspection. These features must be captured sufficiently and clearly for the inspector to evaluate.
5. If at any point the inspector believes that the remote inspection process is not allowing them to properly assess compliance, they may require that a site inspection be conducted at a future date or instruct the customer to make different arrangements.
  - 5.1. In areas within the jobsite where there is no Wi-Fi or cell service, at the sole discretion of the inspector, the contractor may be allowed to provide video and/or photographic documentation of the item(s) to be inspected for review by the authorized inspector at a later time.
6. The onsite inspection may be conducted by an approved third-party inspection agency or by the AHJ's inspection staff.

## Customer: Prepare to Receive Remote Virtual Inspection Call

1. Ensure that the lens and screen of any device being used to capture images or video has been cleaned. Dust, grit, smudges, etc., might interfere with the image quality and distorting the inspector's view.
2. To minimize interruptions during the RVI and to ensure that the video feed will be uninterrupted, make sure that all notifications are turned off in the Settings of the mobile device used for the RVI. Should the video be interrupted, the inspection could be delayed or have to be rescheduled.
3. Be prepared to answer the inspector's call at any time during the scheduled timeframe. Be cooperative and closely follow the inspector's instructions.

4. As each site and inspection is different, allot the proper amount of time for the type of inspection and accessibility of the site.
5. Carefully follow the inspector's instructions for where to direct the device and for covering the site. Do not rush the inspector but allow him or her adequate time to conduct the RVI to his or her satisfaction.
6. As much as possible, minimize background noise as that can interfere with communication with the inspector.

## What to Expect During the Inspection

1. Begin inspection at the street view looking at the structure with the address or other required jobsite identification in the video display.
  - 1.1. Inspector may also verify location through GPS/Geotagging where the service is available.
2. Follow the directions of the inspector with respect to the order and direction of inspection.
3. As the inspection progresses, write down any items that the inspector finds that need to be corrected. Be sure the notes are detailed and ask questions of or seek clarification from the inspector at the time of the RVI.
4. If provided a permit card, do not write on it. During the next in-person visit, the inspector should update it then.
5. In most cases, the inspector will relay the results of the inspection before the end of the RVI of passing, failing or not ready for inspection.
6. Do not cover any work needing corrections until corrections are verified by reinspection. Reinspection fees may apply in accordance with the AHJ's policies.
7. Note: At a minimum, there must be an adult of the required legal age on site who will represent the owner/representative during the entire duration of the RVI.
8. The owner/representative must be able to verbally communicate with the remote inspector at all times during the inspection.

## Inspection Results

1. Results of the inspection will be entered into the AHJ's permit database as soon as practicable after the RVI is completed. It is important to note that the inspection was completed using the RVI process.
2. Where an approval tag for utility connections is required, the AHJ should work directly with the utility company.
3. Following the inspection:
  - 3.1. Inspection comments will be available on the AHJ's website, within the AHJ's normal timelines, indicating passing or failing with the list of corrections when applicable.
  - 3.2. In addition, the inspector may email the inspection information upon request to the customer as soon as inspection information is available.

- 3.3. The inspector will determine whether additional fee(s) for reinspection is required.
4. Scheduling a reinspection or the next inspection needed is based on availability of time slots.
5. The authorized inspector may provide an option for the owner/representative to submit electronic documentation that a deficiency or deficiencies have been corrected.
6. It is incumbent on the owner/representative to provide the address and permit number on all submitted correspondence or communications.

## Maintaining Records of Inspections

Required inspection records, including, but not limited to, correction notices, electronic media, recordings or photo documentation, shall be maintained in accordance with the AHJ's policy, laws, regulations, and applicable codes, and may be subject to disclosure.

## 4.0 Training and Communication

Training and effective communication of processes, procedures and requirements are essential and a critical part to the success of any program. This program is no different as it lends itself to new technology, new programs, and methods that are in many cases, new to the building construction and safety industry. Therefore, training of the AHJ's staff as well as the building industry on the various programs and procedures will save time and money and make the administrative and enforcement process a positive experience with minimal confusion. Training also leads to better communications between an AHJ and its customers.



## Staff Training

1. Ensure all staff are trained in the appropriate areas of responsibility.
2. Permit Technicians:
  - 2.1. Review of approved permit applications relative to RVI requirements.
  - 2.2. Required departmental approvals are complete.
  - 2.3. Fee collection process.
  - 2.4. Required documents for the project (plans, calculations, etc.).
3. Remote Inspection Staff:
  - 3.1. Inspection software and hardware.
  - 3.2. Remote inspection procedures.
  - 3.3. Types of platforms used (Facetime, Skype, etc.).
  - 3.4. Reinspection fee procedures.
  - 3.5. Recording inspection results in permit tracking system.

## Customer/Applicant

1. Ensure the owner and representative are trained in their areas of responsibility.
2. Permit applicant:
  - 2.1. Knowledge of the AHJ's departmental approvals required for the project.
  - 2.2. Knowledge of the AHJ's RVI protocol.
  - 2.3. Ensuring project meets RVI protocol.
  - 2.4. Ensure that the project is ready for the RVI at the scheduled time.
  - 2.5. Comply with the inspector's direction.
3. Owner/Contractor/Subcontractor:
  - 3.1. Requesting remote inspection process.
  - 3.2. Knowledge of remote inspections procedures.
  - 3.3. Platform required (Facetime, Skype, Google Duo, etc.).
  - 3.4. Jobsite communication requirements (Wi-Fi, 4G, etc.).
  - 3.5. Communication skills.

## Additional Considerations

1. Adopt basic online security practices. Consult with your IT department for guidance.
2. Consult with your legal counsel to ensure compliance with all federal, state and local requirements related to your RVI program. For example, you may want to consult counsel to find out whether a homeowner's release is needed to conduct an RVI.
3. Ensure that all staff have access to the codes and standards that are applicable to what they are inspecting. The Code Council's Digital Codes Library (<https://codes.iccsafe.org/>) offers online access to all ICC model codes and standards and most state codes.
4. Document lessons learned to improve your RVI program and to support potential long-term establishment of virtual inspection processes.





## 5.0 Appendix A (Examples of Potential Activities)

The following are a few examples of construction activities that may be considered to be included in a RVI Program. This list is not all-inclusive. The determination of whether an inspection can be conducted remotely is at the sole discretion of the AHJ.

- Plumbing system repairs or fixture replacements.
- Construction trailer installations.
- Swimming pool excavations.
- Gas line repairs or gas utility clearance.
- Electric utility clearances.
- HVAC direct replacement or repair.
- Minor residential electrical.
- Miscellaneous repair/exterior repair or upgrades (stucco, windows, etc.).
- Re-roofing/roof covering replacement.
- Water heater or water softener direct replacement.
- New residential plumbing rough-in.
- New residential rough framing inspections.
- Residential rooftop-mounted photovoltaic panel systems.
- HUD manufactured home installation verification.
- Any other inspection approved by the AHJ.

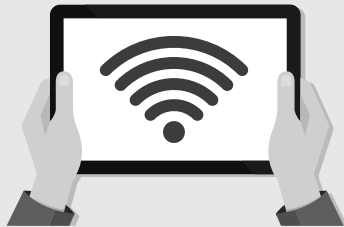




# KEYS TO SUCCESS FOR REMOTE VIRTUAL INSPECTIONS

## The Value of Communication

### WHAT ARE REMOTE VIRTUAL INSPECTIONS (RVI)?

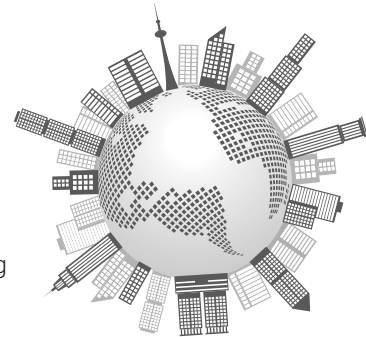


Remote Virtual Inspections, also known as RVI, are a form of inspections which use visual or electronic aids to allow an inspector or team of inspectors to observe certain types of construction, products and/or materials from a distance.

RVI are a solution to help inspectors observe construction and objects that might be inaccessible or in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.

### RVI BENEFITS

- Construction projects can continue without impediment
- Building professionals can continue providing services with minimal health risk during pandemics such as COVID-19
- Authorities Having Jurisdiction (AHJs), testing agencies, manufacturers, laboratories, home builders and contractors are able to provide the vital services needed on all levels for the construction of safe buildings
- Inspectors can continue providing services remotely while saving time and money
- Safe and resilient construction projects can continue to grow and thrive anywhere needed at the local, national or global level



### THE FOUNDATION OF SUCCESS: TRAINING AND COMMUNICATION



With the use of new technology, new programs, and methods, AHJs, testing agencies, manufacturers, laboratories, home builders and contractors can implement effective training of these programs to their staff to create a foundation for successful Remote Virtual Inspections.

A clear understanding of RVI requirements and communication throughout the process by all parties involved is paramount to the completion of successful inspections.



### Recommended Practices for Remote Virtual Inspections (RVI)

## THE KEY STEPS TO A REMOTE VIRTUAL INSPECTION



## LEARN MORE

Read the full version of our Recommended Practices for Virtual Remote Inspections [here](#).

20-13018

## Recommended Practices for Remote Virtual Inspections (RVI)



People Helping People Build a Safer World®

# Get FREE access to hundreds of ICC resources and view the largest collection of code titles

*ICC's Digital Codes Library ([codes.iccsafe.org](https://codes.iccsafe.org)) conveniently provides access to the latest code text while on the go, at home or in the office, in an easy-to-navigate format.*



Available anywhere 24/7

Use on any mobile or digital device

View over 800+ ICC titles

19-17590

Learn how to use this powerful tool at [codes.iccsafe.org](https://codes.iccsafe.org)



# Recommended Practices for Remote Virtual Inspections (RVI)

*Recommended Practices for Remote Virtual Inspections (RVI)* is the most complete source of information on remote inspections. RVI is an alternative to on-site inspections using a video call on a 4G or WiFi telephony (smartphone, tablet, etc.) in order to interact with the inspector. It is a comprehensive tool for local jurisdictions and the building industry alike that desire to implement a remote inspection program.

This publication covers the RVI process, inspection scheduling, preparation, what the owner/contractor should expect, training and communications, and recording and maintaining records. While all types of inspections may not be suitable for RVI, a list of potential construction activities suitable for remote inspections is provided.

RVI also lends itself to connect seamlessly as part of an overall online program that will allow jurisdictions to provide complete services to the public utilizing the latest technology. Online permitting and electronic plan review, together with remote virtual inspections, can provide a complete program that keeps the construction industry moving while providing a healthy environment for all participants.

ISBN 978-1-952468-23-0



9 781952 468230

Item No. 7072S1



## ICC FAMILY OF SOLUTIONS

Evaluation Service • Accreditation Service • General Code  
S. K. Ghosh Associates • ANCR • NTA • Certification  
Digital Code Library • Membership • Plan Review • Publications

[www.iccsafe.org](http://www.iccsafe.org) • 1-888-ICC-SAFE (422-7233)

# Valuable Guides to Changes in the 2021 I-Codes®

## SIGNIFICANT CHANGES TO THE 2021 INTERNATIONAL CODES®

Practical resources that offer a comprehensive analysis of the critical changes made between the 2018 and 2021 editions of the codes. Authored by ICC code experts, these useful tools are “must-have” guides to the many important changes in the 2021 International Codes.

Key changes are identified then followed by in-depth, expert discussion of how the change affects real world application. A full-color photo, table or illustration is included for each change to further clarify application.



**SIGNIFICANT CHANGES TO  
THE IBC®, 2021 EDITION**  
#7024S21



**SIGNIFICANT CHANGES TO THE  
IRC®, 2021 EDITION**  
#7101S21



**SIGNIFICANT CHANGES TO THE  
IFC®, 2021 EDITION**  
#7404S21



**SIGNIFICANT CHANGES TO THE  
IPC®/IMC®/IFGC®, 2021 EDITION**  
#7202S21



**SIGNIFICANT CHANGES TO THE  
IECC®, 2021 EDITION**  
#7808S21

**New to the series!**

20-19101

**Order Your Helpful Guides Today! 1-800-786-4452 | [www.iccsafe.org/books](http://www.iccsafe.org/books)**



# Proctored Remote Online Testing Option (PRONTO™)

## Convenient, Reliable, and Secure Certification Exams

### Take the Test at Your Location

Take advantage of ICC PRONTO, an industry leading, secure online exam delivery service. PRONTO allows you to take ICC Certification exams at your convenience in the privacy of your own home, office or other secure location. Plus, you'll know your pass/fail status immediately upon completion.



With PRONTO, ICC's Proctored Remote Online Testing Option, take your ICC Certification exam from any location with high-speed internet access.



With online proctoring and exam security features you can be confident in the integrity of the testing process and exam results.



Plan your exam for the day and time most convenient for you. PRONTO is available 24/7.



Eliminate the waiting period and get your results in private immediately upon exam completion.

# #1

ICC was the first model code organization to offer secured online proctored exams—part of our commitment to offering the latest technology-based solutions to help building and code professionals succeed and advance. We continue to expand our catalog of PRONTO exam offerings.

**Discover ICC PRONTO and the wealth of certification opportunities available to advance your career: [www.iccsafe.org/MeetPRONTO](http://www.iccsafe.org/MeetPRONTO)**

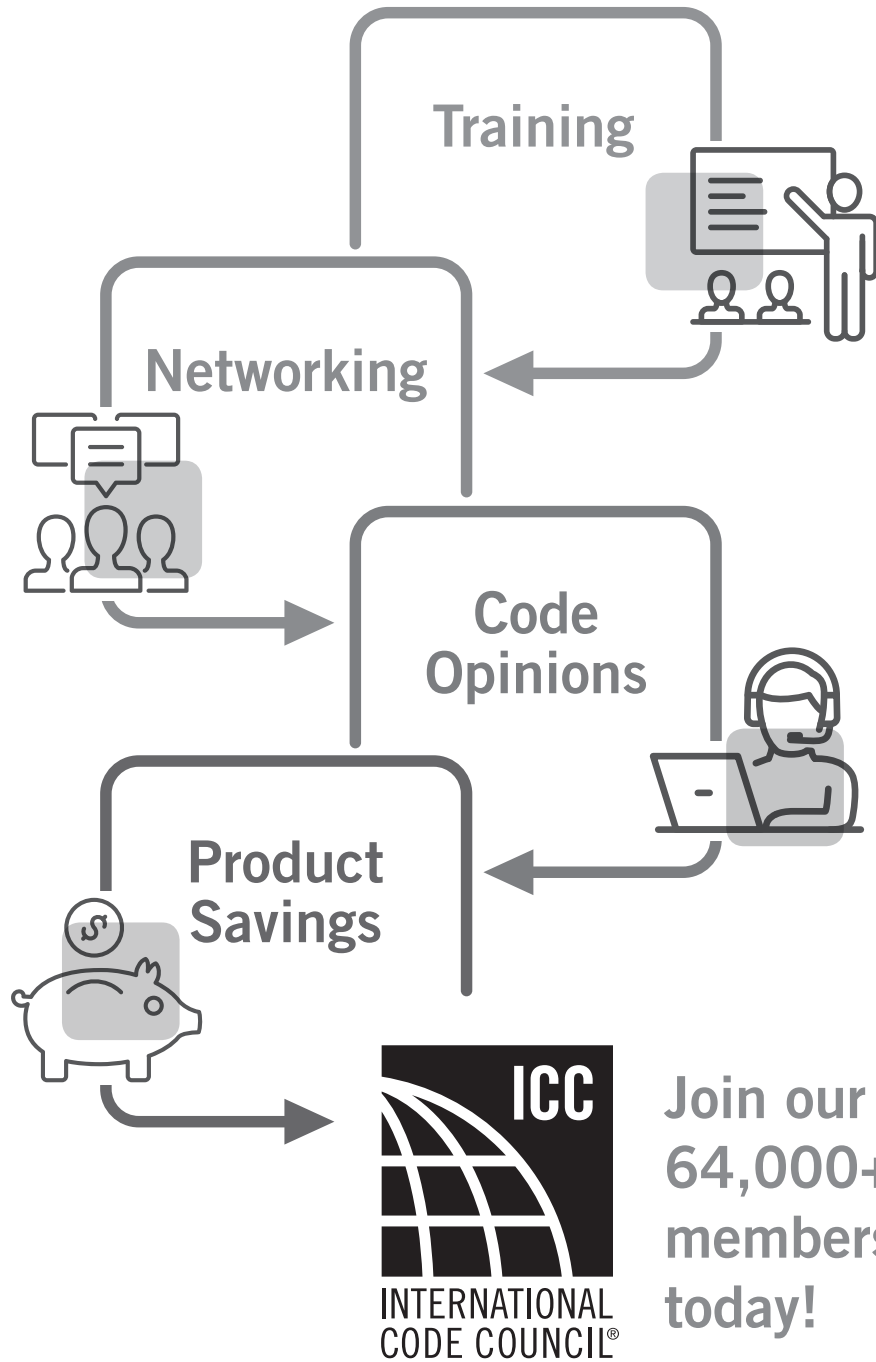


ASSESSMENT  
**center**

**pronto**  
ICC ONLINE EXAMS

# ICC Membership

An Essential Tool to advance your Building Safety Career!



Put the benefits of ICC Membership to work for you and your career!

Visit [www.iccsafe.org/memnow](http://www.iccsafe.org/memnow) or  
call **1-888-ICC-SAFE (422-7233)**, ext. **33804** to learn more.



# LEARNING center

## TRAINING & EDUCATION

The Learning Center at ICC has the training opportunities you need to advance your career and earn valuable CEUs!

### SEMINARS AND INSTITUTES

- Fire & Life Safety Institute
- IBC® and IFC® Fire Protection Systems
- IFC and IBC Hazardous Materials
- IFC Essentials

### FIRE INSPECTOR WEBINAR SERIES

- General Inspection Administration
- General Provisions for Fire Safety, Part I
- General Provisions for Fire Safety, Part II
- Special Occupancies and Operations
- Regulated Materials and Processes

### CERTIFICATION TEST ACADEMY

- Fire Inspector I – 66

### ONLINE LEARNING

- IFC Fire Inspector I – 66 Study Guide
- Hazardous Materials and Use of Control Areas: Based on the IBC and IFC
- Fire Safety Design: Egress & Extinguishing Systems
- International Fire Code Essentials – Fire/Life Safety Systems and Features

**Check out our Class Calendar at [learn.iccsafe.org](http://learn.iccsafe.org) today or call 888-422-7233, x33821 for more information!**



20-18963

**2021**  
**Edition**

# **ARKANSAS**

# **FIRE PREVENTION CODE**

## **VOLUME II BUILDING**

**Based on the 2021 International  
Building Code®**





# ARKANSAS FIRE PREVENTION CODE 2021 EDITION



## VOLUME II

**Based on the 2021  
International Building Code®**

## 2021 Arkansas Fire Prevention Code, Volume II—Building

First Printing: October 2022

ISBN: 978-1-958581-56-8 (loose-leaf edition)

COPYRIGHT © 2022  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This 2021 *Arkansas Fire Prevention Code* contains substantial copyrighted material from the 2021 *International Building Code*®, second printing, which is a copyrighted work owned by the International Code Council, Inc. (“ICC”). Without separate written permission from the copyright owner, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example, and not limitation, photocopying or recording by or in an information storage and/or retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

Trademarks: “International Code Council,” the “International Code Council” logo, “ICC,” the “ICC” logo, “International Building Code,” “IBC” and other names and trademarks appearing in this publication are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission.

PRINTED IN THE USA

T028247





### TO THE PEOPLE OF THE STATE OF ARKANSAS:

The *Arkansas Fire Prevention Code* ("AFPC" or "Fire Code" or "Code") 2021 edition, which supersedes the 2012 edition, has been developed to assist in preventing and controlling fires in and outside of structures in the State of Arkansas. The proper use of this Code can result in saving lives and property through the prevention of fires in our state.

I encourage Arkansas cities and counties to join with the Arkansas State Fire Marshal's Office in our effort to enforce the AFPC by adopting the Fire Code as a local ordinance. The adoption of the AFPC 2021 edition is important, and it is my hope that every citizen will use this Code to their fullest advantage in fire prevention.

### ORDER

Pursuant to the authority vested in the Director of the Division of Arkansas State Police by Section 6 of Act 254 of 1955 (A.C.A. §12-13-105), as amended, I promulgate these rules for the prevention of fire hazards in the State of Arkansas. The rules are set out in detail in the copy attached hereto.

IT IS THEREFORE ORDERED that said rules are to become effective January 1, 2023, in compliance with the Administrative Procedure Act of the State of Arkansas (A.C.A. §25-15-201 through §25-15-214), and shall be known as the *Arkansas Fire Prevention Code*, 2021 edition.

IN WITNESS WHEREOF, I have hereto affixed my signature as Director of the Division of Arkansas State Police this June 20, 2022.

A handwritten signature in black ink, appearing to read "William J. Bryant".

Colonel William J. Bryant  
Director, Arkansas State Police and  
Arkansas Department of Public Safety

## FOREWORD

The *Arkansas Fire Prevention Code* was developed using the nationally and internationally recognized and accepted *International Fire Code*, *International Building Code* and *International Residential Code*, with revisions based on recommendations from Arkansas-based subject matter experts.

There are countless individuals who contributed to the 2021 successful revision of the *Arkansas Fire Prevention Code*. The following Arkansans unselfishly devoted their time and expertise to serve on the informal Arkansas Fire Prevention Code Revision Committee. The State Fire Marshal's Office extends its heartfelt thanks to everyone who participated in the revision process:

- Wally Bailey, Director of Community Development, City of Fort Smith
- James Birchfield, Senior Manager, Fire Code Compliance, Walmart
- Barry Burke, Inspector, State Fire Marshal's Office
- Brian Cotton, Associate Vice Chancellor of Operations, UAMS, Design and Construction
- Charles Covington, Chief State Electrical Inspector, AR Department of Labor
- Jimmie Deer, Building Official, City of Fort Smith
- Roderick Edwards, President, Triple-S Alarm Co., Inc.
- James Engstrom, President, H. James Engstrom and Associates, Inc.
- Jake Feemster, Fire Marshal, Bentonville Fire Department
- Steven Ferren, Executive Vice President, Arkansas Oil Marketers Association
- Dennis Free, Inspector, State Fire Marshal's Office
- Dustin Free, Captain, North Little Rock Fire Department
- (William) Guy Grady, Fire Inspector, Searcy Fire Department
- Paul Hankins, Area Supervisor, Arkansas Department of Human Services Child Care Licensing Division
- J.D. Harper, Executive Director, Arkansas Manufactured Housing Association
- Jimmy Hart, Judge, Conway County Judge
- Joe Hillard, Director of Engineering, Cromwell Architects & Engineers
- Loel Hoffman, President, Austin Permit Services
- Joseph Jerabeck, Captain, Rogers Fire Department
- Kevin Lang, Fire Chief, Paragould Fire Department
- Chris A. Lorton, Commercial Building Inspector, City of Rogers
- Robert Medford, Fire Chief, Camden Fire Department
- Duane Miller, Fire Marshal, Springdale Fire Department
- Robert Morgan, Inspector Supervisor, Arkansas Department of Environmental Quality
- Michael Moyer, Captain, ASP/Regulatory and Building Operations
- Kevin Pfalser, Director, Liquefied Petroleum Gas Board
- Tim Quetsch, Engineer, Arkansas Department of Environmental Quality
- Jerry Robinson, Fire Marshal, North Little Rock Fire Department
- Bill Rumsey, Captain, Rogers Fire Department, Community Risk Reduction Division
- Mike Scott, Chief Building Official, City of Hot Springs
- Brian Sloat, Fire Marshal, Fayetteville Fire Department
- Matthew Swaim, Architect, WER Architects/ Planners
- Darrell Tessman, Assistant Director, ADE Facilities and Transportation
- Clayton Vaden, Architect, Lewis Architects Engineers
- Phil Watkins, Building Official, City of Searcy
- Mark Wheeler, Vice President/District Managers, VSC Fire and Security
- Mark Whitaker, Plan Reviewer, State Fire Marshal's Office
- Jason Wills, Fire Marshal, Jonesboro Fire Department
- Keith Wingfield, President, River Rock Builders

The intent of the *Arkansas Fire Prevention Code* is to reduce the number of fires in Arkansas and reduce the number of other hazard-related concerns. The *Arkansas Fire Prevention Code* establishes minimum rules dealing with fire and building safety.

Written communications for the State Fire Marshal's Office should be directed to:

State Fire Marshal's Office  
 Division of Arkansas State Police  
 Arkansas Department of Public Safety  
 1 State Police Plaza Drive  
 Little Rock, AR 72209

•  
•

The State Fire Marshal's Office can be contacted by telephone at 501-618-8624 (until further notice). The fax number for the State Fire Marshal's Office is 501-618-8621 (until further notice).



Major Lindsey Williams •  
 State Fire Marshal's Office •  
 Division of Arkansas State Police •  
 Arkansas Department of Public Safety •

# STATE OF ARKANSAS

## ARKANSAS FIRE PREVENTION CODE RULES

### 2021 EDITION

### DEFINITIONS

- These Rules are promulgated by the Director of the Division of Arkansas State Police, who serves by operation of law as the Arkansas State Fire Marshal under the authority granted by Arkansas Act 254 of 1955, codified at A.C.A. §12-13-101 to A.C.A. §12-13-116, as amended. The purpose of these Rules is to aid in the implementation, interpretation and enforcement of the *Arkansas Fire Prevention Code* (AFPC), 2021 edition.
- The *International Fire Code*, 2021 edition, the *International Building Code*, 2021 edition, and the *International Residential Code*, 2021 edition, as published by the International Code Council and the rules, as amended and adopted by the Arkansas State Fire Marshal, shall constitute the *Arkansas Fire Prevention Code*, 2021 edition. These Rules shall be effective January 1, 2023.

The following shall be defined as:

INTERNATIONAL PLUMBING CODE shall mean the *Arkansas State Plumbing Code*.

INTERNATIONAL PRIVATE SEWAGE DISPOSAL CODE is replaced by “Arkansas Department of Health Rules and Regulations Pertaining to Onsite Wastewater Systems.”

INTERNATIONAL MECHANICAL CODE shall mean the *mechanical code for Arkansas*.

INTERNATIONAL FUEL GAS CODE shall mean the *Arkansas State Gas Code*.

INTERNATIONAL ENERGY CONSERVATION CODE shall mean the *Arkansas Energy Code*.

INTERNATIONAL FIRE CODE shall mean the *Arkansas Fire Prevention Code*, Volume I.

INTERNATIONAL BUILDING CODE shall mean the *Arkansas Fire Prevention Code*, Volume II.

INTERNATIONAL RESIDENTIAL CODE shall mean the *Arkansas Fire Prevention Code*, Volume III.

NATIONAL ELECTRICAL CODE shall mean the *electrical code for the State of Arkansas*.

BUILDING OFFICIAL shall mean any governmental official having authority to enforce that aspect of the code.

Dotted lines in the margin indicate Arkansas revisions.



Solid stars in the margin indicate Arkansas deletions.





# TABLE OF CONTENTS

<b>CHAPTER 1 SCOPE AND ADMINISTRATION . . . . .</b>	<b>1-1</b>	308 Institutional Group I . . . . .	3-8
<b>PART 1—SCOPE AND APPLICATION . . . . .</b>	<b>1-1</b>	309 Mercantile Group M . . . . .	3-9
Section		310 Residential Group R . . . . .	3-10
101 Scope and General Requirements . . . . .	1-1	311 Storage Group S . . . . .	3-11
102 Applicability . . . . .	1-2	312 Utility and Miscellaneous Group U. . . . .	3-12
<b>PART 2—ADMINISTRATION AND ENFORCEMENT . . . . .</b>	<b>1-3</b>	<b>CHAPTER 4 SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE . . . . .</b>	<b>4-1</b>
103 Code Compliance Agency . . . . .	1-3	Section	
104 Duties and Powers of Building Official. . . . .	1-4	401 Scope . . . . .	4-1
105 Permits . . . . .	1-5	402 Covered Mall and Open Mall Buildings . . . . .	4-1
106 Floor and Roof Design Loads . . . . .	1-7	403 High-rise Buildings . . . . .	4-5
107 Construction Documents . . . . .	1-7	404 Atriums . . . . .	4-8
108 Temporary Structures and Uses . . . . .	1-10	405 Underground Buildings . . . . .	4-9
109 Fees . . . . .	1-11	406 Motor-vehicle-related Occupancies . . . . .	4-10
110 Inspections . . . . .	1-11	407 Group I-2 . . . . .	4-15
111 Certificate of Occupancy . . . . .	1-12	408 Group I-3 . . . . .	4-18
112 Service Utilities . . . . .	1-13	409 Motion Picture Projection Rooms . . . . .	4-21
113 Means of Appeals . . . . .	1-13	410 Stages, Platforms and Technical Production Areas . . . . .	4-21
114 Violations . . . . .	1-13	411 Special Amusement Areas . . . . .	4-23
115 Stop Work Order . . . . .	1-13	412 Aircraft-related Occupancies . . . . .	4-24
116 Unsafe Structures and Equipment . . . . .	1-14	413 Combustible Storage . . . . .	4-28
<b>CHAPTER 2 DEFINITIONS . . . . .</b>	<b>2-1</b>	414 Hazardous Materials . . . . .	4-28
Section		415 Groups H-1, H-2, H-3, H-4 and H-5 . . . . .	4-32
201 General . . . . .	2-1	416 Spray Application of Flammable Finishes . . . . .	4-41
202 Definitions . . . . .	2-1	417 Drying Rooms . . . . .	4-42
<b>CHAPTER 3 OCCUPANCY CLASSIFICATION AND USE . . . . .</b>	<b>3-1</b>	418 Organic Coatings . . . . .	4-42
Section		419 Artificial Decorative Vegetation . . . . .	4-42
301 Scope . . . . .	3-1	420 Groups I-1, R-1, R-2, R-3 and R-4 . . . . .	4-42
302 Occupancy Classification and Use Designation . . . . .	3-1	421 Hydrogen Fuel Gas Rooms . . . . .	4-44
303 Assembly Group A . . . . .	3-1	422 Ambulatory Care Facilities . . . . .	4-44
304 Business Group B . . . . .	3-2	423 Storm Shelters . . . . .	4-45
305 Educational Group E . . . . .	3-3	424 Play Structures . . . . .	4-46
306 Factory Group F . . . . .	3-3	425 Hyperbaric Facilities . . . . .	4-46
307 High-hazard Group H . . . . .	3-4	426 Combustible Dusts, Grain Processing and Storage . . . . .	4-46
		427 Medical Gas Systems . . . . .	4-47
		428 Higher Education Laboratories . . . . .	4-48

## TABLE OF CONTENTS

### CHAPTER 5 GENERAL BUILDING HEIGHTS AND AREAS..... 5-1

#### Section

501	General.....	5-1
502	Building Address.....	5-1
503	General Building Height and Area Limitations...	5-1
504	Building Height and Number of Stories .....	5-2
505	Mezzanines and Equipment Platforms .....	5-2
506	Building Area .....	5-6
507	Unlimited Area Buildings .....	5-9
508	Mixed Use and Occupancy .....	5-12
509	Incidental Uses .....	5-14
510	Special Provisions .....	5-15

### CHAPTER 6 TYPES OF CONSTRUCTION..... 6-1

#### Section

601	General.....	6-1
602	Construction Classification .....	6-1
603	Combustible Material in Types I and II Construction.....	6-5

### CHAPTER 7 FIRE AND SMOKE PROTECTION FEATURES..... 7-1

#### Section

701	General.....	7-1
702	Multiple-use Fire Assemblies .....	7-1
703	Fire-resistance Ratings and Fire Tests .....	7-1
704	Fire-resistance Rating of Structural Members.....	7-2
705	Exterior Walls .....	7-4
706	Fire Walls .....	7-9
707	Fire Barriers.....	7-12
708	Fire Partitions .....	7-13
709	Smoke Barriers .....	7-15
710	Smoke Partitions .....	7-16
711	Floor and Roof Assemblies .....	7-16
712	Vertical Openings .....	7-17
713	Shaft Enclosures .....	7-19
714	Penetrations .....	7-20
715	Joints and Voids.....	7-23
716	Opening Protectives.....	7-24
717	Ducts and Air Transfer Openings .....	7-31
718	Concealed Spaces .....	7-37
719	Fire-resistance Requirements for Plaster.....	7-39
720	Thermal- and Sound-insulating Materials.....	7-39

721	Prescriptive Fire Resistance .....	7-40
722	Calculated Fire Resistance .....	7-65

### CHAPTER 8 INTERIOR FINISHES.....8-1

#### Section

801	Scope.....	8-1
802	General .....	8-1
803	Wall and Ceiling Finishes.....	8-1
804	Interior Floor Finish .....	8-4
805	Combustible Materials in Types I and II Construction .....	8-5
806	Decorative Materials and Trim .....	8-5
807	Insulation.....	8-6
808	Acoustical Ceiling Systems.....	8-6

### CHAPTER 9 FIRE PROTECTION AND LIFE SAFETY SYSTEMS ....9-1

#### Section

901	General .....	9-1
902	Fire Pump and Riser Room Size.....	9-2
903	Automatic Sprinkler Systems .....	9-2
904	Alternative Automatic Fire-extinguishing Systems.....	9-9
905	Standpipe Systems .....	9-12
906	Portable Fire Extinguishers.....	9-14
907	Fire Alarm and Detection Systems .....	9-16
908	Emergency Alarm Systems.....	9-28
909	Smoke Control Systems .....	9-29
910	Smoke and Heat Removal.....	9-37
911	Fire Command Center.....	9-38
912	Fire Department Connections .....	9-40
913	Fire Pumps .....	9-40
914	Emergency Responder Safety Features.....	9-41
915	Carbon Monoxide Detection.....	9-41
916	Gas Detection Systems .....	9-43
917	Mass Notification Systems .....	9-43
918	Emergency Responder Communication Coverage.....	9-43

### CHAPTER 10 MEANS OF EGRESS .....10-1

#### Section

1001	Administration .....	10-1
1002	Maintenance and Plans.....	10-1
1003	General Means of Egress .....	10-1
1004	Occupant Load .....	10-2

## TABLE OF CONTENTS

1005	Means of Egress Sizing . . . . .	10-4	<b>CHAPTER 12 INTERIOR ENVIRONMENT . . . . 12-1</b>
1006	Number of Exits and Exit Access Doorways . . . . .	10-5	Section
1007	Exit and Exit Access Doorway Configuration . . . . .	10-8	1201 General . . . . . 12-1
1008	Means of Egress Illumination . . . . .	10-9	1202 Ventilation . . . . . 12-1
1009	Accessible Means of Egress . . . . .	10-10	1203 Temperature Control . . . . . 12-4
1010	Doors, Gates and Turnstiles . . . . .	10-12	1204 Lighting . . . . . 12-4
1011	Stairways . . . . .	10-22	1205 Yards or Courts . . . . . 12-4
1012	Ramps . . . . .	10-26	1206 Sound Transmission . . . . . 12-5
1013	Exit Signs . . . . .	10-27	1207 Enhanced Classroom Acoustics . . . . . 12-5
1014	Handrails . . . . .	10-28	1208 Interior Space Dimensions . . . . . 12-5
1015	Guards . . . . .	10-29	1209 Access to Unoccupied Spaces . . . . . 12-6
1016	Exit Access . . . . .	10-31	1210 Toilet and Bathroom Requirements . . . . . 12-6
1017	Exit Access Travel Distance . . . . .	10-31	<b>CHAPTER 13 ENERGY EFFICIENCY . . . . . 13-1</b>
1018	Aisles . . . . .	10-33	Section
1019	Exit Access Stairways and Ramps . . . . .	10-33	1301 General . . . . . 13-1
1020	Corridors . . . . .	10-34	<b>CHAPTER 14 EXTERIOR WALLS . . . . . 14-1</b>
1021	Egress Balconies . . . . .	10-35	Section
1022	Exits . . . . .	10-35	1401 General . . . . . 14-1
1023	Interior Exit Stairways and Ramps . . . . .	10-36	1402 Performance Requirements . . . . . 14-1
1024	Exit Passageways . . . . .	10-38	1403 Materials . . . . . 14-2
1025	Luminous Egress Path Markings . . . . .	10-39	1404 Installation of Wall Coverings . . . . . 14-3
1026	Horizontal Exits . . . . .	10-40	1405 Combustible Materials on the Exterior Side of Exterior Walls . . . . . 14-9
1027	Exterior Exit Stairways and Ramps . . . . .	10-41	1406 Metal Composite Materials (MCM) . . . . . 14-10
1028	Exit Discharge . . . . .	10-42	1407 Exterior Insulation and Finish Systems (EIFS) . . . . . 14-10
1029	Egress Courts . . . . .	10-43	1408 High-pressure Decorative Exterior-grade Compact Laminates (HPL) . . . . . 14-11
1030	Assembly . . . . .	10-43	1409 Plastic Composite Decking . . . . . 14-12
1031	Emergency Escape and Rescue . . . . .	10-50	<b>CHAPTER 15 ROOF ASSEMBLIES AND ROOFTOP STRUCTURES . . . . . 15-1</b>
<b>CHAPTER 11 ACCESSIBILITY . . . . . 11-1</b>			Section
Section			1501 General . . . . . 15-1
1101	General . . . . .	11-1	1502 Roof Drainage . . . . . 15-1
1102	Compliance . . . . .	11-1	1503 Weather Protection . . . . . 15-1
1103	Scoping Requirements . . . . .	11-1	1504 Performance Requirements . . . . . 15-2
1104	Accessible Route . . . . .	11-2	1505 Fire Classification . . . . . 15-3
1105	Accessible Entrances . . . . .	11-3	1506 Materials . . . . . 15-4
1106	Parking and Passenger Loading Facilities . . . . .	11-4	1507 Requirements for Roof Coverings . . . . . 15-4
1107	Motor-vehicle-related Facilities . . . . .	11-5	1508 Roof Insulation . . . . . 15-16
1108	Dwelling Units and Sleeping Units . . . . .	11-5	1509 Roof Coatings . . . . . 15-16
1109	Special Occupancies . . . . .	11-9	1510 Radiant Barriers Installed Above Deck . . . . . 15-17
1110	Other Features and Facilities . . . . .	11-11	
1111	Recreational Facilities . . . . .	11-15	
1112	Signage . . . . .	11-17	

## TABLE OF CONTENTS

1511	Rooftop Structures .....	15-17
1512	Reroofing .....	15-19

### CHAPTER 16 STRUCTURAL DESIGN ..... 16-1

#### Section

1601	General .....	16-1
1602	Notations .....	16-1
1603	Construction Documents .....	16-1
1604	General Design Requirements .....	16-2
1605	Load Combinations .....	16-6
1606	Dead Loads .....	16-6
1607	Live Loads .....	16-7
1608	Snow Loads .....	16-15
1609	Wind Loads .....	16-15
1610	Soil Loads and Hydrostatic Pressure .....	16-33
1611	Rain Loads .....	16-33
1612	Flood Loads .....	16-34
1613	Earthquake Loads .....	16-40
1614	Atmospheric Ice Loads .....	16-43
1615	Tsunami Loads .....	16-43
1616	Structural Integrity .....	16-43

### CHAPTER 17 SPECIAL INSPECTIONS AND TESTS ..... 17-1

#### Section

1701	General .....	17-1
1702	New Materials .....	17-1
1703	Approvals .....	17-1
1704	Special Inspections and Tests, Contractor Responsibility and Structural Observation .....	17-2
1705	Required Special Inspections and Tests .....	17-4
1706	Design Strengths of Materials .....	17-13
1707	Alternative Test Procedure .....	17-13
1708	In-situ Load Tests .....	17-13
1709	Preconstruction Load Tests .....	17-14

### CHAPTER 18 SOILS AND FOUNDATIONS .... 18-1

#### Section

1801	General .....	18-1
1802	Design Basis .....	18-1
1803	Geotechnical Investigations .....	18-1
1804	Excavation, Grading and Fill .....	18-3
1805	Dampproofing and Waterproofing .....	18-4
1806	Presumptive Load-bearing Values of Soils ....	18-6

1807	Foundation Walls, Retaining Walls and Embedded Posts and Poles .....	18-6
1808	Foundations .....	18-12
1809	Shallow Foundations .....	18-15
1810	Deep Foundations .....	18-17

### CHAPTER 19 CONCRETE.....19-1

#### Section

1901	General .....	19-1
1902	Coordination of Terminology .....	19-1
1903	Specifications for Tests and Materials .....	19-2
1904	Durability Requirements .....	19-2
1905	Modifications to ACI 318 .....	19-2
1906	Footings for Light-frame Construction .....	19-5
1907	Minimum Slab Provisions .....	19-5
1908	Shotcrete .....	19-5

### CHAPTER 20 ALUMINUM .....20-1

#### Section

2001	General .....	20-1
2002	Materials .....	20-1

### CHAPTER 21 MASONRY.....21-1

#### Section

2101	General .....	21-1
2102	Notations .....	21-1
2103	Masonry Construction Materials .....	21-1
2104	Construction .....	21-2
2105	Quality Assurance .....	21-2
2106	Seismic Design .....	21-2
2107	Allowable Stress Design .....	21-2
2108	Strength Design of Masonry .....	21-3
2109	Empirical Design of Adobe Masonry .....	21-3
2110	Glass Unit Masonry .....	21-5
2111	Masonry Fireplaces .....	21-6
2112	Masonry Heaters .....	21-8
2113	Masonry Chimneys .....	21-9
2114	Dry-stack Masonry .....	21-13

### CHAPTER 22 STEEL.....22-1

#### Section

2201	General .....	22-1
2202	Identification of Steel for Structural Purposes .....	22-1
2203	Protection of Steel for Structural Purposes .....	22-1



TABLE OF CONTENTS

2204	Connections . . . . .	22-1	2504	Vertical and Horizontal Assemblies . . . . .	25-1
2205	Structural Steel . . . . .	22-1	2505	Shear Wall Construction . . . . .	25-1
2206	Composite Structural Steel and Concrete Structures . . . . .	22-2	2506	Gypsum Board and Gypsum Panel Product Materials . . . . .	25-1
2207	Steel Joists . . . . .	22-2	2507	Lathing and Plastering . . . . .	25-2
2208	Steel Cable Structures . . . . .	22-3	2508	Gypsum Construction . . . . .	25-2
2209	Steel Storage Racks . . . . .	22-3	2509	Showers and Water Closets . . . . .	25-4
2210	Cold-formed Steel . . . . .	22-3	2510	Lathing and Furring for Cement Plaster (Stucco) . . . . .	25-4
2211	Cold-formed Steel Light-frame Construction . . . . .	22-4	2511	Interior Plaster . . . . .	25-5
<b>CHAPTER 23 WOOD . . . . . 23-1</b>			2512	Exterior Plaster . . . . .	25-5
Section			2513	Exposed Aggregate Plaster . . . . .	25-6
2301	General . . . . .	23-1	2514	Reinforced Gypsum Concrete . . . . .	25-7
2302	Design Requirements . . . . .	23-1	<b>CHAPTER 26 PLASTIC . . . . . 26-1</b>		
2303	Minimum Standards and Quality . . . . .	23-1	Section		
2304	General Construction Requirements . . . . .	23-10	2601	General . . . . .	26-1
2305	General Design Requirements for Lateral Force-resisting Systems . . . . .	23-23	2602	Finish and Trim . . . . .	26-1
2306	Allowable Stress Design . . . . .	23-25	2603	Foam Plastic Insulation . . . . .	26-1
2307	Load and Resistance Factor Design . . . . .	23-26	2604	Interior Finish and Trim . . . . .	26-7
2308	Conventional Light-frame Construction . . . . .	23-26	2605	Plastic Veneer . . . . .	26-7
2309	Wood Frame Construction Manual . . . . .	23-58	2606	Light-transmitting Plastics . . . . .	26-8
<b>CHAPTER 24 GLASS AND GLAZING . . . . . 24-1</b>			2607	Light-transmitting Plastic Wall Panels . . . . .	26-9
Section			2608	Light-transmitting Plastic Glazing . . . . .	26-10
2401	General . . . . .	24-1	2609	Light-transmitting Plastic Roof Panels . . . . .	26-11
2402	Glazing Replacement . . . . .	24-1	2610	Light-transmitting Plastic Skylight Glazing . . . . .	26-11
2403	General Requirements for Glass . . . . .	24-1	2611	Light-transmitting Plastic Interior Signs . . . . .	26-12
2404	Wind, Snow, Seismic and Dead Loads on Glass . . . . .	24-1	2612	Plastic Composites . . . . .	26-12
2405	Sloped Glazing and Skylights . . . . .	24-3	2613	Fiber-reinforced Polymer . . . . .	26-13
2406	Safety Glazing . . . . .	24-4	2614	Reflective Plastic Core Insulation . . . . .	26-13
2407	Glass in Handrails and Guards . . . . .	24-6	<b>CHAPTER 27 ELECTRICAL Deleted in its entirety. Refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . . 27-1</b>		
2408	Glazing in Athletic Facilities . . . . .	24-7	<b>CHAPTER 28 MECHANICAL SYSTEMS . . . . . 28-1</b>		
2409	Glass in Walkways, Elevator Hoistways and Elevator Cars . . . . .	24-7	Section		
<b>CHAPTER 25 GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER . . . . . 25-1</b>			2801	General . . . . .	28-1
Section			<b>CHAPTER 29 PLUMBING SYSTEMS Deleted in its entirety. Refer to the Arkansas Plumbing Code as adopted by the State of Arkansas . . . . . 29-1</b>		
2501	General . . . . .	25-1			
2502	Performance . . . . .	25-1			
2503	Inspection . . . . .	25-1			

## TABLE OF CONTENTS

### CHAPTER 30 ELEVATORS AND CONVEYING SYSTEMS ..... 30-1

#### Section

3001	General .....	30-1
3002	Hoistway Enclosures .....	30-1
3003	Emergency Operations .....	30-2
3004	Conveying Systems .....	30-2
3005	Machine Rooms .....	30-3
3006	Elevator Lobbies and Hoistway Opening Protection .....	30-3
3007	Fire Service Access Elevator .....	30-4
3008	Occupant Evacuation Elevators .....	30-6

### CHAPTER 31 SPECIAL CONSTRUCTION..... 31-1

#### Section

3101	General .....	31-1
3102	Membrane Structures .....	31-1
3103	Temporary Structures .....	31-2
3104	Pedestrian Walkways and Tunnels .....	31-3
3105	Awnings and Canopies .....	31-4
3106	Marquees .....	31-4
3107	Signs .....	31-5
3108	Telecommunication and Broadcast Towers ....	31-5
3109	Swimming Pools, Spas and Hot Tubs .....	31-5
3110	Automatic Vehicular Gates .....	31-5
3111	Solar Energy Systems .....	31-5
3112	Greenhouses .....	31-5
3113	Relocatable Buildings .....	31-6
3114	Public Use Restroom Buildings in Flood Hazard Areas .....	31-6
3115	Intermodal Shipping Containers .....	31-7

### CHAPTER 32 ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY..... 32-1

#### Section

3201	General .....	32-1
3202	Encroachments .....	32-1

### CHAPTER 33 SAFEGUARDS DURING CONSTRUCTION..... 33-1

#### Section

3301	General .....	33-1
3302	Construction Safeguards .....	33-1
3303	Demolition .....	33-1
3304	Site Work .....	33-1
3305	Sanitary .....	33-2

3306	Protection of Pedestrians .....	33-2
3307	Protection of Adjoining Property .....	33-3
3308	Temporary Use of Streets, Alleys and Public Property .....	33-3
3309	Fire Extinguishers .....	33-4
3310	Means of Egress .....	33-4
3311	Standpipes .....	33-4
3312	Automatic Sprinkler System .....	33-4
3313	Water Supply for Fire Protection .....	33-4
3314	Fire Watch During Construction .....	33-5

### CHAPTER 34 RESERVED .....34-1

### CHAPTER 35 REFERENCED STANDARDS.....35-1

#### APPENDIX A EMPLOYEE QUALIFICATIONS Deleted in its entirety ..... A-1

#### APPENDIX B BOARD OF APPEALS Deleted in its entirety.... B-1

#### APPENDIX C GROUP U—AGRICULTURAL BUILDINGS..... C-1

##### Section

C101	General .....	C-1
C102	Allowable Height and Area .....	C-1
C103	Mixed Occupancies .....	C-1
C104	Exits .....	C-1

#### APPENDIX D FIRE DISTRICTS ..... D-1

##### Section

D101	General .....	D-1
D102	Building Restrictions .....	D-1
D103	Changes to Buildings .....	D-2
D104	Buildings Located Partially in the Fire District .....	D-2
D105	Exceptions to Restrictions in Fire District .....	D-2
D106	Referenced Standards .....	D-3

#### APPENDIX E SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS..... E-1

##### Section

E101	General .....	E-1
E102	Definitions .....	E-1

## TABLE OF CONTENTS

		<b>RESOURCE A RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI). . . Resource A-1</b>
E103	Accessible Route. . . . .	E-1
E104	Special Occupancies . . . . .	E-1
E105	Other Features and Facilities . . . . .	E-2
E106	Telephones . . . . .	E-2
E107	Signage . . . . .	E-3
E108	Bus Stops . . . . .	E-4
E109	Transportation Facilities and Stations. . . . .	E-4
E110	Airports . . . . .	E-5
E111	Referenced Standards . . . . .	E-5
<b>APPENDIX F</b>	<b>RODENTPROOFING Deleted in its entirety . . . . .</b>	<b>F-1</b>
<b>APPENDIX G</b>	<b>FLOOD-RESISTANT CONSTRUCTION Deleted in its entirety . . . . .</b>	<b>G-1</b>
<b>APPENDIX H</b>	<b>SIGNS Deleted in its entirety. . . . .</b>	<b>H-1</b>
<b>APPENDIX I</b>	<b>PATIO COVERS Deleted in its entirety. . . . .</b>	<b>I-1</b>
<b>APPENDIX J</b>	<b>GRADING Deleted in its entirety . . .</b>	<b>J-1</b>
<b>APPENDIX K</b>	<b>ADMINISTRATIVE PROVISIONS Deleted in its entirety. . . . .</b>	<b>K-1</b>
<b>APPENDIX L</b>	<b>EARTHQUAKE RECORDING INSTRUMENTATION Deleted in its entirety. . . . .</b>	<b>L-11</b>
<b>APPENDIX M</b>	<b>TSUNAMI-GENERATED FLOOD HAZARDS Deleted in its entirety . . . . .</b>	<b>M-1</b>
<b>APPENDIX N</b>	<b>REPLICABLE BUILDINGS Deleted in its entirety. . . . .</b>	<b>N-12</b>
<b>APPENDIX O</b>	<b>PERFORMANCE-BASED APPLICATION . . . . .</b>	<b>O-1</b>
Section		
O101	General . . . . .	O-1
<b>INDEX. . . . .</b>		<b>INDEX-1</b>





# CHAPTER 1

## SCOPE AND ADMINISTRATION

### User notes:

**About this chapter:** Chapter 1 establishes the limits of applicability of the code and describes how the code is to be applied and enforced. Chapter 1 is in two parts: Part 1—Scope and Application (Sections 101–102) and Part 2—Administration and Enforcement (Sections 103–116). Section 101 identifies which buildings and structures come under its purview and references other I-Codes as applicable. Standards and codes are scoped to the extent referenced (see Section 102.4).

This code is intended to be adopted as a legally enforceable document and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 1 establish the authority and duties of the code official appointed by the authority having jurisdiction and also establish the rights and privileges of the design professional, contractor and property owner. Chapter 1 is largely concerned with maintaining “due process of law” in enforcing the building performance criteria contained in the body of the code.

**Code development reminder:** Code change proposals to this chapter will be considered by the Administrative Code Development Committee during the 2022 (Group B) Code Development Cycle.

## PART 1—SCOPE AND APPLICATION

### SECTION 101

#### SCOPE AND GENERAL REQUIREMENTS

**101.1 Title.** The provisions of the following chapters shall constitute, be known, and be cited as the *Arkansas Fire Prevention Code*, Volume II, hereinafter known as “this Code.”

**[A] 101.2 Scope.** The provisions of this code shall apply to the construction, *alteration*, relocation, enlargement, replacement, *repair*, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures.

**Exception:** Detached one- and two-family *dwelling*s and *townhouse*s not more than three *stories above grade plane* in height with a separate *means of egress*, and their accessory structures not more than three *stories above grade plane* in height, shall comply with this code or the *Arkansas Fire Prevention Code*, Volume III.

**[A] 101.2.1 Appendices.** Provisions in the appendices shall not apply unless specifically adopted. Appendices C, D, E and O are adopted by the State of Arkansas. Appendix C may only be used in local jurisdictions with prior approval of the local *building official*. Other appendices shall not apply unless adopted by local ordinance.

**[A] 101.3 Purpose.** The purpose of this code is to establish the minimum requirements to provide a reasonable level of safety, health and general welfare through structural strength, *means of egress*, stability, sanitation, light and *ventilation*, energy conservation, and for providing a reasonable level of life safety and property protection from the hazards of fire, *explosion* or *dangerous* conditions, and to provide a reasonable level of safety to fire fighters and emergency responders during emergency operations.

**[A] 101.4 Referenced codes.** The other codes specified in Sections 101.4.1 through 101.4.7 and referenced elsewhere in this code shall be considered to be part of the requirements of this code to the prescribed extent of each such reference.

**[A] 101.4.1 Gas.** The provisions of the *Arkansas Gas Code*, (Arkansas Department of Health, current phone 501-661-2642 until further notice) shall apply to the installation of gas piping from the point of delivery, gas appliances and related accessories as covered in this code. These requirements apply to gas piping systems extending from the point of delivery to the inlet connections of appliances and the installation and operation of residential and commercial gas appliances and related accessories.

**[A] 101.4.2 Mechanical.** The provisions of the *International Mechanical Code* shall apply to the installation, *alterations*, *repairs* and replacement of mechanical systems, including equipment, appliances, fixtures, fittings and appurtenances, including ventilating, heating, cooling, air-conditioning and refrigeration systems, incinerators and other energy-related systems.

**[A] 101.4.3 Plumbing.** The provisions of the *Arkansas State Plumbing and Gas Code*, (Arkansas Department of Health, current phone 501-661-2642 until further notice) shall apply to the installation, *alteration*, *repair* and replacement of plumbing systems, including equipment, appliances, fixtures, fittings and appurtenances, and where connected to a water or sewage system and all aspects of a medical gas system.

**[A] 101.4.4 Fire prevention.** The provisions of the *Arkansas Fire Prevention Code*, Volume I shall apply to matters affecting or relating to structures, processes and premises from the hazard of fire and *explosion* arising from the storage, handling or use of structures, materials or devices; from conditions hazardous to life, property or public welfare in the occupancy of structures or premises; and from the construction, extension, *repair*, *alteration* or removal of fire suppression, *automatic sprinkler systems*

## SCOPE AND ADMINISTRATION

and alarm systems or fire hazards in the structure or on the premises from occupancy or operation.

**[A] 101.4.5 Energy.** The provisions of the *Arkansas Energy Code* shall apply to all matters governing the design and construction of buildings for energy efficiency.

**101.4.6 Vacant buildings.** All buildings which have been vacant for more than 5 years may be evaluated by the building official for upgrades which comply with the life safety requirements of the *Arkansas Fire Prevention Code*, Volumes I and/or II prior to occupancy. All mechanical, electrical, and plumbing systems in buildings left vacant for more than 5 years shall be complete and functioning or repaired as required by the *International Existing Building Code* prior to occupancy. Compliance alternatives may also be evaluated in accordance with the *International Existing Building Code* with the approval of the building official.

**101.4.7 Noncompliant structures.** All existing buildings subject to review for proposed additions, alterations, repairs, or changes of occupancy which did not comply with the applicable code at the time of their construction or which were not upgraded to meet applicable code requirements at the time of a previous addition, alteration, repair or change of occupancy may be evaluated by the building official for upgrades to the entire structure which will comply with life safety requirements of the *Arkansas Fire Prevention Code*, Volume I and/or Volume II. Compliance alternatives may also be evaluated in accordance with the *International Existing Building Code* with the approval of the building official.

## SECTION 102 APPLICABILITY

**[A] 102.1 General.** Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

**[A] 102.2 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

**[A] 102.3 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

**[A] 102.4 Referenced codes and standards.** The codes and standards referenced in this code shall be considered to be part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections 102.4.1 and 102.4.2.

**[A] 102.4.1 Conflicts.** Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**[A] 102.4.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code or the International Codes specified in Section 101.4, the provisions of this code or the International Codes specified in Section 101.4, as applicable, shall take precedence over the provisions in the referenced code or standard.

**[A] 102.5 Partial invalidity.** In the event that any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

**[A] 102.6 Existing structures.** The legal occupancy of any structure existing on the date of adoption of this code shall be permitted to continue without change, except as otherwise specifically provided in this code, the *International Existing Building Code*, the *Arkansas Fire Prevention Code*, Volumes I and II, or as deemed necessary by the building official and/or fire official for the general safety and welfare of the occupants and the public.

**[A] 102.6.1 Buildings not previously occupied.** A building or portion of a building that has not been previously occupied or used for its intended purpose in accordance with the laws in existence at the time of its completion shall comply with the provisions of this code or the *Arkansas Fire Prevention Code*, Volume III, and the *Arkansas Fire Prevention Code*, Volume I, as applicable, for new construction or with any current permit for such occupancy.

**[A] 102.6.2 Buildings previously occupied.** The legal occupancy of any building existing on the date of adoption of this code shall be permitted to continue without change, except as otherwise specifically provided in this code, the *Arkansas Fire Prevention Code*, Volume I or as is deemed necessary by the *building official* for the general safety and welfare of the occupants and the public.

**102.6.3 Health care memorandum of understanding. MEMORANDUM OF UNDERSTANDING—HEALTH CARE FACILITIES.** This Memorandum of Understanding will specify and serve as a method to resolve conflicts between the Arkansas Fire Prevention Code Rules 2021 Edition (hereinafter “Arkansas Fire Prevention Code” or “AFPC”) adopted and enforced by the Arkansas State Fire Marshal’s Office, under the authority of the Director of the Division of the Arkansas State Police, and other federal or state rules governing Arkansas’ health care and long-term care facilities, by law regulated by the Arkansas Department of Health and the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), among others.

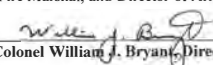
1. The Arkansas Department of Health and the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA) will have inspectors and/or plan reviewers obtain training related to the implementation and application of the National

## SCOPE AND ADMINISTRATION

- Fire Protection Association Life Safety Code (NFPA 101) and the *Arkansas Fire Prevention Code*.
2. The Arkansas Department of Health will have concurrent authority to do Fire and Life Safety Code inspections in health care facilities regulated by the Arkansas Department of Health. The Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), will have concurrent authority to do Fire and Life Safety inspections in long-term care facilities regulated by the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA). The Arkansas Department of Health's authority and the authority of the Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA) will be concurrent with the current authority of any other relevant federal, state or local government agency having authority to do said inspections.
  3. The Arkansas Fire Prevention Code is the fire prevention code for the State of Arkansas.
  4. When there is a conflict between the Arkansas Fire Prevention Code and the National Fire Protection Association Life Safety Code (NFPA 101), New Health Care Occupancies Chapter, Existing Health Care Occupancies Chapter, New Ambulatory Health Care Occupancies Chapter, and Existing Ambulatory Health Care Occupancies Chapter, as adopted by the United States Department of Health and Human Services, Centers for Medicare Medicaid Services, per Title 42 Code of Federal Regulations, the aforementioned chapters in the Life Safety Code shall govern.
  5. For new construction, when one of the affected agencies [Arkansas Department of Health, Arkansas Department of Human Services, Division of Provider Services and Quality Assurance (DPSQA), local fire official, or local building official] determines or perceives that a conflict exists between the *Arkansas Fire Prevention Code* and the National Fire Protection Association Life Safety Code (NFPA 101), as it relates to types of construction or allowable area requirements, they shall provide written notification of the perceived conflict to the project architect or engineer and the other affected agencies. The agency alleging the conflict will convene a meeting with the other affected agencies to resolve the conflict. The resolution of the conflict must be unanimous. If the group is unable to resolve the conflict unanimously, the issue will be referred to the Arkansas State Fire Marshal for final resolution.


Agreed to as evidenced by the signatures of the participating parties for their respective offices or associations below:

Arkansas State Fire Marshal, and Director of Arkansas State Police or his designee

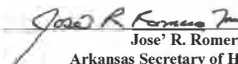
  
Colonel William J. Bryant, Director of Division of Arkansas State Police

  
Major Lindsey Williams, Arkansas State Fire Marshal

Arkansas Hospital Association

  
Mr. Bo Ryal, President and Chief Operating Officer

Arkansas Department of Health

  
Jose R. Romero, MD, FAAP, FIDSA, FPIDS, FAAAS,  
Arkansas Secretary of Health, Director, Arkansas Department of Health


Arkansas Department of Human Services

  
Ms. Cindy Gillespie, Secretary, Department of Human Services

Arkansas Fire Chiefs' Association

  
Chief Chad Mosby

Arkansas Fire Marshals' Association

  
Battalion Chief/Eire Marshal Jason Wills

Code Officials of Arkansas Chapter of International Code Council ("ICC")

  
Ms. Jackie Baker

## PART 2—ADMINISTRATION AND ENFORCEMENT

SECTION 103  
CODE COMPLIANCE AGENCY

**[A] 103.1 Creation of enforcement agency.** Local jurisdictions are authorized to establish a department to be called the Building Department and the person in charge shall be known as the Building Official. The function of the agency shall be the implementation, administration and enforcement of the provisions of this code.

**[A] 103.2 Appointment.** The *building official* shall be appointed by the chief appointing authority of the jurisdiction.

**[A] 103.3 Deputies.** In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the *building official* shall have the authority to appoint a deputy building official, other related technical officers, inspectors and other employees. Such employees shall have powers as delegated by the *building official*.



## SCOPE AND ADMINISTRATION

## SECTION 104

### DUTIES AND POWERS OF BUILDING OFFICIAL

**[A] 104.1 General.** The *building official* is hereby authorized and directed to enforce the provisions of this code. The *building official* shall have the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions. Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code.

**[A] 104.2 Applications and permits.** The *building official* shall receive applications, review *construction documents* and issue *permits* for the erection, and *alteration*, demolition and moving of buildings and structures, inspect the premises for which such *permits* have been issued and enforce compliance with the provisions of this code.

**[A] 104.2.1 Determination of substantially improved or substantially damaged existing buildings and structures in flood hazard areas.** For applications for reconstruction, rehabilitation, *repair*, *alteration*, *addition* or other improvement of *existing buildings or structures* located in *flood hazard areas*, the *building official* shall determine if the proposed work constitutes *substantial improvement* or *repair* of *substantial damage*. Where the *building official* determines that the proposed work constitutes *substantial improvement* or *repair* of *substantial damage*, and where required by this code, the *building official* shall require the building to meet the requirements of Section 1612 or Section R322 of the *International Residential Code*, as applicable.

**[A] 104.3 Notices and orders.** The *building official* shall issue necessary notices or orders to ensure compliance with this code.

**[A] 104.4 Inspections.** The *building official* shall make the required inspections, or the *building official* shall have the authority to accept reports of inspection by *approved agencies* or individuals. Reports of such inspections shall be in writing and be certified by a responsible officer of such *approved agency* or by the responsible individual. The *building official* is authorized to engage such expert opinion as deemed necessary to report on unusual technical issues that arise, subject to the approval of the appointing authority.

**[A] 104.5 Identification.** The *building official* shall carry proper identification when inspecting structures or premises in the performance of duties under this code.

**[A] 104.6 Right of entry.** Where it is necessary to make an inspection to enforce the provisions of this code, or where the *building official* has reasonable cause to believe that there exists in a structure or on a premises a condition that is contrary to or in violation of this code that makes the structure or premises unsafe, *dangerous* or hazardous, the *building official* is authorized to enter the structure or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that if such structure or premises be occupied that credentials be presented to the occupant and entry requested. If such structure or premises is unoccupied, the *building official* shall first make a reason-

able effort to locate the *owner* or other person having charge or control of the structure or premises and request entry. If entry is refused, the *building official* shall have recourse to the remedies provided by law to secure entry.

**[A] 104.7 Department records.** The *building official* shall keep official records of applications received, *permits* and certificates issued, fees collected, reports of inspections, and notices and orders issued. Such records shall be retained in the official records for the period required for retention of public records.

**[A] 104.8 Liability.** The *building official*, member of the board of appeals or employee charged with the enforcement of this code, while acting for the jurisdiction in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance, shall not thereby be civilly or criminally rendered liable personally and is hereby relieved from personal liability for any damage accruing to persons or property as a result of any act or by reason of an act or omission in the discharge of official duties.

**[A] 104.8.1 Legal defense.** Any suit or criminal complaint instituted against an officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by legal representatives of the jurisdiction until the final termination of the proceedings. The *building official* or any subordinate shall not be liable for cost in any action, suit or proceeding that is instituted in pursuance of the provisions of this code.

**[A] 104.9 Approved materials and equipment.** Materials, equipment and devices *approved* by the *building official* shall be constructed and installed in accordance with such approval.

**[A] 104.9.1 Used materials and equipment.** Materials that are reused shall comply with the requirements of this code for new materials. Used equipment and devices shall not be reused unless *approved* by the *building official*.

**[A] 104.10 Modifications.** Where there are practical difficulties involved in carrying out the provisions of this code, the *building official* shall have the authority to grant modifications for individual cases, upon application of the *owner* or the owner's authorized agent, provided that the *building official* shall first find that special individual reason makes the strict letter of this code impractical, the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, *accessibility*, life and fire safety or structural requirements. The details of action granting modifications shall be recorded and entered in the files of the department of building safety.

**[A] 104.10.1 Flood hazard areas.** The *building official* shall not grant modifications to any provision required in *flood hazard areas* as established by Section 1612.3 unless a determination has been made that:

1. A showing of good and sufficient cause that the unique characteristics of the size, configuration or topography of the site render the elevation standards of Section 1612 inappropriate.



2. A determination that failure to grant the variance would result in exceptional hardship by rendering the lot undevelopable.
3. A determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, cause fraud on or victimization of the public, or conflict with existing laws or ordinances.
4. A determination that the variance is the minimum necessary to afford relief, considering the *flood hazard*.
5. Submission to the applicant of written notice specifying the difference between the *design flood elevation* and the elevation to which the building is to be built, stating that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced floor elevation, and stating that construction below the *design flood elevation* increases risks to life and property.

**[A] 104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. An alternative material, design or method of construction shall be *approved* where the *building official* finds that the proposed alternative meets all of the following:

1. The alternative material, design or method of construction is satisfactory and complies with the intent of the provisions of this code.
2. The material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code as it pertains to the following:
  - 2.1. Quality.
  - 2.2. Strength.
  - 2.3. Effectiveness.
  - 2.4. *Fire resistance*.
  - 2.5. Durability.
  - 2.6. Safety.

Where the alternative material, design or method of construction is not approved, the *building official* shall respond in writing, stating the reasons why the alternative was not approved.

**[A] 104.11.1 Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

**[A] 104.11.2 Tests.** Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as

evidence of compliance to be made without expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved agency*. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

**104.11.3 Performance-based options.** When acceptable to the *building official*, the most current edition of the *ICC Performance Code for Buildings and Facilities* or the *SFPE Engineering Guide to Performance-Based Fire Protection* may be followed.

## SECTION 105 PERMITS

**[A] 105.1 Required.** Any *owner* or owner's authorized agent who intends to construct, enlarge, alter, *repair*, move, demolish or change the occupancy of a building or structure, or to erect, install, enlarge, alter, *repair*, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be performed, shall first make application to the *building official* and obtain the required *permit*, where required. If there is no building official appointed, the owner, authorized agent or contractor shall make application to the State Fire Marshal.

**[A] 105.1.1 Annual permit.** Instead of an individual *permit* for each *alteration* to an already *approved* electrical, gas, mechanical or plumbing installation, the *building official* is authorized to issue an annual *permit* upon application therefor to any person, firm or corporation regularly employing one or more qualified tradespersons in the building, structure or on the premises owned or operated by the applicant for the *permit*.

**[A] 105.1.2 Annual permit records.** The person to whom an annual *permit* is issued shall keep a detailed record of *alterations* made under such annual *permit*. The *building official* shall have access to such records at all times or such records shall be filed with the *building official* as designated.

**[A] 105.2 Work exempt from permit.** Exemptions from *permit* requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this jurisdiction. *Permits* shall not be required for the following:

### Building:

1. One-story detached accessory structures used as tool and storage sheds, playhouses and similar uses, provided that the floor area is not greater than 120 square feet (11 m<sup>2</sup>).
2. Fences not over 7 feet (2134 mm) high.
3. Oil derricks.

## SCOPE AND ADMINISTRATION

4. Retaining walls that are not over 4 feet (1219 mm) in height measured from the bottom of the footing to the top of the wall, unless supporting a surcharge or impounding Class I, II or IIIA liquids.
5. Water tanks supported directly on grade if the capacity is not greater than 5,000 gallons (18 925 L) and the ratio of height to diameter or width is not greater than 2:1.
6. Sidewalks and driveways not more than 30 inches (762 mm) above adjacent grade, and not over any *basement* or *story* below and are not part of an *accessible route*.
7. Painting, papering, tiling, carpeting, cabinets, counter tops and similar finish work.
8. Temporary motion picture, television and theater stage sets and scenery.
9. Prefabricated *swimming pools* accessory to a Group R-3 occupancy that are less than 24 inches (610 mm) deep, are not greater than 5,000 gallons (18 925 L) and are installed entirely above ground.
10. Shade cloth structures constructed for nursery or agricultural purposes, not including service systems.
11. Swings and other playground equipment accessory to detached one- and two-family *dwelling*s.
12. Window awnings in Group R-3 and U occupancies, supported by an *exterior wall* that do not project more than 54 inches (1372 mm) from the *exterior wall* and do not require additional support.
13. Nonfixed and movable fixtures, cases, racks, counters and partitions not over 5 feet 9 inches (1753 mm) in height.

### Electrical:

1. **Repairs and maintenance:** Minor repair work, including the replacement of lamps or the connection of *approved* portable electrical equipment to *approved* permanently installed receptacles.
2. **Radio and television transmitting stations:** The provisions of this code shall not apply to electrical equipment used for radio and television transmissions, but do apply to equipment and wiring for a power supply and the installations of towers and antennas.
3. **Temporary testing systems:** A *permit* shall not be required for the installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.

### Gas:

1. Portable heating appliance.
2. Replacement of any minor part that does not alter approval of equipment or make such equipment unsafe.

### Mechanical:

1. Portable heating appliance.
2. Portable ventilation equipment.
3. Portable cooling unit.
4. Steam, hot or chilled water piping within any heating or cooling equipment regulated by this code.
5. Replacement of any part that does not alter its approval or make it unsafe.
6. Portable evaporative cooler.
7. Self-contained refrigeration system containing 10 pounds (4.54 kg) or less of refrigerant and actuated by motors of 1 horsepower (0.75 kW) or less.

### Plumbing:

1. The stopping of leaks in drains, water, soil, waste or vent pipe, provided, however, that if any concealed trap, drain pipe, water, soil, waste or vent pipe becomes defective and it becomes necessary to remove and replace the same with new material, such work shall be considered as new work and a *permit* shall be obtained and inspection made as provided in this code.
2. The clearing of stoppages or the repairing of leaks in pipes, valves or fixtures and the removal and reinstallation of water closets, provided that such repairs do not involve or require the replacement or rearrangement of valves, pipes or fixtures.

**[A] 105.2.1 Emergency repairs.** Where equipment replacements and repairs must be performed in an emergency situation, the *permit* application shall be submitted within the next working business day to the *building official*.

**[A] 105.2.2 Public service agencies.** A *permit* shall not be required for the installation, *alteration* or repair of generation, transmission, distribution or metering or other related equipment that is under the ownership and control of public service agencies by established right.

**[A] 105.3 Application for permit.** To obtain a *permit*, the applicant shall first file an application therefor in writing on a form furnished by the department of building safety for that purpose. Such application shall:

1. Identify and describe the work to be covered by the *permit* for which application is made.
2. Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.
3. Indicate the use and occupancy for which the proposed work is intended.
4. Be accompanied by *construction documents* and other information as required in Section 107.
5. State the valuation of the proposed work.

6. Be signed by the applicant, or the applicant's authorized agent.
7. Give such other data and information as required by the *building official*.

**[A] 105.3.1 Action on application.** The *building official* shall examine or cause to be examined applications for *permits* and amendments thereto within a reasonable time after filing. If the application or the *construction documents* do not conform to the requirements of pertinent laws, the *building official* shall reject such application in writing, stating the reasons therefor. If the *building official* is satisfied that the proposed work conforms to the requirements of this code and laws and ordinances applicable thereto, the *building official* shall issue a *permit* therefor as soon as practicable.

**[A] 105.3.2 Time limitation of application.** An application for a *permit* for any proposed work shall be deemed to have been abandoned 180 days after the date of filing, unless such application has been pursued in good faith or a *permit* has been issued; except that the *building official* is authorized to grant one or more extensions of time for additional periods not exceeding 90 days each. The extension shall be requested in writing and justifiable cause demonstrated.

**105.3.3 Permit issued on basis of an affidavit.** Whenever a permit is issued in reliance upon an affidavit or whenever the work to be covered by a permit involves installation under conditions which, in the opinion of the building official, are hazardous or complex, the building official shall require that the architect or engineer who signed the affidavit or prepared the drawings or computations shall supervise such work. In addition, he or she shall be responsible for conformity with the permit, provide copies of inspection reports as inspections are performed, and upon completion make and file with the building official a written affidavit that the work has been done in conformity with the reviewed plans and with the structural provisions of the technical codes. In the event such architect or engineer is not available, the owner shall employ in his/her stead a competent person or agency whose qualifications are reviewed by the building official.

**[A] 105.4 Validity of permit.** The issuance or granting of a *permit* shall not be construed to be a *permit* for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. *Permits* presuming to give authority to violate or cancel the provisions of this code or other ordinances of the jurisdiction shall not be valid. The issuance of a *permit* based on *construction documents* and other data shall not prevent the *building official* from requiring the correction of errors in the *construction documents* and other data. The *building official* is authorized to prevent occupancy or use of a structure where in violation of this code or of any other ordinances of this jurisdiction.

**[A] 105.5 Expiration.** Every *permit* issued shall become invalid unless the work on the site authorized by such *permit* is commenced within 180 days after its issuance, or if the

work authorized on the site by such *permit* is suspended or abandoned for a period of 180 days after the time the work is commenced. The *building official* is authorized to grant, in writing, one or more extensions of time, for periods not more than 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.

**[A] 105.6 Suspension or revocation.** The *building official* is authorized to suspend or revoke a *permit* issued under the provisions of this code wherever the *permit* is issued in error or on the basis of incorrect, inaccurate or incomplete information, or in violation of any ordinance or regulation or any of the provisions of this code.

**[A] 105.7 Placement of permit.** The building *permit* or copy shall be kept on the site of the work until the completion of the project.

## SECTION 106 FLOOR AND ROOF DESIGN LOADS

**[A] 106.1 Live loads posted.** In commercial or industrial buildings, for each floor or portion thereof designed for *live loads* exceeding 50 psf (2.40 kN/m<sup>2</sup>), such design *live loads* shall be conspicuously posted by the *owner* or the owner's authorized agent in that part of each *story* in which they apply, using durable signs. It shall be unlawful to remove or deface such notices.

**[A] 106.2 Issuance of certificate of occupancy.** A certificate of occupancy required by Section 111 shall not be issued until the floor load signs, required by Section 106.1, have been installed.

**[A] 106.3 Restrictions on loading.** It shall be unlawful to place, or cause or permit to be placed, on any floor or roof of a building, structure or portion thereof, a *load* greater than is permitted by this code.

## SECTION 107 CONSTRUCTION DOCUMENTS

**[A] 107.1 General.** Submittal documents consisting of *construction documents*, statement of *special inspections*, geotechnical report and other data shall be submitted in two or more sets, or in a digital format where allowed by the building official, with each *permit* application. The *construction documents* shall be prepared by a *registered design professional* where required by the statutes of the jurisdiction in which the project is to be constructed. Where special conditions exist, the *building official* is authorized to require additional *construction documents* to be prepared by a *registered design professional*. A *registered design professional*, an architect or engineer legally registered under the laws of this state regulating the practice of architecture or engineering, shall be required and shall affix his or her official seal to said drawings, specifications and accompanying data, for the following:

1. All Group A, E, and I occupancies, except Group A occupancies with an occupant load less than or equal to 50;



## SCOPE AND ADMINISTRATION

- 2. Buildings and structures 3 or more stories in height; and
- 3. Buildings and structures 5,000 square feet (464 m<sup>2</sup>) or more in area.

For all other buildings and structures, the submittal shall bear the certification of the applicant that some specific state law exception permits its preparation by a person not so registered.

**Exception:** The *building official* is authorized to waive the submission of *construction documents* and other data not required to be prepared by a *registered design professional* if it is found that the nature of the work applied for is such that review of *construction documents* is not necessary to obtain compliance with this code.

**[A] 107.2 Construction documents.** *Construction documents* shall be in accordance with Sections 107.2.1 through 107.2.8.

**[A] 107.2.1 Information on construction documents.** *Construction documents* shall be dimensioned and drawn on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *building official*. *Construction documents* shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations, as determined by the *building official*.

**[A] 107.2.2 Fire protection system shop drawings.** Shop drawings for the *fire protection systems* shall be submitted to indicate conformance to this code and the *construction documents* and shall be *approved* prior to the start of system installation. Shop drawings shall contain all information as required by the referenced installation standards in Chapter 9.

**[A] 107.2.3 Means of egress.** The *construction documents* shall show in sufficient detail the location, construction, size and character of all portions of the *means of egress* including the path of the exit discharge to the *public way* in compliance with the provisions of this code. In other than occupancies in Groups R-2, R-3, and I-1, the *construction documents* shall designate the number of occupants to be accommodated on every floor, and in all rooms and spaces.

**[A] 107.2.4 Exterior wall envelope.** *Construction documents* for all buildings shall describe the *exterior wall envelope* in sufficient detail to determine compliance with this code. The *construction documents* shall provide details of the *exterior wall envelope* as required, including flashing, intersections with dissimilar materials, corners, end details, control joints, intersections at roof, eaves or parapets, means of drainage, water-resistive barrier and details around openings.

The *construction documents* shall include manufacturer's installation instructions that provide supporting documentation that the proposed penetration and opening details described in the *construction documents* maintain the weather resistance of the *exterior wall envelope*. The

supporting documentation shall fully describe the *exterior wall* system that was tested, where applicable, as well as the test procedure used.

**[A] 107.2.5 Exterior balconies and elevated walking surfaces.** Where balconies or other elevated walking surfaces have *weather-exposed surfaces*, and the structural framing is protected by an impervious moisture barrier, the *construction documents* shall include details for all elements of the impervious moisture barrier system. The *construction documents* shall include manufacturer's installation instructions.

**[A] 107.2.6 Site plan.** The *construction documents* submitted with the application for *permit* shall be accompanied by a site plan showing to scale the size and location of new construction and *existing structures* on the *site*, distances from *lot lines*, the established street grades and the proposed finished grades and, as applicable, *flood hazard areas*, *floodways*, and *design flood elevations*; and it shall be drawn in accordance with an accurate boundary line survey. In the case of demolition, the *site plan* shall show construction to be demolished and the location and size of *existing structures* and construction that are to remain on the *site* or plot. The *building official* is authorized to waive or modify the requirement for a site plan where the application for *permit* is for *alteration* or *repair* or where otherwise warranted.

**[A] 107.2.6.1 Design flood elevations.** Where *design flood elevations* are not specified, they shall be established in accordance with Section 1612.3.1.

**[A] 107.2.7 Structural information.** The *construction documents* shall provide the information specified in Section 1603.

**107.2.8 Relocatable buildings.** *Construction documents* for *relocatable buildings* shall comply with Section 3113.

**107.2.9 Structural and fire-resistance integrity.** Plans for all buildings shall indicate how required structural and fire-resistance integrity will be maintained where a penetration of a required fire-resistant wall, floor, or partition will be made for electrical, gas, mechanical, plumbing and communication conduits, pipes, and systems. Such plans shall also indicate in sufficient detail how the fire integrity will be maintained where required fire-resistant floors intersect the exterior walls and where joints occur in required fire-resistant construction assemblies.

**107.2.10 Hazardous occupancies.** The building official may require the following:

1. **General site plan.** A general site plan drawn at a legible scale which shall include, but not be limited to, the location of all buildings, exterior storage facilities, permanent access ways, evacuation routes, parking lots, internal roads, chemical loading areas, equipment cleaning areas, storm and sanitary sewer accesses, emergency equipment and adjacent property uses. The exterior storage areas shall be identified with the hazard classes and the maximum quantities per hazard class of hazardous materials stored within.



2. **Building floor plan.** A building floor plan drawn to a legible scale which shall include, but not be limited to, all hazardous materials storage facilities within the building and shall indicate rooms, doorways, corridors, exits, fire-rated assemblies with their hourly rating, location of liquid-tight rooms, and evacuation routes. Each hazardous material storage facility shall be identified on the plan with the hazard classes and quantity range per hazard class of the hazardous materials stored within.

**107.2.11 Public and Assembly Occupancies.** Plans and specifications shall be submitted to the State Fire Marshal and their approval secured before construction or substantial remodeling of any of the following classes of building is started, or before a change in occupancy to one of the following classes is made, if not approved by the local authority having jurisdiction:

1. Asylums, hospitals, nursing or convalescent homes, or other health care facilities, regardless of capacity;
2. Schools and educational institutions having a capacity in excess of 50 pupils, and residence buildings, including dormitories, having sleeping accommodations for 50 or more persons;
3. Auditoriums, theaters, indoor stadiums, gymnasiums, churches or other places of assembly having a capacity in excess of 100 or more persons; or
4. Department stores or factories having a capacity in excess of 200 persons.

**107.2.12 Cover sheet and plan certification requirements.** Plans and specifications shall contain the following items and information when submitted to the State Fire Marshal's Office or Authority Having Jurisdiction:

1. An architect's stamp and signature or engineer's stamp and signature shall be placed on the front page of each plan submitted and an architect's stamp or engineer's stamp shall be placed on each subsequent page of the plans. Architects and engineers must be registered by the State of Arkansas.
2. The following paragraph shall be placed on the front page of the plans and blueprints with the registered architect's or engineer's signature:  
*"I hereby certify that these plans and specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these plans and specifications are as required by law and in compliance with the Arkansas Fire Prevention Code for the State of Arkansas."*
3. On the front page of the plans or blueprints, the following information is to be noted regarding the project:
  - (A) The occupancy classification(s) (Chapter 3, Volume II);

- (B) The type of construction (existing and proposed) (Chapter 6, Volume II) including sprinkler or non-sprinkler.
- (C) Allowable height and building area per floor (existing and proposed) (Table 503, Chapter 5 Volume II).
- (D) Floor areas and occupant loads (existing and proposed), as follows:
  - a. Area, gross floor (Chapter 2, Volume II) for each floor of all buildings, broken down by use and including a total.
  - b. Area, net floor (Chapter 3, Volume II) for the following occupancies:
    1. Assembly occupancies and uses;
    2. Day care;
    3. All educational occupancies (including uses above the 12th Grade).

When mixed occupancies exist, all occupancies and floor areas will be calculated and listed separately in accordance with the above guidelines.

- (E) Separation distances for each exterior wall to assumed and common property lines (Chapter 2, Volume II).
- (F) Exit access corridor and stair shaft enclosure protection requirements.
- (G) All rated construction assemblies including UL or other approved listing (Chapter 7, Volume II).
- (H) All firestop assemblies including UL or other approved listing (Section 714, Volume II).
- (I) Statement of Special Inspections including a complete list of required inspections. For large or complicated projects this item may be abbreviated and referenced to a complete statement in another location in the plans and specifications (Chapter 17 Volume II).
4. In accordance with Arkansas Act 1100 of 1991 (A.C.A. §§12-80-101 through §12-80-106 as amended), the structural plans of each public building and structure shall bear the following:
  - (A) Licensed Arkansas engineer's seal and signature;
  - (B) A statement of reference to what seismic zone the structure is designed to satisfy; and
  - (C) Information required by Chapter 16 of Volume II of the *Arkansas Fire Prevention Code*.

**[A] 107.3 Examination of documents.** The *building official* shall examine or cause to be examined the accompanying submittal documents and shall ascertain by such examinations whether the construction indicated and described is in accordance with the requirements of this code and other pertinent laws or ordinances.

SCOPE AND ADMINISTRATION

[A] **107.3.1 Approval of construction documents.** When the *building official* issues a *permit*, the *construction documents* shall be *approved*, in writing or by stamp, as “Reviewed for Code Compliance.” One set of *construction documents* so reviewed shall be retained by the *building official*. The other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection by the *building official* or a duly authorized representative.

[A] **107.3.2 Previous approvals.** This code shall not require changes in the *construction documents*, construction or designated occupancy of a structure for which a lawful *permit* has been heretofore issued or otherwise lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.

[A] **107.3.3 Phased approval.** The *building official* is authorized to issue a *permit* for the construction of foundations or any other part of a building or structure before the *construction documents* for the whole building or structure have been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such *permit* for the foundation or other parts of a building or structure shall proceed at the holder’s own risk with the building operation and without assurance that a *permit* for the entire structure will be granted.

[A] **107.3.4 Design professional in responsible charge.** Where it is required that documents be prepared by a *registered design professional*, the *building official* shall be authorized to require the *owner* or the *owner’s* authorized agent to engage and designate on the building *permit* application a *registered design professional* who shall act as the *registered design professional in responsible charge*. If the circumstances require, the *owner* or the *owner’s* authorized agent shall designate a substitute *registered design professional in responsible charge* who shall perform the duties required of the original *registered design professional in responsible charge*. The *building official* shall be notified in writing by the *owner* or the *owner’s* authorized agent if the *registered design professional in responsible charge* is changed or is unable to continue to perform the duties.

The *registered design professional in responsible charge* shall be responsible for reviewing and coordinating submittal documents prepared by others, including phased and deferred submittal items, for compatibility with the design of the building.

[A] **107.3.4.1 Deferred submittals.** Deferral of any submittal items shall have the prior approval of the *building official*. The *registered design professional in responsible charge* shall list the *deferred submittals* on the *construction documents* for review by the *building official*.

Documents for *deferred submittal* items shall be submitted to the *registered design professional in responsible charge* who shall review them and forward

them to the *building official* with a notation indicating that the *deferred submittal* documents have been reviewed and found to be in general conformance to the design of the building. The *deferred submittal* items shall not be installed until the *deferred submittal* documents have been *approved* by the *building official*.

[A] **107.4 Amended construction documents.** Work shall be installed in accordance with the *approved construction documents*, and any changes made during construction that are not in compliance with the *approved construction documents* shall be resubmitted for approval as an amended set of *construction documents*.

[A] **107.5 Retention of construction documents.** One set of *approved construction documents* shall be retained by the *building official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

**107.6 Affidavits.** The building official may accept a sworn or affirmed affidavit from a registered architect or engineer stating that the plans submitted conform to the technical codes. For buildings and structures, the affidavit shall state that the plans conform to the laws as to egress, type of construction, and general arrangement and, if accompanied by drawings, show the structural design and that the plans and design conform to the requirements of the technical codes as to strength, stresses, strains, loads and stability. The building official may without any examination or inspection accept such affidavit, provided the architect or engineer who made such affidavit agrees to submit to the building official copies of inspection reports as inspections are performed; and submits copies of inspection reports upon completion of the structure, electrical, gas, mechanical or plumbing systems with his/her certification that the structure, and each electrical, gas mechanical or plumbing system has been erected in accordance with the requirements of the technical codes. Where the building official relies upon such affidavit, the architect or engineer shall assume full responsibility for the compliance with all provisions of the technical codes and other pertinent laws or ordinances.

SECTION 108  
TEMPORARY STRUCTURES AND USES

[A] **108.1 General.** The *building official* is authorized to issue a *permit* for temporary structures and temporary uses. Such *permits* shall be limited as to time of service, but shall not be permitted for more than 180 days. The *building official* is authorized to grant extensions for demonstrated cause.

[A] **108.2 Conformance.** Temporary structures and uses shall comply with the requirements in Section 3103.

[A] **108.3 Temporary power.** The *building official* is authorized to give permission to temporarily supply and use power in part of an electric installation before such installation has been fully completed and the final certificate of completion has been issued. The part covered by the temporary certifi-

cate shall comply with the requirements specified for temporary lighting, heat or power in NFPA 70.

**[A] 108.4 Termination of approval.** The *building official* is authorized to terminate such *permit* for a temporary structure or use and to order the temporary structure or use to be discontinued.

## SECTION 109 FEES

**[A] 109.1 Payment of fees.** A *permit* shall not be valid until the fees prescribed by law have been paid, nor shall an amendment to a *permit* be released until the additional fee, if any, has been paid.

**[A] 109.2 Schedule of permit fees.** Where a *permit* is required, a fee for each *permit* shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**[A] 109.3 Permit valuations.** The applicant for a *permit* shall provide an estimated *permit* value at time of application. *Permit* valuations shall reflect the total value of work, including materials and labor, for which the *permit* is being issued, such as electrical, gas, mechanical, plumbing equipment and permanent systems. If, in the opinion of the *building official*, the valuation is underestimated on the application, the *permit* shall be denied, unless the applicant can show detailed estimates to meet the approval of the *building official*. Final building *permit* valuation shall be set by the *building official*.

**[A] 109.4 Work commencing before permit issuance.** Any person who commences any work before obtaining the necessary *permits* shall be subject to a fee established by the *building official* that shall be in addition to the required *permit* fees.

**[A] 109.5 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition for work done in connection to or concurrently with the work authorized by a building *permit* shall not relieve the applicant or holder of the *permit* from the payment of other fees that are prescribed by law.

**[A] 109.6 Refunds.** The *building official* is authorized to establish a refund policy.

## SECTION 110 INSPECTIONS

**[A] 110.1 General.** Construction or work for which a *permit* is required shall be subject to inspection by the *building official* and such construction or work shall remain visible and able to be accessed for inspection purposes until *approved*. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other ordinances of the jurisdiction. Inspections presuming to give authority to violate or cancel the provisions of this code or of other ordinances of the jurisdiction shall not be valid. It shall be the duty of the *owner* or the

*owner's* authorized agent to cause the work to remain visible and able to be accessed for inspection purposes. Neither the *building official* nor the jurisdiction shall be liable for expense entailed in the removal or replacement of any material required to allow inspection.

**[A] 110.2 Preliminary inspection.** Before issuing a *permit*, the *building official* is authorized to examine or cause to be examined buildings, structures and *sites* for which an application has been filed.

**[A] 110.3 Required inspections.** The *building official*, upon notification, shall make the inspections set forth in Sections 110.3.1 through 110.3.12.

**[A] 110.3.1 Footing and foundation inspection.** Footing and foundation inspections shall be made after excavations for footings are complete and any required reinforcing steel is in place. For concrete foundations, any required forms shall be in place prior to inspection. Materials for the foundation shall be on the job, except where concrete is ready mixed in accordance with ASTM C94, the concrete need not be on the job.

**[A] 110.3.2 Concrete slab and under-floor inspection.** Concrete slab and under-floor inspections shall be made after in-slab or under-floor reinforcing steel and building service equipment, conduit, piping accessories and other ancillary equipment items are in place, but before any concrete is placed or floor sheathing installed, including the subfloor.

**[A] 110.3.3 Lowest floor elevation.** In *flood hazard areas*, upon placement of the *lowest floor*, including the *basement*, and prior to further vertical construction, the elevation certification required in Section 1612.4 or the *International Residential Code*, as applicable, shall be submitted to the *building official*.

**[A] 110.3.4 Frame inspection.** Framing inspections shall be made after the roof deck or sheathing, all framing, *fire-blocking* and bracing are in place and pipes, chimneys and vents to be concealed are complete and the rough electrical, plumbing, heating wires, pipes and ducts are *approved*.

**[A] 110.3.5 Types IV-A, IV-B and IV-C connection protection inspection.** In buildings of Types IV-A, IV-B and IV-C construction, where connection *fire-resistance ratings* are provided by wood cover calculated to meet the requirements of Section 2304.10.1, inspection of the wood cover shall be made after the cover is installed, but before any other coverings or finishes are installed.

**[A] 110.3.6 Lath, gypsum board and gypsum panel product inspection.** Lath, *gypsum board* and *gypsum panel product* inspections shall be made after lathing, *gypsum board* and *gypsum panel products*, interior and exterior, are in place, but before any plastering is applied or *gypsum board* and *gypsum panel product* joints and fasteners are taped and finished.



## SCOPE AND ADMINISTRATION

**Exception:** *Gypsum board and gypsum panel products* that are not part of a fire-resistance-rated assembly or a shear assembly.

**[A] 110.3.7 Weather-exposed balcony and walking surface waterproofing.** Where balconies or other elevated walking surfaces have *weather-exposed surfaces*, and the structural framing is protected by an impervious moisture barrier, all elements of the impervious moisture barrier system shall not be concealed until inspected and *approved*.

**Exception:** Where *special inspections* are provided in accordance with Section 1705.1.1, Item 3.

**[A] 110.3.8 Fire- and smoke-resistant penetrations.** Protection of joints and penetrations in fire-resistance-rated assemblies, *smoke barriers* and *smoke partitions* shall not be concealed from view until inspected and *approved*.

**[A] 110.3.9 Energy efficiency inspections.** Inspections shall be made to determine compliance with Chapter 13 and shall include, but not be limited to, inspections for: envelope insulation *R*- and *U*-values, *fenestration U*-value, duct system *R*-value, and HVAC and water-heating equipment efficiency.

**[A] 110.3.10 Other inspections.** In addition to the inspections specified in Sections 110.3.1 through 110.3.9, the *building official* is authorized to make or require other inspections of any construction work to ascertain compliance with the provisions of this code and other laws that are enforced by the department of building safety.

**[A] 110.3.11 Special inspections.** For *special inspections*, see Chapter 17.

**[A] 110.3.12 Final inspection.** The final inspection shall be made after all work required by the building *permit* is completed.

**[A] 110.3.12.1 Flood hazard documentation.** If located in a *flood hazard area*, documentation of the elevation of the *lowest floor* as required in Section 1612.4 shall be submitted to the *building official* prior to the final inspection.

**[A] 110.4 Inspection agencies.** The *building official* is authorized to accept reports of *approved* inspection agencies, provided that such agencies satisfy the requirements as to qualifications and reliability.

**[A] 110.5 Inspection requests.** It shall be the duty of the holder of the building *permit* or their duly authorized agent to notify the *building official* when work is ready for inspection. It shall be the duty of the *permit* holder to provide access to and means for inspections of such work that are required by this code.

**[A] 110.6 Approval required.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *building official*. The *building official*, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or notify the *permit* holder or the *permit* holder's agent wherein the

same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the *building official*.

## SECTION 111 CERTIFICATE OF OCCUPANCY

**[A] 111.1 Change of occupancy.** A building or structure shall not be used or occupied in whole or in part, and a *change of occupancy* of a building or structure or portion thereof shall not be made, until the *building official* has issued a certificate of occupancy therefor as provided herein. Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the *jurisdiction*. Certificates presuming to give authority to violate or cancel the provisions of this code or other ordinances of the *jurisdiction* shall not be valid.

**Exception:** Certificates of occupancy are not required for work exempt from *permits* in accordance with Section 105.2.

**[A] 111.2 Certificate issued.** After the *building official* inspects the building or structure and does not find violations of the provisions of this code or other laws that are enforced by the department, the *building official* shall issue a certificate of occupancy that contains the following:

1. The *permit* number.
2. The address of the structure.
3. The name and address of the *owner* or the owner's authorized agent.
4. A description of that portion of the structure for which the certificate is issued.
5. A statement that the described portion of the structure has been inspected for compliance with the requirements of this code.
6. The name of the *building official*.
7. The edition of the code under which the *permit* was issued.
8. The use and occupancy, in accordance with the provisions of Chapter 3.
9. The type of construction as defined in Chapter 6.
10. The design *occupant load*.
11. Where an *automatic sprinkler system* is provided, whether the sprinkler system is required.
12. Any special stipulations and conditions of the building *permit*.

**[A] 111.3 Temporary occupancy.** The *building official* is authorized to issue a temporary certificate of occupancy before the completion of the entire work covered by the *permit*, provided that such portion or portions shall be occupied safely. The *building official* shall set a time period during which the temporary certificate of occupancy is valid.



[A] **111.4 Revocation.** The *building official* is authorized to suspend or revoke a certificate of occupancy or completion issued under the provisions of this code, in writing, wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the building or structure or portion thereof is in violation of the provisions of this code or other ordinance of the *jurisdiction*.

## SECTION 112 SERVICE UTILITIES

[A] **112.1 Connection of service utilities.** A person shall not make connections from a utility, a source of energy, fuel, or power, or a water system or sewer system to any building or system that is regulated by this code for which a *permit* is required, until approved by the *building official*.

[A] **112.2 Temporary connection.** The *building official* shall have the authority to authorize the temporary connection of the building or system to the utility, the source of energy, fuel, or power, or the water system or sewer system for the purpose of testing systems or for use under a temporary approval.

[A] **112.3 Authority to disconnect service utilities.** The *building official* shall have the authority to authorize disconnection of utility service to the building, structure or system regulated by this code and the referenced codes and standards in case of emergency where necessary to eliminate an immediate hazard to life or property or where such utility connection has been made without the approval required by Section 112.1 or 112.2. The *building official* shall notify the serving utility, and wherever possible the *owner* or the owner's authorized agent and occupant of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnecting, the *owner* or the owner's authorized agent or occupant of the building, structure or service system shall be notified in writing, as soon as practical thereafter.

## SECTION 113 MEANS OF APPEALS

[A] **113.1 General.** In order to hear and decide appeals of orders, decisions or determinations made by the *building official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The board of appeals shall be appointed by the applicable governing authority and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *building official*.

[A] **113.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equivalent or better form of construction is proposed. The board shall not have authority to waive requirements of this code or interpret the administration of this code.

[A] **113.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training to pass on matters pertaining to building construction and are not employees of the jurisdiction.

[A] **113.4 Administration.** The *building official* shall take immediate action in accordance with the decision of the board.

## SECTION 114 VIOLATIONS

[A] **114.1 Unlawful acts.** It shall be unlawful for any person, firm or corporation to erect, construct, alter, extend, *repair*, move, remove, demolish or occupy any building, structure or equipment regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

[A] **114.2 Notice of violation.** The *building official* is authorized to serve a notice of violation or order on the person responsible for the erection, construction, *alteration*, extension, *repair*, moving, removal, demolition or occupancy of a building or structure in violation of the provisions of this code, or in violation of a *permit* or certificate issued under the provisions of this code. Such order shall direct the discontinuance of the illegal action or condition and the abatement of the violation.

[A] **114.3 Prosecution of violation.** If the notice of violation is not complied with promptly, the *building official* is authorized to request the legal counsel of the jurisdiction to institute the appropriate proceeding at law or in equity to restrain, correct or abate such violation, or to require the removal or termination of the unlawful occupancy of the building or structure in violation of the provisions of this code or of the order or direction made pursuant thereto.

[A] **114.4 Violation penalties.** Any person who violates a provision of this code or fails to comply with any of the requirements thereof or who erects, constructs, alters or repairs a building or structure in violation of the *approved construction documents* or directive of the *building official*, or of a *permit* or certificate issued under the provisions of this code, shall be subject to penalties as prescribed by law.

## SECTION 115 STOP WORK ORDER

[A] **115.1 Authority.** Where the *building official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a *dangerous* or unsafe manner, the *building official* is authorized to issue a stop work order.

[A] **115.2 Issuance.** The stop work order shall be in writing and shall be given to the *owner* of the property, the owner's authorized agent or the person performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order and the conditions under which the cited work is authorized to resume.

## SCOPE AND ADMINISTRATION

**[A] 115.3 Emergencies.** Where an emergency exists, the *building official* shall not be required to give a written notice prior to stopping the work.

**[A] 115.4 Failure to comply.** Any person who shall continue any work after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be subject to fines established by the authority having *jurisdiction*.

or cause to be abated or corrected such unsafe conditions either by repair, rehabilitation, demolition or other approved corrective action. To the extent that repairs, *alterations* or *additions* are made or a *change of occupancy* occurs during the restoration of the structure, such *repairs, alterations, additions* and *change of occupancy* shall comply with the requirements of the *International Existing Building Code*.

## SECTION 116 UNSAFE STRUCTURES AND EQUIPMENT

**[A] 116.1 Unsafe conditions.** Structures or existing equipment that are or hereafter become unsafe, insanitary or deficient because of inadequate *means of egress* facilities, inadequate light and *ventilation*, or that constitute a fire hazard, or are otherwise *dangerous* to human life or the public welfare, or that involve illegal or improper occupancy or inadequate maintenance, shall be deemed an unsafe condition. Unsafe structures shall be taken down and removed or made safe, as the *building official* deems necessary and as provided for in this section. A vacant structure that is not secured against unauthorized entry shall be deemed unsafe.

**[A] 116.2 Record.** The *building official* shall cause a report to be filed on an unsafe condition. The report shall state the occupancy of the structure and the nature of the unsafe condition.

**[A] 116.3 Notice.** If an unsafe condition is found, the *building official* shall serve on the *owner* of the structure, or the owner's authorized agent, a written notice that describes the condition deemed unsafe and specifies the required repairs or improvements to be made to abate the unsafe condition, or that requires the unsafe structure to be demolished within a stipulated time. Such notice shall require the person thus notified to declare immediately to the *building official* acceptance or rejection of the terms of the order.

**[A] 116.4 Method of service.** Such notice shall be deemed properly served where a copy thereof is served in accordance with one of the following methods:

1. A copy is delivered to the *owner* personally.
2. A copy is sent by certified or registered mail addressed to the *owner* at the last known address with the return receipt requested.
3. A copy is delivered in any other manner as prescribed by local law.

If the certified or registered letter is returned showing that the letter was not delivered, a copy thereof shall be posted in a conspicuous place in or about the structure affected by such notice. Service of such notice in the foregoing manner on the owner's authorized agent shall constitute service of notice on the *owner*.

**[A] 116.5 Restoration or abatement.** Where the structure or equipment determined to be unsafe by the *building official* is restored to a safe condition, the owner, the owner's authorized agent, operator or occupant of a structure, premises or equipment deemed unsafe by the *building official* shall abate

## CHAPTER 2

# DEFINITIONS

### User notes:

**About this chapter:** Codes, by their very nature, are technical documents. Every word, term and punctuation mark can add to or change the meaning of a technical requirement. It is necessary to maintain a consensus on the specific meaning of each term contained in the code. Chapter 2 performs this function by stating clearly what specific terms mean for the purposes of the code.

**Code development reminder:** Code change proposals to sections preceded by the designation [A] or [BS] will be considered by one of the code development committees meeting during the 2022 (Group B) Code Development Cycle.

### SECTION 201 GENERAL

**201.1 Scope.** Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings shown in this chapter.

**201.2 Interchangeability.** Words used in the present tense include the future; words stated in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

**201.3 Terms defined in other codes.** Where terms are not defined in this code and are defined in the *International Energy Conservation Code*, *International Fuel Gas Code*, *International Fire Code*, *International Mechanical Code* or *International Plumbing Code*, such terms shall have the meanings ascribed to them as in those codes, as amended by the State of Arkansas.

**201.4 Terms not defined.** Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

### SECTION 202 DEFINITIONS

**[BG] 24-HOUR BASIS.** The actual time that a person is an occupant within a facility for the purpose of receiving care. It shall not include a facility that is open for 24 hours and is capable of providing care to someone visiting the facility during any segment of the 24 hours.

**[BS] AAC MASONRY.** *Masonry* made of autoclaved aerated concrete (AAC) units, manufactured without internal reinforcement and bonded together using thin- or thick-bed mortar.

**[BE] ACCESSIBLE.** A site, *building*, *facility* or portion thereof that complies with Chapter 11.

**[BE] ACCESSIBLE MEANS OF EGRESS.** A continuous and unobstructed way of egress travel from any accessible point in a *building* or *facility* to a *public way*.

**[BE] ACCESSIBLE ROUTE.** A continuous, unobstructed path that complies with Chapter 11.

**[BE] ACCESSIBLE UNIT.** A *dwelling unit* or *sleeping unit* that complies with this code and the provisions for *Accessible units* in ICC A117.1.

**[BS] ACCREDITATION BODY.** An *approved*, third-party organization that is independent of the grading and inspection agencies, and the lumber mills, and that initially accredits and subsequently monitors, on a continuing basis, the competency and performance of a grading or inspection agency related to carrying out specific tasks.

**[A] ADDITION.** An extension or increase in floor area, number of *stories* or height of a building or structure.

**[BS] ADHERED MASONRY VENEER.** *Veneer* secured and supported through the adhesion of an *approved* bonding material applied to an *approved* backing.

**[BS] ADOBE CONSTRUCTION.** Construction in which the exterior *load-bearing* and *nonload-bearing walls* and partitions are of unfired clay *masonry units*, and floors, roofs and interior framing are wholly or partly of wood or other *approved* materials.

**Adobe, stabilized.** Unfired clay *masonry units* to which admixtures, such as emulsified asphalt, are added during the manufacturing process to limit the units' water absorption so as to increase their durability.

**Adobe, unstabilized.** Unfired clay *masonry units* that do not meet the definition of "Adobe, stabilized."

**[F] AEROSOL CONTAINER.** A metal can or plastic container up to a maximum size of 33.8 fluid ounces (1000 ml), or a glass bottle up to a maximum size of 4 fluid ounces (118 ml), designed and intended to dispense an aerosol.

**[F] AEROSOL PRODUCT.** A combination of a container, a propellant and a material that is dispensed. Aerosol products shall be classified by means of the calculation of their chemical heats of combustion and shall be designated Level 1, Level 2 or Level 3.

**Level 1 aerosol products.** Those with a total chemical heat of combustion that is less than or equal to 8,600 British thermal units per pound (Btu/lb) (20 kJ/g).

**Level 2 aerosol products.** Those with a total chemical heat of combustion that is greater than 8,600 Btu/lb (20 kJ/g), but less than or equal to 13,000 Btu/lb (30 kJ/g).

## DEFINITIONS

**Level 3 aerosol products.** Those with a total chemical heat of combustion that is greater than 13,000 Btu/lb (30 kJ/g).

**[BS] AGGREGATE.** In roofing, crushed stone, crushed slag or water-worn gravel used for surfacing for *roof coverings*.

**[BG] AGRICULTURAL BUILDING.** A structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products. This structure shall not be a place of human habitation or a place of employment where agricultural products are processed, treated or packaged, nor shall it be a place used by the public.

**[BF] AIR-IMPERMEABLE INSULATION.** An insulation having an air permeance equal to or less than  $0.02 \text{ l/s} \times \text{m}^2$  at 75 pa pressure differential tested in accordance with ASTM E283 or ASTM E2178.

**[BG] AIR-INFLATED STRUCTURE.** A structure that uses air-pressurized membrane beams, arches or other elements to enclose space. Occupants of such a structure do not occupy the pressurized area used to support the structure.

**[BG] AIR-SUPPORTED STRUCTURE.** A structure wherein the shape of the structure is attained by air pressure and occupants of the structure are within the elevated pressure area. *Air-supported structures* are of two basic types:

**Double skin.** Similar to a single skin, but with an attached liner that is separated from the outer skin and provides an airspace which serves for insulation, acoustic, aesthetic or similar purposes.

**Single skin.** Where there is only the single outer skin and the air pressure is directly against that skin.

**[BE] AISLE.** An unenclosed *exit access* component that defines and provides a path of egress travel.

**[BE] AISLE ACCESSWAY.** That portion of an *exit access* that leads to an *aisle*.

**[F] ALARM NOTIFICATION APPLIANCE.** A *fire alarm system* component such as a bell, horn, speaker, light or text display that provides audible, tactile or visible outputs, or any combination thereof.

**[F] ALARM SIGNAL.** A signal indicating an emergency requiring immediate action, such as a signal indicative of fire.

**[F] ALARM VERIFICATION FEATURE.** A feature of *automatic* fire detection and alarm systems to reduce unwanted alarms wherein *smoke detectors* report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period, after being automatically reset, in order to be accepted as a valid alarm-initiation signal.

**[BS] ALLOWABLE STRESS DESIGN.** A method of proportioning structural members, such that elastically computed stresses produced in the members by *nominal loads* do not exceed *specified* allowable stresses (also called “working stress design”).

**[A] ALTERATION.** Any construction or renovation to an *existing structure* other than *repair* or *addition*.

**[BE] ALTERNATING TREAD DEVICE.** A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.

**[BG] AMBULATORY CARE FACILITY.** Buildings or portions thereof used to provide medical, surgical, psychiatric, nursing or similar care on a less than *24-hour basis* to persons who are rendered *incapable of self-preservation* by the services provided or staff has accepted responsibility for care recipients already incapable.

**[BG] ANCHOR BUILDING.** An exterior perimeter building of a group other than H having direct access to a *covered* or *open mall building* but having required *means of egress* independent of the mall.

**[BS] ANCHORED MASONRY VENEER.** *Veneer* secured with *approved* mechanical fasteners to an *approved* backing.

**[BF] ANNULAR SPACE.** The opening around the penetrating item.

**[F] ANNUNCIATOR.** A unit containing one or more indicator lamps, alphanumeric displays or other equivalent means in which each indication provides status information about a circuit, condition or location.

**[A] APPROVED.** Acceptable to the *building official*.

**[A] APPROVED AGENCY.** An established and recognized agency that is regularly engaged in conducting tests, furnishing inspection services or furnishing product certification where such agency has been *approved* by the *building official*.

**[BS] APPROVED FABRICATOR.** An established and qualified person, firm or corporation *approved* by the *building official* pursuant to Chapter 17 of this code.

**[A] APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

**[BS] AREA (for masonry).**

**Gross cross-sectional.** The *area* delineated by the out-to-out *specified dimensions* of *masonry* in the plane under consideration.

**Net cross-sectional.** The *area* of *masonry units*, grout and mortar crossed by the plane under consideration based on out-to-out *specified dimensions*.

**[BG] AREA, BUILDING.** The area included within surrounding *exterior walls*, or *exterior walls* and *fire walls*, exclusive of vent *shafts* and *courts*. Areas of the building not provided with surrounding walls shall be included in the *building area* if such areas are included within the horizontal projection of the roof or floor above.

**[BE] AREA OF REFUGE.** An area where persons unable to use *stairways* can remain temporarily to await instructions or assistance during emergency evacuation.

**[BE] AREA OF SPORT ACTIVITY.** That portion of an indoor or outdoor space where the play or practice of a sport occurs.



## DEFINITIONS

**[BG] AREAWAY.** A subsurface space adjacent to a building open at the top or protected at the top by a grating or guard.

**ASSEMBLY SEATING, MULTILEVEL.** See “*Multilevel assembly seating*.”

**[BG] ATRIUM.** A vertical space that is closed at the top, connecting two or more *stories* in Group I-2 and I-3 occupancies or three or more *stories* in all other occupancies.

**[BG] ATTIC.** The space between the ceiling framing of the top *story* and the underside of the roof.

**[F] AUDIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of hearing.

**[F] AUTOMATIC.** As applied to fire protection devices, a device or system providing an emergency function without the necessity for human intervention and activated as a result of a predetermined temperature rise, rate of temperature rise or combustion products.

**[F] AUTOMATIC FIRE-EXTINGUISHING SYSTEM.** An *approved* system of devices and equipment which automatically detects a fire and discharges an *approved* fire-extinguishing agent onto or in the area of a fire.

**[F] AUTOMATIC SMOKE DETECTION SYSTEM.** A *fire alarm system* that has initiation devices that utilize *smoke detectors* for protection of an area such as a room or space with detectors to provide early warning of fire.

**[F] AUTOMATIC SPRINKLER SYSTEM.** An *automatic sprinkler system*, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The system includes a suitable water supply. The portion of the system above the ground is a network of specially sized or hydraulically designed piping installed in a structure or area, generally overhead, and to which *automatic* sprinklers are connected in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the *fire area*.

**[F] AUTOMATIC WATER MIST SYSTEM.** A system consisting of a water supply, a pressure source and a distribution piping system with attached nozzles, which, at or above a minimum operating pressure defined by its listing, discharges water in fine droplets meeting the requirements of NFPA 750 for the purpose of the control, suppression or extinguishment of a fire. Such systems include wet-pipe, dry-pipe and preaction types. The systems are designed as engineered, preengineered, local-application or total-flooding systems.

**[F] AVERAGE AMBIENT SOUND LEVEL.** The root mean square, A-weighted sound pressure level measured over a 24-hour period, or the time any person is present, whichever time period is less.

**[BG] AWNING.** An architectural projection that provides weather protection, identity or decoration and is partially or wholly supported by the building to which it is attached. An awning is composed of a lightweight *frame structure* over which a covering is attached.

**[BF] BACKING.** The wall or surface to which the *veneer* is secured.

**[BE] BALANCED DOOR.** A door equipped with double-pivoted hardware so designed as to cause a semicounterbalanced swing action when opening.

**[F] BALED COTTON.** A natural seed fiber wrapped in and secured with industry accepted materials, usually consisting of burlap, woven polypropylene, polyethylene or cotton or sheet polyethylene, and secured with steel, synthetic or wire bands or wire; also includes linters (lint removed from the cottonseed) and motes (residual materials from the ginning process).

**[F] BALED COTTON, DENSELY PACKED.** Cotton made into banded bales with a packing density of not less than 22 pounds per cubic foot (360 kg/m<sup>3</sup>), and dimensions complying with the following: a length of 55 inches (1397 mm), a width of 21 inches (533.4 mm) and a height of 27.6 to 35.4 inches (701 to 899 mm).

**[BS] BALLAST.** In roofing, *ballast* comes in the form of large stones or paver systems or light-weight interlocking paver systems and is used to provide uplift resistance for roofing systems that are not adhered or mechanically attached to the roof deck.

**[F] BARRICADE.** A structure that consists of a combination of walls, floor and roof, which is designed to withstand the rapid release of energy in an *explosion* and which is fully confined, partially vented or fully vented; or other effective method of shielding from *explosive* materials by a natural or artificial barrier.

**Artificial barricade.** An artificial mound or revetment a minimum thickness of 3 feet (914 mm).

**Natural barricade.** Natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures that require protection cannot be seen from the magazine or building containing *explosives* when the trees are bare of leaves.

**[BS] BASE FLOOD.** The *flood* having a 1-percent chance of being equaled or exceeded in any given year.

**[BS] BASE FLOOD ELEVATION.** The elevation of the *base flood*, including wave height, relative to the National Geodetic Vertical Datum (NGVD), North American Vertical Datum (NAVD) or other datum specified on the *Flood Insurance Rate Map* (FIRM).

**[BG] BASEMENT.** A *story* that is not a *story above grade plane* (see “*Story above grade plane*”). This definition of “Basement” does not apply to the provisions of Section 1612 for *flood loads*.

**[BS] BASEMENT (for flood loads).** The portion of a building having its floor subgrade (below ground level) on all sides. This definition of “Basement” is limited in application to the provisions of Section 1612.

**[BS] BEARING WALL STRUCTURE.** A building or other structure in which vertical *loads* from floors and roofs are primarily supported by walls.

**[BS] BED JOINT.** The horizontal layer of *mortar* on which a *masonry unit* is laid.

## DEFINITIONS

**[BE] BLEACHERS.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a *building element* (see “*Grandstand*”).

**[BG] BOARDING HOUSE.** A building arranged or used for lodging for compensation, with or without meals, and not occupied as a single-family unit.

**[F] BOILING POINT.** The temperature at which the vapor pressure of a *liquid* equals the atmospheric pressure of 14.7 pounds per square inch (psia) (101 kPa) or 760 mm of mercury. Where an accurate boiling point is unavailable for the material in question, or for mixtures which do not have a constant boiling point, for the purposes of this classification, the 20-percent evaporated point of a distillation performed in accordance with ASTM D86 shall be used as the boiling point of the *liquid*.

**[BS] BRACED WALL LINE.** A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.

**[BS] BRACED WALL PANEL.** A full-height section of wall constructed to resist in-plane shear *loads* through interaction of framing members, sheathing material and anchors. The panel’s length meets the requirements of its particular bracing method and contributes toward the total amount of bracing required along its *braced wall line*.

**[BE] BREAKOUT.** For revolving doors, a process whereby wings or door panels can be pushed open manually for *means of egress* travel.

**[BS] BRICK.**

**Calcium silicate (sand lime brick).** A pressed and subsequently autoclaved unit that consists of sand and lime, with or without the inclusion of other materials.

**Clay or shale.** A solid or hollow *masonry unit* of *clay* or *shale*, usually formed into a rectangular *prism*, then burned or fired in a kiln; *brick* is a ceramic product.

**Concrete.** A concrete *masonry unit* made from Portland cement, water, and suitable aggregates, with or without the inclusion of other materials.

**[A] BUILDING.** Any structure utilized or intended for supporting or sheltering any occupancy.

**BUILDING AREA.** See “*Area, building*.”

**[BG] BUILDING ELEMENT.** A fundamental component of building construction, specified in TABLE 601, which may or may not be of fire-resistance-rated construction and is constructed of materials based on the building type of construction.

**BUILDING HEIGHT.** See “*Height, building*.”

**[BG] BUILDING LINE.** The line established by law, beyond which a building shall not extend, except as specifically provided by law.

**[A] BUILDING OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative.

**[BS] BUILDING-INTEGRATED PHOTOVOLTAIC (BIPV) PRODUCT.** A building product that incorporates *photovoltaic modules* and functions as a component of the building envelope.

**[BS] BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL (BIPV ROOF PANEL).** A *photovoltaic panel* that functions as a component of the building envelope.

**[BS] BUILT-UP ROOF COVERING.** Two or more layers of felt cemented together and surfaced with a cap sheet, mineral *aggregate*, smooth coating or similar surfacing material.

**[BG] CANOPY.** A permanent structure or architectural projection of rigid construction over which a covering is attached that provides weather protection, identity or decoration. A *canopy* is permitted to be structurally independent or supported by attachment to a building on one or more sides.

**[F] CAPACITOR ENERGY STORAGE SYSTEM.** A stationary, rechargeable energy storage system consisting of capacitors, chargers, controls and associated electrical equipment designed to provide electrical power to a building or facility. The system is typically used to provide standby or emergency power, an uninterruptible power supply, load shedding, load sharing or similar capabilities.

**[F] CARBON DIOXIDE EXTINGUISHING SYSTEMS.** A system supplying carbon dioxide (CO<sub>2</sub>) from a pressurized vessel through fixed pipes and nozzles. The system includes a manual- or *automatic*-actuating mechanism.

**[F] CARBON MONOXIDE ALARM.** A single- or multiple-station alarm intended to detect carbon monoxide gas and alert occupants by a distinct audible signal. It incorporates a sensor, control components and an alarm notification appliance in a single unit.

**[F] CARBON MONOXIDE DETECTOR.** A device with an integral sensor to detect carbon monoxide gas and transmit an alarm signal to a connected alarm control unit.

**[BG] CARE SUITE.** In Group I-2 occupancies, a group of treatment rooms, care recipient sleeping rooms and the support rooms or spaces and circulation space within the suite where staff are in attendance for supervision of all care recipients within the suite, and the suite is in compliance with the requirements of Section 407.4.4.

**[BS] CAST STONE.** A building stone manufactured from Portland cement concrete precast and used as a *trim*, *veneer* or facing on or in buildings or structures.

**[F] CEILING LIMIT.** The maximum concentration of an airborne contaminant to which one may be exposed. The ceiling limits utilized are those published in DOL 29 CFR Part 1910.1000. The ceiling Recommended Exposure Limit (REL-C) concentrations published by the US National Institute for Occupational Safety and Health (NIOSH), Threshold Limit Value—Ceiling (TLV-C) concentrations published by the American Conference of Governmental Industrial Hygienists (ACGIH), Ceiling Workplace Environmental Exposure Level (WEEL-Ceiling) Guides published by the American Industrial Hygiene Association (AIHA), and other

*approved*, consistent measures are allowed as surrogates for hazardous substances not listed in DOL 29 CFR Part 1910.1000.

**[BF] CEILING RADIATION DAMPER.** A *listed* device installed in a ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly to limit automatically the radiative heat transfer through an air inlet/outlet opening. Ceiling radiation dampers include air terminal units, ceiling dampers and ceiling air diffusers. Ceiling radiation dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic ceiling radiation damper is tested and rated for closure under elevated temperature airflow.

**[BG] CELL (Group I-3 occupancy).** A room within a *housing unit* in a detention or correctional facility used to confine inmates or prisoners.

**[BS] CELL (masonry).** A void space having a gross cross-sectional *area* greater than 1½ square inches (967 mm²).

**[BG] CELL TIER.** Levels of *cells* vertically stacked above one another within a *housing unit*.

**[BS] CEMENT PLASTER.** A mixture of Portland or blended cement, Portland cement or blended cement and hydrated lime, *masonry* cement or plastic cement and aggregate and other *approved* materials as specified in this code.

**[BF] CERAMIC FIBER BLANKET.** A high-temperature mineral wool insulation material made of alumina-silica ceramic or calcium magnesium silicate soluble fibers and weighing 4 to 10 pounds per cubic foot (pcf) (64 to 160 kg/m³).

**[BS] CERTIFICATE OF COMPLIANCE.** A certificate stating that materials and products meet specified standards or that work was done in compliance with *approved construction documents*.

**[A] CHANGE OF OCCUPANCY.** Either of the following shall be considered as a change of occupancy where this code requires a greater degree of safety, accessibility, structural strength, fire protection, *means of egress*, ventilation or sanitation than is existing in the current building or structure:

1. Any change in the occupancy classification of a building or structure.
2. Any change in the purpose of, or a change in the level of activity within, a building or structure.

**[M] CHIMNEY.** A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning appliance to the outdoor atmosphere.

**Factory-built chimney.** A *listed* and *labeled* chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

**Masonry chimney.** A field-constructed chimney composed of solid *masonry units*, bricks, stones, or concrete.

**Metal chimney.** A field-constructed chimney of metal.

## **[M] CHIMNEY TYPES.**

**High-heat appliance type.** An *approved* chimney for removing the products of combustion from fuel-burning, high-heat appliances producing combustion gases in excess of 2,000°F (1093°C) measured at the appliance flue outlet (see Section 2113.11.3).

**Low-heat appliance type.** An *approved* chimney for removing the products of combustion from fuel-burning, low-heat appliances producing combustion gases not in excess of 1,000°F (538°C) under normal operating conditions, but capable of producing combustion gases of 1,400°F (760°C) during intermittent forces firing for periods up to 1 hour. Temperatures shall be measured at the appliance flue outlet.

**Masonry type.** A field-constructed chimney of solid *masonry units* or stones.

**Medium-heat appliance type.** An *approved* chimney for removing the products of combustion from fuel-burning, medium-heat appliances producing combustion gases not exceeding 2,000°F (1093°C) measured at the appliance flue outlet (see Section 2113.11.2).

**[BE] CIRCULATION PATH.** An exterior or interior way of passage from one place to another for pedestrians.

**[F] CLEAN AGENT.** Electrically nonconducting, volatile or gaseous fire extinguishant that does not leave a residue upon vaporation.

**[BF] CLIMATE ZONE.** A geographical region that has been assigned climatic criteria as specified in Chapters 3 [CE] and 3 [RE] of the *International Energy Conservation Code*.

**[BG] CLINIC, OUTPATIENT.** Buildings or portions thereof used to provide *medical care* on less than a 24-hour basis to persons who are not rendered *incapable of self-preservation* by the services provided.

**[F] CLOSED SYSTEM.** The use of a *solid* or *liquid hazardous material* involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all *uses* of *compressed gases*. Examples of closed systems for *solids* and *liquids* include product conveyed through a piping system into a closed vessel, system or piece of equipment.

**[BS] COASTAL A ZONE.** Area within a *special flood hazard area*, landward of a V zone or landward of an open coast without mapped *coastal high-hazard areas*. In a *coastal A zone*, the principal source of *flooding* must be astronomical tides, storm surges, seiches or tsunamis, not riverine *flooding*. During the *base flood* conditions, the potential for breaking wave height shall be greater than or equal to 1½ feet (457 mm). The inland limit of the *coastal A zone* is (a) the *Limit of Moderate Wave Action* if delineated on a FIRM, or (b) designated by the authority having jurisdiction.

**[BS] COASTAL HIGH-HAZARD AREA.** Area within the *special flood hazard area* extending from offshore to the inland limit of a primary dune along an open coast and any other area that is subject to high-velocity wave action from



## DEFINITIONS

storms or seismic sources, and shown on a *Flood Insurance Rate Map* (FIRM) or other flood hazard map as velocity Zone V, VO, VE or V1-30.

**[BS] COLLAR JOINT.** Vertical longitudinal space between *wythes* of *masonry* or between *masonry wythe* and backup construction that is permitted to be filled with *mortar* or grout.

**[BS] COLLECTOR.** A horizontal *diaphragm* element parallel and in line with the applied force that collects and transfers *diaphragm* shear forces to the vertical elements of the lateral force-resisting system or distributes forces within the *diaphragm*, or both.

**[BF] COMBINATION FIRE/SMOKE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to close *automatically* upon the detection of heat and resist the passage of flame and smoke. The device is installed to operate automatically, controlled by a smoke detection system, and where required, is capable of being positioned from a *fire command center*.

**[BS] COMBINED PILE RAFT.** A geotechnical composite construction that combines the bearing effect of both foundation elements, raft and piles, by taking into account interactions between the foundation elements and the subsoil.

**[F] COMBUSTIBLE DUST.** Finely divided *solid* material that is 420 microns or less in diameter and which, when dispersed in air in the proper proportions, could be ignited by a flame, spark or other source of ignition. Combustible dust will pass through a US No. 40 standard sieve.

**[F] COMBUSTIBLE FIBERS.** Readily ignitable and free-burning materials in a fibrous or shredded form, such as cocoa fiber, cloth, cotton, excelsior, hay, hemp, henequen, istle, jute, kapok, oakum, rags, sisal, Spanish moss, straw, tow, wastepaper, certain synthetic fibers or other like materials. This definition does not include densely packed *baled cotton*.

**[F] COMBUSTIBLE LIQUID.** A *liquid* having a closed cup *flash point* at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

The category of combustible liquids does not include *compressed gases* or *cryogenic fluids* or *liquids* that do not have a fire point when tested in accordance with ASTM D92.

**Class II.** *Liquids* having a closed cup *flash point* at or above 100°F (38°C) and below 140°F (60°C).

**Class IIIA.** *Liquids* having a closed cup *flash point* at or above 140°F (60°C) and below 200°F (93°C).

**Class IIIB.** *Liquids* having a closed cup *flash point* at or above 200°F (93°C).

**[F] COMMERCIAL MOTOR VEHICLE.** A motor vehicle used to transport passengers or property where the motor vehicle meets one of the following:

1. Has a gross vehicle weight rating of 10,000 pounds (4540 kg) or more.
2. Is designed to transport 16 or more passengers, including the driver.

**[BE] COMMON PATH OF EGRESS TRAVEL.** That portion of *exit access* travel distance measured from the most remote point of each room, area or space to that point where the occupants have separate and distinct access to two *exits* or *exit access* doorways.

**[BE] COMMON USE.** Interior or exterior *circulation paths*, rooms, spaces or elements that are not for public use and are made available for the shared use of two or more people.

**[F] COMPRESSED GAS.** A material or mixture of materials that meets both of the following:

1. Is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure.
2. Has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa) which is either liquefied, nonliquefied or in solution, except those gases which have no other health- or physical-hazard properties are not considered to be compressed until the pressure in the packaging exceeds 41 psia (282 kPa) at 68°F (20°C).

The states of a compressed gas are categorized as follows:

1. Nonliquefied compressed gases are gases, other than those in solution, which are in a packaging under the charged pressure and are entirely gaseous at a temperature of 68°F (20°C).
2. Liquefied compressed gases are gases that, in a packaging under the charged pressure, are partially *liquid* at a temperature of 68°F (20°C).
3. Compressed gases in solution are nonliquefied gases that are dissolved in a solvent.
4. Compressed gas mixtures consist of a mixture of two or more compressed gases contained in a packaging, the hazard properties of which are represented by the properties of the mixture as a whole.

**[BS] CONCRETE.**

**Carbonate aggregate.** Concrete made with aggregates consisting mainly of calcium or magnesium carbonate, such as limestone or dolomite, and containing 40 percent or less quartz, chert or flint.

**Cellular.** A lightweight insulating concrete made by mixing a preformed foam with Portland cement slurry and having a dry unit weight of approximately 30 pcf (480 kg/m<sup>3</sup>).

**Lightweight aggregate.** Concrete made with aggregates of expanded clay, shale, slag or slate or sintered fly ash or any natural lightweight aggregate meeting ASTM C330 and possessing equivalent fire-resistance properties and weighing 85 to 115 pcf (1360 to 1840 kg/m<sup>3</sup>).

**Perlite.** A lightweight insulating concrete having a dry unit weight of approximately 30 pcf (480 kg/m<sup>3</sup>) made with perlite concrete aggregate. Perlite aggregate is produced from a volcanic rock which, when heated, expands to form a glass-like material of cellular structure.

**Sand-lightweight.** Concrete made with a combination of expanded clay, shale, slag, slate, sintered fly ash, or any natural lightweight aggregate meeting ASTM C330 and



## DEFINITIONS

possessing equivalent fire-resistance properties and natural sand. Its unit weight is generally between 105 and 120 pcf (1680 and 1920 kg/m<sup>3</sup>).

**Siliceous aggregate.** Concrete made with normal-weight aggregates consisting mainly of silica or compounds other than calcium or magnesium carbonate, which contains more than 40-percent quartz, chert or flint.

**Vermiculite.** A light weight insulating concrete made with *vermiculite* concrete aggregate which is laminated micaceous material produced by expanding the ore at high temperatures. When added to a Portland cement slurry the resulting concrete has a dry unit weight of approximately 30 pcf (480 kg/m<sup>3</sup>).

**[BG] CONGREGATE LIVING FACILITIES.** A building or part thereof that contains *sleeping units* where residents share bathroom or kitchen facilities, or both.

**[F] CONSTANTLY ATTENDED LOCATION.** A designated location at a facility staffed by trained personnel on a continuous basis where alarm or supervisory signals are monitored and facilities are provided for notification of the fire department or other emergency services.

**[A] CONSTRUCTION DOCUMENTS.** Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit.

**[BG] CONSTRUCTION TYPES.** See Section 602.

**Type I.** See Section 602.2.

**Type II.** See Section 602.2.

**Type III.** See Section 602.3.

**Type IV.** See Section 602.4.

**Type V.** See Section 602.5.

**[BF] CONTINUOUS INSULATION (ci).** Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior, or is integral to any opaque surface of the building envelope.

**[F] CONTROL AREA.** Spaces within a building where quantities of *hazardous materials* not exceeding the maximum allowable quantities per control area are stored, dispensed, *used* or handled. See the definition of “*Outdoor control area*” in the *International Fire Code*.

**[BS] CONTROLLED LOW-STRENGTH MATERIAL.** A self-compacted, cementitious material used primarily as a backfill in place of compacted fill.

**[BS] CONVENTIONAL LIGHT-FRAME CONSTRUCTION.** Construction whose primary structural elements are formed by a system of repetitive wood-framing members. See Section 2308 for conventional *light-frame construction* provisions.

**[BG] CORNICE.** A projecting horizontal molded element located at or near the top of an architectural feature.

**[BE] CORRIDOR.** An enclosed *exit access* component that defines and provides a path of egress travel.

**CORRIDOR, OPEN-ENDED.** See “*Open-ended corridor*.”

**[BF] CORRIDOR DAMPER.** A *listed* device intended for use where air ducts penetrate or terminate at horizontal openings in the ceilings of fire-resistance-rated corridors, where the *corridor* ceiling is permitted to be constructed as required for the *corridor* walls.

**[BS] CORROSION RESISTANCE.** The ability of a material to withstand deterioration of its surface or its properties when exposed to its environment.

**[F] CORROSIVE.** A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR, Part 173.137, such chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.

**[BG] COURT.** An open, uncovered space, unobstructed to the sky, bounded on three or more sides by exterior building walls or other enclosing devices.

**[BG] COVERED MALL BUILDING.** A single building enclosing a number of tenants and occupants, such as retail stores, drinking and dining establishments, entertainment and amusement facilities, passenger transportation terminals, offices and other similar uses wherein two or more tenants have a main entrance into one or more malls. *Anchor buildings* shall not be considered as a part of the covered mall building. The term “covered mall building” shall include *open mall buildings* as defined below.

**Mall.** A roofed or covered common pedestrian area within a *covered mall building* that serves as access for two or more tenants and not to exceed three levels that are open to each other. The term “mall” shall include open malls as defined below.

**Open mall.** An unroofed common pedestrian way serving a number of tenants not exceeding three levels. Circulation at levels above grade shall be permitted to include open exterior balconies leading to exits discharging at grade.

**Open mall building.** Several structures housing a number of tenants, such as retail stores, drinking and dining establishments, entertainment and amusement facilities, offices, and other similar uses, wherein two or more tenants have a main entrance into one or more open malls. *Anchor buildings* are not considered as a part of the open mall building.

**[BS] CRIPPLE WALL.** A framed stud wall extending from the top of the foundation to the underside of floor framing for the lowest occupied floor level.

**[F] CRITICAL CIRCUIT.** A circuit that requires continuous operation to ensure safety of the structure and occupants.

**[BS] CROSS-LAMINATED TIMBER.** A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross oriented and bonded with structural adhesive to form a solid wood element.

## DEFINITIONS

**[F] CRYOGENIC FLUID.** A *liquid* having a *boiling point* lower than -150°F (-101°C) at 14.7 pounds per square inch atmosphere (psia) (an absolute pressure of 101 kPa).

**[BG] CUSTODIAL CARE.** Assistance with day-to-day living tasks; such as assistance with cooking, taking medication, bathing, using toilet facilities and other tasks of daily living. *Custodial care* includes persons receiving care who have the ability to respond to emergency situations and evacuate at a slower rate and/or who have mental and psychiatric complications.

**[BS] DALLE GLASS.** A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

**DAMPER.** See “*Ceiling radiation damper*,” “*Combination fire/smoke damper*,” “*Corridor damper*,” “*Fire damper*” and “*Smoke damper*.”

**[BS] DANGEROUS.** Any building, structure or portion thereof that meets any of the conditions described below shall be deemed *dangerous*:

1. The building or structure has collapsed, has partially collapsed, has moved off its foundation or lacks the necessary support of the ground.
2. There exists a significant risk of collapse, detachment or dislodgment of any portion, member, appurtenance or ornamentation of the building or structure under permanent, routine, or frequent *loads*; under actual loads already in effect; or under snow, wind, rain, *flood*, earthquake, or other environmental loads when such *loads* are imminent.

**[F] DAY BOX.** A portable magazine designed to hold *explosive* materials constructed in accordance with the requirements for a Type 3 magazine as defined and classified in Chapter 56 of the *International Fire Code*.

**[BS] DEAD LOAD.** The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, *stairways*, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, including cranes and material handling systems.

**[BS] DECORATIVE GLASS.** A carved, leaded or *Dalle glass* or glazing material whose purpose is decorative or artistic, not functional; whose coloring, texture or other design qualities or components cannot be removed without destroying the glazing material and whose surface, or assembly into which it is incorporated, is divided into segments.

**[F] DECORATIVE MATERIALS.** All materials applied over the building *interior finish* for decorative, acoustical or other effect including, but not limited to, curtains, draperies, fabrics and streamers; and all other materials utilized for decorative effect including, but not limited to, bulletin boards, artwork, posters, photographs, batting, cloth, cotton, hay, stalks, straw, vines, leaves, trees, moss and similar items, foam plastics and materials containing foam plastics. Decorative materials do not include wall coverings, ceiling coverings, floor coverings, ordinary window shades, *interior finish* and materials 0.025 inch (0.64 mm) or less in thickness applied directly to and adhering tightly to a substrate.

**[BS] DEEP FOUNDATION.** A deep foundation is a foundation element that does not satisfy the definition of a *shallow foundation*.

**[BE] DEFEND-IN-PLACE.** A method of emergency response that engages building components and trained staff to provide occupant safety during an emergency. Emergency response involves remaining in place, relocating within the building, or both, without evacuating the building.

**[A] DEFERRED SUBMITTAL.** Those portions of the design that are not submitted at the time of the application and that are to be submitted to the *building official* within a specified period.

**[F] DEFLAGRATION.** An exothermic reaction, such as the extremely rapid oxidation of a flammable dust or vapor in air, in which the reaction progresses through the unburned material at a rate less than the velocity of sound. A deflagration can have an explosive effect.

**[BF] DELAYED-ACTION CLOSER.** A *self-closing* device that incorporates a delay prior to the initiation of closing. Delayed-action closers are mechanical devices with an adjustable delay.

**[F] DELUGE SYSTEM.** A sprinkler system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers. When this valve opens, water flows into the piping system and discharges from all sprinklers attached thereto.

**[BS] DESIGN EARTHQUAKE GROUND MOTION.** The earthquake ground motion that buildings and structures are specifically proportioned to resist in Section 1613.

**[BS] DESIGN FLOOD.** The *flood* associated with the greater of the following two areas:

1. Area with a flood plain subject to a 1-percent or greater chance of *flooding* in any year.
2. Area designated as a *flood hazard area* on a community's flood hazard map, or otherwise legally designated.

**[BS] DESIGN FLOOD ELEVATION.** The elevation of the “*design flood*,” including wave height, relative to the datum specified on the community's legally designated flood hazard map. In areas designated as Zone AO, the *design flood elevation* shall be the elevation of the highest existing grade of the building's perimeter plus the depth number (in feet) specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number shall be taken as being equal to 2 feet (610 mm).

**DESIGN PROFESSIONAL, REGISTERED.** See “*Registered design professional*.”

**DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE, REGISTERED.** See “*Registered design professional in responsible charge*.”

**[BS] DESIGN STRENGTH.** The product of the nominal strength and a *resistance factor* (or strength reduction factor).

**[BS] DESIGNATED SEISMIC SYSTEM.** Those nonstructural components that require design in accordance with Chapter 13 of ASCE 7 and for which the component importance factor,  $I_p$ , is greater than 1 in accordance with Section 13.1.3 of ASCE 7.

**[F] DETACHED BUILDING.** A separate single-story building, without a *basement* or crawl space, used for the storage or use of *hazardous materials* and located an *approved* distance from all structures.

**[BS] DETAILED PLAIN CONCRETE STRUCTURAL WALL.** See Section 1905.1.1.

**[BE] DETECTABLE WARNING.** A standardized surface feature built in or applied to walking surfaces or other elements to warn visually impaired persons of hazards on a *circulation path*.

**[F] DETECTOR, HEAT.** A fire detector that senses heat—either abnormally high temperature or rate of rise, or both.

**[F] DETONATION.** An exothermic reaction characterized by the presence of a shock wave in the material which establishes and maintains the reaction. The reaction zone progresses through the material at a rate greater than the velocity of sound. The principal heating mechanism is one of shock compression. Detonations have an explosive effect.

**[BG] DETOXIFICATION FACILITIES.** Facilities that provide treatment for substance abuse, serving care recipients who are *incapable of self-preservation* or who are harmful to themselves or others.

**[BS] DIAPHRAGM.** A horizontal or sloped system acting to transmit lateral forces to vertical elements of the lateral force-resisting system. When the term “*diaphragm*” is used, it shall include horizontal bracing systems.

**Diaphragm, blocked.** In light-frame construction, a diaphragm in which all sheathing edges not occurring on a framing member are supported on and fastened to blocking.

**Diaphragm boundary.** In light-frame construction, a location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.

**Diaphragm chord.** A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.

**Diaphragm, unblocked.** A diaphragm that has edge nailing at supporting members only. Blocking between supporting structural members at panel edges is not included. Diaphragm panels are field nailed to supporting members.

**[BS] DIMENSIONS.** This definition applies only to Chapter 21.

**Nominal.** The *specified dimension* plus an allowance for the *joints* with which the units are to be laid. Nominal *dimensions* are usually stated in whole numbers. Thickness is given first, followed by height and then length.

**Specified.** *Dimensions* specified for the manufacture or construction of a unit, *joint* or element.

**[BE] DIRECT ACCESS.** A path of travel from a space to an immediately adjacent space through an opening in the common wall between the two spaces.

**[F] DISPENSING.** The pouring or transferring of any material from a container, tank or similar vessel, whereby vapors, dusts, fumes, mists or gases are liberated to the atmosphere.

**DOOR, BALANCED.** See “*Balanced door*.”

**DOOR, LOW-ENERGY POWER-OPERATED.** See “*Low-energy power-operated door*.”

**DOOR, POWER-ASSISTED.** See “*Power-assisted door*.”

**DOOR, POWER-OPERATED.** See “*Power-operated door*.”

**DOORWAY, EXIT ACCESS.** See “*Exit access doorway*.”

**[BG] DORMITORY.** A space in a building where group sleeping accommodations are provided in one room, or in a series of closely associated rooms, for persons not members of the same family group, under joint occupancy and single management, as in college *dormitories* or fraternity houses.

**[BF] DRAFTSTOP.** A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor/ceiling assemblies, roof/ceiling assemblies and *attics*.

**DRAG STRUT.** See “*Collector*.”

**[BS] DRILLED SHAFT.** A cast-in-place *deep foundation* element, also referred to as a caisson, drilled pier or bored pile, constructed by drilling a hole (with or without permanent casing or drilling fluid) into soil or rock and filling it with fluid concrete after the drilling equipment is removed.

**Socketed drilled shaft.** A drilled shaft with a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock.

**[BS] DRY FLOODPROOFING.** A combination of design modifications that results in a building or structure, including the attendant utilities and equipment and sanitary facilities, being water tight with walls substantially impermeable to the passage of water and with structural components having the capacity to resist *loads* as identified in ASCE 7.

**[F] DRY-CHEMICAL EXTINGUISHING AGENT.** A powder composed of small particles, usually of sodium bicarbonate, potassium bicarbonate, urea-potassium-based bicarbonate, potassium chloride or monoammonium phosphate, with added particulate material supplemented by special treatment to provide resistance to packing, resistance to moisture absorption (caking) and the proper flow capabilities.

**[A] DWELLING.** A building that contains one or two *dwelling units* used, intended or designed to be used, rented, leased, let or hired out to be occupied for living purposes.

**[A] DWELLING UNIT.** A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.



## DEFINITIONS

**[BG] DWELLING UNIT, EFFICIENCY.** A *dwelling unit* where all permanent provisions for living, sleeping, eating and cooking are contained in a single room.

**DWELLING UNIT OR SLEEPING UNIT, MULTI-STORY.** See “*Multistory unit.*”

**[BE] EGRESS COURT.** A *court* or *yard* which provides access to a *public way* for one or more *exits*.

**[BG] ELECTRIC VEHICLE CHARGING STATION.** One or more vehicle spaces served by an electric vehicle charging system.

**[BF] ELECTRICAL CIRCUIT PROTECTIVE SYSTEM.** A specific construction of devices, materials, or coatings installed as a fire-resistive barrier system applied to electrical system components, such as cable trays, conduits and other raceways, open run cables and conductors, cables, and conductors.

**[F] ELEVATOR GROUP.** A grouping of elevators in a building located adjacent or directly across from one another that responds to common hall call buttons.

**[F] EMERGENCY ALARM SYSTEM.** A system to provide indication and warning of emergency situations involving *hazardous materials*.

**[F] EMERGENCY CONTROL STATION.** An *approved* location on the premises where signals from emergency equipment are received and which is staffed by trained personnel.

**[BE] EMERGENCY ESCAPE AND RESCUE OPENING.** An operable exterior window, door or other similar device that provides for a means of escape and access for rescue in the event of an emergency.

**[F] EMERGENCY POWER SYSTEM.** A source of *automatic* electric power of a required capacity and duration to operate required life safety, fire alarm, detection and ventilation systems in the event of a failure of the primary power. Emergency power systems are required for electrical loads where interruption of the primary power could result in loss of human life or serious injuries.

**[F] EMERGENCY VOICE/ALARM COMMUNICATIONS.** Dedicated manual or *automatic* facilities for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building.

**[BF] EMITTANCE.** The ratio of radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

**[BE] EMPLOYEE WORK AREA.** All or any portion of a space used only by employees and only for work. *Corridors*, toilet rooms, kitchenettes and break rooms are not employee work areas.

**[F] ENERGY STORAGE SYSTEM, ELECTROCHEMICAL.** An energy storage system that stores energy and produces electricity using chemical reactions. It includes, among others, battery ESS and capacitor ESS.

**[BS] ENGINEERED WOOD RIM BOARD.** A full-depth *structural composite lumber*, *wood structural panel*, *structural glued laminated timber* or *prefabricated wood I-joist* member designed to transfer horizontal (shear) and vertical (compression) *loads*, provide attachment for *diaphragm* sheathing, siding and exterior deck ledgers, and provide lateral support at the ends of floor or roof joists or rafters.

**ENTRANCE, PUBLIC.** See “*Public entrance.*”

**ENTRANCE, RESTRICTED.** See “*Restricted entrance.*”

**ENTRANCE, SERVICE.** See “*Service entrance.*”

**[BG] EQUIPMENT PLATFORM.** An unoccupied, elevated platform used exclusively for mechanical systems or industrial process equipment, including the associated elevated walkways, *stairways*, *alternating tread devices* and ladders necessary to access the platform (see Section 505.3).

**[BS] ESSENTIAL FACILITIES.** Buildings and other structures that are intended to remain operational in the event of extreme environmental loading from *flood*, wind, snow or earthquakes.

**[F] EXHAUSTED ENCLOSURE.** An appliance or piece of equipment that consists of a top, a back and two sides providing a means of local exhaust for capturing gases, fumes, vapors and mists. Such enclosures include laboratory hoods, exhaust fume hoods and similar appliances and equipment used to locally retain and exhaust the gases, fumes, vapors and mists that could be released. Rooms or areas provided with general *ventilation*, in themselves, are not exhausted enclosures.

**[A] EXISTING BUILDING.** A building erected prior to the date of adoption of the appropriate code, or one for which a legal building *permit* has been issued.

**[BS] EXISTING STRUCTURE.** A structure erected prior to the date of adoption of the appropriate code, or one for which a legal building *permit* has been issued.

**[BE] EXIT.** That portion of a *means of egress* system between the *exit access* and the *exit discharge* or *public way*. Exit components include exterior exit doors at the *level of exit discharge*, *interior exit stairways* and *ramps*, *exit passageways*, *exterior exit stairways* and *ramps* and *horizontal exits*.

**EXIT, HORIZONTAL.** See “*Horizontal exit.*”

**[BE] EXIT ACCESS.** That portion of a *means of egress* system that leads from any occupied portion of a building or structure to an *exit*.

**[BE] EXIT ACCESS DOORWAY.** A door or access point along the path of egress travel from an occupied room, area or space where the path of egress enters an intervening room, *corridor*, *exit access stairway* or *ramp*.

**[BE] EXIT ACCESS RAMP.** A *ramp* within the *exit access* portion of the *means of egress* system.

**[BE] EXIT ACCESS STAIRWAY.** A *stairway* within the *exit access* portion of the *means of egress* system.

**[BE] EXIT DISCHARGE.** That portion of a *means of egress* system between the termination of an *exit* and a *public way*.



**[BE] EXIT DISCHARGE, LEVEL OF.** The *story* at the point at which an *exit* terminates and an *exit discharge* begins.

**[BE] EXIT PASSAGEWAY.** An *exit* component that is separated from other interior spaces of a building or structure by fire-resistance-rated construction and opening protectives, and provides for a protected path of egress travel in a horizontal direction to an *exit* or to the *exit discharge*.

**[BF] EXPANDED VINYL WALL COVERING.** Wall covering consisting of a woven textile backing, an expanded vinyl base coat layer and a nonexpanded vinyl skin coat. The expanded base coat layer is a homogeneous vinyl layer that contains a blowing agent. During processing, the blowing agent decomposes, causing this layer to expand by forming closed cells. The total thickness of the wall covering is approximately 0.055 inch to 0.070 inch (1.4 mm to 1.78 mm).

**[F] EXPLOSION.** An effect produced by the sudden violent expansion of gases, which may be accompanied by a shock wave or disruption, or both, of enclosing materials or structures. An explosion could result from any of the following:

1. Chemical changes such as rapid oxidation, *deflagration* or *detonation*, decomposition of molecules and runaway polymerization (usually *detonations*).
2. Physical changes such as pressure tank ruptures.
3. Atomic changes (nuclear fission or fusion).

**[F] EXPLOSIVE.** A chemical compound, mixture or device, the primary or common purpose of which is to function by explosion. The term includes, but is not limited to: dynamite, black powder, pellet powder, initiating explosives, detonators, safety fuses, squibs, detonating cord, igniter cord, and igniters. The term “explosive” includes any material determined to be within the scope of USC Title 18: Chapter 40 and also includes any material classified as an explosive other than consumer fireworks, 1.4G by the *hazardous materials* regulations of DOTn 49 CFR Parts 100-185.

**High explosive.** Explosive material, such as dynamite, which can be caused to detonate by means of a No. 8 test blasting cap when unconfined.

**Low explosive.** Explosive material that will burn or deflagrate when ignited. It is characterized by a rate of reaction that is less than the speed of sound. Examples of low explosives include, but are not limited to: black powder; safety fuse; igniters; igniter cord; fuse lighters; fireworks; and propellants, 1.3C.

**Mass-detonating explosives.** Division 1.1, 1.2 and 1.5 explosives alone or in combination, or loaded into various types of ammunition or containers, most of which can be expected to explode virtually instantaneously when a small portion is subjected to fire, severe concussion, impact, the impulse of an initiating agent or the effect of a considerable discharge of energy from without. Materials that react in this manner represent a mass explosion hazard. Such an explosive will normally cause severe structural damage to adjacent objects. Explosive propagation could occur immediately to other items of ammunition and explosives stored sufficiently close to and not adequately protected from the initially exploding pile

with a time interval short enough so that two or more quantities must be considered as one for quantity-distance purposes.

**UN/DOTn Class 1 explosives.** The former classification system used by DOTn included the terms “high” and “low” explosives as defined herein. The following terms further define explosives under the current system applied by DOTn for all explosive materials defined as hazard Class 1 materials. Compatibility group letters are used in concert with the division to specify further limitations on each division noted (i.e., the letter G identifies the material as a pyrotechnic substance or article containing a pyrotechnic substance and similar materials).

**Division 1.1.** Explosives that have a mass explosion hazard. A mass explosion is one which affects almost the entire *load* instantaneously.

**Division 1.2.** Explosives that have a projection hazard but not a mass explosion hazard.

**Division 1.3.** Explosives that have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard.

**Division 1.4.** Explosives that pose a minor explosion hazard. The explosive effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire must not cause virtually instantaneous explosion of almost the entire contents of the package.

**Division 1.5.** Very insensitive explosives. This division is comprised of substances that have a mass explosion hazard, but that are so insensitive there is very little probability of initiation or of transition from burning to *detonation* under normal conditions of transport.

**Division 1.6.** Extremely insensitive articles which do not have a mass explosion hazard. This division is comprised of articles that contain only extremely insensitive detonating substances and which demonstrate a negligible probability of accidental initiation or propagation.

**[BE] EXTERIOR EXIT RAMP.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to *yards, courts* or *public ways*.

**[BE] EXTERIOR EXIT STAIRWAY.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and is open to *yards, courts* or *public ways*.

**[BF] EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS).** EIFS are nonstructural, nonload-bearing, *exterior wall* cladding systems that consist of an insulation board attached either adhesively or mechanically, or both, to the substrate; an integrally reinforced base coat and a textured protective finish coat.

**[BF] EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) WITH DRAINAGE.** An EIFS that incorporates a means of drainage applied over a *water-resistive barrier*.

**[BF] EXTERIOR SURFACES.** *Weather-exposed surfaces.*

## DEFINITIONS

**[BF] EXTERIOR WALL.** A wall, bearing or nonbearing, that is used as an enclosing wall for a building, other than a *fire wall*, and that has a slope of 60 degrees (1.05 rad) or greater with the horizontal plane.

**[BF] EXTERIOR WALL COVERING.** A material or assembly of materials applied on the exterior side of *exterior walls* for the purpose of providing a weather-resisting barrier, insulation or for aesthetics, including but not limited to, *veneers*, siding, *exterior insulation and finish systems*, architectural trim and embellishments such as *cornices*, soffits, facias, gutters and leaders.

**[BF] EXTERIOR WALL ENVELOPE.** A system or assembly of *exterior wall* components, including *exterior wall* covering materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.

**[BF] F RATING.** The time period that the *through-penetration firestop system* or *perimeter fire containment system* limits the spread of fire through the penetration or void.

**[BF] FABRIC PARTITION.** A partition consisting of a finished surface made of fabric, without a continuous rigid backing, that is directly attached to a framing system in which the vertical framing members are spaced greater than 4 feet (1219 mm) on center.

**[BS] FABRICATED ITEM.** Structural, *load-bearing* or lateral *load-resisting* members or assemblies consisting of materials assembled prior to installation in a building or structure, or subjected to operations such as heat treatment, thermal cutting, cold working or reforming after manufacture and prior to installation in a building or structure. Materials produced in accordance with standards referenced by this code, such as rolled structural steel shapes, steel reinforcing bars, *masonry units* and *wood structural panels*, or in accordance with a referenced standard that provides requirements for quality control done under the supervision of a third-party quality control agency, are not “*fabricated items*.”

**[F] FABRICATION AREA.** An area within a semiconductor fabrication facility and related research and development areas in which there are processes using hazardous production materials. Such areas are allowed to include ancillary rooms or areas such as dressing rooms and offices that are directly related to the fabrication area processes.

**[A] FACILITY.** All or any portion of buildings, structures, site improvements, elements and pedestrian or vehicular routes located on a *site*.

**[BS] FACTORED LOAD.** The product of a *nominal load* and a load factor.

**[BS] FENESTRATION.** Products classified as either *vertical fenestration* or *skylights and sloped glazing*, installed in such a manner as to preserve the weather-resistant barrier of the wall or roof in which they are installed. *Fenestration* includes products with glass or other transparent or translucent materials.

**[BS] FENESTRATION, VERTICAL.** Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees from the vertical.

**[BS] FIBERBOARD.** A fibrous, homogeneous panel made from lignocellulosic fibers (usually wood or cane) and having a density of less than 31 pounds per cubic foot (pcf) (497 kg/m<sup>3</sup>) but more than 10 pcf (160 kg/m<sup>3</sup>).

**[BS] FIBER-CEMENT (BACKER BOARD, SIDING, SOFFIT, TRIM AND UNDERLAYMENT) PRODUCTS.** Manufactured thin section composites of hydraulic cementitious matrices and discrete nonasbestos fibers.

**[BF] FIBER-REINFORCED POLYMER.** A polymeric composite material consisting of reinforcement fibers, such as glass, impregnated with a fiber-binding polymer which is then molded and hardened. Fiber-reinforced polymers are permitted to contain cores laminated between fiber-reinforced polymer facings.

**FIELD NAILING.** See “*Nailing, field*.”

**FIRE ALARM BOX, MANUAL.** See “*Manual fire alarm box*.”

**[F] FIRE ALARM CONTROL UNIT.** A system component that receives inputs from *automatic* and *manual fire alarm* devices and may be capable of supplying power to detection devices and transponders or off-premises transmitters. The control unit may be capable of providing a transfer of power to the notification appliances and transfer of condition to relays or devices.

**[F] FIRE ALARM SIGNAL.** A signal initiated by a *fire alarm-initiating device* such as a *manual fire alarm box*, *automatic fire detector*, waterflow switch or other device whose activation is indicative of the presence of a fire or fire signature.

**[F] FIRE ALARM SYSTEM.** A system or portion of a combination system consisting of components and circuits arranged to monitor and annunciate the status of *fire alarm* or *supervisory signal-initiating devices* and to initiate the appropriate response to those signals.

**[BF] FIRE AREA.** The aggregate floor area enclosed and bounded by *fire walls*, *fire barriers*, *exterior walls* or *horizontal assemblies* of a building. Areas of the building not provided with surrounding walls shall be included in the fire area if such areas are included within the horizontal projection of the roof or floor next above.

**[BF] FIRE BARRIER.** A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

**FIRE CODE OFFICIAL.** The fire chief or other designated authority charged with the administration and enforcement of the *Arkansas Fire Prevention Code*, or a duly authorized representative.

**[F] FIRE COMMAND CENTER.** The principal attended or unattended location where the status of detection, alarm communications and control systems is displayed, and from which the systems can be manually controlled.

## DEFINITIONS

**[BF] FIRE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to close automatically upon detection of heat and resist the passage of flame. Fire dampers are classified for use in either static systems that will automatically shut down in the event of a fire, or in dynamic systems that continue to operate during a fire. A dynamic fire damper is tested and rated for closure under elevated temperature airflow.

**[F] FIRE DETECTOR, AUTOMATIC.** A device designed to detect the presence of a fire signature and to initiate action.

**[BF] FIRE DOOR.** The door component of a *fire door assembly*.

**[BF] FIRE DOOR ASSEMBLY.** Any combination of a *fire door*, frame, hardware and other accessories that together provide a specific degree of fire protection to the opening.

**FIRE DOOR ASSEMBLY, FLOOR.** See “*Floor fire door assembly*.”

**[BF] FIRE EXIT HARDWARE.** *Panic hardware* that is *listed* for use on *fire door assemblies*.

**[F] FIRE LANE.** A road or other passageway developed to allow the passage of fire apparatus. A fire lane is not necessarily intended for vehicular traffic other than fire apparatus.

**[BF] FIRE PARTITION.** A vertical assembly of materials designed to restrict the spread of fire in which openings are protected.

**[BF] FIRE PROTECTION RATING.** The period of time that an opening protective will maintain the ability to confine a fire as determined by tests specified in Section 716. Ratings are stated in hours or minutes.

**[F] FIRE PROTECTION SYSTEM.** *Approved* devices, equipment and systems or combinations of systems used to detect a fire, activate an alarm, extinguish or control a fire, control or manage smoke and products of a fire or any combination thereof.

**[BF] FIRE PROTECTIVE CURTAIN ASSEMBLY.** An assembly consisting of a fabric curtain, a bottom bar, guides, a coil, and an operating and closing system.

**[BF] FIRE RESISTANCE.** That property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

**[F] FIRE SAFETY FUNCTIONS.** Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of harmful effects of fire.

**[BF] FIRE SEPARATION DISTANCE.** The distance measured from the building face to one of the following:

1. The closest interior *lot line*.
2. To the centerline of a street, an alley or *public way*.
3. To an imaginary line between two buildings on the lot.

The distance shall be measured at right angles from the face of the wall.

**[BF] FIRE WALL.** A fire-resistance-rated wall having protected openings, which restricts the spread of fire and extends continuously from the foundation to or through the roof, with sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall.

**[BF] FIRE WINDOW ASSEMBLY.** A window constructed and glazed to give protection against the passage of fire.

**[BF] FIREBLOCKING.** Building materials, or materials *approved* for use as fireblocking, installed to resist the free passage of flame to other areas of the building through concealed spaces.

**[M] FIREPLACE.** A hearth and fire chamber or similar prepared place in which a fire may be made and which is built in conjunction with a chimney.

**[BS] FIREPLACE THROAT.** The opening between the top of the firebox and the smoke chamber.

**[BF] FIRE-RATED GLAZING.** Glazing with either a *fire protection rating* or a *fire-resistance rating*.

**[BF] FIRE-RESISTANCE RATING.** The period of time a *building element*, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by the tests, or the methods based on tests, prescribed in Section 703.

**[BF] FIRE-RESISTANT JOINT SYSTEM.** An assemblage of specific materials or products that are designed, tested and fire-resistance rated in accordance with either ASTM E1966 or UL 2079 to resist for a prescribed period of time the passage of fire through *joints* made in or between fire-resistance-rated assemblies.

**[BS] FIRE-RETARDANT-TREATED WOOD.** Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced surface-burning characteristics and resist propagation of fire.

**FIRESTOP, MEMBRANE-PENETRATION.** See “*Membrane-penetration firestop*.”

**FIRESTOP, PENETRATION.** See “*Penetration firestop*.”

**FIRESTOP SYSTEM, THROUGH-PENETRATION.** See “*Through-penetration firestop system*.”

**[F] FIREWORKS.** Any composition or device for the purpose of producing a visible or audible effect for entertainment purposes by combustion, *deflagration* or *detonation* that meets the definition of 1.4G fireworks or 1.3G fireworks.

**Fireworks, 1.3G.** Large fireworks devices, which are explosive materials, intended for use in fireworks displays and designed to produce audible or visible effects by combustion, *deflagration* or *detonation*. Such 1.3G fireworks include, but are not limited to, firecrackers containing more than 130 milligrams (2 grains) of explosive composition, aerial shells containing more than 40 grams of pyrotechnic composition, and other display



## DEFINITIONS

pieces which exceed the limits for classification as 1.4G fireworks. Such 1.3G fireworks are also described as fireworks, UN0335 by the DOTn.

**Fireworks, 1.4G.** Small fireworks devices containing restricted amounts of pyrotechnic composition designed primarily to produce visible or audible effects by combustion or deflagration that complies with the construction, chemical composition and labeling regulations of the DOTn for fireworks, UN0336, and the US Consumer Product Safety Commission (CPSC) as set forth in CPSC 16 CFR: Parts 1500 and 1507.

**[BG] FIXED BASE OPERATOR (FBO).** A commercial business granted the right by the airport sponsor to operate on an airport and provide aeronautical services, such as fueling, hangaring, *tie-down* and parking, aircraft rental, aircraft maintenance and flight instruction.

**[BE] FIXED SEATING.** Furniture or fixture designed and installed for the use of sitting and secured in place including bench-type seats and seats with or without backs or armrests.

**[BF] FLAME SPREAD.** The propagation of flame over a surface.

**[BF] FLAME SPREAD INDEX.** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84 or UL 723.

**[F] FLAMMABLE GAS.** A material that is a gas at 68°F (20°C) or less at 14.7 pounds per square inch atmosphere (psia) (101 kPa) of pressure [a material that has a *boiling point* of 68°F (20°C) or less at 14.7 psia (101 kPa)], which also meets one of the following:

1. Is ignitable at 14.7 psia (101 kPa) when in a mixture of 13 percent or less by volume with air.
2. Has a flammable range at 14.7 psia (101 kPa) with air of at least 12 percent, regardless of the lower limit.

The limits specified shall be determined at 14.7 psi (101 kPa) of pressure and a temperature of 68°F (20°C) in accordance with ASTM E681.

**[F] FLAMMABLE LIQUEFIED GAS.** A liquefied compressed gas which, under a charged pressure, is partially liquid at a temperature of 68°F (20°C) and which is flammable.

**[F] FLAMMABLE LIQUID.** A *liquid* having a closed cup *flash point* below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

**Class IA.** *Liquids* having a *flash point* below 73°F (23°C) and a *boiling point* below 100°F (38°C).

**Class IB.** *Liquids* having a *flash point* below 73°F (23°C) and a *boiling point* at or above 100°F (38°C).

**Class IC.** *Liquids* having a *flash point* at or above 73°F (23°C) and below 100°F (38°C). The category of flammable liquids does not include *compressed gases* or *cryogenic fluids*, or liquids that do not have a fire point when tested in accordance with ASTM D92.

**[F] FLAMMABLE MATERIAL.** A material capable of being readily ignited from common sources of heat or at a temperature of 600°F (316°C) or less.

**[F] FLAMMABLE SOLID.** A *solid*, other than a blasting agent or *explosive*, that is capable of causing fire through friction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable *solid* as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.1 inch (2.5 mm) per second along its major axis.

**[F] FLAMMABLE VAPORS OR FUMES.** The concentration of flammable constituents in air that exceeds 25 percent of their *lower flammable limit (LFL)*.

**[F] FLASH POINT.** The minimum temperature in degrees Fahrenheit at which a *liquid* will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flash point of a *liquid* shall be determined by appropriate test procedure and apparatus as specified in ASTM D56, ASTM D93 or ASTM D3278.

**[BE] FLIGHT.** A continuous run of rectangular treads, *winders* or combination thereof from one landing to another.

**FLOOD, DESIGN.** See “*Design flood.*”

**[BS] FLOOD DAMAGE-RESISTANT MATERIALS.** Any construction material capable of withstanding direct and prolonged contact with floodwaters without sustaining any damage that requires more than cosmetic *repair*.

**FLOOD ELEVATION, DESIGN.** See “*Design flood elevation.*”

**[BS] FLOOD HAZARD AREA.** The greater of the following two areas:

1. The area within a flood plain subject to a 1-percent or greater chance of *flooding* in any year.
2. The area designated as a flood hazard area on a community’s flood hazard map, or otherwise legally designated.

**FLOOD HAZARD AREAS, SPECIAL.** See “*Special flood hazard area.*”

**[BS] FLOOD INSURANCE RATE MAP (FIRM).** An official map of a community on which the Federal Emergency Management Agency (FEMA) has delineated both the *special flood hazard areas* and the risk premium zones applicable to the community.

**[BS] FLOOD INSURANCE STUDY.** The official report provided by the Federal Emergency Management Agency containing the *Flood Insurance Rate Map (FIRM)*, the Flood Boundary and *Floodway Map (FBFM)*, the water surface elevation of the *base flood* and supporting technical data.



## DEFINITIONS

**[BS] FLOOD or FLOODING.** A general and temporary condition of partial or complete inundation of normally dry land from:

1. The overflow of inland or tidal waters.
2. The unusual and rapid accumulation or runoff of surface waters from any source.

**[BS] FLOODWAY.** The channel of the river, creek or other watercourse and the adjacent land areas that must be reserved in order to discharge the *base flood* without cumulatively increasing the water surface elevation more than a designated height.

**[BE] FLOOR AREA, GROSS.** The floor area within the inside perimeter of the *exterior walls* of the building under consideration, exclusive of vent *shafts* and *courts*, without deduction for *corridors*, *stairways*, *ramps*, closets, the thickness of interior walls, columns or other features. The floor area of a building, or portion thereof, not provided with surrounding *exterior walls* shall be the usable area under the horizontal projection of the roof or floor above. The *gross floor area* shall not include *shafts* with no openings or interior *courts*.

**[BE] FLOOR AREA, NET.** The actual occupied area not including unoccupied accessory areas such as *corridors*, *stairways*, *ramps*, toilet rooms, mechanical rooms and closets.

**[BF] FLOOR FIRE DOOR ASSEMBLY.** A combination of a *fire door*, a frame, hardware and other accessories installed in a horizontal plane, which together provide a specific degree of fire protection to a through-opening in a fire-resistance-rated floor (see Section 712.1.13.1).

**[BF] FOAM PLASTIC INSULATION.** A plastic that is intentionally expanded by the use of a foaming agent to produce a reduced-density plastic containing voids consisting of open or closed cells distributed throughout the plastic for thermal insulating or acoustical purposes and that has a density less than 20 pounds per cubic foot (pcf) (320 kg/m<sup>3</sup>).

**[F] FOAM-EXTINGUISHING SYSTEM.** A special system discharging a foam made from concentrates, either mechanically or chemically, over the area to be protected.

**[BE] FOLDING AND TELESCOPIC SEATING.** Tiered seating having an overall shape and size that is capable of being reduced for purposes of moving or storing and is not a *building element*.

**[BG] FOOD COURT.** A public seating area located in the *mall* that serves adjacent food preparation tenant spaces.

**[BG] FOSTER CARE FACILITIES.** Facilities that provide care to more than five children, 2½ years of age or less.

**[BS] FOUNDATION PIER.** This definition applies only to Chapter 21.

An isolated vertical foundation member whose horizontal dimension measured at right angles to its thickness does not exceed three times its thickness and whose height is equal to or less than four times its thickness.

**[BS] FRAME STRUCTURE.** A building or other structure in which vertical *loads* from floors and roofs are primarily supported by columns.

**[F] FUEL CELL POWER SYSTEM, STATIONARY.** A stationary energy-generation system that converts the chemical energy of a fuel and oxidant to electric energy (DC or AC electricity) by an electrochemical process.

**Field-fabricated fuel cell power system.** A *stationary fuel cell power system* that is assembled at the job site and is not a preengineered or prepackaged factory-assembled fuel cell power system.

**Preengineered fuel cell power system.** A *stationary fuel cell power system* consisting of components and modules that are produced in a factory and shipped to the job site for assembly.

**Prepackaged fuel cell power system.** A *stationary fuel cell power system* that is factory assembled as a single, complete unit and shipped as a complete unit for installation at the job site.

**[BS] GABLE.** The triangular portion of a wall beneath the end of a dual-slope, pitched, or mono-slope roof or portion thereof and above the top plates of the story or level of the ceiling below.

**[BE] GAMING.** To deal, operate, carry on, conduct, maintain or expose for play any game played with cards, dice, equipment or any mechanical, electromechanical or electronic device or machine for money, property, checks, credit or any representative of value except where occurring at private home or operated by a charitable or educational organization.

**[BE] GAMING AREA.** Single or multiple areas of a building or facility where gaming machines or tables are present and *gaming* occurs, including but not limited to, primary casino gaming areas, VIP gaming areas, high-roller gaming areas, bar tops, lobbies, dedicated rooms or spaces such as in retail or restaurant establishments, sports books and tournament areas.

**[BE] GAMING MACHINE TYPE.** Categorization of gaming machines per type of game played on them, including, but not limited to, slot machines, video poker and video keno.

**[BE] GAMING TABLE TYPE.** Categorization of gaming tables per the type of game played on them, including, but not limited to, baccarat, bingo, blackjack/21, craps, pai gow, poker, roulette.

**[F] GAS CABINET.** A fully enclosed, ventilated noncombustible enclosure used to provide an isolated environment for *compressed gas* cylinders in storage or *use*. Doors and access ports for exchanging cylinders and accessing pressure-regulating controls are allowed to be included.

**[F] GAS DETECTION SYSTEM.** A system or portion of a combination system that utilizes one or more stationary sensors to detect the presence of a specified gas at a specified concentration and initiate one or more responses required by this code, such as notifying a responsible person, activating

## DEFINITIONS

an alarm signal, or activating or deactivating equipment. A self-contained gas detection and alarm device is not classified as a gas detection system.

**[F] GAS ROOM.** A separately ventilated, fully enclosed room in which only *compressed gases* and associated equipment and supplies are stored or *used*.

**[F] GASEOUS HYDROGEN SYSTEM.** An assembly of piping, devices and apparatus designed to generate, store, contain, distribute or transport a nontoxic, gaseous hydrogen-containing mixture having not less than 95-percent hydrogen gas by volume and not more than 1-percent oxygen by volume. Gaseous hydrogen systems consist of items such as *compressed gas* containers, reactors and appurtenances, including pressure regulators, pressure relief devices, manifolds, pumps, compressors and interconnecting piping and tubing and controls.

**[BF] GLASS FIBERBOARD.** Fibrous glass roof insulation consisting of inorganic glass fibers formed into rigid boards using a binder. The board has a top surface faced with asphalt and kraft reinforced with glass fiber.

**[BS] GLASS MAT GYPSUM PANEL.** A *gypsum panel* consisting of a noncombustible core primarily of gypsum, surfaced with glass mat partially or completely embedded in the core.

**[BS] GRADE (LUMBER).** The classification of lumber in regard to strength and utility in accordance with American Softwood Lumber Standard DOC PS 20 and the grading rules of an *approved* lumber rules-writing agency.

**[BE] GRADE FLOOR EMERGENCY ESCAPE AND RESCUE OPENING.** An *emergency escape and rescue opening* located such that the bottom of the clear opening is not more than 44 inches (1118 mm) above or below the finished ground level adjacent to the opening.

**[BG] GRADE PLANE.** A reference plane representing the average of finished ground level adjoining the building at *exterior walls*. Where the finished ground level slopes away from the *exterior walls*, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building, between the building and a point 6 feet (1829 mm) from the building.

**GRADE PLANE, STORY ABOVE.** See “*Story above grade plane*.”

**[BE] GRANDSTAND.** Tiered seating supported on a dedicated structural system and two or more rows high and is not a *building element* (see “*Bleachers*”).

**[BG] GREENHOUSE.** A structure or thermally isolated area of a building that maintains a specialized sunlit environment used for and essential to the cultivation, protection or maintenance of plants.

**[BG] GROSS LEASABLE AREA.** The total floor area designed for tenant occupancy and exclusive use. The area of tenant occupancy is measured from the centerlines of joint partitions to the outside of the tenant walls. All tenant areas, including areas used for storage, shall be included in calculating *gross leasable area*.

**[BG] GROUP HOME.** A facility for social rehabilitation, substance abuse or mental health problems that contains a group housing arrangement that provides *custodial care* but does not provide *medical care*.

**[BE] GUARD.** A building component or a system of building components located at or near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to a lower level.

**[BG] GUESTROOM.** A room used or intended to be used by one or more guests for living or sleeping purposes.

**[BS] GYPSUM BOARD.** The generic name for a family of sheet products consisting of a noncombustible core primarily of gypsum with paper surfacing.

**[BS] GYPSUM PANEL PRODUCT.** The general name for a family of sheet products consisting essentially of gypsum complying with the standards specified in Table 2506.2 and Table 2507.2, and Chapter 35. *Gypsum board* and *glass mat gypsum panels* are examples of *gypsum panel products*.

**[BS] GYPSUM PLASTER.** A mixture of calcined gypsum or calcined gypsum and lime and aggregate and other *approved* materials as specified in this code.

**[BS] GYPSUM SHEATHING.** *Gypsum panel products* specifically manufactured with enhanced water resistance for use as a substrate for exterior surface materials.

**[BS] GYPSUM VENEER PLASTER.** *Gypsum plaster* applied to an *approved* base in one or more coats normally not exceeding  $\frac{1}{4}$  inch (6.4 mm) in total thickness.

**[BS] GYPSUM WALLBOARD.** A *gypsum board* used primarily as an interior surfacing for building structures.

**[BG] HABITABLE SPACE.** A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered *habitable spaces*.

**[F] HALOGENATED EXTINGUISHING SYSTEM.** A fire-extinguishing system using one or more atoms of an element from the halogen chemical series: fluorine, chlorine, bromine and iodine.

**[F] HANDLING.** The deliberate transport by any means to a point of storage or *use*.

**[BE] HANDRAIL.** A horizontal or sloping rail intended for grasping by the hand for guidance or support.

**[BS] HARDBOARD.** A fibrous-felted, homogeneous panel made from lignocellulosic fibers consolidated under heat and pressure in a hot press to a density not less than 31 pcf (497 kg/m<sup>3</sup>).

**HARDWARE.** See “*Fire exit hardware*” and “*Panic hardware*.”

**[F] HAZARDOUS MATERIALS.** Those chemicals or substances that are *physical hazards* or *health hazards* as classified in Section 307 and the *International Fire Code*, whether the materials are in usable or waste condition.

**[F] HAZARDOUS PRODUCTION MATERIAL (HPM).** A *solid*, *liquid* or gas associated with semiconductor manufacturing that has a degree-of-hazard rating in health,

flammability or instability of Class 3 or 4 as ranked by NFPA 704 and which is *used* directly in research, laboratory or production processes which have as their end product materials that are not hazardous.

**[BS] HEAD JOINT.** Vertical *mortar joint* placed between *masonry units* within the *wythe* at the time the *masonry units* are laid.

**[F] HEALTH HAZARD.** A classification of a chemical for which there is statistically significant evidence that acute or chronic health effects are capable of occurring in exposed persons. The term “health hazard” includes chemicals that are *toxic* or *highly toxic*, and *corrosive*.

**HEAT DETECTOR.** See “*Detector, heat.*”

**[BG] HEIGHT, BUILDING.** The vertical distance from *grade plane* to the average height of the highest roof surface.

**[BS] HELICAL PILE.** Manufactured steel *deep foundation* element consisting of a central shaft and one or more helical bearing plates. A *helical pile* is installed by rotating it into the ground. Each helical bearing plate is formed into a screw thread with a uniform defined pitch.

**[F] HELIPAD.** A structural surface that is used for the landing, taking off, taxiing and parking of helicopters.

**[F] HELIPORT.** An area of land or water or a structural surface that is used, or intended for use, for the landing and taking off of helicopters, and any appurtenant areas that are used, or intended for use, for heliport buildings or other heliport facilities.

**[F] HELISTOP.** The same as “heliport,” except that no fueling, defueling, maintenance, repairs or storage of helicopters is permitted.

**[F] HIGHER EDUCATION LABORATORY.** Laboratories in Group B occupancies used for educational purposes above the 12th grade. Storage, use and handling of chemicals in such laboratories shall be limited to purposes related to testing, analysis, teaching, research or developmental activities on a nonproduction basis.

**[F] HIGHLY TOXIC.** A material which produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical that has a median lethal dose ( $LD_{50}$ ) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
2. A chemical that has a median lethal dose ( $LD_{50}$ ) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration ( $LC_{50}$ ) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as *highly toxic*. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

**[BF] HIGH-PRESSURE DECORATIVE EXTERIOR-GRADE COMPACT LAMINATE (HPL).** Panels consisting of layers of cellulose fibrous material impregnated with thermosetting resins and bonded together by a high-pressure process to form a homogeneous nonporous core suitable for exterior use.

**[BF] HIGH-PRESSURE DECORATIVE EXTERIOR-GRADE COMPACT LAMINATE (HPL) SYSTEM.** An *exterior wall covering* fabricated using HPL in a specific assembly including *joints*, seams, attachments, substrate, framing and other details as appropriate to a particular design.

**[BG] HIGH-RISE BUILDING.** A building with an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.

**[A] HISTORIC BUILDINGS.** Any building or structure that is one or more of the following:

1. Listed or certified as eligible for listing by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places, in the National Register of Historic Places.
2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a National Register, state designated or locally designated historic district.

**[BF] HORIZONTAL ASSEMBLY.** A fire-resistance-rated floor or *roof assembly* of materials designed to restrict the spread of fire in which continuity is maintained.

**[BE] HORIZONTAL EXIT.** An *exit* component consisting of fire-resistance-rated construction and opening protectives intended to compartmentalize portions of a building thereby creating refuge areas that afford safety from the fire and smoke from the area of fire origin.

**[BG] HOSPITALS AND PSYCHIATRIC HOSPITALS.** Facilities that provide care or treatment for the medical, psychiatric, obstetrical, or surgical treatment of care recipients who are *incapable of self-preservation*.

**[BG] HOUSING UNIT.** A *dormitory* or a group of *cells* with a common dayroom in Group I-3.

**HPM.** See “*Hazardous Production Material.*”

**[F] HPM ROOM.** A room used in conjunction with or serving a Group H-5 occupancy, where *HPM* is stored or *used* and which is classified as a Group H-2, H-3 or H-4 occupancy.

**[BS] HURRICANE-PRONE REGIONS.** Areas vulnerable to hurricanes defined as:

1. The US Atlantic Ocean and Gulf of Mexico coasts where the basic design wind speed, *V*, for Risk Category II buildings is greater than 115 mph (51.4 m/s);



## DEFINITIONS

2. Hawaii, Puerto Rico, Guam, Virgin Islands and American Samoa.

**[F] HYDROGEN FUEL GAS ROOM.** A room or space that is intended exclusively to house a *gaseous hydrogen system*.

**[BS] ICE-SENSITIVE STRUCTURE.** A structure for which the effect of an atmospheric ice *load* governs the design of a structure or portion thereof. This includes, but is not limited to, lattice structures, guyed masts, overhead lines, light suspension and cable-stayed bridges, aerial cable systems (e.g., for ski lifts or logging operations), amusement rides, open catwalks and platforms, flagpoles and signs.

**[F] IMMEDIATELY DANGEROUS TO LIFE AND HEALTH (IDLH).** The concentration of airborne contaminants which poses a threat of death, immediate or delayed permanent adverse health effects, or effects that could prevent escape from such an environment. This contaminant concentration level is established by the National Institute of Occupational Safety and Health (NIOSH) based on both toxicity and flammability. It generally is expressed in parts per million by volume (ppmv/v) or milligrams per cubic meter (mg/m<sup>3</sup>). If adequate data do not exist for precise establishment of IDLH concentrations, an independent certified industrial hygienist, industrial toxicologist, appropriate regulatory agency or other source *approved* by the *building official* shall make such determination.

**[BS] IMPACT LOAD.** The *load* resulting from moving machinery, elevators, craneways, vehicles and other similar forces and kinetic *loads*, pressure and possible surcharge from fixed or moving *loads*.

**[BS] IMPACT PROTECTIVE SYSTEM.** Construction that has been shown by testing to withstand the impact of test missiles and that is applied, attached or locked over exterior glazing.

**[BG] INCAPABLE OF SELF-PRESERVATION.** Persons who, because of age, physical limitations, mental limitations, chemical dependency or medical treatment, cannot respond as an individual to an emergency situation.

**[F] INCOMPATIBLE MATERIALS.** Materials that, when mixed, have the potential to react in a manner that generates heat, fumes, gases or byproducts which are hazardous to life or property.

**[BS] INDIVIDUAL TRUSS MEMBER.** A truss chord or truss web.

**[F] INERT GAS.** A gas that is capable of reacting with other materials only under abnormal conditions such as high temperatures, pressures and similar extrinsic physical forces. Within the context of the code, inert gases do not exhibit either physical or health hazard properties as defined (other than acting as a simple asphyxiant) or hazard properties other than those of a *compressed gas*. Some of the more common inert gases include argon, helium, krypton, neon, nitrogen and xenon.

**[F] INITIATING DEVICE.** A system component that originates transmission of a change-of-state condition, such as in a *smoke detector*, *manual fire alarm box* or supervisory switch.

**[BF] INSULATING SHEATHING.** A rigid panel or board insulation material having a thermal resistance of not less than R-2 of the core material with properties suitable for use on walls, floors, roofs or foundations.

**[BE] INTENDED TO BE OCCUPIED AS A RESIDENCE.** This refers to a *dwelling unit* or *sleeping unit* that can or will be used all or part of the time as the occupant's place of abode.

**[BE] INTERIOR EXIT RAMP.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and provides for a protected path of egress travel to the *exit discharge* or *public way*.

**[BE] INTERIOR EXIT STAIRWAY.** An *exit* component that serves to meet one or more *means of egress* design requirements, such as required number of *exits* or *exit access* travel distance, and provides for a protected path of egress travel to the *exit discharge* or *public way*.

**[BF] INTERIOR FINISH.** Interior finish includes *interior wall* and *ceiling finish* and *interior floor finish*.

**[BF] INTERIOR FLOOR FINISH.** The exposed floor surfaces of buildings including coverings applied over a finished floor or *stair*, including risers.

**[BF] INTERIOR FLOOR-WALL BASE.** *Interior floor finish trim* used to provide a functional or decorative border at the intersection of walls and floors.

**[BF] INTERIOR SURFACES.** Surfaces other than weather exposed surfaces.

**[BF] INTERIOR WALL AND CEILING FINISH.** The exposed *interior surfaces* of buildings, including but not limited to: fixed or movable walls and partitions; toilet room privacy partitions; columns; ceilings; and interior wainscoting, paneling or other finish applied structurally or for decoration, acoustical correction, surface insulation, structural fire resistance or similar purposes, but not including *trim*.

**[BS] INTERLAYMENT.** A layer of felt or nonbituminous saturated felt not less than 18 inches (457 mm) wide, shingled between each course of a wood-shake *roof covering*.

**[BS] INTERMODAL SHIPPING CONTAINER.** A six-sided steel unit originally constructed as a general cargo container used for the transport of goods and materials.

**[BF] INTUMESCENT FIRE-RESISTANT COATINGS.** Thin film liquid mixture applied to substrates by brush, roller, spray or trowel which expands into a protective foamed layer to provide fire-resistant protection of the substrates when exposed to flame or intense heat.

**[BS] JOINT.** The opening in or between adjacent assemblies that is created due to building tolerances, or is designed to allow independent movement of the building in any plane caused by thermal, seismic, wind or any other loading.

**[A] JURISDICTION.** The governmental unit that has adopted this code.



**[BF] L RATING.** The air leakage rating of a *through penetration firestop system* or a fire-resistant *joint system* when tested in accordance with UL 1479 or UL 2079, respectively.

**[A] LABEL.** An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material and the name and identification of an *approved agency*, and that indicates that the representative sample of the product or material has been tested and evaluated by an *approved agency* (see Section 1703.5, “*Manufacturer’s designation*” and “*Mark*”).

**[A] LABELED.** Equipment, materials or products to which has been affixed a *label*, seal, symbol or other identifying *mark* of a nationally recognized testing laboratory, *approved agency* or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and whose labeling indicates either that the equipment, material or product meets identified standards or has been tested and found suitable for a specified purpose.

**[F] LABORATORY SUITE.** A fire-rated, enclosed laboratory area providing one or more laboratory spaces within a Group B educational occupancy that includes ancillary uses such as offices, bathrooms and corridors that are contiguous with the laboratory area, and are constructed in accordance with Section 428.

**LEVEL OF EXIT DISCHARGE.** See “*Exit discharge, level of.*”

**[F] LIFE SAFETY SYSTEMS.** Systems, devices and equipment that enhance or facilitate evacuation, smoke control, compartmentation and isolation.

**[BF] LIGHT-DIFFUSING SYSTEM.** Construction consisting in whole or in part of lenses, panels, grids or baffles made with light-transmitting plastics positioned below independently mounted electrical light sources, skylights or light-transmitting plastic roof panels. Lenses, panels, grids and baffles that are part of an electrical fixture shall not be considered as a light-diffusing system.

**[BS] LIGHT-FRAME CONSTRUCTION.** Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

**[BF] LIGHT-TRANSMITTING PLASTIC ROOF PANELS.** Structural plastic panels other than *skylights* that are fastened to structural members, or panels or sheathing and that are used as light-transmitting media in the plane of the roof.

**[BF] LIGHT-TRANSMITTING PLASTIC WALL PANELS.** Plastic materials that are fastened to structural members, or to structural panels or sheathing, and that are used as light-transmitting media in *exterior walls*.

**[BS] LIMIT OF MODERATE WAVE ACTION.** Line shown on FIRMs to indicate the inland limit of the 1 $\frac{1}{2}$ -foot (457 mm) breaking wave height during the *base flood*.

**[BS] LIMIT STATE.** A condition beyond which a structure or member becomes unfit for service and is judged to be no longer useful for its intended function (*serviceability limit state*) or to be unsafe (*strength limit state*).

**[F] LIQUID.** A material that has a melting point that is equal to or less than 68°F (20°C) and a *boiling point* that is greater than 68°F (20°C) at 14.7 pounds per square inch absolute (psia) (101 kPa). When not otherwise identified, the term “liquid” includes both *flammable* and *combustible liquids*.

**[F] LIQUID STORAGE ROOM.** A room classified as a Group H-3 occupancy used for the storage of *flammable* or *combustible liquids* in a closed condition.

**[F] LIQUID USE, DISPENSING AND MIXING ROOM.** A room in which Class I, II and IIIA *flammable* or *combustible liquids* are *used*, dispensed or mixed in open containers.

**[A] LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *building official* and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

**[BS] LIVE LOAD.** A *load* produced by the use and occupancy of the building or other structure that does not include construction or environmental *loads* such as wind load, snow load, rain load, earthquake load, flood load or dead load.

**[BS] LIVE LOAD, ROOF.** A *load* on a roof produced:

1. During maintenance by workers, equipment and materials; or
2. During the life of the structure by movable objects such as planters or other similar small decorative appurtenances that are not occupancy related.

**[BG] LIVE/WORK UNIT.** A *dwelling unit* or *sleeping unit* in which a significant portion of the space includes a nonresidential use that is operated by the tenant.

**[BS] LOAD AND RESISTANCE FACTOR DESIGN (LRFD).** A method of proportioning structural members and their connections using load and *resistance factors* such that no applicable *limit state* is reached when the structure is subjected to appropriate load combinations. The term “LRFD” is used in the design of steel and wood structures.

**[BS] LOAD EFFECTS.** Forces and deformations produced in structural members by the applied *loads*.

**[BS] LOAD FACTOR.** A factor that accounts for deviations of the actual *load* from the *nominal load*, for uncertainties in the analysis that transforms the *load* into a *load effect*, and for the probability that more than one extreme *load* will occur simultaneously.

**[BS] LOADS.** Forces or other actions that result from the weight of building materials, occupants and their possessions, environmental effects, differential movement and restrained dimensional changes. Permanent *loads* are those *loads* in

## DEFINITIONS

which variations over time are rare or of small magnitude, such as *dead loads*. All other *loads* are variable loads (see “*Nominal loads*”).

**[BG] LODGING HOUSE.** A one-family dwelling where one or more occupants are primarily permanent in nature and rent is paid for guest rooms.

**[A] LOT.** A portion or parcel of land considered as a unit.

**[A] LOT LINE.** A line dividing one lot from another, or from a street or any public place.

**[BE] LOW-ENERGY POWER-OPERATED DOOR.** A swinging, sliding or folding door that opens automatically upon an action by a pedestrian such as pressing a push plate or waving a hand in front of a sensor. The door closes automatically, and operates with decreased forces and decreased speeds (see “*Power-assisted door*” and “*Power-operated door*”).

**[F] LOWER FLAMMABLE LIMIT (LFL).** The minimum concentration of vapor in air at which propagation of flame will occur in the presence of an ignition source. The LFL is sometimes referred to as “LEL” or “lower explosive limit.”

**[BS] LOWEST FLOOR.** The *lowest floor* of the lowest enclosed area, including *basement*, but excluding any unfinished or flood-resistant enclosure, usable solely for vehicle parking, building access or limited storage provided that such enclosure is not built so as to render the structure in violation of Section 1612.

**[BS] MAIN WINDFORCE-RESISTING SYSTEM.** An assemblage of structural elements assigned to provide support and stability for the overall structure. The system generally receives wind loading from more than one surface

**MALL BUILDING, COVERED and MALL BUILDING, OPEN.** See “*Covered mall building*.”

**[F] MANUAL FIRE ALARM BOX.** A manually operated device used to initiate an *alarm signal*.

**[A] MANUFACTURER’S DESIGNATION.** An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules (see “*Label*” and “*Mark*”).

**[A] MARK.** An identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material (see “*Label*” and “*Manufacturer’s designation*”).

**[BG] MARQUEE.** A *canopy* that has a top surface which is sloped less than 25 degrees from the horizontal and is located less than 10 feet (3048 mm) from operable openings above or adjacent to the level of the marquee.

**[BS] MASONRY.** A built-up construction or combination of building units or materials of clay, shale, concrete, glass, gypsum, stone or other *approved* units bonded together with or without *mortar* or grout or other accepted methods of joining.

**Glass unit masonry.** Masonry composed of glass units bonded by *mortar*.

**Plain masonry.** Masonry in which the tensile resistance of the masonry is taken into consideration and the effects of stresses in reinforcement are neglected.

**Reinforced masonry.** Masonry construction in which reinforcement acting in conjunction with the masonry is used to resist forces.

**Solid masonry.** Masonry consisting of solid *masonry units* laid contiguously with the *joints* between the units filled with *mortar*.

**Unreinforced (plain) masonry.** Masonry in which the tensile resistance of masonry is taken into consideration and the resistance of the reinforcing steel, if present, is neglected.

**[BS] MASONRY UNIT.** *Brick*, tile, stone, glass block or concrete block conforming to the requirements specified in Section 2103.

**Hollow.** A *masonry unit* whose net cross-sectional *area* in any plane parallel to the load-bearing surface is less than 75 percent of its gross cross-sectional *area* measured in the same plane.

**Solid.** A *masonry unit* whose net cross-sectional *area* in every plane parallel to the load-bearing surface is 75 percent or more of its gross cross-sectional *area* measured in the same plane.

**[BG] MASS TIMBER.** Structural elements of Type IV construction primarily of solid, built-up, panelized or engineered wood products that meet minimum cross-section dimensions of Type IV construction.

**[BF] MASTIC FIRE-RESISTANT COATINGS.** Liquid mixture applied to a substrate by brush, roller, spray or trowel that provides fire-resistant protection of a substrate when exposed to flame or intense heat.

**[BE] MEANS OF EGRESS.** A continuous and unobstructed path of vertical and horizontal egress travel from any occupied portion of a building or structure to a *public way*. A *means of egress* consists of three separate and distinct parts: the *exit access*, the *exit* and the *exit discharge*.

**[BF] MECHANICAL EQUIPMENT SCREEN.** A rooftop structure, not covered by a roof, used to aesthetically conceal plumbing, electrical or mechanical equipment from view.

**[BG] MECHANICAL-ACCESS ENCLOSED PARKING GARAGE.** An enclosed parking garage that employs parking machines, lifts, elevators or other mechanical devices for vehicle moving from and to street level and in which public occupancy in the garage is prohibited in all areas except the vehicle access bay.

**[BG] MECHANICAL-ACCESS OPEN PARKING GARAGES.** *Open parking garages* employing parking machines, lifts, elevators or other mechanical devices for vehicles moving from and to street level and in which public occupancy is prohibited above the street level.

**[BG] MEDICAL CARE.** Care involving medical or surgical procedures, nursing or for psychiatric purposes.

## DEFINITIONS

**[BF] MEMBRANE PENETRATION.** A breach in one side of a floor-ceiling, roof-ceiling or wall assembly to accommodate an item installed into or passing through the breach.

**[BG] MEMBRANE-COVERED CABLE STRUCTURE.** A nonpressurized structure in which a mast and cable system provides support and tension to the membrane weather barrier and the membrane imparts stability to the structure.

**[BG] MEMBRANE-COVERED FRAME STRUCTURE.** A nonpressurized building wherein the structure is composed of a rigid framework to support a tensioned membrane which provides the weather barrier.

**[BF] MEMBRANE-PENETRATION FIRESTOP.** A material, device or construction installed to resist for a prescribed time period the passage of flame and heat through openings in a protective membrane in order to accommodate cables, cable trays, conduit, tubing, pipes or similar items.

**[BF] MEMBRANE-PENETRATION FIRESTOP SYSTEM.** An assemblage consisting of a fire-resistance-rated floor-ceiling, roof-ceiling or wall assembly, one or more penetrating items installed into or passing through the breach in one side of the assembly and the materials or devices, or both, installed to resist the spread of fire into the assembly for a prescribed period of time.

**[BE] MERCHANDISE PAD.** A merchandise pad is an area for display of merchandise surrounded by *aisles*, permanent fixtures or walls. Merchandise pads contain elements such as nonfixed and movable fixtures, cases, racks, counters and partitions as indicated in Section 105.2 from which customers browse or shop.

**[BF] METAL COMPOSITE MATERIAL (MCM).** A factory-manufactured panel consisting of metal skins bonded to both faces of a solid plastic core.

**[BF] METAL COMPOSITE MATERIAL (MCM) SYSTEM.** An *exterior wall covering* fabricated using MCM in a specific assembly including *joints*, seams, attachments, substrate, framing and other details as appropriate to a particular design.

**[BS] METAL ROOF PANEL.** An interlocking metal sheet having a minimum installed weather exposure of 3 square feet (0.279 m<sup>2</sup>) per sheet.

**[BS] METAL ROOF SHINGLE.** An interlocking metal sheet having an installed weather exposure less than 3 square feet (0.279 m<sup>2</sup>) per sheet.

**[BG] MEZZANINE.** An intermediate level or levels between the floor and ceiling of any *story* and in accordance with Section 505.

**[BS] MICROPILE.** A *micropile* is a bored, grouted-in-place *deep foundation* element that develops its load-carrying capacity by means of a bond zone in soil, bedrock or a combination of soil and bedrock.

**[BF] MINERAL BOARD.** A rigid felted thermal insulation board consisting of either felted mineral fiber or cellular beads of expanded aggregate formed into flat rectangular units.

**[BF] MINERAL FIBER.** Insulation composed principally of fibers manufactured from rock, slag or glass, with or without binders.

**[BF] MINERAL WOOL.** Synthetic vitreous fiber insulation made by melting predominately igneous rock or furnace slag, and other inorganic materials, and then physically forming the melt into fibers.

**[BS] MODIFIED BITUMEN ROOF COVERING.** One or more layers of polymer-modified asphalt sheets. The sheet materials shall be fully adhered or mechanically attached to the substrate or held in place with an *approved ballast* layer.

**[BS] MORTAR.** A mixture consisting of cementitious materials, fine aggregates, water, with or without admixtures, that is used to construct unit masonry assemblies.

**[BS] MORTAR, SURFACE-BONDING.** A mixture to bond concrete *masonry units* that contains hydraulic cement, glass fiber reinforcement with or without inorganic fillers or organic modifiers and water.

**[BE] MULTILEVEL ASSEMBLY SEATING.** Seating that is arranged in distinct levels where each level is composed of either multiple rows, or a single row of box seats accessed from a separate level.

**[F] MULTIPLE-STATION ALARM DEVICE.** Two or more single-station alarm devices that can be interconnected such that actuation of one causes all integral or separate audible alarms to operate. A multiple-station alarm device can consist of one single-station alarm device having connections to other detectors or to a *manual fire alarm box*.

**[F] MULTIPLE-STATION SMOKE ALARM.** Two or more single-station alarm devices that are capable of interconnection such that actuation of one causes the appropriate *alarm signal* to operate in all interconnected alarms.

**[BE] MULTISTORY UNIT.** A *dwelling unit* or *sleeping unit* with *habitable space* located on more than one story.

**[BF] NAILABLE SUBSTRATE.** A product or material such as framing, sheathing or furring, composed of wood, wood-based materials or other materials providing equivalent fastener withdrawal resistance.

**[BS] NAILING, BOUNDARY.** A special nailing pattern required by design at the boundaries of *diaphragms*.

**[BS] NAILING, EDGE.** A special nailing pattern required by design at the edges of each panel within the assembly of a *diaphragm* or *shear wall*.

**[BS] NAILING, FIELD.** Nailing required between the sheathing panels and framing members at locations other than *boundary nailing* and *edge nailing*.

**[BS] NATURALLY DURABLE WOOD.** The heartwood of the following species except for the occasional piece with corner sapwood, provided 90 percent or more of the width of each side on which it occurs is heartwood.

**Decay resistant.** Redwood, cedar, black locust and black walnut.

**Termite resistant.** Redwood, Alaska yellow cedar, Eastern red cedar and Western red cedar.



## DEFINITIONS

**[BS] NOMINAL LOADS.** The magnitudes of the *loads* specified in Chapter 16 (dead, live, soil, wind, snow, rain, flood and earthquake).

**[BS] NOMINAL SIZE (LUMBER).** The commercial size designation of width and depth, in standard sawn lumber and glued-laminated lumber *grades*; somewhat larger than the standard net size of dressed lumber, in accordance with DOCPS 20 for sawn lumber and with the ANSI/AWC NDS for glued-laminated lumber.

**[BG] NONCOMBUSTIBLE MEMBRANE STRUCTURE.** A membrane structure in which the membrane and all component parts of the structure are noncombustible.

**[BF] NONCOMBUSTIBLE PROTECTION (FOR MASS TIMBER).** Noncombustible material, in accordance with Section 703.6, designed to increase the *fire-resistance rating* and delay the combustion of *mass timber*.

**[BS] NONSTRUCTURAL CONCRETE.** Any element made of plain or reinforced concrete that is not part of a structural system required to transfer either gravity or lateral *loads* to the ground.

**[F] NORMAL TEMPERATURE AND PRESSURE (NTP).** A temperature of 70°F (21°C) and a pressure of 1 atmosphere [14.7 psia (101 kPa)].

**[BE] NOSING.** The leading edge of treads of *stairs* and of landings at the top of *stairway flights*.

**NOTIFICATION ZONE.** See “*Zone, notification.*”

**[F] NUISANCE ALARM.** An alarm caused by mechanical failure, malfunction, improper installation or lack of proper maintenance, or an alarm activated by a cause that cannot be determined.

**[BG] NURSING HOMES.** Facilities that provide care, including both intermediate care facilities and skilled nursing facilities where any of the persons are *incapable of self-preservation*.

**[BE] OCCUPANT LOAD.** The number of persons for which the *means of egress* of a building or portion thereof is designed.

**[BG] OCCUPIABLE SPACE.** A room or enclosed space designed for human occupancy in which individuals congregate for amusement, educational or similar purposes or in which occupants are engaged at labor, and which is equipped with *means of egress* and light and *ventilation* facilities meeting the requirements of this code.

**[BG] OPEN PARKING GARAGE.** A structure or portion of a structure with the openings as described in Section 406.5.2 on two or more sides that is used for the parking or storage of private motor vehicles as described in Section 406.5.3.

**[F] OPEN SYSTEM.** The *use of a solid or liquid hazardous material* involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for *solids* and *liquids* include dispensing from or into open beakers or containers, dip tank and plating tank operations.

**[BE] OPEN-AIR ASSEMBLY SEATING.** Seating served by *means of egress* that is not subject to smoke accumulation within or under a structure and is open to the atmosphere.

**[BE] OPEN-ENDED CORRIDOR.** An interior *corridor* that is open on each end and connects to an exterior *stairway* or *ramp* at each end with no intervening doors or separation from the *corridor*.

**[BF] OPENING PROTECTIVE.** A *fire door assembly*, *fire shutter assembly*, *fire window assembly* or glass-block assembly in a fire-resistance-rated wall or partition.

**[F] OPERATING BUILDING.** A building occupied in conjunction with the manufacture, transportation or *use of explosive materials*. Operating buildings are separated from one another with the use of intraplant or intraline distances.

**[BS] ORDINARY PRECAST STRUCTURAL WALL.** See Section 1905.1.1.

**[BS] ORDINARY REINFORCED CONCRETE STRUCTURAL WALL.** See Section 1905.1.1.

**[BS] ORDINARY STRUCTURAL PLAIN CONCRETE WALL.** See Section 1905.1.1.

**[F] ORGANIC PEROXIDE.** An organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms have been replaced by an organic radical. Organic peroxides can pose an *explosion* hazard (*detonation* or *deflagration*) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

**Class I.** Those formulations that are capable of *deflagration* but not *detonation*.

**Class II.** Those formulations that burn very rapidly and that pose a moderate reactivity hazard.

**Class III.** Those formulations that burn rapidly and that pose a moderate reactivity hazard.

**Class IV.** Those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.

**Class V.** Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.

**Unclassified detonable.** Organic peroxides that are capable of *detonation*. These peroxides pose an extremely high *explosion* hazard through rapid explosive decomposition.

**[BS] ORTHOGONAL.** To be in two horizontal directions, at 90 degrees (1.57 rad) to each other.

**[BS] OTHER STRUCTURES.** This definition applies only to Chapters 16 through 23.

Structures, other than buildings, for which loads are specified in Chapter 16.

**OUTPATIENT CLINIC.** See “*Clinic, outpatient.*”

**[A] OWNER.** Any person, agent, operator, entity, firm or corporation having any legal or equitable interest in the property; or recorded in the official records of the state, county or municipality as holding an interest or title to the property; or



otherwise having possession or control of the property, including the guardian of the estate of any such person, and the executor or administrator of the estate of such person if ordered to take possession of real property by a court.

**[F] OXIDIZER.** A material that readily yields oxygen or other *oxidizing gas*, or that readily reacts to promote or initiate combustion of combustible materials and, if heated or contaminated, can result in vigorous self-sustained decomposition.

**Class 4.** An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock and that causes a severe increase in the burning rate of combustible materials with which it comes into contact. Additionally, the oxidizer causes a severe increase in the burning rate and can cause spontaneous ignition of combustibles.

**Class 3.** An oxidizer that causes a severe increase in the burning rate of combustible materials with which it comes in contact.

**Class 2.** An oxidizer that will cause a moderate increase in the burning rate of combustible materials with which it comes in contact.

**Class 1.** An oxidizer that does not moderately increase the burning rate of combustible materials.

**[F] OXIDIZING GAS.** A gas that can support and accelerate combustion of other materials more than air does.

**[BS] PANEL (PART OF A STRUCTURE).** The section of a floor, wall or roof comprised between the supporting frame of two adjacent rows of columns and girders or column bands of floor or roof construction.

**[BE] PANIC HARDWARE.** A door-latching assembly incorporating a device that releases the latch upon the application of a force in the direction of egress travel. See “*Fire exit hardware*.”

**[BS] PARTICLEBOARD.** A generic term for a panel primarily composed of cellulosic materials (usually wood), generally in the form of discrete pieces or particles, as distinguished from fibers. The cellulosic material is combined with synthetic resin or other suitable bonding system by a process in which the interparticle bond is created by the bonding system under heat and pressure.

**[BF] PENETRATION FIRESTOP.** A *through-penetration* firestop or a *membrane-penetration firestop*.

**[BG] PENTHOUSE.** An enclosed, unoccupied rooftop structure used for sheltering mechanical and electrical equipment, tanks, elevators and related machinery, *stairways*, and vertical *shaft* openings.

**[BS] PERFORMANCE CATEGORY.** A designation of *wood structural panels* as related to the panel performance used in Chapter 23.

**[BF] PERIMETER FIRE CONTAINMENT SYSTEM.** An assemblage of specific materials or products that is designed to resist for a prescribed period of time the passage

of fire through voids created at the intersection of exterior curtain wall assemblies and fire-resistance-rated floor or floor/ceiling assemblies.

**[BS] PERMANENT INDIVIDUAL TRUSS MEMBER DIAGONAL BRACING (PITMDB).** Structural member or assembly intended to permanently stabilize the *PITMRs*.

**[BS] PERMANENT INDIVIDUAL TRUSS MEMBER RESTRAINT (PITMR).** Restraint that is used to prevent local buckling of an individual truss chord or web member because of the axial forces in the *individual truss member*.

**[A] PERMIT.** An official document or certificate issued by the *building official* that authorizes performance of a specified activity.

**[A] PERSON.** An individual, heirs, executors, administrators or assigns, and also includes a firm, partnership or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

**[BG] PERSONAL CARE SERVICE.** The care of persons who do not require *medical care*. Personal care involves responsibility for the safety of the persons while inside the building

**[BE] PHOTOLUMINESCENT.** Having the property of emitting light that continues for a length of time after excitation by visible or invisible light has been removed.

**[BS] PHOTOVOLTAIC MODULE.** A complete, environmentally protected unit consisting of solar cells, optics and other components, exclusive of tracker, designed to generate DC power when exposed to sunlight.

**[BS] PHOTOVOLTAIC PANEL.** A collection of modules mechanically fastened together, wired and designed to provide a field-installable unit.

**[BS] PHOTOVOLTAIC PANEL SYSTEM.** A system that incorporates discrete *photovoltaic panels*, that converts solar radiation into electricity, including rack support systems.

**[BS] PHOTOVOLTAIC SHINGLES.** A *roof covering* resembling shingles that incorporates *photovoltaic modules*.

**[F] PHYSICAL HAZARD.** A chemical for which there is evidence that it is a *combustible liquid*, *cryogenic fluid*, *explosive*, flammable (*solid*, *liquid* or *gas*), *organic peroxide* (*solid* or *liquid*), *oxidizer* (*solid* or *liquid*), *oxidizing gas*, *pyrophoric* (*solid*, *liquid* or *gas*), *unstable (reactive) material* (*solid*, *liquid* or *gas*) or *water-reactive material* (*solid* or *liquid*).

**[F] PHYSIOLOGICAL WARNING THRESHOLD LEVEL.** A concentration of airborne contaminants, normally expressed in parts per million (ppm) or milligrams per cubic meter (mg/m<sup>3</sup>), that represents the concentration at which persons can sense the presence of the contaminant due to odor, irritation or other quick-acting physiological response. When used in conjunction with the permissible exposure limit (PEL) the physiological warning threshold levels are those consistent with the classification system used to establish the PEL. See the definition of “*Permissible exposure limit (PEL)*” in the *International Fire Code*.

## DEFINITIONS

**PLACE OF RELIGIOUS WORSHIP.** See “*Religious worship, place of.*”

**[BF] PLASTIC COMPOSITE.** A generic designation that refers to wood/plastic composites, plastic lumber and similar materials.

**[BF] PLASTIC GLAZING.** Plastic materials that are glazed or set in a frame or sash or are otherwise supported.

**[BF] PLASTIC LUMBER.** A manufactured product made primarily of plastic materials (filled or unfilled) which is generally rectangular in cross section.

**[BG] PLATFORM.** A raised area within a building used for worship, the presentation of music, plays or other entertainment; the head table for special guests; the raised area for lecturers and speakers; boxing and wrestling rings; theater-in-the-round *stages*; and similar purposes wherein, other than horizontal sliding curtains, there are no overhead hanging curtains, drops, scenery or stage effects other than lighting and sound. A temporary platform is one installed for not more than 30 days.

**[BG] PLAY STRUCTURE.** A structure composed of one or more components, where the user enters a play environment.

**[BF] POLYPROPYLENE SIDING.** A shaped material, made principally from polypropylene homopolymer, or copolymer, which in some cases contains fillers or reinforcements, that is used to clad *exterior walls* of buildings.

**[BS] PORCELAIN TILE.** Ceramic tile having an absorption of 0.5 percent or less in accordance with Table 10 of ANSI A137.1, or Tables 4 or 5 of ANSI A137.3.

**[BS] POSITIVE ROOF DRAINAGE.** A design that accounts for deflections from all *design loads* and has sufficient additional slope to ensure that drainage of the roof occurs within 48 hours of precipitation.

**[BE] POWER-ASSISTED DOOR.** Swinging door which opens by reduced pushing or pulling force on the door-operating hardware. The door closes automatically after the pushing or pulling force is released and functions with decreased forces. See “*Low-energy power-operated door*” and “*Power-operated door.*”

**[BE] POWER-OPERATED DOOR.** Swinging, sliding, or folding door which opens automatically when approached by a pedestrian or opens automatically upon an action by a pedestrian. The door closes automatically and includes provisions such as presence sensors to prevent entrapment. See “*Low energy power-operated door*” and “*Power-assisted door.*”

**[BS] PREFABRICATED WOOD I-JOIST.** Structural member manufactured using sawn or *structural composite lumber* flanges and *wood structural panel* webs bonded together with exterior exposure adhesives, which forms an “I” cross-sectional shape.

**[BS] PRESERVATIVE-TREATED WOOD.** Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced susceptibility to damage by fungi, insects or marine borers.

**[BS] PRESTRESSED MASONRY.** Masonry in which internal stresses have been introduced to counteract potential tensile stresses in *masonry* resulting from applied *loads*.

**[BG] PRIMARY STRUCTURAL FRAME.** The primary structural frame shall include all of the following structural members:

1. The columns.
2. Structural members having direct connections to the columns, including girders, beams, trusses and spandrels.
3. Members of the floor construction and roof construction having direct connections to the columns.
4. Members that are essential to the vertical stability of the *primary structural frame* under gravity loading.

**[BG] PRIVATE GARAGE.** A building or portion of a building in which motor vehicles used by the *owner* or tenants of the building or buildings on the premises are stored or kept, without provisions for repairing or servicing such vehicles for profit.

**[BG] PROSCENIUM WALL.** The wall that separates the *stage* from the auditorium or assembly seating area.

**PSYCHIATRIC HOSPITALS.** See “*Hospitals and psychiatric hospitals.*”

**[BE] PUBLIC ENTRANCE.** An entrance that is not a *service entrance* or a *restricted entrance*.

**[A] PUBLIC WAY.** A street, alley or other parcel of land open to the outside air leading to a street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and which has a clear width and height of not less than 10 feet (3048 mm).

**[BE] PUBLIC-USE AREAS.** Interior or exterior rooms or spaces that are made available to the general public.

**[BG] PUZZLE ROOM.** A puzzle room is a type of *special amusement area* in which occupants are encouraged to solve a challenge to escape from a room or series of rooms.

**[F] PYROPHORIC.** A chemical with an auto-ignition temperature in air, at or below a temperature of 130°F (54.4°C).

**[F] PYROTECHNIC COMPOSITION.** A chemical mixture that produces visible light displays or sounds through a self-propagating, heat-releasing chemical reaction which is initiated by ignition.

**[BF] RADIANT BARRIER.** A material having a low-*emittance* surface of 0.1 or less installed in building assemblies.

**[BE] RAMP.** A walking surface that has a running slope steeper than one unit vertical in 20 units horizontal (5-percent slope).

**RAMP, EXIT ACCESS.** See “*Exit access ramp.*”

**RAMP, EXTERIOR EXIT.** See “*Exterior exit ramp.*”

**RAMP, INTERIOR EXIT.** See “*Interior exit ramp.*”

**[BG] RAMP-ACCESS OPEN PARKING GARAGES.** *Open parking garages* employing a series of continuously rising floors or a series of interconnecting ramps between floors permitting the movement of vehicles under their own power from and to the street level.

**[A] RECORD DRAWINGS.** Drawings (“as built”) that document the location of all devices, appliances, wiring sequences, wiring methods and connections of the components of a *fire alarm system* as installed.

**[BF] REFLECTIVE PLASTIC CORE INSULATION.** An insulation material packaged in rolls, that is less than  $\frac{1}{2}$  inch (12.7 mm) thick, with not less than one exterior low-emittance surface (0.1 or less) and a core material containing voids or cells.

**[A] REGISTERED DESIGN PROFESSIONAL.** An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or *jurisdiction* in which the project is to be constructed.

**[A] REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE.** A *registered design professional* engaged by the owner or the owner’s authorized agent to review and coordinate certain aspects of the project, as determined by the *building official*, for compatibility with the design of the building or structure, including submittal documents prepared by others, deferred submittal documents and phased submittal documents.

**[BG] RELIGIOUS WORSHIP, PLACE OF.** A building or portion thereof intended for the performance of religious services.

**[A] RELOCATABLE BUILDING.** A partially or completely assembled building constructed and designed to be reused multiple times and transported to different building sites.

**[A] REPAIR.** The reconstruction, replacement or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.

**[BG] REPAIR GARAGE.** A building, structure or portion thereof used for servicing or repairing motor vehicles.

**[BS] REROOFING.** The process of recovering or replacing an existing *roof covering*. See “*Roof recover*” and “*Roof replacement*.”

**[BG] RESIDENTIAL AIRCRAFT HANGAR.** An accessory building less than 2,000 square feet (186 m<sup>2</sup>) and 20 feet (6096 mm) in *building height* constructed on a one- or two-family property where aircraft are stored. Such use will be considered as a residential accessory use incidental to the dwelling.

**[BS] RESISTANCE FACTOR.** A factor that accounts for deviations of the actual strength from the *nominal strength* and the manner and consequences of failure (also called “strength reduction factor”).

**[BE] RESTRICTED ENTRANCE.** An entrance that is made available for common use on a controlled basis, but not public use, and that is not a *service entrance*.

**[BG] RETRACTABLE AWNING.** A retractable *awning* is a cover with a frame that retracts against a building or other structure to which it is entirely supported.

**[BS] RISK CATEGORY.** A categorization of buildings and *other structures* for determination of *flood*, wind, snow, ice and earthquake *loads* based on the risk associated with unacceptable performance.

**[BS] RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE<sub>R</sub>) GROUND MOTION RESPONSE ACCELERATIONS.** The most severe earthquake effects considered by this code, determined for the orientation that results in the largest maximum response to horizontal ground motions and with adjustment for targeted risk.

**[BS] ROOF ASSEMBLY (For application to Chapter 15 only).** A system designed to provide weather protection and resistance to design *loads*. The system consists of a *roof covering* and roof deck or a single component serving as both the *roof covering* and the roof deck. A roof assembly can include an *underlayment*, a thermal barrier, insulation or a *vapor retarder*.

**[BS] ROOF COATING.** A fluid-applied, adhered coating used for roof maintenance or *roof repair*, or as a component of a *roof covering system* or *roof assembly*.

**[BS] ROOF COVERING.** The covering applied to the roof deck for weather resistance, fire classification or appearance.

**ROOF COVERING SYSTEM.** See “*Roof assembly*.”

**[BS] ROOF DECK.** The flat or sloped surface constructed on top of the *exterior walls* of a building or other supports for the purpose of enclosing the *story* below, or sheltering an area, to protect it from the elements, not including its supporting members or vertical supports.

**ROOF DRAINAGE, POSITIVE.** See “*Positive roof drainage*.”

**[BS] ROOF RECOVER.** The process of installing an additional *roof covering* over a prepared existing *roof covering* without removing the existing *roof covering*.

**[BS] ROOF REPAIR.** Reconstruction or renewal of any part of an existing roof for the purposes of correcting damage or restoring pre-damage condition.

**[BS] ROOF REPLACEMENT.** The process of removing the existing *roof covering*, repairing any damaged substrate and installing a new *roof covering*.

**[BG] ROOF VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, *attics*, cathedral ceilings or other enclosed spaces over which a roof assembly is installed.

**[BG] ROOFTOP STRUCTURE.** A structure erected on top of the roof deck or on top of any part of a building.

**[BS] RUNNING BOND.** The placement of *masonry units* such that *head joints* in successive courses are horizontally offset at least one-quarter the unit length.

**[BG] SALLYPORT.** A security vestibule with two or more doors or gates where the intended purpose is to prevent continuous and unobstructed passage by allowing the release of only one door or gate at a time.



## DEFINITIONS

**[BE] SCISSOR STAIRWAY.** Two interlocking *stairways* providing two separate paths of egress located within one *exit* enclosure.

**[BS] SCUPPER.** An opening in a wall or parapet that allows water to drain from a roof.

**[BG] SECONDARY STRUCTURAL MEMBERS.** The following structural members shall be considered secondary members and not part of the *primary structural frame*:

1. Structural members not having direct connections to the columns.
2. Members of the floor construction and roof construction not having direct connections to the columns.
3. Bracing members that are not designated as part of a *primary structural frame* or bearing wall.

**[BS] SEISMIC DESIGN CATEGORY.** A classification assigned to a structure based on its *risk category* and the severity of the *design earthquake ground motion* at the site.

**[BS] SEISMIC FORCE-RESISTING SYSTEM.** That part of the structural system that has been considered in the design to provide the required resistance to the prescribed seismic forces.

**[BF] SELF-CLOSING.** As applied to a *fire door* or other opening protective, means equipped with an device that will ensure closing after having been opened.

**[BE] SELF-LUMINOUS.** Illuminated by a self-contained power source, other than batteries, and operated independently of external power sources.

**SELF-PRESERVATION, INCAPABLE OF.** See “*Incapable of self-preservation.*”

**[BG] SELF-SERVICE STORAGE FACILITY.** Real property designed and used for the purpose of renting or leasing individual storage spaces to customers for the purpose of storing and removing personal property on a self-service basis.

**[F] SERVICE CORRIDOR.** A fully enclosed passage used for transporting *HPM* and purposes other than required *means of egress*.

**[BE] SERVICE ENTRANCE.** An entrance intended primarily for delivery of goods or services.

**[BF] SHAFT.** An enclosed space extending through one or more *stories* of a building, connecting vertical openings in successive floors, or floors and roof.

**[BF] SHAFT ENCLOSURE.** The walls or construction forming the boundaries of a *shaft*.

**[BS] SHALLOW FOUNDATION.** A *shallow foundation* is an individual or strip footing, a mat foundation, a slab-on-grade foundation or a similar foundation element.

**[BS] SHEAR WALL.** This definition applies only to Chapter 23.

A wall designed to resist lateral forces parallel to the plane of a wall.

**Shear wall, perforated.** A *wood structural panel* sheathed wall with openings, that has not been specifically designed and detailed for force transfer around openings.

**Shear wall segment, perforated.** A section of shear wall with full-height sheathing that meets the height-to-width ratio limits of Section 4.3.4 of AWC SDPWS.

**[BS] SHINGLE FASHION.** A method of installing roof or wall coverings, *water-resistive barriers*, flashing or other building components such that upper layers of material are placed overlapping lower layers of material to provide for drainage via gravity and moisture control.

**[BS] SINGLE-PLY MEMBRANE.** A roofing membrane that is field applied using one layer of membrane material (either homogeneous or composite) rather than multiple layers.

**[F] SINGLE-STATION SMOKE ALARM.** An assembly incorporating the detector, the control equipment and the alarm-sounding device in one unit, operated from a power supply either in the unit or obtained at the point of installation.

**[BG] SITE.** A parcel of land bounded by a *lot line* or a designated portion of a public right-of-way.

**[BS] SITE CLASS.** A classification assigned to a site based on the types of soils present and their engineering properties as defined in Section 1613.2.2.

**[BS] SITE COEFFICIENTS.** The values of  $F_a$  and  $F_v$ , indicated in Table 1613.2.3(1) and Table 1613.2.3(2), respectively.

**[BG] SITE-FABRICATED STRETCH SYSTEM.** A system, fabricated on site and intended for acoustical, tackable or aesthetic purposes, that is composed of three elements:

1. A frame (constructed of plastic, wood, metal or other material) used to hold fabric in place.
2. A core material (infill, with the correct properties for the application).
3. An outside layer, composed of a textile, fabric or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame.

**[BS] SKYLIGHT, UNIT.** A factory-assembled, glazed *fenestration* unit, containing one panel of glazing material that allows for natural lighting through an opening in the *roof assembly* while preserving the weather-resistant barrier of the roof.

**[BS] SKYLIGHTS AND SLOPED GLAZING.** Glass or other transparent or translucent glazing material installed at a slope of 15 degrees (0.26 rad) or more from vertical. *Unit skylights, tubular daylighting devices*, glazing materials, solariums, *sunrooms*, roofs and sloped walls are included in this definition.

**[A] SLEEPING UNIT.** A single unit that provides rooms or spaces for one or more persons, includes permanent provisions for sleeping and can include provisions for living,



eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a dwelling unit are not sleeping units.

**[F] SMOKE ALARM.** A single- or multiple-station alarm responsive to smoke. See “*Multiple-station smoke alarm*” and “*Single-station smoke alarm*.”

**[BF] SMOKE BARRIER.** A continuous membrane, either vertical or horizontal, such as a wall, floor or ceiling assembly, that is designed and constructed to restrict the movement of smoke.

**[BG] SMOKE COMPARTMENT.** A space within a building separated from other interior areas of the building by *smoke barriers*, including interior walls and *horizontal assemblies*.

**[BF] SMOKE DAMPER.** A *listed* device installed in ducts and air transfer openings designed to resist the passage of smoke. The device is installed to operate automatically, controlled by a smoke detection system, and where required, is capable of being positioned from a *fire command center*.

**[F] SMOKE DETECTOR.** A *listed* device that senses visible or invisible particles of combustion.

**[BF] SMOKE PARTITION.** A wall assembly that extends from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.

**[BF] SMOKE-DEVELOPED INDEX.** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E84.

**[BF] SMOKEPROOF ENCLOSURE.** An *exit stairway* or *ramp* designed and constructed so that the movement of the products of combustion produced by a fire occurring in any part of the building into the enclosure is limited.

**[BE] SMOKE-PROTECTED ASSEMBLY SEATING.** Seating served by *means of egress* that is not subject to smoke accumulation within or under a structure for a specified design time by means of passive design or by mechanical ventilation.

**[BG] SOFT CONTAINED PLAY EQUIPMENT STRUCTURE.** A play structure containing one or more components where the user enters a play environment that utilizes pliable materials.

**[F] SOLID.** A material that has a melting point, decomposes or sublimates at a temperature greater than 68°F (20°C).

**[BG] SPECIAL AMUSEMENT AREA.** A special amusement area is any temporary or permanent building or portion thereof that is occupied for amusement, entertainment or educational purposes and is arranged in a manner that:

1. Makes the means of egress path not readily apparent due to visual or audio distractions.
2. Intentionally confounds identification of the means of egress path.
3. Otherwise makes the means of egress path not readily available because of the nature of the attraction or

mode of conveyance through the building or structure.

**[BG] SPECIAL EVENT STRUCTURE.** Any ground-supported structure, *platform*, *stage*, *stage scaffolding* or rigging, canopy, tower or similar structure supporting entertainment-related equipment or signage.

**[BS] SPECIAL FLOOD HAZARD AREA.** The land area subject to flood hazards and shown on a *Flood Insurance Rate Map* or other flood hazard map as Zone A, AE, A1-30, A99, AR, AO, AH, V, VO, VE or V1-30.

**[BS] SPECIAL INSPECTION.** Inspection of construction requiring the expertise of an *approved special inspector* in order to ensure compliance with this code and the approved *construction documents*.

**Continuous special inspection.** *Special inspection* by the *special inspector* who is present continuously when and where the work to be inspected is being performed.

**Periodic special inspection.** *Special inspection* by the *special inspector* who is intermittently present where the work to be inspected has been or is being performed.

**[BS] SPECIAL INSPECTOR.** A qualified person employed or retained by an *approved agency* and *approved* by the *building official* as having the competence necessary to inspect a particular type of construction requiring *special inspection*.

**[BS] SPECIFIED COMPRESSIVE STRENGTH OF MASONRY,  $f'_m$ .** Minimum compressive strength, expressed as force per unit of net cross-sectional area, required of the *masonry* used in construction by the *approved construction documents*, and upon which the project design is based. Whenever the quantity  $f'_m$  is under the radical sign, the square root of numerical value only is intended and the result has units of pounds per square inch (psi) (MPa).

**[BF] SPLICE.** The result of a factory and/or field method of joining or connecting two or more lengths of a *fire-resistant joint system* into a continuous entity.

**SPORT ACTIVITY, AREA OF.** See “*Area of sport activity*.”

**[F] SPRAY ROOM.** A room designed to accommodate spraying operations.

**[BF] SPRAY-APPLIED FOAM PLASTIC.** Single- and multiple-component, spray-applied foam plastic insulation used in nonstructural applications that are installed at locations wherein the material is applied in a liquid or frothed state, permitted to free rise and cure in situ.

**[BF] SPRAYED FIRE-RESISTANT MATERIALS.** Cementitious or fibrous materials that are sprayed to provide fire-resistant protection of the substrates.

**[BG] STAGE.** A space within a building utilized for entertainment or presentations, which includes overhead hanging curtains, drops, scenery or stage effects other than lighting and sound.

**[BE] STAIR.** A change in elevation, consisting of one or more risers.

## DEFINITIONS

**[BE] STAIRWAY.** One or more *flights of stairs*, either exterior or interior, with the necessary landings and platforms connecting them, to form a continuous and uninterrupted passage from one level to another.

**STAIRWAY, EXIT ACCESS.** See “*Exit access stairway.*”

**STAIRWAY, EXTERIOR EXIT.** See “*Exterior exit stairway.*”

**STAIRWAY, INTERIOR EXIT.** See “*Interior exit stairway.*”

**STAIRWAY, SCISSOR.** See “*Scissor stairway.*”

**[BE] STAIRWAY, SPIRAL.** A *stairway* having a closed circular form in its plan view with uniform section-shaped treads attached to and radiating from a minimum-diameter supporting column.

**[F] STANDBY POWER SYSTEM.** A source of *automatic* electric power of a required capacity and duration to operate required building, *hazardous materials* or *ventilation* systems in the event of a failure of the primary power. Standby power systems are required for electrical loads where interruption of the primary power could create hazards or hamper rescue or fire-fighting operations.

**[F] STANDPIPE, TYPES OF.** Standpipe types are as follows:

**Automatic dry.** A dry standpipe system, normally filled with pressurized air, that is arranged through the use of a device, such as dry pipe valve, to admit water into the system piping *automatically* upon the opening of a hose valve. The water supply for an *automatic* dry standpipe system shall be capable of supplying the system demand.

**Automatic wet.** A wet standpipe system that has a water supply that is capable of supplying the system demand *automatically*.

**Manual dry.** A dry standpipe system that does not have a permanent water supply attached to the system. Manual dry standpipe systems require water from a fire department pumper to be pumped into the system through the fire department connection in order to meet the system demand.

**Manual wet.** A wet standpipe system connected to a water supply for the purpose of maintaining water within the system but does not have a water supply capable of delivering the system demand attached to the system. Manual-wet standpipe systems require water from a fire department pumper (or the like) to be pumped into the system in order to meet the system demand.

**Semiautomatic dry.** A dry standpipe system that is arranged through the use of a device, such as a deluge valve, to admit water into the system piping upon activation of a remote control device located at a hose connection. A remote control activation device shall be provided at each hose connection. The water supply for a semiautomatic dry standpipe system shall be capable of supplying the system demand.

**[F] STANDPIPE SYSTEM, CLASSES OF.** Standpipe classes are as follows:

**Class I system.** A system providing 2½-inch (64 mm) hose connections to supply water for use by fire departments and those trained in handling heavy fire streams.

**Class II system.** A system providing 1½-inch (38 mm) hose stations to supply water for use primarily by the building occupants or by the fire department during initial response.

**Class III system.** A system providing 1½-inch (38 mm) hose stations to supply water for use by building occupants and 2½-inch (64 mm) hose connections to supply a larger volume of water for use by fire departments and those trained in handling heavy fire streams.

**[BS] STEEL CONSTRUCTION, COLD-FORMED.** That type of construction made up entirely or in part of *steel structural members* cold formed to shape from sheet or strip steel such as roof deck, floor and wall panels, studs, floor joists, roof joists and other structural elements.

**[BS] STEEL ELEMENT, STRUCTURAL.** Any *steel structural member* of a building or structure consisting of rolled shapes, pipe, hollow structural sections, plates, bars, sheets, rods or steel castings other than cold-formed steel or *steel joist* members.

**[BS] STEEL JOIST.** Any *steel structural member* of a building or structure made of hot-rolled or cold-formed solid or open-web sections, or riveted or welded bars, strip or sheet steel members, or slotted and expanded, or otherwise deformed rolled sections.

**[BF] STEEP SLOPE.** A roof slope 2 units vertical in 12 units horizontal (17-percent slope) or greater.

**[BS] STONE MASONRY.** *Masonry* composed of field, quarried or *cast stone* units bonded by *mortar*.

**[F] STORAGE, HAZARDOUS MATERIALS.** The keeping, retention or leaving of hazardous materials in closed containers, tanks, cylinders, or similar vessels; or vessels supplying operations through closed connections to the vessel.

**[BS] STORAGE RACKS, STEEL.** Cold-formed or hot-rolled steel structural members which are formed into *steel storage racks*, including pallet storage racks, movable-shelf racks, rack-supported systems, automated storage and retrieval systems (stacker racks), push-back racks, pallet-flow racks, case-flow racks, pick modules and rack-supported platforms. Other types of racks, such as drive-in or drive-through racks, cantilever racks, portable racks or racks made of materials other than steel, are not considered storage racks for the purpose of this code.

**[BS] STORAGE RACKS, STEEL CANTILEVERED.** A framework or assemblage composed of cold-formed or hot-rolled steel structural members, primarily in the form of vertical columns, extended bases, horizontal arms projecting from the faces of the columns, and longitudinal (down-aisle) bracing between columns. There may be shelf beams between the arms, depending on the products being stored; this definition does not include other types of racks such as pallet storage racks, drive-in racks, drive-through racks, or racks made of materials other than steel.

**[BG] STORM SHELTER.** A building, structure or portions thereof, constructed in accordance with ICC 500 and designated for use during a severe wind storm event, such as a hurricane or tornado.

**Community storm shelter.** A storm shelter not defined as a “Residential storm shelter.”

**Residential storm shelter.** A storm shelter serving occupants of *dwelling units* and having an *occupant load* not exceeding 16 persons.

**[BG] STORY.** That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above (see “*Basement*,” “*Building height*,” “*Grade plane*” and “*Mezzanine*”). A story is measured as the vertical distance from top to top of two successive tiers of beams or finished floor surfaces and, for the topmost story, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

**[BG] STORY ABOVE GRADE PLANE.** Any *story* having its finished floor surface entirely above *grade plane*, or in which the finished surface of the floor next above is:

1. More than 6 feet (1829 mm) above *grade plane*; or
2. More than 12 feet (3658 mm) above the finished ground level at any point.

**[BS] STRENGTH.** This term is defined two ways, the first for use in Chapter 16 and the second for use in Chapter 21.

#### For Chapter 16:

**Nominal strength.** The capacity of a structure or member to resist the effects of loads, as determined by computations using specified material strengths and dimensions and equations derived from accepted principles of structural mechanics or by field tests or laboratory tests of scaled models, allowing for modeling effects and differences between laboratory and field conditions.

**Required strength.** Strength of a member, cross section or connection required to resist factored loads or related internal moments and forces in such combinations as stipulated by these provisions.

**Strength design.** A method of proportioning structural members such that the computed forces produced in the members by factored loads do not exceed the member design strength [also called “load and resistance factor design” (LRFD)]. The term “strength design” is used in the design of concrete and masonry structural elements.

#### For Chapter 21:

**Design strength.** Nominal strength multiplied by a strength reduction factor.

**Nominal strength.** Strength of a member or cross section calculated in accordance with these provisions before application of any strength-reduction factors.

**Required strength.** Strength of a member or cross section required to resist factored loads.

**[BS] STRUCTURAL COMPOSITE LUMBER.** Structural member manufactured using wood elements bonded together with exterior adhesives. Examples of *structural composite lumber* are:

**Laminated strand lumber (LSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths not less than 150 times the least dimension of the wood strand elements.

**Laminated veneer lumber (LVL).** A composite of wood veneer sheet elements with wood fibers primarily oriented along the length of the member, where the veneer element thicknesses are 0.25 inches (6.4 mm) or less.

**Oriented strand lumber (OSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inches (2.54 mm) or less and their average lengths not less than 75 times and less than 150 times the least dimension of the strand elements.

**Parallel strand lumber (PSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member where the least dimension of the wood strand elements is 0.25 inches (6.4 mm) or less and their average lengths not less than 300 times the least dimension of the wood strand elements.

**[BS] STRUCTURAL GLUED-LAMINATED TIMBER.**

An engineered, stress-rated product of a timber laminating plant, composed of assemblies of specially selected and prepared wood laminations in which the grain of all laminations is approximately parallel longitudinally and the laminations are bonded with adhesives.

**[BS] STRUCTURAL OBSERVATION.** The visual observation of the structural system by a *registered design professional* for general conformance to the *approved construction documents*.

**[A] STRUCTURE.** That which is built or constructed.

**[BS] SUBSTANTIAL DAMAGE.** Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred.

**[BS] SUBSTANTIAL IMPROVEMENT.** Any *repair*, *reconstruction*, *rehabilitation*, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered *substantial improvement* regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a building required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.



## DEFINITIONS

- Any *alteration* of a historic structure provided that the *alteration* will not preclude the structure's continued designation as a historic structure.

**[BG] SUNROOM.** A one-story structure attached to a building with a glazing area in excess of 40 percent of the gross area of the structure's *exterior walls* and roof.

**[F] SUPERVISING STATION.** A facility that receives signals and at which personnel are in attendance at all times to respond to these signals.

**[F] SUPERVISORY SERVICE.** The service required to monitor performance of guard tours and the operative condition of fixed suppression systems or other systems for the protection of life and property.

**[F] SUPERVISORY SIGNAL.** A signal indicating the need of action in connection with the supervision of guard tours, the fire suppression systems or equipment or the maintenance features of related systems.

**[F] SUPERVISORY SIGNAL-INITIATING DEVICE.** An initiation device, such as a valve supervisory switch, water-level indicator or low-air pressure switch on a dry-pipe sprinkler system, whose change of state signals an off-normal condition and its restoration to normal of a fire protection or life safety system, or a need for action in connection with guard tours, fire suppression systems or equipment or maintenance features of related systems.

**[BS] SUSCEPTIBLE BAY.** A roof or portion thereof with either of the following:

- A slope less than  $\frac{1}{4}$ -inch per foot (0.0208 rad).
- On which water is impounded, in whole or in part, and the secondary drainage system is functional but the primary drainage system is blocked.

A roof surface with a slope of  $\frac{1}{4}$ -inch per foot (0.0208 rad) or greater towards points of free drainage is not a susceptible bay.

**[BG] SWIMMING POOL.** Any structure intended for swimming, recreational bathing or wading that contains water over 24 inches (610 mm) deep. This includes in-ground, above-ground and on-ground pools; hot tubs; spas and fixed-in-place wading pools.

**[BF] T RATING.** The time period that the *penetration firestop system*, including the penetrating item, limits the maximum temperature rise to 325°F (163°C) above its initial temperature through the penetration on the nonfire side when tested in accordance with ASTM E814 or UL 1479.

**[BG] TECHNICAL PRODUCTION AREA.** Open elevated areas or spaces intended for entertainment technicians to walk on and occupy for servicing and operating entertainment technology systems and equipment. Galleries, including fly and lighting galleries, gridirons, catwalks, and similar areas are designed for these purposes.

**[BG] TENSILE MEMBRANE STRUCTURE.** A membrane structure having a shape that is determined by tension in the membrane and the geometry of the support structure. Typically, the structure consists of both flexible elements (e.g., membrane and cables), nonflexible elements

(e.g., struts, masts, beams and arches) and the anchorage (e.g., supports and foundations). This includes frame-supported *tensile membrane structures*.

**[F] TENT.** A structure, enclosure, *umbrella structure* or shelter, with or without sidewalls or drops, constructed of fabric or pliable material supported in any manner except by air or the contents it protects (see "*Umbrella structure*").

**[BF] TERMINATED STOPS.** Factory feature of a door frame where the stops of the door frame are terminated not more than 6 inches (152 mm) from the bottom of the door frame. Terminated stops are also known as "hospital stops" or "sanitary stops."

**[BG] THERMAL ISOLATION.** A separation of conditioned spaces, between a *sunroom* and a *dwelling unit*, consisting of existing or new walls, doors or windows.

**[BF] THERMOPLASTIC MATERIAL.** A plastic material that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

**[BF] THERMOSETTING MATERIAL.** A plastic material that is capable of being changed into a substantially nonreformable product when cured.

**[BF] THROUGH PENETRATION.** A breach in both sides of a floor, floor-ceiling or wall assembly to accommodate an item passing through the breaches.

**[BF] THROUGH-PENETRATION FIRESTOP SYSTEM.** An assemblage consisting of a fire-resistance-rated floor, floor-ceiling, or wall assembly, one or more penetrating items passing through the breaches in both sides of the assembly and the materials or devices, or both, installed to resist the spread of fire through the assembly for a prescribed period of time.

**[BS] TIE, WALL.** Metal connector that connects *wythes* of *masonry* walls together.

**[BS] TIE-DOWN (HOLD-DOWN).** A device used to resist uplift of the chords of *shear walls*.

**[BS] TILE, STRUCTURAL CLAY.** A hollow *masonry unit* composed of burned clay, shale, fire clay or mixture thereof, and having parallel cells.

**[F] TIRES, BULK STORAGE OF.** Storage of tires where the area available for storage exceeds 20,000 cubic feet (566 m<sup>3</sup>).

**[A] TOWNHOUSE.** A single-family *dwelling unit* constructed in a group of three or more attached units in which each unit extends from the foundation to roof and with open space on at least two sides.

**[F] TOXIC.** A chemical falling within any of the following categories:

- A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 50 milligrams per kilogram, but not more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.
- A chemical that has a median lethal dose (LD<sub>50</sub>) of more than 200 milligrams per kilogram, but not more than 1,000 milligrams per kilogram of body weight



when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

3. A chemical that has a median lethal concentration ( $LC_{50}$ ) in air of more than 200 parts per million, but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

**[BG] TRANSIENT.** Occupancy of a *dwelling unit* or *sleeping unit* for not more than 30 days.

**[BG] TRANSIENT AIRCRAFT.** Aircraft based at another location and that is at the transient location for not more than 90 days.

**TREATED WOOD.** See “*Fire-retardant-treated wood*” and “*Preservative-treated wood*.”

**[BF] TRIM.** Picture molds, chair rails, baseboards, *hand-rails*, door and window frames and similar decorative or protective materials used in fixed applications.

**[F] TROUBLE SIGNAL.** A signal initiated by the *fire alarm system* or device indicative of a fault in a monitored circuit or component.

**[BS] TSUNAMI DESIGN GEODATABASE.** The ASCE database (version 2016-1.0) of *Tsunami Design Zone* maps and associated design data for the states of Alaska, California, Hawaii, Oregon and Washington.

**[BS] TSUNAMI DESIGN ZONE.** An area identified on the *Tsunami Design Zone* map between the shoreline and the inundation limit, within which certain structures designated in Chapter 16 are designed for or protected from inundation.

**[BS] TUBULAR DAYLIGHTING DEVICE (TDD).** A non-operable *fenestration* unit primarily designed to transmit daylight from a roof surface to an interior ceiling via a tubular conduit. The basic unit consists of an exterior glazed weathering surface, a light-transmitting tube with a reflective interior surface, and an interior-sealing device such as a translucent ceiling panel. The unit can be factory assembled, or field-assembled from a manufactured kit.

**[BE] TYPE A UNIT.** A *dwelling unit* or *sleeping unit* designed and constructed for accessibility in accordance with this code and the provisions for *Type A units* in ICC A117.1.

**[BE] TYPE B UNIT.** A *dwelling unit* or *sleeping unit* designed and constructed for accessibility in accordance with this code and the provisions for *Type B units* in ICC A117.1, consistent with the design and construction requirements of the federal Fair Housing Act.

**[F] UMBRELLA STRUCTURE.** A structure, enclosure or shelter with or without sidewalls or drops, constructed of fabric or pliable material supported by a central pole or poles (see “*Tent*”).

**[BS] UNDERLAYMENT.** One or more layers of a material that is applied to a steep-slope *roof covering* deck under the *roof covering* and resists liquid water that penetrates the *roof covering*.

**[BS] UNDERPINNING.** The alteration of an existing foundation to transfer *loads* to a lower elevation using new piers, piles or other permanent structural support elements installed below the existing foundation.

**UNIT SKYLIGHT.** See “*Skylight, unit*.”

**[F] UNSTABLE (REACTIVE) MATERIAL.** A material, other than an *explosive*, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including *explosion*, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with *incompatible materials*. Unstable (reactive) materials are subdivided as follows:

**Class 1.** Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

**Class 2.** Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at *normal temperatures and pressures*, and that can undergo violent chemical change at elevated temperatures and pressures.

**Class 3.** Materials that in themselves are capable of *detonation* or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

**Class 4.** Materials that in themselves are readily capable of *detonation* or *explosive* decomposition or explosive reaction at *normal temperatures and pressures*. This class includes materials that are sensitive to mechanical or localized thermal shock at *normal temperatures and pressures*.

**[F] USE (MATERIAL).** Placing a material into action, including *solids*, *liquids* and gases.

**[BG] VAPOR DIFFUSION PORT.** An assembly constructed or installed within a roof assembly at an opening in the roof deck to convey water vapor from an unvented *attic* to the outside atmosphere.

**[BF] VAPOR PERMEABLE.** The property of having a moisture vapor permeance rating of 5 perms ( $2.9 \times 10^{-10}$  kg/Pa  $\times$  s  $\times$  m<sup>2</sup>) or greater, when tested in accordance with Procedure A or Procedure B of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

## DEFINITIONS

**[BF] VAPOR RETARDER CLASS.** A measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E96 as follows:

**Class I:** 0.1 perm or less.

**Class II:**  $0.1 < \text{perm} \leq 1.0$  perm.

**Class III:**  $1.0 < \text{perm} \leq 10$  perm.

**[BS] VEGETATIVE ROOF.** An assembly of interacting components designed to waterproof a building's top surface that includes, by design, vegetation and related landscape elements.

**[BS] VEHICLE BARRIER.** A component or a system of components, near open sides or walls of garage floors or ramps that act as a restraint for vehicles.

**[BG] VEHICULAR GATE.** A gate that is intended for use at a vehicular entrance or exit to a facility, building or portion thereof, and that is not intended for use by pedestrian traffic.

**[BF] VENEER.** A facing attached to a wall for the purpose of providing ornamentation, protection or insulation, but not counted as adding strength to the wall.

**[M] VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

**[BF] VINYL SIDING.** A shaped material, made principally from rigid polyvinyl chloride (PVC), that is used as an *exterior wall covering*.

**[F] VISIBLE ALARM NOTIFICATION APPLIANCE.** A notification appliance that alerts by the sense of sight.

**[BG] WALKWAY, PEDESTRIAN.** A walkway used exclusively as a pedestrian trafficway.

**[BS] WALL.** This definition applies only to Chapter 21.

A vertical element with a horizontal length-to-thickness ratio greater than three, used to enclose space.

**Cavity wall.** A wall built of *masonry units* or of concrete, or a combination of these materials, arranged to provide an airspace within the wall, and in which the inner and outer parts of the wall are tied together with metal ties.

**Dry-stacked, surface-bonded wall.** A wall built of concrete *masonry units* where the units are stacked dry, without *mortar* on the bed or *head joints*, and where both sides of the wall are coated with a surface-bonding *mortar*.

**Parapet wall.** The part of any wall entirely above the roof line.

**[BS] WALL, LOAD-BEARING.** Any wall meeting either of the following classifications:

1. Any metal or wood stud wall that supports more than 100 pounds per linear foot (1459 N/m) of vertical load in addition to its own weight.
2. Any *masonry*, concrete or *mass timber* wall that supports more than 200 pounds per linear foot (2919 N/m) of vertical *load* in addition to its own weight.

**[BS] WALL, NONLOAD-BEARING.** Any wall that is not a *load-bearing wall*.

**[F] WATER-REACTIVE MATERIAL.** A material that explodes; violently reacts; produces *flammable*, *toxic* or other hazardous gases; or evolves enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

**Class 3.** Materials that react explosively with water without requiring heat or confinement.

**Class 2.** Materials that react violently with water or have the ability to boil water. Materials that produce *flammable*, *toxic* or other hazardous gases or evolve enough heat to cause autoignition or ignition of combustibles upon exposure to water or moisture.

**Class 1.** Materials that react with water with some release of energy, but not violently.

**[BF] WATER-RESISTIVE BARRIER.** A material behind an *exterior wall covering* that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the *exterior wall* assembly.

**[BF] WEATHER-EXPOSED SURFACES.** Surfaces of walls, ceilings, floors, roofs, soffits and similar surfaces exposed to the weather except the following:

1. Ceilings and roof soffits enclosed by walls, fascia, bulkheads or beams that extend not less than 12 inches (305 mm) below such ceiling or roof soffits.
2. Walls or portions of walls beneath an unenclosed roof area, where located a horizontal distance from an open exterior opening equal to not less than twice the height of the opening.
3. Ceiling and roof soffits located a minimum horizontal distance of 10 feet (3048 mm) from the outer edges of the ceiling or roof soffits.

**[F] WET-CHEMICAL EXTINGUISHING SYSTEM.** A solution of water and potassium-carbonate-based chemical, potassium-acetate-based chemical or a combination thereof, forming an extinguishing agent.

**[BE] WHEELCHAIR SPACE.** A space for a single wheelchair and its occupant.

**[BS] WIND SPEED,  $V$ .** Basic design wind speeds.

**[BS] WIND SPEED,  $V_{asd}$ .** Allowable stress design wind speeds.

**[BS] WINDBORNE DEBRIS REGION.** Areas within *hurricane-prone regions* located:

1. Within 1 mile (1.61 km) of the mean high-water line where an Exposure D condition exists upwind at the waterline and the basic design wind speed,  $V$ , is 130 mph (58 m/s) or greater; or
2. In areas where the basic design wind speed is 140 mph (63 m/s) or greater.

For *Risk Category II* buildings and structures and *Risk Category III* buildings and structures, except health care facilities, the windborne debris region shall be based on Figure

## DEFINITIONS

1609.3.(1). For *Risk Category* IV buildings and structures and *Risk Category* III health care facilities, the windborne debris region shall be based on Figure 1609.3(2).

**[BE] WINDER.** A tread with nonparallel edges.

**WINDFORCE-RESISTING SYSTEM, MAIN.** See “*Main windforce-resisting system*.”

**[BS] WIRE BACKING.** Horizontal strands of tautened wire attached to surfaces of vertical supports which, when covered with the building paper, provide a backing for *cement plaster*.

**[F] WIRELESS PROTECTION SYSTEM.** A system or a part of a system that can transmit and receive signals without the aid of wire.

**[BS] WOOD SHEAR PANEL.** A wood floor, roof or wall component sheathed to act as a *shear wall* or *diaphragm*.

**[BS] WOOD STRUCTURAL PANEL.** A panel manufactured from *veneers*, wood strands or wafers or a combination of *veneer* and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of *wood structural panels* are:

**Composite panels.** A wood structural panel that is comprised of wood veneer and reconstituted wood-based material and bonded together with waterproof adhesive.

**Oriented strand board (OSB).** A mat-formed wood structural panel comprised of thin rectangular wood strands arranged in cross-aligned layers with surface layers normally arranged in the long panel direction and bonded with waterproof adhesive.

**Plywood.** A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers. The plies are bonded with waterproof adhesive that cures on application of heat and pressure.

**[BS] WOOD/PLASTIC COMPOSITE.** A composite material made primarily from wood or cellulose-based materials and plastic.

**[F] WORKSTATION.** A defined space or an independent principal piece of equipment using *HPM* within a *fabrication area* where a specific function, laboratory procedure or research activity occurs. *Approved* or *listed hazardous materials storage cabinets*, *flammable liquid storage cabinets* or gas cabinets serving a workstation are included as part of the workstation. A workstation is allowed to contain *ventilation* equipment, fire protection devices, detection devices, electrical devices and other processing and scientific equipment.

**[BS] WYTHER.** Each continuous, vertical section of a wall, one *masonry unit* in thickness.

**[BG] YARD.** An open space, other than a *court*, unobstructed from the ground to the sky, except where specifically provided by this code, on the lot on which a building is situated.

**[F] ZONE.** A defined area within the protected premises. A zone can define an area from which a signal can be received, an area to which a signal can be sent or an area in which a form of control can be executed.

**[F] ZONE, NOTIFICATION.** An area within a building or facility covered by notification appliances which are activated simultaneously.





## CHAPTER 3

# OCCUPANCY CLASSIFICATION AND USE

### User note:

**About this chapter:** Chapter 3 provides the criteria by which buildings and structures are classified into use groups and occupancies. Through the balance of the code, occupancy classification is fundamental in the setting of features of construction; occupant safety requirements, especially building limitations; means of egress; fire protection systems; and interior finishes.

### SECTION 301 SCOPE

**301.1 General.** The provisions of this chapter shall control the classification of all buildings and structures as to occupancy and use. Different classifications of occupancy and use represent varying levels of hazard and risk to building occupants and adjacent properties.

### SECTION 302 OCCUPANCY CLASSIFICATION AND USE DESIGNATION

**302.1 Occupancy classification.** Occupancy classification is the formal designation of the primary purpose of the building, structure or portion thereof. Structures shall be classified into one or more of the occupancy groups specified in this section based on the nature of the hazards and risks to building occupants generally associated with the intended purpose of the building or structure. An area, room or space that is intended to be occupied at different times for different purposes shall comply with all applicable requirements associated with such potential multipurpose. Structures containing multiple occupancy groups shall comply with Section 508. Where a structure is proposed for a purpose that is not specified in this section, such structure shall be classified in the occupancy it most nearly resembles based on the fire safety and relative hazard. Occupied roofs shall be classified in the group that the occupancy most nearly resembles, according to the fire safety and relative hazard, and shall comply with Section 503.1.4.

1. Assembly (see Section 303): Groups A-1, A-2, A-3, A-4 and A-5.
2. Business (see Section 304): Group B.
3. Educational (see Section 305): Group E.
4. Factory and Industrial (see Section 306): Groups F-1 and F-2.
5. High Hazard (see Section 307): Groups H-1, H-2, H-3, H-4 and H-5.
6. Institutional (see Section 308): Groups I-1, I-2, I-3 and I-4.
7. Mercantile (see Section 309): Group M.
8. Residential (see Section 310): Groups R-1, R-2, R-3 and R-4.

9. Storage (see Section 311): Groups S-1 and S-2.

10. Utility and Miscellaneous (see Section 312): Group U.

**302.2 Use designation.** Occupancy groups contain subordinate uses having similar hazards and risks to building occupants. Uses include, but are not limited to, those functional designations specified within the occupancy group descriptions in Section 302.1. Certain uses require specific limitations and controls in accordance with the provisions of Chapter 4 and elsewhere in this code.

### SECTION 303 ASSEMBLY GROUP A

**303.1 Assembly Group A.** Assembly Group A occupancy includes, among others, the use of a building or structure, or a portion thereof, for the gathering of persons for purposes such as civic, social or religious functions; recreation, food or drink consumption or awaiting transportation.

**303.1.1 Small buildings and tenant spaces.** A building or tenant space used for assembly purposes with an *occupant load* of less than 50 persons shall be classified as a Group B occupancy.

**303.1.2 Small assembly spaces.** The following rooms and spaces shall not be classified as Assembly occupancies:

1. A room or space used for assembly purposes with an *occupant load* of less than 50 persons and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.
2. A room or space used for assembly purposes that is less than 750 square feet (70 m<sup>2</sup>) in area and accessory to another occupancy shall be classified as a Group B occupancy or as part of that occupancy.

**303.1.3 Associated with Group E occupancies.** A room or space used for assembly purposes that is associated with a Group E occupancy is not considered a separate occupancy.

**303.1.4 Accessory to places of religious worship.** Accessory religious educational rooms and religious auditoriums with *occupant loads* of less than 100 per room or space are not considered separate occupancies.

## OCCUPANCY CLASSIFICATION AND USE

**303.1.5 Special amusement areas.** *Special amusement areas* shall comply with Section 411.

**303.2 Assembly Group A-1.** Group A-1 occupancy includes assembly uses, usually with fixed seating, intended for the production and viewing of the performing arts or motion pictures including, but not limited to:

- Motion picture theaters
- Symphony and concert halls
- Television and radio studios admitting an audience
- Theaters

**303.3 Assembly Group A-2.** Group A-2 occupancy includes assembly uses intended for food and/or drink consumption including, but not limited to:

- Banquet halls
- Casinos (*gaming areas*)
- Nightclubs
- Restaurants, cafeterias and similar dining facilities (including associated commercial kitchens)
- Taverns and bars

**303.4 Assembly Group A-3.** Group A-3 occupancy includes assembly uses intended for worship, recreation or amusement and other assembly uses not classified elsewhere in Group A including, but not limited to:

- Amusement arcades
- Art galleries
- Bowling alleys
- Community halls
- Courtrooms
- Dance halls (not including food or drink consumption)
- Exhibition halls
- Funeral parlors
- Greenhouses* for the conservation and exhibition of plants that provide public access
- Gymnasiums (without spectator seating)
- Indoor *swimming pools* (without spectator seating)
- Indoor tennis courts (without spectator seating)
- Lecture halls
- Libraries
- Museums
- Places of religious worship*
- Pool and billiard parlors
- Waiting areas in transportation terminals

**303.5 Assembly Group A-4.** Group A-4 occupancy includes assembly uses intended for viewing of indoor sporting events and activities with spectator seating including, but not limited to:

- Arenas
- Skating rinks
- Swimming pools*
- Tennis courts

**303.6 Assembly Group A-5.** Group A-5 occupancy includes assembly uses intended for participation in or viewing outdoor activities including, but not limited to:

- Amusement park structures
- Bleachers*
- Grandstands*
- Stadiums

## SECTION 304 BUSINESS GROUP B

**304.1 Business Group B.** Business Group B occupancy includes, among others, the use of a building or structure, or a portion thereof, for office, professional or service-type transactions, including storage of records and accounts. Business occupancies shall include, but not be limited to, the following:

- Airport traffic control towers
- Ambulatory care facilities*
- Animal hospitals, kennels and pounds
- Banks
- Barber and beauty shops
- Car wash
- Civic administration
- Clinic, outpatient*
- Dry cleaning and laundries: pick-up and delivery stations and self-service
- Educational occupancies for students above the 12th grade including *higher education laboratories*
- Electronic data processing
- Food processing establishments and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities not more than 2,500 square feet (232 m<sup>2</sup>) in area
- Laboratories: testing and research
- Motor vehicle showrooms
- Post offices
- Print shops
- Professional services (architects, attorneys, dentists, physicians, engineers, etc.)
- Radio and television stations
- Telephone exchanges
- Training and skill development not in a school or academic program (this shall include, but not be limited to, tutoring centers, martial arts studios, gymnastics and similar uses regardless of the ages served, and where not classified as a Group A occupancy)

**304.2 Airport traffic control towers.** Airport traffic control towers shall comply with Section 412.2.

**304.3 Ambulatory care facilities.** *Ambulatory care facilities* shall comply with Section 422.

**304.4 Higher education laboratories.** *Higher education laboratories* shall comply with Section 428.

## SECTION 305 EDUCATIONAL GROUP E

**305.1 Educational Group E.** Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade.

- Rooms normally occupied by preschool, kindergarten, or first grade students shall be located on a level of exit discharge. Rooms normally occupied by second-grade students shall not be located more than one level above the level of exit discharge and then provided with a dedicated and independent means of egress.

**305.1.1 Accessory to places of religious worship.** Religious educational rooms and religious auditoriums, which are accessory to *places of religious worship* in accordance with Section 303.1.4 and have *occupant loads* of less than 100 per room or space, shall be classified as Group A-3 occupancies.

**305.2 Group E, day care facilities.** This group includes buildings and structures or portions thereof occupied by more than five children older than 2½ years of age who receive educational, supervision or *personal care services* for fewer than 24 hours per day.

**305.2.1 Within places of religious worship.** Rooms and spaces within *places of religious worship* providing such day care during religious functions shall be classified as part of the primary occupancy.

**305.2.2 Five or fewer children.** A facility having five or fewer children receiving such day care shall be classified as part of the primary occupancy.

**305.2.3 Five or fewer children in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer children receiving such day care shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

**305.3 Storm shelters in Group E occupancies.** *Storm shelters* shall be provided for Group E occupancies where required by Section 423.5.

## SECTION 306 FACTORY GROUP F

**306.1 Factory Industrial Group F.** Factory Industrial Group F occupancy includes, among others, the use of a building or structure, or a portion thereof, for assembling, disassembling, fabricating, finishing, manufacturing, packaging, repair or processing operations that are not classified as a Group H hazardous or Group S storage occupancy.

**306.2 Moderate-hazard factory industrial, Group F-1.** Factory industrial uses that are not classified as Factory Industrial F-2 Low Hazard shall be classified as F-1 Moder-

ate Hazard and shall include, but not be limited to, the following:

Aircraft (manufacturing, not to include repair)  
Appliances  
Athletic equipment  
Automobiles and other motor vehicles  
Bakeries  
Beverages: over 16-percent alcohol content  
Bicycles  
Boats  
Brooms or brushes  
Business machines  
Cameras and photo equipment  
Canvas or similar fabric  
Carpets and rugs (includes cleaning)  
Clothing  
Construction and agricultural machinery  
Disinfectants  
Dry cleaning and dyeing  
Electric generation plants  
Electronics  
Energy storage systems (ESS) in dedicated use buildings  
Engines (including rebuilding)  
Food processing establishments and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities more than 2,500 square feet (232 m<sup>2</sup>) in area  
Furniture  
Hemp products  
Jute products  
Laundries  
Leather products  
Machinery  
Metals  
Millwork (sash and door)  
Motion pictures and television filming (without spectators)  
Musical instruments  
Optical goods  
Paper mills or products  
Photographic film  
Plastic products  
Printing or publishing  
Recreational vehicles  
Refuse incineration  
Shoes  
Soaps and detergents

## OCCUPANCY CLASSIFICATION AND USE

Textiles  
Tobacco  
Trailers  
Upholstering  
Water/sewer treatment facilities  
Wood; distillation  
Woodworking (cabinet)

**306.2.1 Aircraft manufacturing facilities.** Aircraft manufacturing facilities shall comply with Section 412.6.

**306.3 Low-hazard factory industrial, Group F-2.** Factory industrial uses that involve the fabrication or manufacturing of noncombustible materials that during finishing, packing or processing do not involve a significant fire hazard shall be classified as F-2 occupancies and shall include, but not be limited to, the following:

Beverages: up to and including 16-percent alcohol content  
Brick and masonry  
Ceramic products  
Foundries  
Glass products  
Gypsum  
Ice  
Metal products (fabrication and assembly)

## SECTION 307 HIGH-HAZARD GROUP H

**[F] 307.1 High-hazard Group H.** High-hazard Group H occupancy includes, among others, the use of a building or structure, or a portion thereof, that involves the manufacturing, processing, generation or storage of materials that constitute a physical or *health hazard* in quantities in excess of those allowed in *control areas* complying with Section 414, based on the maximum allowable quantity limits for *control areas* set forth in Tables 307.1(1) and 307.1(2). Hazardous occupancies are classified in Groups H-1, H-2, H-3, H-4 and H-5 and shall be in accordance with this section, the requirements of Section 415 and the *International Fire Code*. *Hazardous materials* stored, or used on top of roofs or canopies, shall be classified as outdoor storage or use and shall comply with the *International Fire Code*.

**[F] 307.1.1 Uses other than Group H.** An occupancy that stores, uses or handles *hazardous materials* as described in one or more of the following items shall not be classified as Group H, but shall be classified as the occupancy that it most nearly resembles.

1. Buildings and structures occupied for the application of flammable finishes, provided that such buildings or areas conform to the requirements of Section 416 and the *International Fire Code*.
2. Wholesale and retail sales and storage of flammable and combustible liquids in mercantile

occupancies conforming to the *International Fire Code*.

3. Closed piping system containing *flammable or combustible liquids* or gases utilized for the operation of machinery or equipment.
4. Cleaning establishments that utilize *combustible liquid* solvents having a *flash point* of 140°F (60°C) or higher in closed systems employing equipment *listed* by an *approved* testing agency, provided that this occupancy is separated from all other areas of the building by 1-hour *fire barriers* constructed in accordance with Section 707 or 1-hour *horizontal assemblies* constructed in accordance with Section 711, or both.
5. Cleaning establishments that utilize a liquid solvent having a *flash point* at or above 200°F (93°C).
6. Liquor stores and distributors without bulk storage.
7. Refrigeration systems.
8. The storage or utilization of materials for agricultural purposes on the premises.
9. Stationary storage battery systems installed in accordance with the *International Fire Code*.
10. *Corrosive* personal or household products in their original packaging used in retail display.
11. Commonly used *corrosive* building materials.
12. Buildings and structures occupied for *aerosol product* storage, aerosol cooking spray products or plastic aerosol 3 products shall be classified as Group S-1, provided that such buildings conform to the requirements of the *International Fire Code*.
13. Display and storage of nonflammable solid and nonflammable or noncombustible liquid *hazardous materials* in quantities not exceeding the maximum allowable quantity per *control area* in Group M or S occupancies complying with Section 414.2.5.
14. The storage of black powder, smokeless propellant and small arms primers in Groups M and R-3 and special industrial *explosive* devices in Groups B, F, M and S, provided such storage conforms to the quantity limits and requirements prescribed in the *International Fire Code*.
15. Stationary fuel cell power systems installed in accordance with the *International Fire Code*.
16. Capacitor energy storage systems in accordance with the *International Fire Code*.
17. Group B *higher education laboratory* occupancies complying with Section 428 and Chapter 38 of the *International Fire Code*.
18. Distilling or brewing of beverages conforming to the requirements of the *International Fire Code*.
19. The storage of beer, distilled spirits and wines in barrels and casks conforming to the requirements of the *International Fire Code*.



## OCCUPANCY CLASSIFICATION AND USE

**TABLE 307.1(1)**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, j, m, n, p</sup>**

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible dust	NA	H-2	See Note q	NA	NA	See Note q	NA	NA	See Note q	NA
Combustible fiber <sup>d</sup>	Loose	H-3	(100)	NA	NA	(100)	NA	NA	(20)	NA
	Baled <sup>o</sup>		(1,000)			(1,000)			(200)	
Combustible liquid <sup>c, i</sup>	II	H-2 or H-3	NA	120 <sup>d, e</sup>	NA	NA	120 <sup>d</sup>	NA	NA	30 <sup>d</sup>
	IIIA	H-2 or H-3		330 <sup>d, e</sup>			330 <sup>d</sup>			80 <sup>d</sup>
	IIIB	NA		13,200 <sup>c, f</sup>			13,200 <sup>f</sup>			3,300 <sup>f</sup>
Cryogenic flammable	NA	H-2	NA	45 <sup>d</sup>	NA	NA	45 <sup>d</sup>	NA	NA	10 <sup>d</sup>
Cryogenic inert	NA	NA	NA	NA	NL	NA	NA	NL	NA	NA
Cryogenic oxidizing	NA	H-3	NA	45 <sup>d</sup>	NA	NA	45 <sup>d</sup>	NA	NA	10 <sup>d</sup>
Explosives	Division 1.1	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.2	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.3	H-1 or H-2	5 <sup>e, g</sup>	(5) <sup>e, g</sup>		1 <sup>g</sup>	(1) <sup>g</sup>		1 <sup>g</sup>	(1) <sup>g</sup>
	Division 1.4	H-3	50 <sup>e, g</sup>	(50) <sup>e, g</sup>		50 <sup>g</sup>	(50) <sup>g</sup>		NA	NA
	Division 1.4G	H-3	125 <sup>e, 1</sup>	NA		NA	NA		NA	NA
	Division 1.5	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>		0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	Division 1.6	H-1	1 <sup>e, g</sup>	NA		NA	NA		NA	NA
Flammable gas	Gaseous	H-2	NA	NA	1,000 <sup>d, e</sup>	NA	NA	1,000 <sup>d, e</sup>	NA	NA
	Liquefied			(150) <sup>d, e</sup>	NA		(150) <sup>d, e</sup>	NA		
Flammable liquid <sup>c</sup>	IA	H-2 or H-3	NA	30 <sup>d, e</sup>	NA	NA	30 <sup>d</sup>	NA	NA	10 <sup>d</sup>
	IB and IC			120 <sup>d, e</sup>			120 <sup>d</sup>			30 <sup>d</sup>
Flammable liquid, combination (IA, IB, IC)	NA	H-2 or H-3	NA	120 <sup>d, e, h</sup>	NA	NA	120 <sup>d, h</sup>	NA	NA	30 <sup>d, h</sup>
Flammable solid	NA	H-3	125 <sup>d, e</sup>	NA	NA	125 <sup>d</sup>	NA	NA	25 <sup>d</sup>	NA
Inert gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA
Organic peroxide	UD	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	I	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>		1 <sup>d</sup>	(1) <sup>d</sup>		1 <sup>d</sup>	(1) <sup>d</sup>
	II	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>		50 <sup>d</sup>	(50) <sup>d</sup>		10 <sup>d</sup>	(10) <sup>d</sup>
	III	H-3	125 <sup>d, e</sup>	(125) <sup>d, e</sup>		125 <sup>d</sup>	(125) <sup>d</sup>		25 <sup>d</sup>	(25) <sup>d</sup>
	IV	NA	NL	NL		NL	NL		NL	NL
	V	NA	NL	NL		NL	NL		NL	NL

(continued)

## OCCUPANCY CLASSIFICATION AND USE

**TABLE 307.1(1)—continued**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD<sup>a, i, m, n, p</sup>**

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Oxidizer	4	H-1	1 <sup>g</sup>	(1) <sup>e, g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	NA	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	3 <sup>k</sup>	H-2 or H-3	10 <sup>d, e</sup>	(10) <sup>d, e</sup>		2 <sup>d</sup>	(2) <sup>d</sup>		2 <sup>d</sup>	(2) <sup>d</sup>
	2	H-3	250 <sup>d, e</sup>	(250) <sup>d, e</sup>		250 <sup>d</sup>	(250) <sup>d</sup>		50 <sup>d</sup>	(50) <sup>d</sup>
	1	NA	4,000 <sup>e, f</sup>	(4,000) <sup>e, f</sup>		4,000 <sup>f</sup>	(4,000) <sup>f</sup>		1,000 <sup>f</sup>	(1,000) <sup>f</sup>
Oxidizing gas	Gaseous	H-3	NA	NA	1,500 <sup>d, e</sup>	NA	NA	1,500 <sup>d, e</sup>	NA	NA
	Liquefied			(150) <sup>d, e</sup>	NA		(150) <sup>d, e</sup>	NA		
Pyrophoric	NA	H-2	4 <sup>e, g</sup>	(4) <sup>e, g</sup>	50 <sup>e, g</sup>	1 <sup>g</sup>	(1) <sup>g</sup>	10 <sup>e, g</sup>	0	0
Unstable (reactive)	4	H-1	1 <sup>e, g</sup>	(1) <sup>e, g</sup>	10 <sup>e, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>	2 <sup>e, g</sup>	0.25 <sup>g</sup>	(0.25) <sup>g</sup>
	3	H-1 or H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	50 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>	10 <sup>d, e</sup>	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>	750 <sup>d, e</sup>	50 <sup>d</sup>	(50) <sup>d</sup>	750 <sup>d, e</sup>	10 <sup>d</sup>	(10) <sup>d</sup>
	1	NA	NL	NL	NL	NL	NL	NL	NL	NL
Water reactive	3	H-2	5 <sup>d, e</sup>	(5) <sup>d, e</sup>	NA	5 <sup>d</sup>	(5) <sup>d</sup>	NA	1 <sup>d</sup>	(1) <sup>d</sup>
	2	H-3	50 <sup>d, e</sup>	(50) <sup>d, e</sup>		50 <sup>d</sup>	(50) <sup>d</sup>		10 <sup>d</sup>	(10) <sup>d</sup>
	1	NA	NL	NL		NL	NL		NL	NL

For SI: 1 cubic foot = 0.028 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

NL = Not Limited; NA = Not Applicable; UD = Unclassified Detonable.

a. For use of control areas, see Section 414.2.

b. The aggregate quantity in use and storage shall not exceed the quantity specified for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited provided the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs or consumer products, and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied cumulatively.

e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets, gas rooms or exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10 of the *International Fire Code*. Where Note d also applies, the increase for both notes shall be applied cumulatively.

f. Quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

g. Allowed only in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

h. Containing not more than the maximum allowable quantity per control area of Class IA, IB or IC flammable liquids.

i. The maximum allowable quantity shall not apply to fuel oil storage complying with Section 605.4.2 of the *International Fire Code*.

j. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

k. A maximum quantity of 220 pounds of solid or 22 gallons of liquid Class 3 oxidizers is allowed when such materials are necessary for maintenance purposes, operation or sanitation of equipment when the storage containers and the manner of storage are approved.

l. Net weight of the pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks, including packaging, shall be used.

m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2 of the *International Fire Code*.

n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.5, see Tables 414.2.5(1) and 414.2.5(2).

o. Densely packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.

p. The following shall not be included in determining the maximum allowable quantities:

1. Liquid or gaseous fuel in fuel tanks on vehicles.

2. Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with the *International Fire Code*.

3. Gaseous fuels in piping systems and fixed appliances regulated by the *International Fuel Gas Code*.

4. Liquid fuels in piping systems and fixed appliances regulated by the *International Mechanical Code*.

5. Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 5705.5 and 5705.5.1 of the *International Fire Code*. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction documents.

q. Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3.

**TABLE 307.1(2)**  
**[F] TABLE 307.1(2)**  
**MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A HEALTH HAZARD<sup>a, c, f, h, i</sup>**

MATERIAL	STORAGE <sup>b</sup>			USE-CLOSED SYSTEMS <sup>b</sup>			USE-OPEN SYSTEMS <sup>b</sup>	
	Solid pounds <sup>d, e</sup>	Liquid gallons (pounds) <sup>d, e</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>	Gas cubic feet at NTP (pounds) <sup>d</sup>	Solid pounds <sup>d</sup>	Liquid gallons (pounds) <sup>d</sup>
Corrosives	5,000	500	Gaseous 810 <sup>e</sup>	5,000	500	Gaseous 810 <sup>e</sup>	1,000	100
			Liquefied (150)			Liquefied (150)		
Highly Toxic	10	(10)	Gaseous 20 <sup>g</sup>	10	(10)	Gaseous 20 <sup>g</sup>	3	(3)
			Liquefied (4) <sup>g</sup>			Liquefied (4) <sup>g</sup>		
Toxic	500	(500)	Gaseous 810 <sup>e</sup>	500	(500)	Gaseous 810 <sup>e</sup>	125	(125)
			Liquefied (150) <sup>e</sup>			Liquefied (150) <sup>e</sup>		

For SI: 1 cubic foot = 0.028 m<sup>3</sup>, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

a. For use of control areas, see Section 414.2.

b. The aggregate quantity in use and storage shall not exceed the quantity specified for storage.

c. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs or consumer products, and cosmetics containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied cumulatively.

e. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, gas cabinets or exhausted enclosures as specified in the *International Fire Code*. Where Note d also applies, the increase for both notes shall be applied cumulatively.

f. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 414.2.5, see Tables 414.2.5(1) and 414.2.5(2).

g. Allowed only where stored in approved exhausted gas cabinets or exhausted enclosures as specified in the *International Fire Code*.

h. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

i. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2 of the *International Fire Code*.

**[F] 307.2 Hazardous materials.** *Hazardous materials* in any quantity shall conform to the requirements of this code, including Section 414, and the *International Fire Code*.

**[F] 307.3 High-hazard Group H-1.** Buildings and structures containing materials that pose a detonation hazard shall be classified as Group H-1. Such materials shall include, but not be limited to, the following:

Detonable *pyrophoric* materials

*Explosives*:

Division 1.1

Division 1.2

Division 1.3

Division 1.4

Division 1.5

Division 1.6

*Organic peroxides*, unclassified detonable

*Oxidizers*, Class 4

*Unstable (reactive) materials*, Class 3 detonable and Class 4

**[F] 307.3.1 Occupancies containing explosives not classified as H-1.** The following occupancies containing *explosive* materials shall be classified as follows:

1. Division 1.3 *explosive* materials that are used and maintained in a form where either confinement or configuration will not elevate the hazard from a mass fire to mass *explosion* hazard shall be allowed in H-2 occupancies.

2. Articles, including articles packaged for shipment, that are not regulated as a Division 1.4 *explosive* under Bureau of Alcohol, Tobacco, Firearms and Explosives regulations, or unpackaged articles used in process operations that do not propagate a detonation or deflagration between articles shall be allowed in H-3 occupancies.

**[F] 307.4 High-hazard Group H-2.** Buildings and structures containing materials that pose a deflagration hazard or a hazard from accelerated burning shall be classified as Group H-2. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA *flammable or combustible liquids* that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103.4 kPa).

*Combustible dusts* where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 414.1.3.

*Cryogenic fluids*, flammable.

*Flammable gases*.

*Organic peroxides*, Class I.

*Oxidizers*, Class 3, that are used or stored in normally open containers or systems, or in closed containers or systems pressurized at more than 15 pounds per square inch gauge (103 kPa).

## OCCUPANCY CLASSIFICATION AND USE

*Pyrophoric liquids, solids and gases, nondetonable.*

*Unstable (reactive) materials, Class 3, nondetonable.*

*Water-reactive materials, Class 3.*

**[F] 307.5 High-hazard Group H-3.** Buildings and structures containing materials that readily support combustion or that pose a *physical hazard* shall be classified as Group H-3. Such materials shall include, but not be limited to, the following:

Class I, II or IIIA *flammable or combustible liquids* that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103.4 kPa) or less

*Combustible fibers*, other than densely packed *baled cotton*, where manufactured, generated or used in such a manner that the concentration and conditions create a fire or *explosion* hazard based on information prepared in accordance with Section 414.1.3

Consumer *fireworks*, 1.4G (Class C, Common)

*Cryogenic fluids*, oxidizing

*Flammable solids*

*Organic peroxides*, Class II and III

*Oxidizers*, Class 2

*Oxidizers*, Class 3, that are used or stored in normally closed containers or systems pressurized at 15 pounds per square inch gauge (103 kPa) or less

*Oxidizing gases*

*Unstable (reactive) materials*, Class 3

*Water-reactive materials*, Class 2

**[F] 307.6 High-hazard Group H-4.** Buildings and structures containing materials that are *health hazards* shall be classified as Group H-4. Such materials shall include, but not be limited to, the following:

*Corrosives*

*Highly toxic materials*

*Toxic materials*

**[F] 307.7 High-hazard Group H-5.** Semiconductor fabrication facilities and comparable research and development areas in which hazardous production materials (HPM) are used and the aggregate quantity of materials is in excess of those specified in Table 307.1(1) and [F] Table 307.1(2) shall be classified as Group H-5. Such facilities and areas shall be designed and constructed in accordance with Section 415.11.

**[F] 307.8 Multiple hazards.** Buildings and structures containing a material or materials representing hazards that are classified in one or more of Groups H-1, H-2, H-3 and H-4 shall conform to the code requirements for each of the occupancies so classified.

## SECTION 308 INSTITUTIONAL GROUP I

**308.1 Institutional Group I.** Institutional Group I occupancy includes, among others, the use of a building or

structure, or a portion thereof, in which care or supervision is provided to persons who are or are *incapable of self-preservation* without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted. Institutional occupancies shall be classified as Group I-1, I-2, I-3 or I-4.

**308.2 Institutional Group I-1.** Institutional Group I-1 occupancy shall include buildings, structures or portions thereof for more than 16 persons, excluding staff, who reside on a *24-hour basis* in a supervised environment and receive *custodial care*. Buildings of Group I-1 shall be classified as one of the occupancy conditions specified in Section 308.2.1 or 308.2.2 and shall comply with Section 420. This group shall include, but not be limited to, the following:

Alcohol and drug centers

Assisted living facilities

Congregate care facilities

*Group homes*

Halfway houses

Residential board and care facilities

Social rehabilitation facilities

**308.2.1 Condition 1.** This occupancy condition shall include buildings in which all persons receiving *custodial care* who, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

**308.2.2 Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving *custodial care* who require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation.

**308.2.3 Six to 16 persons receiving custodial care.** A facility housing not fewer than six and not more than 16 persons receiving *custodial care* shall be classified as Group R-4.

**308.2.4 Five or fewer persons receiving custodial care.** A facility with five or fewer persons receiving *custodial care* shall be classified as Group R-3 or shall comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**308.3 Institutional Group I-2.** Institutional Group I-2 occupancy shall include buildings and structures used for *medical care* on a *24-hour basis* for more than five persons who are *incapable of self-preservation*. This group shall include, but not be limited to, the following:

*Foster care facilities*

*Detoxification facilities*

*Hospitals*

*Nursing homes*

*Psychiatric hospitals*

**308.3.1 Occupancy conditions.** Buildings of Group I-2 shall be classified as one of the occupancy conditions



specified in Section 308.3.1.1 or 308.3.1.2 and shall comply with Section 407.

**308.3.1.1 Condition 1.** This occupancy condition shall include facilities that provide nursing and *medical care* but do not provide emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric or detoxification, including but not limited to *nursing homes* and *foster care facilities*.

**308.3.1.2 Condition 2.** This occupancy condition shall include facilities that provide nursing and *medical care* and could provide emergency care, surgery, obstetrics or in-patient stabilization units for psychiatric or detoxification, including but not limited to *hospitals*.

**308.3.2 Five or fewer persons receiving *medical care*.** A facility with five or fewer persons receiving *medical care* shall be classified as Group R-3 or shall comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**308.4 Institutional Group I-3.** Institutional Group I-3 occupancy shall include buildings and structures that are inhabited by more than five persons who are under restraint or security. A Group I-3 facility is occupied by persons who are generally *incapable of self-preservation* due to security measures not under the occupants' control. This group shall include, but not be limited to, the following:

- Correctional centers
- Detention centers
- Jails
- Prerelease centers
- Prisons
- Reformatories

Buildings of Group I-3 shall be classified as one of the occupancy conditions specified in Sections 308.4.1 through 308.4.5 and shall comply with Section 408.

**308.4.1 Condition 1.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas, and other spaces where access or occupancy is permitted, to the exterior via *means of egress* without restraint. A Condition 1 facility is permitted to be constructed as Group R.

**308.4.2 Condition 2.** This occupancy condition shall include buildings in which free movement is allowed from sleeping areas and any other occupied *smoke compartment* to one or more other *smoke compartments*. Egress to the exterior is impeded by locked exits.

**308.4.3 Condition 3.** This occupancy condition shall include buildings in which free movement is allowed within individual *smoke compartments*, such as within a residential unit composed of individual *sleeping units* and group activity spaces, where egress is impeded by remote-controlled release of *means of egress* from such a *smoke compartment* to another *smoke compartment*.

**308.4.4 Condition 4.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Remote-controlled release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the *smoke compartment* to other *smoke compartments*.

**308.4.5 Condition 5.** This occupancy condition shall include buildings in which free movement is restricted from an occupied space. Staff-controlled manual release is provided to permit movement from *sleeping units*, activity spaces and other occupied areas within the *smoke compartment* to other *smoke compartments*.

**308.5 Institutional Group I-4, day care facilities.** Institutional Group I-4 occupancy shall include buildings and structures occupied by more than five persons of any age who receive *custodial care* for fewer than 24 hours per day by persons other than parents or guardians; relatives by blood, marriage or adoption; and in a place other than the home of the person cared for. Rooms normally occupied by preschool, kindergarten or first-grade students shall be located on a level of exit discharge. Rooms normally occupied by second-grade students shall not be located more than one level above the level of exit discharge and shall be provided with a dedicated and independent means of egress when above the level of exit discharge. This group shall include, but not be limited to, the following:

Adult day care

Child day care

**308.5.1 Classification as Group E.** A child day care facility that provides care for more than five but not more than 100 children 2½ years or less of age, where the rooms in which the children are cared for are located on a *level of exit discharge* serving such rooms and each of these child care rooms has an *exit* door directly to the exterior, shall be classified as Group E.

**308.5.2 Within a place of religious worship.** Rooms and spaces within *places of religious worship* providing such care during religious functions shall be classified as part of the primary occupancy.

**308.5.3 Five or fewer persons receiving care.** A facility having five or fewer persons receiving *custodial care* shall be classified as part of the primary occupancy.

**308.5.4 Five or fewer persons receiving care in a dwelling unit.** A facility such as the above within a *dwelling unit* and having five or fewer persons receiving *custodial care* shall be classified as a Group R-3 occupancy or shall comply with the *International Residential Code*.

## SECTION 309 MERCANTILE GROUP M

**309.1 Mercantile Group M.** Mercantile Group M occupancy includes, among others, the use of a building or structure or a portion thereof for the display and sale of merchandise, and involves stocks of goods, wares or merchandise incidental to such purposes and where the

## OCCUPANCY CLASSIFICATION AND USE

public has access. Mercantile occupancies shall include, but not be limited to, the following:

- Department stores
- Drug stores
- Greenhouses* for display and sale of plants that provide public access.
- Markets
- Motor fuel-dispensing facilities
- Retail or wholesale stores
- Sales rooms

**309.2 Quantity of hazardous materials.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid *hazardous materials* stored or displayed in a single *control area* of a Group M occupancy shall not exceed the quantities in Table 414.2.5(1).

**309.3 Motor fuel-dispensing facilities.** Motor fuel-dispensing facilities shall comply with Section 406.7.

### SECTION 310 RESIDENTIAL GROUP R

**310.1 Residential Group R.** Residential Group R includes, among others, the use of a building or structure, or a portion thereof, for sleeping purposes when not classified as an Institutional Group I or when not regulated by the *International Residential Code*. Group R occupancies not constructed in accordance with the *International Residential Code* as permitted by Sections 310.4.1 and 310.4.2 shall comply with Section 420.

**310.2 Residential Group R-1.** Residential Group R-1 occupancies containing *sleeping units* where the occupants are primarily *transient* in nature, including:

- Boarding houses (transient)* with more than 10 occupants
- Congregate living facilities (transient)* with more than 10 occupants
- Hotels (*transient*)
- Motels (*transient*)

**310.3 Residential Group R-2.** Residential Group R-2 occupancies containing *sleeping units* or more than two *dwelling units* where the occupants are primarily permanent in nature, including:

- Apartment houses
- Congregate living facilities* (nontransient) with more than 16 occupants
  - Boarding houses (nontransient)*
  - Convents
  - Dormitories*
  - Fraternities and sororities
  - Monasteries
- Hotels (nontransient)
- Live/work units*
- Motels (nontransient)
- Vacation timeshare properties

**310.4 Residential Group R-3.** Residential Group R-3 occupancies where the occupants are primarily permanent in nature and not classified as Group R-1, R-2, R-4 or I, including:

- Buildings that do not contain more than two *dwelling units*
- Care facilities that provide accommodations for five or fewer persons receiving care
- Congregate living facilities* (nontransient) with 16 or fewer occupants
  - Boarding houses* (nontransient)
  - Convents
  - Dormitories*
  - Fraternities and sororities
  - Monasteries
- Congregate living facilities (transient)* with 10 or fewer occupants

- Boarding houses (transient)*
- Lodging houses (transient)* with five or fewer *guest rooms* and 10 or fewer occupants

**310.4.1 Care facilities within a dwelling.** Care facilities for five or fewer persons receiving care that are within a single-family dwelling are permitted to comply with the *International Residential Code* provided an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**310.4.2 Lodging houses.** Owner-occupied *lodging houses* with five or fewer *guest rooms* and 10 or fewer total occupants shall be permitted to be constructed in accordance with the *International Residential Code*, provided that an *automatic sprinkler system* is installed in accordance with Section 903.3.1.3 or Section P2904 of the *International Residential Code*.

**310.5 Residential Group R-4.** Residential Group R-4 occupancy shall include buildings, structures or portions thereof for more than five but not more than 16 persons, excluding staff, who reside on a *24-hour basis* in a supervised residential environment and receive *custodial care*. Buildings of Group R-4 shall be classified as one of the occupancy conditions specified in Section 310.5.1 or 310.5.2. This group shall include, but not be limited to, the following:

- Alcohol and drug centers
- Assisted living facilities
- Congregate care facilities
- Group homes*
- Halfway houses
- Residential board and care facilities
- Social rehabilitation facilities

Group R-4 occupancies shall meet the requirements for construction as defined for Group R-3, except as otherwise provided for in this code.

**310.5.1 Condition 1.** This occupancy condition shall include buildings in which all persons receiving *custodial*

*care*, without any assistance, are capable of responding to an emergency situation to complete building evacuation.

**310.5.2 Condition 2.** This occupancy condition shall include buildings in which there are any persons receiving *custodial care* who require limited verbal or physical assistance while responding to an emergency situation to complete building evacuation.

## SECTION 311 STORAGE GROUP S

**311.1 Storage Group S.** Storage Group S occupancy includes, among others, the use of a building or structure, or a portion thereof, for storage that is not classified as a hazardous occupancy.

**311.1.1 Accessory storage spaces.** A room or space used for storage purposes that is accessory to another occupancy shall be classified as part of that occupancy.

**311.1.2 Combustible storage.** High-piled stock or rack storage, or *attic*, under-floor and concealed spaces used for storage of combustible materials, shall be in accordance with Section 413.

**311.2 Moderate-hazard storage, Group S-1.** Storage Group S-1 occupancies are buildings occupied for storage uses that are not classified as Group S-2, including, but not limited to, storage of the following:

- Aerosol products*, Levels 2 and 3
- Aircraft hangar (storage and repair)
- Bags: cloth, burlap and paper
- Bamboos and rattan
- Baskets
- Belting: canvas and leather
- Beverages over 16-percent alcohol content
- Books and paper in rolls or packs
- Boots and shoes
- Buttons, including cloth covered, pearl or bone
- Cardboard and cardboard boxes
- Clothing, woolen wearing apparel
- Cordage
- Dry boat storage (indoor)
- Furniture
- Furs
- Glues, mucilage, pastes and size
- Grains
- Horns and combs, other than celluloid
- Leather
- Linoleum
- Lumber
- Motor vehicle *repair garages* complying with the maximum allowable quantities of *hazardous materials* specified in Table 307.1(1) (see Section 406.8)
- Photo engravings

- Resilient flooring
- Self-service storage facility* (mini-storage)
- Silks
- Soaps
- Sugar
- Tires, bulk storage of
- Tobacco, cigars, cigarettes and snuff
- Upholstery and mattresses
- Wax candles

**311.2.1 Aircraft hangers.** Aircraft hangars used for storage or repair shall comply with Section 412.3.

**311.2.2 Motor vehicle repair garages** Motor vehicle *repair garages* shall comply with Section 406.8.

**311.3 Low-hazard storage, Group S-2.** Storage Group S-2 occupancies include, among others, buildings used for the storage of noncombustible materials such as products on wood pallets or in paper cartons with or without single thickness divisions; or in paper wrappings. Such products are permitted to have a negligible amount of plastic *trim*, such as knobs, handles or film wrapping. Group S-2 storage uses shall include, but not be limited to, storage of the following:

- Asbestos
- Beverages up to and including 16-percent alcohol
- Cement in bags
- Chalk and crayons
- Dairy products in nonwaxed coated paper containers
- Dry cell batteries
- Electrical coils
- Electrical motors
- Empty cans
- Food products
- Foods in noncombustible containers
- Fresh fruits and vegetables in nonplastic trays or containers
- Frozen foods
- Glass
- Glass bottles, empty or filled with noncombustible liquids
- Gypsum board*
- Inert pigments
- Ivory
- Meats
- Metal cabinets
- Metal desks with plastic tops and *trim*
- Metal parts
- Metals
- Mirrors
- Oil-filled and other types of distribution transformers
- Public parking garages, open or enclosed
- Porcelain and pottery

## OCCUPANCY CLASSIFICATION AND USE

Stoves  
Talc and soapstones  
Washers and dryers

**311.3.1 Public parking garages.** Public parking garages shall comply with Section 406.4 and the additional requirements of Section 406.5 for *open parking garages* or Section 406.6 for enclosed parking garages.

## SECTION 312 UTILITY AND MISCELLANEOUS GROUP U

**312.1 General.** Buildings and structures of an accessory character and miscellaneous structures not classified in any specific occupancy shall be constructed, equipped and maintained to conform to the requirements of this code commensurate with the fire and life hazard incidental to their occupancy. Group U shall include, but not be limited to, the following:

*Agricultural buildings*

Aircraft hangars, accessory to a one- or two-family residence (see Section 412.4)

Barns

Carports

Communication equipment structures with a *gross floor area* of less than 1,500 square feet (139 m<sup>2</sup>)

Fences more than 7 feet (2134 mm) in height

Grain silos, accessory to a residential occupancy

Livestock shelters

*Private garages*

Retaining walls

Sheds

Stables

Tanks

Towers

**312.1.1 Greenhouses.** *Greenhouses* not classified as another occupancy shall be classified as Use Group U.

**312.2 Private garages and carports.** *Private garages* and carports shall comply with Section 406.3.

**312.3 Residential aircraft hangars.** Aircraft hangars accessory to a one- or two-family residence shall comply with Section 412.4.



## CHAPTER 4

# SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

### User note:

**About this chapter:** Chapter 4 provides detailed criteria for special uses and occupancies. The unique characteristics of a live/work unit as opposed to a 30-story high-rise building call for specific standards for each. Twenty-seven sections address covered and open mall buildings, atriums, hospitals, stages, buildings where hazardous materials are used and stored, jails and prisons, ambulatory care facilities and storm shelters, among other special occupancy issues.

### SECTION 401 SCOPE

**401.1 Detailed occupancy and use requirements.** In addition to the occupancy and construction requirements in this code, the provisions of this chapter apply to the occupancies and use described herein.

### SECTION 402 COVERED MALL AND OPEN MALL BUILDINGS

**402.1 Applicability.** The provisions of this section shall apply to buildings or structures defined herein as *covered or open mall buildings* not exceeding three floor levels at any point nor more than three *stories above grade plane*. Except as specifically required by this section, *covered and open mall buildings* shall meet applicable provisions of this code.

#### Exceptions:

1. Foyers and lobbies of Group B, R-1 and R-2 occupancies are not required to comply with this section.
2. Buildings need not comply with the provisions of this section where they totally comply with other applicable provisions of this code.

**402.1.1 Open mall building perimeter line.** For the purpose of this code, a perimeter line shall be established. The perimeter line shall encircle all buildings and structures that comprise the *open mall building* and shall encompass any open-air interior walkways, open-air courtyards or similar open-air spaces. The perimeter line shall define the extent of the *open mall building*. *Anchor buildings* and parking structures shall be outside of the perimeter line and are not considered as part of the *open mall building*.

**402.2 Open space.** A *covered mall building* and attached *anchor buildings* and parking garages shall be surrounded on all sides by a permanent open space or not less than 60 feet (18 288 mm). An *open mall building* and *anchor buildings* and parking garages adjoining the perimeter line shall be

surrounded on all sides by a permanent open space of not less than 60 feet (18 288 mm).

**Exception:** The permanent open space of 60 feet (18 288 mm) shall be permitted to be reduced to not less than 40 feet (12 192 mm), provided that the following requirements are met:

1. The reduced open space shall not be allowed for more than 75 percent of the perimeter of the *covered or open mall building* and *anchor buildings*.
2. The *exterior wall* facing the reduced open space shall have a *fire-resistance rating* of not less than 3 hours.
3. Openings in the *exterior wall* facing the reduced open space shall have opening protectives with a *fire protection rating* of not less than 3 hours.
4. Group E, H, I or R occupancies are not located within the *covered or open mall building* or *anchor buildings*.

**402.3 Lease plan.** Each owner of a *covered mall building* or of an *open mall building* shall provide both the building and fire departments with a lease plan showing the location of each occupancy and its *exits* after the certificate of occupancy has been issued. Modifications or changes in occupancy or use from that shown on the lease plan shall not be made without prior approval of the *building official*.

**402.4 Construction.** The construction of *covered and open mall buildings*, *anchor buildings* and parking garages associated with a mall building shall comply with Sections 402.4.1 through 402.4.3.

**402.4.1 Area and types of construction.** The *building area* and type of construction of *covered mall* or *open mall buildings*, *anchor buildings* and parking garages shall comply with this section.

**402.4.1.1 Covered and open mall buildings.** The *building area* of any *covered mall* or *open mall building* shall not be limited provided that the *covered mall*

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

or *open mall building* does not exceed three floor levels at any point nor three *stories above grade plane*, and is of Type I, II, III or IV construction.

**402.4.1.2 Anchor buildings.** The *building area* and *building height* of any *anchor building* shall be based on the type of construction as required by Section 503 as modified by Sections 504 and 506.

**Exception:** The *building area* of any *anchor building* shall not be limited provided that the *anchor building* is not more than three *stories above grade plane*, and is of Type I, II, III or IV construction.

**402.4.1.3 Parking garage.** The *building area* and *building height* of any parking garage shall be based on the type of construction as required by Sections 406.5 and 406.6, respectively.

**402.4.2 Fire-resistance-rated separation.** Fire-resistance-rated separation is not required between tenant spaces and the *mall*. Fire-resistance-rated separation is not required between a *food court* and adjacent tenant spaces or the *mall*.

**402.4.2.1 Tenant separations.** Each tenant space shall be separated from other tenant spaces by a *fire partition* complying with Section 708. A tenant separation wall is not required between any tenant space and the *mall*.

**402.4.2.2 Anchor building separation.** An *anchor building* shall be separated from the *covered or open mall building* by *fire walls* complying with Section 706.

### Exceptions:

1. *Anchor buildings* of not more than three *stories above grade plane* that have an occupancy classification the same as that permitted for tenants of the *mall building* shall be separated by 2-hour fire-resistance-rated *fire barriers* complying with Section 707.
2. The *exterior walls* of *anchor buildings* separated from an *open mall building* by an *open mall* shall comply with Table 705.5.

**402.4.2.2.1 Openings between anchor building and mall.** Except for the separation between Group R-1 *sleeping units* and the *mall*, openings between *anchor buildings* of Type IA, IB, IIA or IIB construction and the *mall* need not be protected.

**402.4.2.3 Parking garages.** An attached garage for the storage of passenger vehicles having a capacity of not more than nine persons and *open parking garages* shall be considered as a separate building where it is separated from the *covered or open mall building* or *anchor building* by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

Parking garages, which are separated from *covered mall buildings*, *open mall buildings* or *anchor buildings*, shall comply with the provisions of Table 705.5.

*Pedestrian walkways* and tunnels that connect garages to *mall buildings* or *anchor buildings* shall be constructed in accordance with Section 3104.

**402.4.3 Open mall construction.** Floor assemblies in, and roof assemblies over, the *open mall* of an *open mall building* shall be open to the atmosphere for not less than 20 feet (9096 mm), measured perpendicular from the face of the tenant spaces on the lowest level, from edge of balcony to edge of balcony on upper floors and from edge of roof line to edge of roof line. The openings within, or the unroofed area of, an *open mall* shall extend from the lowest/grade level of the open mall through the entire roof assembly. Balconies on upper levels of the *mall* shall not project into the required width of the opening.

**402.4.3.1 Pedestrian walkways.** *Pedestrian walkways* connecting balconies in an *open mall* shall be located not less than 20 feet (9096 mm) from any other *pedestrian walkway*.

**[F] 402.5 Automatic sprinkler system.** *Covered and open mall buildings* and buildings connected shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, which shall comply with all of the following:

1. The *automatic sprinkler system* shall be complete and operative throughout occupied space in the *mall building* prior to occupancy of any of the tenant spaces. Unoccupied tenant spaces shall be similarly protected unless provided with *approved* alternative protection.
2. Sprinkler protection for the *mall* of a *covered mall building* shall be independent from that provided for tenant spaces or *anchor buildings*.
3. Sprinkler protection for the tenant spaces of an *open mall building* shall be independent from that provided for *anchor buildings*.
4. Sprinkler protection shall be provided beneath exterior circulation balconies located adjacent to an *open mall*.
5. Where tenant spaces are supplied by the same system, they shall be independently controlled.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of *open parking garages* separated from the covered or *open mall building* in accordance with Section 402.4.2.3 and constructed in accordance with Section 406.5.

**402.6 Interior finishes and features.** *Interior finishes* within the *mall* and installations within the *mall* shall comply with Sections 402.6.1 through 402.6.4.

**402.6.1 Interior finish** *Interior wall and ceiling finishes* within the *mall* of a *covered mall building* and within the *exits* of *covered or open mall buildings* shall have a mini-

maximum *flame spread index* and *smoke-developed index* of Class B in accordance with Chapter 8. *Interior floor finishes* shall meet the requirements of Section 804.

**402.6.2 Kiosks.** Kiosks and similar structures (temporary or permanent) located within the *mall* of a *covered mall building* or within the perimeter line of an *open mall building* shall meet the following requirements:

1. Combustible kiosks or other structures shall not be located within a *covered* or *open mall* unless constructed of any of the following materials:
  - 1.1. *Fire-retardant-treated* wood complying with Section 2303.2.
  - 1.2. Foam plastics having a maximum heat release rate not greater than 100 kW (105 Btu/h) when tested in accordance with the exhibit booth protocol in UL 1975 or when tested in accordance with NFPA 289 using the 20 kW ignition source.
  - 1.3. Aluminum composite material (ACM) meeting the requirements of Class A *interior finish* in accordance with Chapter 8 when tested as an assembly in the maximum thickness intended.
2. Kiosks or similar structures located within the *mall* shall be provided with *approved automatic sprinkler system* and detection devices.
3. The horizontal separation between kiosks or groupings thereof and other structures within the *mall* shall be not less than 20 feet (6096 mm).
4. Each kiosk or similar structure or groupings thereof shall have an area not greater than 300 square feet (28 m<sup>2</sup>).

**402.6.3 Play structures.** Play structures located within a *mall building* or within the perimeter line of an *open mall building* shall comply with Section 424. The horizontal separation between *play structures*, kiosks and similar structures within the *mall* shall be not less than 20 feet (6096 mm).

**402.6.4 Plastic signs.** Plastic signs affixed to the storefront of any tenant space facing a *mall* or *open mall* shall be limited as specified in Sections 402.6.4.1 through 402.6.4.5.

**402.6.4.1 Area.** Plastic signs shall be not more than 20 percent of the wall area facing the *mall*.

**402.6.4.2 Height and width.** Plastic signs shall be not greater than 36 inches (914 mm) in height, except that where the sign is vertical, the height shall be not greater than 96 inches (2438 mm) and the width shall be not greater than 36 inches (914 mm).

**402.6.4.3 Location.** Plastic signs shall be located not less than 18 inches (457 mm) from adjacent tenants.

**402.6.4.4 Plastics other than foam plastics.** Plastics other than foam plastics used in signs shall be light-transmitting plastics complying with Section 2606.4 or shall have a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with

ASTM D1929, and a *flame spread index* not greater than 75 and *smoke-developed index* not greater than 450 when tested in the manner intended for use in accordance with ASTM E84 or UL 723 or meet the acceptance criteria of Section 803.1.1.1 when tested in accordance with NFPA 286.

**402.6.4.4.1 Encasement.** Edges and backs of plastic signs in the *mall* shall be fully encased in metal.

**402.6.4.5 Foam plastics.** Foam plastics used in signs shall have flame-retardant characteristics such that the sign has a maximum heat-release rate of 150 kilowatts when tested in accordance with UL 1975 or when tested in accordance with NFPA 289 using the 20 kW ignition source, and the foam plastics shall have the physical characteristics specified in this section. Foam plastics used in signs installed in accordance with Section 402.6.4 shall not be required to comply with the *flame spread* and *smoke-developed indices* specified in Section 2603.3.

**402.6.4.5.1 Density.** The density of foam plastics used in signs shall be not less than 20 pounds per cubic foot (pcf) (320 kg/ m<sup>3</sup>).

**402.6.4.5.2 Thickness.** The thickness of foam plastic signs shall not be greater than 1/2 inch (12.7 mm).

**[F] 402.7 Emergency systems.** *Covered and open mall buildings, anchor buildings* and associated parking garages shall be provided with emergency systems complying with Sections 402.7.1 through 402.7.5.

**[F] 402.7.1 Standpipe system.** *Covered and open mall buildings* shall be equipped throughout with a *standpipe system* as required by Section 905.3.3.

**[F] 402.7.2 Smoke control.** *Atriums* connecting three or more *stories* in a *covered mall building* shall be provided with a smoke control system in accordance with Section 909.

**[F] 402.7.3 Emergency power.** *Covered mall buildings* greater than 50,000 square feet (4645 m<sup>2</sup>) in area and *open mall buildings* greater than 50,000 square feet (4645 m<sup>2</sup>) within the established perimeter line shall be provided with emergency power that is capable of operating the *emergency voice/alarm communication system* in accordance with Section 2702.

**[F] 402.7.4 Emergency voice/alarm communication system.** Where the total floor area is greater than 50,000 square feet (4645 m<sup>2</sup>) within either a *covered mall building* or within the perimeter line of an *open mall building*, an *emergency voice/alarm communication system* shall be provided.

The fire department shall have access to any *emergency voice/alarm communication systems* serving a *mall*, required or otherwise. The systems shall be provided in accordance with Section 907.5.2.2.

**[F] 402.7.5 Fire department access to equipment.** Rooms or areas containing controls for air-conditioning systems or *fire protection systems* shall be identified for use by the fire department.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**402.8 Means of egress.** *Covered mall buildings, open mall buildings* and each tenant space within a *mall building* shall be provided with *means of egress* as required by this section and this code. Where there is a conflict between the requirements of this code and the requirements of Sections 402.8.1 through 402.8.8, the requirements of Sections 402.8.1 through 402.8.8 shall apply.

**402.8.1 Mall width.** For the purpose of providing required egress, *malls* are permitted to be considered as corridors but need not comply with the requirements of Section 1005.1 of this code where the width of the *mall* is as specified in this section.

**402.8.1.1 Minimum width.** The aggregate clear egress width of the *mall* in either a *covered or open mall building* shall be not less than 20 feet (6096 mm). The *mall* width shall be sufficient to accommodate the *occupant load* served. Any portion of the minimum required aggregate egress width shall be not less than 10 feet (3048 mm) measured to a height of 8 feet (2438 mm) between any projection of a tenant space bordering the *mall* and the nearest kiosk, vending machine, bench, display opening, *food court* or other obstruction to *means of egress* travel.

**402.8.2 Determination of occupant load.** The *occupant load* permitted in any individual tenant space in a *covered or open mall building* shall be determined as required by this code. *Means of egress* requirements for individual tenant spaces shall be based on the *occupant load* thus determined.

**402.8.2.1 Occupant formula.** In determining required *means of egress* of the *mall*, the number of occupants for whom *means of egress* are to be provided shall be based on *gross leasable area* of the *covered or open mall building* (excluding *anchor buildings*) and the *occupant load factor* as determined by Equation 4-1.

$$OLF = (0.00007)(GLA) + 25 \quad \text{(Equation 4-1)}$$

where:

*OLF* = The *occupant load factor* (square feet per person).

*GLA* = The *gross leasable area* (square feet).

**Exception:** Tenant spaces attached to a *covered or open mall building* but with a *means of egress* system that is totally independent of the open mall of an *open mall building* or of a *covered mall building* shall not be considered as *gross leasable area* for determining the required *means of egress* for the *mall building*.

**402.8.2.2 OLF range.** The *occupant load factor* (*OLF*) is not required to be less than 30 and shall not exceed 50.

**402.8.2.3 Anchor buildings.** The *occupant load* of *anchor buildings* opening into the *mall* shall not be included in computing the total number of occupants for the *mall*.

**402.8.2.4 Food courts.** The *occupant load* of a *food court* shall be determined in accordance with Section

1004. For the purposes of determining the *means of egress* requirements for the *mall*, the *food court occupant load* shall be added to the *occupant load* of the covered or *open mall building* as calculated in Section 402.8.2.1.

**402.8.3 Number of means of egress.** Wherever the distance of travel to the *mall* from any location within a tenant space used by persons other than employees is greater than 75 feet (22 860 mm) or the tenant space has an *occupant load* of 50 or more, not fewer than two *means of egress* shall be provided.

**402.8.4 Arrangements of means of egress.** Assembly occupancies with an *occupant load* of 500 or more located within a *covered mall building* shall be so located such that their entrance will be immediately adjacent to a principal entrance to the mall and shall have not less than one-half of their required *means of egress* opening directly to the exterior of the *covered mall building*. Assembly occupancies located within the perimeter line of an *open mall building* shall be permitted to have their main *exit* open to the *open mall*.

**402.8.4.1 Anchor building means of egress.**

Required *means of egress* for *anchor buildings* shall be provided independently from the *mall means of egress* system. The *occupant load* of *anchor buildings* opening into the *mall* shall not be included in determining *means of egress* requirements for the *mall*. The path of egress travel of *malls* shall not exit through *anchor buildings*. *Malls* terminating at an *anchor building* where other *means of egress* has not been provided shall be considered as a dead-end *mall*.

**402.8.5 Distance to exits.** Within each individual tenant space in a *covered or open mall building*, the distance of travel from any point to an *exit* or entrance to the *mall* shall be not greater than 200 feet (60 960 mm).

The distance of travel from any point within a *mall* of a *covered mall building* to an *exit* shall be not greater than 200 feet (60 960 mm). The maximum distance of travel from any point within an *open mall* to the perimeter line of the *open mall building* shall be not greater than 200 feet (60 960 mm).

**402.8.6 Access to exits.** Where more than one *exit* is required, they shall be so arranged that it is possible to travel in either direction from any point in a *mall* of a *covered mall building* to separate *exits* or from any point in an *open mall* of an *open mall building* to two separate locations on the perimeter line, provided that neither location is an *exterior wall* of an *anchor building* or parking garage. The width of an *exit passageway* or *corridor* from a *mall* shall be not less than 66 inches (1676 mm).

**Exception:** Access to *exits* is permitted by way of a dead-end *mall* that does not exceed a length equal to twice the width of the *mall* measured at the narrowest location within the dead-end portion of the *mall*.

**402.8.6.1 Exit passageways.** Where *exit passageways* provide a secondary *means of egress* from a tenant



space, the *exit passageways* shall be constructed in accordance with Section 1024.

**402.8.7 Service areas fronting on exit passageways.** Mechanical rooms, electrical rooms, building service areas and service elevators are permitted to open directly into *exit passageways*, provided that the *exit passageway* is separated from such rooms with not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire protection rating* of openings in the *fire barriers* shall be not less than 1 hour.

**402.8.8 Security grilles and doors.** Horizontal sliding or vertical security grilles or doors that are a part of a required *means of egress* shall conform to the following:

1. Doors and grilles shall remain in the full open position during the period of occupancy by the general public.
2. Doors or grilles shall not be brought to the closed position when there are 10 or more persons occupying spaces served by a single *exit* or 50 or more persons occupying spaces served by more than one *exit*.
3. The doors or grilles shall be openable from within without the use of any special knowledge or effort where the space is occupied.
4. Where two or more *exits* are required, not more than one-half of the *exits* shall be permitted to include either a horizontal sliding or vertical rolling grille or door.

## SECTION 403 HIGH-RISE BUILDINGS

**403.1 Applicability.** *High-rise buildings* shall comply with Sections 403.2 through 403.6.

**Exceptions:** The provisions of Sections 403.2 through 403.6 shall not apply to the following buildings and structures:

1. Airport traffic control towers in accordance with Section 412.2.
2. *Open parking garages* in accordance with Section 406.5.
3. The portion of a building containing a Group A-5 occupancy in accordance with Section 303.6.
4. Special industrial occupancies in accordance with Section 503.1.1.
5. Buildings containing any one of the following:
  - 5.1. A Group H-1 occupancy.
  - 5.2. A Group H-2 occupancy in accordance with Section 415.8, 415.9.2, 415.9.3 or 426.1.
  - 5.3. A Group H-3 occupancy in accordance with Section 415.8.

**403.2 Construction.** The construction of *high-rise buildings* shall comply with the provisions of Sections 403.2.1 through 403.2.3.

**403.2.1 Reduction in fire-resistance rating.** The *fire-resistance rating* reductions specified in Sections 403.2.1.1 and 403.2.1.2 shall be allowed in buildings that have sprinkler control valves equipped with supervisory initiating devices and water-flow initiating devices for each floor.

**403.2.1.1 Type of construction.** The following reductions in the minimum *fire-resistance rating* of the *building elements* in TABLE 601 shall be permitted as follows:

1. For buildings not greater than 420 feet (128 m) in *building height*, the *fire-resistance rating* of the *building elements* in Type IA construction shall be permitted to be reduced to the minimum *fire-resistance ratings* for the *building elements* in Type IB.

**Exception:** The required *fire-resistance rating* of columns supporting floors shall not be reduced.

2. In other than Group F-1, H-2, H-3, H-5, M and S-1 occupancies, the *fire-resistance rating* of the *building elements* in Type IB construction shall be permitted to be reduced to the *fire-resistance ratings* in Type IIA.
3. The *building height* and *building area* limitations of a building containing *building elements* with reduced *fire-resistance ratings* shall be permitted to be the same as the building without such reductions.

**403.2.1.2 Shaft enclosures.** For buildings not greater than 420 feet (128 m) in *building height*, the required *fire-resistance rating* of the *fire barriers* enclosing vertical *shafts*, other than *interior exit stairway* and elevator hoistway enclosures, is permitted to be reduced to 1 hour where *automatic* sprinklers are installed within the *shafts* at the top and at alternate floor levels.

**[BS] 403.2.2 Structural integrity of interior exit stairways and elevator hoistway enclosures.** For *high-rise buildings of Risk Category III or IV* in accordance with Section 1604.5, and for all buildings that are more than 420 feet (128 m) in *building height*, enclosures for *interior exit stairways* and elevator hoistway enclosures shall comply with Sections 403.2.2.1 through 403.2.2.4.

**[BS] 403.2.2.1 Wall assembly materials—soft body impact.** The panels making up the enclosures for *interior exit stairways* and elevator hoistway enclosures shall meet or exceed Soft Body Impact Classification Level 2 as measured by the test method described in ASTM C1629/C1629M when tested from the exterior side of the enclosure.

**[BS] 403.2.2.2 Wall assembly materials—hard body impact.** The panels making up the enclosures for *inter-*

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

rior exit stairways and elevator hoistway enclosures that are not exposed to the interior of the enclosure shall be in accordance with one of the following:

1. The wall assembly shall incorporate not fewer than two layers of impact-resistant panels, each of which meets or exceeds Hard Body Impact Classification Level 2 as measured by the test method described in ASTM C1629/C1629M.
2. The wall assembly shall incorporate not fewer than one layer of impact-resistant panels that meet or exceed Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C1629/C1629M.
3. The wall assembly incorporates multiple layers of any material, tested in tandem, that meets or exceeds Hard Body Impact Classification Level 3 as measured by the test method described in ASTM C1629/C1629M.

**[BS] 403.2.2.3 Concrete and masonry walls.** Concrete or masonry walls shall be deemed to satisfy the requirements of Sections 403.2.2.1 and 403.2.2.2.

**[BS] 403.2.2.4 Other wall assemblies.** Any other wall assembly that provides impact resistance equivalent to that required by Sections 403.2.2.1 for Soft Body Impact Classification Level 2 and 403.2.2.2 for Hard Body Impact Classification Level 3, as measured by the test method described in ASTM C1629/C1629M, shall be permitted.

**403.2.3 Sprayed fire-resistant materials (SFRM).** The bond strength of the SFRM installed throughout the building shall be in accordance with Table 403.2.3.

**TABLE 403.2.3  
MINIMUM BOND STRENGTH**

HEIGHT OF BUILDING <sup>a</sup>	SFRM MINIMUM BOND STRENGTH
Up to 420 feet	430 psf
Greater than 420 feet	1,000 psf

For SI: 1 foot = 304.8 mm, 1 pound per square foot (psf) = 0.0479 kW/m<sup>2</sup>.

a. Above the lowest level of fire department vehicle access.

**[F] 403.3 Automatic sprinkler system.** Buildings and structures shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and a secondary water supply where required by Section 403.3.3.

**Exception:** An *automatic sprinkler system* shall not be required in spaces or areas of telecommunications equipment buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided that those spaces or areas are equipped throughout with an *automatic* fire detection system in accordance with Section 907.2 and are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 403.3.1 Number of sprinkler risers and system design.** Each sprinkler system zone in buildings that are more than 420 feet (128 m) in *building height* shall be supplied by not fewer than two risers. Each riser shall supply sprinklers on alternate floors. If more than two risers are provided for a zone, sprinklers on adjacent floors shall not be supplied from the same riser.

**[F] 403.3.1.1 Riser location.** Sprinkler risers shall be placed in *interior exit stairways* and *ramps* that are remotely located in accordance with Section 1007.1.

**[F] 403.3.2 Water supply to required fire pumps.** In all buildings that are more than 420 feet (128 m) in *building height* and buildings of Type IVA and IVB construction that are more than 120 feet (36 576 mm) in *building height*, required fire pumps shall be supplied by connections to not fewer than two water mains located in different streets. Separate supply piping shall be provided between each connection to the water main and the pumps. Each connection and the supply piping between the connection and the pumps shall be sized to supply the flow and pressure required for the pumps to operate.

**Exception:** Two connections to the same main shall be permitted provided that the main is valved such that an interruption can be isolated so that the water supply will continue without interruption through not fewer than one of the connections.

**[F] 403.3.3 Secondary water supply.** An *automatic* secondary on-site water supply having a capacity not less than the hydraulically calculated sprinkler demand, including the hose stream requirement, shall be provided for *high-rise buildings* assigned to *Seismic Design Category* C, D, E or F as determined by Section 1613. An additional fire pump shall not be required for the secondary water supply unless needed to provide the minimum design intake pressure at the suction side of the fire pump supplying the *automatic sprinkler system*. The secondary water supply shall have a duration of not less than 30 minutes as determined by the occupancy hazard classification in accordance with NFPA 13.

**[F] 403.3.4 Fire pump room.** Fire pumps shall be located in rooms protected in accordance with Section 913.2.1.

**[F] 403.4 Emergency systems.** The detection, alarm and emergency systems of *high-rise buildings* shall comply with Sections 403.4.1 through 403.4.8.

**[F] 403.4.1 Smoke detection.** Smoke detection shall be provided in accordance with Section 907.2.13.1.

**[F] 403.4.2 Fire alarm system.** A *fire alarm* system shall be provided in accordance with Section 907.2.13.

**[F] 403.4.3 Standpipe system.** A *high-rise building* shall be equipped with a *standpipe system* as required by Section 905.3.

**[F] 403.4.4 Emergency voice/alarm communication system.** An *emergency voice/alarm communication system* shall be provided in accordance with Section 907.5.2.2.

**[F] 403.4.5 Emergency communication coverage.** In-building, two-way emergency responder communication coverage shall be provided in accordance with Section 510 of the *International Fire Code*.

**[F] 403.4.6 Fire command.** A *fire command center* complying with Section 911 shall be provided in a location *approved* by the fire code official.

**[F] 403.4.7 Smoke removal.** To facilitate smoke removal in post-fire salvage and overhaul operations, buildings and structures shall be equipped with natural or mechanical *ventilation* for removal of products of combustion in accordance with one of the following:

1. Easily identifiable, manually operable windows or panels shall be distributed around the perimeter of each floor at not more than 50-foot (15 240 mm) intervals. The area of operable windows or panels shall be not less than 40 square feet (3.7 m<sup>2</sup>) per 50 linear feet (15 240 mm) of perimeter.

**Exceptions:**

1. In Group R-1 occupancies, each *sleeping unit* or suite having an *exterior wall* shall be permitted to be provided with 2 square feet (0.19 m<sup>2</sup>) of venting area in lieu of the area specified in Item 1.
2. Windows shall be permitted to be fixed provided that glazing can be cleared by fire fighters.
2. Mechanical air-handling equipment providing one exhaust air change every 15 minutes for the area involved. Return and exhaust air shall be moved directly to the outside without recirculation to other portions of the building.
3. Any other *approved* design that will produce equivalent results.

**[F] 403.4.8 Standby and emergency power.** A *standby power system* complying with Section 2702 and Section 3003 shall be provided for the standby power loads specified in Section 403.4.8.3. An *emergency power system* complying with Section 2702 shall be provided for the emergency power loads specified in Section 403.4.8.4.

**[F] 403.4.8.1 Equipment room.** If the *standby or emergency power system* includes a generator set inside a building, the system shall be located in a separate room enclosed with 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. System supervision with manual start and transfer features shall be provided at the *fire command center*.

**Exception:** In Group I-2, Condition 2, manual start and transfer features for the critical branch of the emergency power are not required to be provided at the *fire command center*.

**[F] 403.4.8.2 Fuel line piping protection.** Fuel lines supplying a generator set inside a building shall be

separated from areas of the building other than the room the generator is located in by one of the following methods:

1. A fire-resistant pipe-protection system that has been tested in accordance with UL 1489. The system shall be installed as tested and in accordance with the manufacturer's installation instructions, and shall have a rating of not less than 2 hours. Where the building is protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1, the required rating shall be reduced to 1 hour.
2. An assembly that has a *fire-resistance rating* of not less than 2 hours. Where the building is protected throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the required fire-resistance rating shall be reduced to 1 hour.
3. Other approved methods.

**[F] 403.4.8.3 Standby power loads.** The following are classified as standby power loads:

1. *Ventilation and automatic* fire detection equipment for *smokeproof* enclosures.
2. Elevators..
3. Where elevators are provided in a *high-rise building* for *accessible* means of egress, fire service access or occupant self-evacuation, the *standby power system* shall also comply with Sections 1009.4, 3007 or 3008, as applicable.

**[F] 403.4.8.4 Emergency power loads.** The following are classified as emergency power loads:

1. Exit signs and *means of egress* illumination required by Chapter 10.
2. Elevator car lighting.
3. *Emergency voice/alarm communications systems*.
4. *Automatic* fire detection systems.
5. *Fire alarm* systems.
6. Electrically powered fire pumps.
7. Power and lighting for the *fire command center* required by Section 403.4.6.

**403.5 Means of egress and evacuation.** The *means of egress* in *high-rise buildings* shall comply with Sections 403.5.1 through 403.5.5.

**403.5.1 Remoteness of interior exit stairways.** Required *interior exit stairways* shall be separated by a distance not less than 30 feet (9144 mm) or not less than one-fourth of the length of the maximum overall diagonal dimension of the building or area to be served, whichever is less. The distance shall be measured in a straight line between the nearest points of the enclosure surrounding the *interior exit stairways*. In buildings with three or more *interior exit stairways*, not fewer than two of the *interior exit*



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

*stairways* shall comply with this section. Interlocking or *scissor stairways* shall be counted as one *interior exit stairway*.

**403.5.2 Additional interior exit stairway.** For buildings other than Group R-2 and their ancillary spaces that are more than 420 feet (128 m) in *building height*, one additional *interior exit stairway* meeting the requirements of Sections 1011 and 1023 shall be provided in addition to the minimum number of *exits* required by Section 1006.3. The total capacity of any combination of remaining *interior exit stairways* with one *interior exit stairway* removed shall be not less than the total capacity required by Section 1005.1. *Scissor stairways* shall not be considered the additional *interior exit stairway* required by this section.

**Exceptions:**

1. An additional *interior exit stairway* shall not be required to be installed in buildings having elevators used for occupant self-evacuation in accordance with Section 3008.
2. An additional *interior exit stairway* shall not be required for other portions of the building where the highest occupiable floor level in those areas is less than 420 feet (128 m) in *building height*.

**403.5.3 Stairway door operation.** *Stairway* doors other than the exit discharge doors shall be permitted to be locked from the *stairway* side. *Stairway* doors that are locked from the *stairway* side shall be capable of being unlocked simultaneously without unlatching upon a signal from the *fire command center*.

**403.5.3.1 Stairway communication system.** A telephone or other two-way communications system connected to an *approved constantly attended station* shall be provided at not less than every fifth floor in each *stairway* where the doors to the *stairway* are locked.

**403.5.4 Smokeproof enclosures.** Every required *interior exit stairway* serving floors more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access shall be a *smokeproof enclosure* in accordance with Sections 909.20 and 1023.12.

**403.5.5 Luminous egress path markings.** Luminous egress path markings shall be provided in accordance with Section 1025.

**403.6 Elevators.** Elevator installation and operation in *high-rise buildings* shall comply with Chapter 30 and Sections 403.6.1 and 403.6.2.

**403.6.1 Fire service access elevator.** In buildings with an occupied floor more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, not fewer than two fire service access elevators, or all elevators, whichever is less, shall be provided in accordance with Section 3007. Each fire service access elevator shall have a capacity of not less than 3,500 pounds (1588 kg) and shall comply with Section 3002.4.

**403.6.2 Occupant evacuation elevators.** Where installed in accordance with Section 3008, passenger elevators for general public use shall be permitted to be used for occupant self-evacuation.

## SECTION 404 ATRIUMS

**404.1 General.** The provisions of Sections 404.1 through 404.11 shall apply to buildings containing *atriums*. *Atriums* are not permitted in buildings or structures classified as Group H.

**Exception:** Vertical openings that comply with Sections 712.1.1 through 712.1.3, and Sections 712.1.9 through 712.1.14.

**404.2 Use.** The floor of the *atrium* shall not be used for other than low fire hazard uses and only *approved* materials and decorations in accordance with the *International Fire Code* shall be used in the *atrium* space.

**Exception:** The *atrium* floor area is permitted to be used for any *approved* use where the individual space is provided with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[F] 404.3 Automatic sprinkler protection.** An *approved automatic sprinkler system* shall be installed throughout the entire building.

**Exceptions:**

1. That area of a building adjacent to or above the *atrium* need not be sprinklered provided that portion of the building is separated from the *atrium* portion by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.
2. Where the ceiling of the *atrium* is more than 55 feet (16 764 mm) above the floor, sprinkler protection at the ceiling of the *atrium* is not required.

**[F] 404.4 Fire alarm system.** A *fire alarm* system shall be provided in accordance with Section 907.2.14.

**404.5 Smoke control.** A smoke control system shall be installed in accordance with Section 909.

**Exceptions:**

1. In other than Group I-2, and Group I-1, Condition 2, smoke control is not required for *atriums* that connect only two *stories*.
2. A smoke control system is not required for *atriums* connecting more than two *stories* when all of the following are met:
  - 2.1. Only the two lowest *stories* shall be permitted to be open to the *atrium*.
  - 2.2. All *stories* above the lowest two *stories* shall be separated from the *atrium* in accordance with the provisions for a *shaft* in Section 713.4.



**404.6 Enclosure of atriums.** *Atrium* spaces shall be separated from adjacent spaces by a 1-hour *fire barrier* constructed in accordance with Section 707 or a *horizontal assembly* constructed in accordance with Section 711, or both.

**Exceptions:**

1. A *fire barrier* is not required where a glass wall forming a *smoke partition* is provided. The glass wall shall comply with all of the following:
  - 1.1. *Automatic* sprinklers are provided along both sides of the separation wall and doors, or on the room side only if there is not a walkway on the *atrium* side. The sprinklers shall be located between 4 inches and 12 inches (102 mm and 305 mm) away from the glass and at intervals along the glass not greater than 6 feet (1829 mm). The sprinkler system shall be designed so that the entire surface of the glass is wet upon activation of the sprinkler system without obstruction;
  - 1.2. The glass wall shall be installed in a gasketed frame in a manner that the framing system deflects without breaking (loading) the glass before the sprinkler system operates; and
  - 1.3. Where glass doors are provided in the glass wall, they shall be either *self-closing* or automatic-closing.
2. A *fire barrier* is not required where a glass-block wall assembly complying with Section 2110 and having a  $\frac{3}{4}$ -hour *fire protection rating* is provided.
3. A *fire barrier* is not required between the *atrium* and the adjoining spaces of up to three floors of the *atrium* provided that such spaces are accounted for in the design of the smoke control system.
4. A *fire barrier* is not required between the *atrium* and the adjoining spaces where the *atrium* is not required to be provided with a smoke control system.
5. A *horizontal assembly* is not required between the *atrium* and openings for escalators complying with Section 712.1.3.
6. A *horizontal assembly* is not required between the *atrium* and openings for *exit access stairways* and *ramps* complying with Item 4 of Section 1019.3.

[F] **404.7 Standby power.** Equipment required to provide smoke control shall be provided with standby power in accordance with Section 909.11.

**404.8 Interior finish.** The *interior finish* of walls and ceilings of the *atrium* shall be not less than Class B. Sprinkler protection shall not result in a reduction in class.

**404.9 Exit access travel distance.** *Exit access* travel distance for areas open to an *atrium* shall comply with the requirements of Section 1017.

**404.10 Exit stairways in an atrium.** Where an *atrium* contains an *interior exit stairway* all the following shall be met:

1. The entry to the exit stairway is the edge of the closest riser of the exit stairway.
2. The entry of the exit stairway shall have access from a minimum of two directions.
3. The distance between the entry to an exit stairway in an atrium and the entrance to a minimum of one exit stairway enclosed in accordance with Section 1023.2 shall comply with the separation required by Section 1007.1.1.
4. Exit access travel distance shall be measured to the closest riser of the exit stairway.
5. Not more than 50 percent of the exit stairways shall be located in the same atrium.

**404.11 Interior exit stairway discharge.** Discharge of *interior exit stairways* through an *atrium* shall be in accordance with Section 1028.

## SECTION 405 UNDERGROUND BUILDINGS

**405.1 General.** The provisions of Sections 405.2 through 405.9 apply to building spaces having a floor level used for human occupancy more than 30 feet (9144 mm) below the finished floor of the lowest *level of exit discharge*.

**Exceptions:** The provisions of Section 405 are not applicable to the following buildings or portions of buildings:

1. One- and two-family *dwelling*s, sprinklered in accordance with Section 903.3.1.3.
2. Parking garages provided with *automatic sprinkler systems* in compliance with Section 405.3.
3. Fixed guideway transit systems.
4. *Grandstands*, *bleachers*, stadiums, arenas and similar facilities.
5. Where the lowest *story* is the only *story* that would qualify the building as an underground building and has an area not greater than 1,500 square feet (139 m<sup>2</sup>) and has an *occupant load* less than 10.
6. Pumping stations and other similar mechanical spaces intended only for limited periodic use by service or maintenance personnel.

**405.2 Construction requirements.** The underground portion of the building shall be of Type I construction.

[F] **405.3 Automatic sprinkler system.** The highest *level of exit discharge* serving the underground portions of the building and all levels below shall be equipped with an *automatic*

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

*sprinkler system* installed in accordance with Section 903.3.1.1. Water-flow switches and control valves shall be supervised in accordance with Section 903.4.

**405.4 Compartmentation.** Compartmentation shall be in accordance with Sections 405.4.1 through 405.4.3.

**405.4.1 Number of compartments.** A building having a floor level more than 60 feet (18 288 mm) below the finished floor of the lowest *level of exit discharge* shall be divided into not fewer than two compartments of approximately equal size. Such compartmentation shall extend through the highest *level of exit discharge* serving the underground portions of the building and all levels below.

**Exception:** The lowest *story* need not be compartmented where the area is not greater than 1,500 square feet (139 m<sup>2</sup>) and has an *occupant load* of less than 10.

**405.4.2 Smoke barrier penetration.** The compartments shall be separated from each other by a *smoke barrier* in accordance with Section 709. Penetrations between the two compartments shall be limited to plumbing and electrical piping and conduit that are firestopped in accordance with Section 714. Doorways shall be protected by *fire door assemblies* that comply with Section 716, automatic-closing by smoke detection in accordance with Section 716.2.6.6 and installed in accordance with NFPA 105 and Section 716.2.2.1. Where provided, each compartment shall have an air supply and an exhaust system independent of the other compartments.

**405.4.3 Elevators.** Where elevators are provided, each compartment shall have direct access to an elevator. Where an elevator serves more than one compartment, an enclosed elevator lobby shall be provided and shall be separated from each compartment by a *smoke barrier* in accordance with Section 709. Doorways in the *smoke barrier* shall be protected by *fire door assemblies* that comply with Section 716, shall comply with the smoke and draft control assembly requirements of Section 716.2.2.1 with the UL 1784 test conducted without an artificial bottom seal, and shall be automatic-closing by smoke detection in accordance with Section 716.2.6.6.

**405.5 Smoke control system.** A smoke control system shall be provided in accordance with Sections 405.5.1 and 405.5.2.

**405.5.1 Control system.** A smoke control system is required to control the migration of products of combustion in accordance with Section 909 and the provisions of this section. Smoke control shall restrict movement of smoke to the general area of fire origin and maintain *means of egress* in a usable condition.

**405.5.2 Compartment smoke control system.** Where compartmentation is required, each compartment shall have an independent smoke control system. The system shall be automatically activated and capable of manual operation in accordance with Sections 907.2.18 and 907.2.19.

**[F] 405.6 Fire alarm systems.** A *fire alarm* system shall be provided where required by Sections 907.2.18 and 907.2.19.

**405.7 Means of egress.** *Means of egress* shall be in accordance with Sections 405.7.1 and 405.7.2.

**405.7.1 Number of exits.** Each floor level shall be provided with not fewer than two *exits*. Where compartmentation is required by Section 405.4, each compartment shall have not fewer than one *exit* and not fewer than one *exit access* doorway into the adjoining compartment.

**405.7.2 Smokeproof enclosure.** Every required *stairway* serving floor levels more than 30 feet (9144 mm) below the finished floor of its *level of exit discharge* shall comply with the requirements for a *smokeproof enclosure* as provided in Section 1023.12.

**[F] 405.8 Standby and emergency power.** A *standby power system* complying with Section 2702 shall be provided for the standby power loads specified in Section 405.8.1. An *emergency power system* complying with Section 2702 shall be provided for the emergency power loads specified in Section 405.8.2.

**[F] 405.8.1 Standby power loads.** The following are classified as standby power loads:

1. Smoke control system.
2. *Ventilation* and *automatic* fire detection equipment for *smokeproof* enclosures.
3. Elevators, as required in Section 3003.

**[F] 405.8.2 Emergency power loads.** The following are classified as emergency power loads:

1. *Emergency voice/alarm communications* systems.
2. *Fire alarm* systems.
3. *Automatic* fire detection systems.
4. Elevator car lighting.
5. *Means of egress* and *exit* sign illumination as required by Chapter 10.
6. Fire pumps.

**[F] 405.9 Standpipe system.** The underground building shall be equipped throughout with a *standpipe system* in accordance with Section 905.

## SECTION 406

### MOTOR-VEHICLE-RELATED OCCUPANCIES

**406.1 General.** All motor-vehicle-related occupancies shall comply with Section 406.2. *Private garages* and carports shall also comply with Section 406.3. Open public parking garages shall also comply with Sections 406.4 and 406.5. Enclosed public parking garages shall also comply with Sections 406.4 and 406.6. Motor fuel-dispensing facilities shall also comply with Section 406.7. *Repair garages* shall also comply with Section 406.8.

**406.2 Design.** *Private garages* and carports, open and enclosed public parking garages, motor fuel-dispensing facilities and *repair garages* shall comply with Sections 406.2.1 through 406.2.9.

**406.2.1 Automatic garage door openers and vehicular gates.** Automatic garage door openers shall be listed and labeled in accordance with UL 325. Where provided, *automatic vehicular gates* shall comply with Section 3110.

**406.2.2 Clear height.** The clear height of each floor level in vehicle and pedestrian traffic areas shall be not less than 7 feet (2134 mm). Canopies under which fuels are dispensed shall have a clear height in accordance with Section 406.7.2.

**Exception:** A lower clear height is permitted for a parking tier in *mechanical-access open parking garages* where approved by the *building official*.

**406.2.3 Accessible parking spaces.** Where parking is provided, accessible parking spaces, access aisles and vehicular routes serving accessible parking shall be provided in accordance with Section 1106.

**406.2.4 Floor surfaces.** Floor surfaces shall be of concrete or similar approved noncombustible and nonabsorbent materials. The area of floor used for the parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway. The surface of vehicle fueling pads in motor fuel-dispensing facilities shall be in accordance with Section 406.7.1.

**Exceptions:**

1. Asphalt parking surfaces shall be permitted at ground level for public parking garages and private carports.
2. Slip-resistant, nonabsorbent, *interior floor finishes* having a critical radiant flux not more than  $0.45 \text{ W/cm}^2$ , as determined by ASTM E648 or NFPA 253, shall be permitted in *repair garages*.

**406.2.5 Sleeping rooms.** Openings between a motor vehicle-related occupancy and a room used for sleeping purposes shall not be permitted.

**406.2.6 Fuel dispensing.** The dispensing of fuel shall only be permitted in motor fuel-dispensing facilities in accordance with Section 406.7.

**406.2.7 Electric vehicle charging stations and systems.** Where provided, electric vehicle charging systems shall be installed in accordance with NFPA 70. Electric vehicle charging system equipment shall be *listed* and labeled in accordance with UL 2202. Electric vehicle supply equipment shall be *listed* and labeled in accordance with UL 2594. Accessibility to *electric vehicle charging stations* shall be provided in accordance with Section 1107.

**406.2.8 Mixed occupancies and uses.** Mixed uses shall be allowed in the same building as public parking garages and *repair garages* in accordance with Section 508.1. Mixed uses in the same building as an *open parking garage* are subject to Sections 402.4.2.3, 406.5.11, 508.1, 510.3, 510.4 and 510.7.

**406.2.9 Equipment and appliances.** Equipment and appliances shall be installed in accordance with Sections

406.2.9.1 through 406.2.9.3 and the *International Mechanical Code*, *International Fuel Gas Code* and NFPA 70.

**406.2.9.1 Elevation of ignition sources.** Equipment and appliances having an ignition source and located in hazardous locations and public garages, *private garages*, *repair garages*, automotive motor fuel-dispensing facilities and parking garages shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor surface on which the equipment or appliance rests. For the purpose of this section, rooms or spaces that are not part of the living space of a *dwelling unit* and that communicate directly with a *private garage* through openings shall be considered to be part of the *private garage*.

**Exception:** Elevation of the ignition source is not required for appliances that are listed as flammable vapor ignition resistant.

**406.2.9.1.1 Parking garages.** Connection of a parking garage with any room in which there is a fuel-fired appliance shall be by means of a vestibule providing a two-doorway separation, except that a single door is permitted where the sources of ignition in the appliance are elevated in accordance with Section 406.2.9.

**Exception:** This section shall not apply to appliance installations complying with Section 406.2.9.2 or 406.2.9.3.

**406.2.9.2 Public garages.** Appliances located in public garages, motor fuel-dispensing facilities, *repair garages* or other areas frequented by motor vehicles shall be installed not less than 8 feet (2438 mm) above the floor. Where motor vehicles are capable of passing under an appliance, the appliance shall be installed at the clearances required by the appliance manufacturer and not less than 1 foot (305 mm) higher than the tallest vehicle garage door opening.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 406.2.9.1 and NFPA 30A.

**406.2.9.3 Private garages.** Appliances located in *private garages* and carports shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and are installed in accordance with Section 406.2.9.1.

**406.3 Private garages and carports.** *Private garages* and carports shall comply with Sections 406.2 and 406.3, or they shall comply with Sections 406.2 and 406.4.

**406.3.1 Classification.** *Private garages* and carports shall be classified as Group U occupancies. Each *private garage* shall be not greater than 1,000 square feet (93 m<sup>2</sup>) in area. Multiple *private garages* are permitted in a build-



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

ing where each *private garage* is separated from the other *private garages* by 1-hour *fire barriers* in accordance with Section 707, or 1-hour *horizontal assemblies* in accordance with Section 711, or both.

**406.3.2 Separation.** For other than *private garages* adjacent to dwelling units, the separation of *private garages* from other occupancies shall comply with Section 508. Separation of *private garages* from *dwelling units* shall comply with Sections 406.3.2.1 and 406.3.2.2.

**406.3.2.1 Dwelling unit separation.** The *private garage* shall be separated from the *dwelling unit* and its *attic* area by means of *gypsum board*, not less than  $\frac{1}{2}$ -inch (12.7 mm) in thickness, applied to the garage side. Garages beneath habitable rooms shall be separated from all habitable rooms above by not less than a  $\frac{5}{8}$ -inch (15.9 mm) Type X *gypsum board* or equivalent and  $\frac{1}{2}$ -inch (12.7 mm) *gypsum board* applied to structures supporting the separation from habitable rooms above the garage. Door openings between a *private garage* and the *dwelling unit* shall be equipped with either solid wood doors or solid or honeycomb core steel doors not less than  $1\frac{3}{8}$  inches (34.9 mm) in thickness, or doors in compliance with Section 716.2.2.1 with a *fire protection rating* of not less than 20 minutes. Doors shall be *self-closing* and self-latching.

**406.3.2.2 Ducts.** Ducts in a *private garage* and ducts penetrating the walls or ceilings separating the *dwelling unit* from the garage, including its *attic* area, shall be constructed of sheet steel of not less than 0.019 inch (0.48 mm) in thickness and shall not have openings into the garage.

**406.3.3 Carports.** Carports shall be open on not fewer than two sides. Carports open on fewer than two sides shall be considered to be a garage and shall comply with the requirements for *private garages*.

**406.3.3.1 Carport separation.** A separation is not required between a Group R-3 and U carport, provided that the carport is entirely open on two or more sides and there are not enclosed areas above.

**406.4 Public parking garages.** Parking garages, other than *private garages*, shall be classified as public parking garages and shall comply with the provisions of Sections 406.2 and 406.4 and shall be classified as either an *open parking garage* or an enclosed parking garage. *Open parking garages* shall also comply with Section 406.5. Enclosed parking garages shall also comply with Section 406.6. See Section 510 for special provisions for parking garages.

**406.4.1 Guards.** *Guards* shall be provided in accordance with Section 1015. *Guards* serving as *vehicle barriers* shall comply with Sections 406.4.2 and 1015.

**406.4.2 Vehicle barriers.** *Vehicle barriers* not less than 2 feet 9 inches (835 mm) in height shall be placed where the vertical distance from the floor of a drive lane or parking space to the ground or surface directly below is greater than 1 foot (305 mm). *Vehicle barriers* shall

comply with the loading requirements of Section 1607.10.

**Exception:** *Vehicle barriers* are not required in vehicle storage compartments in a mechanical access parking garage.

**406.4.3 Ramps.** Vehicle ramps shall not be considered as required *exits* unless pedestrian facilities are provided. Vehicle ramps that are utilized for vertical circulation as well as for parking shall not exceed a slope of 1 unit vertical in 15 units horizontal (6.67-percent slope).

**406.5 Open parking garages.** *Open parking garages* shall comply with Sections 406.2, 406.4 and 406.5.

**406.5.1 Construction.** *Open parking garages* shall be of Type I, II or IV construction. *Open parking garages* shall meet the design requirements of Chapter 16. For *vehicle barriers*, see Section 406.4.2.

**406.5.2 Openings.** For natural *ventilation* purposes, the exterior side of the structure shall have uniformly distributed openings on two or more sides. The area of such openings in *exterior walls* on a tier shall be not less than 20 percent of the total perimeter wall area of each tier. The aggregate length of the openings considered to be providing natural *ventilation* shall be not less than 40 percent of the perimeter of the tier. Interior walls shall be not less than 20 percent open with uniformly distributed openings.

**Exception:** Openings are not required to be distributed over 40 percent of the building perimeter where the required openings are uniformly distributed over two opposing sides of the building.

**406.5.2.1 Openings below grade.** Where openings below grade provide required natural *ventilation*, the outside horizontal clear space shall be one and one-half times the depth of the opening. The width of the horizontal clear space shall be maintained from grade down to the bottom of the lowest required opening.

**406.5.3 Mixed occupancies and uses.** Mixed uses shall be allowed in the same building as an *open parking garage* subject to the provisions of Sections 402.4.2.3, 406.5.11, 508.1, 510.3, 510.4 and 510.7.

**406.5.4 Area and height.** Area and height of *open parking garages* shall be limited as set forth in Chapter 5 for Group S-2 occupancies and as further provided for in Section 508.1.

**406.5.4.1 Single use.** Where the *open parking garage* is used exclusively for the parking or storage of private motor vehicles, and the building is without other uses, the area and height shall be permitted to comply with Table 406.5.4, along with increases allowed by Section 406.5.5.

**Exception:** The grade-level tier is permitted to contain an office, waiting and toilet rooms having a total combined area of not more than 1,000 square feet (93 m<sup>2</sup>). Such area need not be separated from the *open parking garage*.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

In *open parking garages* having a spiral or sloping floor, the horizontal projection of the structure at any cross section shall not exceed the allowable area per parking tier. In the case of an *open parking garage* having a continuous spiral floor, each 9 feet 6 inches (2896 mm) of height, or portion thereof, shall be considered under these provisions to be a tier.

**406.5.5 Area and height increases.** The allowable area and height of *open parking garages* shall be increased in accordance with the provisions of this section. Garages with sides open on three-fourths of the building's perimeter are permitted to be increased by 25 percent in area and one tier in height. Garages with sides open around the entire building's perimeter are permitted to be increased by 50 percent in area and one tier in height. For a side to be considered open under these provisions, the total area of openings along the side shall be not less than 50 percent of the interior area of the side at each tier and such openings shall be equally distributed along the length of the tier. For purposes of calculating the interior area of the side, the height shall not exceed 7 feet (2134 mm).

Allowable tier areas in Table 406.5.4 shall be increased for *open parking garages* constructed to heights less than the table maximum. The gross tier area of the garage shall not exceed that permitted for the higher structure. Not fewer than three sides of each such larger tier shall have continuous horizontal openings not less than 30 inches (762 mm) in clear height extending for not less than 80 percent of the length of the sides. All parts of such larger tier shall be not more than 200 feet (60 960 mm) horizontally from such an opening. In addition, each such opening shall face a street or yard with access to a street with a width of not less than 30 feet (9144 mm) for the full length of the opening, and *standpipes* shall be provided in each such tier.

*Open parking garages* of Type II construction, with all sides open, shall be unlimited in allowable area where the *building height* does not exceed 75 feet (22 860 mm). For a side to be considered open, the total area of openings along the side shall be not less than 50 percent of the interior area of the side at each tier and such openings shall be equally distributed along the length of the tier. For purposes of calculating the interior area of the side, the height shall not exceed 7 feet (2134 mm). All portions of

tiers shall be within 200 feet (60 960 mm) horizontally from such openings or other natural *ventilation* openings as defined in Section 406.5.2. These openings shall be permitted to be provided in *courts* with a minimum dimension of 20 feet (6096 mm) for the full width of the openings.

**406.5.6 Fire separation distance.** *Exterior walls* and openings in *exterior walls* shall comply with Table 601 and Table 705.5. The distance to an adjacent *lot line* shall be determined in accordance with Section 705 and Table 705.5.

**406.5.7 Means of egress.** Where persons other than parking attendants are permitted, *open parking garages* shall meet the *means of egress* requirements of Chapter 10. Where persons other than parking attendants are not permitted, there shall be not fewer than two exit stairways. Each *exit stairway* shall be not less than 36 inches (914 mm) in width. Lifts shall be permitted to be installed for use of employees only, provided that they are completely enclosed by noncombustible materials.

**[F] 406.5.8 Standpipe system.** An *open parking garage* shall be equipped with a *standpipe system* as required by Section 905.3.

**406.5.9 Enclosure of vertical openings.** Enclosure shall not be required for vertical openings except as specified in Section 406.5.7.

**406.5.10 Ventilation.** *Ventilation*, other than the percentage of openings specified in Section 406.5.2, shall not be required.

**406.5.11 Prohibitions.** The following uses and alterations are not permitted:

1. Vehicle repair work.
2. Parking of buses, trucks and similar vehicles.
3. Partial or complete closing of required openings in *exterior walls* by tarpaulins or any other means.
4. Dispensing of fuel.

**406.6 Enclosed parking garages.** Enclosed parking garages shall comply with Sections 406.2, 406.4 and 406.6.

**406.6.1 Heights and areas.** Enclosed vehicle parking garages and portions thereof that do not meet the definition of *open parking garages* shall be limited to the allowable heights and areas specified in Sections 504 and

**TABLE 406.5.4**  
**OPEN PARKING GARAGES AREA AND HEIGHT**

TYPE OF CONSTRUCTION	AREA PER TIER (square feet)	Ramp access	HEIGHT (in tiers)	
			Mechanical access	
			Automatic sprinkler system	
			No	Yes
IA	Unlimited	Unlimited	Unlimited	Unlimited
IB	Unlimited	12 tiers	12 tiers	18 tiers
IIA	50,000	10 tiers	10 tiers	15 tiers
IIB	50,000	8 tiers	8 tiers	12 tiers
IV	50,000	4 tiers	4 tiers	4 tiers

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

506 as modified by Section 507. Roof parking is permitted.

**406.6.2 Ventilation.** A mechanical *ventilation* system and exhaust system shall be provided in accordance with *Chapters 4 and 5 of the International Mechanical Code*.

**Exception:** Mechanical *ventilation* shall not be required for enclosed parking garages that are accessory to one- and two-family *dwellings*.

**[F] 406.6.3 Automatic sprinkler system.** An enclosed parking garage shall be equipped with an *automatic sprinkler system* in accordance with Section 903.2.10.

**406.6.4 Mechanical-access enclosed parking garages.** *Mechanical-access enclosed parking garages* shall be in accordance with Sections 406.6.4.1 through 406.6.4.4.

**406.6.4.1 Separation.** *Mechanical-access enclosed parking garages* shall be separated from other occupancies and accessory uses by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or by not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

**406.6.4.2 Smoke removal.** A mechanical smoke removal system, installed in accordance with Section 910.4, shall be provided for all areas containing a *mechanical-access enclosed parking garage*.

**406.6.4.3 Fire control equipment room.** Fire control equipment, consisting of the *fire alarm* control unit, mechanical *ventilation* controls and an emergency shutdown switch, shall be provided in a room located where the equipment is able to be accessed by the fire service from a secured exterior door of the building. The room shall be not less than 50 square feet (4.65 m<sup>2</sup>) in area and shall be in a location that is approved by the fire code official.

**406.6.4.3.1 Emergency shutdown switch.** The mechanical parking system shall be provided with a manually activated emergency shutdown switch for use by emergency personnel. The switch shall be clearly identified and shall be in a location approved by the fire code official.

**406.6.4.4 Fire department access doors.** Access doors shall be provided in accordance with Section 3206.7 of the *International Fire Code*.

**406.7 Motor fuel-dispensing facilities.** Motor fuel-dispensing facilities shall comply with the *International Fire Code* and Sections 406.2 and 406.7.

**406.7.1 Vehicle fueling pad.** The vehicle shall be fueled on noncoated concrete or other *approved* paving material having a resistance not exceeding 1 megohm as determined by the methodology in CEN EN 1081.

**406.7.2 Canopies.** Canopies under which fuels are dispensed shall have a clear, unobstructed height of not less than 13 feet 6 inches (4115 mm) to the lowest projecting element in the vehicle drive-through area. Canopies and their supports over pumps shall be of noncombustible materials, *fire-retardant-treated wood* complying with Chapter 23, heavy timber complying with

Section 2304.11 or construction providing 1-hour *fire resistance*. Combustible materials used in or on a *canopy* shall comply with one of the following:

1. Shielded from the pumps by a noncombustible element of the *canopy*, or heavy timber complying with Section 2304.11.
2. Plastics covered by aluminum facing having a thickness of not less than 0.010 inch (0.30 mm) or corrosion-resistant steel having a base metal thickness of not less than 0.016 inch (0.41 mm). The plastic shall have a *flame spread index* of 25 or less and a *smoke-developed index* of 450 or less when tested in the form intended for use in accordance with ASTM E84 or UL 723 and a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D1929.
3. Panels constructed of light-transmitting plastic materials shall be permitted to be installed in *canopies* erected over motor vehicle fuel-dispensing station fuel dispensers, provided that the panels are located not less than 10 feet (3048 mm) from any building on the same *lot* and face *yards* or streets not less than 40 feet (12 192 mm) in width on the other sides. The aggregate areas of plastics shall be not greater than 1,000 square feet (93 m<sup>2</sup>). The maximum area of any individual panel shall be not greater than 100 square feet (9.3 m<sup>2</sup>).

**406.7.2.1 Canopies used to support gaseous hydrogen systems.** *Canopies* that are used to shelter dispensing operations where flammable compressed gases are located on the roof of the *canopy* shall be in accordance with the following:

1. The *canopy* shall meet or exceed Type I construction requirements.
2. Operations located under *canopies* shall be limited to refueling only.
3. The *canopy* shall be constructed in a manner that prevents the accumulation of hydrogen gas.

**406.8 Repair garages.** *Repair garages* shall be constructed in accordance with the *International Fire Code* and Sections 406.2 and 406.8. This occupancy shall not include motor fuel-dispensing facilities, as regulated in Section 406.7.

**406.8.1 Ventilation.** *Repair garages* shall be mechanically ventilated in accordance with the *International Mechanical Code*. The *ventilation* system shall be controlled at the entrance to the garage.

**[F] 406.8.2 Gas detection system.** *Repair garages* used for repair of vehicles fueled by nonodorized gases including but not limited to hydrogen and nonodorized LNG, shall be provided with a *gas detection system* that complies with Section 916. The *gas detection system* shall be designed to detect leakage of nonodorized gaseous fuel. Where lubrication or chassis service pits are provided in garages used for repairing nonodorized LNG-fueled vehicles, gas sensors shall be provided in such pits.

**[F] 406.8.2.1 System activation.** Activation of a gas detection alarm shall result in all of the following:

1. Initiation of distinct audible and visual alarm signals in the *repair garage*, where the *ventilation* system is interlocked with gas detection.
2. Deactivation of all heating systems located in the *repair garage*.
3. Activation of the mechanical *ventilation* system, where the system is interlocked with gas detection.

**[F] 406.8.2.2 Failure of the gas detection system.** Failure of the *gas detection system* shall automatically deactivate the heating system, activate the mechanical ventilation system where the system is interlocked with the *gas detection system*, and cause a trouble signal to sound at an *approved* location.

**[F] 406.8.3 Automatic sprinkler system.** A *repair garage* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.2.9.1.

## SECTION 407 GROUP I-2

**407.1 General.** Occupancies in Group I-2 shall comply with the provisions of Sections 407.1 through 407.11 and other applicable provisions of this code.

**407.2 Corridors continuity and separation.** *Corridors* in occupancies in Group I-2 shall be continuous to the *exits* and shall be separated from other areas in accordance with Section 407.3 except spaces conforming to Sections 407.2.1 through 407.2.6.

**407.2.1 Waiting and similar areas.** Waiting areas, public-use areas or group meeting spaces constructed as required for *corridors* shall be permitted to be open to a *corridor*, only where all of the following criteria are met:

1. The spaces are not occupied as care recipient's sleeping rooms, treatment rooms, incidental uses in accordance with Section 509, or hazardous uses.
2. The open space is protected by an *automatic* fire detection system installed in accordance with Section 907.
3. The *corridors* onto which the spaces open, in the same *smoke compartment*, are protected by an *automatic* fire detection system installed in accordance with Section 907, or the *smoke compartment* in which the spaces are located is equipped throughout with quick-response sprinklers in accordance with Section 903.3.2.
4. The space is arranged so as not to obstruct access to the required *exits*.

**407.2.2 Care providers' stations.** Spaces for care providers', supervisory staff, doctors' and nurses' charting, communications and related clerical areas shall be permitted to be open to the *corridor*, where such spaces are constructed as required for *corridors*.

**407.2.3 Psychiatric treatment areas.** Areas wherein psychiatric care recipients who are *incapable of self-preservation* are housed, or group meeting or multipurpose therapeutic spaces other than incidental uses in accordance with Section 509, under continuous supervision by facility staff, shall be permitted to be open to the *corridor*, where the following criteria are met:

1. Each area does not exceed 1,500 square feet (140 m<sup>2</sup>).
2. The area is located to permit supervision by the facility staff.
3. The area is arranged so as not to obstruct any access to the required *exits*.
4. The area is equipped with an *automatic* fire detection system installed in accordance with Section 907.2.
5. Not more than one such space is permitted in any one *smoke compartment*.
6. The walls and ceilings of the space are constructed as required for *corridors*.

**407.2.4 Gift shops.** Gift shops and associated storage that are less than 500 square feet (455 m<sup>2</sup>) in area shall be permitted to be open to the *corridor* where such spaces are constructed as required for *corridors*.

**407.2.5 Nursing home housing units.** In Group I-2, Condition 1 occupancies, in areas where *nursing home* residents are housed, shared living spaces, group meeting or multipurpose therapeutic spaces shall be permitted to be open to the *corridor*, where all of the following criteria are met:

1. The walls and ceilings of the space are constructed as required for *corridors*.
2. The spaces are not occupied as resident sleeping rooms, treatment rooms, incidental uses in accordance with Section 509, or hazardous uses.
3. The open space is protected by an *automatic* fire detection system installed in accordance with Section 907.
4. The *corridors* onto which the spaces open, in the same *smoke compartment*, are protected by an *automatic* fire detection system installed in accordance with Section 907, or the *smoke compartment* in which the spaces are located is equipped throughout with quick-response sprinklers in accordance with Section 903.3.2.
5. The space is arranged so as not to obstruct access to the required *exits*.

**407.2.6 Nursing home cooking facilities.** In Group I-2, Condition 1 occupancies, rooms or spaces that contain a cooking facility with domestic cooking appliances shall be permitted to be open to the *corridor* where all of the following criteria are met:

1. The number of care recipients housed in the *smoke compartment* shall not be greater than 30.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

2. The number of care recipients served by the cooking facility shall not be greater than 30.
3. Not more than one cooking facility area shall be permitted in a *smoke compartment*.
4. The *corridor* shall be a clearly identified space delineated by construction or floor pattern, material or color.
5. The space containing the domestic cooking facility shall be arranged so as not to obstruct access to the required *exit*.
6. The cooking appliance shall comply with Section 407.2.7.

**407.2.7 Domestic cooking appliances.** In Group I-2 occupancies, installation of cooking appliances used in domestic cooking facilities shall comply with all of the following:

1. The types of cooking appliances permitted shall be limited to ovens, cooktops, ranges, warmers and microwaves.
2. Domestic cooking hoods installed and constructed in accordance with Section 505 of the International Mechanical Code shall be provided over cooktops and ranges.
3. Cooktops and ranges shall be protected in accordance with Section 904.14.
4. A shut-off for the fuel and electrical power supply to the cooking equipment shall be provided in a location to which only staff has access.
5. A timer shall be provided that automatically deactivates the cooking appliances within a period of not more than 120 minutes.
6. A portable fire extinguisher shall be provided. Installation shall be in accordance with Section 906, and the extinguisher shall be located within a 30-foot (9144 mm) distance of travel from each domestic cooking appliance.

**Exceptions:**

1. Cooktops and ranges located within smoke compartments with no patient sleeping or patient care areas are not required to comply with this section.
2. Cooktops and ranges used for care recipient training or nutritional counseling are not required to comply with Item 3 of this section.

**407.3 Corridor wall construction.** *Corridor* walls shall be constructed as *smoke partitions* in accordance with Section 710.

**407.3.1 Corridor doors.** *Corridor* doors, other than those in a wall required to be rated by Section 509.4 or for the enclosure of a vertical opening or an *exit*, shall not have a required *fire protection rating* and shall not be required to be equipped with *self-closing* or automatic-closing devices, but shall provide an effective barrier to limit the transfer of smoke and shall be equipped with positive

latching. Roller latches are not permitted. Other doors shall conform to Section 716.

**407.3.1.1 Door construction.** Doors in *corridors* not required to have a *fire protection rating* shall comply with the following:

1. Solid doors shall have close-fitting operational tolerances, head and jamb stops.
2. Dutch-style doors shall have an astragal, rabbet or bevel at the meeting edges of the upper and lower door sections. Both the upper and lower door sections shall have latching hardware. Dutch-style doors shall have hardware that connects the upper and lower sections to function as a single leaf.
3. To provide makeup air for exhaust systems in accordance with Section 1020.7, Exception 1, doors are permitted to have louvers or to have a clearance between the bottom of the door and the floor surface that is  $\frac{2}{3}$  inch (19.1 mm) maximum.

**407.4 Means of egress.** Group I-2 occupancies shall be provided with *means of egress* complying with Chapter 10 and Sections 407.4.1 through 407.4.4. The fire safety and evacuation plans provided in accordance with Section 1002.2 shall identify the building components necessary to support a *defend-in-place* emergency response in accordance with Sections 403 and 404 of the *International Fire Code*.

**407.4.1 Direct access to a corridor.** Habitable rooms in Group I-2 occupancies shall have an exit access door leading directly to a *corridor*.

**Exceptions:**

1. Rooms with *exit* doors opening directly to the outside at ground level.
2. Rooms arranged as *care suites* complying with Section 407.4.4.

**407.4.1.1 Locking devices.** Locking devices that restrict access to a care recipient's room from the *corridor* and that are operable only by staff from the corridor side shall not restrict the *means of egress* from the care recipient's room.

**Exceptions:**

1. This section shall not apply to rooms in psychiatric treatment and similar care areas.
2. Locking arrangements in accordance with Section 1010.2.14.

**407.4.2 Distance of travel.** The distance of travel between any point in a Group I-2 occupancy sleeping room, not located in a *care suite*, and an *exit access* door in that room shall be not greater than 50 feet (15 240 mm).

**407.4.3 Projections in nursing home corridors.** In Group I-2, Condition 1 occupancies, where the *corridor* width is not less than 96 inches (2440 mm), projections



shall be permitted for furniture where all of the following criteria are met:

1. The furniture is attached to the floor or to the wall.
2. The furniture does not reduce the clear width of the *corridor* to less than 72 inches (1830 mm) except where other encroachments are permitted in accordance with Section 1005.7.
3. The furniture is positioned on only one side of the *corridor*.
4. Each arrangement of furniture is 50 square feet (4.6 m<sup>2</sup>) maximum in area.
5. Furniture arrangements are separated by 10 feet (3048 mm) minimum.
6. Placement of furniture is considered as part of the fire and safety plans in accordance with Section 1002.2.

**407.4.4 Group I-2 care suites.** *Care suites* in Group I-2 shall comply with Sections 407.4.4.1 through 407.4.4.4 and either Section 407.4.4.5 or 407.4.4.6.

**407.4.4.1 Exit access through care suites.** *Exit* access from all other portions of a building not classified as a *care suite* shall not pass through a *care suite*.

**407.4.4.2 Separation.** *Care suites* shall be separated from other portions of the building, including other *care suites*, by a *smoke partition* complying with Section 710.

**407.4.4.3 Access to corridor.** Every *care suite* shall have a door leading directly to an *exit access corridor* or *horizontal exit*. Movement from habitable rooms within a *care suite* shall not require more than 100 feet (30 480 mm) of travel within the *care suite* to a door leading to the *exit access corridor* or *horizontal exit*. Where a *care suite* is required to have more than one *exit access* door by Section 407.4.4.5.2 or 407.4.4.6.2, the additional door shall lead directly to an *exit access corridor*, *exit* or an adjacent suite.

**407.4.4.4 Doors within care suites.** Doors in *care suites* serving habitable rooms shall be permitted to comply with one of the following:

1. Manually operated horizontal sliding doors permitted in accordance with Exception 9 to Section 1010.1.2.
2. *Power-operated doors* permitted in accordance with Section 1010.1.2, Exception 7.
3. *Means of egress* doors complying with Section 1010.

**407.4.4.5 Care suites containing sleeping room areas.** Sleeping rooms shall be permitted to be grouped into *care suites* where one of the following criteria is met:

1. The *care suite* is not used as an *exit access* for more than eight care recipient beds.
2. The arrangement of the *care suite* allows for direct and constant visual supervision into the sleeping rooms by care providers.

3. An *automatic* smoke detection system is provided in the sleeping rooms and installed in accordance with NFPA 72.

**407.4.4.5.1 Area.** *Care suites* containing sleeping rooms shall be not greater than 7,500 square feet (696 m<sup>2</sup>) in area.

**Exception:** *Care suites* containing sleeping rooms shall be permitted to be not greater than 10,000 square feet (929 m<sup>2</sup>) in area where an *automatic* smoke detection system is provided throughout the *care suite* and installed in accordance with NFPA 72.

**407.4.4.5.2 Exit access.** Any sleeping room, or any *care suite* that contains sleeping rooms, of more than 1,000 square feet (93 m<sup>2</sup>) shall have not fewer than two *exit access* doors from the *care suite* located in accordance with Section 1007.

**407.4.4.6 Care suites not containing sleeping rooms.** Areas not containing sleeping rooms, but only treatment areas and the associated rooms, spaces or circulation space, shall be permitted to be grouped into *care suites* and shall conform to the limitations in Sections 407.4.4.6.1 and 407.4.4.6.2.

**407.4.4.6.1 Area.** *Care suites* of rooms, other than sleeping rooms, shall have an area not greater than 12,500 square feet (1161 m<sup>2</sup>).

**Exception:** *Care suites* not containing sleeping rooms shall be permitted to be not greater than 15,000 square feet (1394 m<sup>2</sup>) in area where an *automatic* smoke detection system is provided throughout the *care suite* in accordance with Section 907.

**407.4.4.6.2 Exit access.** *Care suites*, other than sleeping rooms, with an area of more than 2,500 square feet (232 m<sup>2</sup>) shall have not fewer than two *exit access* doors from the *care suite* located in accordance with Section 1007.

**407.5 Smoke barriers.** *Smoke barriers* shall be provided to subdivide every *story* used by persons receiving care, treatment or sleeping into not fewer than two *smoke compartments*. *Smoke barriers* shall be provided to subdivide other *stories* with an *occupant load* of 50 or more persons, into not fewer than two *smoke compartments*. The *smoke barrier* shall be in accordance with Section 709.

**407.5.1 Smoke compartment size.** *Stories* shall be divided into *smoke compartments* with an area of not more than 22,500 square feet (2092 m<sup>2</sup>) in Group I-2 occupancies.

**Exceptions:**

1. A *smoke compartment* in Group I-2, Condition 2 is permitted to have an area of not more than 40,000 square feet (3716 m<sup>2</sup>) provided that all patient sleeping rooms within that *smoke compartment* are configured for single patient occupancy and any suite within the *smoke compartment* complies with Section 407.4.4.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

2. A *smoke compartment* in Group I-2, Condition 2 without patient sleeping rooms is permitted to have an area of not more than 40,000 square feet (3716 m<sup>2</sup>).

**407.5.2 Exit access travel distance.** The distance of travel from any point in a *smoke compartment* to a *smoke barrier* door shall be not greater than 200 feet (60 960 mm).

**407.5.3 Refuge area.** Refuge areas shall be provided within each *smoke compartment*. The size of the refuge area shall accommodate the occupants and care recipients from the adjoining *smoke compartment*. Where a *smoke compartment* is adjoined by two or more *smoke compartments*, the minimum area of the refuge area shall accommodate the largest *occupant load* of the adjoining compartments. The size of the refuge area shall provide the following:

1. Not less than 30 net square feet (2.8 m<sup>2</sup>) for each care recipient confined to bed or stretcher.
2. Not less than 6 square feet (0.56 m<sup>2</sup>) for each ambulatory care recipient not confined to bed or stretcher and for other occupants.

Areas or spaces permitted to be included in the calculation of refuge area are corridors, sleeping areas, treatment rooms, lounge or dining areas and other low-hazard areas.

**407.5.4 Independent egress.** A *means of egress* shall be provided from each *smoke compartment* created by *smoke barriers* without having to return through the *smoke compartment* from which *means of egress* originated. *Smoke compartments* that do not contain an *exit* shall be provided with *direct access* to not less than two adjacent *smoke compartments*.

**407.5.5 Horizontal assemblies.** *Horizontal assemblies* supporting *smoke barriers* required by this section shall be designed to resist the movement of smoke. Elevator lobbies shall be in accordance with Section 3006.2.

**407.6 Automatic-closing doors.** Automatic-closing doors with hold-open devices shall comply with Sections 709.5 and 716.2.

**407.6.1 Activation of automatic-closing doors.** Automatic-closing doors on hold-open devices in accordance with Section 716.2.6.6 shall also close upon activation of a *fire alarm* system, an *automatic sprinkler system*, or both. The *automatic* release of the hold-open device on one door shall release all such doors within the same *smoke compartment*.

**[F] 407.7 Automatic sprinkler system.** *Smoke compartments* containing sleeping rooms shall be equipped throughout with an *automatic sprinkler* system in accordance with Sections 903.3.1.1 and 903.3.2.

**[F] 407.8 Fire alarm system.** A *fire alarm* system shall be provided in accordance with Section 907.2.6.

**[F] 407.9 Automatic fire detection.** *Corridors* in Group I-2, Condition 1 occupancies and spaces permitted to be open to

the *corridors* by Section 407.2 shall be equipped with an *automatic* fire detection system.

Group I-2, Condition 2 occupancies shall be equipped with smoke detection as required in Section 407.2.

### Exceptions:

1. Corridor smoke detection is not required where sleeping rooms are provided with *smoke detectors* that comply with UL 268. Such detectors shall provide a visual display on the corridor side of each sleeping room and an audible and visual alarm at the care provider's station attending each unit.
2. *Corridor* smoke detection is not required where sleeping room doors are equipped with automatic door-closing devices with integral *smoke detectors* on the unit sides installed in accordance with their listing, provided that the integral detectors perform the required alerting function.

**407.10 Secured yards.** Grounds are permitted to be fenced and gates therein are permitted to be equipped with locks, provided that safe dispersal areas having 30 net square feet (2.8 m<sup>2</sup>) for bed and stretcher care recipients and 6 net square feet (0.56 m<sup>2</sup>) for ambulatory care recipients and other occupants are located between the building and the fence. Such provided safe dispersal areas shall be located not less than 50 feet (15 240 mm) from the building they serve.

**[F] 407.11 Electrical systems.** In Group I-2 occupancies, the essential electrical system for electrical components, equipment and systems shall be designed and constructed in accordance with the provisions of Chapter 27 and NFPA 99.

## SECTION 408 GROUP I-3

**408.1 General.** Occupancies in Group I-3 shall comply with the provisions of Sections 408.1 through 408.11 and other applicable provisions of this code (see Section 308.5).

**408.2 Other occupancies.** Buildings or portions of buildings in Group I-3 occupancies where security operations necessitate the locking of required *means of egress* shall be permitted to be classified as a different occupancy. Occupancies classified as other than Group I-3 shall meet the applicable requirements of this code for that occupancy where provisions are made for the release of occupants at all times.

*Means of egress* from detention and correctional occupancies that traverse other use areas shall, as a minimum, conform to requirements for detention and correctional occupancies.

**Exception:** It is permissible to exit through a *horizontal exit* into other contiguous occupancies that do not conform to detention and correctional occupancy egress provisions but that do comply with requirements set forth in the appropriate occupancy, as long as the occupancy is not a Group H use.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**408.3 Means of egress.** Except as modified or as provided for in this section, the *means of egress* provisions of Chapter 10 shall apply.

**408.3.1 Door width.** Doors to resident *sleeping units* shall have a clear width of not less than 28 inches (711 mm).

**408.3.2 Sliding doors.** Where doors in a *means of egress* are of the horizontal-sliding type, the force to slide the door to its fully open position shall be not greater than 50 pounds (220 N) with a perpendicular force against the door of 50 pounds (220 N).

**408.3.3 Guard tower doors.** A hatch or trap door not less than 16 square feet (610 m<sup>2</sup>) in area through the floor and having dimensions of not less than 2 feet (610 mm) in any direction shall be permitted to be used as a portion of the *means of egress* from guard towers.

**408.3.4 Spiral stairways.** *Spiral stairways* that conform to the requirements of Section 1011.10 are permitted for access to and between staff locations.

**408.3.5 Ship's ladders.** Ship's ladders shall be permitted for egress from control rooms or elevated facility observation rooms in accordance with Section 1011.15.

**408.3.6 Exit discharge.** *Exits* are permitted to discharge into a fenced or walled courtyard. Enclosed *yards* or *courts* shall be of a size to accommodate all occupants, be located not less than 50 feet (15 240 mm) from the building and have an area of not less than 15 square feet (1.4 m<sup>2</sup>) per person.

**408.3.7 Sallyports.** A *sallyport* shall be permitted in a *means of egress* where there are provisions for continuous and unobstructed passage through the *sallyport* during an emergency egress condition.

**408.3.8 Interior exit stairway and ramp construction.** One *interior exit stairway* or *ramp* in each building shall be permitted to have glazing installed in doors and interior walls at each landing level providing access to the *interior exit stairway* or *ramp*, provided that the following conditions are met:

1. The *interior exit stairway* or *ramp* shall not serve more than four floor levels.
2. *Exit* doors shall be not less than  $\frac{3}{4}$ -hour *fire door assemblies* complying with Section 716.
3. The total area of glazing at each floor level shall not exceed 5,000 square inches (3.2 m<sup>2</sup>) and individual panels of glazing shall not exceed 1,296 square inches (0.84 m<sup>2</sup>).
4. The glazing shall be protected on both sides by an *automatic sprinkler system*. The sprinkler system shall be designed to wet completely the entire surface of any glazing affected by fire when actuated.
5. The glazing shall be in a gasketed frame and installed in such a manner that the framing system

will deflect without breaking (loading) the glass before the sprinkler system operates.

6. Obstructions, such as curtain rods, drapery traverse rods, curtains, drapes or similar materials shall not be installed between the automatic sprinklers and the glazing.

**408.4 Locks.** Egress doors are permitted to be locked in accordance with the applicable use condition. Doors from a refuge area to the outside are permitted to be locked with a key in lieu of locking methods described in Section 408.4.1. The keys to unlock the exterior doors shall be available at all times and the locks shall be operable from both sides of the door.

**408.4.1 Remote release.** Remote release of locks on doors in a *means of egress* shall be provided with reliable means of operation, remote from the resident living areas, to release locks on all required doors. In Occupancy Condition 3 or 4, the arrangement, accessibility and security of the release mechanisms required for egress shall be such that with the minimum available staff at any time, the lock mechanisms are capable of being released within 2 minutes.

**Exception:** Provisions for remote locking and unlocking of occupied rooms in Occupancy Condition 4 are not required provided that not more than 10 locks are necessary to be unlocked in order to move occupants from one *smoke compartment* to a refuge area within 3 minutes. The opening of necessary locks shall be accomplished with not more than two separate keys.

**[F] 408.4.2 Power-operated doors and locks.** *Power-operated* sliding doors or *power-operated* locks for swinging doors shall be operable by a manual release mechanism at the door. Emergency power shall be provided for the doors and locks in accordance with Section 2702.

**Exceptions:**

1. Emergency power is not required in facilities with 10 or fewer locks complying with the exception to Section 408.4.1.
2. Emergency power is not required where remote mechanical operating releases are provided.

**408.4.3 Redundant operation.** Remote release, mechanically operated sliding doors or remote release, mechanically operated locks shall be provided with a mechanically operated release mechanism at each door, or shall be provided with a redundant remote release control.

**408.4.4 Relock capability.** Doors remotely unlocked under emergency conditions shall not automatically relock when closed unless specific action is taken at the remote location to enable doors to relock.

**408.5 Protection of vertical openings.** Any vertical opening shall be protected by a shaft enclosure in accordance with Section 713, or shall be in accordance with Section 408.5.1.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**408.5.1 Floor openings.** Openings in floors within a *housing unit* are permitted without a shaft enclosure, provided that all of the following conditions are met:

1. The entire normally occupied areas so interconnected are open and unobstructed so as to enable observation of the areas by supervisory personnel.
2. *Means of egress* capacity is sufficient for all occupants from all interconnected *cell tiers* and areas.
3. The height difference between the floor levels of the highest and lowest *cell tiers* shall not exceed 23 feet (7010 mm).
4. Egress from any portion of the *cell tier* to an *exit* or *exit access* door shall not require travel on more than one additional floor level within the *housing unit*.

**408.5.2 Shaft openings in communicating floor levels.**

Where a floor opening is permitted between communicating floor levels of a *housing unit* in accordance with Section 408.5.1, plumbing chases serving vertically stacked individual cells contained within the *housing unit* shall be permitted without a shaft enclosure.

**408.6 Smoke barrier.** Occupancies in Group I-3 shall have *smoke barriers* complying with Sections 408.6 and 709 to divide every *story* occupied by residents for sleeping, or any other *story* having an *occupant load* of 50 or more persons, into not fewer than two *smoke compartments*.

**Exception:** Spaces having a direct exit to one of the following, provided that the locking arrangement of the doors involved complies with the requirements for doors at the *smoke barrier* for the use condition involved:

1. A *public way*.
2. A building separated from the resident housing area by a 2-hour fire-resistance-rated assembly or 50 feet (15 240 mm) of open space.
3. A secured *yard* or *court* having a holding space 50 feet (15 240 mm) from the housing area that provides 6 square feet (0.56 m<sup>2</sup>) or more of refuge area per occupant, including residents, staff and visitors.

**408.6.1 Smoke compartments.** The number of residents in any *smoke compartment* shall be not more than 200. The distance of travel to a door in a *smoke barrier* from any room door required as *exit access* shall be not greater than 150 feet (45 720 mm). The distance of travel to a door in a *smoke barrier* from any point in a room shall be not greater than 200 feet (60 960 mm).

**408.6.2 Refuge area.** Not less than 6 net square feet (0.56 m<sup>2</sup>) per occupant shall be provided on each side of each *smoke barrier* for the total number of occupants in adjoining *smoke compartments*. This space shall be readily available wherever the occupants are moved across the *smoke barrier* in a fire emergency.

**408.6.3 Independent egress.** A *means of egress* shall be provided from each *smoke compartment* created by *smoke barriers* without having to return through the *smoke compartment* from which *means of egress* originates.

**408.7 Security glazing.** In occupancies in Group I-3, windows and doors in 1-hour *fire barriers* constructed in accordance with Section 707, *fire partitions* constructed in accordance with Section 708 and *smoke barriers* constructed in accordance with Section 709 shall be permitted to have security glazing installed provided that the following conditions are met.

1. Individual panels of glazing shall not exceed 1,296 square inches (0.84 m<sup>2</sup>).
2. The glazing shall be protected on both sides by an *automatic sprinkler system*. The sprinkler system shall be designed to, when actuated, wet completely the entire surface of any glazing affected by fire.
3. The glazing shall be in a gasketed frame and installed in such a manner that the framing system will deflect without breaking (loading) the glass before the sprinkler system operates.
4. Obstructions, such as curtain rods, drapery traverse rods, curtains, drapes or similar materials shall not be installed between the automatic sprinklers and the glazing.

**408.8 Subdivision of resident housing areas.** Sleeping areas and any contiguous day room, group activity space or other common spaces where residents are housed shall be separated from other spaces in accordance with Sections 408.8.1 through 408.8.4.

**408.8.1 Occupancy Conditions 3 and 4.** Each sleeping area in Occupancy Conditions 3 and 4 shall be separated from the adjacent common spaces by a smoke-tight partition where the distance of travel from the sleeping area through the common space to the *corridor* exceeds 50 feet (15 240 mm).

**408.8.2 Occupancy Condition 5.** Each sleeping area in Occupancy Condition 5 shall be separated from adjacent sleeping areas, *corridors* and common spaces by a smoke-tight partition. Additionally, common spaces shall be separated from the *corridor* by a smoke-tight partition.

**408.8.3 Openings in room face.** The aggregate area of openings in a solid sleeping room face in Occupancy Conditions 2, 3, 4 and 5 shall not exceed 120 square inches (0.77 m<sup>2</sup>). The aggregate area shall include all openings including door undercuts, food passes and grilles. Openings shall be not more than 36 inches (914 mm) above the floor. In Occupancy Condition 5, the openings shall be closeable from the room side.

**408.8.4 Smoke-tight doors.** Doors in openings in partitions required to be smoke tight by Section 408.8 shall be substantial doors, of construction that will resist the passage of smoke. Latches and door closures are not required on *cell* doors.

**408.9 Windowless buildings.** For the purposes of this section, a windowless building or portion of a building is one with nonopenable windows, windows not readily breakable or without windows. Windowless buildings shall be provided with an engineered smoke control system to provide a tenable environment for exiting from the *smoke*



*compartment* in the area of fire origin in accordance with Section 909 for each windowless *smoke compartment*.

[F] **408.10 Fire alarm system.** A *fire alarm* system shall be provided in accordance with Section 907.2.6.3.

[F] **408.11 Automatic sprinkler system.** Group I-3 occupancies shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.6.

## SECTION 409 MOTION PICTURE PROJECTION ROOMS

**409.1 General.** The provisions of Sections 409.1 through 409.5 shall apply to rooms in which ribbon-type cellulose acetate or other safety film is utilized in conjunction with electric arc, xenon or other light-source projection equipment that develops hazardous gases, dust or radiation. Where cellulose nitrate film is utilized or stored, such rooms shall comply with NFPA 40.

**409.1.1 Projection room required.** Every motion picture machine projecting film as mentioned within the scope of this section shall be enclosed in a projection room. Appurtenant electrical equipment, such as rheostats, transformers and generators, shall be within the projection room or in an adjacent room of equivalent construction.

**409.2 Construction of projection rooms.** Every projection room shall be of permanent construction consistent with the construction requirements for the type of building in which the projection room is located. Openings are not required to be protected.

The room shall have a floor area of not less than 80 square feet (7.44 m<sup>2</sup>) for a single machine and not less than 40 square feet (3.7 m<sup>2</sup>) for each additional machine. Each motion picture projector, floodlight, spotlight or similar piece of equipment shall have a clear working space of not less than 30 inches by 30 inches (762 mm by 762 mm) on each side and at the rear thereof, but only one such space shall be required between two adjacent projectors. The projection room and the rooms appurtenant thereto shall have a ceiling height of not less than 7 feet 6 inches (2286 mm). The aggregate of openings for projection equipment shall not exceed 25 percent of the area of the wall between the projection room and the auditorium. Openings shall be provided with glass or other *approved* material, so as to close completely the opening.

**409.3 Projection room and equipment ventilation.** *Ventilation* shall be provided in accordance with the *International Mechanical Code*.

**409.3.1 Supply air.** Each projection room shall be provided with adequate air supply inlets so arranged as to provide well-distributed air throughout the room. Air inlet ducts shall provide an amount of air equivalent to the amount of air being exhausted by projection equipment. Air is permitted to be taken from the outside; from adjacent spaces within the building, provided that the volume and infiltration rate are sufficient; or from the building air-conditioning system, provided that it is so arranged as

to provide sufficient air when other systems are not in operation.

**409.3.2 Exhaust air.** Projection rooms are permitted to be exhausted through the lamp exhaust system. The lamp exhaust system shall be positively interconnected with the lamp so that the lamp will not operate unless there is the required airflow. Exhaust air ducts shall terminate at the exterior of the building in such a location that the exhaust air cannot be readily recirculated into any air supply system. The projection room *ventilation* system is permitted to also serve appurtenant rooms, such as the generator and rewind rooms.

**409.3.3 Projection machines.** Each projection machine shall be provided with an exhaust duct that will draw air from each lamp and exhaust it directly to the outside of the building. The lamp exhaust is permitted to serve to exhaust air from the projection room to provide room air circulation. Such ducts shall be of rigid materials, except for a flexible connector *approved* for the purpose. The projection lamp or projection room exhaust system, or both, is permitted to be combined but shall not be interconnected with any other exhaust or return system, or both, within the building.

**409.4 Lighting control.** Provisions shall be made for control of the auditorium lighting and the *means of egress* lighting systems of theaters from inside the projection room and from not less than one other convenient point in the building.

**409.5 Miscellaneous equipment.** Each projection room shall be provided with rewind and film storage facilities.

## SECTION 410 STAGES, PLATFORMS AND TECHNICAL PRODUCTION AREAS

**410.1 Applicability.** The provisions of Sections 410.1 through 410.7 shall apply to all parts of buildings and structures that contain *stages* or *platforms* and similar appurtenances as herein defined.

**410.2 Stages.** *Stage* construction shall comply with Sections 410.2.1 through 410.2.7.

**410.2.1 Stage construction.** *Stages* shall be constructed of materials as required for floors for the type of construction of the building in which such *stages* are located.

**Exception:** *Stages* need not be constructed of the same materials as required for the type of construction provided that the construction complies with one of the following:

1. *Stages* of Type IIB or IV construction with a nominal 2-inch (51 mm) wood deck, provided that the *stage* is separated from other areas in accordance with Section 410.2.4.
2. In buildings of Type IIA, IIIA and VA construction, a fire-resistance-rated floor is not required, provided that the space below the *stage* is equipped with an *automatic sprinkler system* or *fire-extinguishing system* in accordance with Section 903 or 904.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

3. In all types of construction, the finished floor shall be constructed of wood or *approved* noncombustible materials. Openings through stage floors shall be equipped with tight-fitting, solid wood trap doors with *approved* safety locks.

**410.2.1.1 Stage height and area.** Stage areas shall be measured to include the entire performance area and adjacent backstage and support areas not separated from the performance area by fire-resistance-rated construction. *Stage* height shall be measured from the lowest point on the *stage* floor to the highest point of the roof or floor deck above the *stage*.

**410.2.2 Technical production areas: galleries, grid-irons and catwalks.** Beams designed only for the attachment of portable or fixed theater equipment, grid-irons, galleries and catwalks shall be constructed of *approved* materials consistent with the requirements for the type of construction of the building; and a *fire-resistance rating* shall not be required. These areas shall not be considered to be floors, *stories*, *mezzanines* or levels in applying this code.

**Exception:** Floors of fly galleries and catwalks shall be constructed of any *approved* material.

**410.2.3 Exterior stage doors.** Where protection of openings is required, exterior *exit* doors shall be protected with *fire door assemblies* that comply with Section 716. Exterior openings that are located on the *stage* for *means of egress* or loading and unloading purposes, and that are likely to be open during occupancy of the theater, shall be constructed with vestibules to prevent air drafts into the auditorium.

**410.2.4 Proscenium wall.** Where the *stage* height is greater than 50 feet (15 240 mm), all portions of the *stage* shall be completely separated from the seating area by a *proscenium wall* with not less than a 2-hour *fire-resistance rating* extending continuously from the foundation to the roof.

**410.2.5 Proscenium curtain.** Where a *proscenium wall* is required to have a *fire-resistance rating*, the *stage* opening shall be provided with a fire curtain complying with NFPA 80, horizontal sliding doors complying with Section 716 having a *fire protection rating* of not less than 1 hour, or an *approved* water curtain complying with Section 903.3.1.1 or, in facilities not utilizing the provisions of *smoke-protected assembly seating* in accordance with Section 1030.6.2, a smoke control system complying with Section 909 or natural *ventilation* designed to maintain the smoke level not less than 6 feet (1829 mm) above the floor of the *means of egress*.

**410.2.6 Scenery.** Combustible materials used in sets and scenery shall meet the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701, in accordance with Section 806 and the *International Fire Code*. Foam plastics and materials containing foam plastics shall comply with Section 2603 and the *International Fire Code*.

**410.2.7 Stage ventilation.** Emergency *ventilation* shall be provided for *stages* larger than 1,000 square feet (93 m<sup>2</sup>) in floor area, or with a *stage* height greater than 50 feet (15 240 mm). Such *ventilation* shall comply with Section 410.2.7.1 or 410.2.7.2.

**410.2.7.1 Roof vents.** Two or more vents constructed to open automatically by *approved* heat-activated devices and with an aggregate clear opening area of not less than 5 percent of the area of the *stage* shall be located near the center and above the highest part of the *stage area*. Supplemental means shall be provided for manual operation of the ventilator. Curbs shall be provided as required for skylights in Section 2610.2. Vents shall be *labeled*.

**[F] 410.2.7.2 Smoke control.** Smoke control in accordance with Section 909 shall be provided to maintain the smoke layer interface not less than 6 feet (1829 mm) above the highest level of the assembly seating or above the top of the proscenium opening where a *proscenium wall* is provided in compliance with Section 410.2.4.

**410.3 Platform construction.** Permanent *platforms* shall be constructed of materials as required for the type of construction of the building in which the permanent *platform* is located. Permanent *platforms* are permitted to be constructed of *fire-retardant-treated wood* for Types I, II and IV construction where the *platforms* are not more than 30 inches (762 mm) above the main floor, and not more than one-third of the room floor area and not more than 3,000 square feet (279 m<sup>2</sup>) in area. Where the space beneath the permanent *platform* is used for storage or any purpose other than equipment, wiring or plumbing, the floor assembly shall be not less than 1-hour fire-resistance-rated construction. Where the space beneath the permanent *platform* is used only for equipment, wiring or plumbing, the underside of the permanent *platform* need not be protected.

**410.3.1 Temporary platforms.** *Platforms* installed for a period of not more than 30 days are permitted to be constructed of any materials permitted by this code. The space between the floor and the *platform* above shall only be used for plumbing and electrical wiring to *platform* equipment.

**410.4 Dressing and appurtenant rooms.** Dressing and appurtenant rooms shall comply with Sections 410.4.1 and 410.4.2.

**410.4.1 Separation from stage.** The *stage* shall be separated from dressing rooms, scene docks, property rooms, workshops, storerooms and compartments appurtenant to the *stage* and other parts of the building by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire-resistance rating* shall be not less than 2 hours for *stage* heights greater than 50 feet (15 240 mm) and not less than 1 hour for *stage* heights of 50 feet (15 240 mm) or less.

**410.4.2 Separation from each other.** Dressing rooms, scene docks, property rooms, workshops, storerooms and

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

compartments appurtenant to the *stage* shall be separated from each other by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**410.5 Means of egress.** Except as modified or as provided for in this section, the provisions of Chapter 10 shall apply.

**410.5.1 Arrangement.** Where two or more *exits* or *exit access doorways* from the *stage* are required in accordance with Section 1006.2, not fewer than one *exit* or *exit access doorway* shall be provided on each side of a *stage*.

**410.5.2 Stairway and ramp enclosure.** *Exit access stairways* and *ramps* serving a *stage* or *platform* are not required to be enclosed. *Exit access stairways* and *ramps* serving *technical production areas* are not required to be enclosed.

**410.5.3 Technical production areas.** *Technical production areas* shall be provided with *means of egress* and *means of escape* in accordance with Sections 410.5.3.1 through 410.5.3.5.

**410.5.3.1 Number of means of egress.** Not fewer than one *means of egress* shall be provided from *technical production areas*.

**410.5.3.2 Exit access travel distance.** The *exit access travel distance* shall be not greater than 300 feet (91 440 mm) for buildings without a sprinkler system and 400 feet (122 mm) for buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**410.5.3.3 Two means of egress.** Where two *means of egress* are required, the *common path of travel* shall be not greater than 100 feet (30 480 mm).

**Exception:** A means of escape to a roof in place of a second *means of egress* is permitted.

**410.5.3.4 Path of egress travel.** The following *exit access* components are permitted where serving *technical production areas*:

1. *Stairways*.
2. *Ramps*.
3. *Spiral stairways*.
4. *Catwalks*.
5. *Alternating tread devices*.
6. Permanent ladders.

**410.5.3.5 Width.** The path of egress travel within and from technical support areas shall be not less than 22 inches (559 mm).

**[F] 410.6 Automatic sprinkler system.** *Stages* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Sprinklers shall be installed under the roof and gridiron and under all catwalks and galleries over the *stage*. Sprinklers shall be installed in dressing

rooms, performer lounges, shops and storerooms accessory to such *stages*.

#### Exceptions:

1. Sprinklers are not required under *stage* areas less than 4 feet (1219 mm) in clear height that are utilized exclusively for storage of tables and chairs, provided that the concealed space is separated from the adjacent spaces by Type X *gypsum board* not less than  $\frac{5}{8}$ -inch (15.9 mm) in thickness.
2. Sprinklers are not required for *stages* 1,000 square feet (93 m<sup>2</sup>) or less in area and 50 feet (15 240 mm) or less in height where curtains, scenery or other combustible hangings are not retractable vertically. Combustible hangings shall be limited to a single main curtain, borders, legs and a single backdrop.
3. Sprinklers are not required within portable orchestra enclosures on *stages*.

**[F] 410.7 Standpipes.** *Standpipe systems* shall be provided in accordance with Section 905.

## SECTION 411 SPECIAL AMUSEMENT AREAS

**411.1 General.** *Special amusement areas* having an *occupant load* of 50 or more shall comply with the requirements for the appropriate Group A occupancy and Sections 411.1 through 411.7. *Special amusement areas* having an *occupant load* of less than 50 shall comply with the requirements for a Group B occupancy and Sections 411.1 through 411.7.

**Exception:** *Special amusement areas* that are without walls or a roof and constructed to prevent the accumulation of smoke need not comply with this section.

**[F] 411.2 Automatic sprinkler system.** Buildings containing *special amusement areas* shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. Where the *special amusement area* is temporary, the sprinkler water supply shall be of an *approved* temporary means.

**Exception:** *Automatic sprinklers* are not required where the total floor area of a temporary *special amusement area* is less than 1,000 square feet (93 m<sup>2</sup>) and the *exit access travel distance* from any point in the *special amusement area* to an exit is less than 50 feet (15 240 mm).

**[F] 411.3 Automatic smoke detection.** Buildings containing *special amusement areas* shall be equipped with an *automatic smoke detection system* in accordance with Section 907.2.12.

**[F] 411.4 Emergency voice/alarm communications system.** An *emergency voice/alarm communications system* shall be provided in accordance with Section 907.2.12.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**411.5 Puzzle room exiting.** *Puzzle room* exiting shall comply with one of the following:

1. Exiting in accordance with Chapter 10.
2. An alternative design approved by the building official.
3. Exits shall be open and readily available upon activation by the automatic fire alarm system, automatic sprinkler system, and a manual control at a constantly attended location.

**411.6 Exit marking.** Exit signs shall be installed at the required *exit* or *exit access doorways* serving *special amusement areas* in accordance with this section and Section 1013. *Approved* directional exit markings shall be provided. Where mirrors, mazes or other designs are utilized that disguise the path of egress travel such that they are not apparent, *approved* and *listed* low-level exit signs that comply with Section 1013.5, and directional path markings *listed* in accordance with UL 1994, shall be provided and located not more than 8 inches (203 mm) above the walking surface and on or near the path of egress travel. Such markings shall become visible in an emergency. The directional exit marking shall be activated by the *automatic smoke detection system* and the *automatic sprinkler system* in accordance with Section 907.2.12.

**411.6.1 Photoluminescent exit signs.** Where *photoluminescent exit* signs are installed, activating light source and viewing distance shall be in accordance with the listing and markings of the signs.

**411.7 Interior finish.** The *interior finish* in *special amusement areas* shall be Class A in accordance with Section 803.1.

## SECTION 412 AIRCRAFT-RELATED OCCUPANCIES

**412.1 General.** Aircraft-related occupancies shall comply with Sections 412.1 through 412.7 and the *International Fire Code*.

**412.2 Airport traffic control towers.** The provisions of Sections 412.2.1 through 412.2.6 shall apply to airport traffic control towers occupied only for the following uses:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Office spaces incidental to the tower operation.
5. Lounges for employees, including sanitary facilities.

**412.2.1 Construction.** The construction of airport traffic control towers shall comply with the provisions of Sections 412.2.1.1 through 412.2.1.3.

**412.2.1.1 Type of construction.** Airport traffic control towers shall be constructed to comply with the height limitations of Table 412.2.1.1.

**TABLE 412.2.1.1  
HEIGHT LIMITATIONS FOR  
AIRPORT TRAFFIC CONTROL TOWERS**

TYPE OF CONSTRUCTION	HEIGHT <sup>a</sup> (feet)
IA	Unlimited
IB	240
IIA	100
IIB	85
IIIA	65

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. Height to be measured from *grade plane* to cab floor.

**[BS] 412.2.1.2 Structural integrity of interior exit stairways and elevator hoistway enclosures.** Enclosures for *interior exit stairways* and elevator hoistway enclosures shall comply with Section 403.2.2 in airport traffic control towers where the control cab is located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.

**412.2.1.3 Sprayed fire-resistant materials (SFRM).** The bond strength of the SFRM installed in airport traffic control towers shall be in accordance with Section 403.2.3 where the control cab is located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access.

**412.2.2 Means of egress and evacuation.** The *means of egress* in airport traffic control towers shall comply with Sections 412.2.2.1 through 412.2.2.3.

**412.2.2.1 Stairways.** *Stairways* in airport traffic control towers shall be in accordance with Section 1011. *Exit stairways* shall be *smokeproof enclosures* complying with one of the alternatives provided in Section 909.20.

**Exception:** *Stairways* in airport traffic control towers are not required to comply with Section 1011.12.

**412.2.2.2 Exit access.** From observation levels, airport traffic control towers shall be permitted to have a single means of *exit access* for a distance of travel not greater than 100 feet (30 480 mm). *Exit access stairways* from the observation level need not be enclosed.

**412.2.2.3 Number of exits.** Not less than one *exit stairway* shall be permitted for airport traffic control towers of any height provided that the *occupant load* per floor is not greater than 15 and the area per floor does not exceed 1,500 square feet (140 m<sup>2</sup>).

**412.2.2.3.1 Interior finish.** Where an airport traffic control tower is provided with only one *exit stairway*, *interior wall and ceiling finishes* shall be either Class A or Class B.

**412.2.2.3.2 Exit separation.** Where an airport traffic control tower is equipped throughout with an *automatic sprinkler system* in accordance with



Section 903.3.1.1 and two *exits* are required, the exit separation distance required by Section 1007 shall be not less than one-fourth of the length of the maximum overall dimension of the area served.

**[F] 412.2.3 Emergency systems.** The detection, alarm and emergency systems of airport traffic control towers shall comply with Sections 412.2.3.1 through 412.2.3.3.

**[F] 412.2.3.1 Automatic smoke detection systems.** Airport traffic control towers shall be provided with an *automatic* smoke detection system installed in accordance with Section 907.2.22.

**[F] 412.2.3.2 Fire command center.** A *fire command center* shall be provided in airport traffic control towers where the control cab is located more than 75 feet (22 860 mm) above the lowest level of fire department vehicle access. The *fire command center* shall comply with Section 911.

**Exceptions:**

1. The *fire command center* shall be located in the airport control tower or an adjacent contiguous building where building functions are interdependent.
2. The room shall be not less than 150 square feet (14 m<sup>2</sup>) in area with a minimum dimension of 10 feet (3048 mm).
3. The following features shall not be required in an airport traffic control tower *fire command center*.
  - 3.1. Emergency voice/alarm control unit.
  - 3.2. Public address system.
  - 3.3. Status indicators and controls for the air distributions centers.
  - 3.4. Generator supervision devices, manual start and transfer features.
  - 3.5. Elevator emergency or standby power switches where emergency or standby power is provided.

**[F] 412.2.3.3 Smoke removal.** Smoke removal in airport traffic control towers shall be provided in accordance with Section 403.4.7.

**[F] 412.2.4 Automatic sprinkler system.** Where an occupied floor is located more than 35 feet (10 668 mm) above the lowest level of fire department vehicle access, airport traffic control towers shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[F] 412.2.4.1 Fire pump room.** Fire pumps shall be located in rooms that are separated from all other areas of the building by 2-hour *fire barriers* constructed in accordance with Section 707 or 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

**Exception:** Separation is not required for fire pumps physically separated in accordance with NFPA 20.

**[F] 412.2.5 Protection of elevator wiring and cables.** Wiring and cables serving elevators in airport traffic control towers shall be protected in accordance with Section 3007.8.1.

**412.2.5.1 Elevators for occupant evacuation.** Where provided in addition to an exit stairway, occupant evacuation elevators shall be in accordance with Section 3008.

**412.2.6 Accessibility.** Airport traffic control towers shall be *accessible* except as specified in Section 1104.4.

**412.3 Aircraft hangars.** Aircraft hangars shall be in accordance with Sections 412.3.1 through 412.3.6.

**412.3.1 Exterior walls.** *Exterior walls* located less than 30 feet (9144 mm) from *lot lines* or a *public way* shall have a *fire-resistance rating* not less than 2 hours.

**412.3.2 Basements.** Where hangars have *basements*, floors over *basements* shall be of Type IA construction and shall be made tight against seepage of water, oil or vapors. There shall not be openings or communication between *basements* and the hangar. Access to *basements* shall be from outside only.

**412.3.3 Floor surface.** Floors shall be graded and drained to prevent water or fuel from remaining on the floor. Floor drains shall discharge through an oil separator to the sewer or to an outside vented sump.

**Exception:** Aircraft hangars with individual lease spaces not exceeding 2,000 square feet (186 m<sup>2</sup>) each in which servicing, repairing or washing is not conducted and fuel is not dispensed shall have floors that are graded toward the door, but shall not require a separator.

**412.3.4 Heating equipment.** Heating equipment shall be placed in another room separated by 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. Entrance shall be from the outside or by means of a vestibule providing a two-doorway separation.

**Exceptions:**

1. Unit heaters and vented infrared radiant heating equipment suspended not less than 10 feet (3048 mm) above the upper surface of wings or engine enclosures of the highest aircraft that are permitted to be housed in the hangar need not be located in a separate room provided that they are mounted not less than 8 feet (2438 mm) above the floor in shops, offices and other sections of the hangar communicating with storage or service areas.
2. Entrance to the separated room shall be permitted by a single interior door provided that the sources of ignition in the appliances are not less than 18 inches (457 mm) above the floor.

**412.3.5 Finishing.** The process of “doping,” involving use of a volatile flammable solvent, or of painting, shall be carried on in a separate *detached building* equipped

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

with *automatic fire-extinguishing equipment* in accordance with Section 903.

**[F] 412.3.6 Fire suppression.** Aircraft hangars shall be provided with a fire suppression system designed in accordance with NFPA 409, based on the classification for the hangar given in Table 412.3.6.

**Exception:** Where a *fixed base operator* has separate repair facilities on site, Group II hangars operated by a *fixed base operator* used for storage of *transient aircraft* only shall have a fire suppression system, but the system is exempt from foam requirements.

**[F] 412.3.6.1 Hazardous operations.** Any Group III aircraft hangar according to Table 412.3.6 that contains hazardous operations including, but not limited to, the following shall be provided with a Group I or II fire suppression system in accordance with NFPA 409 as applicable:

1. Doping.
2. Hot work including, but not limited to, welding, torch cutting and torch soldering.
3. Fuel transfer.
4. Fuel tank repair or maintenance not including defueled tanks in accordance with NFPA 409, inerted tanks or tanks that have never been fueled.
5. Spray finishing operations.
6. Total fuel capacity of all aircraft within the unsprinklered single *fire area* in excess of 1,600 gallons (6057 L).
7. Total fuel capacity of all aircraft within the maximum single *fire area* in excess of 7,500 gallons (28 390 L) for a hangar with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[F] 412.3.6.2 Separation of maximum single fire areas.** Maximum single *fire areas* established in accordance with hangar classification and construction type in Table 412.3.6 shall be separated by 2-hour *fire*

*walls* constructed in accordance with Section 706. In determining the maximum single *fire area* as set forth in Table 412.3.6, ancillary uses that are separated from aircraft servicing areas by a *fire barrier* of not less than 1 hour, constructed in accordance with Section 707, shall not be included in the area.

**412.4 Residential aircraft hangars.** *Residential aircraft hangars* shall comply with Sections 412.4.1 through 412.4.5.

**412.4.1 Fire separation.** A hangar shall not be attached to a *dwelling* unless separated by a *fire barrier* having a *fire-resistance rating* of not less than 1 hour. Such separation shall be continuous from the foundation to the underside of the roof and unpierced except for doors leading to the *dwelling unit*. Doors into the *dwelling unit* shall be equipped with *self-closing* devices and conform to the requirements of Section 716 with a noncombustible raised sill not less than 4 inches (102 mm) in height. Openings from a hangar directly into a room used for sleeping purposes shall not be permitted.

**412.4.2 Egress.** A hangar shall provide two *means of egress*. One of the doors into the dwelling shall be considered as meeting only one of the two *means of egress*.

**[F] 412.4.3 Smoke alarms.** *Smoke alarms* shall be provided within the hangar in accordance with Section 907.2.22.

**412.4.4 Independent systems.** Electrical, mechanical and plumbing drain, waste and vent (DWV) systems installed within the hangar shall be independent of the systems installed within the dwelling. Building sewer lines shall be permitted to be connected outside the structures.

**Exception:** *Smoke detector* wiring and feed for electrical subpanels in the hangar.

**412.4.5 Height and area limits.** *Residential aircraft hangars* shall be not greater than 2,000 square feet (186 m<sup>2</sup>) in area and 20 feet (6096 mm) in *building height*.

**[F] 412.5 Aircraft paint hangars.** Aircraft painting operations shall be conducted in an aircraft paint hangar that complies with the provisions of Sections 412.5.1 through

**[F] TABLE 412.3.6**  
**HANGAR FIRE SUPPRESSION REQUIREMENTS<sup>a, b, c</sup>**

MAXIMUM SINGLE FIRE AREA (square feet)	TYPE OF CONSTRUCTION								
	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
≥ 40,001	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I	Group I
40,000	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
30,000	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II	Group II
20,000	Group III	Group III	Group II	Group II	Group II	Group II	Group II	Group II	Group II
15,000	Group III	Group III	Group III	Group II	Group III	Group II	Group III	Group II	Group II
12,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II	Group II
8,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group II
5,000	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III	Group III

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. Aircraft hangars with a door height greater than 28 feet shall be provided with fire suppression for a Group I hangar regardless of maximum fire area.

b. Groups shall be as classified in accordance with NFPA 409.

c. Membrane structures complying with Section 3102 shall be classified as a Group IV hangar.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

412.5.8. Buildings and structures, or parts thereof, used for the application of flammable finishes shall comply with the applicable provisions of Section 416.

**[F] 412.5.1 Occupancy classification.** Aircraft paint hangars shall be classified in accordance with the provisions of Section 307.1. Aircraft paint hangars shall comply with the applicable requirements of this code and the *International Fire Code* for such occupancy.

**412.5.2 Construction.** Aircraft paint hangars shall be of Type I or II construction.

**[F] 412.5.3 Spray equipment cleaning operations.** Spray equipment cleaning operations shall be conducted in a liquid use, dispensing and mixing room.

**[F] 412.5.4 Operations.** Only those *flammable liquids* necessary for painting operations shall be permitted in quantities less than the maximum allowable quantities per *control area* in Table 307.1(1). Spray equipment cleaning operations exceeding the maximum allowable quantities per *control area* in Table 307.1(1) shall be conducted in a liquid use, dispensing and mixing room.

**[F] 412.5.5 Storage.** Storage of *flammable or combustible liquids* exceeding the maximum allowable quantities per *control area* in Table 307.1(1) shall be in a *liquid storage room*.

**[F] 412.5.6 Fire suppression.** Aircraft paint hangars shall be provided with fire suppression as required by NFPA 409.

**[F] 412.5.7 Ventilation.** Aircraft paint hangars shall be provided with *ventilation* as required in the *International Mechanical Code*.

**[F] 412.5.8 Electrical.** Electrical equipment and devices within the aircraft paint hangar shall comply with NFPA 70.

**[F] 412.5.8.1 Class I, Division I hazardous locations.** The area within 10 feet (3048 mm) horizontally from aircraft surfaces and from the floor to 10 feet (3048 mm) above the aircraft surface shall be classified as a Class I, Division I location.

**[F] 412.5.8.2 Class I, Division 2 hazardous locations.** The area horizontally from aircraft surfaces between 10 feet (3048 mm) and 30 feet (9144 mm) and from the floor to 30 feet (9144 mm) above the aircraft surface shall be classified as a Class I, Division 2 location.

**412.6 Aircraft manufacturing facilities.** In buildings used for the manufacturing of aircraft, *exit access* travel distances indicated in Section 1017.1 shall be increased in accordance with the following:

1. The building shall be of Type I or II construction.
2. *Exit access* travel distance shall not exceed the distances given in Table 412.6.

**412.6.1 Ancillary areas.** Rooms, areas and spaces ancillary to the primary manufacturing area shall be permitted to egress through such area having a minimum height as indicated in Table 412.6. *Exit access* travel distance within the ancillary room, area or space shall not exceed that indicated in Table 1017.2 based on the occupancy classification of that ancillary area. Total *exit access* travel distance shall not exceed that indicated in Table 412.6.

**[F] 412.7 Heliports and helistops.** *Heliports* and *helistops* shall be permitted to be erected on buildings or other locations where they are constructed in accordance with Sections 412.7.1 through 412.7.5.

**[F] 412.7.1 Size.** The landing area for helicopters less than 3,500 pounds (1588 kg) shall be not less than 20 feet (6096 mm) in length and width. The landing area shall be surrounded on all sides by a clear area having an average width at roof level of 15 feet (4572 mm), and all widths shall be not less than 5 feet (1524 mm).

**[F] 412.7.2 Design.** Helicopter landing areas and the supports thereof on the roof of a building shall be noncombustible construction. Landing areas shall be designed to confine any flammable liquid spillage to the landing area itself and provisions shall be made to drain such spillage away from any *exit* or *stairway* serving the helicopter landing area or from a structure housing such *exit* or *stairway*. For structural design requirements, see Section 1607.6.

**412.7.3 Means of egress.** The *means of egress* from *heliports* and *helistops* shall comply with the provisions of Chapter 10. Landing areas located on buildings or structures shall have two or more *exits* or *access to exits*. For landing areas less than 60 feet (18 288 mm) in length or less than 2,000 square feet (186 m<sup>2</sup>) in area, the second *means of egress* is permitted to be a fire escape, *alternating tread device* or ladder leading to the floor below.

**[F] 412.7.4 Rooftop heliports and helistops.** Rooftop *heliports* and *helistops* shall comply with NFPA 418.

TABLE 412.6  
AIRCRAFT MANUFACTURING EXIT ACCESS TRAVEL DISTANCE

HEIGHT (feet) <sup>a</sup>	MANUFACTURING AREA (square feet) <sup>b</sup>					
	≥ 150,000	≥ 200,000	≥ 250,000	≥ 500,000	≥ 750,000	≥ 1,000,000
≥ 25	400	450	500	500	500	500
≥ 50	400	500	600	700	700	700
≥ 75	400	500	700	850	1,000	1,000
≥ 100	400	500	750	1,000	1,250	1,500

For SI: 1 foot = 304.8 mm.

a. Contiguous floor area of the aircraft manufacturing facility having the indicated height.

b. Minimum height from finished floor to bottom of ceiling or roof slab or deck.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

[F] **412.7.5 Standpipe system.** In buildings equipped with a *standpipe system*, the standpipe shall extend to the roof level in accordance with Section 905.3.6.

### SECTION 413 COMBUSTIBLE STORAGE

**413.1 General.** High-piled stock or rack storage in any occupancy group shall comply with the *International Fire Code*.

**413.2 Attic, under-floor and concealed spaces.** Attic, under-floor and concealed spaces used for storage of combustible materials shall be protected on the storage side as required for 1-hour fire-resistance-rated construction. Openings shall be protected by assemblies that are *self-closing* and are of noncombustible construction or solid wood core not less than  $1\frac{3}{4}$  inches (45 mm) in thickness.

**Exception:** Neither fire-resistance-rated construction nor opening protectives are required in any of the following locations:

1. Areas protected by *approved automatic sprinkler systems*.
2. Group R-3 and U occupancies.

### SECTION 414 HAZARDOUS MATERIALS

[F] **414.1 General.** The provisions of Sections 414.1 through 414.6 shall apply to buildings and structures occupied for the manufacturing, processing, dispensing, use or storage of *hazardous materials*.

[F] **414.1.1 Other provisions.** Buildings and structures with an occupancy in Group H shall comply with this section and the applicable provisions of Section 415 and the *International Fire Code*.

[F] **414.1.2 Materials.** The safe design of hazardous material occupancies is material dependent. Individual material requirements are found in Sections 307 and 415, the *International Mechanical Code* and the *International Fire Code*.

[F] **414.1.2.1 Aerosol products, aerosol cooking spray products and plastic aerosol 3 products.** Level 2 and 3 aerosol products, aerosol cooking spray products and plastic aerosol 3 products shall be stored and displayed in accordance with the *International Fire Code*. See Section 311.2 and the *International Fire Code* for occupancy group requirements.

[F] **414.1.3 Information required.** A report shall be submitted to the *building official* identifying the maximum expected quantities of *hazardous materials* to be stored, used in a *closed system* and used in an *open system*, and subdivided to separately address *hazardous material* classification categories based on Tables 307.1(1) and 307.1(2). The methods of protection from such hazards, including but not limited to *control areas*,

fire protection systems and Group H occupancies shall be indicated in the report and on the *construction documents*. The opinion and report shall be prepared by a qualified person, firm or corporation *approved* by the *building official* and provided without charge to the enforcing agency.

For buildings and structures with an occupancy in Group H, separate floor plans shall be submitted identifying the locations of anticipated contents and processes so as to reflect the nature of each occupied portion of every building and structure.

[F] **414.2 Control areas.** *Control areas* shall comply with Sections 414.2.1 through 414.2.5 and the *International Fire Code*.

**Exception:** *Higher education laboratories* in accordance with Section 428 and Chapter 38 of the *International Fire Code*.

[F] **414.2.1 Construction requirements.** *Control areas* shall be separated from each other by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

[F] **414.2.2 Percentage of maximum allowable quantities.** The percentage of maximum allowable quantities of *hazardous materials* per *control area* permitted at each floor level within a building shall be in accordance with Table 414.2.2.

[F] **414.2.3 Number.** The maximum number of *control areas* within a building shall be in accordance with Table 414.2.2. For the purposes of determining the number of *control areas* within a building, each portion of a building separated by one or more *fire walls* complying with Section 706 shall be considered a separate building.

[F] **414.2.4 Fire-resistance rating requirements.** The required *fire-resistance rating* for *fire barriers* shall be in accordance with Table 414.2.2. The floor assembly of the *control area* and the construction supporting the floor of the *control area* shall have a *fire-resistance rating* of not less than 2 hours.

**Exception:** The floor assembly of the *control area* and the construction supporting the floor of the *control area* are allowed to be 1-hour fire-resistance-rated in buildings of Types IIA, IIIA, IV and VA construction, provided that both of the following conditions exist:

1. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
2. The building is three or fewer *stories above grade plane*.

[F] **414.2.5 Hazardous material in Group M display and storage areas and in Group S storage areas.** *Hazardous materials* located in Group M and Group S occupancies shall be in accordance with Sections 414.2.5.1 through 414.2.5.3.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

[F] TABLE 414.2.2  
DESIGN AND NUMBER OF CONTROL AREAS

STORY		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA <sup>a</sup>	NUMBER OF CONTROL AREAS PER STORY	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b</sup>
Above grade plane	Higher than 9	5	1	2
	7–9	5	2	2
	6	12.5	2	2
	5	12.5	2	2
	4	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below grade plane	1	75	3	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 307.1(1) and 307.1(2), with all increases allowed in the notes to those tables.

b. Separation shall include fire barriers and horizontal assemblies as necessary to provide separation from other portions of the building.

**[F] 414.2.5.1 Nonflammable solids and nonflammable and noncombustible liquids.** The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials permitted within a single *control area* of a Group M display and storage area, a Group S storage area or an outdoor *control area* is permitted to exceed the maximum allowable quantities per *control area* specified in Tables 307.1(1) and 307.1(2) without classifying the building or use as a Group H occupancy, provided that the materials are displayed and stored in accordance with the *International Fire Code* and quantities do not exceed the maximum allowable specified in Table 414.2.5(1).

**[F] 414.2.5.2 Flammable and combustible liquids.** In Group M occupancy wholesale and retail sales uses, indoor storage of *flammable and combustible liquids* shall not exceed the maximum allowable quantities per *control area* as indicated in Table 414.2.5(2), provided that the materials are displayed and stored in accordance with the *International Fire Code*.

**[F] 414.2.5.3 Aerosol products, aerosol cooking spray products or plastic aerosol 3 products.** The maximum quantity of *aerosol products*, aerosol cooking spray products or plastic aerosol 3 products in Group M occupancy retail display areas, storage areas adjacent to retail display areas and retail storage areas shall be in accordance with the *International Fire Code*.

**[F] 414.3 Ventilation.** Rooms, areas or spaces in which *explosive, corrosive, combustible, flammable or highly toxic* dusts, mists, fumes, vapors or gases are or have the potential to be emitted due to the processing, *use*, handling or storage

of materials shall be mechanically ventilated where required by this code, the *International Fire Code* or the *International Mechanical Code*.

Emissions generated at workstations shall be confined to the area in which they are generated as specified in the *International Fire Code* and the *International Mechanical Code*.

**[F] 414.4 Hazardous material systems.** Systems involving *hazardous materials* shall be suitable for the intended application. Controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate or path. *Automatic* controls, where provided, shall be designed to be fail safe.

**[F] 414.5 Inside storage, dispensing and use.** The inside storage, dispensing and *use of hazardous materials* shall be in accordance with Sections 414.5.1 through 414.5.3 of this code and the *International Fire Code*.

**[F] 414.5.1 Explosion control.** *Explosion* control shall be provided in accordance with the *International Fire Code* as required by Table 414.5.1 where quantities of *hazardous materials* specified in that table exceed the maximum allowable quantities in Table 307.1(1) or where a structure, room or space is occupied for purposes involving *explosion* hazards as required by Section 415 or the *International Fire Code*.

**[F] 414.5.2 Emergency or standby power.** Where required by the *International Fire Code* or this code, mechanical *ventilation*, treatment systems, temperature control, alarm, detection or other electrically operated systems shall be provided with emergency or standby power in accordance with Section 2702. For storage and use areas for *highly toxic or toxic* materials, see Sections 6004.2.2.8 and 6004.3.4.2 of the *International Fire Code*.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] TABLE 414.2.5(1)**  
**MAXIMUM ALLOWABLE QUANTITY PER INDOOR AND OUTDOOR CONTROL AREA IN**  
**GROUP M AND S OCCUPANCIES OF NONFLAMMABLE SOLIDS AND NONFLAMMABLE AND NONCOMBUSTIBLE LIQUIDS<sup>d, e, f</sup>**

CONDITION		MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA	
Material <sup>a</sup>	Class	Solids (pounds)	Liquids (gallons)
<b>A. Health-hazard materials—nonflammable and noncombustible solids and liquids</b>			
1. Corrosives <sup>b, c</sup>	Not Applicable	9,750	975
2. Highly toxics	Not Applicable	20 <sup>b, c</sup>	2 <sup>b, c</sup>
3. Toxics <sup>b, c</sup>	Not Applicable	1,000 <sup>k</sup>	100
<b>B. Physical-hazard materials—nonflammable and noncombustible solids and liquids</b>			
1. Oxidizers <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	1,350 <sup>e</sup>	115
	2	2,250 <sup>h</sup>	225
	1	18,000 <sup>i, j</sup>	1,800 <sup>i, j</sup>
2. Unstable (reactives) <sup>b, c</sup>	4	Not Allowed	Not Allowed
	3	550	55
	2	1,150	115
	1	Not Limited	Not Limited
3. Water reactives	3 <sup>b, c</sup>	550	55
	2 <sup>b, c</sup>	1,150	115
	1	Not Limited	Not Limited

For SI: 1 pound = 0.454 kg, 1 gallon = 3.785 L.

- Hazard categories are as specified in the *International Fire Code*.
- Maximum allowable quantities shall be increased 100 percent in buildings that are sprinklered in accordance with Section 903.3.1.1. Where Note c also applies, the increase for both notes shall be applied accumulatively.
- Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, in accordance with the *International Fire Code*. Where Note b also applies, the increase for both notes shall be applied accumulatively.
- See Table 414.2.2 for design and number of control areas.
- Allowable quantities for other hazardous material categories shall be in accordance with Section 307.
- Maximum quantities shall be increased 100 percent in outdoor control areas.
- Maximum amounts shall be increased to 2,250 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- Maximum amounts shall be increased to 4,500 pounds where individual packages are in the original sealed containers from the manufacturer or packager and do not exceed 10 pounds each.
- The permitted quantities shall not be limited in a building equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
- Quantities are unlimited in an outdoor control area.
- Maximum allowable quantities of consumer products shall be increased to 10,000 pounds where individual packages are in the original, sealed containers from the manufacturer and the toxic classification is exclusively based on the LC threshold and no other hazardous materials classifications apply.

**[F] TABLE 414.2.5(2)**  
**MAXIMUM ALLOWABLE QUANTITY OF FLAMMABLE AND**  
**COMBUSTIBLE LIQUIDS IN WHOLESALE AND RETAIL SALES OCCUPANCIES PER CONTROL AREA<sup>a</sup>**

TYPE OF LIQUID	MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA (gallons)		
	Sprinklered in accordance with Note b densities and arrangements	Sprinklered in accordance with Tables 5704.3.6.3(4) through 5704.3.6.3(8) and 5704.3.7.5.1 of the <i>International Fire Code</i>	Nonsprinklered
Class IA	60	60	30
Class IB, IC, II and IIIA	7,500 <sup>c</sup>	15,000 <sup>c</sup>	1,600
Class IIIB	Unlimited	Unlimited	13,200

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 gallon = 3.785 L, 1 gallon per minute per square foot = 40.75 L/min/m<sup>2</sup>.

- Control areas shall be separated from each other by not less than a 1-hour *fire barrier* wall.
- To be considered as sprinklered, a building shall be equipped throughout with an approved automatic sprinkler system with a design providing minimum densities as follows:
  - For uncartoned commodities on shelves 6 feet or less in height where the ceiling height does not exceed 18 feet, quantities are those permitted with a minimum sprinkler design density of Ordinary Hazard Group 2.
  - For cartoned, palletized or racked commodities where storage is 4 feet 6 inches or less in height and where the ceiling height does not exceed 18 feet, quantities are those permitted with a minimum sprinkler design density of 0.21 gallon per minute per square foot over the most remote 1,500-square-foot area.
- Where wholesale and retail sales or storage areas exceed 50,000 square feet in area, the maximum allowable quantities are allowed to be increased by 2 percent for each 1,000 square feet of area in excess of 50,000 square feet, up to not more than 100 percent of the table amounts. A control area separation is not required. The cumulative amounts, including amounts attained by having an additional control area, shall not exceed 30,000 gallons.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] TABLE 414.5.1**  
**EXPLOSION CONTROL REQUIREMENTS<sup>a, h</sup>**

MATERIAL	CLASS	EXPLOSION CONTROL METHODS	
		Barricade construction	Explosion (deflagration) venting or explosion (deflagration) prevention systems <sup>b</sup>
HAZARD CATEGORY			
Combustible dusts <sup>c</sup>	—	Not Required	Required
Cryogenic flammables	—	Not Required	Required
Explosives	Division 1.1	Required	Not Required
	Division 1.2	Required	Not Required
	Division 1.3	Not Required	Required
	Division 1.4	Not Required	Required
	Division 1.5	Required	Not Required
	Division 1.6	Required	Not Required
Flammable gas	Gaseous	Not Required	Required
	Liquefied	Not Required	Required
Flammable liquid	IA <sup>d</sup>	Not Required	Required
	IB <sup>e</sup>	Not Required	Required
Organic peroxides	U	Required	Not Permitted
	I	Required	Not Permitted
Oxidizer liquids and solids	4	Required	Not Permitted
Pyrophoric gas	—	Not Required	Required
Unstable (reactive)	4	Required	Not Permitted
	3 Detonable	Required	Not Permitted
	3 Nondetonable	Not Required	Required
Water-reactive liquids and solids	3	Not Required	Required
	2 <sup>g</sup>	Not Required	Required
SPECIAL USES			
Acetylene generator rooms	—	Not Required	Required
Electrochemical energy storage system <sup>i</sup>	—	Not Required	Required
Energy storage system <sup>i</sup>	—	Not Required	Required
Grain processing	—	Not Required	Required
Liquefied petroleum gas-distribution facilities	—	Not Required	Required
Where explosion hazards exist <sup>f</sup>	Detonation	Required	Not Permitted
	Deflagration	Not Required	Required

a. See Section 414.1.3.

b. See the International Fire Code.

c. Combustible dusts where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.8.2 of the International Fire Code. See definition of "Combustible dust" in Chapter 2.

d. Storage or use.

e. In open use or dispensing.

f. Rooms containing dispensing and use of hazardous materials where an explosive environment can occur because of the characteristics or nature of the hazardous materials or as a result of the dispensing or use process.

g. A method of explosion control shall be provided where Class 2 water-reactive materials can form potentially explosive mixtures.

h. Explosion venting is not required for Group H-5 fabrication areas complying with Section 415.11.1 and the International Fire Code.

i. Where explosion control is required in Section 1207 of the *International Fire Code*.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

[F] **414.5.2.1 Exempt applications.** Emergency or standby power is not required for the mechanical ventilation systems provided for any of the following:

1. Storage of Class IB and IC flammable and combustible liquids in closed containers not exceeding 6.5 gallons (25 L) capacity.
2. Storage of Class 1 and 2 oxidizers.
3. Storage of Class II, III, IV and V organic peroxides.
4. Storage of asphyxiant, irritant and radioactive gases.

[F] **414.5.2.2 Fail-safe engineered systems.** Standby power for mechanical ventilation, treatment systems and temperature control systems shall not be required where an approved fail-safe engineered system is installed.

[F] **414.5.3 Spill control, drainage and containment.** Rooms, buildings or areas occupied for the storage of solid and liquid *hazardous materials* shall be provided with a means to control spillage and to contain or drain off spillage and fire protection water discharged in the storage area where required in the *International Fire Code*. The methods of spill control shall be in accordance with the *International Fire Code*.

[F] **414.6 Outdoor storage, dispensing and use.** The outdoor storage, dispensing and use of *hazardous materials* shall be in accordance with the *International Fire Code*.

[F] **414.6.1 Weather protection.** Where weather protection is provided for sheltering outdoor *hazardous material* storage or use areas, such areas shall be considered outdoor storage or *use* where the weather protection structure complies with Sections 414.6.1.1 through 414.6.1.3.

[F] **414.6.1.1 Walls.** Walls shall not obstruct more than one side of the structure.

**Exception:** Walls shall be permitted to obstruct portions of multiple sides of the structure, provided that the obstructed area is not greater than 25 percent of the structure's perimeter.

[F] **414.6.1.2 Separation distance.** The distance from the structure to buildings, *lot lines*, *public ways* or *means of egress* to a *public way* shall be not less than the distance required for an outside *hazardous material* storage or use area without weather protection.

[F] **414.6.1.3 Noncombustible construction.** The overhead structure shall be of *approved* noncombustible construction with a maximum area of 1,500 square feet (140 m<sup>2</sup>).

**Exception:** The maximum area is permitted to be increased as provided by Section 506.

## SECTION 415

### GROUPS H-1, H-2, H-3, H-4 AND H-5

[F] **415.1 General.** The provisions of Sections 415.1 through 415.11 shall apply to the storage and use of hazardous materials in excess of the maximum allowable quantities per *control area* listed in Section 307.1.

[F] **415.2 Compliance.** Buildings and structures with an occupancy in Group H shall comply with the applicable provisions of Section 414 and the *International Fire Code*.

[F] **415.3 Automatic fire detection systems.** Group H occupancies shall be provided with an automatic fire detection system in accordance with Section 907.2.

[F] **415.4 Automatic sprinkler system.** Group H occupancies shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.5.

[F] **415.5 Emergency alarms.** Emergency alarms for the detection and notification of an emergency condition in Group H occupancies shall be provided as set forth herein.

[F] **415.5.1 Storage.** An approved manual emergency alarm system shall be provided in buildings, rooms or areas used for storage of hazardous materials. Emergency alarm-initiating devices shall be installed outside of each interior *exit* or exit access door of storage buildings, rooms or areas. Activation of an emergency alarm-initiating device shall sound a local alarm to alert occupants of an emergency situation involving hazardous materials.

[F] **415.5.2 Dispensing, use and handling.** Where hazardous materials having a hazard ranking of 3 or 4 in accordance with NFPA 704 are transported through *corridors*, *interior exit stairways* or *ramps*, or exit passageways, there shall be an emergency telephone system, a local manual alarm station or an approved alarm-initiating device at not more than 150-foot (45 720 mm) intervals and at each exit and *exit access doorway* throughout the transport route. The signal shall be relayed to an approved central, proprietary or remote station service or constantly attended on-site location and shall initiate a local audible alarm.

[F] **415.5.3 Supervision.** Emergency alarm systems required by Section 415.5.1 or 415.5.2 shall be electrically supervised and monitored by an approved central, proprietary or remote station service or shall initiate an audible and visual signal at a constantly attended on-site location.

[F] **415.5.4 Emergency alarm systems.** *Emergency alarm systems* required by Section 415.5.1 or 415.5.2 shall be provided with emergency or standby power in accordance with Section 2702.2.

[F] **415.6 Fire separation distance.** Group H occupancies shall be located on property in accordance with the other provisions of this chapter. In Groups H-2 and H-3, not less than 25 percent of the perimeter wall of the occupancy shall be an *exterior wall*.



**[F] 415.6.1 Rooms for flammable or combustible liquid use, dispensing or mixing in open systems.** Rooms for *flammable or combustible liquid use*, dispensing or mixing in open systems having a floor area of not more than 500 square feet (46.5 m<sup>2</sup>) need not be located on the outer perimeter of the building where they are in accordance with the *International Fire Code* and NFPA 30.

**[F] 415.6.2 Liquid storage rooms and rooms for flammable or combustible liquid use in closed systems.** *Liquid storage rooms* and rooms for *flammable or combustible liquid use* in closed systems, having a floor area of not more than 1,000 square feet (93 m<sup>2</sup>) need not be located on the outer perimeter where they are in accordance with the *International Fire Code* and NFPA 30.

**[F] 415.6.3 Spray paint booths.** Spray paint booths that comply with the *International Fire Code* need not be located on the outer perimeter.

**[F] 415.6.4 Group H occupancy minimum fire separation distance.** Regardless of any other provisions, buildings containing Group H occupancies shall be set back to the *minimum fire separation distance* as set forth in Sections 415.6.4.1 through 415.6.4.4. Distances shall be measured from the walls enclosing the occupancy to *lot lines*, including those on a public way. Distances to assumed *lot lines* established for the purpose of determining *exterior wall* and opening protection are not to be used to establish the *minimum fire separation distance* for buildings on sites where explosives are manufactured or used where separation is provided in accordance with the quantity distance tables specified for *explosive* materials in the *International Fire Code*.

**[F] 415.6.4.1 Group H-1.** Group H-1 occupancies shall be set back not less than 75 feet (22 860 mm) and not less than required by the *International Fire Code*.

**Exception:** *Fireworks* manufacturing buildings separated in accordance with NFPA 1124.

**[F] 415.6.4.2 Group H-2.** Group H-2 occupancies shall be set back not less than 30 feet (9144 mm) where the area of the occupancy is greater than 1,000 square feet (93 m<sup>2</sup>) and it is not required to be located in a *detached building*.

**[F] 415.6.4.3 Groups H-2 and H-3.** Group H-2 and H-3 occupancies shall be set back not less than 50 feet (15 240 mm) where a *detached building* is required (see Table 415.6.5).

**[F] 415.6.4.4 Explosive materials.** Group H-2 and H-3 occupancies containing materials with *explosive* characteristics shall be separated as required by the *International Fire Code*. Where separations are not specified, the distances required shall be determined by a technical report issued in accordance with Section 414.1.3.

**[F] 415.6.5 Detached buildings for Group H-1, H-2 or H-3 occupancy.** The storage or use of hazardous materials in excess of those amounts specified in Table 415.6.5 shall be in accordance with the applicable provisions of Sections 415.7 and 415.8.

**[F] 415.6.5.1 Wall and opening protection.** Where a *detached building* is required by Table 415.6.5, wall and opening protection based on *fire separation distance* is not required.

**[F] 415.7 Special provisions for Group H-1 occupancies.** Group H-1 occupancies shall be in detached buildings not used for other purposes. Roofs shall be of lightweight construction with suitable thermal insulation to prevent sensitive material from reaching its decomposition temperature. Group H-1 occupancies containing materials that are in themselves both physical and health hazards in quantities exceeding the maximum allowable quantities per *control area* in Table 307.1(2) shall comply with requirements for both Group H-1 and H-4 occupancies.

**[F] 415.7.1 Floors in storage rooms.** Floors in storage areas for organic peroxides, *pyrophoric* materials and unstable (reactive) materials shall be of liquid-tight, noncombustible construction.

**[F] 415.8 Special provisions for Group H-2 and H-3 occupancies.** Group H-2 and H-3 occupancies containing quantities of hazardous materials in excess of those set forth in Table 415.6.5 shall be in *detached buildings* used for manufacturing, processing, dispensing, use or storage of hazardous materials. Materials specified for Group H-1 occupancies in Section 307.3 are permitted to be located within Group H-2 or H-3 *detached buildings* provided that the amount of materials per *control area* do not exceed the maximum allowed quantity specified in Table 307.1(1).

**[F] 415.8.1 Multiple hazards.** Group H-2 or H-3 occupancies containing materials that are in themselves both physical and health hazards in quantities exceeding the maximum allowable quantities per *control area* in Table 307.1(2) shall comply with requirements for Group H-2, H-3 or H-4 occupancies as applicable.

**[F] 415.8.2 Separation of incompatible materials.** Hazardous materials other than those specified in Table 415.6.5 shall be allowed in manufacturing, processing, dispensing, use or storage areas when separated from *incompatible materials* in accordance with the provisions of the *International Fire Code*.

**[F] 415.8.3 Water reactives.** Group H-2 and H-3 occupancies containing water-reactive materials shall be resistant to water penetration. Piping for conveying liquids shall not be over or through areas containing water reactives, unless isolated by *approved* liquid-tight construction.

**Exception:** Fire protection piping shall be permitted over or through areas containing water reactives without isolating it with liquid-tight construction.

**[F] 415.8.4 Floors in storage rooms.** Floors in storage areas for organic peroxides, oxidizers, *pyrophoric* materials, unstable (reactive) materials and water-reactive solids and liquids shall be of liquid-tight, noncombustible construction.

**[F] 415.8.5 Waterproof room.** Rooms or areas used for the storage of water-reactive solids and liquids shall be constructed in a manner that resists the penetration of

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

water through the use of waterproof materials. Piping carrying water for other than *approved automatic sprinkler systems* shall not be within such rooms or areas.

**[F] 415.9 Group H-2.** Occupancies in Group H-2 shall be constructed in accordance with Sections 415.9.1 through 415.9.3 and the *International Fire Code*.

**[F] 415.9.1 Flammable and combustible liquids.** The storage, handling, processing and transporting of flammable and combustible liquids in Group H-2 and H-3 occupancies shall be in accordance with Sections 415.9.1.1 through 415.9.1.9, the *International Mechanical Code* and the *International Fire Code*.

**[F] 415.9.1.1 Mixed occupancies.** Where the storage tank area is located in a building of two or more occupancies and the quantity of liquid exceeds the maximum allowable quantity for one *control area*, the use shall be completely separated from adjacent occupancies in accordance with the requirements of Section 508.4.

**[F] 415.9.1.1.1 Height exception.** Where storage tanks are located within a building not more than

one *story above grade plane*, the height limitation of Section 504 shall not apply for Group H.

**[F] 415.9.1.2 Tank protection.** Storage tanks shall be noncombustible and protected from physical damage. *Fire barriers* or *horizontal assemblies* or both around the storage tanks shall be permitted as the method of protection from physical damage.

**[F] 415.9.1.3 Tanks.** Storage tanks shall be approved tanks conforming to the requirements of the *International Fire Code*.

**[F] 415.9.1.4 Leakage containment.** A liquid-tight containment area compatible with the stored liquid shall be provided. The method of spill control, drainage control and secondary containment shall be in accordance with the *International Fire Code*.

**Exception:** Rooms where only double-wall storage tanks conforming to Section 415.9.1.3 are used to store Class I, II and IIIA flammable and combustible liquids shall not be required to have a leakage containment area.

**[F] TABLE 415.6.5  
DETACHED BUILDING REQUIRED**

A DETACHED BUILDING IS REQUIRED WHERE THE QUANTITY OF MATERIAL EXCEEDS THAT SPECIFIED HEREIN			
Material	Class	Solids and Liquids (tons) <sup>a, b</sup>	Gases (cubic feet) <sup>a, b</sup>
Explosives	Division 1.1	Maximum Allowable Quantity	Not Applicable
	Division 1.2	Maximum Allowable Quantity	
	Division 1.3	Maximum Allowable Quantity	
	Division 1.4	Maximum Allowable Quantity	
	Division 1.4 <sup>c</sup>	1	
	Division 1.5	Maximum Allowable Quantity	
	Division 1.6	Maximum Allowable Quantity	
Oxidizers	Class 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Unstable (reactives) detonable	Class 3 or 4	Maximum Allowable Quantity	Maximum Allowable Quantity
Oxidizer, liquids and solids	Class 3	1,200	Not Applicable
	Class 2	2,000	Not Applicable
Organic peroxides	Detonable	Maximum Allowable Quantity	Not Applicable
	Class I	Maximum Allowable Quantity	Not Applicable
	Class II	25	Not Applicable
	Class III	50	Not Applicable
Unstable (reactives) nondetonable	Class 3	1	2,000
	Class 2	25	10,000
Water reactives	Class 3	1	Not Applicable
	Class 2	25	Not Applicable
Pyrophoric gases <sup>d</sup>	Not Applicable	Not Applicable	2,000

For SI: 1 ton = 906 kg, 1 cubic foot = 0.02832 m<sup>3</sup>, 1 pound = 0.454 kg.

- For materials that are detonable, the distance to other buildings or lot lines shall be in accordance with Section 415.6 of this code or Chapter 56 of the *International Fire Code* based on trinitrotoluene (TNT) equivalence of the material, whichever is greater.
- "Maximum Allowable Quantity" means the maximum allowable quantity per control area set forth in Table 307.1(1).
- Limited to Division 1.4 materials and articles, including articles packaged for shipment, that are not regulated as an explosive under Bureau of Alcohol, Tobacco, Firearms and Explosives (BATF) regulations or unpackaged articles used in process operations that do not propagate a detonation or deflagration between articles, provided that the net explosive weight of individual articles does not exceed 1 pound.
- Detached buildings are not required, for gases in gas rooms that support H-5 fabrication facilities where the gas room is separated from other areas by a fire barrier with a fire-resistance rating of not less than 2 hours and the gas is located in a gas cabinet that is internally sprinklered, equipped with continuous leak detection, automatic shutdown and is not manifolded upstream of pressure controls. Additionally, the gas supply is limited to cylinders that do not exceed 125 pounds (57 kg) water capacity in accordance with 49 CFR 173.192 for Hazard Zone A toxic gases.

**[F] 415.9.1.5 Leakage alarm.** An *approved* automatic alarm shall be provided to indicate a leak in a storage tank and room. The alarm shall sound an audible signal, 15 dBA above the ambient sound level, at every point of entry into the room in which the leaking storage tank is located. An *approved* sign shall be posted on every entry door to the tank storage room indicating the potential hazard of the interior room environment, or the sign shall state, "WARNING, WHEN ALARM SOUNDS, THE ENVIRONMENT WITHIN THE ROOM MAY BE HAZARDOUS." The leakage alarm shall be supervised in accordance with Chapter 9 to transmit a trouble signal.

**[F] 415.9.1.6 Tank vent.** Storage tank vents for Class I, II or IIIA liquids shall terminate to the outdoor air in accordance with the *International Fire Code*.

**[F] 415.9.1.7 Room ventilation.** Storage tank areas storing Class I, II or IIIA liquids shall be provided with mechanical ventilation. The mechanical ventilation system shall be in accordance with the *International Mechanical Code* and the *International Fire Code*.

**[F] 415.9.1.8 Explosion venting.** Where Class I liquids are being stored, explosion venting shall be provided in accordance with the *International Fire Code*.

**[F] 415.9.1.9 Tank openings other than vents.** Tank openings other than vents from tanks inside buildings shall be designed to ensure that liquids or vapor concentrations are not released inside the building.

**[F] 415.9.2 Liquefied petroleum gas facilities.** The construction and installation of liquefied petroleum gas facilities shall be in accordance with the requirements of this code, the *International Fire Code*, the *International Fuel Gas Code*, the *International Mechanical Code* and NFPA 58.

**[F] 415.9.3 Dry cleaning plants.** The construction and installation of dry cleaning plants shall be in accordance with the requirements of this code, the *International Mechanical Code*, the *International Plumbing Code* and NFPA 32. Dry cleaning solvents and systems shall be classified in accordance with the *International Fire Code*.

**[F] 415.10 Groups H-3 and H-4.** Groups H-3 and H-4 shall be constructed in accordance with the applicable provisions of this code and the *International Fire Code*.

**[F] 415.10.1 Flammable and combustible liquids.** The storage, handling, processing and transporting of flammable and combustible liquids in Group H-3 occupancies shall be in accordance with Section 415.9.1.

**[F] 415.10.2 Gas rooms.** Where gas rooms are provided, such rooms shall be separated from other areas by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 415.10.3 Floors in storage rooms.** Floors in storage areas for *corrosive* liquids and *highly toxic* or toxic materials shall be of liquid-tight, noncombustible construction.

**[F] 415.10.4 Separation of highly toxic solids and liquids.** *Highly toxic* solids and liquids not stored in *approved* hazardous materials storage cabinets shall be isolated from other hazardous materials storage by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 415.11 Group H-5.** In addition to the requirements set forth elsewhere in this code, Group H-5 shall comply with the provisions of Sections 415.11.1 through 415.11.12 and the *International Fire Code*.

**[F] 415.11.1 Fabrication areas.** *Fabrication areas* shall comply with Sections 415.11.1.1 through 415.11.1.8.

**[F] 415.11.1.1 Hazardous materials.** Hazardous materials and hazardous production materials (HPM) shall comply with Sections 415.11.1.1.1 and 415.11.1.1.2.

**[F] 415.11.1.1.1 Aggregate quantities.** The aggregate quantities of hazardous materials stored and used in a single *fabrication area* shall not exceed the quantities set forth in Table 415.11.1.1.1.

**Exception:** The quantity limitations for any hazard category in Table 415.11.1.1.1 shall not apply where the *fabrication area* contains quantities of hazardous materials not exceeding the maximum allowable quantities per *control area* established by Tables 307.1(1) and 307.1(2).

**[F] 415.11.1.1.2 Hazardous production materials.** The maximum quantities of hazardous production materials (HPM) stored in a single *fabrication area* shall not exceed the maximum allowable quantities per *control area* established by Table 307.1(1) and Table 307.1(2).

**[F] 415.11.1.2 Separation.** *Fabrication areas*, whose sizes are limited by the quantity of hazardous materials allowed by Table 415.11.1.1.1, shall be separated from each other, from *corridors* and from other parts of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

#### Exceptions:

1. Doors within such *fire barrier* walls, including doors to *corridors*, shall be only *self-closing fire door assemblies* having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.
2. Windows between *fabrication areas* and *corridors* are permitted to be fixed glazing listed and labeled for a *fire protection rating* of not less than  $\frac{3}{4}$  hour in accordance with Section 716.

**[F] 415.11.1.3 Location of occupied levels.** Occupied levels of *fabrication areas* shall be located at or above the first story above grade plane.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] TABLE 415.11.1.1.1**  
**QUANTITY LIMITS FOR HAZARDOUS MATERIALS IN A SINGLE FABRICATION AREA IN GROUP H-5<sup>a</sup>**

HAZARD CATEGORY		SOLIDS (pounds per square foot)	LIQUIDS (gallons per square foot)	GAS (cubic feet @ NTP/square foot)
PHYSICAL-HAZARD MATERIALS				
Combustible dust		Note b	Not Applicable	Not Applicable
Combustible fiber	Loose	Note b	Not Applicable	Not Applicable
	Baled	Notes b and c		
Combustible liquid	II	Not Applicable	0.01	Not Applicable
	IIIA		0.02	
	IIIB		Not Limited	
Combination Class	I, II and IIIA		0.04	
Cryogenic gas	Flammable	Not Applicable	Not Applicable	Note d
	Oxidizing			1.25
Explosives		Note b	Note b	Note b
Flammable gas	Gaseous	Not Applicable	Not Applicable	Note d
	Liquefied			Note d
Flammable liquid	IA	Not Applicable	0.0025	Not Applicable
	IB		0.025	
	IC		0.025	
Combination Class	IA, IB and IC		0.025	
Combination Class	I, II and IIIA		0.04	
Flammable solid		0.001	Not Applicable	Not Applicable
Organic peroxide	Unclassified detonable	Note b	Not Applicable	Not Applicable
	Class I	Note b		
	Class II	0.025		
	Class III	0.1		
	Class IV	Not Limited		
	Class V	Not Limited		
Oxidizing gas	Gaseous	Not Applicable	Not Applicable	1.25
	Liquefied			1.25
Combination of gaseous and liquefied				
Oxidizer	Class 4	Note b	Note b	Not Applicable
	Class 3	0.003	0.03	
	Class 2	0.003	0.03	
	Class 1	0.003	0.03	
Combination Class	1, 2, 3	0.003	0.03	
Pyrophoric materials		0.01	0.00125	Notes d and e
Unstable (reactive)	Class 4	Note b	Note b	Note b
	Class 3	0.025	0.0025	Note b
	Class 2	0.1	0.01	Note b
	Class 1	Not Limited	Not Limited	Not Limited
Water reactive	Class 3	0.01 <sup>f</sup>	0.00125	Not Applicable
	Class 2	0.25	0.025	
	Class 1	Not Limited	Not Limited	
HEALTH-HAZARD MATERIALS				
Corrosives		Not Limited	Not Limited	Not Limited
Highly toxic		Not Limited	Not Limited	Note d
Toxics		Not Limited	Not Limited	Note d

For SI: 1 pound = 0.454 kg, 1 pound per square foot = 4.882 kg/m<sup>2</sup>, 1 gallon per square foot = 40.7 L/m<sup>2</sup>, 1 cubic foot @ NTP/square foot = 0.305 m<sup>3</sup> @ NTP/m<sup>2</sup>, 1 cubic foot = 0.02832 m<sup>3</sup>.

a. Hazardous materials within piping shall not be included in the calculated quantities.

b. Quantity of hazardous materials in a single fabrication shall not exceed the maximum allowable quantities per control area in Tables 307.1(1) and 307.1(2).

c. Densely packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.

d. The aggregate quantity of flammable, pyrophoric, toxic and highly toxic gases shall not exceed the greater of 0.2 cubic feet at NTP/square foot or 9,000 cubic feet at NTP.

e. The aggregate quantity of pyrophoric gases in the building shall not exceed the amounts set forth in Table 415.6.5.

f. Quantity of Class 3 water-reactive solids in a single tool shall not exceed 1 pound.



**[F] 415.11.1.4 Floors.** Except for surfacing, floors within *fabrication areas* shall be of noncombustible construction.

Openings through floors of *fabrication areas* are permitted to be unprotected where the interconnected levels are used solely for mechanical equipment directly related to such *fabrication areas* (see Section 415.11.1.5).

Floors forming a part of an occupancy separation shall be liquid tight.

**[F] 415.11.1.5 Shafts and openings through floors.** Elevator hoistways, vent *shafts* and other openings through floors shall be enclosed where required by Sections 712 and 713. Mechanical, duct and piping penetrations within a *fabrication area* shall not extend through more than two floors. The *annular space* around penetrations for cables, cable trays, tubing, piping, conduit or ducts shall be sealed at the floor level to restrict the movement of air. The *fabrication area*, including the areas through which the ductwork and piping extend, shall be considered to be a single conditioned environment.

**[F] 415.11.1.6 Ventilation.** Mechanical exhaust *ventilation* at the rate of not less than 1 cubic foot per minute per square foot [ $0.0051 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of floor area shall be provided throughout the portions of the *fabrication area* where HPM are used or stored. The exhaust air duct system of one *fabrication area* shall not connect to another duct system outside that *fabrication area* within the building.

A *ventilation* system shall be provided to capture and exhaust gases, fumes and vapors at workstations.

Two or more operations at a *workstation* shall not be connected to the same exhaust system where either one or the combination of the substances removed could constitute a fire, explosion or hazardous chemical reaction within the exhaust duct system.

Exhaust ducts penetrating *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711 shall be contained in a *shaft* of equivalent fire-resistance-rated construction. Exhaust ducts shall not penetrate *fire walls*.

*Fire dampers* shall not be installed in exhaust ducts.

**[F] 415.11.1.7 Transporting hazardous production materials to fabrication areas.** HPM shall be transported to *fabrication areas* through enclosed piping or tubing systems that comply with Section 415.11.7, through *service corridors* complying with Section 415.11.3, or in *corridors* as permitted in the exception to Section 415.11.2. The handling or transporting of HPM within *service corridors* shall comply with the *International Fire Code*.

**[F] 415.11.1.8 Electrical.** Electrical equipment and devices within the *fabrication area* shall comply with NFPA 70. The requirements for hazardous locations need not be applied where the average air change is not

less than four times that set forth in Section 415.11.1.6 and where the number of air changes at any location is not less than three times that required by Section 415.11.1.6. The use of recirculated air shall be permitted.

**[F] 415.11.1.8.1 Workstations.** Workstations shall not be energized without adequate exhaust *ventilation*. See Section 415.11.1.6 for workstation exhaust *ventilation requirements*.

**[F] 415.11.2 Corridors.** *Corridors* shall comply with Chapter 10 and shall be separated from *fabrication areas* as specified in Section 415.11.1.2. *Corridors* shall not contain HPM and shall not be used for transporting such materials except through closed piping systems as provided in Section 415.11.7.4.

**Exception:** Where existing *fabrication areas* are altered or modified, HPM is allowed to be transported in existing *corridors*, subject to the following conditions:

1. Nonproduction HPM is allowed to be transported in *corridors* if utilized for maintenance, lab work and testing.
2. Where existing *fabrication areas* are altered or modified, HPM is allowed to be transported in existing *corridors*, subject to the following conditions:
  - 2.1. *Corridors.* *Corridors* adjacent to the *fabrication area* where the alteration work is to be done shall comply with Section 1020 for a length determined as follows:
    - 2.1.1. The length of the common wall of the *corridor* and the *fabrication area*; and
    - 2.1.2. For the distance along the *corridor* to the point of entry of HPM into the *corridor* serving that *fabrication area*.
  - 2.2. *Emergency alarm system.* There shall be an emergency telephone system, a local manual alarm station or other *approved* alarm-initiating device within *corridors* at not more than 150-foot (45 720 mm) intervals and at each exit and doorway. The signal shall be relayed to an *approved* central, proprietary or remote station service or the *emergency control station* and shall initiate a local audible alarm.
  - 2.3. *Pass-throughs.* *Self-closing* doors having a *fire protection rating* of not less than 1 hour shall separate pass-throughs from existing *corridors*. Pass-throughs shall be constructed as required for the *corridors* and protected by an *approved automatic sprinkler system*.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] 415.11.3 Service corridors.** *Service corridors* within a Group H-5 occupancy shall comply with Sections 415.11.3.1 through 415.11.3.4.

**[F] 415.11.3.1 Use conditions.** *Service corridors* shall be separated from *corridors* as required by Section 415.11.1.2. *Service corridors* shall not be used as a required *corridor*.

**[F] 415.11.3.2 Mechanical ventilation.** *Service corridors* shall be mechanically ventilated as required by Section 415.11.1.6 or at not less than six air changes per hour.

**[F] 415.11.3.3 Means of egress.** The distance of travel from any point in a *service corridor* to an *exit*, *exit access corridor* or door into a *fabrication area* shall be not greater than 75 feet (22 860 mm). Dead ends shall be not greater than 4 feet (1219 mm) in length. There shall be not less than two *exits*, and not more than one-half of the required *means of egress* shall require travel into a *fabrication area*. Doors from *service corridors* shall swing in the direction of egress travel and shall be *self-closing*.

**[F] 415.11.3.4 Minimum width.** The clear width of a *service corridor* shall be not less than 5 feet (1524 mm), or 33 inches (838 mm) wider than the widest cart or truck used in the *service corridor*, whichever is greater.

**[F] 415.11.4 Emergency alarm system.** *Emergency alarm systems* shall be provided in accordance with this section and Sections 415.5.1 and 415.5.2. The maximum allowable quantity per *control area* provisions shall not apply to *emergency alarm systems* required for HPM.

**[F] 415.11.4.1 Service corridors.** An *emergency alarm system* shall be provided in *service corridors*, with not fewer than one alarm device in each *service corridor*.

**[F] 415.11.4.2 Corridors and interior exit stairways and ramps.** Emergency alarms for *corridors*, *interior exit stairways* and *ramps* and *exit passageways* shall comply with Section 415.5.2.

**[F] 415.11.4.3 Liquid storage rooms, HPM rooms and gas rooms.** Emergency alarms for liquid storage rooms, HPM rooms and gas rooms shall comply with Section 415.5.1.

**[F] 415.11.4.4 Alarm-initiating devices.** An *approved* emergency telephone system, local alarm manual pull stations, or other *approved* alarm-initiating devices are allowed to be used as emergency alarm-initiating devices.

**[F] 415.11.4.5 Alarm signals.** Activation of the *emergency alarm system* shall sound a local alarm and transmit a signal to the *emergency control station*.

**[F] 415.11.5 Storage of hazardous production materials.** Storage of hazardous production materials (HPM) in *fabrication areas* shall be within *approved* or *listed* storage cabinets or gas cabinets or within a *workstation*. The

storage of HPM in quantities greater than those specified in Section 5004.2 of the *International Fire Code* shall be in liquid storage rooms, HPM rooms or gas rooms as appropriate for the materials stored. The storage of other hazardous materials shall be in accordance with other applicable provisions of this code and the *International Fire Code*.

**[F] 415.11.6 HPM rooms, gas rooms, liquid storage room construction.** HPM rooms, gas rooms and liquid shall be constructed in accordance with Sections 415.11.6.1 through 415.11.6.9.

**[F] 415.11.6.1 HPM rooms and gas rooms.** HPM rooms and gas rooms shall be separated from other areas by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire-resistance rating* shall be not less than 2 hours where the area is 300 square feet (27.9 m<sup>2</sup>) or more and not less than 1 hour where the area is less than 300 square feet (27.9 m<sup>2</sup>).

**[F] 415.11.6.2 Liquid storage rooms.** Liquid storage rooms shall be constructed in accordance with the following requirements:

1. Rooms greater than 500 square feet (46.5 m<sup>2</sup>) in area, shall have not fewer than one exterior door *approved* for fire department access.
2. Rooms shall be separated from other areas by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire-resistance rating* shall be not less than 1 hour for rooms up to 150 square feet (13.9 m<sup>2</sup>) in area and not less than 2 hours where the room is more than 150 square feet (13.9 m<sup>2</sup>) in area.
3. Shelving, racks and wainscoting in such areas shall be of noncombustible construction or wood of not less than 1-inch (25 mm) nominal thickness or *fire-retardant-treated wood* complying with Section 2303.2.
4. Rooms used for the storage of Class I flammable liquids shall not be located in a *basement*.

**[F] 415.11.6.3 Floors.** Except for surfacing, floors of HPM rooms and liquid storage rooms shall be of noncombustible liquid-tight construction. Raised grating over floors shall be of noncombustible materials.

**[F] 415.11.6.4 Location.** Where HPM rooms, liquid storage rooms and gas rooms are provided, they shall have not fewer than one *exterior wall* and such wall shall be not less than 30 feet (9144 mm) from *lot lines*, including *lot lines* adjacent to *public ways*.

**[F] 415.11.6.5 Explosion control.** Explosion control shall be provided where required by Section 414.5.1.

**[F] 415.11.6.6 Exits.** Where two *exits* are required from HPM rooms, liquid storage rooms and gas rooms, one shall be directly to the outside of the building.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] 415.11.6.7 Doors.** Doors in a *fire barrier* wall, including doors to *corridors*, shall be *self-closing fire door assemblies* having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.

**[F] 415.11.6.8 Ventilation.** Mechanical exhaust ventilation shall be provided in liquid storage rooms, HPM rooms and gas rooms at the rate of not less than 1 cubic foot per minute per square foot ( $0.044 \text{ L/s/m}^2$ ) of floor area or six air changes per hour.

Exhaust ventilation for gas rooms shall be designed to operate at a negative pressure in relation to the surrounding areas and direct the exhaust ventilation to an exhaust system.

**[F] 415.11.6.9 Emergency alarm system.** An *approved emergency alarm system* shall be provided for HPM rooms, liquid storage rooms and gas rooms.

Emergency alarm-initiating devices shall be installed outside of each interior exit door of such rooms.

Activation of an emergency alarm-initiating device shall sound a local alarm and transmit a signal to the *emergency control station*.

An *approved* emergency telephone system, local alarm manual pull stations or other *approved* alarm-initiating devices are allowed to be used as emergency alarm-initiating devices.

**[F] 415.11.7 Piping and tubing.** Hazardous production materials piping and tubing shall comply with this section and ASME B31.3.

**[F] 415.11.7.1 HPM having a health-hazard ranking of 3 or 4.** Systems supplying HPM liquids or gases having a health-hazard ranking of 3 or 4 shall be welded throughout, except for connections, to the systems that are within a ventilated enclosure if the material is a gas, or an *approved* method of drainage or containment is provided for the connections if the material is a liquid.

**[F] 415.11.7.2 Location in service corridors.** Hazardous production materials supply piping or tubing in *service corridors* shall be exposed to view.

**[F] 415.11.7.3 Excess flow control.** Where HPM gases or liquids are carried in pressurized piping above 15 pounds per square inch gauge (psig) ( $103.4 \text{ kPa}$ ), excess flow control shall be provided. Where the piping originates from within a *liquid storage room*, *HPM room* or *gas room*, the excess flow control shall be located within the *liquid storage room*, *HPM room* or *gas room*. Where the piping originates from a bulk source, the excess flow control shall be located as close to the bulk source as practical.

**[F] 415.11.7.4 Installations in corridors and above other occupancies.** The installation of HPM piping and tubing within the space defined by the walls of corridors and the floor or roof above, or in concealed spaces above other occupancies, shall be in accordance

with Sections 415.11.7.1 through 415.11.7.3 and the following conditions:

1. Automatic sprinklers shall be installed within the space unless the space is less than 6 inches (152 mm) in the least dimension.
2. *Ventilation* not less than six air changes per hour shall be provided. The space shall not be used to convey air from any other area.
3. Where the piping or tubing is used to transport HPM liquids, a receptor shall be installed below such piping or tubing. The receptor shall be designed to collect any discharge or leakage and drain it to an *approved* location. The 1-hour enclosure shall not be used as part of the receptor.
4. HPM supply piping and tubing and nonmetallic waste lines shall be separated from the corridor and from occupancies other than Group H-5 by *fire barriers* or by an *approved* method or assembly that has a *fire-resistance rating* of not less than 1 hour. Access openings into the enclosure shall be protected by *approved* fire-protection-rated assemblies.
5. Readily accessible manual or automatic remotely activated fail-safe emergency shutoff valves shall be installed on piping and tubing other than waste lines at the following locations:
  - 5.1. At branch connections into the *fabrication area*.
  - 5.2. At entries into *corridors*.

**Exception:** Transverse crossings of the *corridors* by supply piping that is enclosed within a ferrous pipe or tube for the width of the *corridor* need not comply with Items 1 through 5.

**[F] 415.11.7.5 Identification.** Piping, tubing and HPM waste lines shall be identified in accordance with ANSI A13.1 to indicate the material being transported.

**[F] 415.11.8 Gas detection systems.** A *gas detection system* complying with Section 916 shall be provided for HPM gases where the *physiological warning threshold level* of the gas is at a higher level than the accepted permissible exposure limit (PEL) for the gas and for flammable gases in accordance with Sections 415.11.8.1 through 415.11.8.2.

**[F] 415.11.8.1 Where required.** A *gas detection system* shall be provided in the areas identified in Sections 415.11.8.1.1 through 415.11.8.1.4.

**[F] 415.11.8.1.1 Fabrication areas.** A *gas detection system* shall be provided in fabrication areas where HPM gas is used in the *fabrication area*.

**[F] 415.11.8.1.2 HPM rooms.** A *continuous gas detection system* shall be provided in HPM rooms where HPM gas is used in the room.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] 415.11.8.1.3 Gas cabinets, exhausted enclosures and gas rooms.** A *gas detection system* shall be provided in gas cabinets and exhausted enclosures for HPM gas. A *gas detection system* shall be provided in gas rooms where HPM gases are not located in gas cabinets or exhausted enclosures.

**[F] 415.11.8.1.4 Corridors.** Where HPM gases are transported in piping placed within the space defined by the walls of a corridor and the floor or roof above the corridor, a *gas detection system* shall be provided where piping is located and in the corridor.

**Exception:** A *gas detection system* is not required for occasional transverse *crossings* of the corridors by supply piping that is enclosed in a ferrous pipe or tube for the width of the corridor.

**[F] 415.11.8.2 Gas detection system operation.** The *gas detection system* shall be capable of monitoring the room, area or equipment in which the HPM gas is located at or below all the following gas concentrations:

1. Immediately *dangerous* to life and health (IDLH) values where the monitoring point is within an *exhausted enclosure*, ventilated enclosure or *gas cabinet*.
2. Permissible exposure limit (PEL) levels where the monitoring point is in an area outside an *exhausted enclosure*, ventilated enclosure or *gas cabinet*.
3. For flammable gases, the monitoring detection threshold level shall be vapor concentrations in excess of 25 percent of the lower flammable limit (LFL) where the monitoring is within or outside an *exhausted enclosure*, ventilated enclosure or *gas cabinet*.
4. Except as noted in this section, monitoring for *highly toxic* and toxic gases shall also comply with Chapter 60 of the *International Fire Code*.

**[F] 415.11.8.2.1 Alarms.** The *gas detection system* shall initiate a local alarm and transmit a signal to the *emergency control station* when a short-term hazard condition is detected. The alarm shall be both visual and audible and shall provide warning both inside and outside the area where the gas is detected. The audible alarm shall be distinct from all other alarms.

**[F] 415.11.8.2.2 Shutoff of gas supply.** The gas detection system shall automatically close the shutoff valve at the source on gas supply piping and tubing related to the system being monitored for which gas is detected when a short-term hazard condition is detected. Automatic closure of shutoff valves shall comply with the following:

1. Where the gas detection sampling point initiating the gas detection system alarm is

within a *gas cabinet* or *exhausted enclosure*, the shutoff valve in the *gas cabinet* or *exhausted enclosure* for the specific gas detected shall automatically close.

2. Where the gas detection sampling point initiating the gas detection system alarm is within a room and compressed gas containers are not in gas cabinets or an *exhausted enclosure*, the shutoff valves on all gas lines for the specific gas detected shall automatically close.
3. Where the gas detection sampling point initiating the gas detection system alarm is within a piping distribution manifold enclosure, the shutoff valve supplying the manifold for the compressed gas container of the specific gas detected shall automatically close.

**Exception:** Where the gas detection sampling point initiating the gas detection system alarm is at the use location or within a gas valve enclosure of a branch line downstream of a piping distribution manifold, the shutoff valve for the branch line located in the piping distribution manifold enclosure shall automatically close.

**[F] 415.11.9 Manual fire alarm system.** An *approved* manual *fire alarm* system shall be provided throughout buildings containing Group H-5. Activation of the alarm system shall initiate a local alarm and transmit a signal to the *emergency control station*. The *fire alarm* system shall be designed and installed in accordance with Section 907.

**[F] 415.11.10 Emergency control station.** An *emergency control station* shall be provided in accordance with Sections 415.11.10.1 through 415.11.10.3.

**[F] 415.11.10.1 Location.** The *emergency control station* shall be located on the premises at an *approved* location outside the *fabrication area*.

**[F] 415.11.10.2 Staffing.** Trained personnel shall continuously staff the *emergency control station*.

**[F] 415.11.10.3 Signals.** The *emergency control station* shall receive signals from emergency equipment and alarm and detection systems. Such emergency equipment and alarm and detection systems shall include, but not be limited to, the following where such equipment or systems are required to be provided either in this chapter or elsewhere in this code:

1. *Automatic sprinkler system* alarm and monitoring systems.
2. *Manual fire alarm* systems.
3. *Emergency alarm* systems.
4. *Gas detection* systems.
5. Smoke detection systems.
6. Emergency power system.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

7. Automatic detection and alarm systems for *pyrophoric* liquids and Class 3 water-reactive liquids required in Section 2705.2.3.4 of the *International Fire Code*.
8. Exhaust *ventilation* flow alarm devices for *pyrophoric* liquids and Class 3 water-reactive liquids cabinet exhaust *ventilation* systems required in Section 2705.2.3.4 of the *International Fire Code*.

**[F] 415.11.11 Emergency power system.** An emergency power system shall be provided in Group H-5 occupancies in accordance with Section 2702. The emergency power system shall supply power automatically to the electrical systems specified in Section 415.11.11.1 when the normal electrical supply system is interrupted.

**[F] 415.11.11.1 Required electrical systems.** Emergency power shall be provided for electrically operated equipment and connected control circuits for the following systems:

1. HPM exhaust *ventilation* systems.
2. HPM gas cabinet *ventilation* systems.
3. HPM exhausted enclosure *ventilation* systems.
4. HPM gas room *ventilation* systems.
5. HPM gas detection systems.
6. *Emergency alarm* systems.
7. Manual and automatic *fire alarm* systems.
8. *Automatic sprinkler* system monitoring and alarm systems.
9. Automatic alarm and detection systems for *pyrophoric* liquids and Class 3 water-reactive liquids required in Section 2705.2.3.4 of the *International Fire Code*.
10. Flow alarm switches for *pyrophoric* liquids and Class 3 water-reactive liquids cabinet exhaust *ventilation* systems required in Section 2705.2.3.4 of the *International Fire Code*.
11. Electrically operated systems required elsewhere in this code or in the *International Fire Code* applicable to the use, storage or handling of HPM.

**[F] 415.11.11.2 Exhaust ventilation systems.** Exhaust *ventilation* systems are allowed to be designed to operate at not less than one-half the normal fan speed on the emergency power system where it is demonstrated that the level of exhaust will maintain a safe atmosphere.

**[F] 415.11.12 Automatic sprinkler system protection in exhaust ducts for HPM.** An *approved automatic sprinkler* system shall be provided in exhaust ducts conveying gases, vapors, fumes, mists or dusts generated from HPM in accordance with Sections 415.11.12.1 through 415.11.12.3 and the *International Mechanical Code*.

**[F] 415.11.12.1 Metallic and noncombustible nonmetallic exhaust ducts.** An *approved automatic sprinkler* system shall be provided in metallic and noncombustible

nonmetallic exhaust ducts where all of the following conditions apply:

1. Where the largest cross-sectional diameter is equal to or greater than 10 inches (254 mm).
2. The ducts are within the building.
3. The ducts are conveying flammable gases, vapors or fumes.

**[F] 415.11.12.2 Combustible nonmetallic exhaust ducts.** *Automatic sprinkler* system protection shall be provided in combustible nonmetallic exhaust ducts where the largest cross-sectional diameter of the duct is equal to or greater than 10 inches (254 mm).

**Exception:** Ducts need not be provided with automatic sprinkler protection as follows:

1. Ducts *listed* or *approved* for applications without *automatic sprinkler* system protection.
2. Ducts not more than 12 feet (3658 mm) in length installed below ceiling level.

**[F] 415.11.12.3 Automatic sprinkler locations.** Sprinkler systems shall be installed at 12-foot (3658 mm) intervals in horizontal ducts and at changes in direction. In vertical ducts, sprinklers shall be installed at the top and at alternate floor levels.

## SECTION 416

## SPRAY APPLICATION OF FLAMMABLE FINISHES

**[F] 416.1 General.** The provisions of this section shall apply to the construction, installation and use of buildings and structures, or parts thereof, for the spray application of flammable finishes. Operations and equipment shall comply with the *International Fire Code*.

**[F] 416.2 Spray rooms.** *Spray rooms* shall be enclosed with not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. Floors shall be water-proofed and drained in an *approved* manner.

**[F] 416.2.1 Construction.** Walls and ceilings of *spray rooms* shall be constructed of noncombustible materials or the interior surface shall be completely covered with noncombustible materials. Aluminum shall not be used.

**[F] 416.2.2 Surfaces.** The *interior surfaces* of *spray rooms* shall be smooth and shall be so constructed to permit the free passage of exhaust air from all parts of the interior and to facilitate washing and cleaning, and shall be so designed to confine residues within the room.

**[F] 416.2.3 Ventilation.** Mechanical *ventilation* and interlocks with the spraying operation shall be in accordance with the *International Fire Code* and *International Mechanical Code*.

**[F] 416.3 Spraying spaces.** Spraying spaces shall be ventilated with an exhaust system to prevent the accumulation of flammable mist or vapors in accordance with the *International Mechanical Code*. Where such spaces are not

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

separately enclosed, noncombustible spray curtains shall be provided to restrict the spread of flammable vapors.

**[F] 416.3.1 Surfaces.** The *interior surfaces* of spraying spaces shall be smooth; shall be so constructed to permit the free passage of exhaust air from all parts of the interior and to facilitate washing and cleaning; and shall be so designed to confine residues within the spraying space. Aluminum shall not be used.

**[F] 416.4 Spray booths.** Spray booths shall be designed, constructed and operated in accordance with the *International Fire Code*.

**[F] 416.5 Fire protection.** An *automatic sprinkler system* or *fire-extinguishing system* shall be provided in all spray rooms and spray booths, and shall be installed in accordance with Chapter 9.

### SECTION 417 DRYING ROOMS

**[F] 417.1 General.** A drying room or dry kiln installed within a building shall be constructed entirely of *approved* noncombustible materials or assemblies of such materials regulated by the *approved* rules or as required in the general and specific sections of this chapter for special occupancies and where applicable to the general requirements of the *International Mechanical Code*.

**[F] 417.2 Piping clearance.** Overhead heating pipes shall have a clearance of not less than 2 inches (51 mm) from combustible contents in the dryer.

**[F] 417.3 Insulation.** Where the operating temperature of the dryer is 175°F (79°C) or more, metal enclosures shall be insulated from adjacent combustible materials by not less than 12 inches (305 mm) of airspace, or the metal walls shall be lined with 1/4-inch (6.4 mm) insulating mill board or other approved equivalent insulation.

**[F] 417.4 Fire protection.** Drying rooms designed for high-hazard materials and processes, including special occupancies as provided for in Chapter 4, shall be protected by an *approved automatic fire-extinguishing system* complying with the provisions of Chapter 9.

### SECTION 418 ORGANIC COATINGS

**[F] 418.1 Building features.** Manufacturing of organic coatings shall be done only in buildings that do not have pits or basements.

**[F] 418.2 Location.** Organic coating manufacturing operations and operations incidental to or connected therewith shall not be located in buildings having other occupancies.

**[F] 418.3 Process mills.** Mills operating with close clearances and that process flammable and heat-sensitive materials, such as nitrocellulose, shall be located in a *detached building* or noncombustible structure.

**[F] 418.4 Tank storage.** Storage areas for *flammable and combustible liquid* tanks inside of structures shall be located

at or above grade and shall be separated from the processing area by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 418.5 Nitrocellulose storage.** Nitrocellulose storage shall be located on a detached pad or in a separate structure or a room enclosed with not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 418.6 Finished products.** Storage rooms for finished products that are *flammable or combustible liquids* shall be separated from the processing area by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

\*

### SECTION 419 ARTIFICIAL DECORATIVE VEGETATION

**[F] 419.1 Artificial decorative vegetation.** Artificial decorative vegetation exceeding 6 feet (1830 mm) in height and permanently installed outdoors within 5 feet (1524 mm) of a building, or on the roof of a building, shall comply with Section 321.1 of the *International Fire Code*.

**Exception:** Artificial decorative vegetation located more than 30 feet (9144 mm) from the exterior wall of a building.

### SECTION 420 GROUPS I-1, R-1, R-2, R-3 AND R-4

**420.1 General.** Occupancies in Groups I-1, R-1, R-2, R-3 and R-4 shall comply with the provisions of Sections 420.1 through 420.11 and other applicable provisions of this code.

**420.2 Separation walls.** Walls separating *dwelling units* in the same building, walls separating *sleeping units* in the same building and walls separating *dwelling* or *sleeping units* from other occupancies contiguous to them in the same building shall be constructed as *fire partitions* in accordance with Section 708.

**420.3 Horizontal separation.** Floor assemblies separating *dwelling units* in the same buildings, floor assemblies separating *sleeping units* in the same building and floor assemblies separating *dwelling* or *sleeping units* from other occupancies contiguous to them in the same building shall be constructed as *horizontal assemblies* in accordance with Section 711.

**[F] 420.4 Automatic sprinkler system.** Group R occupancies shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.8. Group I-1 occupancies shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.2.6. Quick-response or residential *automatic* sprinklers shall be installed in accordance with Section 903.3.2.

**[F] 420.5 Fire alarm systems and smoke alarms.** *Fire alarm* systems and smoke alarms shall be provided in Group

I-1, R-1 and R-2 occupancies in accordance with Sections 907.2.6, 907.2.8 and 907.2.9, respectively. Single- or multiple-station smoke alarms shall be provided in Groups I-1, R-2, R-3 and R-4 in accordance with Section 907.2.11.

**420.6 Smoke barriers in Group I-1, Condition 2.** *Smoke barriers* shall be provided in Group I-1, Condition 2 to subdivide every *story* used by persons receiving care, treatment or sleeping and to provide other *stories* with an *occupant load* of 50 or more persons, into not fewer than two *smoke compartments*. Such *stories* shall be divided into *smoke compartments* with an area of not more than 22,500 square feet (2092 m<sup>2</sup>) and the distance of travel from any point in a *smoke compartment* to a *smoke barrier* door shall not exceed 200 feet (60 960 mm). The *smoke barrier* shall be in accordance with Section 709.

**420.6.1 Refuge area.** Refuge areas shall be provided within each *smoke compartment*. The size of the refuge area shall accommodate the occupants and care recipients from the adjoining *smoke compartment*. Where a *smoke compartment* is adjoined by two or more *smoke compartments*, the minimum area of the refuge area shall accommodate the largest occupant load of the adjoining compartments. The size of the refuge area shall provide the following:

1. Not less than 15 net square feet (1.4 m<sup>2</sup>) for each care recipient.
2. Not less than 6 net square feet (0.56 m<sup>2</sup>) for other occupants.

Areas or spaces permitted to be included in the calculation of the refuge area are corridors, lounge or dining areas and other low-hazard areas.

**420.7 Group I-1 assisted living housing units.** In Group I-1 occupancies, where a *fire-resistance corridor* is provided in areas where assisted living residents are housed, shared living spaces, group meeting or multipurpose therapeutic spaces open to the *corridor* shall be in accordance with all of the following criteria:

1. The walls and ceilings of the space are constructed as required for *corridors*.
2. The spaces are not occupied as resident sleeping rooms, treatment rooms, incidental uses in accordance with Section 509, or hazardous uses.
3. The open space is protected by an *automatic* fire detection system installed in accordance with Section 907.
4. In Group I-1, Condition 1, the *corridors* onto which the spaces open are protected by an *automatic* fire detection system installed in accordance with Section 907, or the spaces are equipped throughout with quick-response sprinklers in accordance with Section 903.3.2.
5. In Group I-1, Condition 2, the *corridors* onto which the spaces open, in the same *smoke compartment*, are protected by an *automatic* fire detection system installed in accordance with Section 907, or the *smoke compartment* in which the spaces are located

is equipped throughout with quick-response sprinklers in accordance with Section 903.3.2.

6. The space is arranged so as not to obstruct access to the required *exits*.

**420.8 Group I-1 cooking facilities.** In Group I-1 occupancies, rooms or spaces that contain a cooking facility with domestic cooking appliances shall be permitted to be open to the *corridor* where all of the following criteria are met:

1. In Group I-1, Condition 1 occupancies, the number of care recipients served by one cooking facility shall not be greater than 30.
2. In Group I-1, Condition 2 occupancies, the number of care recipients served by one cooking facility and within the same *smoke compartment* shall not be greater than 30.
3. The space containing the cooking facilities shall be arranged so as not to obstruct access to the required *exit*.
4. The cooking appliances shall comply with Section 420.9.

**420.9 Domestic cooking appliances.** In Group I-1 occupancies, installation of cooking appliance used in domestic cooking facilities shall comply with all of the following:

1. The types of cooking appliances permitted shall be limited to ovens, cooktops, ranges, warmers and microwaves.
2. Domestic cooking hoods installed and constructed in accordance with Section 505 of the International Mechanical Code shall be provided over cooktops or ranges.
3. Cooktops and ranges shall be protected in accordance with Section 904.14.
4. A shutoff for the fuel and electrical supply to the cooking equipment shall be provided in a location to which only staff has access.
5. A timer shall be provided that automatically deactivates the cooking appliances within a period of not more than 120 minutes.
6. A portable fire extinguisher shall be provided. Installation shall be in accordance with Section 906 and the extinguisher shall be located within a 30-foot (9144 mm) distance of travel from each domestic cooking appliance.

#### Exceptions:

1. Cooking facilities provided within care recipients' individual *dwelling units* are not required to comply with this section.
2. Cooktops and ranges used for care-recipient training or nutritional counseling are not required to comply with Item 3 of this section

**420.10 Group R cooking facilities.** In Group R occupancies, cooking appliances used for domestic cooking operations shall be in accordance with Section 917.2 of the *International Mechanical Code*.



## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**420.11 Group R-2 dormitory cooking facilities.** Domestic cooking appliances for use by residents of Group R-2 college dormitories shall be in accordance with Sections 420.11.1 and 420.11.2.

**420.11.1 Cooking appliances.** Where located in Group R-2 college dormitories, domestic cooking appliances for use by residents shall be in compliance with all of the following:

1. The types of domestic cooking appliances shall be limited to ovens, cooktops, ranges, warmers, coffee makers and microwaves.
2. Domestic cooking appliances shall be limited to approved locations.
3. Cooktops and ranges shall be protected in accordance with Section 904.14.
4. Cooktops and ranges shall be provided with a domestic cooking hood installed and constructed in accordance with Section 505 of the *International Mechanical Code*.

**420.11.2 Cooking appliances in sleeping rooms.** Cooktops, ranges and ovens shall not be installed or used in sleeping rooms.

### SECTION 421 HYDROGEN FUEL GAS ROOMS

**[F] 421.1 General.** Where required by the *International Fire Code*, hydrogen fuel gas rooms shall be designed and constructed in accordance with Sections 421.1 through 421.7.

**[F] 421.2 Location.** Hydrogen fuel gas rooms shall not be located below grade.

**[F] 421.3 Design and construction.** Hydrogen fuel gas rooms not classified as Group H shall be separated from other areas of the building in accordance with Section 509.1.

**[F] 421.3.1 Pressure control.** Hydrogen fuel gas rooms shall be provided with a ventilation system designed to maintain the room at a negative pressure in relation to surrounding rooms and spaces.

**[F] 421.3.2 Windows.** Operable windows in interior walls shall not be permitted. Fixed windows shall be permitted where in accordance with Section 716.

**[F] 421.4 Exhaust ventilation.** Hydrogen fuel gas rooms shall be provided with mechanical exhaust ventilation in accordance with the applicable provisions of Section 502.16.1 of the *International Mechanical Code*.

**[F] 421.5 Gas detection system.** Hydrogen fuel gas rooms shall be provided with a gas detection system that complies with Sections 421.5.1, 421.5.2, and 916.

**[F] 421.5.1 System activation.** Activation of a gas detection alarm shall result in both of the following:

1. Initiation of distinct audible and visible alarm signals both inside and outside of the hydrogen fuel gas room.

2. Automatic activation of the mechanical exhaust ventilation system.

**[F] 421.5.2 Failure of the gas detection system.** Failure of the gas detection system shall automatically activate the mechanical exhaust ventilation system, stop hydrogen generation, and cause a trouble signal to sound at an approved location.

**[F] 421.6 Explosion control.** Explosion control shall be provided where required by Section 414.5.1.

**[F] 421.7 Standby power.** Mechanical ventilation and gas detection systems shall be provided with a standby power system in accordance with Section 2702.

### SECTION 422 AMBULATORY CARE FACILITIES

**422.1 General.** Occupancies classified as ambulatory care facilities shall comply with the provisions of Sections 422.1 through 422.6 and other applicable provisions of this code.

**422.2 Separation.** Ambulatory care facilities where the potential for four or more care recipients are to be incapable of self-preservation at any time shall be separated from adjacent spaces, corridors or tenants with a fire partition installed in accordance with Section 708.

**422.3 Smoke compartments.** Where the aggregate area of one or more ambulatory care facilities is greater than 10,000 square feet (929 m<sup>2</sup>) on one story, the story shall be provided with a smoke barrier to subdivide the story into not fewer than two smoke compartments. The area of any one such smoke compartment shall be not greater than 22,500 square feet (2092 m<sup>2</sup>). The distance of travel from any point in a smoke compartment to a smoke barrier door shall be not greater than 200 feet (60 960 mm). The smoke barrier shall be installed in accordance with Section 709 with the exception that smoke barriers shall be continuous from outside wall to an outside wall, a floor to a floor, or from a smoke barrier to a smoke barrier or a combination thereof.

**422.3.1 Means of egress.** Where ambulatory care facilities require smoke compartmentation in accordance with Section 422.3, the fire safety evacuation plans provided in accordance with Section 1002.2 shall identify the building components necessary to support a defend-in-place emergency response in accordance with Sections 403 and 404 of the *International Fire Code*.

**422.3.2 Refuge area.** Not less than 30 net square feet (2.8 m<sup>2</sup>) for each nonambulatory care recipient shall be provided within the aggregate area of corridors, care recipient rooms, treatment rooms, lounge or dining areas and other low-hazard areas within each smoke compartment. Each occupant of an ambulatory care facility shall be provided with access to a refuge area without passing through or utilizing adjacent tenant spaces.

**422.3.3 Independent egress.** A means of egress shall be provided from each smoke compartment created by smoke barriers without having to return through the smoke compartment from which means of egress originated.



[F] **422.4 Automatic sprinkler systems.** *Automatic sprinkler systems* shall be provided for *ambulatory care facilities* in accordance with Section 903.2.2.

[F] **422.5 Fire alarm systems.** A *fire alarm system* shall be provided for *ambulatory care facilities* in accordance with Section 907.2.2.

[F] **422.6 Electrical systems.** In *ambulatory care facilities*, the essential electrical system for electrical components, equipment and systems shall be designed and constructed in accordance with the provisions of Chapter 27 and NFPA 99.

**422.7 Domestic cooking.** Installation of cooking appliances used in domestic cooking facilities shall comply with all of the following:

1. The types of cooking appliances permitted are limited to ovens, cooktops, ranges, warmers and microwaves.
2. Domestic cooking hoods installed and constructed in accordance with Section 505 of the International Mechanical Code shall be provided over cooktops or ranges.
3. A shutoff for the fuel and electrical supply to the cooking equipment shall be provided in a location to which only staff has access.
4. A timer shall be provided that automatically deactivates the cooking appliances within a period of not more than 120 minutes.
5. A portable fire extinguisher shall be provided. Installation shall be in accordance with Section 906 and the extinguisher shall be located within a 30-foot (9144 mm) distance of travel from each domestic cooking appliance.

## SECTION 423 STORM SHELTERS

**423.1 General.** This section applies to the construction of storm shelters constructed as separate detached buildings or constructed as rooms or spaces within buildings for the purpose of providing protection from storms that produce high winds, such as tornadoes and hurricanes, during the storm. This section specifies where *storm shelters* are required and provides requirements for the design and construction of *storm shelters*. Design of facilities for use as emergency shelters after the storm are outside the scope of ICC 500 and shall comply with Table 1604.5 as a *Risk Category IV Structure*.

**423.2 Construction.** *Storm shelters* shall be constructed in accordance with this code and ICC 500 and shall be designated as hurricane shelters, tornado shelters, or combined hurricane and tornado shelters. Buildings or structures that are also designated as emergency shelters shall also comply with Table 1604.5 as *Risk Category IV structures*.

Any *storm shelter* not required by this section shall be permitted to be constructed, provided that such structures meet the requirements of this code and ICC 500.

**423.3 Occupancy classification.** The occupancy classification for a *storm shelter* shall be determined in accordance with this section.

**423.3.1 Dedicated storm shelters.** A facility designed to be occupied solely as a *storm shelter* shall be classified as Group A-3 for the determination of requirements other than those covered in ICC 500.

### Exceptions:

1. The occupancy category for dedicated storm shelters with an occupant load of fewer than 50 persons as determined in accordance with ICC 500 shall be in accordance with Section 303.
2. The occupancy category for a dedicated residential storm shelter shall be the Group R occupancy served.

**423.3.2 Storm shelters within host buildings.** Where designated *storm shelters* are constructed as a room or space within a host building that will normally be occupied for other purposes, the requirements of this code for the occupancy of the building, or the individual rooms or spaces thereof, shall apply unless otherwise required by ICC 500.

**423.4 Critical emergency operations.** In areas where the shelter design wind speed for tornados in accordance with Figure 304.2(1) of ICC 500 is 250 mph, 911 call stations, emergency operation centers and fire, rescue, ambulance and police stations shall comply with Table 1604.5 as a *Risk Category IV structure* and shall be provided with a *storm shelter* constructed in accordance with ICC 500.

**423.5 Group E occupancies.** In areas where the shelter design wind speed for tornados is 250 mph in accordance with Figure 304.2(1) of ICC 500, all Group E occupancies with an *occupant load* of 50 or more shall have a storm shelter constructed in accordance with ICC 500.

### Exceptions:

1. Group E day care facilities.
2. Group E occupancies accessory to *places of religious worship*.
3. Buildings meeting the requirements for shelter design in ICC 500.

**423.5.1 Required occupant capacity.** The required occupant capacity of the *storm shelter* shall include all of the buildings on the site and shall be the greater of the following:

1. The total *occupant load* of the classrooms, vocational rooms and offices in the Group E occupancy.
2. The *occupant load* of the largest indoor assembly space that is associated with the Group E occupancy.

### Exceptions:

1. Where a new building is being added on an existing Group E site, and where the new building is not of sufficient size to

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

accommodate the required occupant capacity of the *storm shelter* for all of the buildings on the site, the storm shelter shall at a minimum accommodate the required occupant capacity for the new building.

2. Where approved by the *building official*, the required occupant capacity of the shelter shall be permitted to be reduced by the occupant capacity of any existing *storm shelters* on the site.

**423.5.2 Location.** Storm shelters shall be located within the buildings they serve or shall be located where the maximum distance of travel from not fewer than one exterior door of each building to a door of the shelter serving that building does not exceed 1,000 feet (305 m).

## SECTION 424 PLAY STRUCTURES

**424.1 General.** Play structures installed inside all occupancies covered by this code that exceed 10 feet (3048 mm) in height or 150 square feet (14 m<sup>2</sup>) in area shall comply with Sections 424.2 through 424.5.

**424.2 Materials.** Play structures shall be constructed of noncombustible materials or of combustible materials that comply with the following:

1. *Fire-retardant-treated* wood complying with Section 2303.2.
2. Light-transmitting plastics complying with Section 2606.
3. Foam plastics (including the pipe foam used in *soft-contained play equipment structures*) having a maximum heat-release rate not greater than 100 kilowatts when tested in accordance with UL 1975 or when tested in accordance with NFPA 289, using the 20 kW ignition source.
4. Aluminum composite material (ACM) meeting the requirements of Class A *interior finish* in accordance with Chapter 8 when tested as an assembly in the maximum thickness intended for use.
5. Textiles and films complying with the fire propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
6. Plastic materials used to construct rigid components of *soft-contained play equipment structures* (such as tubes, windows, panels, junction boxes, pipes, slides and decks) exhibiting a peak rate of heat release not exceeding 400 kW/m<sup>2</sup> when tested in accordance with ASTM E1354 at an incident heat flux of 50 kW/m<sup>2</sup> in the horizontal orientation at a thickness of 6 mm.
7. Ball pool balls, used in *soft-contained play equipment structures*, having a maximum heat-release rate not greater than 100 kilowatts when tested in accordance with UL 1975 or when tested in accordance with NFPA 289, using the 20 kW ignition source. The minimum specimen test size shall be 36 inches

by 36 inches (914 mm by 914 mm) by an average of 21 inches (533 mm) deep, and the balls shall be held in a box constructed of galvanized steel poultry netting wire mesh.

8. Foam plastics shall be covered by a fabric, coating or film meeting the fire propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
9. The floor covering placed under the children's *play structure* shall exhibit a Class I *interior floor finish* classification, as described in Section 804, when tested in accordance with ASTM E648 or NFPA 253.
10. Interior finishes for structures exceeding 600 square feet (56 m<sup>2</sup>) in area or 10 feet (3048 mm) in height shall have a flame spread index not greater than that specified in Table 803.13 for the occupancy group and location designated. Interior wall and ceiling finish materials tested in accordance with NFPA 286 and meeting the acceptance criteria of Section 803.1.1.1, shall be permitted to be used where a Class A classification in accordance with ASTM E84 or UL 723 is required.

**[F] 424.3 Fire protection.** Play structures shall be provided with the same level of *approved* fire suppression and detection devices required for other structures in the same occupancy.

**424.4 Separation.** Play structures shall have a horizontal separation from building walls, partitions and from elements of the *means of egress* of not less than 5 feet (1524 mm). Play structures shall have a horizontal separation from other *play structures* of not less than 20 feet (6090 mm).

**424.5 Area limits.** Play structures shall be not greater than 600 square feet (56 m<sup>2</sup>) in area, unless a special investigation, acceptable to the *building official*, has demonstrated adequate fire safety.

**424.5.1 Design.** *Play structures* exceeding 600 square feet (56 m<sup>2</sup>) in area or 10 feet (3048 mm) in height shall be designed in accordance with Chapter 16.

## SECTION 425 HYPERBARIC FACILITIES

**425.1 Hyperbaric facilities.** Hyperbaric facilities shall meet the requirements contained in Chapter 14 of NFPA 99.

## SECTION [F] 426 COMBUSTIBLE DUSTS, GRAIN PROCESSING AND STORAGE

**[F] 426.1 General.** The provisions of Sections 426.1.1 through 426.1.7 shall apply to buildings in which materials that produce *combustible dusts* are stored or handled. Buildings that store or handle *combustible dusts* shall comply with the applicable provisions of the *International Fire Code*. Where required by the fire code official, NFPA 652 and the applicable provisions of NFPA 61, NFPA 85, NFPA 120, NFPA 484, NFPA 654, NFPA 655 and NFPA 664 shall apply.

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

**[F] 426.1.1 Type of construction and height exceptions.** Buildings shall be constructed in compliance with the height, number of *stories* and area limitations specified in Sections 504 and 506; except that where erected of Type I or II construction, the heights and areas of grain elevators and similar structures shall be unlimited, and where of Type IV construction, the maximum *building height* shall be 65 feet (19 812 mm) and except further that, in isolated areas, the maximum *building height* of Type IV structures shall be increased to 85 feet (25 908 mm).

**[F] 426.1.2 Grinding rooms.** Every room or space occupied for grinding or other operations that produce *combustible dusts* in such a manner that the room or space is classified as a Group H-2 occupancy shall be enclosed with *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire-resistance rating* of the enclosure shall be not less than 2 hours where the area is not more than 3,000 square feet (279 m<sup>2</sup>), and not less than 4 hours where the area is greater than 3,000 square feet (279 m<sup>2</sup>).

**[F] 426.1.3 Conveyors.** Conveyors, chutes, piping and similar equipment passing through the enclosures of rooms or spaces shall be constructed dirt tight and vapor tight, and be of *approved* noncombustible materials complying with Chapter 30.

**[F] 426.1.4 Explosion control.** *Explosion* control shall be provided as specified in the *International Fire Code*, or spaces shall be equipped with the equivalent mechanical *ventilation* complying with the *International Mechanical Code*.

**[F] 426.1.5 Grain elevators.** Grain elevators, malt houses and buildings for similar occupancies shall not be located within 30 feet (9144 mm) of interior *lot lines* or structures on the same *lot*, except where erected along a railroad right-of-way.

**[F] 426.1.6 Coal pockets.** Coal pockets located less than 30 feet (9144 mm) from interior *lot lines* or from structures on the same *lot* shall be constructed of not less than Type IB construction. Where more than 30 feet (9144 mm) from interior *lot lines*, or where erected along a railroad right-of-way, the minimum type of construction of such structures not more than 65 feet (19 812 mm) in *building height* shall be Type IV.

**[F] 426.1.7 Tire rebuilding.** Buffing operations shall be located in a room separated from the remainder of the building housing the tire rebuilding or tire recapping operation by a 1-hour *fire barrier*.

**Exception:** Buffing operations are not required to be separated where all of the following conditions are met:

1. Buffing operations are equipped with an *approved* continuous automatic water-spray system directed at the point of cutting action.
2. Buffing machines are connected to particle-collecting systems providing a minimum air

movement of 1,500 cubic feet per minute (cfm) (0.71 m<sup>3</sup>/s) in volume and 4,500 feet per minute (fpm) (23 m/s) in-line velocity.

3. The collecting system shall discharge the rubber particles to an *approved* outdoor noncombustible or fire-resistant container, which is emptied at frequent intervals to prevent overflow.

## SECTION 427 MEDICAL GAS SYSTEMS

**[F] 427.1 General.** Medical gases at health care-related facilities intended for patient or veterinary care shall comply with Sections 427.2 through 427.2.3 in addition to requirements of Chapter 53 of the *International Fire Code*.

**[F] 427.2 Interior supply location.** Medical gases shall be located in areas dedicated to the storage of such gases without other storage or uses. Where containers of medical gases in quantities greater than the permitted amount are located inside the buildings, they shall be located in a 1-hour exterior room, 1-hour interior room or a *gas cabinet* in accordance with Section 427.2.1, 427.2.2 or 427.2.3, respectively. Rooms or areas where medical gases are stored or used in quantities exceeding the maximum allowable quantity per control area as set forth in TABLE 307.1(1) and [F] TABLE 307.1(2) shall be in accordance with Group H occupancies.

**[F] 427.2.1 One-hour exterior room.** A 1-hour exterior room shall be a room or enclosure separated from the remainder of the building by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both, with a *fire-resistance rating* of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be provided with *self-closing* smoke- and draft-control assemblies having a *fire protection rating* of not less than 1 hour. Rooms shall have not less than one *exterior wall* that is provided with not less than two vents. Each vent shall have a minimum free air opening of not less than 36 square inches (232 cm<sup>2</sup>) for each 1,000 cubic feet (28 m<sup>3</sup>) at normal temperature and pressure (NTP) of gas stored in the room and shall be not less than 72 square inches (465 cm<sup>2</sup>) in aggregate free opening area. One vent shall be within 6 inches (152 mm) of the floor and one shall be within 6 inches (152 mm) of the ceiling. Rooms shall be provided with not fewer than one automatic fire sprinkler to provide container cooling in case of fire.

**[F] 427.2.2 One-hour interior room.** Where an *exterior wall* cannot be provided for the room, a 1-hour interior room shall be provided and shall be a room or enclosure separated from the remainder of the building by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both, with a *fire-resistance rating* of not less than 1 hour. Openings between the room or enclosure and interior spaces shall be provided with *self-closing* smoke- and draft-control assemblies having a *fire protection rating* of not less than 1 hour. An *automatic sprinkler*

## SPECIAL DETAILED REQUIREMENTS BASED ON OCCUPANCY AND USE

system shall be installed within the room. The room shall be exhausted through a duct to the exterior. Supply and exhaust ducts shall be enclosed in a 1-hour rated *shaft enclosure* from the room to the exterior. Approved mechanical *ventilation* shall comply with the *International Mechanical Code* and be provided with a minimum rate of 1 cubic foot per minute per square foot (0.00508 m<sup>3</sup>/s/m<sup>2</sup>) of the area of the room.

**[F] 427.2.3 Gas cabinets.** Gas cabinets shall be constructed in accordance with Section 5003.8.6 of the *International Fire Code* and shall comply with the following:

1. Cabinets shall be exhausted to the exterior through a dedicated exhaust duct system installed in accordance with Chapter 5 of the *International Mechanical Code*.
2. Supply and exhaust ducts shall be enclosed in a 1-hour rated *shaft enclosure* from the cabinet to the exterior. The average velocity of *ventilation* at the face of access ports or windows shall be not less than 200 feet per minute (1.02 m/s) with a minimum of 150 feet per minute (0.76 m/s) at any point of the access port or window.
3. Cabinets shall be provided with an *automatic sprinkler system* internal to the cabinet.

### SECTION 428 HIGHER EDUCATION LABORATORIES

**[F] 428.1 Scope.** Higher education laboratories complying with the requirements of Sections 428.1 through 428.4 shall be permitted to exceed the maximum allowable quantities of *hazardous materials* in *control areas* set forth in Tables 307.1(1) and [F] 307.1(2) without requiring classification as a Group H occupancy. Except as specified in Section 428,

such laboratories shall comply with all applicable provisions of this code and the *International Fire Code*.

**[F] 428.2 Application.** The provisions of Section 428 shall be applied as exceptions or additions to applicable requirements of this code. Unless specifically modified by Section 428, the storage, *use* and handling of *hazardous materials* shall comply with all other provisions in Chapters 38 and 50 through 67 of the *International Fire Code* and this code for quantities not exceeding the maximum allowable quantity.

**[F] 428.3 Laboratory suite construction.** Where *laboratory suites* are provided, they shall be constructed in accordance with this section and Chapter 38 of the *International Fire Code*. The number of *laboratory suites* and percentage of maximum allowable quantities of *hazardous materials* in *laboratory suites* shall be in accordance with Table 428.3.

**[F] 428.3.1 Separation from other nonlaboratory areas.** *Laboratory suites* shall be separated from other portions of the building in accordance with the most restrictive of the following:

1. *Fire barriers* and *horizontal assemblies* as required in Table 428.3. *Fire barriers* shall be constructed in accordance with Section 707 and *horizontal assemblies* constructed in accordance with Section 711.

**Exception:** Where an individual *laboratory suite* occupies more than one *story*, the *fire-resistance rating* of intermediate floors contained within the *laboratory suite* shall comply with the requirements of this code.

2. Separations as required by Section 508.

**[F] 428.3.2 Separation from other laboratory suites.** *Laboratory suites* shall be separated from other *laboratory suites* in accordance with Table 428.3.

**[F] TABLE 428.3  
DESIGN AND NUMBER OF LABORATORY SUITES PER FLOOR**

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER LAB SUITE <sup>a</sup>	NUMBER OF LAB SUITES PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS <sup>b</sup>
Above Grade Plane	21+	Not allowed	Not Permitted	Not Permitted
	16-20	25	1	2 <sup>c</sup>
	11-15	50	1	2 <sup>c</sup>
	7-10	50	2	2 <sup>c</sup>
	4-6	75	4	1
	3	100	4	1
	1-2	100	6	1
Below Grade Plane	1	75	4	1
	2	50	2	1
	Lower than 2	Not Allowed	Not Allowed	Not Allowed

- a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 307.1(1) and 307.1(2), with all increases allowed in the footnotes to those tables.
- b. Fire barriers shall include walls, floors and ceilings necessary to provide separation from other portions of the building.
- c. Vertical fire barriers separating laboratory suites from other spaces on the same floor shall be permitted to be 1-hour fire-resistance rated.



**[F] 428.3.3 Floor assembly fire resistance.** The floor assembly supporting *laboratory suites* and the construction supporting the floor of *laboratory suites* shall have a *fire-resistance rating* of not less than 2 hours.

**Exception:** The floor assembly of the *laboratory suites* and the construction supporting the floor of the *laboratory suites* are allowed to be 1-hour *fire-resistance* rated in buildings of Types IIA, IIIA and VA construction, provided that the building is three or fewer *stories*.

**[F] 428.3.4 Maximum number.** The maximum number of *laboratory suites* shall be in accordance with Table 428.3. Where a building contains both *laboratory suites* and *control areas*, the total number of *laboratory suites* and *control areas* within a building shall not exceed the maximum number of *laboratory suites* in accordance with Table 428.3.

**[F] 428.3.5 Means of egress.** *Means of egress* shall be in accordance with Chapter 10.

**[F] 428.3.6 Standby or emergency power.** Standby or emergency power shall be provided in accordance with Section 414.5.2 where *laboratory suites* are located above the sixth *story above grade plane* or located in a *story* below *grade plane*.

**[F] 428.3.7 Ventilation.** *Ventilation* shall be in accordance with Chapter 7 of NFPA 45, and the *International Mechanical Code*.

**[F] 428.3.8 Liquid-tight floor.** Portions of *laboratory suites* where *hazardous materials* are present shall be provided with a liquid-tight floor.

**[F] 428.3.9 Automatic sprinkler systems.** Buildings containing *laboratory suites* shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[F] 428.4 Percentage of maximum allowable quantity in each laboratory suite.** The percentage of maximum allowable quantities of *hazardous materials* in each *laboratory suite* shall be in accordance with Table 428.3.



## CHAPTER 5

# GENERAL BUILDING HEIGHTS AND AREAS

### User note:

**About this chapter:** Chapter 5 establishes the limits to which a building can be built. Building height, number of stories and building area are specified in this chapter. Chapter 5 must be used in conjunction with the occupancies established in Chapter 3 and the types of construction established in Chapter 6. This chapter also specifies the impact that mezzanines, accessory occupancies and mixed occupancies have on the overall size of a building.

## SECTION 501 GENERAL

**501.1 Scope.** The provisions of this chapter control the height and area of structures hereafter erected and *additions to existing structures*.

## SECTION 502 BUILDING ADDRESS

**[F] 502.1 Address identification.** New and existing buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be a minimum of 4 inches (102 mm) high with a minimum stroke width of  $\frac{1}{2}$  inch (12.7 mm). Where required by the fire code official, address identification shall be provided in additional approved locations to facilitate emergency response. Where access is by means of a private road and the building address cannot be viewed from the public way, a monument, pole or other approved sign or means shall be used to identify the structure. Address identification shall be maintained.

## SECTION 503 GENERAL BUILDING HEIGHT AND AREA LIMITATIONS

**503.1 General.** Unless otherwise specifically modified in Chapter 4 and this chapter, *building height*, number of *stories* and *building area* shall not exceed the limits specified in Sections 504 and 506 based on the type of construction as determined by Section 602 and the occupancies as determined by Section 302 except as modified hereafter. *Building height*, number of *stories* and *building area* provisions shall be applied independently. For the purposes of determining area limitations, height limitations and type of construction, each portion of a building separated by one or more *fire walls* complying with Section 706 shall be considered to be a separate building.

**503.1.1 Special industrial occupancies.** Buildings and structures designed to house special industrial processes that require large areas and unusual *building heights* to accommodate craneways or special machinery and equip-

ment, including, among others, rolling mills; structural metal fabrication shops and foundries; or the production and distribution of electric, gas or steam power, shall be exempt from the *building height*, number of *stories* and *building area* limitations specified in Sections 504 and 506.

**503.1.2 Buildings on same lot.** Two or more buildings on the same lot shall be regulated as separate buildings or shall be considered as portions of one building where the *building height*, number of *stories* of each building and the aggregate *building area* of the buildings are within the limitations specified in Sections 504 and 506. The provisions of this code applicable to the aggregate building shall be applicable to each *building*.

**503.1.3 Type I construction.** Buildings of Type I construction permitted to be of unlimited tabular *building heights and areas* are not subject to the special requirements that allow unlimited area buildings in Section 507 or unlimited *building height* in Sections 503.1.1 and 504.3 or increased *building heights and areas* for other types of construction.

**503.1.4 Occupied roofs.** A roof level or portion thereof shall be permitted to be used as an occupied roof provided the occupancy of the roof is an occupancy that is permitted by Table 504.4 for the *story* immediately below the roof. The area of the occupied roofs shall not be included in the *building area* as regulated by Section 506. An occupied roof shall not be included in the *building height* or number of *stories* as regulated by Section 504, provided that the *penthouses* and other enclosed *rooftop structures* comply with Section 1511.

### Exceptions:

1. The occupancy located on an occupied roof shall not be limited to the occupancies allowed on the *story* immediately below the roof where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 and occupant notification in accordance with Sections 907.5.2.1 and 907.5.2.3 is provided in the area of the occupied roof. *Emergency voice/alarm communication* system notification per Section 907.5.2.2 shall also be provided in the area of the occupied roof where such system is required elsewhere in the building.

## GENERAL BUILDING HEIGHTS AND AREAS

2. Assembly occupancies shall be permitted on roofs of open parking spaces of Type I or Type II construction, in accordance with the exception to Section 903.2.1.6.

### 503.1.4.1 Enclosures over occupied roof areas.

Elements or structures enclosing the occupied roof areas shall not extend more than 48 inches (1220 mm) above the surface of the occupied roof.

**Exception:** *Penthouses* constructed in accordance with Section 1511.2 and towers, domes, spires and cupolas constructed in accordance with Section 1511.5.

## SECTION 504

### BUILDING HEIGHT AND NUMBER OF STORIES

**504.1 General.** The height, in feet, and the number of *stories* of a building shall be determined based on the type of construction, occupancy classification and whether there is an *automatic sprinkler system* installed throughout the building.

**Exception:** The *building height* of one-story aircraft hangars, aircraft paint hangars and buildings used for the manufacturing of aircraft shall not be limited where the building is provided with an *automatic sprinkler system* or *automatic fire-extinguishing system* in accordance with Chapter 9 and is entirely surrounded by *public ways* or *yards* not less in width than one and one-half times the *building height*.

**504.1.1 Unlimited area buildings.** The height of unlimited area buildings shall be designed in accordance with Section 507.

**504.1.2 Special provisions.** The special provisions of Section 510 permit the use of special conditions that are exempt from, or modify, the specific requirements of this chapter regarding the allowable heights of buildings based on the occupancy classification and type of construction, provided the special condition complies with the provisions specified in Section 510.

**504.2 Mixed occupancy.** In a building containing mixed occupancies in accordance with Section 508, no individual occupancy shall exceed the height and number of *story* limits specified in this section for the applicable occupancies.

**504.3 Height in feet.** The maximum height, in feet, of a building shall not exceed the limits specified in Table 504.3.

**Exception:** Towers, spires, steeples and other *rooftop structures* shall be constructed of materials consistent with the required type of construction of the building except where other construction is permitted by Section 1511.2.4. Such structures shall not be used for habitation or storage. The structures shall be unlimited in height where of noncombustible materials and shall not extend more than 20 feet (6096 mm) above the allowable *building height* where of combustible materials (see Chapter 15 for additional requirements).

**504.4 Number of stories.** The maximum number of *stories* above grade plane of a building shall not exceed the limits specified in Table 504.4.

## SECTION 505

### MEZZANINES AND EQUIPMENT PLATFORMS

**505.1 General.** *Mezzanines* shall comply with Section 505.2. *Equipment platforms* shall comply with Section 505.3.

**505.2 Mezzanines.** A *mezzanine* or *mezzanines* in compliance with Section 505.2 shall be considered a portion of the *story* below. Such *mezzanines* shall not contribute to either the *building area* or number of *stories* as regulated by Section 503.1. The area of the *mezzanine* shall be included in determining the *fire area*. The clear height above and below the *mezzanine* floor construction shall be not less than 7 feet (2134 mm).

**505.2.1 Area limitation.** The aggregate area of a *mezzanine* or *mezzanines* within a room shall be not greater than one-third of the floor area of that room or space in which they are located. The enclosed portion of a room shall not be included in a determination of the floor area of the room in which the *mezzanine* is located. In determining the allowable *mezzanine* area, the area of the *mezzanine* shall not be included in the floor area of the room.

#### Exceptions:

1. The aggregate area of *mezzanines* in buildings and structures of Type I or II construction for special industrial occupancies in accordance with Section 503.1.1 shall be not greater than two-thirds of the floor area of the room.
2. The aggregate area of *mezzanines* in buildings and structures of Type I or II construction shall be not greater than one-half of the floor area of the room in buildings and structures equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1 and an *approved emergency voice/alarm communication system* in accordance with Section 907.5.2.2.
3. The aggregate area of a *mezzanine* within a *dwelling unit* that is located in a building equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2 shall not be greater than one-half of the floor area of the room, provided that:
  - 3.1. Except for enclosed closets and bathrooms, the *mezzanine* shall be open to the room in which such *mezzanine* is located;
  - 3.2. The opening to the room shall be unobstructed except for walls not more than 42 inches (1067 mm) in height, columns and posts; and
  - 3.3. Exceptions to Section 505.2.3 shall not be permitted.



## GENERAL BUILDING HEIGHTS AND AREAS

**505.2.1.1 Aggregate area of mezzanines and equipment platforms.** Where a room contains both a *mezzanine* and an *equipment platform*, the aggregate area of the two raised floor levels shall be not greater than two-thirds of the floor area of that room or space in which they are located. The area of the *mezzanine* shall not exceed the area determined in accordance with Section 505.2.1.

**505.2.2 Means of egress.** The *means of egress* for *mezzanines* shall comply with the applicable provisions of Chapter 10.

**505.2.3 Openness.** A *mezzanine* shall be open and unobstructed to the room in which such *mezzanine* is located except for walls not more than 42 inches (1067 mm) in height, columns and posts.

**Exceptions:**

1. *Mezzanines* or portions thereof are not required to be open to the room in which the *mezzanines* are located, provided that the *occupant load* of the aggregate area of the enclosed space is not greater than 10.

2. A *mezzanine* having two or more exits or access to exits is not required to be open to the room in which the *mezzanine* is located.
3. *Mezzanines* or portions thereof are not required to be open to the room in which the *mezzanines* are located, provided that the aggregate floor area of the enclosed space is not greater than 10 percent of the *mezzanine* area.
4. In industrial facilities, *mezzanines* used for control equipment are permitted to be glazed on all sides.
5. In occupancies other than Groups H and I, which are no more than two *stories* above grade plane and equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, a *mezzanine* having two or more *exits* or *access to exits* shall not be required to be open to the room in which the *mezzanine* is located.

**TABLE 504.3**  
**ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE<sup>a</sup>**

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS <sup>b</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	270	180	85	85	70	60
H-1, H-2, H-3, H-5	NS <sup>c, d</sup>	UL	160	65	55	65	55	120	90	65	65	50	40
	S												
H-4	NS <sup>c, d</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	140	100	85	85	70	60
I-1 Condition 1, I-3	NS <sup>d, e</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-1 Condition 2, I-2	NS <sup>d, e, f</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85									
I-4	NS <sup>d, g</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
R <sup>h</sup>	NS <sup>d</sup>	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

For SI: 1 foot = 304.8 mm.

UL = Unlimited; NS = Buildings not equipped throughout with an automatic sprinkler system; S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

- a. See Chapters 4 and 5 for specific exceptions to the allowable height in this chapter.
- b. See Section 903.2 for the minimum thresholds for protection by an automatic sprinkler system for specific occupancies.
- c. New Group H occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.5.
- d. The NS value is only for use in evaluation of existing building height in accordance with the *International Existing Building Code*.
- e. New Group I-1 and I-3 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6. For new Group I-1 occupancies Condition 1, see Exception 1 of Section 903.2.6.
- f. New and existing Group I-2 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6 and Section 1103.5 of the *International Fire Code*.
- g. For new Group I-4 occupancies, see Exceptions 2 and 3 of Section 903.2.6.
- h. New Group R occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.8.

## GENERAL BUILDING HEIGHTS AND AREAS

**TABLE 504.4**  
**ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE<sup>a, b</sup>**

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	3	3	3	2	1
	S	UL	6	4	3	4	3	9	6	4	4	3	2
A-2	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-3	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-4	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-5	NS	UL	UL	UL	UL	UL	UL	1	1	1	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	18	12	9	6	4	3
E	NS	UL	5	3	2	3	2	3	3	3	3	1	1
	S	UL	6	4	3	4	3	9	6	4	4	2	2
F-1	NS	UL	11	4	2	3	2	3	3	3	4	2	1
	S	UL	12	5	3	4	3	10	7	5	5	3	2
F-2	NS	UL	11	5	3	4	3	5	5	5	5	3	2
	S	UL	12	6	4	5	4	12	8	6	6	4	3
H-1	NS <sup>c, d</sup>	1	1	1	1	1	1	NP	NP	NP	1	1	NP
	S							1	1	1			
H-2	NS <sup>c, d</sup>	UL	3	2	1	2	1	1	1	1	2	1	1
	S							2	2	2			
H-3	NS <sup>c, d</sup>	UL	6	4	2	4	2	3	3	3	4	2	1
	S							4	4	4			
H-4	NS <sup>c, d</sup>	UL	7	5	3	5	3	5	5	5	5	3	2
	S	UL	8	6	4	6	4	8	7	6	6	4	3
H-5	NS <sup>c, d</sup>	4	4	3	3	3	3	2	2	2	3	3	2
	S							3	3	3			
I-1 Condition 1	NS <sup>d, e</sup>	UL	9	4	3	4	3	4	4	4	4	3	2
	S	UL	10	5	4	5	4	10	7	5	5	4	3
I-1 Condition 2	NS <sup>d, e</sup>	UL	9	4	3	4	3	3	3	3	4	3	2
	S	UL	10	5				10	6	4			
I-2	NS <sup>d, f</sup>	UL	4	2	1	1	NP	NP	NP	NP	1	1	NP
	S	UL	5	3				7	5	1			
I-3	NS <sup>d, e</sup>	UL	4	2	1	2	1	2	2	2	2	2	1
	S	UL	5	3	2	3	2	7	5	3	3	3	2
I-4	NS <sup>d, g</sup>	UL	5	3	2	3	2	3	3	3	3	1	1
	S	UL	6	4	3	4	3	9	6	4	4	2	2
M	NS	UL	11	4	2	4	2	4	4	4	4	3	1
	S	UL	12	5	3	5	3	12	8	6	5	4	2

(continued)

**TABLE 504.4—continued**  
**ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE<sup>a, b</sup>**

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	See Footnotes	Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
R-1 <sup>h</sup>	NS <sup>d</sup>	UL	11	4	4	4	4	4	4	4	4	3	2
	S13R	4	4									4	3
	S	UL	12	5	5	5	5	18	12	8	5	4	3
R-2 <sup>h</sup>	NS <sup>d</sup>	UL	11	4	4	4	4	4	4	4	4	3	2
	S13R	4	4	4								4	3
	S	UL	12	5	5	5	5	18	12	8	5	4	3
R-3 <sup>h</sup>	NS <sup>d</sup>	UL	11	4	4	4	4	4	4	4	4	3	3
	S13D	4	4									3	3
	S13R	4	4									4	4
	S	UL	12	5	5	5	5	18	12	5	5	4	4
R-4 <sup>h</sup>	NS <sup>d</sup>	UL	11	4	4	4	4	4	4	4	4	3	2
	S13D	4	4									3	2
	S13R	4	4									4	3
	S	UL	12	5	5	5	5	18	12	5	5	4	3
S-1	NS	UL	11	4	2	3	2	4	4	4	4	3	1
	S	UL	12	5	4	4	4	10	7	5	5	4	2
S-2	NS	UL	11	5	3	4	3	4	4	4	5	4	2
	S	UL	12	6	4	5	4	12	8	5	6	5	3
U	NS	UL	5	4	2	3	2	4	4	4	4	2	1
	S	UL	6	5	3	4	3	9	6	5	5	3	2

UL = Unlimited; NP = Not Permitted; NS = Buildings not equipped throughout with an automatic sprinkler system; S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

- See Chapters 4 and 5 for specific exceptions to the allowable height in this chapter.
- See Section 903.2 for the minimum thresholds for protection by an automatic sprinkler system for specific occupancies.
- New Group H occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.5.
- The NS value is only for use in evaluation of existing *building height* in accordance with the *International Existing Building Code*.
- New Group I-1 and I-3 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6. For new Group I-1 occupancies, Condition 1, see Exception 1 of Section 903.2.6.
- New and existing Group I-2 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6 and 1103.5 of the *International Fire Code*.
- For new Group I-4 occupancies, see Exceptions 2 and 3 of Section 903.2.6.
- New Group R occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.8.

**505.3 Equipment platforms.** *Equipment platforms* in buildings shall not be considered as a portion of the floor below. Such *equipment platforms* shall not contribute to either the *building area* or the number of *stories* as regulated by Section 503.1. The area of the *equipment platform* shall not be included in determining the *fire area* in accordance with Section 903. *Equipment platforms* shall not be a part of any *mezzanine* and such platforms and the walkways, *stairways*, *alternating tread devices* and ladders providing access to an *equipment platform* shall not serve as a part of the *means of egress* from the building.

**505.3.1 Area limitation.** The aggregate area of all *equipment platforms* within a room shall be not greater than two-thirds of the area of the room in which they are located. Where an *equipment platform* is located in the

same room as a *mezzanine*, the area of the *mezzanine* shall be determined by Section 505.2.1 and the combined aggregate area of the *equipment platforms* and *mezzanines* shall be not greater than two-thirds of the room in which they are located. The area of the *mezzanine* shall not exceed the area determined in accordance with Section 505.2.1.

**505.3.2 Automatic sprinkler system.** Where located in a building that is required to be protected by an *automatic sprinkler system*, *equipment platforms* shall be fully protected by sprinklers above and below the platform, where required by the standards referenced in Section 903.3.

**505.3.3 Guards.** *Equipment platforms* shall have *guards* where required by Section 1015.2.

## SECTION 506 BUILDING AREA

**506.1 General.** The floor area of a building shall be determined based on the type of construction, occupancy classification, whether there is an *automatic sprinkler system* installed throughout the building and the amount of building frontage on *public way* or open space.

**506.1.1 Unlimited area buildings.** Unlimited area buildings shall be designed in accordance with Section 507.

**506.1.2 Special provisions.** The special provisions of Section 510 permit the use of special conditions that are exempt from, or modify, the specific requirements of this chapter regarding the allowable areas of buildings based on the occupancy classification and type of construction, provided the special condition complies with the provisions specified in Section 510.

**506.1.3 Basements.** *Basements* need not be included in the total allowable floor area of a building provided the total area of such *basements* does not exceed the area permitted for a one-story above grade plane building.

**506.2 Allowable area determination.** The allowable area of a building shall be determined in accordance with the applicable provisions of Sections 506.2.1, 506.2.2 and 506.3.

**506.2.1 Single-occupancy buildings.** The allowable area of each *story* of a single-occupancy building shall be determined in accordance with Equation 5-1:

$$A_a = A_t + (NS \times I_f) \quad \text{(Equation 5-1)}$$

where:

$A_a$  = Allowable area (square feet).

$A_t$  = Tabular allowable area factor (NS, S1, S13R or S13D value, as applicable) in accordance with Table 506.2.

$NS$  = Tabular allowable area factor in accordance with Table 506.2 for nonsprinklered building (regardless of whether the building is sprinklered).

$I_f$  = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.

The allowable area per story of a single-occupancy building with a maximum of three stories above grade shall be determined by Equation 5-1. The total allowable area of a single-occupancy building more than three *stories above grade plane* shall be determined in accordance with Equation 5-2:

$$A_a = [A_t + (NS \times I_f)] \times S_a \quad \text{(Equation 5-2)}$$

where:

$A_a$  = Allowable area (square feet).

$A_t$  = Tabular allowable area factor (NS, S13R, S13D or SM value, as applicable) in accordance with Table 506.2.

$NS$  = Tabular allowable area factor in accordance with Table 506.2 for a nonsprinklered building (regardless of whether the building is sprinklered).

$I_f$  = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.

$S_a$  = 3 where the actual number of stories above grade plane exceeds three, or

$S_a$  = 4 where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2.

The actual area of any individual floor shall not exceed the allowable area per Equation 5-1.

**506.2.2 Mixed-occupancy buildings.** The allowable area of each *story* of a mixed-occupancy building shall be determined in accordance with the applicable provisions of, Section 508.3.2 for nonseparated occupancies and Section 508.4.2 for separated occupancies.

For buildings with more than three *stories above grade plane*, the total *building area* shall be such that the aggregate sum of the ratios of the actual area of each *story* divided by the allowable area of such stories, determined in accordance with Equation 5-3 based on the applicable provisions of Section 508.1, shall not exceed three.

$$A_a = [A_t + (NS \times I_f)] \quad \text{(Equation 5-3)}$$

$A_a$  = Allowable area (square feet).

$A_t$  = Tabular allowable area factor (NS, S13R, S13D or SM value, as applicable) in accordance with Table 506.2.

$NS$  = Tabular allowable area factor in accordance with Table 506.2 for a nonsprinklered building, regardless of whether the building is sprinklered.

$I_f$  = Area factor increase due to frontage (percent) as calculated in accordance with Section 506.3.

**Exception:** For buildings designed as separated occupancies under Section 508.4 and equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2, the total building area shall be such that the aggregate sum of the ratios of the actual area of each story divided by the allowable area of such stories determined in accordance with Equation 5-3 based on the applicable provisions of Section 508.1, shall not exceed four.

**506.2.2.1 Group H-2 or H-3 mixed occupancies.** For a building containing Group H-2 or H-3 occupancies, the allowable area shall be determined in accordance with Section 508.4.2, with the automatic sprinkler system increase applicable only to the portions of the building not classified as Group H-2 or H-3.

**506.3 Frontage increase.** Every building shall adjoin or have access to a *public way* to receive an area factor increase based on frontage. Area factor increase shall be determined in accordance with Sections 506.3.1 through 506.3.3.

**506.3.1 Minimum percentage of perimeter.** To qualify for an area factor increase based on frontage, a building shall have not less than 25 percent of its perimeter on a *public way* or open space. Such open space shall be either on the same lot or dedicated for public use and shall be accessed from a street or approved *fire lane*.



## GENERAL BUILDING HEIGHTS AND AREAS

**TABLE 506.2**  
**ALLOWABLE AREA FACTOR (A<sub>i</sub> = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET<sup>a, b</sup>**

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	UL	15,500	8,500	14,000	8,500	45,000	30,000	18,750	15,000	11,500	5,500
	S1	UL	UL	62,000	34,000	56,000	34,000	180,000	120,000	75,000	60,000	46,000	22,000
	SM	UL	UL	46,500	25,500	42,000	25,500	135,000	90,000	56,250	45,000	34,500	16,500
A-2	NS	UL	UL	15,500	9,500	14,000	9,500	45,000	30,000	18,750	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	180,000	120,000	75,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	135,000	90,000	56,250	45,000	34,500	18,000
A-3	NS	UL	UL	15,500	9,500	14,000	9,500	45,000	30,000	18,750	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	180,000	120,000	75,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	135,000	90,000	56,250	45,000	34,500	18,000
A-4	NS	UL	UL	15,500	9,500	14,000	9,500	45,000	30,000	18,750	15,000	11,500	6,000
	S1	UL	UL	62,000	38,000	56,000	38,000	180,000	120,000	75,000	60,000	46,000	24,000
	SM	UL	UL	46,500	28,500	42,000	28,500	135,000	90,000	56,250	45,000	34,500	18,000
A-5	NS	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S1												
	SM												
B	NS	UL	UL	37,500	23,000	28,500	19,000	108,000	72,000	45,000	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	432,000	288,000	180,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	324,000	216,000	135,000	108,000	54,000	27,000
E	NS	UL	UL	26,500	14,500	23,500	14,500	76,500	51,000	31,875	25,500	18,500	9,500
	S1	UL	UL	106,000	58,000	94,000	58,000	306,000	204,000	127,500	102,000	74,000	38,000
	SM	UL	UL	79,500	43,500	70,500	43,500	229,500	153,000	95,625	76,500	55,500	28,500
F-1	NS	UL	UL	25,000	15,500	19,000	12,000	100,500	67,000	41,875	33,500	14,000	8,500
	S1	UL	UL	100,000	62,000	76,000	48,000	402,000	268,000	167,500	134,000	56,000	34,000
	SM	UL	UL	75,000	46,500	57,000	36,000	301,500	201,000	125,625	100,500	42,000	25,500
F-2	NS	UL	UL	37,500	23,000	28,500	18,000	151,500	101,000	63,125	50,500	21,000	13,000
	S1	UL	UL	150,000	92,000	114,000	72,000	606,000	404,000	252,500	202,000	84,000	52,000
	SM	UL	UL	112,500	69,000	85,500	54,000	454,500	303,000	189,375	151,500	63,000	39,000
H-1	NS <sup>c</sup>	21,000	16,500	11,000	7,000	9,500	7,000	10,500	10,500	10,500	10,500	7,500	NP
	S1												
H-2	NS <sup>c</sup>	21,000	16,500	11,000	7,000	9,500	7,000	10,500	10,500	10,500	10,500	7,500	3,000
	S1												
	SM												
H-3	NS <sup>c</sup>	UL	60,000	26,500	14,000	17,500	13,000	25,500	25,500	25,500	25,500	10,000	5,000
	S1												
	SM												
H-4	NS <sup>c, d</sup>	UL	UL	37,500	17,500	28,500	17,500	72,000	54,000	40,500	36,000	18,000	6,500
	S1	UL	UL	150,000	70,000	114,000	70,000	288,000	216,000	162,000	144,000	72,000	26,000
	SM	UL	UL	112,500	52,500	85,500	52,500	216,000	162,000	121,500	108,000	54,000	19,500
H-5	NS <sup>c, d</sup>	UL	UL	37,500	23,000	28,500	19,000	72,000	54,000	40,500	36,000	18,000	9,000
	S1	UL	UL	150,000	92,000	114,000	76,000	288,000	216,000	162,000	144,000	72,000	36,000
	SM	UL	UL	112,500	69,000	85,500	57,000	216,000	162,000	121,500	108,000	54,000	27,000

(continued)

## GENERAL BUILDING HEIGHTS AND AREAS

**TABLE 506.2—continued**  
**ALLOWABLE AREA FACTOR ( $A_t$  = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET<sup>a, b</sup>**

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		Type I		Type II		Type III		Type IV				Type V	
		A	B	A	B	A	B	A	B	C	HT	A	B
I-1	NS <sup>d, e</sup>	UL	55,000	19,000	10,000	16,500	10,000	54,000	36,000	18,000	18,000	10,500	4,500
	S1	UL	220,000	76,000	40,000	66,000	40,000	216,000	144,000	72,000	72,000	42,000	18,000
	SM	UL	165,000	57,000	30,000	49,500	30,000	162,000	108,000	54,000	54,000	31,500	13,500
I-2	NS <sup>d, f</sup>	UL	UL	15,000	11,000	12,000	NP	36,000	24,000	12,000	12,000	9,500	NP
	S1	UL	UL	60,000	44,000	48,000	NP	144,000	96,000	48,000	48,000	38,000	NP
	SM	UL	UL	45,000	33,000	36,000	NP	108,000	72,000	36,000	36,000	28,500	NP
I-3	NS <sup>d, e</sup>	UL	UL	15,000	10,000	10,500	7,500	36,000	24,000	12,000	12,000	7,500	5,000
	S1	UL	UL	60,000	40,000	42,000	30,000	144,000	96,000	48,000	48,000	30,000	20,000
	SM	UL	UL	45,000	30,000	31,500	22,500	108,000	72,000	36,000	36,000	22,500	15,000
I-4	NS <sup>d, g</sup>	UL	60,500	26,500	13,000	23,500	13,000	76,500	51,000	25,500	25,500	18,500	9,000
	S1	UL	121,000	106,000	52,000	94,000	52,000	306,000	204,000	102,000	102,000	74,000	36,000
	SM	UL	181,500	79,500	39,000	70,500	39,000	229,500	153,000	76,500	76,500	55,500	27,000
M	NS	UL	UL	21,500	12,500	18,500	12,500	61,500	41,000	26,625	20,500	14,000	9,000
	S1	UL	UL	86,000	50,000	74,000	50,000	246,000	164,000	102,500	82,000	56,000	36,000
	SM	UL	UL	64,500	37,500	55,500	37,500	184,500	123,000	76,875	61,500	42,000	27,000
R-1 <sup>h</sup>	NS <sup>d</sup>	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S13R												
	S1												
	SM												
R-2 <sup>h</sup>	NS <sup>d</sup>	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S13R												
	S1												
	SM												
R-3 <sup>h</sup>	NS <sup>d</sup>	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
	S13D												
	S13R												
	S1												
	SM												
R-4 <sup>h</sup>	NS <sup>d</sup>	UL	UL	24,000	16,000	24,000	16,000	61,500	41,000	25,625	20,500	12,000	7,000
	S13D												
	S13R												
	S1												
	SM												
S-1	NS	UL	48,000	26,000	17,500	26,000	17,500	76,500	51,000	31,875	25,500	14,000	9,000
	S1	UL	192,000	104,000	70,000	104,000	70,000	306,000	204,000	127,500	102,000	56,000	36,000
	SM	UL	144,000	78,000	52,500	78,000	52,500	229,500	153,000	95,625	76,500	42,000	27,000
S-2	NS	UL	79,000	39,000	26,000	39,000	26,000	115,500	77,000	48,125	38,500	21,000	13,500
	S1	UL	316,000	156,000	104,000	156,000	104,000	462,000	308,000	192,500	154,000	84,000	54,000
	SM	UL	237,000	117,000	78,000	117,000	78,000	346,500	231,000	144,375	115,500	63,000	40,500
U	NS <sup>i</sup>	UL	35,500	19,000	8,500	14,000	8,500	54,000	36,000	22,500	18,000	9,000	5,500
	S1	UL	142,000	76,000	34,000	56,000	34,000	216,000	144,000	90,000	72,000	36,000	22,000
	SM	UL	106,500	57,000	25,500	42,000	25,500	162,000	108,000	67,500	54,000	27,000	16,500

(continued)

**TABLE 506.2—continued**  
**ALLOWABLE AREA FACTOR ( $A_f$  = NS, S1, S13R, S13D or SM, as applicable) IN SQUARE FEET<sup>a, b</sup>**

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

UL = Unlimited; NP = Not Permitted; NS = Buildings not equipped throughout with an automatic sprinkler system; S1 = Buildings a maximum of one story above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; SM = Buildings two or more stories above grade plane equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1; S13R = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.2; S13D = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.3.

- See Chapters 4 and 5 for specific exceptions to the allowable area in this chapter.
- See Section 903.2 for the minimum thresholds for protection by an automatic sprinkler system for specific occupancies.
- New Group H occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.5.
- The NS value is only for use in evaluation of existing building area in accordance with the *International Existing Building Code*.
- New Group I-1 and I-3 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6. For new Group I-1 occupancies, Condition 1, see Exception 1 of Section 903.2.6.
- New and existing Group I-2 occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.6 and Section 1103.5 of the *International Fire Code*.
- New Group I-4 occupancies see Exceptions 2 and 3 of Section 903.2.6.
- New Group R occupancies are required to be protected by an automatic sprinkler system in accordance with Section 903.2.8.
- The maximum allowable area for a single-story nonsprinklered Group U greenhouse is permitted to be 9,000 square feet, or the allowable area shall be permitted to comply with Table C102.1 of Appendix C.

**506.3.2 Minimum frontage distance.** To qualify for an area factor increase based on frontage, the *public way* or open space adjacent to the building perimeter shall have a minimum distance ( $W$ ) of 20 feet (6096 mm) measured at right angles from the building face to any of the following:

- The closest interior lot line.
- The entire width of a street, alley or *public way*.
- The exterior face of an adjacent building on the same property.

The frontage increase shall be based on the smallest *public way* or open space that is 20 feet (6096 mm) or greater, and the percentage of building perimeter having a minimum 20 feet (6096 mm) *public way* or open space.

**506.3.3 Amount of increase.** The area factor increase based on frontage shall be determined in accordance with Table 506.3.3.

**506.3.3.1 Section 507 buildings.** Where a building meets the requirements of Section 507, as applicable, except for compliance with the minimum 60-foot (18 288 mm) *public way* or *yard* requirement, the area factor increase based on frontage shall be determined in accordance with Table 506.3.3.1.

## SECTION 507 UNLIMITED AREA BUILDINGS

**507.1 General.** The area of buildings of the occupancies and configurations specified in Sections 507.1 through 507.13 shall not be limited. Basements not more than one *story* below *grade plane* shall be permitted.

**507.1.1 Accessory occupancies.** Accessory occupancies shall be permitted in unlimited area buildings in accordance with the provisions of Section 508.2, otherwise the requirements of Sections 507.3 through 507.13 shall be applied, where applicable.

**TABLE 506.3.3**  
**FRONTAGE INCREASE FACTOR<sup>a</sup>**

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (feet)			
	0 to less than 20	20 to less than 25	25 to less than 30	30 or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

**TABLE 506.3.3.1**  
**SECTION 507 BUILDINGS<sup>a</sup>**

PERCENTAGE OF BUILDING PERIMETER	OPEN SPACE (feet)					
	30 to less than 35	35 to less than 40	40 to less than 45	45 to less than 50	50 to less than 55	55 to less than 60
0 to less than 25	0	0	0	0	0	0
25 to less than 50	0.29	0.33	0.38	0.42	0.46	0.50
50 to less than 75	0.58	0.67	0.75	0.83	0.92	1.00
75 to 100	0.88	1.00	1.13	1.25	1.38	1.50

a. Interpolation is permitted.

## GENERAL BUILDING HEIGHTS AND AREAS

**507.2 Measurement of open spaces.** Where Sections 507.3 through 507.13 require buildings to be surrounded and adjoined by *public ways* and *yards*, those open spaces shall be determined as follows:

1. *Yards* shall be measured from the building perimeter in all directions to the closest interior *lot lines* or to the exterior face of an opposing building located on the same *lot*, as applicable.
2. Where the building fronts on a *public way*, the entire width of the *public way* shall be used.

**507.2.1 Reduced open space.** The *public ways* or *yards* of 60 feet (18 288 mm) in width required in Sections 507.3, 507.4, 507.5, 507.6 and 507.12 shall be permitted to be reduced to not less than 40 feet (12 192 mm) in width, provided that the following requirements are met:

1. The reduced width shall not be allowed for more than 75 percent of the perimeter of the building.
2. The *exterior walls* facing the reduced width shall have a *fire-resistance rating* of not less than 3 hours.
3. Openings in the *exterior walls* facing the reduced width shall have opening protectives with a *fire protection rating* of not less than 3 hours.

**507.3 Nonsprinklered, one-story buildings.** The area of a Group F-2 or S-2 building not more than one *story* in height shall not be limited where the building is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.4 Sprinklered, one-story buildings.** The area of a Group A-4 building not more than one *story above grade plane* of other than Type V construction, or the area of a Group B, F, M or S building no more than one *story above grade plane* of any construction type, shall not be limited where the building is provided with an *automatic sprinkler system* throughout in accordance with Section 903.3.1.1 and is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

### Exceptions:

1. Buildings and structures of Type I or II construction for rack storage facilities that do not have access by the public shall not be limited in height, provided that such buildings conform to the requirements of Sections 507.4 and 903.3.1.1 and Chapter 32 of the *International Fire Code*.
2. The *automatic sprinkler system* shall not be required in areas occupied for indoor participant sports, such as tennis, skating, swimming and equestrian activities in occupancies in Group A-4, provided that the following criteria are met:
  - 2.1. *Exit* doors directly to the outside are provided for occupants of the participant sports areas.
  - 2.2. The building is equipped with a *fire alarm system* with *manual fire alarm boxes* installed in accordance with Section 907.

- 2.3. An *automatic sprinkler system* is provided in storage rooms, press boxes, concession booths or other spaces ancillary to the sport activity space.

**507.4.1 Mixed occupancy buildings with Groups A-1 and A-2.** Group A-1 and A-2 occupancies of other than Type V construction shall be permitted within mixed occupancy buildings of unlimited area complying with Section 507.4, provided that the following criteria are met:

1. Group A-1 and A-2 occupancies are separated from other occupancies as required for separated occupancies in Section 508.4.4 with no reduction allowed in the *fire-resistance rating* of the separation based upon the installation of an *automatic sprinkler system*.
2. Each area of the portions of the building used for Group A-1 or A-2 occupancies shall not exceed the maximum allowable area permitted for such occupancies in Section 503.1.
3. *Exit* doors from Group A-1 and A-2 occupancies shall discharge directly to the exterior of the building.

**507.5 Two-story buildings.** The area of a Group B, F, M or S building not more than two *stories above grade plane* shall not be limited where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.6 Group A-3 buildings of Type II construction.** The area of a Group A-3 building not more than one *story above grade plane*, used as a *place of religious worship*, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor *swimming pool* or tennis court of Type II construction, shall not be limited provided that the following criteria are met:

1. The building shall not have a *stage* other than a *platform*.
2. The building shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
3. The building shall be surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.7 Group A-3 buildings of Type III and IV construction.** The area of a Group A-3 building of Type III or IV construction, with not more than one *story above grade plane* and used as a *place of religious worship*, community hall, dance hall, exhibition hall, gymnasium, lecture hall, indoor *swimming pool* or tennis court, shall not be limited provided that the following criteria are met:

1. The building shall not have a *stage* other than a *platform*.
2. The building shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.



3. The assembly floor shall be located at or within 21 inches (533 mm) of street or grade level and all *exits* are provided with *ramps* complying with Section 1012 to the street or grade level.
4. The building shall be surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.8 Group H-2, H-3 and H-4 occupancies.** Group H-2, H-3 and H-4 occupancies shall be permitted in unlimited area buildings containing Group F or S occupancies in accordance with Sections 507.4 and 507.5 and the provisions of Sections 507.8.1 through 507.8.4.

**507.8.1 Allowable area.** The aggregate floor area of Group H occupancies located in an unlimited area building shall not exceed 10 percent of the area of the building or the area limitations for the Group H occupancies as specified in Section 506 based on the perimeter of each Group H floor area that fronts on a *public way* or open space.

**507.8.1.1 Located within the building.** The aggregate floor area of Group H occupancies not located at the perimeter of the building shall not exceed 25 percent of the area limitations for the Group H occupancies as specified in Section 506.

**507.8.1.1.1 Rooms for flammable or combustible liquid use, dispensing or mixing in open systems.** Rooms for *flammable* or *combustible liquid* use, dispensing or mixing in open systems having a floor area of not more than 500 square feet (46.5 m<sup>2</sup>) need not be located on the outer perimeter of the building where they are in accordance with the *International Fire Code* and NFPA 30.

**507.8.1.1.2 Liquid storage rooms and rooms for flammable or combustible liquid use in closed systems.** Liquid storage rooms and rooms for *flammable* or *combustible liquid* use in closed systems having a floor area of not more than 1,000 square feet (93 m<sup>2</sup>) need not be located on the outer perimeter where they are in accordance with the *International Fire Code* and NFPA 30.

**507.8.1.1.3 Spray paint booths.** Spray paint booths that comply with the *International Fire Code* need not be located on the outer perimeter.

**507.8.2 Located on building perimeter.** Except as provided for in Section 507.8.1.1, Group H occupancies shall be located on the perimeter of the building. In Group H-2 and H-3 occupancies, not less than 25 percent of the perimeter of such occupancies shall be an *exterior wall*.

**507.8.3 Occupancy separations.** Group H occupancies shall be separated from the remainder of the unlimited area building and from each other in accordance with Table 508.4.

**507.8.4 Height limitations.** For two-story, unlimited area buildings, Group H occupancies shall not be located more than one *story above grade plane* unless permitted based

on the allowable height and number of *stories* and feet as specified in Section 504 based on the type of construction of the unlimited area building.

**507.9 Unlimited mixed occupancy buildings with Group H-5.** The area of a Group B, F, H-5, M or S building not more than two *stories above grade plane* shall not be limited where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, and is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width, provided that the following criteria are met:

1. Buildings containing Group H-5 occupancy shall be of Type I or II construction.
2. Each area used for Group H-5 occupancy shall be separated from other occupancies as required in Sections 415.11 and 508.4.
3. Each area used for Group H-5 occupancy shall not exceed the maximum allowable area permitted for such occupancies in Section 503.1 including modifications of Section 506.

**Exception:** Where the Group H-5 occupancy exceeds the maximum allowable area, the Group H-5 shall be subdivided into areas that are separated by 2-hour *fire barriers*.

**507.10 Aircraft paint hangar.** The area of a Group H-2 aircraft paint hangar not more than one *story above grade plane* shall not be limited where such aircraft paint hangar complies with the provisions of Section 412.5 and is surrounded and adjoined by *public ways* or *yards* not less in width than one and one-half times the *building height*.

**507.11 Group E buildings.** The area of a Group E building not more than one *story above grade plane*, of Type II, IIIA or IV construction, shall not be limited provided that the following criteria are met:

1. Each classroom shall have not less than two *means of egress*, with one of the *means of egress* being a direct exit to the outside of the building complying with Section 1022.
2. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
3. The building is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.12 Motion picture theaters.** In buildings of Type II construction, the area of a motion picture theater located on the first *story above grade plane* shall not be limited where the building is provided with an *automatic sprinkler system* throughout in accordance with Section 903.3.1.1 and is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**507.13 Covered and open mall buildings and anchor buildings.** The area of *covered and open mall buildings* and *anchor buildings* not exceeding three *stories* in height that comply with Section 402 shall not be limited.

## GENERAL BUILDING HEIGHTS AND AREAS

## SECTION 508 MIXED USE AND OCCUPANCY

**508.1 General.** Each portion of a building shall be individually classified in accordance with Section 302.1. Where a building contains more than one occupancy group, the building or portion thereof shall comply with the applicable provisions of Section 508.2, 508.3, 508.4 or 508.5, or a combination of these sections.

### Exceptions:

1. Occupancies separated in accordance with Section 510.
2. Where required by Table 415.6.5, areas of Group H-1, H-2 and H-3 occupancies shall be located in a *detached building* or structure.

**508.2 Accessory occupancies.** Accessory occupancies are those occupancies that are ancillary to the main occupancy of the building or portion thereof. Accessory occupancies shall comply with the provisions of Sections 508.2.1 through 508.2.4.

**508.2.1 Occupancy classification.** Accessory occupancies shall be individually classified in accordance with Section 302.1. The requirements of this code shall apply to each portion of the building based on the occupancy classification of that space.

**508.2.2 Allowable building height.** The allowable height and number of *stories* of the building containing accessory occupancies shall be in accordance with Section 504 for the main occupancy of the building.

**508.2.3 Allowable building area.** The allowable area of the building shall be based on the applicable provisions of Section 506 for the main occupancy of the building. Aggregate accessory occupancies shall not occupy more than 10 percent of the floor area of the *story* in which they are located and shall not exceed the tabular values for nonsprinklered buildings in Table 506.2 for each such accessory occupancy.

**508.2.4 Separation of occupancies.** No separation is required between accessory occupancies and the main occupancy.

### Exceptions:

1. Group H-2, H-3, H-4 and H-5 occupancies shall be separated from all other occupancies in accordance with Section 508.4.
2. Group I-1, R-1, R-2 and R-3 *dwelling units* and *sleeping units* shall be separated from other *dwelling* or *sleeping units* and from accessory occupancies contiguous to them in accordance with the requirements of Section 420.

**508.3 Nonseparated occupancies.** Buildings or portions of buildings that comply with the provisions of this section shall be considered as nonseparated occupancies.

**508.3.1 Occupancy classification.** Nonseparated occupancies shall be individually classified in accordance with Section 302.1. The requirements of this code shall apply

to each portion of the building based on the occupancy classification of that space. In addition, the most restrictive provisions of Chapter 9 that apply to the nonseparated occupancies shall apply to the total nonseparated occupancy area.

**508.3.1.1 High-rise buildings.** Where nonseparated occupancies occur in a *high-rise building*, the most restrictive requirements of Section 403 that apply to the nonseparated occupancies shall apply throughout the *high-rise building*.

**508.3.1.2 Group I-2, Condition 2 occupancies.** Where one of the nonseparated occupancies is Group I-2, Condition 2, the most restrictive requirements of Sections 407, 509 and 712 shall apply throughout the *fire area* containing the Group I-2 occupancy. The most restrictive requirements of Chapter 10 shall apply to the path of egress from the Group I-2, Condition 2 occupancy up to and including the *exit discharge*.

**508.3.2 Allowable building area, height and number of stories.** The allowable *building area*, *height* and number of *stories* of the building or portion thereof shall be based on the most restrictive allowances for the occupancy groups under consideration for the type of construction of the building in accordance with Section 503.1.

**508.3.3 Separation.** No separation is required between nonseparated occupancies.

### Exceptions:

1. Group H-2, H-3, H-4 and H-5 occupancies shall be separated from all other occupancies in accordance with Section 508.4.
2. Group I-1, R-1, R-2 and R-3 *dwelling units* and *sleeping units* shall be separated from other *dwelling* or *sleeping units* and from other occupancies contiguous to them in accordance with the requirements of Section 420.

**508.4 Separated occupancies.** Buildings or portions of buildings that comply with the provisions of this section shall be considered as separated occupancies.

**508.4.1 Occupancy classification.** Separated occupancies shall be individually classified in accordance with Section 302.1. Each separated space shall comply with this code based on the occupancy classification of that portion of the building. The most restrictive provisions of Chapter 9 that apply to the separate occupancies shall apply to the total nonfire-barrier-separated occupancy areas. Occupancy separations that serve to define *fire area* limits established in Chapter 9 for requiring a *fire protection system* shall also comply with Section 901.7.

**508.4.2 Allowable building area.** In each *story*, the *building area* shall be such that the sum of the ratios of the actual *building area* of each separated occupancy divided by the allowable *building area* of each separated occupancy shall not exceed 1.

**508.4.3 Allowable building height and number of stories.** Each separated occupancy shall comply with the

*building height limitations* and *story limitations* based on the type of construction of the building in accordance with Section 503.1.

**Exception:** Special provisions of Section 510 shall permit occupancies at *building heights* and number of *stories* other than provided in Section 503.1.

**508.4.4 Separation.** Individual occupancies shall be separated from adjacent occupancies in accordance with Table 508.4.

**508.4.4.1 Construction.** Required separations shall be *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both, so as to completely separate adjacent occupancies. *Mass timber* elements serving as *fire barriers* or *horizontal assemblies* to separate occupancies in Type IV-B or IV-C construction shall be separated from the interior of the building with an *approved* thermal barrier consisting of *gypsum board* that is not less than 1/2 inch (12.7 mm) in thickness or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

**508.5 Live/work units** A *live/work unit* shall comply with Sections 508.5 through 508.5.11.

**Exception:** *Dwelling or sleeping units* that include an office that is less than 10 percent of the area of the *dwelling unit* are permitted to be classified as *dwelling units* with accessory occupancies in accordance with Section 508.2.

**508.5.1 Limitations.** The following shall apply to live/work areas:

1. The *live/work unit* is permitted to be not greater than 3,000 square feet (279 m<sup>2</sup>) in area.
2. The nonresidential area is permitted to be not more than 50 percent of the area of each *live/work unit*.
3. The nonresidential area function shall be limited to the first or main floor only of the *live/work unit*.
4. Not more than five nonresidential workers or employees are allowed to occupy the nonresidential area at any one time.

**508.5.2 Occupancies.** *Live/work units* shall be classified as a Group R-2 occupancy. Separation requirements found in Sections 420 and 508 shall not apply within the *live/work unit* where the *live/work unit* is in compliance with Section 508.5. Nonresidential uses that would otherwise be classified as either a Group H or S occupancy shall not be permitted in a *live/work unit*.

**Exception:** Storage shall be permitted in the *live/work unit* provided that the aggregate area of storage in the nonresidential portion of the *live/work unit* shall be limited to 10 percent of the space dedicated to nonresidential activities.

**508.5.3 Means of egress.** Except as modified by this section, the *means of egress* components for a *live/work unit* shall be designed in accordance with Chapter 10 for the function served.

TABLE 508.4  
REQUIRED SEPARATION OF OCCUPANCIES (HOURS)<sup>f</sup>

OCCUPANCY	A, E		I-1 <sup>a</sup> , I-3, I-4		I-2		R <sup>a</sup>		F-2, S-2 <sup>b</sup> , U		B <sup>c</sup> , F-1, M, S-1		H-1		H-2		H-3, H-4		H-5	
	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS	S	NS
A, E	N	N	1	2	2	NP	1	2	N	1	1	2	NP	NP	3	4	2	3	2	NP
I-1 <sup>a</sup> , I-3, I-4	1	2	N	N	2	NP	1	NP	1	2	1	2	NP	NP	3	NP	2	NP	2	NP
I-2	2	NP	2	NP	N	N	2	NP	2	NP	2	NP	NP	NP	3	NP	2	NP	2	NP
R <sup>a</sup>	1	2	1	NP	2	NP	N	N	1 <sup>c</sup>	2 <sup>c</sup>	1	2	NP	NP	3	NP	2	NP	2	NP
F-2, S-2 <sup>b</sup> , U	N	1	1	2	2	NP	1 <sup>c</sup>	2 <sup>c</sup>	N	N	1	2	NP	NP	3	4	2	3	2	NP
B <sup>c</sup> , F-1, M, S-1	1	2	1	2	2	NP	1	2	1	2	N	N	NP	NP	2	3	1	2	1	NP
H-1	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	NP	N	NP	NP	NP	NP	NP	NP	NP
H-2	3	4	3	NP	3	NP	3	NP	3	4	2	3	NP	NP	N	NP	1	NP	1	NP
H-3, H-4	2	3	2	NP	2	NP	2	NP	2	3	1	2	NP	NP	1	NP	1 <sup>d</sup>	NP	1	NP
H-5	2	NP	2	NP	2	NP	2	NP	2	NP	1	NP	NP	NP	1	NP	1	NP	N	NP

S = Buildings equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

NS = Buildings not equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1.

N = No separation requirement.

NP = Not Permitted.

a. See Section 420.

b. The required separation from areas used only for private or pleasure vehicles shall be reduced by 1 hour but not to less than 1 hour.

c. See Sections 406.3.2 and 406.6.4.

d. Separation is not required between occupancies of the same classification.

e. See Section 422.2 for *ambulatory care facilities*.

f. Occupancy separations that serve to define fire area limits established in Chapter 9 for requiring fire protection systems shall also comply with Section 707.3.10 and Table 707.3.10 in accordance with Section 901.7.

## GENERAL BUILDING HEIGHTS AND AREAS

**508.5.4 Egress capacity.** The egress capacity for each element of the *live/work unit* shall be based on the *occupant load* for the function served in accordance with Table 1004.5.

**508.5.5 Spiral stairways.** *Spiral stairways* that conform to the requirements of Section 1011.10 shall be permitted.

**508.5.6 Vertical openings.** Floor openings between floor levels of a *live/work unit* are permitted without enclosure.

**[F] 508.5.7 Fire protection.** The *live/work unit* shall be provided with a monitored *fire alarm* system where required by Section 907.2.9 and an *automatic sprinkler system* in accordance with Section 903.2.8.

**508.5.8 Structural.** Floors within a *live/work unit* shall be designed for the *live loads* in Table 1607.1, based on the function within the space.

**508.5.9 Accessibility.** *Accessibility* shall be designed in accordance with Chapter 11 for the function served.

**508.5.10 Ventilation.** The applicable *ventilation* requirements of the *International Mechanical Code* shall apply

to each area within the *live/work unit* for the function within that space.

**508.5.11 Plumbing facilities.** The nonresidential area of the *live/work unit* shall be provided with minimum plumbing facilities as specified by Chapter 29, based on the function of the nonresidential area. Where the nonresidential area of the *live/work unit* is required to be accessible by Section 1108.6.2.1, the plumbing fixtures specified by Chapter 29 shall be accessible.

SECTION 509  
INCIDENTAL USES

**509.1 General** Incidental uses located within single occupancy or mixed occupancy buildings shall comply with the provisions of this section. Incidental uses are ancillary functions associated with a given occupancy that generally pose a greater level of risk to that occupancy and are limited to those uses specified in Table 509.1.

**Exception:** Incidental uses within and serving a *dwelling unit* are not required to comply with this section.

[F]TABLE 509.1  
INCIDENTAL USES

ROOM OR AREA	SEPARATION AND/OR PROTECTION
Furnace room where any piece of equipment is over 400,000 Btu per hour input	1 hour or provide automatic sprinkler system
Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower	1 hour or provide automatic sprinkler system
Refrigerant machinery room	1 hour or provide automatic sprinkler system
Hydrogen fuel gas rooms, not classified as Group H	1 hour in Group B, F, M, S and U occupancies; 2 hours in Group A, E, I and R occupancies.
Incinerator rooms	2 hours and provide automatic sprinkler system
Paint shops, not classified as Group H, located in occupancies other than Group F	2 hours; or 1 hour and provide automatic sprinkler system
In Group E occupancies, laboratories and vocational shops not classified as Group H	1 hour or provide automatic sprinkler system
In Group I-2 occupancies, laboratories not classified as Group H	1 hour and provide automatic sprinkler system
In <i>ambulatory care facilities</i> , laboratories not classified as Group H	1 hour or provide automatic sprinkler system
Laundry rooms over 100 square feet	1 hour or provide automatic sprinkler system
In Group I-2, laundry rooms over 100 square feet	1 hour
Group I-3 cells and Group I-2 patient rooms equipped with padded surfaces	1 hour
In Group I-2, physical plant maintenance shops	1 hour
In ambulatory care facilities or Group I-2 occupancies, waste and linen collection rooms with containers that have an aggregate volume of 10 cubic feet or greater	1 hour
In other than ambulatory care facilities and Group I-2 occupancies, waste and linen collection rooms over 100 square feet	1 hour or provide automatic sprinkler system
In ambulatory care facilities or Group I-2 occupancies, storage rooms greater than 100 square feet	1 hour
Electrical installations and transformers	See Sections 110.26 through 110.34 and Sections 450.8 through 450.48 of NFPA 70 for protection and separation requirements.

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square inch (psi) = 6.9 kPa, 1 British thermal unit (Btu) per hour = 0.293 watts, 1 horsepower = 746 watts, 1 gallon = 3.785 L, 1 cubic foot = 0.0283 m<sup>3</sup>.



**509.2 Occupancy classification.** Incidental uses shall not be individually classified in accordance with Section 302.1. Incidental uses shall be included in the building occupancies within which they are located.

**509.3 Area limitations.** Incidental uses shall not occupy more than 10 percent of the *building area* of the *story* in which they are located.

**509.4 Separation and protection.** The incidental uses specified in Table 509.1 shall be separated from the remainder of the building or equipped with an *automatic sprinkler system*, or both, in accordance with the provisions of that table.

**509.4.1 Separation.** Where Table 509.1 specifies a fire-resistance-rated separation, the incidental uses shall be separated from the remainder of the *building* by a *fire barrier* constructed in accordance with Section 707 or a *horizontal assembly* constructed in accordance with Section 711, or both. Construction supporting 1-hour *fire barriers* or *horizontal assemblies* used for incidental use separations in buildings of Type IIB, IIIB and VB construction is not required to be fire-resistance rated unless required by other sections of this code.

**509.4.1.1 Type IV-B and IV-C construction.** Where Table 509.1 specifies a fire-resistance-rated separation, *mass timber* elements serving as *fire barriers* or *horizontal assemblies* in Type IV-B or IV-C construction shall be separated from the interior of the incidental use with an *approved* thermal barrier consisting of *gypsum board* that is not less than 1/2 inch (12.7 mm) in thickness or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

**509.4.2 Protection.** Where Table 509.1 permits an *automatic sprinkler system* without a *fire barrier*, the incidental uses shall be separated from the remainder of the building by construction capable of resisting the passage of smoke. The walls shall extend from the top of the foundation or floor assembly below to the underside of the ceiling that is a component of a fire-resistance-rated floor assembly or roof assembly above or to the underside of the floor or roof sheathing, deck or slab above. Doors shall be self- or automatic-closing upon detection of smoke in accordance with Section 716.2.6.6. Doors shall not have air transfer openings and shall not be undercut in excess of the clearance permitted in accordance with NFPA 80. Walls surrounding the incidental use shall not have air transfer openings unless provided with *smoke dampers* in accordance with Section 710.8.

**509.4.2.1 Protection limitation.** Where an *automatic sprinkler system* is provided in accordance with Table 509.1, only the space occupied by the incidental use need be equipped with such a system.

## SECTION 510 SPECIAL PROVISIONS

**510.1 General.** The provisions in Sections 510.2 through 510.9 shall permit the use of special conditions that are

exempt from, or modify, the specific requirements of this chapter regarding the allowable *building heights and areas* of buildings based on the occupancy classification and type of construction, provided the special condition complies with the provisions specified in this section for such condition and other applicable requirements of this code. The provisions of Sections 510.2 through 510.8 are to be considered independent and separate from each other.

**510.2 Horizontal building separation allowance.** A building shall be considered as separate and distinct buildings for the purpose of determining area limitations, continuity of *fire walls*, limitation of number of *stories* and type of construction where the following conditions are met:

1. The buildings are separated with a *horizontal assembly* having a *fire-resistance rating* of not less than 3 hours. Where vertical offsets are provided as part of a *horizontal assembly*, the vertical offset and the structure supporting the vertical offset shall have a *fire-resistance rating* of not less than 3 hours.
2. The building below, including the *horizontal assembly*, is of Type IA construction.
3. *Shaft, stairway, ramp* and escalator enclosures through the *horizontal assembly* shall have not less than a 2-hour *fire-resistance rating* with opening protectives in accordance with Section 716.

**Exception:** Where the enclosure walls below the *horizontal assembly* have not less than a 3-hour *fire-resistance rating* with opening protectives in accordance with Section 716, the enclosure walls extending above the *horizontal assembly* shall be permitted to have a 1-hour *fire-resistance rating*, provided that the following conditions are met:

1. The building above the *horizontal assembly* is not required to be of Type I construction.
2. The enclosure connects fewer than four stories.
3. The enclosure opening protectives above the *horizontal assembly* have a *fire protection rating* of not less than 1 hour.
4. *Interior exit stairways* located within the Type IA building are permitted to be of combustible materials where the following requirements are met:
  - 4.1. The building above the Type IA building is of Type III, IV, or V construction.
  - 4.2. The *stairway* located in the Type IA building is enclosed by 3-hour fire-resistance-rated construction with opening protectives in accordance with Section 716.
5. The building or buildings above the *horizontal assembly* shall be permitted to have multiple Group A occupancy uses, each with an *occupant load* of less than 300, or Group B, M, R or S occupancies.
6. The building below the *horizontal assembly* shall be protected throughout by an *approved automatic*

## GENERAL BUILDING HEIGHTS AND AREAS

*sprinkler system* in accordance with Section 903.3.1.1, and shall be permitted to be any occupancy allowed by this code except Group H.

7. The maximum *building height* in feet (mm) shall not exceed the limits set forth in Section 504.3 for the building having the smaller allowable height as measured from the *grade plane*.

**510.3 Group S-2 enclosed parking garage with Group S-2 open parking garage above.** A Group S-2 enclosed parking garage with not more than one *story above grade plane* and located below a Group S-2 *open parking garage* shall be classified as a separate and distinct building for the purpose of determining the type of construction where the following conditions are met:

1. The allowable area of the building shall be such that the sum of the ratios of the actual area divided by the allowable area for each separate occupancy shall not exceed 1.
2. The Group S-2 enclosed parking garage is of Type I or II construction and is at least equal to the *fire-resistance* requirements of the Group S-2 *open parking garage*.
3. The height and the number of tiers of the Group S-2 *open parking garage* shall be limited as specified in Table 406.5.4.
4. The floor assembly separating the Group S-2 enclosed parking garage and Group S-2 *open parking garage* shall be protected as required for the floor assembly of the Group S-2 enclosed parking garage. Openings between the Group S-2 enclosed parking garage and Group S-2 *open parking garage*, except exit openings, shall not be required to be protected.
5. The Group S-2 enclosed parking garage is used exclusively for the parking or storage of private motor vehicles, but shall be permitted to contain an office, waiting room and toilet room having a total area of not more than 1,000 square feet (93 m<sup>2</sup>) and mechanical equipment rooms associated with the operation of the building.

**510.4 Parking beneath Group R.** Where a maximum one *story above grade plane* Group S-2 parking garage, enclosed or open, or combination thereof, of Type I construction or open of Type IV construction, with grade entrance, is provided under a building of Group R, the number of *stories* to be used in determining the minimum type of construction shall be measured from the floor above such a parking area. The floor assembly between the parking garage and the Group R above shall comply with the type of construction required for the parking garage and shall also provide a *fire-resistance rating* not less than the mixed occupancy separation required in Section 508.4.

**510.5 Group R-1 and R-2 buildings of Type IIIA construction.** For buildings of Type IIIA construction in Groups R-1 and R-2, the maximum allowable height in Table 504.3 shall be increased by 10 feet (3048 mm) and the maximum allowable number of *stories* in Table 504.4 shall be increased by one where the first-floor assembly above the

*basement* has a *fire-resistance rating* of not less than 3 hours and the floor area is subdivided by 2-hour fire-resistance-rated *fire walls* into areas of not more than 3,000 square feet (279 m<sup>2</sup>).

**510.6 Group R-1 and R-2 buildings of Type IIA construction.** The height limitation for buildings of Type IIA construction in Groups R-1 and R-2 shall be increased to nine *stories* and 100 feet (30 480 mm) where the building is separated by not less than 50 feet (15 240 mm) from any other building on the *lot* and from *lot lines*, the *exits* are segregated in an area enclosed by a 2-hour fire-resistance-rated *fire wall* and the first floor assembly has a *fire-resistance rating* of not less than 1½ hours.

**510.7 Open parking garage beneath Groups A, I, B, M and R.** *Open parking garages* constructed under Groups A, I, B, M and R shall not exceed the height and area limitations permitted under Section 406.5. The height and area of the portion of the building above the *open parking garage* shall not exceed the limitations in Section 503 for the upper occupancy. The height, in both feet and *stories*, of the portion of the building above the *open parking garage* shall be measured from *grade plane* and shall include both the *open parking garage* and the portion of the building above the parking garage.

**510.7.1 Fire separation.** *Fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711 between the parking occupancy and the upper occupancy shall correspond to the required *fire-resistance rating* prescribed in Table 508.4 for the uses involved. The type of construction shall apply to each occupancy individually, except that structural members, including main bracing within the open parking structure, which is necessary to support the upper occupancy, shall be protected with the more restrictive fire-resistance-rated assemblies of the groups involved as shown in Table 601. *Means of egress* for the upper occupancy shall conform to Chapter 10 and shall be separated from the parking occupancy by *fire barriers* having not less than a 2-hour *fire-resistance rating* as required by Section 707 with *self-closing doors* complying with Section 716 or *horizontal assemblies* having not less than a 2-hour *fire-resistance rating* as required by Section 711, with *self-closing doors* complying with Section 716. *Means of egress* from the *open parking garage* shall comply with Section 406.5.

**510.8 Group B or M buildings with Group S-2 open parking garage above.** Group B or M occupancies located below a Group S-2 *open parking garage* of a lesser type of construction shall be considered as a separate and distinct building from the Group S-2 *open parking garage* for the purpose of determining the type of construction where the following conditions are met:

1. The buildings are separated with a *horizontal assembly* having a *fire-resistance rating* of not less than 2 hours.
2. The occupancies in the building below the *horizontal assembly* are limited to Groups B and M.

3. The occupancy above the *horizontal assembly* is limited to a Group S-2 *open parking garage*.
4. The building below the *horizontal assembly* is of Type IA construction.

**Exception:** The building below the *horizontal assembly* shall be permitted to be of Type IB or II construction, but not less than the type of construction required for the Group S-2 *open parking garage* above, where the building below is not greater than *one story* in height above *grade plane*.

5. The height and area of the building below the *horizontal assembly* does not exceed the limits set forth in Section 503.
6. The height and area of the Group S-2 *open parking garage* does not exceed the limits set forth in Section 406.5. The height, in both feet and *stories*, of the Group S-2 *open parking garage* shall be measured from *grade plane* and shall include the building below the *horizontal assembly*.
7. *Exits* serving the Group S-2 *open parking garage* shall discharge at grade with direct and unobstructed access to a street or *public way* and are separated from the building below the *horizontal assembly* by 2-hour *fire barriers* constructed in accordance with Section 707 or 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

#### **510.9 Multiple buildings above a horizontal assembly.**

Where two or more buildings are provided above the *horizontal assembly* separating a Group S-2 parking garage or building below from the buildings above in accordance with the special provisions in Section 510.2, 510.3 or 510.8, the buildings above the *horizontal assembly* shall be regarded as separate and distinct buildings from each other and shall comply with all other provisions of this code as applicable to each separate and distinct building.





## CHAPTER 6

# TYPES OF CONSTRUCTION

### User note:

**About this chapter:** Chapter 6 establishes five types of construction in which each building must be categorized. This chapter looks at the materials used in the building (combustible or noncombustible) and the extent to which building elements such as the building frame, roof, wall and floor can resist fire. Depending on the type of construction and the specific building element, fire resistance of 1 to 3 hours is specified.

### SECTION 601 GENERAL

**601.1 Scope.** The provisions of this chapter shall control the classification of buildings as to type of construction.

### SECTION 602 CONSTRUCTION CLASSIFICATION

**602.1 General.** Buildings and structures erected or to be erected, altered or extended in height or area shall be classified in one of the five *construction types* defined in Sections 602.2 through 602.5. The *building elements* shall have a *fire-resistance rating* not less than that specified in Table 601 and *exterior walls* shall have a *fire-resistance rating* not less than that specified in Table 705.5. Where required to have a *fire-resistance rating* by Table 601, *building elements* shall comply with the applicable provisions of Section 703.2. The protection of openings, ducts and air transfer openings in

*building elements* shall not be required unless required by other provisions of this code.

**602.1.1 Minimum requirements.** A building or portion thereof shall not be required to conform to the details of a type of construction higher than that type which meets the minimum requirements based on occupancy even though certain features of such a building actually conform to a higher type of construction.

**602.2 Types I and II.** Types I and II construction are those types of construction in which the *building elements* specified in Table 601 are of noncombustible materials, except as permitted in Section 603 and elsewhere in this code.

**602.3 Type III.** Type III construction is that type of construction in which the *exterior walls* are of noncombustible materials and the interior *building elements* are of any material permitted by this code. *Fire-retardant-treated wood* framing and sheathing complying with Section 2303.2 shall be permitted within *exterior wall* assemblies of a 2-hour rating or less.

**TABLE 601  
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)**

BUILDING ELEMENT	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame <sup>f</sup> (see Section 202)	3 <sup>a, b</sup>	2 <sup>a, b, c</sup>	1 <sup>b, c</sup>	0 <sup>c</sup>	1 <sup>b, c</sup>	0	3 <sup>a</sup>	2 <sup>a</sup>	2 <sup>a</sup>	HT	1 <sup>b, c</sup>	0
Bearing walls												
Exterior <sup>e, f</sup>	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3 <sup>a</sup>	2 <sup>a</sup>	1	0	1	0	3	2	2	1/HT <sup>g</sup>	1	0
Nonbearing walls and partitions Exterior	See Table 705.5											
Nonbearing walls and partitions Interior <sup>d</sup>	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1 1/2 <sup>b</sup>	1 <sup>b, c</sup>	1 <sup>b, c</sup>	0 <sup>c</sup>	1 <sup>b, c</sup>	0	1 1/2	1	1	HT	1 <sup>b, c</sup>	0

For SI: 1 foot = 304.8 mm.

- Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.
- Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.
- In all occupancies, heavy timber complying with Section 2304.11 shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.
- Not less than the fire-resistance rating required by other sections of this code.
- Not less than the fire-resistance rating based on fire separation distance (see Table 705.5).
- Not less than the fire-resistance rating as referenced in Section 704.10.
- Heavy timber bearing walls supporting more than two floors or more than a floor and a roof shall have a fire resistance rating of not less than 1 hour.

## TYPES OF CONSTRUCTION

**602.4 Type IV.** Type IV construction is that type of construction in which the *building elements* are *mass timber* or noncombustible materials and have *fire-resistance ratings* in accordance with Table 601. *Mass timber* elements shall meet the *fire-resistance-rating* requirements of this section based on either the *fire-resistance rating* of the *noncombustible protection*, the *mass timber*, or a combination of both and shall be determined in accordance with Section 703.2. The minimum dimensions and permitted materials for *building elements* shall comply with the provisions of this section and Section 2304.11. *Mass timber* elements of Types IV-A, IV-B and IV-C construction shall be protected with *noncombustible protection* applied directly to the *mass timber* in accordance with Sections 602.4.1 through 602.4.3. The time assigned to the *noncombustible protection* shall be determined in accordance with Section 703.6 and comply with Section 722.7.

*Cross-laminated timber* shall be labeled as conforming to ANSI/APA PRG 320 as referenced in Section 2303.1.4.

Exterior *load-bearing walls* and *nonload-bearing walls* shall be *mass timber* construction, or shall be of noncombustible construction.

**Exception:** Exterior load-bearing walls and nonload-bearing walls of Type IV-HT Construction in accordance with Section 602.4.4.

The interior *building elements*, including *nonload-bearing walls* and partitions, shall be of *mass timber* construction or of noncombustible construction.

**Exception:** Interior building elements and nonload-bearing walls and partitions of Type IV-HT construction in accordance with Section 602.4.4.

Combustible concealed spaces are not permitted except as otherwise indicated in Sections 602.4.1 through 602.4.4. Combustible stud spaces within light frame walls of Type IV-HT construction shall not be considered concealed spaces, but shall comply with Section 718.

In buildings of Type IV-A, IV-B, and IV-C construction with an occupied floor located more than 75 feet (22 860 mm) above the lowest level of fire department access, up to and including 12 *stories* or 180 feet (54 864 mm) above *grade plane*, *mass timber* interior exit and elevator hoistway enclosures shall be protected in accordance with Section 602.4.1.2. In buildings greater than 12 *stories* or 180 feet (54 864 mm) above *grade plane*, interior exit and elevator hoistway enclosures shall be constructed of noncombustible materials.

**602.4.1 Type IV-A.** *Building elements* in Type IV-A construction shall be protected in accordance with Sections 602.4.1.1 through 602.4.1.6. The required *fire-resistance rating* of noncombustible elements and protected *mass timber* elements shall be determined in accordance with Section 703.2.

**602.4.1.1 Exterior protection.** The outside face of *exterior walls* of *mass timber* construction shall be protected with *noncombustible protection* with a minimum assigned time of 40 minutes, as specified in Table 722.7.1(1). Components of the *exterior wall*

*covering* shall be of noncombustible material except *water-resistive barriers* having a peak heat release rate of less than 150kW/m<sup>2</sup>, a total heat release of less than 20 MJ/m<sup>2</sup> and an effective heat of combustion of less than 18MJ/kg as determined in accordance with ASTM E1354 and having a *flame spread index* of 25 or less and a *smoke-developed index* of 450 or less as determined in accordance with ASTM E84 or UL 723. The ASTM E1354 test shall be conducted on specimens at the thickness intended for use, in the horizontal orientation and at an incident radiant heat flux of 50 kW/m<sup>2</sup>.

**602.4.1.2 Interior protection.** Interior faces of all *mass timber* elements, including the inside faces of exterior *mass timber* walls and *mass timber* roofs, shall be protected with materials complying with Section 703.3.

**602.4.1.2.1 Protection time.** *Noncombustible protection* shall contribute a time equal to or greater than times assigned in Table 722.7.1(1), but not less than 80 minutes. The use of materials and their respective protection contributions specified in Table 722.7.1(2) shall be permitted to be used for compliance with Section 722.7.1.

**602.4.1.3 Floors.** The floor assembly shall contain a noncombustible material not less than 1 inch (25 mm) in thickness above the *mass timber*. Floor finishes in accordance with Section 804 shall be permitted on top of the noncombustible material. The underside of floor assemblies shall be protected in accordance with Section 602.4.1.2.

**602.4.1.4 Roofs.** The *interior surfaces* of *roof assemblies* shall be protected in accordance with Section 602.4.1.2. *Roof coverings* in accordance with Chapter 15 shall be permitted on the outside surface of the *roof assembly*.

**602.4.1.5 Concealed spaces.** Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the *International Mechanical Code*, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected in accordance with Section 602.4.1.2.

**602.4.1.6 Shafts.** *Shafts* shall be permitted in accordance with Sections 713 and 718. Both the *shaft* side and room side of *mass timber* elements shall be protected in accordance with Section 602.4.1.2.

**602.4.2 Type IV-B.** *Building elements* in Type IV-B construction shall be protected in accordance with Sections 602.4.2.1 through 602.4.2.6. The required *fire-resistance rating* of noncombustible elements or *mass timber* elements shall be determined in accordance with Section 703.2.

**602.4.2.1 Exterior protection.** The outside face of *exterior walls* of *mass timber* construction shall be

protected with *noncombustible protection* with a minimum assigned time of 40 minutes, as specified in Table 722.7.1(1). Components of the *exterior wall covering* shall be of noncombustible material except *water-resistive barriers* having a peak heat release rate of less than 150kW/m<sup>2</sup>, a total heat release of less than 20 MJ/m<sup>2</sup> and an effective heat of combustion of less than 18MJ/kg as determined in accordance with ASTM E1354, and having a *flame spread index* of 25 or less and a *smoke-developed index* of 450 or less as determined in accordance with ASTM E84 or UL 723. The ASTM E1354 test shall be conducted on specimens at the thickness intended for use, in the horizontal orientation and at an incident radiant heat flux of 50 kW/m<sup>2</sup>.

**602.4.2.2 Interior protection.** Interior faces of all *mass timber* elements, including the inside face of exterior *mass timber* walls and *mass timber* roofs, shall be protected, as required by this section, with materials complying with Section 707.3.

**602.4.2.2.1 Protection time.** *Noncombustible protection* shall contribute a time equal to or greater than times assigned in Table 722.7.1(1), but not less than 80 minutes. The use of materials and their respective protection contributions specified in Table 722.7.1(2) shall be permitted to be used for compliance with Section 722.7.1.

**602.4.2.2.2 Protected area.** Interior faces of *mass timber* elements, including the inside face of exterior *mass timber* walls and *mass timber* roofs, shall be protected in accordance with Section 602.4.2.2.1.

**Exceptions:** Unprotected portions of mass timber ceilings and walls complying with Section 602.4.2.2.4 and the following:

1. Unprotected portions of mass timber ceilings and walls complying with one of the following:
  - 1.1. Unprotected portions of mass timber ceilings, including attached beams, shall be permitted and shall be limited to an area equal to 20 percent of the floor area in any dwelling unit or fire area.
  - 1.2. Unprotected portions of mass timber walls, including attached columns, shall be permitted and shall be limited to an area equal to 40 percent of the floor area in any dwelling unit or fire area.
  - 1.3. Unprotected portions of both walls and ceilings of mass timber, including attached columns and beams, in any dwelling unit or fire area shall be permitted in accordance with Section 602.4.2.2.3.
2. Mass timber columns and beams that are not an integral portion of walls or ceil-

ings, respectively, shall be permitted to be unprotected without restriction of either aggregate area or separation from one another.

**602.4.2.2.3 Mixed unprotected areas.** In each *dwelling unit* or *fire area*, where both portions of ceilings and portions of walls are unprotected, the total allowable unprotected area shall be determined in accordance with Equation 6-1.

$$(U_{tc}/U_{ac}) + (U_{tw}/U_{aw}) \leq 1 \quad (\text{Equation 6-1})$$

where:

$U_{tc}$  = Total unprotected mass timber ceiling areas.

$U_{ac}$  = Allowable unprotected mass timber ceiling area conforming to Exception 1.1 of Section 602.4.2.2.2.

$U_{tw}$  = Total unprotected mass timber wall areas.

$U_{aw}$  = Allowable unprotected mass timber wall area conforming to Exception 1.2 of Section 602.4.2.2.2.

**602.4.2.2.4 Separation distance between unprotected mass timber elements.** In each *dwelling unit* or *fire area*, unprotected portions of *mass timber* walls and ceilings shall be not less than 15 feet (4572 mm) from unprotected portions of other walls and ceilings, measured horizontally along the ceiling and from other unprotected portions of walls measured horizontally along the floor.

**602.4.2.3 Floors.** The floor assembly shall contain a noncombustible material not less than 1 inch (25 mm) in thickness above the *mass timber*. Floor finishes in accordance with Section 804 shall be permitted on top of the noncombustible material. The underside of floor assemblies shall be protected in accordance with Section 602.4.1.2.

**602.4.2.4 Roofs.** The *interior surfaces* of roof assemblies shall be protected in accordance with Section 602.4.2.2 except, in nonoccupiable spaces, they shall be treated as a concealed space with no portion left unprotected. *Roof coverings* in accordance with Chapter 15 shall be permitted on the outside surface of the roof assembly.

**602.4.2.5 Concealed spaces.** Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the *International Mechanical Code*, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected in accordance with Section 602.4.1.2.

**602.4.2.6 Shafts.** *Shafts* shall be permitted in accordance with Sections 713 and 718. Both the *shaft* side and room side of *mass timber* elements shall be protected in accordance with Section 602.4.1.2.

## TYPES OF CONSTRUCTION

**602.4.3 Type IV-C.** *Building elements* in Type IV-C construction shall be protected in accordance with Sections 602.4.3.1 through 602.4.3.6. The required *fire-resistance rating of building elements* shall be determined in accordance with Section 703.2.

**602.4.3.1 Exterior protection.** The exterior side of walls of combustible construction shall be protected with *noncombustible protection* with a minimum assigned time of 40 minutes, as determined in Table 722.7.1(1). Components of the *exterior wall covering* shall be of noncombustible material except *water-resistive barriers* having a peak heat release rate of less than 150 kW/m<sup>2</sup>, a total heat release of less than 20 MJ/m<sup>2</sup> and an effective heat of combustion of less than 18 MJ/kg as determined in accordance with ASTM E1354 and having a *flame spread index* of 25 or less and a *smoke-developed index* of 450 or less as determined in accordance with ASTM E84 or UL 723. The ASTM E1354 test shall be conducted on specimens at the thickness intended for use, in the horizontal orientation and at an incident radiant heat flux of 50 kW/m<sup>2</sup>.

**602.4.3.2 Interior protection.** *Mass timber* elements are permitted to be unprotected.

**602.4.3.3 Floors.** Floor finishes in accordance with Section 804 shall be permitted on top of the floor construction.

**602.4.3.4 Roof coverings.** *Roof coverings* in accordance with Chapter 15 shall be permitted on the outside surface of the roof assembly.

**602.4.3.5 Concealed spaces.** Concealed spaces shall not contain combustibles other than electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the *International Mechanical Code*, and shall comply with all applicable provisions of Section 718. Combustible construction forming concealed spaces shall be protected with *noncombustible protection* with a minimum assigned time of 40 minutes, as specified in Table 722.7.1(1).

**602.4.3.6 Shafts.** *Shafts* shall be permitted in accordance with Sections 713 and 718. *Shafts* and elevator hoistway and *interior exit stairway enclosures* shall be protected with *noncombustible protection* with a minimum assigned time of 40 minutes, as specified in Table 722.7.1(1), on both the inside of the *shaft* and the outside of the *shaft*.

**602.4.4 Type IV-HT.** Type IV-HT (Heavy Timber) construction is that type of construction in which the *exterior walls* are of noncombustible materials and the interior *building elements* are of solid wood, laminated heavy timber or *structural composite lumber* (SCL), without concealed spaces or with concealed spaces complying with Section 602.4.4.3. The minimum dimensions for permitted materials including solid timber, glued-laminated timber, SCL and *cross-laminated timber* (CLT) and

the details of Type IV construction shall comply with the provisions of this section and Section 2304.11. *Exterior walls* complying with Section 602.4.4.1 or 602.4.4.2 shall be permitted. Interior walls and partitions not less than 1-hour fire-resistance rated or heavy timber conforming with Section 2304.11.2.2 shall be permitted.

**602.4.4.1 Fire-retardant-treated wood in exterior walls.** *Fire-retardant-treated wood* framing and sheathing complying with Section 2303.2 shall be permitted within *exterior wall* assemblies with a 2-hour rating or less.

**602.4.4.2 Cross-laminated timber in exterior walls.** *Cross-laminated timber* (CLT) not less than 4 inches (102 mm) in thickness complying with Section 2303.1.4 shall be permitted within *exterior wall* assemblies with a 2-hour rating or less. Heavy timber structural members appurtenant to the CLT *exterior wall* shall meet the requirements of Table 2304.11 and be fire-resistance rated as required for the *exterior wall*. The exterior surface of the cross-laminated timber and heavy timber elements shall be protected by one the following:

1. *Fire-retardant-treated wood* sheathing complying with Section 2303.2 and not less than <sup>15</sup>/<sub>32</sub> inch (12 mm) thick.
2. *Gypsum board* not less than <sup>1</sup>/<sub>2</sub> inch (12.7 mm) thick.
3. A noncombustible material.

**602.4.4.3 Concealed spaces.** Concealed spaces shall not contain combustible materials other than *building elements* and electrical, mechanical, fire protection, or plumbing materials and equipment permitted in plenums in accordance with Section 602 of the *International Mechanical Code*. Concealed spaces shall comply with applicable provisions of Section 718. Concealed spaces shall be protected in accordance with one or more of the following:

1. The building shall be sprinklered throughout in accordance with Section 903.3.1.1 and automatic sprinklers shall also be provided in the concealed space.
2. The concealed space shall be completely filled with noncombustible insulation.
3. Surfaces within the concealed space shall be fully sheathed with not less than <sup>5</sup>/<sub>8</sub>-inch Type X gypsum board.

**Exception:** Concealed spaces within interior walls and partitions with a 1-hour or greater fire-resistance rating complying with Section 2304.11.2.2 shall not require additional protection.

**602.4.4.4 Exterior structural members.** Where a horizontal separation of 20 feet (6096 mm) or more is provided, wood columns and arches conforming to heavy timber sizes complying with Section 2304.11 shall be permitted to be used externally.



**602.5 Type V.** Type V construction is that type of construction in which the structural elements, *exterior walls* and interior walls are of any materials permitted by this code.

### SECTION 603 COMBUSTIBLE MATERIAL IN TYPES I AND II CONSTRUCTION

**603.1 Allowable materials.** Combustible materials shall be permitted in buildings of Type I or II construction in the following applications and in accordance with Sections 603.1.1 through 603.1.3:

1. *Fire-retardant-treated wood* shall be permitted in:
  - 1.1. Nonbearing partitions where the required *fire-resistance rating* is 2 hours or less except in *shaft enclosures* within Group I-2 occupancies and *ambulatory care facilities*.
  - 1.2. Nonbearing *exterior walls* where fire-resistance-rated construction is not required.
  - 1.3. Roof construction, including girders, trusses, framing and decking.

#### Exceptions:

1. In buildings of Type IA construction exceeding two *stories above grade plane*, *fire-retardant-treated wood* is not permitted in roof construction where the vertical distance from the upper floor to the roof is less than 20 feet (6096 mm).
2. Group I-2, roof construction containing *fire-retardant-treated wood* shall be covered by not less than a Class A *roof covering* or roof assembly, and the roof assembly shall have a *fire-resistance rating* where required by the construction type.
- 1.4. Balconies, porches, decks and exterior *stairways* not used as required exits on buildings three *stories* or less above grade plane.
2. Thermal and acoustical insulation, other than foam plastics, having a *flame spread index* of not more than 25.

#### Exceptions:

1. Insulation placed between two layers of noncombustible materials without an intervening airspace shall be allowed to have a *flame spread index* of not more than 100.
2. Insulation installed between a finished floor and solid decking without intervening airspace shall be allowed to have a *flame spread index* of not more than 200.

3. Foam plastics in accordance with Chapter 26.
4. *Roof coverings* that have an A, B or C classification.
5. *Interior floor finish* and floor covering materials installed in accordance with Section 804.
6. Millwork such as doors, door frames, window sashes and frames.
7. *Interior wall and ceiling finishes* installed in accordance with Section 803.
8. *Trim* installed in accordance with Section 806.
9. Where not installed greater than 15 feet (4572 mm) above grade, show windows, nailing or furring strips and wooden bulkheads below show windows, including their frames, aprons and show cases.
10. Finish flooring installed in accordance with Section 805.
11. Partitions dividing portions of stores, offices or similar places occupied by one tenant only and that do not establish a *corridor* serving an *occupant load* of 30 or more shall be permitted to be constructed of *fire-retardant-treated wood*, 1-hour fire-resistance-rated construction or of wood panels or similar light construction up to 6 feet (1829 mm) in height.
12. *Stages* and *platforms* constructed in accordance with Sections 410.2 and 410.3, respectively.
13. Combustible *exterior wall coverings*, balconies and similar projections and bay or oriel windows in accordance with Chapter 14 and Section 705.2.3.1.
14. Blocking such as for handrails, millwork, cabinets and window and door frames.
15. Light-transmitting plastics as permitted by Chapter 26.
16. Mastics and caulking materials applied to provide flexible seals between components of *exterior wall* construction.
17. Exterior plastic *veneer* installed in accordance with Section 2605.2.
18. Nailing or furring strips as permitted by Section 803.15.
19. Heavy timber as permitted by Note c to Table 601 and Sections 602.4.4.4 and 705.2.3.1.
20. Aggregates, component materials and admixtures as permitted by Section 703.2.1.2.
21. Sprayed fire-resistant materials and intumescent and mastic fire-resistant coatings, determined on the basis of *fire resistance* tests in accordance with Section 703.2 and installed in accordance with Sections 1705.15 and 1705.16, respectively.
22. Materials used to protect penetrations in fire-resistance-rated assemblies in accordance with Section 714.
23. Materials used to protect *joints* in fire-resistance-rated assemblies in accordance with Section 715.
24. Materials allowed in the concealed spaces of buildings of Types I and II construction in accordance with Section 718.5.

## TYPES OF CONSTRUCTION

25. Materials exposed within plenums complying with Section 602 of the *International Mechanical Code*.
26. Wall construction of freezers and coolers of less than 1,000 square feet (92.9 m<sup>2</sup>), in size, lined on both sides with noncombustible materials and the building is protected throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
27. Wood nailers for parapet flashing and roof cants.

**603.1.1 Ducts.** The use of nonmetallic ducts shall be permitted where installed in accordance with the limitations of the *International Mechanical Code*.

**603.1.2 Piping.** The use of combustible piping materials shall be permitted where installed in accordance with the limitations of the *International Mechanical Code* and the *International Plumbing Code*.

**603.1.3 Electrical.** The use of electrical wiring methods with combustible insulation, tubing, raceways and related components shall be permitted where installed in accordance with the limitations of this code.

## CHAPTER 7

# FIRE AND SMOKE PROTECTION FEATURES

### User note:

**About this chapter:** Chapter 7 provides detailed requirements for fire-resistance-rated construction, including structural members, walls, partitions and horizontal assemblies. Other portions of the code describe where certain fire-resistance-rated elements are required. This chapter specifies how these elements are constructed, how openings in walls and partitions are protected and how penetrations of such elements are protected.

### SECTION 701 GENERAL

**701.1 Scope.** The provisions of this chapter shall govern the materials, systems and assemblies used for structural *fire resistance* and fire-resistance-rated construction separation of adjacent spaces to safeguard against the spread of fire and smoke within a building and the spread of fire to or from buildings.

### SECTION 702 MULTIPLE-USE FIRE ASSEMBLIES

**702.1 Multiple-use fire assemblies.** Fire assemblies that serve multiple purposes in a building shall comply with all of the requirements that are applicable for each of the individual fire assemblies.

### SECTION 703 FIRE-RESISTANCE RATINGS AND FIRE TESTS

**703.1 Scope.** Materials prescribed herein for *fire resistance* shall conform to the requirements of this chapter.

**703.2 Fire resistance.** The *fire-resistance rating* of building elements, components or assemblies shall be determined in accordance with Section 703.2.1 or 703.2.2 without the use of automatic sprinklers or any other fire suppression system being incorporated, or in accordance with Section 703.2.3.

**703.2.1 Tested assemblies.** A *fire-resistance rating* of building elements, components or assemblies shall be determined by the test procedures set forth in ASTM E119 or UL 263. The *fire-resistance rating* of penetrations and *fire-resistant joint systems* shall be determined in accordance with Sections 714 and 715, respectively.

**703.2.1.1 Nonsymmetrical wall construction.** Interior walls and partitions of nonsymmetrical construction shall be tested with both faces exposed to the furnace, and the assigned *fire-resistance rating* shall be the shortest duration obtained from the two tests conducted in compliance with ASTM E119 or UL 263. Where evidence is furnished to show that the wall was tested with the least fire-resistant side exposed to

the furnace, subject to acceptance of the *building official*, the wall need not be subjected to tests from the opposite side (see Section 705.5 for *exterior walls*).

**703.2.1.2 Combustible components.** Combustible aggregates are permitted in gypsum and Portland cement concrete mixtures for fire-resistance-rated construction. Any component material or admixture is permitted in assemblies if the resulting tested assembly meets the *fire-resistance* test requirements of this code.

**703.2.1.3 Restrained classification.** Fire-resistance-rated assemblies tested under ASTM E119 or UL 263 shall not be considered to be restrained unless evidence satisfactory to the *building official* is furnished by the *registered design professional* showing that the construction qualifies for a restrained classification in accordance with ASTM E119 or UL 263. Restrained construction shall be identified on the *construction documents*.

**703.2.1.4 Supplemental features.** Where materials, systems or devices that have not been tested as part of a fire-resistance-rated assembly are incorporated into the *building element*, component or assembly, sufficient data shall be made available to the *building official* to show that the required *fire-resistance rating* is not reduced.

**703.2.1.5 Exterior bearing walls.** In determining the *fire-resistance rating* of exterior bearing walls, compliance with the ASTM E119 or UL 263 criteria for unexposed surface temperature rise and ignition of cotton waste due to passage of flame or gases is required only for a period of time corresponding to the required *fire-resistance rating* of an exterior nonbearing wall with the same *fire separation distance*, and in a building of the same group. Where the *fire-resistance rating* determined in accordance with this exception exceeds the *fire-resistance rating* determined in accordance with ASTM E119 or UL 263, the fire exposure time period, water pressure and application duration criteria for the hose stream test of ASTM E119 or UL 263 shall be based on the *fire-resistance rating* determined in accordance with this section.

## FIRE AND SMOKE PROTECTION FEATURES

**703.2.2 Analytical methods.** The fire resistance of *building elements*, components or assemblies established by an analytical method shall be by any of the methods listed in this section, based on the fire exposure and acceptance criteria specified in ASTM E119 or UL 263.

1. *Fire-resistance* designs documented in approved sources.
2. Prescriptive designs of fire-resistance-rated *building elements*, components or assemblies as prescribed in Section 721.
3. Calculations in accordance with Section 722.
4. Engineering analysis based on a comparison of *building element*, component or assemblies designs having *fire-resistance ratings* as determined by the test procedures set forth in ASTM E119 or UL 263.
5. *Fire-resistance* designs certified by an *approved agency*.

**703.2.3 Approved alternate method.** The *fire resistance* of *building elements*, components or assemblies not complying with Section 703.2.1 or 703.2.2 shall be permitted to be established by an alternative protection method in accordance with Section 104.11.

**703.3 Noncombustibility tests.** The tests indicated in Section 703.3.1 shall serve as criteria for acceptance of building materials as set forth in Sections 602.2, 602.3 and 602.4 in Types I, II, III and IV construction. The term “noncombustible” does not apply to the *flame spread* characteristics of *interior finish* or *trim* materials. A material shall not be classified as a noncombustible building construction material if it is subject to an increase in combustibility or *flame spread* beyond the limitations herein established through the effects of age, moisture or other atmospheric conditions.

**703.3.1 Noncombustible materials.** Materials required to be noncombustible shall be tested in accordance with ASTM E136. Alternately, materials required to be noncombustible shall be tested in accordance with ASTM E2652 using the acceptance criteria prescribed by ASTM E136.

**Exception:** Materials having a structural base of noncombustible material as determined in accordance with ASTM E136, or with ASTM E2652 using the acceptance criteria prescribed by ASTM E136, with a surfacing of not more than 0.125 inch (3.18 mm) in thickness having a flame spread index not greater than 50 when tested in accordance with ASTM E84 or UL 723 shall be acceptable as noncombustible.

**703.4 Fire-resistance-rated glazing.** Fire-resistance-rated glazing, when tested in accordance with ASTM E119 or UL 263 and complying with the requirements of Section 707, shall be permitted. Fire-resistance-rated glazing shall bear a *label* marked in accordance with Table 716.1(1) issued by an agency and shall be permanently identified on the glazing.

**703.5 Marking and identification.** Where there is an accessible concealed floor, floor-ceiling or *attic* space, *fire walls*, *fire barriers*, *fire partitions*, *smoke barriers* and *smoke parti-*

*tions* or any other wall required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling in the concealed space. Such identification shall:

1. Be located within 15 feet (4572 mm) of the end of each wall and at intervals not exceeding 30 feet (9144 mm) measured horizontally along the wall or partition.
2. Include lettering not less than 3 inches (76 mm) in height with a minimum  $\frac{3}{8}$ -inch (9.5 mm) stroke in a contrasting color incorporating the suggested wording, “FIRE AND/OR SMOKE BARRIER—PROTECT ALL OPENINGS,” or other wording.

**703.6 Determination of noncombustible protection time contribution.** The time, in minutes, contributed to the *fire-resistance rating* by the *noncombustible protection* of *mass timber building elements*, components, or assemblies, shall be established through a comparison of assemblies tested using procedures set forth in ASTM E119 or UL 263. The test assemblies shall be identical in construction, loading and materials, other than the *noncombustible protection*. The two test assemblies shall be tested to the same criteria of structural failure with the following conditions:

1. Test Assembly 1 shall be without protection.
2. Test Assembly 2 shall include the representative noncombustible protection. The protection shall be fully defined in terms of configuration details, attachment details, joint sealing details, accessories and all other relevant details.

The *noncombustible protection* time contribution shall be determined by subtracting the *fire-resistance* time, in minutes, of Test Assembly 1 from the *fire-resistance* time, in minutes, of Test Assembly 2.

**703.7 Sealing of adjacent mass timber elements.** In buildings of Types IV-A, IV-B and IV-C construction, sealant or adhesive shall be provided to resist the passage of air in the following locations:

1. At abutting edges and intersections of mass timber building elements required to be fire-resistance rated.
2. At abutting intersections of mass timber building elements and building elements of other materials where both are required to be fire-resistance rated.

Sealants shall meet the requirements of ASTM C920. Adhesives shall meet the requirements of ASTM D3498.

**Exception:** Sealants or adhesives need not be provided where they are not a required component of a tested fire-resistance-rated assembly.

## SECTION 704 FIRE-RESISTANCE RATING OF STRUCTURAL MEMBERS

**704.1 Requirements.** The *fire-resistance ratings* of structural members and assemblies shall comply with this section and the requirements for the type of construction as specified in Table 601. The *fire-resistance ratings* shall be not less



than the ratings required for the fire-resistance-rated assemblies supported by the structural members.

**Exception:** *Fire barriers, fire partitions, smoke barriers and horizontal assemblies* as provided in Sections 707.5, 708.4, 709.4 and 711.2, respectively.

**704.2 Column protection.** Where columns are required to have protection to achieve a *fire-resistance rating*, the entire column shall be provided individual encasement protection by protecting it on all sides for the full column height, including connections to other structural members, with materials having the required *fire-resistance rating*. Where the column extends through a ceiling, the encasement protection shall be continuous from the top of the foundation or floor/ceiling assembly below through the ceiling space to the top of the column.

**Exception:** Columns that meet the limitations of Section 704.4.1.

**704.3 Protection of the primary structural frame other than columns.** Members of the *primary structural frame* other than columns that are required to have protection to achieve a *fire-resistance rating* and support more than two floors or one floor and roof, or support a *load-bearing wall* or a *nonload-bearing wall* more than two stories high, shall be provided individual encasement protection by protecting them on all sides for the full length, including connections to other structural members, with materials having the required *fire-resistance rating*.

**Exception:** Individual encasement protection on all sides shall be permitted on all exposed sides provided that the extent of protection is in accordance with the required *fire-resistance rating*, as determined in Section 703.

**704.4 Protection of secondary structural members.** *Secondary structural members* that are required to have protection to achieve a *fire-resistance rating* shall be protected by individual encasement protection.

**704.4.1 Light-frame construction.** Studs, columns and boundary elements that are integral elements in *walls of light-frame construction* and are located entirely between the top and bottom plates or tracks shall be permitted to have required *fire-resistance ratings* provided by the membrane protection provided for the *wall*.

**704.4.2 Horizontal assemblies.** *Horizontal assemblies* are permitted to be protected with a membrane or ceiling where the membrane or ceiling provides the required *fire-resistance rating* and is installed in accordance with Section 711.

**704.5 Truss protection.** The required thickness and construction of fire-resistance-rated assemblies enclosing trusses shall be based on the results of full-scale tests or combinations of tests on truss components or on *approved* calculations based on such tests that satisfactorily demonstrate that the assembly has the required *fire resistance*.

**704.6 Attachments to structural members.** The edges of lugs, brackets, rivets and bolt heads attached to structural members shall be permitted to extend to within 1 inch (25 mm) of the surface of the fire protection.

**704.6.1 Secondary attachments to structural members.** Where primary and secondary structural steel members require fire protection, secondary steel attachments to those structural members shall be protected with the same fire-resistive material and thickness as required for the structural member. The protection shall extend away from the structural member a distance of not less than 12 inches (305 mm), or shall be applied to the entire length where the attachment is less than 12 inches (305 mm) long. Where an attachment is hollow and the ends are open, the fire-resistive material and thickness shall be applied to both exterior and interior of the hollow steel attachment.

**704.7 Reinforcing.** Thickness of protection for concrete or masonry reinforcement shall be measured to the outside of the reinforcement except that stirrups and spiral reinforcement ties are permitted to project not more than 0.5 inch (12.7 mm) into the protection.

**704.8 Embedments and enclosures.** Pipes, wires, conduits, ducts or other service facilities shall not be embedded in the required fire protective covering of a structural member that is required to be individually encased.

**704.9 Impact protection.** Where the fire protective covering of a structural member is subject to impact damage from moving vehicles, the handling of merchandise or other activity, the fire protective covering shall be protected by corner guards or by a substantial jacket of metal or other noncombustible material to a height adequate to provide full protection, but not less than 5 feet (1524 mm) from the finished floor.

**Exception:** Corner protection is not required on concrete columns in parking garages.

**704.10 Exterior structural members.** Load-bearing structural members located within the *exterior walls* or on the outside of a building or structure shall be provided with the highest *fire-resistance rating* as determined in accordance with the following:

1. As required by Table 601 for the type of *building element* based on the type of construction of the building.
2. As required by Table 601 for exterior bearing walls based on the type of construction.
3. As required by Table 705.5 for *exterior walls* based on the *fire separation distance*.

**704.11 Bottom flange protection.** Fire protection is not required at the bottom flange of lintels, shelf angles and plates, spanning not more than 6 feet 4 inches (1931 mm) whether part of the *primary structural frame* or not, and from the bottom flange of lintels, shelf angles and plates not part of the structural frame, regardless of span.

**704.12 Seismic isolation systems.** *Fire-resistance ratings* for the isolation system shall meet the *fire-resistance rating* required for the columns, walls or other structural elements in which the isolation system is installed in accordance with Table 601. Isolation systems required to have a *fire-resistance rating* shall be protected with *approved* materials or

## FIRE AND SMOKE PROTECTION FEATURES

construction assemblies designed to provide the same degree of *fire resistance* as the structural element in which the system is installed when tested in accordance with ASTM E119 or UL 263 (see Section 703.2).

Such isolation system protection applied to isolator units shall be capable of retarding the transfer of heat to the isolator unit in such a manner that the required gravity load-carrying capacity of the isolator unit will not be impaired after exposure to the standard time-temperature curve fire test prescribed in ASTM E119 or UL 263 for a duration not less than that required for the *fire-resistance rating* of the structure element in which the system is installed.

Such isolation system protection applied to isolator units shall be suitably designed and securely installed so as not to dislodge, loosen, sustain damage or otherwise impair its ability to accommodate the seismic movements for which the isolator unit is designed and to maintain its integrity for the purpose of providing the required fire-resistance protection.

**704.13 Sprayed fire-resistant materials (SFRM).** Sprayed fire-resistant materials (SFRM) shall comply with Sections 704.13.1 through 704.13.5.

**704.13.1 Fire-resistance rating.** The application of SFRM shall be consistent with the *fire-resistance rating* and the listing, including, but not limited to, minimum thickness and dry density of the applied SFRM, method of application, substrate surface conditions and the use of bonding adhesives, sealants, reinforcing or other materials.

**704.13.2 Manufacturer's installation instructions.** The application of SFRM shall be in accordance with the manufacturer's installation instructions. The instructions shall include, but are not limited to, substrate temperatures and surface conditions and SFRM handling, storage, mixing, conveyance, method of application, curing and *ventilation*.

**704.13.3 Substrate condition.** The SFRM shall be applied to a substrate in compliance with Sections 704.13.3.1 and 704.13.3.2.

**704.13.3.1 Surface conditions.** Substrates to receive SFRM shall be free of dirt, oil, grease, release agents, loose scale and any other condition that prevents adhesion. The substrates shall be free of primers, paints and encapsulants other than those fire tested and *listed* by a nationally recognized testing agency. Primed, painted or encapsulated steel shall be allowed, provided that testing has demonstrated that required adhesion is maintained.

**704.13.3.2 Primers, paints and encapsulants.** Where the SFRM is to be applied over primers, paints or encapsulants other than those specified in the listing, the material shall be field tested in accordance with

ASTM E736. Where testing of the SFRM with primers, paints or encapsulants demonstrates that required adhesion is maintained, SFRM shall be permitted to be applied to primed, painted or encapsulated wide flange steel shapes in accordance with the following conditions:

1. The beam flange width does not exceed 12 inches (305 mm); or
2. The column flange width does not exceed 16 inches (400 mm); or
3. The beam or column web depth does not exceed 16 inches (400 mm).
4. The average and minimum bond strength values shall be determined based on not fewer than five bond tests conducted in accordance with ASTM E736. Bond tests conducted in accordance with ASTM E736 shall indicate an average bond strength of not less than 80 percent and an individual bond strength of not less than 50 percent, when compared to the bond strength of the SFRM as applied to clean, uncoated  $\frac{1}{8}$ -inch-thick (3.2 mm) steel plate.

**704.13.4 Temperature.** A minimum ambient and substrate temperature of 40°F (4.44°C) shall be maintained during and for not fewer than 24 hours after the application of the SFRM, unless the manufacturer's instructions allow otherwise.

**704.13.5 Finished condition.** The finished condition of SFRM applied to structural members or assemblies shall not, upon complete drying or curing, exhibit cracks, voids, spalls, delamination or any exposure of the substrate. Surface irregularities of SFRM shall be deemed acceptable.

## SECTION 705 EXTERIOR WALLS

**705.1 General.** *Exterior walls* shall comply with this section.

**705.2 Projections.** *Cornices*, eave overhangs, exterior balconies and similar projections extending beyond the *exterior wall* shall conform to the requirements of this section and Section 1405. Exterior egress balconies and exterior *exit stairways* and *ramps* shall comply with Sections 1021 and 1027, respectively. Projections shall not extend any closer to the line used to determine the *fire separation distance* than shown in Table 705.2.

**Exception:** Buildings on the same lot and considered as portions of one building in accordance with Section 705.3 are not required to comply with this section for projections between the buildings.

**TABLE 705.2**  
**MINIMUM DISTANCE OF PROJECTION**

FIRE SEPARATION DISTANCE (FSD) (feet)	MINIMUM DISTANCE FROM LINE USED TO DETERMINE FSD
0 to less than 2	Projections not permitted
2 to less than 3	24 inches
3 to less than 5	Two-thirds of FSD
5 or greater	40 inches

For SI: 1 foot = 304.8 mm; 1 inch = 25.4 mm.

**705.2.1 Types I and II construction.** Projections from walls of Type I or II construction shall be of noncombustible materials or combustible materials as allowed by Sections 705.2.3.1 and 705.2.4.

**705.2.2 Type III, IV or V construction.** Projections from walls of Type III, IV or V construction shall be of any *approved* material.

**705.2.3 Projection protection.** Projections extending to within 5 feet (1524 mm) of the line used to determine the *fire separation distance* shall be one of the following:

1. Noncombustible materials.
2. Combustible materials of not less than 1-hour fire-resistance-rated construction.
3. Heavy timber construction complying with Section 2304.11.
4. Fire-retardant-treated wood.
5. As permitted by Section 705.2.3.1.

**Exception:** Type VB construction shall be allowed for combustible projections in Group R-3 and U occupancies with a *fire separation distance* greater than or equal to 5 feet (1524 mm).

**705.2.3.1 Balconies and similar projections.** Balconies and similar projections of combustible construction other than *fire-retardant-treated wood* shall be *fire-resistance* rated where required by Table 601 for floor construction or shall be of heavy timber construction in accordance with Section 2304.11. The aggregate length of the projections shall not exceed 50 percent of the building's perimeter on each floor.

**Exceptions:**

1. On buildings of Types I and II construction, three *stories* or less above *grade plane*, *fire-retardant-treated wood* shall be permitted for balconies, porches, decks and exterior *stairways* not used as required exits.
2. Untreated wood and plastic composites that comply with ASTM D7032 and Section 2612 are permitted for pickets, rails and similar *guard* components that are limited to 42 inches (1067 mm) in height.
3. Balconies and similar projections on buildings of Types III, IV and V construction shall be permitted to be of Type V

construction and shall not be required to have a *fire-resistance rating* where sprinkler protection is extended to these areas.

4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

**705.2.4 Bay and oriel windows.** Bay and oriel windows constructed of combustible materials shall conform to the type of construction required for the building to which they are attached.

**Exception:** *Fire-retardant-treated wood* shall be permitted on buildings three *stories* or less above *grade plane* of Type I, II, III or IV construction.

**705.3 Buildings on the same lot.** For the purposes of determining the required wall and opening protection, projections and *roof-covering* requirements, buildings on the same lot shall be assumed to have an imaginary line between them.

Where a new building is to be erected on the same lot as an *existing building*, the location of the assumed imaginary line with relation to the existing building shall be such that the *exterior wall* and opening protection of the *existing building* meet the criteria as set forth in Sections 705.5 and 705.8.

**Exceptions:**

1. Two or more buildings on the same lot shall be either regulated as separate buildings or shall be considered as portions of one building if the aggregate area of such buildings is within the limits specified in Chapter 5 for a single building. Where the buildings contain different occupancy groups or are of different types of construction, the area shall be that allowed for the most restrictive occupancy or construction.
2. Where an S-2 parking garage of Construction Type I or IIA is erected on the same lot as a Group R-2 building, and there is no *fire separation distance* between these buildings, then the adjoining *exterior walls* between the buildings are permitted to have occupant use openings in accordance with Section 706.8. However, opening protectives in such openings shall only be required in the *exterior wall* of the S-2 parking garage, not in the *exterior wall* openings in the R-2 building, and these opening protectives in the *exterior wall* of the S-2 parking garage shall be not less than 1½-hour *fire protection rating*.

**705.4 Materials.** *Exterior walls* shall be of materials permitted by the building's type of construction.

**705.5 Fire-resistance ratings.** *Exterior walls* shall be *fire-resistance* rated in accordance with Table 601, based on the type of construction, and Table 705.5, based on the *fire separation distance*. The required *fire-resistance rating* of *exterior walls* with a *fire separation distance* of greater than 10 feet (3048 mm) shall be rated for exposure to fire from the inside. The required *fire-resistance rating* of *exterior walls* with a *fire separation distance* of less than or equal to 10 feet (3048 mm) shall be rated for exposure to fire from both sides.

## FIRE AND SMOKE PROTECTION FEATURES

**705.6 Structural stability.** *Exterior walls* shall extend to the height required by Section 705.11. Interior structural elements that brace the *exterior wall* but that are not located within the plane of the *exterior wall* shall have the minimum *fire-resistance rating* required in Table 601 for that structural element. Structural elements that brace the *exterior wall* but are located outside of the *exterior wall* or within the plane of the *exterior wall* shall have the minimum *fire-resistance rating* required in Table 601 and Table 705.5 for the *exterior wall*.

**705.7 Unexposed surface temperature.** Where protected openings are not limited by Section 705.8, the limitation on the rise of temperature on the unexposed surface of *exterior walls* as required by ASTM E119 or UL 263 shall not apply. Where protected openings are limited by Section 705.8, the limitation on the rise of temperature on the unexposed surface of *exterior walls* as required by ASTM E119 or UL 263 shall not apply provided that a correction is made for radiation from the unexposed *exterior wall* surface in accordance with the following formula:

$$A_e = A + (A_f \times F_{eo}) \quad (\text{Equation 7-1})$$

where:

$A_e$  = Equivalent area of protected openings.

$A$  = Actual area of protected openings.

$A_f$  = Area of exterior wall surface in the story under consideration exclusive of openings, on which the temperature limitations of ASTM E119 or UL 263 for walls are exceeded.

$F_{eo}$  = An “equivalent opening factor” derived from Figure 705.7 based on the average temperature of the unexposed wall surface and the fire-resistance rating of the wall.

**705.8 Openings.** Openings in *exterior walls* shall comply with Sections 705.8.1 through 705.8.6.

**705.8.1 Allowable area of openings.** The maximum area of unprotected and protected openings permitted in an *exterior wall* in any *story* of a building shall not exceed the percentages specified in Table 705.8 based on the *fire separation distance* of each individual story.

### Exceptions:

1. In other than Group H occupancies, unlimited unprotected openings are permitted in the first *story above grade plane* where the wall faces one of the following:
  - 1.1. A street and has a *fire separation distance* of more than 15 feet (4572 mm).
  - 1.2. An unoccupied space. The unoccupied space shall be on the same lot or dedicated for public use, shall be not less than 30 feet (9144 mm) in width and shall have access from a street by a posted fire lane in accordance with the *International Fire Code*.
2. Buildings whose exterior bearing walls, exterior nonbearing walls and exterior *primary structural frame* are not required to be fire-resistance rated shall be permitted to have unlimited unprotected openings.

**705.8.2 Protected openings.** Where openings are required to be protected, opening protectives shall comply with Section 716.

**Exception:** Opening protectives are not required where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and the exterior openings are protected by a water curtain using automatic sprinklers *approved* for that use.

**TABLE 705.5**  
**FIRE-RESISTANCE RATING REQUIREMENTS FOR EXTERIOR WALLS BASED ON FIRE SEPARATION DISTANCE<sup>a, d, g</sup>**

FIRE SEPARATION DISTANCE = X (feet)	TYPE OF CONSTRUCTION	OCCUPANCY GROUP H <sup>e</sup>	OCCUPANCY GROUP F-1, M, S-1 <sup>f</sup>	OCCUPANCY GROUP A, B, E, F-2, I, R <sup>i</sup> , S-2, U <sup>h</sup>
X < 5 <sup>b</sup>	All	3	2	1
5 ≤ X < 10	IA, IVA	3	2	1
	Others	2	1	1
10 ≤ X < 30	IA, IB, IVA, IVB	2	1	1 <sup>c</sup>
	IIB, VB	1	0	0
	Others	1	1	1 <sup>c</sup>
X ≥ 30	All	0	0	0

For SI: 1 foot = 304.8 mm.

a. Load-bearing exterior walls shall also comply with the fire-resistance rating requirements of Table 601.

b. See Section 706.1.1 for party walls.

c. Open parking garages complying with Section 406 shall not be required to have a fire-resistance rating.

d. The fire-resistance rating of an exterior wall is determined based upon the fire separation distance of the exterior wall and the story in which the wall is located.

e. For special requirements for Group H occupancies, see Section 415.6.

f. For special requirements for Group S aircraft hangars, see Section 412.3.1.

g. Where Table 705.8 permits nonbearing exterior walls with unlimited area of unprotected openings, the required fire-resistance rating for the exterior walls is 0 hours.

h. For a building containing only a Group U occupancy private garage or carport, the exterior wall shall not be required to have a fire-resistance rating where the fire separation distance is 5 feet (1523 mm) or greater.

i. For a Group R-3 building of Type II-B or Type V-B construction, the exterior wall shall not be required to have a fire-resistance rating where the fire separation distance is 5 feet (1523 mm) or greater.



**705.8.3 Unprotected openings.** Where unprotected openings are permitted, windows and doors shall be constructed of any *approved* materials. Glazing shall conform to the requirements of Chapters 24 and 26.

**705.8.4 Mixed openings.** Where both unprotected and protected openings are located in the *exterior wall* in any *story* of a building, the total area of openings shall be determined in accordance with the following:

$$(A_p/a_p) + (A_u/a_u) \leq 1 \quad (\text{Equation 7-2})$$

$A_p$  = Actual area of protected openings, or the equivalent area of protected openings,  $A_e$  (see Section 705.7).

$a_p$  = Allowable area of protected openings.

$A_u$  = Actual area of unprotected openings.

$a_u$  = allowable area of unprotected openings.

**705.8.5 Vertical separation of openings.** Openings in *exterior walls* in adjacent *stories* shall be separated vertically to protect against fire spread on the exterior of the buildings where the openings are within 5 feet (1524 mm) of each other horizontally and the opening in the lower *story* is not a protected opening with a *fire protection rating* of not less than  $3/4$  hour. Such openings shall be separated vertically not less than 3 feet (914 mm) by spandrel girders, *exterior walls* or other similar assemblies that have a *fire-resistance rating* of not less than 1 hour, rated for exposure to fire from both sides, or by flame barriers that extend horizontally not less than 30 inches (762 mm) beyond the *exterior wall*. Flame barriers

shall have a *fire-resistance rating* of not less than 1 hour. The unexposed surface temperature limitations specified in ASTM E119 or UL 263 shall not apply to the flame barriers unless otherwise required by the provisions of this code.

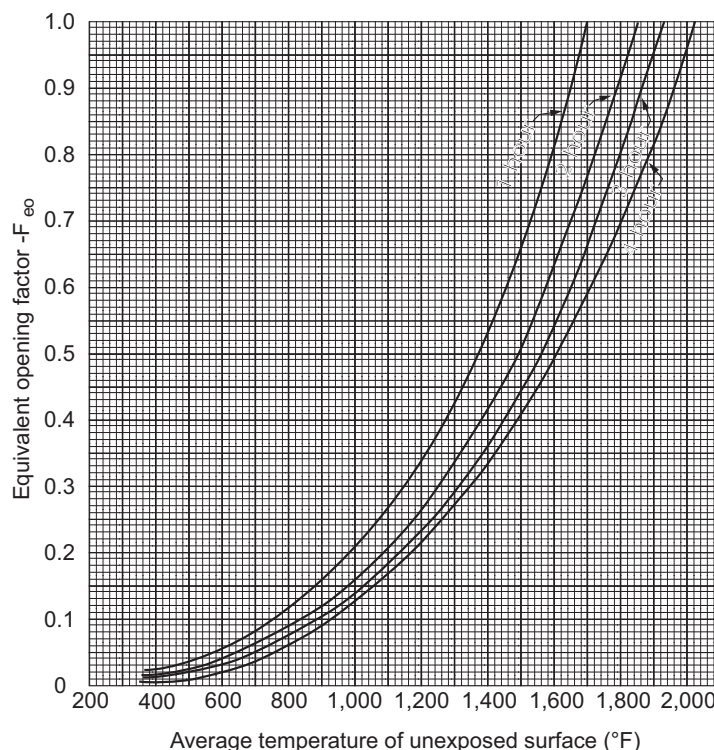
**Exceptions:**

1. This section shall not apply to buildings that are three *stories* or less above *grade plane*.
2. This section shall not apply to buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
3. *Open parking garages*.

**705.8.6 Vertical exposure.** For buildings on the same lot, opening protectives having a *fire protection rating* of not less than  $3/4$  hour shall be provided in every opening that is less than 15 feet (4572 mm) vertically above the roof of an adjacent building or structure based on assuming an imaginary line between them. The opening protectives are required where the *fire separation distances* from the imaginary line to each building or structure are less than 15 feet (4572 mm).

**Exceptions:**

1. Opening protectives are not required where the *roof assembly* of the adjacent building or structure has a *fire-resistance rating* of not less than 1 hour for a minimum distance of 10 feet (3048



For SI:  $^{\circ}\text{C} = [(^{\circ}\text{F}) - 32] / 1.8$ .

**FIGURE 705.7**  
**EQUIVALENT OPENING FACTOR**

## FIRE AND SMOKE PROTECTION FEATURES

mm) from the *exterior wall* facing the imaginary line and the entire length and span of the supporting elements for the fire-resistance-rated roof assembly has a *fire-resistance rating* of not less than 1 hour.

2. Buildings on the same lot and considered as portions of one building in accordance with Section 705.3 are not required to comply with Section 705.8.6.

**705.9 Joints.** *Joints* made in or between *exterior walls* required by this section to have a *fire-resistance rating* shall comply with Section 715.

**Exception:** *Joints* in *exterior walls* that are permitted to have unprotected openings.

**705.9.1 Voids.** The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be protected in accordance with Section 715.4.

**TABLE 705.8**  
**MAXIMUM AREA OF EXTERIOR WALL OPENINGS BASED ON**  
**FIRE SEPARATION DISTANCE AND DEGREE OF OPENING PROTECTION**

FIRE SEPARATION DISTANCE (feet)	DEGREE OF OPENING PROTECTION	ALLOWABLE AREA <sup>a</sup>
0 to less than 3 <sup>b, c, k</sup>	Unprotected, Nonsprinklered (UP, NS)	Not Permitted <sup>k</sup>
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	Not Permitted <sup>k</sup>
	Protected (P)	Not Permitted <sup>k</sup>
3 to less than 5 <sup>d, e</sup>	Unprotected, Nonsprinklered (UP, NS)	Not Permitted
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	15%
	Protected (P)	15%
5 to less than 10 <sup>e, f, j</sup>	Unprotected, Nonsprinklered (UP, NS)	10% <sup>h</sup>
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	25%
	Protected (P)	25%
10 to less than 15 <sup>e, f, g, j</sup>	Unprotected, Nonsprinklered (UP, NS)	15% <sup>h</sup>
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	45%
	Protected (P)	45%
15 to less than 20 <sup>f, g, j</sup>	Unprotected, Nonsprinklered (UP, NS)	25%
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	75%
	Protected (P)	75%
20 to less than 25 <sup>f, g, j</sup>	Unprotected, Nonsprinklered (UP, NS)	45%
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	No Limit
	Protected (P)	No Limit
25 to less than 30 <sup>f, g, j</sup>	Unprotected, Nonsprinklered (UP, NS)	70%
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	No Limit
	Protected (P)	No Limit
30 or greater	Unprotected, Nonsprinklered (UP, NS)	No Limit
	Unprotected, Sprinklered (UP, S) <sup>i</sup>	No Limit
	Protected (P)	No Limit

For SI: 1 foot = 304.8 mm.

UP, NS = Unprotected openings in buildings not equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

UP, S = Unprotected openings in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

P = Openings protected with an opening protective assembly in accordance with Section 705.8.2.

a. Values indicated are the percentage of the area of the exterior wall, per story.

b. For the requirements for fire walls of buildings with differing heights, see Section 706.6.1.

c. For openings in a fire wall for buildings on the same lot, see Section 706.8.

d. The maximum percentage of unprotected and protected openings shall be 25 percent for Group R-3 occupancies.

e. Unprotected openings shall not be permitted for openings with a fire separation distance of less than 15 feet for Group H-2 and H-3 occupancies.

f. The area of unprotected and protected openings shall not be limited for Group R-3 occupancies, with a fire separation distance of 5 feet or greater.

g. The area of openings in an open parking structure with a fire separation distance of 10 feet or greater shall not be limited.

h. Includes buildings accessory to Group R-3.

i. Not applicable to Group H-1, H-2 and H-3 occupancies.

j. The area of openings in a building containing only a Group U occupancy private garage or carport with a fire separation distance of 5 feet or greater shall not be limited.

k. For openings between S-2 parking garage and Group R-2 building, see Section 705.3, Exception 2.

## FIRE AND SMOKE PROTECTION FEATURES

**705.10 Ducts and air transfer openings.** Penetrations by air ducts and air transfer openings in fire-resistance-rated *exterior walls* required to have protected openings shall comply with Section 717.

**Exception:** Foundation vents installed in accordance with this code are permitted.

**705.11 Parapets.** Parapets shall be provided on *exterior walls* of buildings.

**Exceptions:** A parapet need not be provided on an *exterior wall* where any of the following conditions exist:

1. The wall is not required to be *fire-resistance rated* in accordance with Table 705.5 because of *fire separation distance*.
2. The building has an area of not more than 1,000 square feet (93 m<sup>2</sup>) on any floor.
3. Walls that terminate at roofs of not less than 2-hour fire-resistance-rated construction or where the roof, including the deck or slab and supporting construction, is constructed entirely of noncombustible materials.
4. One-hour fire-resistance-rated *exterior walls* that terminate at the underside of the roof sheathing, deck or slab, provided that:
  - 4.1. Where the roof/ceiling framing elements are parallel to the walls, such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction for a width of 4 feet (1220 mm) for Groups R and U and 10 feet (3048 mm) for other occupancies, measured from the interior side of the wall.
  - 4.2. Where roof/ceiling framing elements are not parallel to the wall, the entire span of such framing and elements supporting such framing shall not be of less than 1-hour fire-resistance-rated construction.
  - 4.3. Openings in the roof shall not be located within 5 feet (1524 mm) of the 1-hour fire-resistance-rated *exterior wall* for Groups R and U and 10 feet (3048 mm) for other occupancies, measured from the interior side of the wall.
  - 4.4. The entire building shall be provided with not less than a Class B *roof covering*.
5. In Groups R-2 and R-3 where the entire building is provided with a Class C *roof covering*, the *exterior wall* shall be permitted to terminate at the underside of the roof sheathing or deck in Types III, IV and V construction, provided that one or both of the following criteria is met:
  - 5.1. The roof sheathing or deck is constructed of *approved* noncombustible materials or of *fire-retardant-treated wood* for a distance of 4 feet (1220 mm).

- 5.2. The roof is protected with 0.625-inch (16 mm) Type X *gypsum board* directly beneath the underside of the roof sheathing or deck, supported by not less than nominal 2-inch (51 mm) ledgers attached to the sides of the roof framing members for a minimum distance of 4 feet (1220 mm).

6. Where the wall is permitted to have not less than 25 percent of the *exterior wall* areas containing unprotected openings based on *fire separation distance* as determined in accordance with Section 705.8.

**705.11.1 Parapet construction.** Parapets shall have the same *fire-resistance rating* as that required for the supporting wall, and on any side adjacent to a roof surface, shall have noncombustible faces for the uppermost 18 inches (457 mm), including counterflashing and coping materials. The height of the parapet shall be not less than 30 inches (762 mm) above the point where the roof surface and the wall intersect. Where the roof slopes toward a parapet at a slope greater than 2 units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a *fire separation distance* where protection of wall openings is required, but the height shall be not less than 30 inches (762 mm).

## SECTION 706 FIRE WALLS

**706.1 General.** *Fire walls* shall be constructed in accordance with Sections 706.2 through 706.11. The extent and location of such *fire walls* shall provide a complete separation. Where a *fire wall* separates occupancies that are required to be separated by a *fire barrier wall*, the most restrictive requirements of each separation shall apply.

**706.1.1 Party walls.** Any wall located on a *lot line* between adjacent buildings, which is used or adapted for *joint* service between the two buildings, shall be constructed as a *fire wall* in accordance with Section 706. Party walls shall be constructed without openings and shall create separate buildings.

### Exceptions:

1. Openings in a party wall separating an *anchor building* and a *mall* shall be in accordance with Section 402.4.2.2.1.
2. Party walls and *fire walls* are not required on *lot lines* dividing a building for ownership purposes where the aggregate height and area of the portions of the building located on both sides of the *lot line* do not exceed the maximum height and area requirements of this code. For the *building official's* review and approval, the official shall be provided with copies of dedicated access easements and contractual agreements that permit the *owners* of portions

## FIRE AND SMOKE PROTECTION FEATURES

of the building located on either side of the *lot line* access to the other side for purposes of maintaining fire and *life safety systems* necessary for the operation of the building.

**706.2 Structural stability.** *Fire walls* shall be designed and constructed to allow collapse of the structure on either side without collapse of the wall under fire conditions. *Fire walls* designed and constructed in accordance with NFPA 221 shall be deemed to comply with this section.

**Exception:** In *Seismic Design Categories* D through F, where double *fire walls* are used in accordance with NFPA 221, floor and roof sheathing not exceeding  $\frac{3}{4}$  inch (19.05 mm) thickness shall be permitted to be continuous through the wall assemblies of *light frame construction*.

**706.3 Materials.** *Fire walls* shall be of any *approved* noncombustible materials.

**Exception:** Buildings of Type V construction.

**706.4 Fire-resistance rating.** *Fire walls* shall have a *fire-resistance rating* of not less than that required by Table 706.4.

TABLE 706.4  
FIRE WALL FIRE-RESISTANCE RATINGS

GROUP	FIRE-RESISTANCE RATING (hours)
A, B, E, H-4, I, R-1, R-2, U	3 <sup>a</sup>
F-1, H-3b, H-5, M, S-1	3
H-1, H-2	4 <sup>b</sup>
F-2, S-2, R-3, R-4	2

a. In Type II or V construction, walls shall be permitted to have a 2-hour fire-resistance rating.

b. For Group H-1, H-2 or H-3 buildings, also see Sections 415.7 and 415.8.

**706.5 Horizontal continuity.** *Fire walls* shall be continuous from *exterior wall* to *exterior wall* and shall extend not less than 18 inches (457 mm) beyond the exterior surface of *exterior walls*.

### Exceptions:

- Fire walls* shall be permitted to terminate at the interior surface of combustible exterior sheathing or siding provided that the *exterior wall* has a *fire-resistance rating* of not less than 1 hour for a horizontal distance of not less than 4 feet (1220 mm) on both sides of the *fire wall*. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.
- Fire walls* shall be permitted to terminate at the interior surface of noncombustible exterior sheathing, exterior siding or other noncombustible exterior finishes provided that the sheathing, siding or other exterior noncombustible finish extends a horizontal distance of not less than 4 feet (1220 mm) on both sides of the *fire wall*.
- Fire walls* shall be permitted to terminate at the interior surface of noncombustible exterior sheathing where the building on each side of the

*fire wall* is protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**706.5.1 Exterior walls.** Where the *fire wall* intersects *exterior walls*, the *fire-resistance rating* and opening protection of the *exterior walls* shall comply with one of the following:

- The *exterior walls* on both sides of the *fire wall* shall have a 1-hour *fire-resistance rating* with  $\frac{3}{4}$ -hour protection where opening protection is required by Section 705.8. The *fire-resistance rating* of the *exterior wall* shall extend not less than 4 feet (1220 mm) on each side of the intersection of the *fire wall* to *exterior wall*. *Exterior wall* intersections at *fire walls* that form an angle equal to or greater than 180 degrees (3.14 rad) do not need *exterior wall* protection.
- Buildings or spaces on both sides of the intersecting *fire wall* shall assume to have an imaginary *lot line* at the *fire wall* and extending beyond the exterior of the *fire wall*. The location of the assumed line in relation to the *exterior walls* and the *fire wall* shall be such that the *exterior wall* and opening protection meet the requirements set forth in Sections 705.5 and 705.8. Such protection is not required for *exterior walls* terminating at *fire walls* that form an angle equal to or greater than 180 degrees (3.14 rad).

**706.5.2 Horizontal projecting elements.** *Fire walls* shall extend to the outer edge of horizontal projecting elements such as balconies, roof overhangs, canopies, *marquees* and similar projections that are within 4 feet (1220 mm) of the *fire wall*.

### Exceptions:

- Horizontal projecting elements without concealed spaces, provided that the *exterior wall* behind and below the projecting element has not less than 1-hour fire-resistance-rated construction for a distance not less than the depth of the projecting element on both sides of the *fire wall*. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.
- Noncombustible horizontal projecting elements with concealed spaces, provided that a minimum 1-hour fire-resistance-rated wall extends through the concealed space. The projecting element shall be separated from the building by not less than 1-hour fire-resistance-rated construction for a distance on each side of the *fire wall* equal to the depth of the projecting element. The wall is not required to extend under the projecting element where the building *exterior wall* is not less than 1-hour *fire-resistance rated* for a distance on each side of the *fire wall* equal to the depth of the projecting element. Openings within such *exterior walls*



## FIRE AND SMOKE PROTECTION FEATURES

shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.

3. For combustible horizontal projecting elements with concealed spaces, the *fire wall* need only extend through the concealed space to the outer edges of the projecting elements. The *exterior wall* behind and below the projecting element shall be of not less than 1-hour fire-resistance-rated construction for a distance not less than the depth of the projecting elements on both sides of the *fire wall*. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour.

**706.6 Vertical continuity.** *Fire walls* shall extend from the foundation to a termination point not less than 30 inches (762 mm) above both adjacent roofs.

**Exceptions:**

1. Stepped buildings in accordance with Section 706.6.1.
2. Two-hour fire-resistance-rated walls shall be permitted to terminate at the underside of the roof sheathing, deck or slab, provided that:
  - 2.1. The lower *roof assembly* within 4 feet (1220 mm) of the wall has not less than a 1-hour *fire-resistance rating* and the entire length and span of supporting elements for the rated *roof assembly* has a *fire-resistance rating* of not less than 1 hour.
  - 2.2. Openings in the roof shall not be located within 4 feet (1220 mm) of the *fire wall*.
  - 2.3. Each building shall be provided with not less than a Class B *roof covering*.
3. Walls shall be permitted to terminate at the underside of noncombustible roof sheathing, deck or slabs where both buildings are provided with not less than a Class B *roof covering*. Openings in the roof shall not be located within 4 feet (1220 mm) of the *fire wall*.
4. In buildings of Types III, IV and V construction, walls shall be permitted to terminate at the underside of combustible roof sheathing or decks, provided that all of the following requirements are met:
  - 4.1. Roof openings are not less than 4 feet (1220 mm) from the *fire wall*.
  - 4.2. The roof is covered with a minimum Class B *roof covering*.
  - 4.3. The roof sheathing or deck is constructed of *fire-retardant-treated wood* for a distance of 4 feet (1220 mm) on both sides of the wall or the roof is protected with  $\frac{5}{8}$ -inch (15.9 mm) Type X *gypsum board* directly beneath the underside of the roof

sheathing or deck, supported by not less than 2-inch (51 mm) nominal ledgers attached to the sides of the roof framing members for a distance of not less than 4 feet (1220 mm) on both sides of the *fire wall*.

5. In buildings designed in accordance with Section 510.2, *fire walls* located above the 3-hour *horizontal assembly* required by Section 510.2, Item 1 shall be permitted to extend from the top of this *horizontal assembly*.
6. Buildings with sloped roofs in accordance with Section 706.6.2.

**706.6.1 Stepped buildings.** Where a *fire wall* also serves as an *exterior wall* for a building and separates buildings having different roof levels, such wall shall terminate at a point not less than 30 inches (762 mm) above the lower roof level. *Exterior walls* above the *fire wall* extending more than 30 inches (762 mm) above the lower roof shall be of not less than 1-hour fire-resistance-rated construction from both sides with openings protected by fire assemblies having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. Portions of the *exterior walls* greater than 15 feet (4572 mm) above the lower roof shall be of nonfire-resistance-rated construction unless otherwise rated construction is required by other provisions of this code.

**Exception:** A *fire wall* serving as part of an *exterior wall* that separates buildings having different roof levels shall be permitted to terminate at the underside of the roof sheathing, deck or slab of the lower roof, provided that Items 1, 2 and 3 are met. The *exterior wall* above the *fire wall* is not required to be of fire-resistance-rated construction unless required by other provisions of this code.

1. The lower *roof assembly* within 10 feet (3048 mm) of the *fire wall* has not less than a 1-hour *fire-resistance rating*.
2. The entire length and span of supporting elements for the rated *roof assembly* shall have a *fire-resistance rating* of not less than 1 hour.
3. Openings in the lower roof shall not be located within 10 feet (3048 mm) of the *fire wall*.

**706.6.2 Buildings with sloped roofs.** Where a *fire wall* serves as an interior wall for a building, and the roof on one side or both sides of the *fire wall* slopes toward the *fire wall* at a slope greater than 2 units vertical in 12 units horizontal (2:12), the *fire wall* shall extend to a height equal to the height of the roof located 4 feet (1219 mm) from the *fire wall* plus 30 inches (762 mm). The extension of the *fire wall* shall be not less than 30 inches (762 mm).

**706.7 Combustible framing in fire walls.** Adjacent combustible members entering into a concrete or masonry *fire wall* from opposite sides shall not have less than a 4-inch (102 mm) distance between embedded ends. Where combustible members frame into hollow walls or walls of hollow units, hollow spaces shall be solidly filled for the full thick-

## FIRE AND SMOKE PROTECTION FEATURES

ness of the wall and for a distance not less than 4 inches (102 mm) above, below and between the structural members, with noncombustible materials *approved* for *fireblocking*.

**706.8 Openings.** Each opening through a *fire wall* shall be protected in accordance with Section 716 and shall not exceed 156 square feet (15 m<sup>2</sup>). The aggregate width of openings at any floor level shall not exceed 25 percent of the length of the wall.

### Exceptions:

1. Openings are not permitted in party walls constructed in accordance with Section 706.1.1.
2. Openings shall not be limited to 156 square feet (15 m<sup>2</sup>) where both buildings are equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**706.9 Penetrations.** Penetrations of *fire walls* shall comply with Section 714.

**706.10 Joints.** *Joints* made in or between *fire walls* shall comply with Section 715.

**706.11 Ducts and air transfer openings.** Ducts and air transfer openings shall not penetrate *fire walls*.

**Exception:** Penetrations by ducts and air transfer openings of *fire walls* that are not on a *lot line* shall be allowed provided that the penetrations comply with Section 717. The size and aggregate width of all openings shall not exceed the limitations of Section 706.8.

## SECTION 707 FIRE BARRIERS

**707.1 General.** *Fire barriers* installed as required elsewhere in this code or the *International Fire Code* shall comply with this section.

**707.2 Materials.** *Fire barriers* shall be of materials permitted by the building type of construction.

**707.3 Fire-resistance rating.** The *fire-resistance rating* of *fire barriers* shall comply with this section.

**707.3.1 Shaft enclosures.** The *fire-resistance rating* of the *fire barrier* separating building areas from a *shaft* shall comply with Section 713.4.

**707.3.2 Interior exit stairway and ramp construction.** The *fire-resistance rating* of the *fire barrier* separating building areas from an *interior exit stairway* or *ramp* shall comply with Section 1023.1.

**707.3.3 Enclosures for exit access stairways.** The *fire-resistance rating* of the *fire barrier* separating building areas from an *exit access stairway* or *ramp* shall comply with Section 713.4.

**707.3.4 Exit passageway.** The *fire-resistance rating* of the *fire barrier* separating building areas from an *exit passageway* shall comply with Section 1024.3.

**707.3.5 Horizontal exit.** The *fire-resistance rating* of the separation between building areas connected by a *horizontal exit* shall comply with Section 1026.1.

**707.3.6 Atriums.** The *fire-resistance rating* of the *fire barrier* separating *atriums* shall comply with Section 404.6.

**707.3.7 Incidental uses.** The *fire barrier* separating incidental uses from other spaces in the building shall have a *fire-resistance rating* of not less than that indicated in Table 509.1.

**707.3.8 Control areas.** *Fire barriers* separating *control areas* shall have a *fire-resistance rating* of not less than that required in Section 414.2.4.

**707.3.9 Separated occupancies.** Where the provisions of Section 508.4 are applicable, the *fire barrier* separating mixed occupancies shall have a *fire-resistance rating* of not less than that indicated in Table 508.4 based on the occupancies being separated.

**707.3.10 Fire areas.** The *fire barriers*, *fire walls*, *horizontal assemblies* or combinations thereof separating a single occupancy into different *fire areas* shall have a *fire-resistance rating* of not less than that indicated in Table 707.3.10. The *fire barriers*, *fire walls*, *horizontal assemblies* or combinations thereof separating *fire areas* of mixed occupancies shall have a *fire-resistance rating* of not less than the highest value indicated in Table 707.3.10 for the occupancies under consideration.

**TABLE 707.3.10  
FIRE-RESISTANCE-RATING  
REQUIREMENTS FOR FIRE BARRIERS, FIRE WALLS  
OR HORIZONTAL ASSEMBLIES BETWEEN FIRE AREAS**

OCCUPANCY GROUP	FIRE-RESISTANCE RATING (hours)
H-1, H-2	4
F-1, H-3, S-1	3
A, B, E, F-2, H-4, H-5, I, M, R, S-2	2
U	1

**707.4 Exterior walls.** Where *exterior walls* serve as a part of a required fire-resistance-rated *shaft*, or separation or enclosure for a *stairway*, *ramp* or *exit passageway*, such walls shall comply with the requirements of Section 705 for *exterior walls* and the fire-resistance-rated enclosure or separation requirements shall not apply.

### Exceptions:

1. *Exterior walls* required to be *fire-resistance rated* in accordance with Section 1021 for exterior egress balconies, Section 1023.7 for *interior exit stairways and ramps*, Section 1024.8 for *exit passageways* and Section 1027.6 for *exterior exit stairways and ramps*.
2. *Exterior walls* required to be *fire-resistance rated* in accordance with Section 1207 of the *International Fire Code* for enclosure of energy storage systems.

**707.5 Continuity.** *Fire barriers* shall extend from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, slab or deck above and shall be securely attached thereto. Such *fire barriers* shall be

## FIRE AND SMOKE PROTECTION FEATURES

continuous through concealed space, such as the space above a suspended ceiling. *Joints* and voids at intersections shall comply with Sections 707.8 and 707.9

**Exceptions:**

1. *Shaft enclosures* shall be permitted to terminate at a top enclosure complying with Section 713.12.
2. *Interior exit stairway* and *ramp* enclosures required by Section 1023 and *exit access stairway* and *ramp* enclosures required by Section 1019 shall be permitted to terminate at a top enclosure complying with Section 713.12.
3. An *exit passageway* enclosure required by Section 1024.3 that does not extend to the underside of the roof sheathing, slab or deck above shall be enclosed at the top with construction of the same *fire-resistance rating* as required for the *exit passageway*.

**707.5.1 Supporting construction.** The supporting construction for a *fire barrier* shall be protected to afford the required *fire-resistance rating* of the *fire barrier* supported. Hollow vertical spaces within a *fire barrier* shall be fireblocked in accordance with Section 718.2 at every floor level.

**Exceptions:**

1. The maximum required *fire-resistance rating* for assemblies supporting *fire barriers* separating tank storage as provided for in Section 415.9.1.2 shall be 2 hours, but not less than required by Table 601 for the building construction type.
2. Supporting construction for 1-hour *fire barriers* required by Table 509.1 in buildings of Types IIB, IIIB and VB construction is not required to be *fire-resistance rated* unless required by other sections of this code.

**707.6 Openings.** Openings in a *fire barrier* shall be protected in accordance with Section 716. Openings shall be limited to a maximum aggregate width of 25 percent of the length of the wall, and the maximum area of any single opening shall not exceed 156 square feet (15 m<sup>2</sup>). Openings in enclosures for *exit access stairways* and *ramps*, *interior exit stairways* and *ramps* and *exit passageways* shall also comply with Sections 1019, 1023.4 and 1024.5, respectively.

**Exceptions:**

1. Openings shall not be limited to 156 square feet (15 m<sup>2</sup>) where adjoining floor areas are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
2. Openings shall not be limited to 156 square feet (15 m<sup>2</sup>) or an aggregate width of 25 percent of the length of the wall where the opening protective is a *fire door* serving enclosures for *exit access stairways* and *ramps*, and *interior exit stairways* and *ramps*.

3. Openings shall not be limited to 156 square feet (15 m<sup>2</sup>) or an aggregate width of 25 percent of the length of the wall where the opening protective has been tested in accordance with ASTM E119 or UL 263 and has a minimum *fire-resistance rating* not less than the *fire-resistance rating* of the wall.
4. *Fire window assemblies* permitted in *atrium* separation walls shall not be limited to a maximum aggregate width of 25 percent of the length of the wall.
5. Openings shall not be limited to 156 square feet (15 m<sup>2</sup>) or an aggregate width of 25 percent of the length of the wall where the opening protective is a *fire door assembly* in a *fire barrier* separating an enclosure for *exit access stairways* and *ramps*, and *interior exit stairways* and *ramps* from an *exit passageway* in accordance with Section 1023.3.1.

**707.7 Penetrations.** Penetrations of *fire barriers* shall comply with Section 714.

**707.7.1 Prohibited penetrations.** Penetrations into enclosures for *exit access stairways* and *ramps*, *interior exit stairways* and *ramps*, and *exit passageways* shall be allowed only where permitted by Sections 1019, 1023.5 and 1024.6, respectively.

**707.8 Joints.** *Joints* made in or between *fire barriers*, and *joints* made at the intersection of *fire barriers* with underside of a fire-resistance-rated floor or roof sheathing, slab or deck above, and the exterior vertical wall intersection shall comply with Section 715.

**707.9 Voids at intersections.** The voids created at the intersection of a *fire barrier* and a nonfire-resistance-rated *roof assembly* or a nonfire-resistance-rated *exterior wall assembly* shall be filled. An *approved* material or system shall be used to fill the void, and shall be securely installed in or on the intersection for its entire length so as not to dislodge, loosen or otherwise impair its ability to accommodate expected building movements and to retard the passage of fire and hot gases.

**707.10 Ducts and air transfer openings.** Penetrations in a *fire barrier* by ducts and air transfer openings shall comply with Section 717.

## SECTION 708 FIRE PARTITIONS

**708.1 General.** The following wall assemblies shall comply with this section:

1. Separation walls as required by Section 420.2 for Group I-1 and Group R occupancies.
2. Walls separating tenant spaces in *covered and open mall buildings* as required by Section 402.4.2.1.
3. *Corridor* walls as required by Section 1020.3.
4. Enclosed elevator lobby separation as required by Section 3006.3.
5. Egress balconies as required by Section 1021.2



## FIRE AND SMOKE PROTECTION FEATURES

6. Walls separating *ambulatory care facilities* from adjacent spaces, *corridors* or tenant as required by Section 422.2.
7. Walls separating *dwelling and sleeping units* in Groups R-1 and R-2 in accordance with Sections 907.2.8.1 and 907.2.9.1.
8. Vestibules in accordance with Section 1028.2.

**708.2 Materials.** The walls shall be of materials permitted by the building type of construction.

**708.3 Fire-resistance rating.** *Fire partitions* shall have a *fire-resistance rating* of not less than 1 hour.

### Exceptions:

1. *Corridor* walls permitted to have a  $\frac{1}{2}$ -hour *fire-resistance rating* by Table 1020.2.
2. *Dwelling unit* and *sleeping unit* separations in buildings of Types IIB, IIIB and VB construction shall have *fire-resistance ratings* of not less than  $\frac{1}{2}$  hour in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**708.4 Continuity.** *Fire partitions* shall extend from the top of the foundation or floor/ceiling assembly below and be securely attached to one of the following:

1. The underside of the floor or roof sheathing, deck or slab above.
2. The underside of a floor/ceiling or roof/ceiling assembly having a *fire-resistance rating* that is not less than the *fire-resistance rating* of the *fire partition*.

### Exceptions:

1. *Fire partitions* shall not be required to extend into a crawl space below where the floor above the crawl space has a minimum 1-hour *fire-resistance rating*.
2. *Fire partitions* serving as a *corridor* wall shall not be required to extend above the lower membrane of a *corridor* ceiling provided that the *corridor* ceiling membrane is equivalent to *corridor* wall membrane, and either of the following conditions is met:
  - 2.1. The room-side membrane of the *corridor* wall extends to the underside of the floor or roof sheathing, deck or slab of a fire-resistance-rated floor or roof above.
  - 2.2. The building is equipped with an *automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1 or 903.3.1.2, including *automatic* sprinklers installed in the space between the top of the *fire partition* and underside of the floor or roof sheathing, deck or slab above.
3. *Fire partitions* serving as a *corridor* wall shall be permitted to terminate at the upper membrane of the *corridor* ceiling assembly where the *corridor*

ceiling is constructed as required for the *corridor* wall.

4. *Fire partitions* separating tenant spaces in a *covered or open mall building* complying with Section 402.4.2.1 shall not be required to extend above the underside of a ceiling. Such ceiling shall not be required to be part of a fire-resistance-rated assembly, and the *attic* or space above the ceiling at tenant separation walls shall not be required to be subdivided by *fire partitions*.

**708.4.1 Supporting construction.** The supporting construction for a *fire partition* shall have a *fire-resistance rating* that is equal to or greater than the required *fire-resistance rating* of the supported *fire partition*.

**Exception:** In buildings of Types IIB, IIIB and VB construction, the supporting construction requirement shall not apply to *fire partitions* separating tenant spaces in *covered and open mall buildings*, *fire partitions* separating *dwelling units*, *fire partitions* separating *sleeping units*, *fire partitions* serving as *corridor* walls, *fire partitions* separating *ambulatory care facilities* from adjacent spaces or *corridors*, *fire partitions* separating *dwelling and sleeping units* from Group R-1 and R-2 occupancies and *fire partitions* separating vestibules from the *level of exit discharge*.

**708.4.2 Fireblocks and draftstops in combustible construction.** In combustible construction where *fire partitions* do not extend to the underside of the floor or roof sheathing, deck or slab above, the space above and along the line of the *fire partition* shall be provided with one of the following:

1. *Fireblocking* up to the underside of the floor or roof sheathing, deck or slab above using materials complying with Section 718.2.1.
2. Draftstopping up to the underside of the floor or roof sheathing, deck or slab above using materials complying with Section 718.3.1 for floors or Section 718.4.1 for *attics*.

### Exceptions:

1. Buildings equipped with an *automatic sprinkler system* installed throughout in accordance with Section 903.3.1.1, or in accordance with Section 903.3.1.2 provided that protection is provided in the space between the top of the *fire partition* and underside of the floor or roof sheathing, deck or slab above as required for systems complying with Section 903.3.1.1.
2. Where *corridor* walls provide a *sleeping unit* or *dwelling unit* separation, draftstopping shall only be required above one of the *corridor* walls.
3. In Group R-2 occupancies with fewer than four *dwelling units*, *fireblocking* and draftstopping shall not be required.
4. In Group R-2 occupancies up to and including four *stories* in height in buildings not exceeding 60 feet (18 288 mm) in height above *grade*



plane, the *attic* space shall be subdivided by *draftstops* into areas not exceeding 3,000 square feet (279 m<sup>2</sup>) or above every two *dwelling units*, whichever is smaller.

5. In Group R-3 occupancies with fewer than three *dwelling units*, *fireblocking* and *drafts-topping* shall not be required in floor assemblies.

**708.5 Exterior walls.** Where *exterior walls* serve as a part of a required fire-resistance-rated separation, such walls shall comply with the requirements of Section 705 for *exterior walls*, and the fire-resistance-rated separation requirements shall not apply.

**Exception:** *Exterior walls* required to be fire-resistance rated in accordance with Section 1021.2 for exterior egress balconies, Section 1023.7 for *interior exit stairways* and *ramps* and Section 1027.6 for exterior *exit stairways* and *ramps*.

**708.6 Openings.** Openings in a *fire partition* shall be protected in accordance with Section 716.

**708.7 Penetrations.** Penetrations of *fire partitions* shall comply with Section 714.

**708.8 Joints.** *Joints* made in or between *fire partitions* shall comply with Section 715.

**708.9 Ducts and air transfer openings.** Penetrations in a *fire partition* by ducts and air transfer openings shall comply with Section 717.

## SECTION 709 SMOKE BARRIERS

**709.1 General.** Vertical and horizontal *smoke barriers* shall comply with this section.

**709.2 Materials.** *Smoke barriers* shall be of materials permitted by the building type of construction.

**709.3 Fire-resistance rating.** A 1-hour *fire-resistance rating* is required for *smoke barriers*.

**Exception:** *Smoke barriers* constructed of minimum 0.10-inch-thick (2.5 mm) steel in Group I-3 buildings.

**709.4 Continuity.** *Smoke barriers* shall form an effective membrane continuous from the top of the foundation or floor/ceiling assembly below to the underside of the floor or roof sheathing, deck or slab above, including continuity through concealed spaces, such as those found above suspended ceilings, and interstitial structural and mechanical spaces. The supporting construction shall be protected to afford the required *fire-resistance rating* of the wall or floor supported in buildings of other than Type IIB, IIIB or VB construction. *Smoke-barrier walls* used to separate *smoke compartments* shall comply with Section 709.4.1. *Smoke-barrier walls* used to enclose *areas of refuge* in accordance with Section 1009.6.4 or to enclose elevator lobbies in accordance with Section 405.4.3, 3007.6.2, or 3008.6.2 shall comply with Section 709.4.2.

**Exception:** *Smoke-barrier walls* are not required in interstitial spaces where such spaces are designed and

constructed with ceilings or *exterior walls* that provide resistance to the passage of fire and smoke equivalent to that provided by the *smoke-barrier walls*.

**709.4.1 Smoke-barrier assemblies separating smoke compartments.** *Smoke-barrier assemblies* used to separate *smoke compartments* shall form an effective membrane enclosure that is continuous from an outside wall or *smoke barrier wall* to an outside wall or another *smoke barrier wall* and to the *horizontal assemblies*.

**709.4.2 Smoke-barrier walls enclosing areas of refuge or elevator lobbies.** *Smoke-barrier walls* used to enclose *areas of refuge* in accordance with Section 1009.6.4, or to enclose elevator lobbies in accordance with Section 405.4.3, 3007.6.2, or 3008.6.2, shall form an effective membrane enclosure that terminates at a *fire barrier wall* having a level of *fire protection rating* not less than 1 hour, another *smoke barrier wall* or an outside wall. A smoke and draft control door assembly as specified in Section 716.2.2.1.1 shall not be required at each elevator hoistway door opening or at each exit doorway between an *area of refuge* and the exit enclosure.

**709.5 Openings.** Openings in a *smoke barrier* shall be protected in accordance with Section 716.

### Exceptions:

1. In Group I-1, Condition 2, Group I-2 and *ambulatory care facilities*, where a pair of opposite-swinging doors are installed across a corridor in accordance with Section 709.5.1, the doors shall not be required to be protected in accordance with Section 716. The doors shall be close fitting within operational tolerances, and shall not have a center mullion or undercuts in excess of  $\frac{3}{4}$  inch (19.1 mm), louvers or grilles. The doors shall have head and jamb stops, and astragals or rabbets at meeting edges. Where permitted by the door manufacturer's listing, positive-latching devices are not required. Factory-applied or field-applied protective plates are not required to be labeled.
2. In Group I-1, Condition 2, Group I-2 and *ambulatory care facilities*, special purpose horizontal sliding, accordion or folding doors installed in accordance with Section 1010.3.3 and protected in accordance with Section 716.

**709.5.1 Group I-2 and ambulatory care facilities.** In Group I-2 and *ambulatory care facilities*, where doors protecting openings in *smoke barriers* are installed across a *corridor* and have hold-open devices, the doors shall be automatic-closing in accordance with Section 716.2.6.6. Such doors shall have a vision panel with fire-protection-rated glazing materials in fire-protection-rated frames, the area of which shall not exceed that tested.

**709.6 Penetrations.** Penetrations of *smoke barriers* shall comply with Section 714.

**709.7 Joints.** *Joints* made in or between *smoke barriers* shall comply with Section 715.

## FIRE AND SMOKE PROTECTION FEATURES

**709.8 Ducts and air transfer openings.** Penetrations in a *smoke barrier* by ducts and air transfer openings shall comply with Section 717.

### SECTION 710 SMOKE PARTITIONS

**710.1 General.** *Smoke partitions* installed as required elsewhere in the code shall comply with this section.

**710.2 Materials.** The walls shall be of materials permitted by the building type of construction.

**710.3 Fire-resistance rating.** Unless required elsewhere in the code, *smoke partitions* are not required to have a *fire-resistance rating*.

**710.4 Continuity.** *Smoke partitions* shall extend from the top of the foundation or floor below to the underside of the floor or roof sheathing, deck or slab above or to the underside of the ceiling above where the ceiling membrane is constructed to limit the transfer of smoke.

**710.5 Openings.** Openings in *smoke partitions* shall comply with Sections 710.5.1 through 710.5.3.

**710.5.1 Windows.** Windows in *smoke partitions* shall be sealed to resist the free passage of smoke or be automatic-closing upon detection of smoke.

**710.5.2 Doors.** Doors in *smoke partitions* shall comply with Sections 710.5.2.1 through 710.5.2.3.

**710.5.2.1 Louvers.** Doors in *smoke partitions* shall not include louvers.

**Exception:** Where permitted in accordance with Section 407.3.1.1.

**710.5.2.2 Smoke and draft control doors.** Where required elsewhere in the code, doors in *smoke partitions* shall meet the requirements for a smoke and draft control door assembly tested in accordance with UL 1784. The air leakage rate of the door assembly shall not exceed 3.0 cubic feet per minute per square foot [ $0.015424 \text{ m}^3/(\text{s} \times \text{m}^2)$ ] of door opening at 0.10 inch (24.9 Pa) of water for both the ambient temperature test and the elevated temperature exposure test. Installation of smoke doors shall be in accordance with NFPA 105.

**710.5.2.2.1 Smoke and draft control door labeling.** Smoke and draft control doors complying only with UL 1784 shall be permitted to show the letter “S” on the manufacturer’s labeling.

**710.5.2.3 Self- or automatic-closing doors.** Where required elsewhere in the code, doors in *smoke partitions* shall be self- or automatic-closing by smoke detection in accordance with Section 716.2.6.6.

**710.5.3 Pass-through openings in Group I-2, Condition 2.** Where pass-through openings are provided in

*smoke partitions* in Group I-2, Condition 2 occupancies, such openings shall comply with the following:

1. The smoke compartment in which the pass-through openings occur does not contain a patient care suite or sleeping room.
2. Pass-through openings are installed in a wall, door or vision panel that is not required to have a fire-resistance rating.
3. The top of the pass-through opening is located a maximum of 48 inches (1219 mm) above the floor.
4. The aggregate area of all such pass-through openings within a single room shall not exceed 80 square inches (0.05 m<sup>2</sup>).

**710.6 Penetrations.** The space around penetrating items shall be filled with an *approved* material to limit the free passage of smoke.

**710.7 Joints.** *Joints* shall be filled with an *approved* material to limit the free passage of smoke.

**710.8 Ducts and air transfer openings.** The space around a duct penetrating a *smoke partition* shall be filled with an *approved* material to limit the free passage of smoke. Air transfer openings in *smoke partitions* shall be provided with a *smoke damper* complying with Section 717.3.2.2.

**Exception:** Where the installation of a *smoke damper* will interfere with the operation of a required smoke control system in accordance with Section 909, *approved* alternative protection shall be utilized.

### SECTION 711 FLOOR AND ROOF ASSEMBLIES

**711.1 General.** *Horizontal assemblies* shall comply with Section 711.2. Nonfire-resistance-rated floor and *roof assemblies* shall comply with Section 711.3.

**711.2 Horizontal assemblies.** *Horizontal assemblies* shall comply with Sections 711.2.1 through 711.2.6.

**711.2.1 Materials.** Assemblies shall be of materials permitted by the building type of construction.

**711.2.2 Continuity.** Assemblies shall be continuous without vertical openings, except as permitted by this section and Section 712.

**711.2.3 Supporting construction.** The supporting construction shall be protected to afford the required *fire-resistance rating* of the *horizontal assembly* supported.

**Exception:** In buildings of Type IIB, IIIB or VB construction, the construction supporting the *horizontal assembly* is not required to be fire-resistance rated at the following:

1. *Horizontal assemblies* at the separations of incidental uses as specified by Table 509.1

provided that the required *fire-resistance rating* does not exceed 1 hour.

2. *Horizontal assemblies* at the separations of *dwelling units* and *sleeping units* as required by Section 420.3.
3. *Horizontal assemblies* at *smoke barriers* constructed in accordance with Section 709.

**711.2.4 Fire-resistance rating.** The *fire-resistance rating* of *horizontal assemblies* shall comply with Sections 711.2.4.1 through 711.2.4.6 but shall be not less than that required by the building type of construction.

**711.2.4.1 Separating mixed occupancies.** Where the *horizontal assembly* separates mixed occupancies, the assembly shall have a *fire-resistance rating* of not less than that required by Section 508.4 based on the occupancies being separated.

**711.2.4.2 Separating fire areas.** Where the *horizontal assembly* separates a single occupancy into different *fire areas*, the assembly shall have a *fire-resistance rating* of not less than that required by Section 707.3.10.

**711.2.4.3 Dwelling units and sleeping units.** *Horizontal assemblies* serving as *dwelling* or *sleeping unit* separations in accordance with Section 420.3 shall be not less than 1-hour *fire-resistance-rated* construction.

**Exception:** *Horizontal assemblies* separating *dwelling units* and *sleeping units* shall be not less than  $\frac{1}{2}$ -hour *fire-resistance-rated* construction in a building of Types IIB, IIIB and VB construction, where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**711.2.4.4 Separating smoke compartments.** Where the *horizontal assembly* is required to be a *smoke barrier*, the assembly shall comply with Section 709.

**711.2.4.5 Separating incidental uses.** Where the *horizontal assembly* separates incidental uses from the remainder of the building, the assembly shall have a *fire-resistance rating* of not less than that required by Section 509.

**711.2.4.6 Other separations.** Where a *horizontal assembly* is required by other sections of this code, the assembly shall have a *fire-resistance rating* of not less than that required by that section.

**711.2.5 Ceiling panels.** Where the weight of lay-in ceiling panels, used as part of *fire-resistance-rated* floor/ceiling or roof/ceiling assemblies, is not adequate to resist an upward force of 1 pound per square foot (48 Pa), wire or other *approved* devices shall be installed above the panels to prevent vertical displacement under such upward force.

**711.2.6 Unusable space.** In 1-hour *fire-resistance-rated* floor/ceiling assemblies, the ceiling membrane is not required to be installed over unusable crawl spaces. In 1-hour *fire-resistance-rated* roof assemblies, the floor

membrane is not required to be installed where unusable attic space occurs above.

**711.3 Nonfire-resistance-rated floor and roof assemblies.** Nonfire-resistance-rated floor, floor/ceiling, roof and roof/ceiling assemblies shall comply with Sections 711.3.1 and 711.3.2.

**711.3.1 Materials.** Assemblies shall be of materials permitted by the building type of construction.

**711.3.2 Continuity.** Assemblies shall be continuous without vertical openings, except as permitted by Section 712.

## SECTION 712 VERTICAL OPENINGS

**712.1 General.** Each vertical opening shall comply in accordance with one of the protection methods in Sections 712.1.1 through 712.1.16.

**712.1.1 Shaft enclosures.** Vertical openings contained entirely within a *shaft enclosure* complying with Section 713 shall be permitted.

**712.1.2 Individual dwelling unit.** Unconcealed vertical openings totally within an individual residential *dwelling unit* and connecting four *stories* or less shall be permitted.

**712.1.3 Escalator openings.** Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, vertical openings for escalators shall be permitted where protected in accordance with Section 712.1.3.1 or 712.1.3.2.

**712.1.3.1 Opening size.** Protection by a draft curtain and closely spaced sprinklers in accordance with NFPA 13 shall be permitted where the area of the vertical opening between *stories* does not exceed twice the horizontal projected area of the escalator. In other than Groups B and M, this application is limited to openings that do not connect more than four *stories*.

**712.1.3.2 Automatic shutters.** Protection of the vertical opening by approved shutters at every penetrated floor shall be permitted in accordance with this section. The shutters shall be of noncombustible construction and have a *fire-resistance rating* of not less than 1.5 hours. The shutter shall be so constructed as to close immediately upon the actuation of a smoke detector installed in accordance with Section 907.3.1 and shall completely shut off the well opening. Escalators shall cease operation when the shutter begins to close. The shutter shall operate at a speed of not more than 30 feet per minute (152.4 mm/s) and shall be equipped with a sensitive leading edge to arrest its progress where in contact with any obstacle, and to continue its progress on release therefrom.

**712.1.4 Penetrations.** Penetrations, concealed and unconcealed, shall be permitted where protected in accordance with Section 714.

**712.1.5 Joints.** *Joints* shall be permitted where complying with Section 712.1.5.1 or 712.1.5.2, as applicable.



## FIRE AND SMOKE PROTECTION FEATURES

**712.1.5.1 Joints in or between horizontal assemblies.** *Joints* made in or between *horizontal assemblies* shall comply with Section 715. The void created at the intersection of a floor/ceiling assembly and an exterior curtain wall assembly shall be permitted where protected in accordance with Section 715.4.

**712.1.5.2 Joints in or between nonfire-resistance-rated floor assemblies.** *Joints* in or between floor assemblies without a required *fire-resistance rating* shall be permitted where they comply with one of the following:

1. The *joint* shall be concealed within the cavity of a wall.
2. The *joint* shall be located above a ceiling.
3. The *joint* shall be sealed, treated or covered with an *approved* material or system to resist the free passage of flame and the products of combustion.

**Exception:** *Joints* meeting one of the exceptions specified in Section 715.3.

**712.1.6 Ducts and air transfer openings.** Penetrations by ducts and air transfer openings shall be protected in accordance with Section 717. Grease ducts shall be protected in accordance with the *International Mechanical Code*.

**712.1.7 Atriums.** *Atriums* complying with Section 404 that connect two or more *stories* in Group I-2 or I-3 occupancies or three or more *stories* in other occupancies shall be permitted.

**Exceptions:**

1. *Atriums* shall not be permitted within Group H occupancies.
2. Balconies or stories within Groups A-1, A-4 and A-5 and *mezzanines* that comply with Section 505 shall not be considered a story as it applies to this section

**712.1.8 Masonry chimney.** Approved vertical openings for masonry chimneys shall be permitted where the *annular space* is fireblocked at each floor level in accordance with Section 718.2.5.

**712.1.9 Two-story openings.** In other than Groups I-2 and I-3, a vertical opening that is not used as one of the applications specified in this section shall be permitted if the opening complies with all of the following items:

1. Does not connect more than two *stories*.
2. Does not penetrate a *horizontal assembly* that separates *fire areas* or *smoke barriers* that separate *smoke compartments*.
3. Is not concealed within the construction of a wall or a floor/ceiling assembly.
4. Is not open to a *corridor* in Group I and R occupancies.
5. Is not open to a *corridor* on nonsprinklered floors.

6. Is separated from floor openings and air transfer openings serving other floors by construction conforming to required *shaft enclosures*.

**712.1.10 Parking garages.** Vertical openings in parking garages for automobile ramps, elevators and duct systems shall comply with Section 712.1.10.1, 712.1.10.2 or 712.1.10.3, as applicable.

**712.1.10.1 Automobile ramps.** Vertical openings for automobile ramps in parking garages shall be permitted where constructed in accordance with Sections 406.5 and 406.6.

**712.1.10.2 Elevators.** Vertical openings for elevator hoistways in parking garages that serve only the parking garage, and complying with Sections 406.5 and 406.6, respectively, shall be permitted.

**712.1.10.3 Duct systems.** Vertical openings for mechanical exhaust or supply duct systems in parking garages complying with Sections 406.5 and 406.6, respectively, shall be permitted to be unenclosed where such duct system is contained within and serves only the parking garage.

**712.1.11 Mezzanine.** Vertical openings between a *mezzanine* complying with Section 505 and the floor below shall be permitted.

**712.1.12 Exit access stairways and ramps.** Vertical openings containing *exit access stairways* or *ramps* in accordance with Section 1019 shall be permitted.

**712.1.13 Openings.** Vertical openings for floor fire doors and access doors shall be permitted where protected by Section 712.1.13.1 or 712.1.13.2.

**712.1.13.1 Horizontal fire door assemblies.** Horizontal *fire door* assemblies used to protect openings in fire-resistance-rated *horizontal assemblies* shall be tested in accordance with NFPA 288, and shall achieve a *fire-resistance rating* not less than the assembly being penetrated. Horizontal *fire door* assemblies shall be labeled by an *approved* agency. The *label* shall be permanently affixed and shall specify the manufacturer, the test standard and the *fire-resistance rating*.

**712.1.13.2 Access doors.** Access doors shall be permitted in ceilings of fire-resistance-rated floor/ceiling and roof/ceiling assemblies, provided that such doors are tested in accordance with ASTM E119 or UL 263 as *horizontal assemblies* and labeled by an *approved agency* for such purpose.

**712.1.14 Group I-3.** In Group I-3 occupancies, vertical openings shall be permitted in accordance with Section 408.5.

**712.1.15 Skylights.** *Skylights* and other penetrations through a fire-resistance-rated roof deck or slab are permitted to be unprotected, provided that the structural integrity of the fire-resistance-rated *roof assembly* is maintained. Unprotected *skylights* shall not be permitted in *roof assemblies* required to be fire-resistance rated in accordance with Section 705.8.6. The supporting



construction shall be protected to afford the required *fire-resistance rating* of the *horizontal assembly* supported.

**712.1.16 Openings otherwise permitted.** Vertical openings shall be permitted where allowed by other sections of this code.

## SECTION 713 SHAFT ENCLOSURES

**713.1 General.** The provisions of this section shall apply to *shafts* required to protect openings and penetrations through floor/ceiling and roof/ceiling assemblies. *Interior exit stairways* and *ramps* shall be enclosed in accordance with Section 1023.

**713.2 Construction.** *Shaft enclosures* shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* in accordance with Section 711, or both.

**713.3 Materials.** *Shaft enclosures* shall be of materials permitted by the building type of construction.

**713.4 Fire-resistance rating.** *Shaft enclosures* shall have a *fire-resistance rating* of not less than 2 hours where connecting four *stories* or more, and not less than 1 hour where connecting less than four *stories*. The number of *stories* connected by the *shaft enclosure* shall include any *base-ments* but not any *mezzanines*. *Shaft enclosures* shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours. *Shaft enclosures* shall meet the requirements of Section 703.2.1.1.

**713.5 Continuity.** *Shaft enclosures* shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both, and shall have continuity in accordance with Section 707.5 for *fire barriers* or Section 711.2.2 for *horizontal assemblies*, as applicable.

**713.6 Exterior walls.** Where *exterior walls* serve as a part of a required *shaft enclosure*, such walls shall comply with the requirements of Section 705 for *exterior walls* and the fire-resistance-rated enclosure requirements shall not apply.

**Exception:** *Exterior walls* required to be fire-resistance rated in accordance with Section 1021.2 for exterior egress balconies, Section 1023.7 for *interior exit stairways* and *ramps* and Section 1027.6 for exterior *exit stairways* and *ramps*.

**713.7 Openings.** Openings in a *shaft enclosure* shall be protected in accordance with Section 716 as required for *fire barriers*. Doors shall be self- or automatic-closing by smoke detection in accordance with Section 716.2.6.6.

**713.7.1 Prohibited openings.** Openings other than those necessary for the purpose of the *shaft* shall not be permitted in *shaft enclosures*.

**713.8 Penetrations.** Penetrations in a *shaft enclosure* shall be protected in accordance with Section 714 as required for *fire barriers*. Structural elements, such as beams or joists, where protected in accordance with Section 714 shall be permitted to penetrate a *shaft enclosure*.

**713.8.1 Prohibited penetrations.** Penetrations other than those necessary for the purpose of the *shaft* shall not be permitted in *shaft enclosures*.

**Exception:** *Membrane penetrations* shall be permitted on the outside of *shaft enclosures*. Such penetrations shall be protected in accordance with Section 714.4.2.

**713.9 Joints.** *Joints* in a *shaft enclosure* shall comply with Section 715.

**713.10 Duct and air transfer openings.** Penetrations of a *shaft enclosure* by ducts and air transfer openings shall comply with Section 717.

**713.11 Enclosure at the bottom.** *Shafts* that do not extend to the bottom of the building or structure shall comply with one of the following:

1. Be enclosed at the lowest level with construction of the same *fire-resistance rating* as the *lowest floor* through which the *shaft* passes, but not less than the rating required for the *shaft enclosure*.
2. Terminate in a room having a use related to the purpose of the *shaft*. The room shall be separated from the remainder of the building by *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The *fire-resistance rating* and opening protectives shall be not less than the protection required for the *shaft enclosure*.
3. Be protected by *approved fire dampers* installed in accordance with their listing at the *lowest floor* level within the *shaft enclosure*.

### Exceptions:

1. The fire-resistance-rated room separation is not required, provided that the only openings in or penetrations of the *shaft enclosure* to the interior of the building occur at the bottom. The bottom of the *shaft* shall be closed off around the penetrating items with materials permitted by Section 718.3.1 for draftstopping, or the room shall be provided with an *approved automatic sprinkler system*.
2. A *shaft enclosure* containing a waste or linen chute shall not be used for any other purpose and shall discharge in a room protected in accordance with Section 713.13.4.
3. The fire-resistance-rated room separation and the protection at the bottom of the *shaft* are not required provided that there are no combustibles in the *shaft* and there are no openings or other penetrations through the *shaft enclosure* to the interior of the building.

**713.12 Enclosure at top.** The top of *shaft enclosures* shall comply with one of the following:

1. Extend to the underside of the roof sheathing, deck or slab of the building, and the *roof assembly* shall comply with the requirements for the type of construction as specified in Table 601.

## FIRE AND SMOKE PROTECTION FEATURES

2. Terminate below the *roof assembly* and be enclosed at the top with construction of the same *fire-resistance rating* as the topmost floor penetrated by the shaft, but not less than the *fire-resistance rating* required for the shaft enclosure.
3. Extend past the *roof assembly* and comply with the requirements of Section 1511.

**713.12.1 Penthouse mechanical rooms.** A fire/smoke damper shall not be required at the penetration of the rooftop structure where shaft enclosures extend up through the roof assembly into a rooftop structure conforming to Section 1511. Ductwork in the shaft shall be connected directly to HVAC equipment.

**713.13 Waste, recycling and linen chutes and incinerator rooms.** Waste, recycling and linen chutes shall comply with the provisions of NFPA 82, Chapter 6 and shall meet the requirements of Sections 712 and 713.13.1 through 713.13.6. Incinerator rooms shall meet the provisions of Sections 713.13.4 and 713.13.5.

**Exception:** Chutes serving and contained within a single dwelling unit.

**713.13.1 Waste, recycling and linen chute enclosures.** A shaft enclosure containing a recycling, waste or linen chute shall not be used for any other purpose and shall be enclosed in accordance with Section 713.4. A shaft enclosure shall be permitted to contain recycling and waste chutes. Openings into the shaft, from access rooms and discharge rooms, shall be protected in accordance with this section and Section 716. Openings into chutes shall not be located in corridors. Doors into chutes shall be self-closing. Discharge doors shall be self-or automatic-closing upon the actuation of a smoke detector in accordance with Section 716.2.6.6, except that heat-activated closing devices shall be permitted between the shaft and the discharge room.

**713.13.2 Materials.** A shaft enclosure containing a waste, recycling, or linen chute shall be constructed of materials as permitted by the building type of construction.

**713.13.3 Chute access rooms.** Access openings for waste, recycling or linen chutes shall be located in rooms or compartments enclosed by not less than 1-hour fire barriers constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with Section 711, or both. Openings into the access rooms shall be protected by opening protectives having a fire protection rating of not less than  $\frac{3}{4}$  hour. Doors shall be self- or automatic-closing upon the detection of smoke in accordance with Section 716.2.6.6. The room or compartment shall be configured to allow the access door to the room or compartment to close and latch with the access panel to the chute in any position.

**713.13.4 Chute discharge room.** Table 509.1 Waste, recycling or linen chutes shall discharge into an enclosed room separated by fire barriers with a fire-resistance rating not less than the required fire rating of the shaft enclosure and constructed in accordance with Section 707 or horizontal assemblies constructed in accordance with

Section 711, or both. Openings into the discharge room from the remainder of the building shall be protected by opening protectives having a fire protection rating equal to the protection required for the shaft enclosure. Doors shall be self- or automatic-closing upon the detection of smoke in accordance with Section 716.2.6.6. Waste chutes shall not terminate in an incinerator room. Waste and linen rooms that are not provided with chutes need only comply with Table 509.1.

**713.13.5 Incinerator room.** Incinerator rooms shall comply with Table 509.1.

**713.13.6 Automatic sprinkler system.** An approved automatic sprinkler system shall be installed in accordance with Section 903.2.11.2.

**713.14 Elevator, dumbwaiter and other hoistways.** Elevator, dumbwaiter and other hoistway enclosures shall be constructed in accordance with Sections 712 and 713, and Chapter 30.

## SECTION 714 PENETRATIONS

**714.1 Scope.** The provisions of this section shall govern the materials and methods of construction used to protect through penetrations and membrane penetrations of horizontal assemblies and fire-resistance-rated wall assemblies.

**714.1.1 Ducts and air transfer openings.** Penetrations of fire-resistance-rated walls by ducts that are not protected with dampers shall comply with Sections 714.3 through 714.4.3. Penetrations of horizontal assemblies not protected with a shaft as permitted by Section 717.6, and not required to be protected with fire dampers by other sections of this code, shall comply with Sections 714.5 through 714.6.2. Ducts and air transfer openings that are protected with dampers shall comply with Section 717.

**714.2 Installation.** A listed penetration firestop system shall be installed in accordance with the manufacturer's installation instructions and the listing criteria.

**714.3 Installation details.** Where sleeves are used, they shall be securely fastened to the assembly penetrated. The space between the item contained in the sleeve and the sleeve itself and any space between the sleeve and the assembly penetrated shall be protected in accordance with this section. Insulation and coverings on or in the penetrating item shall not penetrate the assembly unless the specific material used has been tested as part of the assembly in accordance with this section.

**714.4 Fire-resistance-rated walls.** Penetrations into or through fire walls, fire barriers, smoke barrier walls and fire partitions shall comply with Sections 714.4.1 through 714.4.3. Penetrations in smoke barrier walls shall also comply with Section 714.5.4.

**714.4.1 Through penetrations.** Through penetrations of fire-resistance-rated walls shall comply with Section 714.4.1.1 or 714.4.1.2.

**Exception:** Where the penetrating items are steel, ferrous or copper pipes, tubes or conduits, the annular

## FIRE AND SMOKE PROTECTION FEATURES

*space* between the penetrating item and the fire-resistance-rated wall is permitted to be protected by either of the following measures:

1. In concrete or masonry walls where the penetrating item is a maximum 6-inch (152 mm) nominal diameter and the area of the opening through the wall does not exceed 144 square inches (0.0929 m<sup>2</sup>), concrete, grout or *mortar* is permitted where installed the full thickness of the wall or the thickness required to maintain the *fire-resistance rating*.
2. The material used to fill the *annular space* shall prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E119 or UL 263 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated.

**714.4.1.1 Fire-resistance-rated assemblies.** *Through penetrations* shall be protected using systems installed as tested in the *approved* fire-resistance-rated assembly.

**714.4.1.2 Through-penetration firestop system.** *Through penetrations* shall be protected by an *approved penetration firestop* system installed as tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water and shall have an *F rating* of not less than the required *fire-resistance rating* of the wall penetrated.

**714.4.2 Membrane penetrations.** *Membrane penetrations* shall comply with Section 714.4.1. Where walls or partitions are required to have a *fire-resistance rating*, recessed fixtures shall be installed such that the required *fire resistance* will not be reduced.

#### Exceptions:

1. *Membrane penetrations* of maximum 2-hour fire-resistance-rated walls and partitions by steel electrical boxes that do not exceed 16 square inches (0.0103 m<sup>2</sup>) in area, provided that the aggregate area of the openings through the membrane does not exceed 100 square inches (0.0645 m<sup>2</sup>) in any 100 square feet (9.29 m<sup>2</sup>) of wall area. The *annular space* between the wall membrane and the box shall not exceed  $\frac{1}{8}$  inch (3.2 mm). Such boxes on opposite sides of the wall or partition shall be separated by one of the following:
  - 1.1. By a horizontal distance of not less than 24 inches (610 mm) where the wall or partition is constructed with individual noncommunicating stud cavities.
  - 1.2. By a horizontal distance of not less than the depth of the wall cavity where

the wall cavity is filled with cellulose loose-fill, rockwool or slag *mineral wool* insulation.

- 1.3. By solid *fireblocking* in accordance with Section 718.2.1.
- 1.4. By protecting both outlet boxes with *listed* putty pads.
- 1.5. By other *listed* materials and methods.
2. *Membrane penetrations* by *listed* electrical boxes of any material, provided that such boxes have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the listing. The *annular space* between the wall membrane and the box shall not exceed  $\frac{1}{8}$  inch (3.2 mm) unless *listed* otherwise. Such boxes on opposite sides of the wall or partition shall be separated by one of the following:
  - 2.1. By the horizontal distance specified in the listing of the electrical boxes.
  - 2.2. By solid *fireblocking* in accordance with Section 718.2.1.
  - 2.3. By protecting both boxes with *listed* putty pads.
  - 2.4. By other *listed* materials and methods.
3. *Membrane penetrations* by electrical boxes of any size or type, that have been *listed* as part of a wall opening protective material system for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the listing.
4. *Membrane penetrations* by boxes other than electrical boxes, provided that such penetrating items and the *annular space* between the wall membrane and the box, are protected by an *approved membrane penetration firestop system* installed as tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water, and shall have an *F* and *T rating* of not less than the required *fire-resistance rating* of the wall penetrated and be installed in accordance with their listing.
5. The *annular space* created by the penetration of an automatic sprinkler, provided that it is covered by a metal escutcheon plate.
6. *Membrane penetrations* of maximum 2-hour fire-resistance-rated walls and partitions by steel electrical boxes that exceed 16 square inches (0.0103 m<sup>2</sup>) in area, or steel electrical boxes of any size having an aggregate area through the membrane exceeding 100 square inches (0.0645 m<sup>2</sup>) in any 100 square feet (9.29 m<sup>2</sup>) of wall area, provided that such penetrating items are protected by *listed* putty pads or other



## FIRE AND SMOKE PROTECTION FEATURES

*listed* materials and methods, and installed in accordance with the listing.

**714.4.3 Dissimilar materials.** Noncombustible penetrating items shall not connect to combustible items beyond the point of firestopping unless it can be demonstrated that the *fire-resistance* integrity of the wall is maintained.

**714.5 Horizontal assemblies.** Penetrations of a *fire-resistance-rated* floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly not required to be enclosed in a *shaft* by Section 712.1 shall be protected in accordance with Sections 714.5.1 through 714.5.4.

**714.5.1 Through penetrations.** *Through penetrations* of *horizontal assemblies* shall comply with Section 714.5.1.1 or 714.5.1.2.

### Exceptions:

1. Penetrations by steel, ferrous or copper conduits, pipes, tubes or vents or concrete or masonry items through a single fire-resistance-rated floor assembly where the *annular space* is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste when subjected to ASTM E119 or UL 263 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated. Penetrating items with a maximum 6-inch (152 mm) nominal diameter shall not be limited to the penetration of a single fire-resistance-rated floor assembly, provided that the aggregate area of the openings through the assembly does not exceed 144 square inches (92 900 mm<sup>2</sup>) in any 100 square feet (9.3 m<sup>2</sup>) of floor area.
2. Penetrations in a single concrete floor by steel, ferrous or copper conduits, pipes, tubes or vents with a maximum 6-inch (152 mm) nominal diameter, provided that the concrete, grout or *mortar* is installed the full thickness of the floor or the thickness required to maintain the *fire-resistance rating*. The penetrating items shall not be limited to the penetration of a single concrete floor, provided that the area of the opening through each floor does not exceed 144 square inches (92 900 mm<sup>2</sup>).
3. Penetrations by *listed* electrical boxes of any material, provided that such boxes have been tested for use in fire-resistance-rated assemblies and installed in accordance with the instructions included in the listing.

**714.5.1.1 Fire-resistance-rated assemblies.** *Through penetrations* shall be protected using systems installed as tested in the *approved* fire-resistance-rated assembly.

**714.5.1.2 Through-penetration firestop system.** *Through penetrations* shall be protected by an

*approved through-penetration firestop system* installed and tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 inch of water (2.49 Pa). The system shall have an *F rating/T rating* of not less than 1 hour but not less than the required rating of the floor penetrated.

### Exceptions:

1. Floor penetrations contained and located within the cavity of a wall above the floor or below the floor do not require a *T rating*.
2. Floor penetrations by floor drains, tub drains or shower drains contained and located within the concealed space of a *horizontal assembly* do not require a *T rating*.
3. Floor penetrations of maximum 4-inch (102 mm) nominal diameter metal conduit or tubing penetrating directly into metal-enclosed electrical power switchgear do not require a *T rating*.

**714.5.2 Membrane penetrations.** Penetrations of membranes that are part of a *horizontal assembly* shall comply with Section 714.5.1.1 or 714.5.1.2. Where floor/ceiling assemblies are required to have a *fire-resistance rating*, recessed fixtures shall be installed such that the required *fire resistance* will not be reduced.

### Exceptions:

1. *Membrane penetrations* by steel, ferrous or copper conduits, pipes, tubes or vents, or concrete or masonry items where the *annular space* is protected either in accordance with Section 714.5.1 or to prevent the free passage of flame and the products of combustion. The aggregate area of the openings through the membrane shall not exceed 100 square inches (64 500 mm<sup>2</sup>) in any 100 square feet (9.3 m<sup>2</sup>) of ceiling area in assemblies tested without penetrations.
2. Ceiling *membrane penetrations* of maximum 2-hour *horizontal assemblies* by steel electrical boxes that do not exceed 16 square inches (10 323 mm<sup>2</sup>) in area, provided that the aggregate area of such penetrations does not exceed 100 square inches (64 500 mm<sup>2</sup>) in any 100 square feet (9.29 m<sup>2</sup>) of ceiling area, and the *annular space* between the ceiling membrane and the box does not exceed 1/8 inch (3.2 mm).
3. *Membrane penetrations* by electrical boxes of any size or type, that have been *listed* as part of an opening protective material system for use in *horizontal assemblies* and are installed in accordance with the instructions included in the listing.
4. *Membrane penetrations* by *listed* electrical boxes of any material, provided that such boxes have been tested for use in fire-resis-



tance-rated assemblies and are installed in accordance with the instructions included in the listing. The *annular space* between the ceiling membrane and the box shall not exceed  $\frac{1}{8}$  inch (3.2 mm) unless *listed* otherwise.

5. The *annular space* created by the penetration of a fire sprinkler, provided that it is covered by a metal escutcheon plate.
6. Noncombustible items that are cast into concrete *building elements* and that do not penetrate both top and bottom surfaces of the element.
7. The ceiling membrane of a maximum 2-hour fire-resistance-rated *horizontal assembly* is permitted to be interrupted with the double wood top plate of a wall assembly that is sheathed with Type X *gypsum wallboard*, provided that all penetrating items through the double top plates are protected in accordance with Section 714.5.1.1 or 714.5.1.2 and the ceiling membrane is tight to the top plates.
8. Ceiling *membrane penetrations* by listed luminaires (light fixtures) or by luminaires protected with *listed* materials, which have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the listing.

**714.5.3 Dissimilar materials.** Noncombustible penetrating items shall not connect to combustible materials beyond the point of firestopping unless it can be demonstrated that the *fire-resistance* integrity of the *horizontal assembly* is maintained.

**714.5.4 Penetrations in smoke barriers.** Penetrations in *smoke barriers* shall be protected by an approved *through-penetration firestop system* installed and tested in accordance with the requirements of UL 1479 for air leakage. The *L rating* of the system measured at 0.30 inch (7.47 Pa) of water in both the ambient temperature and elevated temperature tests shall not exceed either of the following:

1. 5.0 cfm per square foot ( $0.025 \text{ m}^3/\text{s} \times \text{m}^2$ ) of penetration opening for each *through-penetration firestop system*.
2. A total cumulative leakage of 50 cfm ( $0.024 \text{ m}^3/\text{s}$ ) for any 100 square feet ( $9.3 \text{ m}^2$ ) of wall area, or floor area.

**714.6 Nonfire-resistance-rated assemblies.** Penetrations of nonfire-resistance-rated floor or floor/ceiling assemblies or the ceiling membrane of a nonfire-resistance-rated roof/ceiling assembly shall meet the requirements of Section 713 or shall comply with Section 714.6.1 or 714.6.2.

**714.6.1 Noncombustible penetrating items.** Noncombustible penetrating items that connect not more than five *stories* are permitted, provided that the *annular space* is filled to resist the free passage of flame and the products

of combustion with an *approved* noncombustible material or with a fill, void or cavity material that is tested and classified for use in *through-penetration firestop systems*.

**714.6.2 Penetrating items.** Penetrating items that connect not more than two *stories* are permitted, provided that the *annular space* is filled with an *approved* material to resist the free passage of flame and the products of combustion.

## SECTION 715 JOINTS AND VOIDS

**715.1 General.** The provisions of this section shall govern the materials and methods of construction used to protect *joints* and voids in or between horizontal and vertical assemblies.

**715.2 Installation.** Systems or materials protecting *joints* and voids shall be securely installed in accordance with the manufacturer's installation instructions in or on the *joint* or void for its entire length so as not to dislodge, loosen or otherwise impair its ability to accommodate expected building movements and to resist the passage of fire and hot gases. *Fire-resistant joint systems* or systems used to protect voids at exterior curtain walls and fire-resistance-rated floor intersections shall also be installed in accordance with the listing criteria.

**715.3 Fire-resistance-rated assembly intersections.** *Joints* installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies shall be protected by an approved *fire-resistant joint system* designed to resist the passage of fire for a time period not less than the required *fire-resistance rating* of the wall, floor or roof in or between which the system is installed.

**Exception:** *Fire-resistant joint systems* shall not be required for *joints* in the following locations:

1. Floors within a single *dwelling unit*.
2. Floors where the *joint* is protected by a shaft enclosure in accordance with Section 713.
3. Floors within *atriums* where the space adjacent to the *atrium* is included in the volume of the *atrium* for smoke control purposes.
4. Floors within *malls*.
5. Floors and ramps within parking garages or structures constructed in accordance with Sections 406.5 and 406.6.
6. *Mezzanine* floors.
7. Walls that are permitted to have unprotected openings.
8. Roofs where openings are permitted.
9. Control *joints* not exceeding a maximum width of 0.625 inch (15.9 mm) and tested in accordance with ASTM E119 or UL 263.
10. The intersection of exterior curtain wall assemblies and the roof slab or roof deck.

## FIRE AND SMOKE PROTECTION FEATURES

**715.3.1 Fire test criteria.** *Fire-resistant joint systems* shall be tested in accordance with the requirements of either ASTM E1966 or UL 2079. Nonsymmetrical wall *joint systems* shall be tested with both faces exposed to the furnace, and the assigned *fire-resistance rating* shall be the shortest duration obtained from the two tests. Where evidence is furnished to show that the wall was tested with the least fire-resistant side exposed to the furnace, subject to acceptance of the *building official*, the wall need not be subjected to tests from the opposite side.

**Exception:** For *exterior walls* with a horizontal *fire separation distance* greater than 10 feet (3048 mm), the joint system shall be required to be tested for interior fire exposure only.

**715.4 Exterior curtain wall/fire-resistance-rated floor intersections.** Voids created at the intersection of exterior curtain wall assemblies and fire-resistance-rated floor or floor/ceiling assemblies shall be protected with an *approved perimeter fire containment system* to prevent the interior spread of fire. Such systems shall provide an *F rating* for a time period not less than the *fire-resistance rating* of the floor or floor/ceiling assembly.

**715.4.1 Fire test criteria.** *Perimeter fire containment systems* shall be tested in accordance with the requirements of ASTM E2307.

**Exception:** Voids created at the intersection of the exterior curtain wall assemblies and floor assemblies where the vision glass extends to the finished floor level shall be permitted to be protected with an approved material to prevent the interior spread of fire. Such material shall be securely installed and capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E119 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inch (0.254 mm) of water column (2.5 Pa) for the time period not less than the fire-resistance rating of the floor assembly.

**715.5 Exterior curtain wall/nonfire-resistance-rated floor assembly intersections.** Voids created at the intersection of exterior curtain wall assemblies and nonfire-resistance-rated floor or floor/ceiling assemblies shall be filled with an *approved material* or system to retard the interior spread of fire and hot gases between *stories*.

**715.6 Exterior curtain wall/vertical fire barrier intersections.** Voids created at the intersection of nonfire-resistance-rated exterior curtain wall assemblies and vertical *fire barriers* shall be filled with an approved material or system to retard the interior spread of fire and hot gases.

**715.7 Curtain wall spandrels.** Height and *fire-resistance* requirements for curtain wall spandrels shall comply with Section 705.8.5. Where Section 705.8.5 does not require fire-resistance-rated curtain wall spandrels, the requirements of Sections 715.4 and 715.5 shall still apply to the intersection between the curtain wall spandrels and the floor.

**715.8 Joints and voids in smoke barriers.** *Fire-resistant joint systems* protecting *joints* in *smoke barriers*, and prime-

ter fire containment systems protecting voids at the intersection of a horizontal *smoke barrier* and an exterior curtain wall, shall be tested in accordance with the requirements of UL 2079 for air leakage. The L rating of the joint system shall not exceed 5 cubic feet per minute per linear foot (0.00775 m<sup>3</sup>/s m) of joint at 0.30 inch (74.7 Pa) of water for both the ambient temperature and elevated temperature tests.

## SECTION 716 OPENING PROTECTIVES

**716.1 General.** Opening protectives required by other sections of this code shall comply with the provisions of this section and shall be installed in accordance with NFPA 80.

**716.1.1 Alternative methods for determining fire protection ratings.** The application of any of the alternative methods specified in this section shall be based on the fire exposure and acceptance criteria specified in NFPA 252, NFPA 257, UL 9, UL 10B or UL 10C. The required *fire resistance* of an opening protective shall be permitted to be established by any of the following methods or procedures:

1. Designs documented in *approved sources*.
2. Calculations performed in an *approved manner*.
3. Engineering analysis based on a comparison of opening protective designs having *fire protection ratings* as determined by the test procedures set forth in NFPA 252, NFPA 257, UL 9, UL 10B or UL 10C.
4. Alternative protection methods as allowed by Section 104.11.

**716.1.2 Glazing.** Glazing used in *fire door assemblies* and *fire window assemblies* shall comply with this section in addition to the requirements of Sections 716.2 and 716.3, respectively.

**716.1.2.1 Safety glazing.** *Fire-protection-rated glazing* and fire-resistance-rated glazing installed in *fire door assemblies* and *fire window assemblies* shall comply with the safety glazing requirements of Chapter 24 where applicable.

**716.1.2.2 Marking fire-rated glazing assemblies.** *Fire-rated glazing assemblies* shall be marked in accordance with Tables 716.1(1), 716.1(2) and 716.1(3).

**716.1.2.2.1 Fire-rated glazing identification.** For *fire-rated glazing*, the *label* shall bear the identification required in Tables 716.1(1) and 716.1(2). “D” indicates that the glazing is permitted to be used in *fire door assemblies* and meets the fire protection requirements of NFPA 252, UL 10B or UL 10C. “H” indicates that the glazing meets the hose stream requirements of NFPA 252, UL 10B or UL 10C. “T” indicates that the glazing meets the temperature requirements of Section 716.2.2.3.1. The placeholder “XXX” represents the fire-rating period, in minutes.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 716.1(1)**  
**MARKING FIRE-RATED GLAZING ASSEMBLIES**

FIRE TEST STANDARD	MARKING	DEFINITION OF MARKING
ASTM E119 or UL 263	W	Meets wall assembly criteria.
ASTM E119 or UL 263	FC	Meets floor/ceiling criteria <sup>a</sup>
NFPA 257 or UL 9	OH	Meets fire window assembly criteria including the hose stream test.
NFPA 252 or UL 10B or UL 10C	D	Meets fire door assembly criteria.
	H	Meets fire door assembly hose stream test.
	T	Meets 450°F temperature rise criteria for 30 minutes
—	XXX	The time in minutes of the fire resistance or fire protection rating of the glazing assembly.

For SI: °C = [(°F) – 32]/1.8.

a. See Section 2409.1

**TABLE 716.1(2)**  
**OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS**

TYPE OF ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)		MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)	DOOR VISION PANEL SIZE <sup>a</sup>	FIRE-RATED GLAZING MARKING DOOR VISION PANEL <sup>b,c</sup>	MINIMUM SIDELIGHT/TRANSOM ASSEMBLY RATING (hours)		FIRE-RATED GLAZING MARKING SIDE-LIGHT/TRANSOM PANEL	
						Fire protection	Fire resistance	Fire protection	Fire resistance
Fire walls and fire barriers having a required fire-resistance rating greater than 1 hour	4		3	See Note a	D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3		3 <sup>d</sup>	See Note a	D-H-W-180	Not Permitted	3	Not Permitted	W-180
	2		1½	100 sq. in.	≤100 sq. in. = D-H-90 >100 sq. in.=D-H-W-90	Not Permitted	2	Not Permitted	W-120
	1½		1½	100 sq. in.	≤100 sq. in. = D-H-90 >100 sq. in.= D-H-W-90	Not Permitted	1½	Not Permitted	W-90
Double fire walls constructed in accordance with NFPA 221	Single-wall assembly rating (hours) <sup>e</sup>	Each wall of the double-wall assembly (hours) <sup>f</sup>	—						
	4	3	3	See Note a	D-H-W-180	Not Permitted	3	Not Permitted	W-180
	3	2	1½	100 sq. in.	≤ 100 sq. in. = D-H-90 >100 sq. in.= D-H-W-90	Not Permitted	2	Not Permitted	W-120
	2	1	1	100 sq. in.	≤ 100 sq. in. = D-H-60 > 100 sq. in. = D-H-W-60	Not Permitted	1	Not Permitted	W-60
Enclosures for shafts, interior exit stairways and interior exit ramps.	2		1½	100 sq. in. <sup>b</sup>	≤100 sq. in. = D-H-90 > 100 sq. in.= D-H-T-W-90	Not Permitted	2	Not Permitted	W-120

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 716.1(2)—continued**  
**OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS**

TYPE OF ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)	MINIMUM FIRE DOOR AND FIRE SHUTTER ASSEMBLY RATING (hours)	DOOR VISION PANEL SIZE <sup>a</sup>	FIRE-RATED GLAZING MARKING DOOR VISION PANEL <sup>b,c</sup>	MINIMUM SIDELIGHT/TRANSOM ASSEMBLY RATING (hours)		FIRE-RATED GLAZING MARKING SIDE-LIGHT/TRANSOM PANEL	
					Fire protection	Fire resistance	Fire protection	Fire resistance
Horizontal exits in fire walls <sup>g</sup>	4	3	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in.=D-H-W-240	Not Permitted	4	Not Permitted	W-240
	3	3 <sup>d</sup>	100 sq. in.	≤100 sq. in. = D-H-180 > 100 sq. in.=D-H-W-180	Not Permitted	3	Not Permitted	W-180
Fire barriers having a required fire-resistance rating of 1 hour: Enclosures for shafts, exit access stairways, exit access ramps, interior exit stairways and interior exit ramps; and exit passageway walls	1	1	100 sq. in.	≤100 sq. in. = D-H-60 >100 sq. in.=D-H-T-W-60	Not Permitted	1	Not Permitted	W-60
					<b>Fire protection</b>			
Other fire barriers	1	3/4	Maximum size tested	D-H	3/4 <sup>h</sup>		D-H <sup>h</sup>	
Fire partitions: Corridor walls	1	1/3 <sup>a</sup>	Maximum size tested	D-20	3/4 <sup>a</sup>		D-H-OH-45	
	0.5	1/3 <sup>a</sup>	Maximum size tested	D-20	1/3		D-H-OH-20	
Other fire partitions	1	3/4 <sup>i</sup>	Maximum size tested	D-H-45	3/4		D-H-45	
	0.5	1/3	Maximum size tested	D-H-20	1/3		D-H-20	
Exterior walls	3	1 1/2	100 sq. in. <sup>a</sup>	≤100 sq. in. = D-H-90 > 100 sq. in. = D-H-W-90	Not Permitted	3	Not Permitted	W-180
	2	1 1/2	Maximum size tested	D-H 90 or D-H-W-90	1 1/2 <sup>h</sup>	2	D-H-OH-90 <sup>h</sup>	W-120
					<b>Fire protection</b>			
	1	3/4	Maximum size tested	D-H-45	3/4 <sup>h</sup>		D-H-45 <sup>h</sup>	
Smoke barriers					<b>Fire protection</b>			
	1	1/3	Maximum size tested	D-20	3/4		D-H-OH-45	

(continued)



**TABLE 716.1(2)—continued**  
**OPENING FIRE PROTECTION ASSEMBLIES, RATINGS AND MARKINGS**

For SI: 1 square inch = 645.2 mm.

- Fire-resistance-rated glazing tested to ASTM E119 in accordance with Section 716.1.2.3 shall be permitted, in the maximum size tested.
- Under the column heading “Fire-rated glazing marking door vision panel,” W refers to the fire-resistance rating of the glazing, not the frame.
- See Section 716.1.2.2.1 and Table 716.1(1) for additional permitted markings.
- Two doors, each with a fire protection rating of 1½ hours, installed on opposite sides of the same opening in a fire wall, shall be deemed equivalent in fire protection rating to one 3-hour fire door.
- As required in Section 706.4.
- As allowed in Section 4.6 of NFPA 221.
- See Section 716.2.5.1.2.
- Fire-protection-rated glazing is not permitted for fire barriers required by Section 1207 of the *International Fire Code* to enclose energy storage systems. Fire-resistance-rated glazing assemblies tested to ASTM E119 or UL 263, as specified in Section 716.1.2.3, shall be permitted.
- Two doors, each with a fire rating of 20 minutes, installed on opposite sides of the same opening in a fire partition, shall be deemed equivalent in fire protection rating to one 45-minute fire door.

**TABLE 716.1(3)**  
**FIRE WINDOW ASSEMBLY FIRE PROTECTION RATINGS**

TYPE OF WALL ASSEMBLY	REQUIRED WALL ASSEMBLY RATING (hours)	MINIMUM FIRE WINDOW ASSEMBLY RATING (hours)	FIRE-RATED GLAZING MARKING
Interior walls			
Fire walls	All	NP <sup>a</sup>	W-XXX <sup>b</sup>
Fire barriers	>1	NP <sup>a</sup>	W-XXX <sup>b</sup>
	1	NP <sup>a</sup>	W-XXX <sup>b</sup>
Atrium separations (Section 707.3.6), Incidental use areas (Section 707.3.7), <sup>c</sup> Mixed occupancy separations (Section 707.3.9)	1	¾	OH-45 or W-60
Fire partitions	1	¾	OH-45 or W-60
	0.5	⅓	OH-20 or W-30
Smoke barriers	1	¾	OH-45 or W-60
Exterior walls	>1	1½	OH-90 or W-XXX <sup>b</sup>
	1	¾	OH-45 or W-60
	0.5	⅓	OH-20 or W-30
Party wall	All	NP	Not Applicable

NP = Not Permitted.

- Not permitted except fire-resistance-rated glazing assemblies tested to ASTM E119 or UL 263, as specified in Section 716.1.2.3.
- XXX = The fire rating duration period in minutes, which shall be equal to the fire-resistance rating required for the wall assembly.
- Fire-protection-rated glazing is not permitted for fire barriers required by Section 1207 of the *International Fire Code* to enclose energy storage systems. Fire-resistance-rated glazing assemblies tested to ASTM E119 or UL 263, as specified in Section 716.1.2.3, shall be permitted.

**716.1.2.2.2 Fire-protection-rated glazing identification.** For *fire-protection-rated* glazing, the label shall bear the following identification required in Tables 716.1(1) and 716.1(3): “OH – XXX.” “OH” indicates that the glazing meets both the fire protection and the hose-stream requirements of NFPA 257 or UL 9 and is permitted to be used in fire window openings. The placeholder “XXX” represents the fire-rating period, in minutes.

**716.1.2.2.3 Fire-resistance-rated glazing identification.** For fire-resistance-rated glazing, the label shall bear the identification required in Section 703.4 and Table 716.1(1).

**716.1.2.2.4 Fire-rated glazing that exceeds the code requirements.** *Fire-rated glazing* assemblies marked as complying with hose stream requirements (H) shall be permitted in applications that do

not require compliance with hose stream requirements. *Fire-rated glazing* assemblies marked as complying with temperature rise requirements (T) shall be permitted in applications that do not require compliance with temperature rise requirements. *Fire-rated glazing* assemblies marked with ratings (XXX) that exceed the ratings required by this code shall be permitted.

**716.1.2.3 Fire-resistance-rated glazing.** Fire-resistance-rated glazing tested as part of a fire-resistance-rated wall or floor/ceiling assembly in accordance with ASTM E119 or UL 263 and labeled in accordance with Section 703.4 shall not otherwise be required to comply with this section where used as part of a wall or floor/ceiling assembly.

**716.1.2.3.1 Glazing in fire door and fire window assemblies.** Fire-resistance-rated glazing shall be

## FIRE AND SMOKE PROTECTION FEATURES

permitted in *fire door* and *fire window assemblies* where tested and installed in accordance with their listings and where in compliance with the requirements of this section.

**716.2 Fire door assemblies.** *Fire door assemblies* required by other sections of this code shall comply with the provisions of this section. *Fire door* frames with transom lights, sidelights or both shall be permitted in accordance with Section 716.2.5.4.

**716.2.1 Testing requirements.** Approved *fire door* and fire shutter assemblies shall be constructed of any material or assembly of component materials that conforms to the test requirements of Sections 716.2.1.1 through 716.2.1.4 and the *fire protection rating* indicated in Table 716.1(2).

### Exceptions:

1. Labeled protective assemblies that conform to the requirements of this section or UL 10A, UL 14B and UL 14C for tin-clad *fire door assemblies*.
2. Floor *fire door assemblies* in accordance with Section 712.1.13.1.

**716.2.1.1 Side-hinged or pivoted swinging doors.** *Fire door* assemblies with side-hinged and pivoted swinging doors shall be tested in accordance with NFPA 252 or UL 10C. For tests conducted in accordance with NFPA 252, the fire test shall be conducted using the positive pressure method specified in the standard.

**716.2.1.2 Other types of assemblies.** *Fire door* assemblies with other types of doors, including swinging elevator doors, horizontal sliding *fire doors*, rolling steel *fire doors*, fire shutters, bottom- and side-hinged chute intake doors, and top-hinged chute discharge doors, shall be tested in accordance with NFPA 252 or UL 10B. For tests conducted in accordance with NFPA 252, the neutral pressure plane in the furnace shall be maintained as nearly equal to the atmospheric pressure as possible at the top of the door, as specified in the standard.

**716.2.1.3 Glazing in transoms lights and sidelights in corridors and smoke barriers.** Glazing material in any other part of the door assembly, including transom lights and sidelights, shall be tested in accordance with NFPA 257 or UL 9, including the hose stream test, in accordance with Section 716.3.1.1.

**716.2.1.4 Smoke and draft control.** *Fire door* assemblies that serve as smoke and draft control assemblies shall be tested in accordance with UL 1784.

**716.2.2 Performance requirements.** *Fire door assemblies* shall be installed in the assemblies specified in Table 716.1(2) and shall comply with the *fire protection rating* specified.

**716.2.2.1 Door assemblies in corridors and smoke barriers.** *Fire door* assemblies required to have a minimum *fire protection rating* of 20 minutes where

located in *corridor* walls or *smoke barrier* walls having a *fire-resistance rating* in accordance with Table 716.1(2) shall be tested in accordance with NFPA 252 or UL 10C without the hose stream test.

### Exceptions:

1. Viewports that require a hole not larger than 1 inch (25 mm) in diameter through the door, have not less than a 0.25-inch-thick (6.4 mm) glass disc and the holder is of metal that will not melt out where subject to temperatures of 1,700°F (927°C).
2. *Corridor* door assemblies in occupancies of Group I-2 shall be in accordance with Section 407.3.1.
3. Unprotected openings shall be permitted for *corridors* in multitheater complexes where each motion picture auditorium has not fewer than one-half of its required *exit* or *exit access doorways* opening directly to the exterior or into an *exit passageway*.
4. Horizontal sliding doors in *smoke barriers* that comply with Sections 408.6 and 408.8.4 in occupancies in Group I-3.

**716.2.2.1.1 Smoke and draft control.** The air leakage rate of the door assembly shall not exceed 3.0 cubic feet per minute per square foot (0.01524 m<sup>3</sup>/s × m<sup>2</sup>) of door opening at 0.10 inch (24.9 Pa) of water for both the ambient temperature and elevated temperature tests. Louvers shall be prohibited. *Terminated stops* shall be prohibited on doors required by Section 405.4.3 to comply with Section 716.2.2.1 and prohibited on doors required by Item 3 of Section 3006.3, or Section 3007.6.3 or 3008.6.3 to comply with this section.

**716.2.2.2 Door assemblies in other fire partitions.** *Fire door* assemblies required to have a minimum *fire protection rating* of 20 minutes where located in other *fire partitions* having a *fire-resistance rating* of 0.5 hour in accordance with Table 716.1(2) shall be tested in accordance with NFPA 252, UL 10B or UL 10C with the hose stream test.

**716.2.2.3 Doors in interior exit stairways and ramps and exit passageways.** *Fire door* assemblies in *interior exit stairways* and *ramps* and *exit passageways* shall have a maximum transmitted temperature rise of not more than 450°F (250°C) above ambient at the end of 30 minutes of standard fire test exposure.

**Exception:** The maximum transmitted temperature rise is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**716.2.2.3.1 Glazing in doors.** Fire-protection-rated glazing in excess of 100 square inches (0.065 m<sup>2</sup>) is not permitted. Fire-resistance-rated glazing in excess of 100 square inches (0.065 m<sup>2</sup>) shall be permitted in *fire doors*. Listed fire-resistance-rated

glazing in a *fire door* shall have a maximum transmitted temperature rise in accordance with Section 716.2.2.3 when the *fire door* is tested in accordance with NFPA 252, UL 10B or UL 10C.

**716.2.3 Fire doors** *Fire doors* installed within a *fire door assembly* shall meet the fire rating indicated in Table 716.1(2).

**716.2.4 Fire door frames.** *Fire door* frames installed as part of a *fire door assembly* shall meet the fire rating indicated in Table 716.1(2).

**716.2.5 Glazing in fire door assemblies.** *Fire-rated glazing* conforming to the opening protection requirements in Section 716.2.1 shall be permitted in *fire door assemblies*.

**716.2.5.1 Size limitations.** Fire-resistance-rated glazing shall comply with the size limitations in Section 716.2.5.1.1. Fire-protection-rated glazing shall comply with the size limitations of NFPA 80, and as provided in Section 716.2.5.1.2.

**716.2.5.1.1 Fire-resistance-rated glazing in door assemblies in fire walls and fire barriers rated greater than 1 hour.** Fire-resistance-rated glazing tested to ASTM E119 or UL 263 and NFPA 252, UL 10B or UL 10C shall be permitted in *fire door assemblies* located in *fire walls* and in *fire barriers* in accordance with Table 716.1(2) to the maximum size tested and in accordance with their listings.

**716.2.5.1.2 Fire-protection-rated glazing in door assemblies in fire walls and fire barriers rated greater than 1 hour.** Fire-protection-rated glazing shall be prohibited in *fire walls* and *fire barriers* except as provided in Sections 716.2.5.1.2.1 and 716.2.5.1.2.2.

**716.2.5.1.2.1 Horizontal exits.** Fire-protection-rated glazing shall be permitted as vision panels in *self-closing* swinging *fire door assemblies* serving as horizontal exits in *fire walls* where limited to 100 square inches (0.065 m<sup>2</sup>).

**716.2.5.1.2.2 Fire barriers.** Fire-protection-rated glazing shall be permitted in *fire doors* having a 1½-hour *fire protection rating* intended for installation in *fire barriers*, where limited to 100 square inches (0.065 m<sup>2</sup>).

**716.2.5.2 Elevator, stairway and ramp protectives.** Approved fire-protection-rated glazing used in *fire door assemblies* in elevator, *stairway* and *ramp enclosures* shall be so located as to furnish clear vision of the passageway or approach to the elevator, *stairway* or *ramp*.

**716.2.5.3 Glazing in door assemblies in corridors and smoke barriers.** In a 20-minute *fire door assembly*, the glazing material in the door itself shall have a minimum fire-protection-rated glazing of 20 minutes and shall be exempt from the hose stream test.

**716.2.5.4 Fire door frames with transom lights and sidelights.** Fire-protection-rated glazing shall be

permitted in door frames with transom lights, sidelights or both, where a ¾-hour *fire protection rating* or less is required and in 2-hour fire-resistance-rated *exterior walls* in accordance with Table 716.1(2). *Fire door* frames with transom lights, sidelights or both, installed with fire-resistance-rated glazing tested as an assembly in accordance with ASTM E119 or UL 263 shall be permitted where a *fire protection rating* exceeding ¾ hour is required in accordance with Table 716.1(2).

**716.2.5.4.1 Energy storage system separation.** Fire-protection-rated glazing shall not be permitted in *fire door* frames with transom lights and sidelights in *fire barriers* required by Section 1207 of the *International Fire Code* to enclose energy storage systems.

**716.2.6 Fire door hardware and closures.** *Fire door* hardware and closures shall be installed on *fire door assemblies* in accordance with the requirements of this section.

**716.2.6.1 Door closing.** *Fire doors* shall be latching and self- or automatic-closing in accordance with this section.

#### Exceptions:

1. *Fire doors* located in common walls separating *sleeping units* in Group R-1 shall be permitted without automatic- or *self-closing* devices.
2. The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 3003.2 shall be permitted to remain open during Phase I emergency recall operation.

**716.2.6.2 Latch required.** Unless otherwise specifically permitted, single side-hinged *swinging fire doors* and both leaves of pairs of side-hinged *swinging fire doors* shall be provided with an active latch bolt that will secure the door when it is closed.

**716.2.6.3 Chute intake door latching.** Chute intake doors shall be positive latching, remaining latched and closed in the event of latch spring failure during a fire emergency.

**716.2.6.4 Automatic-closing fire door assemblies.** Automatic-closing *fire door assemblies* shall be *self-closing* in accordance with NFPA 80.

**716.2.6.5 Delayed-action closers.** Doors required to be *self-closing* and not required to be automatic closing shall be permitted to be equipped with *delayed-action closers*.

**716.2.6.6 Smoke-activated doors.** Automatic-closing doors installed in the following locations shall be permitted to have hold-open devices. Doors shall automatically close by the actuation of *smoke detectors* installed in accordance with Section 907.3 or by loss of power to the *smoke detector* or hold-open device.

## FIRE AND SMOKE PROTECTION FEATURES

Doors that are automatic-closing by smoke detection shall not have more than a 10-second delay before the door starts to close after the smoke detector is actuated. Automatic-closing doors that protect openings installed in the following locations shall comply with this section:

1. In walls that separate incidental uses in accordance with Section 509.4.
2. In *fire walls* in accordance with Section 706.8.
3. In *fire barriers* in accordance with Section 707.6.
4. In *fire partitions* in accordance with Section 708.6.
5. In *smoke barriers* in accordance with Section 709.5.
6. In *smoke partitions* in accordance with Section 710.5.2.3.
7. In *shaft enclosures* in accordance with Section 713.7.
8. In waste and linen chutes, discharge openings and access and discharge rooms in accordance with Section 713.13. Loading doors installed in waste and linen chutes shall meet the requirements of Sections 716.2.6.1 and 716.2.6.3.

**716.2.6.7 Doors in pedestrian ways.** Vertical sliding or vertical rolling steel *fire doors* in openings through which pedestrians travel shall be heat activated or activated by smoke detectors with alarm verification.

**716.2.7 Swinging fire shutters.** Where fire shutters of the swinging type are installed in exterior openings, not less than one row in every three vertical rows shall be arranged to be readily opened from the outside, and shall be identified by distinguishing marks or letters not less than 6 inches (152 mm) high.

**716.2.8 Rolling fire shutters.** Where fire shutters of the rolling type are installed, such shutters shall include *approved* automatic-closing devices.

**716.2.9 Labeled protective assemblies.** *Fire door* assemblies shall be labeled by an *approved agency*. The *labels* shall comply with NFPA 80, and shall be permanently affixed to the door or frame.

**716.2.9.1 Fire door labeling requirements.** *Fire doors* shall be *labeled* showing the name of the manufacturer or other identification readily traceable back to the manufacturer, the name or trademark of the third-party inspection agency, the *fire protection rating* and, where required for *fire doors* in *interior exit stairways and ramps* and *exit passageways* by Section 716.2.2.3, the maximum transmitted temperature end point. Smoke and draft control doors complying with UL 1784 shall be *labeled* as such and shall comply with Section 716.2.9.3. *Labels* shall be *approved* and permanently affixed. The *label* shall be applied at the factory or location where fabrication and assembly are performed.

### 716.2.9.1.1 Light kits, louvers and components.

*Listed* light kits and louvers and their required preparations shall be considered as part of the *labeled* door where such installations are done under the listing program of the third-party agency. *Fire doors* and *fire door assemblies* shall be permitted to consist of components, including glazing, vision light kits and hardware that are *listed* or classified and *labeled* for such use by different third-party agencies.

**716.2.9.2 Oversized doors.** Oversized *fire doors* shall bear an oversized *fire door label* by an *approved agency* or shall be provided with a certificate of inspection furnished by an *approved* testing agency. Where a certificate of inspection is furnished by an *approved* testing agency, the certificate shall state that the door conforms to the requirements of design, materials and construction, but has not been subjected to the fire test.

**716.2.9.3 Smoke and draft control door labeling requirements.** Smoke and draft control doors complying with UL 1784 shall be *labeled* in accordance with Section 716.2.9.1 and shall show the letter “S” on the fire-rating *label* of the door. This marking shall indicate that the door and frame assembly are in compliance where *listed* or *labeled* gasketing is installed.

**716.2.9.4 Fire door frame labeling requirements.** *Fire door* frames shall be labeled showing the names of the manufacturer and the third-party inspection agency.

**716.2.9.5 Labeling.** *Fire-rated glazing* shall bear a *label* or other identification showing the name of the manufacturer, the test standard and information required in Table 716.1(1) that shall be issued by an *approved agency* and shall be permanently identified on the glazing.

**716.2.9.6 Fire door operator labeling requirements.** *Fire door* operators for horizontal sliding doors shall be *labeled* and *listed* for use with the assembly.

**716.2.10 Installation of door assemblies in corridors and smoke barriers.** Installation of smoke doors shall be in accordance with NFPA 105.

**716.3 Fire window assemblies.** *Fire window assemblies* required by other sections of this code shall comply with the provisions of this section.

**716.3.1 Testing requirements.** *Fire window assemblies* shall be constructed of any material or assembly of component materials that conforms to the test requirements of Sections 716.3.1.1 and 716.3.1.2 and the *fire protection rating* indicated in Table 716.1(3).

**716.3.1.1 Testing under positive pressure.** NFPA 257 or UL 9 shall evaluate fire-protection-rated glazing under positive pressure. Within the first 10 minutes of a test, the pressure in the furnace shall be adjusted so not less than two-thirds of the test specimen is



above the neutral pressure plane, and the neutral pressure plane shall be maintained at that height for the balance of the test.

**716.3.1.2 Nonsymmetrical glazing systems.** Nonsymmetrical fire-protection-rated glazing systems in *fire partitions*, *fire barriers* or in *exterior walls* with a *fire separation distance* of 10 feet (3048 mm) or less pursuant to Section 705 shall be tested with both faces exposed to the furnace, and the assigned *fire protection rating* shall be the shortest duration obtained from the two tests conducted in compliance with NFPA 257 or UL 9.

**716.3.2 Performance requirements.** *Fire window assemblies* shall be installed in the assemblies and comply with the *fire protection rating* specified in Table 716.1(3).

**716.3.2.1 Interior fire window assemblies.** Fire-protection-rated glazing used in *fire window assemblies* located in *fire partitions* and *fire barriers* shall be limited to use in assemblies with a maximum *fire-resistance rating* of 1 hour in accordance with this section.

**716.3.2.1.1 Where  $\frac{3}{4}$ -hour-fire-protection window assemblies permitted.** Fire-protection-rated glazing requiring 45-minute opening protection in accordance with Table 716.1(3) shall be limited to *fire partitions* designed in accordance with Section 708 and *fire barriers* utilized in the applications set forth in Sections 707.3.6, 707.3.7 and 707.3.9 where the *fire-resistance rating* does not exceed 1 hour. Fire-resistance-rated glazing assemblies tested in accordance with ASTM E119 or UL 263 shall not be subject to the limitations of this section.

**716.3.2.1.1.1 Energy storage system separation.** *Fire-protection-rated glazing* is not permitted for use in *fire window assemblies* in *fire barriers* required by Section 1207 of the *International Fire Code* to enclose energy storage systems.

**716.3.2.1.2 Area limitations.** The total area of the glazing in fire-protection-rated window assemblies shall not exceed 25 percent of the area of a common wall with any room.

**716.3.2.1.3 Where  $\frac{1}{3}$ -hour-fire-protection window assemblies permitted.** Fire-protection-rated glazing shall be permitted in window assemblies tested to NFPA 257 or UL 9 in *fire partitions* requiring  $\frac{1}{3}$ -hour opening protection in accordance with Table 716.1(3).

**716.3.3 Fire window frames.** Fire window frames installed with a *fire window assembly* shall meet the fire-protection rating indicated in Table 716.1(3).

**716.3.3.1 Window mullions.** Metal mullions that exceed a nominal height of 12 feet (3658 mm) shall be protected with materials to afford the same *fire-resis-*

*tance rating* as required for the wall construction in which the protective is located.

**716.3.4 Fire-protection-rated glazing.** Glazing in *fire window assemblies* shall be fire protection rated in accordance with this section and Table 716.1(3). Fire-protection-rated glazing in *fire window assemblies* shall be tested in accordance with and shall meet the acceptance criteria of NFPA 257 or UL 9. Openings in nonfire-resistance-rated *exterior wall* assemblies that require protection in accordance with Section 705.3, 705.8, 705.8.5 or 705.8.6 shall have a *fire protection rating* of not less than  $\frac{3}{4}$  hour. Fire-protection-rated glazing in  $\frac{1}{2}$ -hour fire-resistance-rated partitions is permitted to have a 20-minute *fire protection rating*.

**716.3.4.1 Glass and glazing.** Glazing in *fire window assemblies* shall be fire-protection-rated glazing installed in accordance with and complying with the size limitations set forth in NFPA 80.

**716.3.5 Labeled protective assemblies.** Glazing in *fire window assemblies* shall be *labeled* by an *approved agency*. The *labels* shall comply with NFPA 80 and Section 716.3.5.2.

**716.3.5.1 Fire window frames.** Fire window frames shall be approved for the intended application.

**716.3.5.2 Labeling requirements.** Fire-protection-rated glazing shall bear a *label* or other identification showing the name of the manufacturer, the test standard and information required in Section 716.1.2.2.2 and Table 716.1(3) that shall be issued by an *approved agency* and permanently identified on the glazing.

**716.3.6 Installation.** *Fire window assemblies* shall be installed in accordance with the provisions of this section.

**716.3.6.1 Closure.** Fire-protection-rated glazing shall be in the fixed position or be automatic-closing and shall be installed in *labeled* frames.

**716.4 Fire protective curtain assembly.** *Approved fire protective curtain assemblies* shall be constructed of any materials or assembly of component materials tested without hose stream in accordance with UL 10D, and shall comply with the Sections 716.4.1 through 716.4.3

**716.4.1 Label.** *Fire protective curtain assemblies* used as opening protectives in fire-rated walls and *smoke partitions* shall be *labeled* in accordance with Section 716.2.9.

**716.4.2 Smoke and draft control.** *Fire protective curtain assemblies* used to protect openings where smoke and draft control assemblies are required shall comply with Section 716.2.1.4.

**716.4.3 Installation.** *Fire protective curtain assemblies* shall be installed in accordance with NFPA 80.

## SECTION 717 DUCTS AND AIR TRANSFER OPENINGS

**717.1 General.** The provisions of this section shall govern the protection of duct penetrations and air transfer openings

## FIRE AND SMOKE PROTECTION FEATURES

in assemblies required to be protected and duct penetrations in nonfire-resistance-rated floor assemblies.

**717.1.1 Ducts and air transfer openings.** Ducts transitioning horizontally between *shafts* shall not require a *shaft enclosure* provided that the duct penetration into each associated *shaft* is protected with *dampers* complying with this section.

**717.1.2 Ducts that penetrate fire-resistance-rated assemblies without dampers.** Ducts that penetrate fire-resistance-rated walls and are not required by this section to have *fire dampers* shall comply with the requirements of Sections 714.3 through 714.4.3. Ducts that penetrate *horizontal assemblies* not required to be contained within a *shaft* and not required by this section to have *fire dampers* shall comply with the requirements of Sections 714.5 through 714.6.2.

**717.1.2.1 Ducts that penetrate nonfire-resistance-rated assemblies.** The space around a duct penetrating a nonfire-resistance-rated floor assembly shall comply with Section 717.6.3.

**717.2 Installation.** *Fire dampers, smoke dampers, combination fire/smoke dampers and ceiling radiation dampers* located within air distribution and smoke control systems shall be installed in accordance with the manufacturer's instructions, the *dampers'* listing and Sections 717.2.1 through 717.2.3.

**717.2.1 Smoke control system.** Where the installation of a *fire damper* will interfere with the operation of a required smoke control system in accordance with Section 909, *approved* alternative protection shall be utilized. Where mechanical systems including ducts and *dampers* utilized for normal building ventilation serve as part of the smoke control system, the expected performance of these systems in smoke control mode shall be addressed in the rational analysis required by Section 909.4.

**717.2.2 Hazardous exhaust ducts.** *Fire dampers* for hazardous exhaust duct systems shall comply with the *International Mechanical Code*.

**717.2.3 Static dampers.** *Fire dampers and ceiling radiation dampers* that are *listed* for use in static systems shall only be installed in heating, *ventilation* and air-conditioning systems that are automatically shut down in the event of a fire.

**717.3 Damper testing, ratings and actuation.** Damper testing, ratings and actuation shall be in accordance with Sections 717.3.1 through 717.3.3.

**717.3.1 Damper testing.** *Dampers* shall be *listed* and *labeled* in accordance with the standards in this section.

1. *Fire dampers* shall comply with the requirements of UL 555.
2. *Smoke dampers* shall comply with the requirements of UL 555S.

3. *Combination fire/smoke dampers* shall comply with the requirements of both UL 555 and UL 555S.
4. *Ceiling radiation dampers* shall comply with the requirements of UL 555C or shall be tested as part of a fire-resistance-rated floor/ceiling or roof/ceiling assembly in accordance with ASTM E119 or UL 263.
5. *Corridor dampers* shall comply with requirements of both UL 555 and UL 555S. *Corridor dampers* shall demonstrate acceptable closure performance when subjected to 150 feet per minute (0.76 mps) velocity across the face of the *damper* during the UL 555 fire exposure test.

**717.3.2 Damper rating.** Damper ratings shall be in accordance with Sections 717.3.2.1 through 717.3.2.4.

**717.3.2.1 Fire damper ratings.** *Fire dampers* shall have the minimum rating specified in Table 717.3.2.1.

TABLE 717.3.2.1  
FIRE DAMPER RATING

TYPE OF PENETRATION	MINIMUM DAMPER RATING (hours)
Less than 3-hour fire-resistance-rated assemblies	1.5
3-hour or greater fire-resistance-rated assemblies	3

**717.3.2.2 Smoke damper ratings.** *Smoke damper* leakage ratings shall be Class I or II. Elevated temperature ratings shall be not less than 250°F (121°C).

**717.3.2.3 Combination fire/smoke damper ratings.** *Combination fire/smoke dampers* shall have the minimum rating specified for *fire dampers* in Table 717.3.2.1 and shall have the minimum rating specified for *smoke dampers* in Section 717.3.2.2.

**717.3.2.4 Corridor damper ratings.** *Corridor dampers* shall have the following minimum ratings:

1. One-hour *fire-resistance rating*.
2. Class I or II leakage rating as specified in Section 717.3.2.2.

**717.3.3 Damper actuation.** *Damper* actuation shall be in accordance with Sections 717.3.3.1 through 717.3.3.5 as applicable.

**717.3.3.1 Fire damper actuation.** Primary heat responsive devices used to actuate *fire dampers* shall meet one of the following requirements:

1. The operating temperature shall be approximately 50°F (10°C) above the normal temperature within the duct system, but not less than 160°F (71°C).
2. The operating temperature shall be not more than 350°F (177°C) where located in a smoke control system complying with Section 909.

**717.3.3.2 Smoke damper actuation.** The *smoke damper* shall close upon actuation of a *listed smoke detector* or detectors installed in accordance with Section 907.3 and one of the following methods, as applicable:

1. Where a *smoke damper* is installed within a duct, a *smoke detector* shall be installed inside the duct or outside the duct with sampling tubes protruding into the duct. The detector or tubes within the duct shall be within 5 feet (1524 mm) of the *damper*. Air outlets and inlets shall not be located between the detector or tubes and the *damper*. The detector shall be *listed* for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, *dampers* shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.
2. Where a *smoke damper* is installed above *smoke barrier* doors in a *smoke barrier*, a spot-type detector shall be installed on either side of the *smoke barrier* door opening. The detector shall be *listed* for releasing service if used for direct interface with the *damper*.
3. Where a *smoke damper* is installed within an air transfer opening in a wall, a spot-type detector shall be installed within 5 feet (1524 mm) horizontally of the *damper*. The detector shall be *listed* for releasing service if used for direct interface with the *damper*.
4. Where a *smoke damper* is installed in a corridor wall or ceiling, the *damper* shall be permitted to be controlled by a smoke detection system installed in the *corridor*.
5. Where a smoke detection system is installed in all areas served by the duct in which the *damper* will be located, the *smoke dampers* shall be permitted to be controlled by the smoke detection system.

**717.3.3.3 Combination fire/smoke damper actuation.** *Combination fire/smoke damper* actuation shall be in accordance with Sections 717.3.3.1 and 717.3.3.2. *Combination fire/smoke dampers* installed in smoke control system *shaft* penetrations shall not be activated by local area smoke detection unless it is secondary to the smoke management system controls.

**717.3.3.4 Ceiling radiation damper actuation.** The operating temperature of a *ceiling radiation damper* actuation device shall be 50°F (27.8°C) above the normal temperature within the duct system, but not less than 160°F (71°C).

**717.3.3.5 Corridor damper actuation.** *Corridor damper* actuation shall be in accordance with Sections 717.3.3.1 and 717.3.3.2.

**717.4 Access and identification.** Access and identification of fire and *smoke dampers* shall comply with Sections 717.4.1 through 717.4.2.

**717.4.1 Access.** *Fire* and *smoke dampers* shall be provided with an approved means of access that is large enough to permit inspection and maintenance of the *damper* and its operating parts. *Dampers* equipped with fusible links, internal operators, or both shall be provided with an access door that is not less than 12 inches (305 mm) square or provided with a removable duct section.

**717.4.1.1 Access openings.** The access shall not affect the integrity of *fire-resistance-rated* assemblies. The access openings shall not reduce the *fire-resistance rating* of the assembly. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

**717.4.1.2 Restricted access.** Where space constraints or physical barriers restrict access to a *damper* for periodic inspection and testing, the *damper* shall be a single- or multi-blade type *damper* and shall comply with the remote inspection requirements of NFPA 80 or NFPA 105.

**717.4.2 Identification.** Access points shall be permanently identified on the exterior by a label having letters not less than 1/2 inch (12.7 mm) in height reading: "FIRE/SMOKE DAMPER," "SMOKE DAMPER" or "FIRE DAMPER."

**717.5 Where required.** *Fire dampers*, *smoke dampers*, *combination fire/smoke dampers*, *ceiling radiation dampers* and *corridor dampers* shall be provided at the locations prescribed in Sections 717.5.1 through 717.5.7 and 717.6. Where an assembly is required to have both *fire dampers* and *smoke dampers*, *combination fire/smoke dampers* or a *fire damper* and a *smoke damper* shall be provided.

**717.5.1 Fire walls.** Ducts and air transfer openings permitted in *fire walls* in accordance with Section 706.11 shall be protected with *listed fire dampers* installed in accordance with their listing.

**717.5.1.1 Horizontal exits.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire wall* that serves as a *horizontal exit*.

**717.5.2 Fire barriers.** Ducts and air transfer openings of *fire barriers* shall be protected with *listed fire dampers* installed in accordance with their listing. Ducts and air transfer openings shall not penetrate enclosures for *interior exit stairways* and *ramps* and *exit passageways*, except as permitted by Sections 1023.5 and 1024.6, respectively.

**Exceptions:** *Fire dampers* are not required at penetrations of *fire barriers* where any of the following apply:

1. Penetrations are tested in accordance with ASTM E119 or UL 263 as part of the fire-resistance-rated assembly.



## FIRE AND SMOKE PROTECTION FEATURES

2. Ducts are used as part of an *approved* smoke control system in accordance with Section 909 and where the use of a *fire damper* would interfere with the operation of a smoke control system.
3. Such walls are penetrated by fully ducted HVAC systems, have a required *fire-resistance rating* of 1 hour or less, are in areas of other than Group H and are in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2. For the purposes of this exception, a fully ducted HVAC system shall be a duct system for conveying supply, return or exhaust air as part of the structure's HVAC system. Such a duct system shall be constructed of sheet steel not less than No. 26 gage thickness and shall be continuous from the air-handling appliance or equipment to the air outlet and inlet terminals. Nonmetal flexible air connectors shall be permitted in the following locations:
  - 3.1. At the duct connection to the air handling unit or equipment located within the mechanical room in accordance with Section 603.9 of the *International Mechanical Code*.
  - 3.2. From an overhead metal duct to a ceiling diffuser within the same room in accordance with Section 603.6.2 of the *International Mechanical Code*.

**717.5.2.1 Horizontal exits.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *fire barrier* that serves as a *horizontal exit*.

**717.5.3 Shaft enclosures.** Shaft enclosures that are permitted to be penetrated by ducts and air transfer openings shall be protected with *listed fire* and *smoke dampers* installed in accordance with their listing.

### Exceptions:

1. *Fire dampers* are not required at penetrations of *shafts* where any of the following criteria are met:
  - 1.1. Steel exhaust subducts having a wall thickness of not less than 0.0187 inch (0.4712 mm) are extended not less than 22 inches (559 mm) vertically in exhaust *shafts*, and an exhaust fan is installed at the upper terminus of the *shaft* that is powered continuously in accordance with Section 909.11, so as to maintain a continuous upward airflow to the outdoors.
  - 1.2. Penetrations are tested in accordance with ASTM E119 or UL 263 as part of the fire-resistance-rated assembly.
  - 1.3. Ducts are used as part of an *approved* smoke control system designed and installed in accordance with Section

909 and where the *fire damper* will interfere with the operation of the smoke control system.

- 1.4. The penetrations are in parking garage exhaust or supply *shafts* that are separated from other building *shafts* by not less than 2-hour fire-resistance-rated construction.
2. In Group B and R occupancies equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, *smoke dampers* are not required at penetrations of *shafts* where all of the following criteria are met:
  - 2.1. Kitchen, clothes dryer, bathroom and toilet room exhaust openings are installed with steel exhaust subducts, having a wall thickness of not less than 0.0187 inch (0.4712 mm).
  - 2.2. The subducts extend not less than 22 inches (559 mm) vertically.
  - 2.3. An exhaust fan is installed at the upper terminus of the *shaft* that is powered continuously in accordance with the provisions of Section 909.11, so as to maintain a continuous upward airflow to the outdoors.
3. *Smoke dampers* are not required at penetration of exhaust or supply *shafts* in parking garages that are separated from other building *shafts* by not less than 2-hour fire-resistance-rated construction.
4. *Smoke dampers* are not required at penetrations of *shafts* where ducts are used as part of an *approved* mechanical smoke control system designed in accordance with Section 909 and where the *smoke damper* will interfere with the operation of the smoke control system.
5. *Fire dampers* and *combination fire/smoke dampers* are not required in kitchen and clothes dryer exhaust systems where *dampers* are prohibited by the *International Mechanical Code*.

**717.5.3.1 Continuous upward airflow.** *Fire dampers* and *smoke dampers* shall not be installed in *shafts* that are required to maintain a continuous upward airflow path where closure of the *damper* would result in the loss of the airflow.

**717.5.4 Fire partitions.** Ducts and air transfer openings that penetrate *fire partitions* shall be protected with *listed fire dampers* installed in accordance with their listing.

**Exceptions:** In occupancies other than Group H, *fire dampers* are not required where any of the following apply:

1. *Corridor walls* in buildings equipped throughout with an *automatic sprinkler system* in



accordance with Section 903.3.1.1 or 903.3.1.2 and the duct is protected as a *through penetration* in accordance with Section 714.

2. Tenant partitions in *covered and open mall buildings* where the walls are not required by provisions elsewhere in the code to extend to the underside of the floor or roof sheathing, slab or deck above.
3. The duct system is constructed of *approved* materials in accordance with the *International Mechanical Code* and the duct penetrating the wall complies with all of the following requirements:
  - 3.1. The duct shall not exceed 100 square inches (0.06 m<sup>2</sup>).
  - 3.2. The duct shall be constructed of steel not less than 0.0217 inch (0.55 mm) in thickness.
  - 3.3. The duct shall not have openings that communicate the *corridor* with adjacent spaces or rooms.
  - 3.4. The duct shall be installed above a ceiling.
  - 3.5. The duct shall not terminate at a wall register in the fire-resistance-rated wall.
  - 3.6. A minimum 12-inch-long (305 mm) by 0.060-inch-thick (1.52 mm) steel sleeve shall be centered in each duct opening. The sleeve shall be secured to both sides of the wall and all four sides of the sleeve with minimum 1½-inch by 1½-inch by 0.060-inch (38 mm by 38 mm by 1.52 mm) steel retaining angles. The retaining angles shall be secured to the sleeve and the wall with No. 10 (M5) screws. The *annular space* between the steel sleeve and the wall opening shall be filled with mineral wool batting on all sides.
4. Such walls are penetrated by ducted HVAC systems, have a required *fire-resistance rating* of 1 hour or less, and are in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2. For the purposes of this exception, a ducted HVAC system shall be a duct system for conveying supply, return or exhaust air as part of the structure's HVAC system. Such a duct system shall be constructed of sheet steel not less than No. 26 gage thickness and shall be continuous from the air-handling appliance or equipment to the air outlet and inlet terminals.

**717.5.4.1 Corridors.** Duct and air transfer openings that penetrate *corridors* shall be protected with *dampers* as follows:

1. A *corridor damper* shall be provided where *corridor* ceilings, constructed as required for the *corridor* walls as permitted in Section 708.4, Exception 3, are penetrated.
2. A *ceiling radiation damper* shall be provided where the ceiling membrane of a fire-resistance-rated floor-ceiling or roof-ceiling assembly, constructed as permitted in Section 708.4, Exception 2, is penetrated.
3. A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *corridor* enclosure required to have smoke and draft control doors in accordance with Section 716.2.2.1.

**Exceptions:**

1. *Smoke dampers* are not required where the building is equipped throughout with an approved smoke control system in accordance with Section 909, and *smoke dampers* are not necessary for the operation and control of the system.
2. *Smoke dampers* are not required in *corridor* penetrations where the duct is constructed of steel not less than 0.019 inch (0.48 mm) in thickness and there are no openings serving the *corridor*.

**717.5.5 Smoke barriers.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point a duct or air transfer opening penetrates a *smoke barrier*. *Smoke dampers* and smoke damper actuation methods shall comply with Section 717.3.3.2.

**Exceptions:**

1. *Smoke dampers* are not required where the openings in ducts are limited to a single *smoke compartment* and the ducts are constructed of steel.
2. *Smoke dampers* are not required in *smoke barriers* required by Section 407.5 for Group I-2, Condition 2—where the HVAC system is fully ducted in accordance with Section 603 of the *International Mechanical Code* and where buildings are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 and equipped with quick-response sprinklers in accordance with Section 903.3.2.

**717.5.6 Exterior walls.** Ducts and air transfer openings in fire-resistance-rated *exterior walls* required to have protected openings in accordance with Section 705.10

## FIRE AND SMOKE PROTECTION FEATURES

shall be protected with *listed fire dampers* installed in accordance with their listing.

**717.5.7 Smoke partitions.** A *listed smoke damper* designed to resist the passage of smoke shall be provided at each point that an air transfer opening penetrates a *smoke partition*. *Smoke dampers* and *smoke damper* actuation methods shall comply with Section 717.3.3.2.

**Exception:** Where the installation of a *smoke damper* will interfere with the operation of a required smoke control system in accordance with Section 909, *approved* alternative protection shall be utilized.

**717.6 Horizontal assemblies.** Penetrations by ducts and air transfer openings of a floor, floor/ceiling assembly or the ceiling membrane of a roof/ceiling assembly shall be protected by a shaft enclosure that complies with Section 713 or shall comply with Sections 717.6.1 through 717.6.3.

**717.6.1 Through penetrations.** In occupancies other than Groups I-2 and I-3, a duct constructed of approved materials in accordance with the *International Mechanical Code* that penetrates a fire-resistance-rated floor/ceiling assembly that connects not more than two stories is permitted without *shaft enclosure* protection, provided that a *listed fire damper* is installed at the floor line or the duct is protected in accordance with Section 714.5. For air transfer openings, see Section 712.1.9.

**Exception:** A duct is permitted to penetrate three floors or less without a *fire damper* at each floor, provided that such duct meets all of the following requirements:

1. The duct shall be contained and located within the cavity of a wall and shall be constructed of steel having a minimum wall thickness of 0.0187 inches (0.4712 mm) (No. 26 gage).
2. The duct shall open into only one *dwelling unit* or *sleeping unit* and the duct system shall be continuous from the unit to the exterior of the building.
3. The duct shall not exceed 4-inch (102 mm) nominal diameter and the total area of such ducts shall not exceed 100 square inches (0.065 m<sup>2</sup>) in any 100 square feet (9.3 m<sup>2</sup>) of floor area.
4. The *annular space* around the duct is protected with materials that prevent the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E119 or UL 263 time-temperature conditions under a minimum positive pressure differential of 0.01 inch (2.49 Pa) of water at the location of the penetration for the time period equivalent to the *fire-resistance rating* of the construction penetrated.
5. Grille openings located in a ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with a *listed ceil-*

*ing radiation damper* installed in accordance with Section 717.6.2.1.

**717.6.2 Membrane penetrations.** Ducts and air transfer openings constructed of *approved* materials in accordance with the *International Mechanical Code* that penetrate the ceiling membrane of a fire-resistance-rated floor/ceiling or roof/ceiling assembly shall be protected with one of the following:

1. A *shaft enclosure* in accordance with Section 713.
2. A *listed ceiling radiation damper* installed at the ceiling line where a duct penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.

### Exceptions:

1. A fire-resistance-rated assembly tested in accordance with ASTM E119 or UL 263 showing that *ceiling radiation dampers* are not required in order to maintain the *fire-resistance rating* of the assembly.
2. Where exhaust duct or outdoor air duct penetrations protected in accordance with Section 714.5.2 are located within the cavity of a wall and do not pass through another dwelling unit or tenant space.
3. Where duct and air transfer openings are protected with a duct outlet penetration system tested as part of a fire-resistance-rated assembly in accordance with ASTM E119 or UL 263.
3. A *listed ceiling radiation damper* installed at the ceiling line where a diffuser with no duct attached penetrates the ceiling of a fire-resistance-rated floor/ceiling or roof/ceiling assembly.

### Exceptions:

1. A fire-resistance-rated assembly tested in accordance with ASTM E119 or UL 263 showing that *ceiling radiation dampers* are not required in order to maintain the *fire-resistance rating* of the assembly.
2. Where duct and air transfer openings are protected with a duct outlet penetration system tested as part of a fire-resistance-rated assembly in accordance with ASTM E119 or UL 263.

**717.6.2.1 Ceiling radiation dampers testing and installation.** *Ceiling radiation dampers* shall be tested in accordance with Section 717.3.1. *Ceiling radiation dampers* shall be installed in accordance with the details specified in the fire-resistance-rated assembly and the manufacturer's instructions and the listing.

**717.6.2.1.1 Dynamic systems.** Only *ceiling radiation dampers labeled* for use in dynamic systems shall be installed in heating, *ventilation* and air-conditioning systems designed to operate with fans on during a fire.

**717.6.2.1.2 Static systems.** Static ceiling radiation dampers shall be provided with systems that are not designed to operate during a fire.

**Exceptions:**

1. Where a static ceiling radiation damper is installed at the opening of a duct, a smoke detector shall be installed inside the duct or outside the duct with sampling tubes protruding into the duct. The detector or tubes in the duct shall be within 5 feet (1524 mm) of the damper. Air outlets and inlets shall not be located between the detector or tubes and the damper. The detector shall be listed for the air velocity, temperature and humidity anticipated at the point where it is installed. Other than in mechanical smoke control systems, dampers shall be closed upon fan shutdown where local smoke detectors require a minimum velocity to operate.
2. Where a static ceiling radiation damper is installed in a ceiling, the ceiling radiation damper shall be permitted to be controlled by a smoke detection system installed in the same room or area as the ceiling radiation damper.
3. A static ceiling radiation damper shall be permitted to be installed in a room where an occupant sensor is provided within the room that will shut down the system.

**717.6.3 Nonfire-resistance-rated floor assemblies.** Duct systems constructed of *approved* materials in accordance with the *International Mechanical Code* that penetrate nonfire-resistance-rated floor assemblies shall be protected by any of the following methods:

1. A *shaft enclosure* in accordance with Section 713.
2. The duct connects not more than two *stories*, and the *annular space* around the penetrating duct is protected with an *approved* noncombustible material that resists the free passage of flame and the products of combustion.
3. In floor assemblies composed of noncombustible materials, a *shaft* shall not be required where the duct connects not more than three stories, the *annular space* around the penetrating duct is protected with an *approved* noncombustible material that resists the free passage of flame and the products of combustion and a *fire damper* is installed at each floor line.

**Exception:** *Fire dampers* are not required in ducts within individual residential *dwelling units*.

**717.7 Flexible ducts and air connectors.** Flexible ducts and air connectors shall not pass through any fire-resistance-rated assembly. Flexible air connectors shall not pass through any wall, floor or ceiling.

## SECTION 718 CONCEALED SPACES

**718.1 General.** *Fireblocking* and draftstopping shall be installed in combustible concealed locations in accordance with this section. *Fireblocking* shall comply with Section 718.2. Draftstopping in floor/ceiling spaces and attic spaces shall comply with Sections 718.3 and 718.4, respectively. The permitted use of combustible materials in concealed spaces of buildings of Type I or II construction shall be limited to the applications indicated in Section 718.5.

**718.2 Fireblocking.** In combustible construction, *fireblocking* shall be installed to cut off concealed draft openings (both vertical and horizontal) and shall form an effective barrier between floors, between a top story and a roof or attic space. *Fireblocking* shall be installed in the locations specified in Sections 718.2.2 through 718.2.7.

**718.2.1 Fireblocking materials.** *Fireblocking* shall consist of the following materials:

1. Two-inch (51 mm) nominal lumber.
2. Two thicknesses of 1-inch (25 mm) nominal lumber with broken lap joints.
3. One thickness of 0.719-inch (18.3 mm) *wood structural panels* with joints backed by 0.719-inch (18.3 mm) *wood structural panels*.
4. One thickness of 0.75-inch (19.1 mm) *particleboard* with joints backed by 0.75-inch (19 mm) *particleboard*.
5. One-half-inch (12.7 mm) *gypsum board*.
6. One-fourth-inch (6.4 mm) cement-based millboard.
7. Batts or blankets of *mineral wool*, *mineral fiber* or other *approved* materials installed in such a manner as to be securely retained in place.
8. Cellulose insulation tested in the form and manner intended for use to demonstrate its ability to remain in place and to retard the spread of fire and hot gases.
9. *Mass timber* complying with Section 2304.11.

**718.2.1.1 Batts or blankets of mineral wool or mineral fiber.** Batts or blankets of *mineral wool* or *mineral fiber* or other *approved* nonrigid materials shall be permitted for compliance with the 10-foot (3048 mm) horizontal *fireblocking* in walls constructed using parallel rows of studs or staggered studs.

**718.2.1.2 Unfaced fiberglass.** Unfaced fiberglass batt insulation used as *fireblocking* shall fill the entire cross section of the wall cavity to a minimum height of 16 inches (406 mm) measured vertically. Where piping, conduit or similar obstructions are encountered, the insulation shall be packed tightly around the obstruction.

**718.2.1.3 Loose-fill insulation material.** Loose-fill insulation material, insulating foam sealants and caulk materials shall not be used as a fireblock unless specif-

## FIRE AND SMOKE PROTECTION FEATURES

ically tested in the form and manner intended for use to demonstrate its ability to remain in place and to retard the spread of fire and hot gases.

**718.2.1.4 Fireblocking integrity.** The integrity of fireblocks shall be maintained.

**718.2.1.5 Double stud walls.** Batts or blankets of mineral or glass fiber or other *approved* nonrigid materials shall be allowed as *fireblocking* in walls constructed using parallel rows of studs or staggered studs.

**718.2.2 Concealed wall spaces.** *Fireblocking* shall be provided in concealed spaces of stud walls and partitions, including furred spaces, and parallel rows of studs or staggered studs, as follows:

1. Vertically at the ceiling and floor levels.
2. Horizontally at intervals not exceeding 10 feet (3048 mm).

**718.2.3 Connections between horizontal and vertical spaces.** *Fireblocking* shall be provided at interconnections between concealed vertical stud wall or partition spaces and concealed horizontal spaces created by an assembly of floor joists or trusses, and between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings, cove ceilings and similar locations.

**718.2.4 Stairways.** *Fireblocking* shall be provided in concealed spaces between *stair* stringers at the top and bottom of the run. Enclosed spaces under *stairways* shall comply with Section 1011.7.3.

**718.2.5 Ceiling and floor openings.** Where required by Section 712.1.8, Exception 1 of Section 714.5.1.2 or Section 714.6, *fireblocking* of the *annular space* around vents, pipes, ducts, chimneys and fireplaces at ceilings and floor levels shall be installed with a material specifically tested in the form and manner intended for use to demonstrate its ability to remain in place and resist the free passage of flame and the products of combustion.

**718.2.5.1 Factory-built chimneys and fireplaces.** Factory-built chimneys and fireplaces shall be fireblocked in accordance with UL 103 and UL 127.

**718.2.6 Exterior wall coverings.** *Fireblocking* shall be installed within concealed spaces of *exterior wall coverings* and other exterior architectural elements where permitted to be of combustible construction as specified in Section 1405 or where erected with combustible frames. *Fireblocking* shall be installed at maximum intervals of 20 feet (6096 mm) in either dimension so that there will be no concealed space exceeding 100 square feet (9.3 m<sup>2</sup>) between *fireblocking*. Where wood furring strips are used, they shall be of *approved* wood of natural decay resistance or *preservative-treated wood*. If noncontinuous, such elements shall have closed ends, with not less than 4 inches (102 mm) of separation between sections.

### Exceptions:

1. *Fireblocking* of *cornices* is not required in single-family *dwelling*s. *Fireblocking* of

*cornices* of a two-family *dwelling* is required only at the line of *dwelling unit* separation.

2. *Fireblocking* shall not be required where the *exterior wall covering* is installed on noncombustible framing and the face of the *exterior wall covering* exposed to the concealed space is covered by one of the following materials:
  - 2.1. Aluminum having a minimum thickness of 0.019 inch (0.5 mm).
  - 2.2. Corrosion-resistant steel having a base metal thickness not less than 0.016 inch (0.4 mm) at any point.
  - 2.3. Other *approved* noncombustible materials.
3. *Fireblocking* shall not be required where the *exterior wall covering* has been tested in accordance with, and complies with the acceptance criteria of, NFPA 285. The *exterior wall covering* shall be installed as tested in accordance with NFPA 285.

**718.2.7 Concealed sleeper spaces.** Where wood sleepers are used for laying wood flooring on masonry or concrete fire-resistance-rated floors, the space between the floor slab and the underside of the wood flooring shall be filled with an *approved* material to resist the free passage of flame and products of combustion or fireblocked in such a manner that open spaces under the flooring shall not exceed 100 square feet (9.3 m<sup>2</sup>) in area and such space shall be filled solidly under permanent partitions so that communication under the flooring between adjoining rooms shall not occur.

### Exceptions:

1. *Fireblocking* is not required for slab-on-grade floors in gymnasiums.
2. *Fireblocking* is required only at the juncture of each alternate lane and at the ends of each lane in a bowling facility.

**718.3 Draftstopping in floors.** Draftstopping shall be installed to subdivide floor/ceiling assemblies where required by Section 708.4.2. In other than Group R occupancies, draftstopping shall be installed to subdivide combustible floor/ceiling assemblies so that horizontal floor areas do not exceed 1,000 square feet (93 m<sup>2</sup>).

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**718.3.1 Draftstopping materials.** Draftstopping materials shall be not less than 1/2-inch (12.7 mm) *gypsum board*, 3/8-inch (9.5 mm) *wood structural panel*, 3/8-inch (9.5 mm) *particleboard*, 1-inch (25-mm) nominal lumber, cement *fiberboard*, batts or blankets of mineral wool or glass fiber, or other *approved* materials adequately supported. The integrity of *draftstops* shall be maintained.

**718.4 Draftstopping in attics.** Draftstopping shall be installed to subdivide *attic* spaces where required by Section 708.4.2. In other than Group R, draftstopping shall be



installed to subdivide combustible *attic* spaces and combustible concealed roof spaces such that any horizontal area does not exceed 3,000 square feet (279 m<sup>2</sup>). *Ventilation* of concealed roof spaces shall be maintained in accordance with Section 1202.2.1.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**718.4.1 Draftstopping materials.** Materials utilized for draftstopping of *attic* spaces shall comply with Section 718.3.1.

**718.4.1.1 Openings.** Openings in the partitions shall be protected by *self-closing* doors with automatic latches constructed as required for the partitions.

**718.5 Combustible materials in concealed spaces in Type I or II construction.** Combustible materials shall not be permitted in concealed spaces of buildings of Type I or II construction.

**Exceptions:**

1. Combustible materials in accordance with Section 603.
2. Combustible materials exposed within plenums complying with Section 602 of the *International Mechanical Code*.
3. Class A *interior finish* materials classified in accordance with Section 803.
4. Combustible piping within partitions or shaft enclosures installed in accordance with the provisions of this code.
5. Combustible piping within concealed ceiling spaces installed in accordance with the *International Mechanical Code* and the *International Plumbing Code*.
6. Combustible insulation and covering on pipe and tubing, installed in concealed spaces other than plenums, complying with Section 720.7.

## SECTION 719 FIRE-RESISTANCE REQUIREMENTS FOR PLASTER

**719.1 Thickness of plaster.** The minimum thickness of *gypsum plaster* or *Portland cement plaster* used in a fire-resistance-rated system shall be determined by the prescribed fire tests. The plaster thickness shall be measured from the face of the lath where applied to gypsum lath or metal lath.

**719.2 Plaster equivalents.** For *fire-resistance* purposes,  $\frac{1}{2}$  inch (12.7 mm) of unsanded *gypsum plaster* shall be deemed equivalent to  $\frac{3}{4}$  inch (19.1 mm) of one-to-three gypsum sand plaster or 1 inch (25 mm) of *Portland cement sand plaster*.

**719.3 Noncombustible furring.** In buildings of Types I and II construction, plaster shall be applied directly on concrete or masonry or on *approved* noncombustible plastering base and furring.

**719.4 Double reinforcement.** Plaster protection more than 1 inch (25 mm) in thickness shall be reinforced with an additional layer of *approved* lath embedded not less than  $\frac{3}{4}$  inch (19.1 mm) from the outer surface and fixed securely in place.

**Exception:** Solid plaster partitions or where otherwise determined by fire tests.

**719.5 Plaster alternatives for concrete.** In reinforced concrete construction, *gypsum plaster* or *Portland cement plaster* is permitted to be substituted for  $\frac{1}{2}$  inch (12.7 mm) of the required poured concrete protection, except that a minimum thickness of  $\frac{3}{8}$  inch (9.5 mm) of poured concrete shall be provided in reinforced concrete floors and 1 inch (25 mm) in reinforced concrete columns in addition to the plaster finish. The concrete base shall be prepared in accordance with Section 2510.7.

## SECTION 720 THERMAL- AND SOUND-INSULATING MATERIALS

**720.1 General.** Insulating materials shall comply with the requirements of this section. Where a *flame spread index* or a *smoke-developed index* is specified in this section, such index shall be determined in accordance with ASTM E84 or UL 723. Any material that is subject to an increase in *flame spread index* or *smoke-developed index* beyond the limits herein established through the effects of age, moisture or other atmospheric conditions shall not be permitted. Insulating materials, when tested in accordance with the requirements of this section, shall include facings, when used, such as vapor retarders, vapor permeable membranes and similar coverings, and all layers of single and multilayer reflective foil insulation and similar materials.

**Exceptions:**

1. *Fiberboard* insulation shall comply with Chapter 23.
2. Foam plastic insulation shall comply with Chapter 26.
3. Duct and pipe insulation and duct and pipe coverings and linings in plenums shall comply with the *International Mechanical Code*.
4. All layers of single and multilayer reflective plastic core insulation shall comply with Section 2614.

**720.2 Concealed installation.** Insulating materials, where concealed as installed in buildings of any type of construction, shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450.

**Exception:** Cellulosic fiber loose-fill insulation complying with the requirements of Section 720.6 shall not be required to meet a *flame spread index* requirement but shall be required to meet a *smoke-developed index* of not more than 450 when tested in accordance with CAN/ULC S102.2.

**720.2.1 Facings.** Where such materials are installed in concealed spaces in buildings of Type III, IV or V construction, the *flame spread* and *smoke-developed*

## FIRE AND SMOKE PROTECTION FEATURES

limitations do not apply to facings, coverings, and layers of reflective foil insulation that are installed behind and in substantial contact with the unexposed surface of the ceiling, wall or floor finish.

**Exception:** All layers of single and multilayer reflective plastic core insulation shall comply with Section 2614.

**720.3 Exposed installation.** Insulating materials, where exposed as installed in buildings of any type of construction, shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450.

**Exception:** Cellulosic fiber loose-fill insulation complying with the requirements of Section 720.6 shall not be required to meet a *flame spread index* requirement but shall be required to meet a *smoke-developed index* of not more than 450 when tested in accordance with CAN/ULC S102.2.

**720.3.1 Attic floors.** Exposed insulation materials installed on *attic* floors shall have a critical radiant flux of not less than 0.12 watt per square centimeter when tested in accordance with ASTM E970.

**720.4 Loose-fill insulation.** Loose-fill insulation materials that cannot be mounted in the ASTM E84 or UL 723 apparatus without a screen or artificial supports shall comply with the *flame spread* and smoke-developed limits of Sections 720.2 and 720.3 when tested in accordance with CAN/ULC S102.2.

**Exception:** Cellulosic fiber loose-fill insulation shall not be required to meet a *flame spread index* requirement when tested in accordance with CAN/ULC S102.2, provided that such insulation has a *smoke-developed index* of not more than 450 and complies with the requirements of Section 720.6.

**720.5 Roof insulation.** The use of combustible roof insulation not complying with Sections 720.2 and 720.3 shall be permitted in any type of construction provided that insulation is covered with *approved roof coverings* directly applied thereto.

**720.6 Cellulosic fiber loose-fill insulation and self-supported spray-applied cellulosic insulation.** Cellulosic fiber loose-fill insulation and self-supported spray-applied cellulosic insulation shall comply with CPSC 16 CFR Parts 1209 and 1404. Each package of such insulating material shall be clearly labeled in accordance with CPSC 16 CFR Parts 1209 and 1404.

**720.7 Insulation and covering on pipe and tubing.** Insulation and covering on pipe and tubing shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450.

**Exception:** Insulation and covering on pipe and tubing installed in plenums shall comply with the *International Mechanical Code*.

## SECTION 721 PRESCRIPTIVE FIRE RESISTANCE

**721.1 General.** The provisions of this section contain prescriptive details of fire-resistance-rated *building*

*elements*, components or assemblies. The materials of construction specified in Tables 721.1(1), 721.1(2) and 721.1(3) shall be assumed to have the *fire-resistance ratings* prescribed therein. Where materials that change the capacity for heat dissipation are incorporated into a fire-resistance-rated assembly, fire test results or other substantiating data shall be made available to the *building official* to show that the required *fire-resistance-rating* time period is not reduced.

**721.1.1 Thickness of protective coverings.** The thickness of fire-resistant materials required for protection of structural members shall be not less than set forth in Table 721.1(1), except as modified in this section. The figures shown shall be the net thickness of the protecting materials and shall not include any hollow space in back of the protection.

**721.1.2 Unit masonry protection.** Where required, metal ties shall be embedded in *bed joints* of unit masonry for protection of steel columns. Such ties shall be as set forth in Table 721.1(1) or be equivalent thereto.

**721.1.3 Reinforcement for cast-in-place concrete column protection.** Cast-in-place concrete protection for steel columns shall be reinforced at the edges of such members with wire ties of not less than 0.18 inch (4.6 mm) in diameter wound spirally around the columns on a pitch of not more than 8 inches (203 mm) or by equivalent reinforcement.

**721.1.4 Plaster application.** The finish coat is not required for plaster protective coatings where those coatings comply with the design mix and thickness requirements of Tables 721.1(1), 721.1(2) and 721.1(3).

**721.1.5 Bonded prestressed concrete tendons.** For members having a single tendon or more than one tendon installed with equal concrete cover measured from the nearest surface, the cover shall be not less than that set forth in Table 721.1(1). For members having multiple tendons installed with variable concrete cover, the average tendon cover shall be not less than that set forth in Table 721.1(1), provided that:

1. The clearance from each tendon to the nearest exposed surface is used to determine the average cover.
2. The clear cover for individual tendons shall not be less than one-half of that set forth in Table 721.1(1). A minimum cover of  $\frac{3}{4}$  inch (19.1 mm) for slabs and 1 inch (25 mm) for beams is required for any aggregate concrete.
3. For the purpose of establishing a *fire-resistance rating*, tendons having a clear covering less than that set forth in Table 721.1(1) shall not contribute more than 50 percent of the required ultimate moment capacity for members less than 350 square inches (0.226 m<sup>2</sup>) in cross-sectional area and 65 percent for larger members. For structural design purposes, however, tendons having a reduced cover are assumed to be fully effective.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(1)**  
**MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON**  
**TIME PERIODS FOR VARIOUS NONCOMBUSTIBLE INSULATING MATERIALS<sup>m</sup>**

STRUCTURAL PARTS TO BE PROTECTED	ITEM NUMBER	INSULATING MATERIAL USED	MINIMUM THICKNESS OF INSULATING MATERIAL FOR THE FOLLOWING FIRE-RESISTANCE PERIODS (inches)			
			4 hours	3 hours	2 hours	1 hour
1. Steel columns and all of primary trusses (continued)	1-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete, members 6" × 6" or greater (not including sandstone, granite and siliceous gravel). <sup>a</sup>	2½	2	1½	1
	1-1.2	Carbonate, lightweight and sand-lightweight aggregate concrete, members 8" × 8" or greater (not including sandstone, granite and siliceous gravel). <sup>a</sup>	2	1½	1	1
	1-1.3	Carbonate, lightweight and sand-lightweight aggregate concrete, members 12" × 12" or greater (not including sandstone, granite and siliceous gravel). <sup>a</sup>	1½	1	1	1
	1-1.4	Siliceous aggregate concrete and concrete excluded in Item 1-1.1, members 6" × 6" or greater. <sup>a</sup>	3	2	1½	1
	1-1.5	Siliceous aggregate concrete and concrete excluded in Item 1-1.1, members 8" × 8" or greater. <sup>a</sup>	2½	2	1	1
	1-1.6	Siliceous aggregate concrete and concrete excluded in Item 1-1.1, members 12" × 12" or greater. <sup>a</sup>	2	1	1	1
	1-2.1	Clay or shale brick with brick and mortar fill. <sup>a</sup>	3¾	—	—	2¼
	1-3.1	4" hollow clay tile in two 2" layers; ½" mortar between tile and column; ⅜" metal mesh 0.046" wire diameter in horizontal joints; tile fill. <sup>a</sup>	4	—	—	—
	1-3.2	2" hollow clay tile; ¾" mortar between tile and column; ⅜" metal mesh 0.046" wire diameter in horizontal joints; limestone concrete fill <sup>a</sup> ; plastered with ¾" gypsum plaster.	3	—	—	—
	1-3.3	2" hollow clay tile with outside wire ties 0.08" diameter at each course of tile or ⅜" metal mesh 0.046" diameter wire in horizontal joints; limestone or trap-rock concrete fill <sup>a</sup> extending 1" outside column on all sides.	—	—	3	—
	1-3.4	2" hollow clay tile with outside wire ties 0.08" diameter at each course of tile with or without concrete fill; ¾" mortar between tile and column.	—	—	—	2
	1-4.1	Cement plaster over metal lath wire tied to ¾" cold-rolled vertical channels with 0.049" (No. 18 B.W. gage) wire ties spaced 3" to 6" on center. Plaster mixed 1:2½ by volume, cement to sand.	—	—	2½ <sup>b</sup>	7⁄8
	1-5.1	Vermiculite concrete, 1:4 mix by volume over paper-backed wire fabric lath wrapped directly around column with additional 2" × 2" 0.065"/0.065" (No. 16/16 B.W. gage) wire fabric placed ¾" from outer concrete surface. Wire fabric tied with 0.049" (No. 18 B.W. gage) wire spaced 6" on center for inner layer and 2" on center for outer layer.	2	—	—	—
	1-6.1	Perlite or vermiculite gypsum plaster over metal lath wrapped around column and furred 1¼" from column flanges. Sheets lapped at ends and tied at 6" intervals with 0.049" (No. 18 B.W. gage) tie wire. Plaster pushed through to flanges.	1½	1	—	—
	1-6.2	Perlite or vermiculite gypsum plaster over self-furring metal lath wrapped directly around column, lapped 1" and tied at 6" intervals with 0.049" (No. 18 B.W. gage) wire.	1¾	1⅜	1	—
	1-6.3	Perlite or vermiculite gypsum plaster on metal lath applied to ¾" cold-rolled channels spaced 24" apart vertically and wrapped flatwise around column.	1½	—	—	—
	1-6.4	Perlite or vermiculite gypsum plaster over two layers of ½" plain full-length gypsum lath applied tight to column flanges. Lath wrapped with 1" hexagonal mesh of No. 20-gage wire and tied with doubled 0.035" diameter (No. 18 B.W. gage) wire ties spaced 23" on center. For three-coat work, the plaster mix for the second coat shall not exceed 100 pounds of gypsum to 2½ cubic feet of aggregate for the 3-hour system.	2½	2	—	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(1)—continued**  
**MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON**  
**TIME PERIODS FOR VARIOUS NONCOMBUSTIBLE INSULATING MATERIALS™**

STRUCTURAL PARTS TO BE PROTECTED	ITEM NUMBER	INSULATING MATERIAL USED	MINIMUM THICKNESS OF INSULATING MATERIAL FOR THE FOLLOWING FIRE-RESISTANCE PERIODS (inches)			
			4 hours	3 hours	2 hours	1 hour
1. Steel columns and all of primary trusses (continued)	1-6.5	Perlite or vermiculite gypsum plaster over one layer of $\frac{1}{2}$ " plain full-length gypsum lath applied tight to column flanges. Lath tied with doubled 0.049" (No. 18 B.W. gage) wire ties spaced 23" on center and scratch coat wrapped with 1" hexagonal mesh 0.035" (No. 20 B.W. gage) wire fabric. For three-coat work, the plaster mix for the second coat shall not exceed 100 pounds of gypsum to $2\frac{1}{2}$ cubic feet of aggregate.	—	2	—	—
	1-7.1	Multiple layers of $\frac{1}{2}$ " gypsum wallboard <sup>c</sup> adhesively <sup>d</sup> secured to column flanges and successive layers. Wallboard applied without horizontal joints. Corner edges of each layer staggered. Wallboard layer below outer layer secured to column with doubled 0.049" (No. 18 B.W. gage) steel wire ties spaced 15" on center. Exposed corners taped and treated.	—	—	2	1
	1-7.2	Three layers of $\frac{5}{8}$ " Type X gypsum wallboard. <sup>c</sup> First and second layer held in place by $\frac{1}{8}$ " diameter by $1\frac{3}{8}$ " long ring shank nails with $\frac{5}{16}$ " diameter heads spaced 24" on center at corners. Middle layer also secured with metal straps at mid-height and 18" from each end, and by metal corner bead at each corner held by the metal straps. Third layer attached to corner bead with 1" long gypsum wallboard screws spaced 12" on center.	—	—	$1\frac{7}{8}$	—
	1-7.3	Three layers of $\frac{5}{8}$ " Type X gypsum wallboard, <sup>c</sup> each layer screw attached to $1\frac{5}{8}$ " steel studs 0.018" thick (No. 25 carbon sheet steel gage) at each corner of column. Middle layer also secured with 0.049" (No. 18 B.W. gage) double-strand steel wire ties, 24" on center. Screws are No. 6 by 1" spaced 24" on center for inner layer, No. 6 by $1\frac{5}{8}$ " spaced 12" on center for middle layer and No. 8 by $2\frac{1}{4}$ " spaced 12" on center for outer layer.	—	$1\frac{7}{8}$	—	—
	1-8.1	Wood-fibered gypsum plaster mixed 1:1 by weight gypsum-to-sand aggregate applied over metal lath. Lath lapped 1" and tied 6" on center at all end, edges and spacers with 0.049" (No. 18 B.W. gage) steel tie wires. Lath applied over $\frac{1}{2}$ " spacers made of $\frac{3}{4}$ " furring channel with 2" legs bent around each corner. Spacers located 1" from top and bottom of member and not greater than 40" on center and wire tied with a single strand of 0.049" (No. 18 B.W. gage) steel tie wires. Corner bead tied to the lath at 6" on center along each corner to provide plaster thickness.	—	—	$1\frac{5}{8}$	—
	1-9.1	Minimum W8x35 wide flange steel column (w/d $\geq 0.75$ ) with each web cavity filled even with the flange tip with normal weight carbonate or siliceous aggregate concrete (3,000 psi minimum compressive strength with 145 pcf $\pm$ 3 pcf unit weight). Reinforce the concrete in each web cavity with a minimum No. 4 deformed reinforcing bar installed vertically and centered in the cavity, and secured to the column web with a minimum No. 2 horizontal deformed reinforcing bar welded to the web every 18" on center vertically. As an alternative to the No. 4 rebar, $\frac{3}{4}$ " diameter by 3" long headed studs, spaced at 12" on center vertically, shall be welded on each side of the web mid-way between the column flanges.	—	—	—	See Note n
2. Webs or flanges of steel beams and girders (continued)	2-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete (not including sandstone, granite and siliceous gravel) with 3" or finer metal mesh placed 1" from the finished surface anchored to the top flange and providing not less than 0.025 square inch of steel area per foot in each direction.	2	$1\frac{1}{2}$	1	1
	2-1.2	Siliceous aggregate concrete and concrete excluded in Item 2-1.1 with 3" or finer metal mesh placed 1" from the finished surface anchored to the top flange and providing not less than 0.025 square inch of steel area per foot in each direction.	$2\frac{1}{2}$	2	$1\frac{1}{2}$	1
	2-2.1	Cement plaster on metal lath attached to $\frac{3}{4}$ " cold-rolled channels with 0.04" (No. 18 B.W. gage) wire ties spaced 3" to 6" on center. Plaster mixed 1:2 $\frac{1}{2}$ by volume, cement to sand.	—	—	$2\frac{1}{2}$ <sup>b</sup>	$\frac{7}{8}$

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(1)—continued**  
**MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON**  
**TIME PERIODS FOR VARIOUS NONCOMBUSTIBLE INSULATING MATERIALS<sup>m</sup>**

STRUCTURAL PARTS TO BE PROTECTED	ITEM NUMBER	INSULATING MATERIAL USED	MINIMUM THICKNESS OF INSULATING MATERIAL FOR THE FOLLOWING FIRE-RESISTANCE PERIODS (inches)			
			4 hours	3 hours	2 hours	1 hour
2. Webs or flanges of steel beams and girders (continued)	2-3.1	Vermiculite gypsum plaster on a metal lath cage, wire tied to 0.165" diameter (No. 8 B.W. gage) steel wire hangers wrapped around beam and spaced 16" on center. Metal lath ties spaced approximately 5" on center at cage sides and bottom.	—	7/8	—	—
	2-4.1	Two layers of 5/8" Type X gypsum wallboard <sup>c</sup> are attached to U-shaped brackets spaced 24" on center. 0.018" thick (No. 25 carbon sheet steel gage) 1 5/8" deep by 1" galvanized steel runner channels are first installed parallel to and on each side of the top beam flange to provide a 1/2" clearance to the flange. The channel runners are attached to steel deck or concrete floor construction with approved fasteners spaced 12" on center. U-shaped brackets are formed from members identical to the channel runners. At the bent portion of the U-shaped bracket, the flanges of the channel are cut out so that 1 5/8"-deep corner channels can be inserted without attachment parallel to each side of the lower flange.  As an alternative, 0.021" thick (No. 24 carbon sheet steel gage) 1" × 2" runner and corner angles shall be used in lieu of channels, and the web cutouts in the U-shaped brackets shall not be required. Each angle is attached to the bracket with 1/2"-long No. 8 self-drilling screws. The vertical legs of the U-shaped bracket are attached to the runners with one 1/2"-long No. 8 self-drilling screw. The completed steel framing provides a 2 1/8" and 1 1/2" space between the inner layer of wallboard and the sides and bottom of the steel beam, respectively. The inner layer of wallboard is attached to the top runners and bottom corner channels or corner angles with 1 1/4"-long No. 6 self-drilling screws spaced 16" on center. The outer layer of wallboard is applied with 1 3/4"-long No. 6 self-drilling screws spaced 8" on center. The bottom corners are reinforced with metal corner beads.	—	—	1 1/4	—
	2-4.2	Three layers of 5/8" Type X gypsum wallboard <sup>c</sup> attached to a steel suspension system as described immediately above utilizing the 0.018" thick (No. 25 carbon sheet steel gage) 1" × 2" lower corner angles. The framing is located so that a 2 1/8" and 2" space is provided between the inner layer of wallboard and the sides and bottom of the beam, respectively. The first two layers of wallboard are attached as described immediately above. A layer of 0.035" thick (No. 20 B.W. gage) 1" hexagonal galvanized wire mesh is applied under the soffit of the middle layer and up the sides approximately 2". The mesh is held in position with the No. 6 1 5/8"-long screws installed in the vertical leg of the bottom corner angles. The outer layer of wallboard is attached with No. 6 2 1/4"-long screws spaced 8" on center. One screw is installed at the mid-depth of the bracket in each layer. Bottom corners are finished as described above.	—	1 7/8	—	—
3. Bonded pretensioned reinforcement in prestressed concrete <sup>e</sup>	3-1.1	Carbonate, lightweight, sand-lightweight and siliceous <sup>f</sup> aggregate concrete				
		Beams or girders	4 <sup>g</sup>	3 <sup>g</sup>	2 1/2	1 1/2
		Solid <sup>h</sup>		2	1 1/2	1

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(1)—continued**  
**MINIMUM PROTECTION OF STRUCTURAL PARTS BASED ON**  
**TIME PERIODS FOR VARIOUS NONCOMBUSTIBLE INSULATING MATERIALS<sup>m</sup>**

STRUCTURAL PARTS TO BE PROTECTED	ITEM NUMBER	INSULATING MATERIAL USED	MINIMUM THICKNESS OF INSULATING MATERIAL FOR THE FOLLOWING FIRE-RESISTANCE PERIODS (inches)			
			4 hours	3 hours	2 hours	1 hour
4. Bonded or unbonded post-tensioned tendons in prestressed concrete <sup>e,i</sup>	4-1.1	Carbonate, lightweight, sand-lightweight and siliceous <sup>f</sup> aggregate concrete Unrestrained members:				
		Solid slabs <sup>h</sup>	—	2	1½	—
		Beams and girders <sup>j</sup>				
		8" wide		4½	2½	1¾
		greater than 12" wide	3	2½	2	1½
	4-1.2	Carbonate, lightweight, sand-lightweight and siliceous aggregate Restrained members: <sup>k</sup>				
		Solid slabs <sup>h</sup>	1¼	1	¾	—
		Beams and girders <sup>j</sup>				
		8" wide	2½	2	1¾	—
		greater than 12" wide	2	1¾	1½	—
5. Reinforcing steel in reinforced concrete columns, beams girders and trusses	5-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete, members 12" or larger, square or round. (Size limit does not apply to beams and girders monolithic with floors.)	1½	1½	1½	1½
		Siliceous aggregate concrete, members 12" or larger, square or round. (Size limit does not apply to beams and girders monolithic with floors.)	2	1½	1½	1½
6. Reinforcing steel in reinforced concrete joists <sup>l</sup>	6-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete	1¼	1¼	1	¾
	6-1.2	Siliceous aggregate concrete	1¾	1½	1	¾
7. Reinforcing and tie rods in floor and roof slabs <sup>l</sup>	7-1.1	Carbonate, lightweight and sand-lightweight aggregate concrete	1	1	¾	¾
	7-1.2	Siliceous aggregate concrete	1¼	1	1	¾

For SI: 1 inch = 25.4 mm, 1 square inch = 645.2 mm<sup>2</sup>, 1 cubic foot = 0.0283 m<sup>3</sup>, 1 pound per cubic foot = 16.02 kg/m<sup>3</sup>.

- Reentrant parts of protected members to be filled solidly.
- Two layers of equal thickness with a ¾-inch airspace between.
- For all of the construction with gypsum wallboard described in Table 721.1(1), gypsum base for veneer plaster of the same size, thickness and core type shall be permitted to be substituted for gypsum wallboard, provided that attachment is identical to that specified for the wallboard and the joints on the face layer are reinforced, and the entire surface is covered with not less than 1/16-inch gypsum veneer plaster.
- An approved adhesive qualified under ASTM E119 or UL 263.
- Where lightweight or sand-lightweight concrete having an oven-dry weight of 110 pounds per cubic foot or less is used, the tabulated minimum cover shall be permitted to be reduced 25 percent, except that the reduced cover shall be not less than ¾ inch in slabs or 1½ inches in beams or girders.
- For solid slabs of siliceous aggregate concrete, increase tendon cover 20 percent.
- Adequate provisions against spalling shall be provided by U-shaped or hooped stirrups spaced not to exceed the depth of the member with a clear cover of 1 inch.
- Prestressed slabs shall have a thickness not less than that required in Table 721.1(3) for the respective fire-resistance time period.
- Fire coverage and end anchorages shall be as follows: Cover to the prestressing steel at the anchor shall be ½ inch greater than that required away from the anchor. Minimum cover to steel-bearing plate shall be 1 inch in beams and ¾ inch in slabs.
- For beam widths between 8 inches and 12 inches, cover thickness shall be permitted to be determined by interpolation.
- Interior spans of continuous slabs, beams and girders shall be permitted to be considered restrained.
- For use with concrete slabs having a comparable fire endurance where members are framed into the structure in such a manner as to provide equivalent performance to that of monolithic concrete construction.
- Generic fire-resistance ratings (those not designated as PROPRIETARY\* in the listing) in GA-600 shall be accepted as if herein specified.
- Additional insulating material is not required on the exposed outside face of the column flange to achieve a 1-hour fire-resistance rating.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
1. Brick of clay or shale	1-1.1	Solid brick of clay or shale. <sup>c</sup>	6	4.9	3.8	2.7
	1-1.2	Hollow brick, not filled.	5.0	4.3	3.4	2.3
	1-1.3	Hollow brick unit wall, grout or filled with perlite vermiculite or expanded shale aggregate.	6.6	5.5	4.4	3.0
	1-2.1	4" nominal thick units not less than 75 percent solid backed with a hat-shaped metal furring channel $\frac{3}{4}$ " thick formed from 0.021" sheet metal attached to the brick wall on 24" centers with approved fasteners, and $\frac{1}{2}$ " Type X gypsum wallboard attached to the metal furring strips with 1"-long Type S screws spaced 8" on center.	—	—	5 <sup>d</sup>	—
2. Combination of clay brick and load-bearing hollow clay tile	2-1.1	4" solid brick and 4" tile (not less than 40 percent solid).	—	8	—	—
	2-1.2	4" solid brick and 8" tile (not less than 40 percent solid).	12	—	—	—
3. Concrete masonry units	3-1.1 <sup>f, g</sup>	Expanded slag or pumice.	4.7	4.0	3.2	2.1
	3-1.2 <sup>f, g</sup>	Expanded clay, shale or slate.	5.1	4.4	3.6	2.6
	3-1.3 <sup>f</sup>	Limestone, cinders or air-cooled slag.	5.9	5.0	4.0	2.7
	3-1.4 <sup>f, g</sup>	Calcareous or siliceous gravel.	6.2	5.3	4.2	2.8
4. Solid concrete <sup>h, i</sup>	4-1.1	Siliceous aggregate concrete.	7.0	6.2	5.0	3.5
		Carbonate aggregate concrete.	6.6	5.7	4.6	3.2
		Sand-lightweight concrete.	5.4	4.6	3.8	2.7
		Lightweight concrete.	5.1	4.4	3.6	2.5
5. Glazed or unglazed facing tile, nonload-bearing	5-1.1	One 2" unit cored 15 percent maximum and one 4" unit cored 25 percent maximum with $\frac{3}{4}$ " mortar-filled collar joint. Unit positions reversed in alternate courses.	—	6 $\frac{3}{8}$	—	—
	5-1.2	One 2" unit cored 15 percent maximum and one 4" unit cored 40 percent maximum with $\frac{3}{4}$ " mortar-filled collar joint. Unit positions side with $\frac{3}{4}$ " gypsum plaster. Two wythes tied together every fourth course with No. 22 gage corrugated metal ties.	—	6 $\frac{3}{4}$	—	—
	5-1.3	One unit with three cells in wall thickness, cored 29 percent maximum.	—	—	6	—
	5-1.4	One 2" unit cored 22 percent maximum and one 4" unit cored 41 percent maximum with $\frac{1}{4}$ " mortar-filled collar joint. Two wythes tied together every third course with 0.030"(No. 22 galvanized sheet steel gage) corrugated metal ties.	—	—	6	—
	5-1.5	One 4" unit cored 25 percent maximum with $\frac{3}{4}$ " gypsum plaster on one side.	—	—	4 $\frac{3}{4}$	—
	5-1.6	One 4" unit with two cells in wall thickness, cored 22 percent maximum.	—	—	—	4
	5-1.7	One 4" unit cored 30 percent maximum with $\frac{3}{4}$ " vermiculite gypsum plaster on one side.	—	—	4 $\frac{1}{2}$	—
	5-1.8	One 4" unit cored 39 percent maximum with $\frac{3}{4}$ " gypsum plaster on one side.	—	—	—	4 $\frac{1}{2}$

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
6. Solid gypsum plaster	6-1.1	$\frac{3}{4}$ " by 0.055" (No. 16 carbon sheet steel gage) vertical cold-rolled channels, 16" on center with 2.6-pound flat metal lath applied to one face and tied with 0.049" (No. 18 B.W. gage) wire at 6" spacing. Gypsum plaster each side mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	2 <sup>d</sup>
	6-1.2	$\frac{3}{4}$ " by 0.05" (No. 16 carbon sheet steel gage) cold-rolled channels 16" on center with metal lath applied to one face and tied with 0.049" (No. 18 B.W. gage) wire at 6" spacing. Perlite or vermiculite gypsum plaster each side. For three-coat work, the plaster mix for the second coat shall not exceed 100 pounds of gypsum to 2½ cubic feet of aggregate for the 1-hour system.	—	—	2½ <sup>d</sup>	2 <sup>d</sup>
	6-1.3	$\frac{3}{4}$ " by 0.055" (No. 16 carbon sheet steel gage) vertical cold-rolled channels, 16" on center with $\frac{3}{8}$ " gypsum lath applied to one face and attached with sheet metal clips. Gypsum plaster each side mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	2 <sup>d</sup>
	6-2.1	Studless with ½" full-length plain gypsum lath and gypsum plaster each side. Plaster mixed 1:1 for scratch coat and 1:2 for brown coat, by weight, gypsum to sand aggregate.	—	—	—	2 <sup>d</sup>
	6-2.2	Studless with ½" full-length plain gypsum lath and perlite or vermiculite gypsum plaster each side.	—	—	2½ <sup>d</sup>	2 <sup>d</sup>
	6-2.3	Studless partition with $\frac{3}{8}$ " rib metal lath installed vertically adjacent edges tied 6" on center with No. 18 gage wire ties, gypsum plaster each side mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	2 <sup>d</sup>
7. Solid perlite and Portland cement	7-1.1	Perlite mixed in the ratio of 3 cubic feet to 100 pounds of Portland cement and machine applied to stud side of 1½" mesh by 0.058-inch (No. 17 B.W. gage) paper-backed woven wire fabric lath wire-tied to 4"-deep steel trussed wire studs 16" on center. Wire ties of 0.049" (No. 18 B.W. gage) galvanized steel wire 6" on center vertically.	—	—	3⅛ <sup>d</sup>	—
8. Solid neat wood fibered gypsum plaster	8-1.1	$\frac{3}{4}$ " by 0.055-inch (No. 16 carbon sheet steel gage) cold-rolled channels, 12" on center with 2.5-pound flat metal lath applied to one face and tied with 0.049" (No. 18 B.W. gage) wire at 6" spacing. Neat gypsum plaster applied each side.	—	—	2 <sup>d</sup>	—
9. Solid wallboard partition	9-1.1	One full-length layer ½" Type X gypsum wallboard <sup>e</sup> laminated to each side of 1" full-length V-edge gypsum coreboard with approved laminating compound. Vertical joints of face layer and coreboard staggered not less than 3".	—	—	2 <sup>d</sup>	—
10. Hollow (studless) gypsum wallboard partition	10-1.1	One full-length layer of $\frac{5}{8}$ " Type X gypsum wallboard <sup>e</sup> attached to both sides of wood or metal top and bottom runners laminated to each side of 1" × 6" full-length gypsum coreboard ribs spaced 2" on center with approved laminating compound. Ribs centered at vertical joints of face plies and joints staggered 24" in opposing faces. Ribs may be recessed 6" from the top and bottom.	—	—	—	2¼ <sup>d</sup>
	10-1.2	1" regular gypsum V-edge full-length backing board attached to both sides of wood or metal top and bottom runners with nails or 1⅝" drywall screws at 24" on center. Minimum width of runners 1⅝". Face layer of ½" regular full-length gypsum wallboard laminated to outer faces of backing board with approved laminating compound.	—	—	4⅝ <sup>d</sup>	—

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
11. Noncombustible studs—interior partition with plaster each side	11-1.1	$3\frac{1}{4}" \times 0.044"$ (No. 18 carbon sheet steel gage) steel studs spaced 24" on center. $\frac{5}{8}"$ gypsum plaster on metal lath each side mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$4\frac{3}{4}^d$
	11-1.2	$3\frac{3}{8}" \times 0.055"$ (No. 16 carbon sheet steel gage) approved nailable <sup>k</sup> studs spaced 24" on center. $\frac{5}{8}"$ neat gypsum wood-fibered plaster each side over $\frac{3}{8}"$ rib metal lath nailed to studs with 6d common nails, 8" on center. Nails driven $1\frac{1}{4}"$ and bent over.	—	—	$5\frac{5}{8}$	—
	11-1.3	$4" \times 0.044"$ (No. 18 carbon sheet steel gage) channel-shaped steel studs at 16" on center. On each side approved resilient clips pressed onto stud flange at 16" vertical spacing, $\frac{1}{4}"$ pencil rods snapped into or wire tied onto outer loop of clips, metal lath wire-tied to pencil rods at 6" intervals, 1" perlite gypsum plaster, each side.	—	$7\frac{5}{8}^d$	—	—
	11-1.4	$2\frac{1}{2}" \times 0.044"$ (No. 18 carbon sheet steel gage) steel studs spaced 16" on center. Wood fibered gypsum plaster mixed 1:1 by weight gypsum to sand aggregate applied on $\frac{3}{4}$ -pound metal lath wire tied to studs, each side. $\frac{3}{4}"$ plaster applied over each face, including finish coat.	—	—	$4\frac{1}{4}^d$	—
12. Wood studs—interior partition with plaster each side	12-1.1 <sup>l, m</sup>	$2" \times 4"$ wood studs 16" on center with $\frac{5}{8}"$ gypsum plaster on metal lath. Lath attached by 4d common nails bent over or No. 14 gage by $1\frac{1}{4}"$ by $\frac{3}{4}"$ crown width staples spaced 6" on center. Plaster mixed 1:1½ for scratch coat and 1:3 for brown coat, by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{8}$
	12-1.2 <sup>l</sup>	$2" \times 4"$ wood studs 16" on center with metal lath and $\frac{7}{8}"$ neat wood-fibered gypsum plaster each side. Lath attached by 6d common nails, 7" on center. Nails driven $1\frac{1}{4}"$ and bent over.	—	—	$5\frac{1}{2}^d$	—
	12-1.3 <sup>l</sup>	$2" \times 4"$ wood studs 16" on center with $\frac{3}{8}"$ perforated or plain gypsum lath and $\frac{1}{2}"$ gypsum plaster each side. Lath nailed with $1\frac{1}{8}"$ by No. 13 gage by $\frac{19}{64}"$ head plasterboard blued nails, 4" on center. Plaster mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{4}$
	12-1.4 <sup>l</sup>	$2" \times 4"$ wood studs 16" on center with $\frac{3}{8}"$ Type X gypsum lath and $\frac{1}{2}"$ gypsum plaster each side. Lath nailed with $1\frac{1}{8}"$ by No. 13 gage by $\frac{19}{64}"$ head plasterboard blued nails, 5" on center. Plaster mixed 1:2 by weight, gypsum to sand aggregate.	—	—	—	$5\frac{1}{4}$
13. Noncombustible studs—interior partition with gypsum wallboard each side	13-1.1	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 24" on center with one full-length layer of $\frac{5}{8}"$ Type X gypsum wallboard <sup>c</sup> applied vertically attached with 1"-long No. 6 dry wall screws to each stud. Screws are 8" on center around the perimeter and 12" on center on the intermediate stud. Where applied horizontally, the Type X gypsum wallboard shall be attached to $3\frac{5}{8}"$ studs and the horizontal joints shall be staggered with those on the opposite side. Screws for the horizontal application shall be 8" on center at vertical edges and 12" on center at intermediate studs.	—	—	—	$2\frac{7}{8}^d$
	13-1.2	0.018" (No. 25 carbon sheet steel gage) channel-shaped studs 25" on center with two full-length layers of $\frac{1}{2}"$ Type X gypsum wallboard <sup>c</sup> applied vertically each side. First layer attached with 1"-long, No. 6 drywall screws, 8" on center around the perimeter and 12" on center on the intermediate stud. Second layer applied with vertical joints offset one stud space from first layer using $1\frac{5}{8}"$ long, No. 6 drywall screws spaced 9" on center along vertical joints, 12" on center at intermediate studs and 24" on center along top and bottom runners.	—	—	$3\frac{5}{8}^d$	—
	13-1.3	0.055" (No. 16 carbon sheet steel gage) approved nailable metal studs <sup>c</sup> 24" on center with full-length $\frac{5}{8}"$ Type X gypsum wallboard <sup>c</sup> applied vertically and nailed 7" on center with 6d cement-coated common nails. Approved metal fastener grips used with nails at vertical butt joints along studs.	—	—	—	$4\frac{7}{8}$

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
14. Wood studs—interior partition with gypsum wallboard each side	14-1.1 <sup>h, m</sup>	2" × 4" wood studs 16" on center with two layers of $\frac{3}{8}$ " regular gypsum wallboard <sup>c</sup> each side, 4d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 8" on center first layer, 5d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 8" on center second layer with laminating compound between layers, joints staggered. First layer applied full length vertically, second layer applied horizontally or vertically.	—	—	—	5
	14-1.2 <sup>l, m</sup>	2" × 4" wood studs 16" on center with two layers $\frac{1}{2}$ " regular gypsum wallboard <sup>c</sup> applied vertically or horizontally each side <sup>k</sup> , joints staggered. Nail base layer with 5d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 8" on center face layer with 8d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 8" on center.	—	—	—	5½
	14-1.3 <sup>l, m</sup>	2" × 4" wood studs 24" on center with $\frac{5}{8}$ " Type X gypsum wallboard <sup>c</sup> applied vertically or horizontally nailed with 6d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 7" on center with end joints on nailing members. Stagger joints each side.	—	—	—	4¾
	14-1.4 <sup>l</sup>	2" × 4" fire-retardant-treated wood studs spaced 24" on center with one layer of $\frac{5}{8}$ " Type X gypsum wallboard <sup>c</sup> applied with face paper grain (long dimension) parallel to studs. Wallboard attached with 6d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 7" on center.	—	—	—	4¾ <sup>d</sup>
	14-1.5 <sup>l, m</sup>	2" × 4" wood studs 16" on center with two layers $\frac{5}{8}$ " Type X gypsum wallboard <sup>c</sup> each side. Base layers applied vertically and nailed with 6d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 9" on center. Face layer applied vertically or horizontally and nailed with 8d cooler <sup>n</sup> or wallboard <sup>n</sup> nails at 7" on center. For nail-adhesive application, base layers are nailed 6" on center. Face layers applied with coating of approved wallboard adhesive and nailed 12" on center.	—	—	6	—
	14-1.6 <sup>l</sup>	2" × 3" fire-retardant-treated wood studs spaced 24" on center with one layer of $\frac{5}{8}$ " Type X gypsum wallboard <sup>c</sup> applied with face paper grain (long dimension) at right angles to studs. Wallboard attached with 6d cement-coated box nails spaced 7" on center.	—	—	—	3⅝ <sup>d</sup>
15. Exterior or interior walls (continued)	15-1.1 <sup>l, m</sup>	Exterior surface with $\frac{3}{4}$ " drop siding over $\frac{1}{2}$ " gypsum sheathing on 2" × 4" wood studs at 16" on center, interior surface treatment as required for 1-hour-rated exterior or interior 2" × 4" wood stud partitions. Gypsum sheathing nailed with 1¾" by No.11 gage by $\frac{7}{16}$ " head galvanized nails at 8" on center. Siding nailed with 7d galvanized smooth box nails.	—	—	—	Varies
	15-1.2 <sup>l, m</sup>	2" × 4" wood studs 16" on center with metal lath and $\frac{3}{4}$ " cement plaster on each side. Lath attached with 6d common nails 7" on center driven to 1" minimum penetration and bent over. Plaster mix 1:4 for scratch coat and 1:5 for brown coat, by volume, cement to sand.	—	—	—	5⅜
	15-1.3 <sup>l, m</sup>	2" × 4" wood studs 16" on center with $\frac{7}{8}$ " cement plaster (measured from the face of studs) on the exterior surface with interior surface treatment as required for interior wood stud partitions in this table. Plaster mix 1:4 for scratch coat and 1:5 for brown coat, by volume, cement to sand.	—	—	—	Varies
	15-1.4	3⅝" No. 16 gage noncombustible studs 16" on center with $\frac{7}{8}$ " cement plaster (measured from the face of the studs) on the exterior surface with interior surface treatment as required for interior, nonbearing, noncombustible stud partitions in this table. Plaster mix 1:4 for scratch coat and 1:5 for brown coat, by volume, cement to sand.	—	—	—	Varies <sup>d</sup>

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
15. Exterior or interior walls (continued)	15-1.5 <sup>m</sup>	2 <sup>1</sup> / <sub>4</sub> " × 3 <sup>3</sup> / <sub>4</sub> " clay face brick with cored holes over <sup>1</sup> / <sub>2</sub> " gypsum sheathing on exterior surface of 2" × 4" wood studs at 16" on center and two layers <sup>5</sup> / <sub>8</sub> " Type X gypsum wallboard <sup>e</sup> on interior surface. Sheathing placed horizontally or vertically with vertical joints over studs nailed 6" on center with 1 <sup>3</sup> / <sub>4</sub> " × No. 11 gage by <sup>7</sup> / <sub>16</sub> " head galvanized nails. Inner layer of wallboard placed horizontally or vertically and nailed 8" on center with 6d cooler <sup>n</sup> or wallboard <sup>n</sup> nails. Outer layer of wallboard placed horizontally or vertically and nailed 8" on center with 8d cooler <sup>n</sup> or wallboard <sup>n</sup> nails. Joints staggered with vertical joints over studs. Outer layer joints taped and finished with compound. Nail heads covered with joint compound. 0.035 inch (No. 20 galvanized sheet gage) corrugated galvanized steel wall ties <sup>3</sup> / <sub>4</sub> " by 6 <sup>5</sup> / <sub>8</sub> " attached to each stud with two 8d cooler <sup>n</sup> or wallboard <sup>n</sup> nails every sixth course of bricks.	—	—	10	—
	15-1.6 <sup>l, m</sup>	2" × 6" fire-retardant-treated wood studs 16" on center. Interior face has two layers of <sup>5</sup> / <sub>8</sub> " Type X gypsum with the base layer placed vertically and attached with 6d box nails 12" on center. The face layer is placed horizontally and attached with 8d box nails 8" on center at joints and 12" on center elsewhere. The exterior face has a base layer of <sup>5</sup> / <sub>8</sub> " Type X gypsum sheathing placed vertically with 6d box nails 8" on center at joints and 12" on center elsewhere. An approved building paper is next applied, followed by self-furred exterior lath attached with 2 <sup>1</sup> / <sub>2</sub> ", No. 12 gage galvanized roofing nails with a <sup>3</sup> / <sub>8</sub> " diameter head and spaced 6" on center along each stud. Cement plaster consisting of a <sup>1</sup> / <sub>2</sub> " brown coat is then applied. The scratch coat is mixed in the proportion of 1:3 by weight, cement to sand with 10 pounds of hydrated lime and 3 pounds of approved additives or admixtures per sack of cement. The brown coat is mixed in the proportion of 1:4 by weight, cement to sand with the same amounts of hydrated lime and approved additives or admixtures used in the scratch coat.	—	—	8 <sup>1</sup> / <sub>4</sub>	—
	15-1.7 <sup>l, m</sup>	2" × 6" wood studs 16" on center. The exterior face has a layer of <sup>5</sup> / <sub>8</sub> " Type X gypsum sheathing placed vertically with 6d box nails 8" on center at joints and 12" on center elsewhere. An approved building paper is next applied, followed by 1" by No. 18 gage self-furred exterior lath attached with 8d by 2 <sup>1</sup> / <sub>2</sub> "-long galvanized roofing nails spaced 6" on center along each stud. Cement plaster consisting of a <sup>1</sup> / <sub>2</sub> " scratch coat, a bonding agent and a <sup>1</sup> / <sub>2</sub> " brown coat and a finish coat is then applied. The scratch coat is mixed in the proportion of 1:3 by weight, cement to sand with 10 pounds of hydrated lime and 3 pounds of approved additives or admixtures per sack of cement. The brown coat is mixed in the proportion of 1:4 by weight, cement to sand with the same amounts of hydrated lime and approved additives or admixtures used in the scratch coat. The interior is covered with <sup>3</sup> / <sub>8</sub> " gypsum lath with 1" hexagonal mesh of 0.035 inch (No. 20 B.W. gage) woven wire lath furred out <sup>5</sup> / <sub>16</sub> " and 1" perlite or vermiculite gypsum plaster. Lath nailed with 1 <sup>1</sup> / <sub>8</sub> " by No. 13 gage by <sup>19</sup> / <sub>64</sub> " head plasterboard glued nails spaced 5" on center. Mesh attached by 1 <sup>3</sup> / <sub>4</sub> " by No. 12 gage by <sup>3</sup> / <sub>8</sub> " head nails with <sup>3</sup> / <sub>8</sub> " furrings, spaced 8" on center. The plaster mix shall not exceed 100 pounds of gypsum to 2 <sup>1</sup> / <sub>2</sub> cubic feet of aggregate.	—	—	8 <sup>3</sup> / <sub>8</sub>	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
15. Exterior or interior walls (continued)	15-1.8 <sup>l, m</sup>	2" × 6" wood studs 16" on center. The exterior face has a layer of $\frac{5}{8}$ " Type X gypsum sheathing placed vertically with 6d box nails 8" on center at joints and 12" on center elsewhere. An approved building paper is next applied, followed by $1\frac{1}{2}$ " by No. 17 gage self-furred exterior lath attached with 8d by $2\frac{1}{2}$ "-long galvanized roofing nails spaced 6" on center along each stud. Cement plaster consisting of a $\frac{1}{2}$ " scratch coat and a $\frac{1}{2}$ " brown coat is then applied. The plaster may be placed by machine. The scratch coat is mixed in the proportion of 1:4 by weight, plastic cement to sand. The brown coat is mixed in the proportion of 1:5 by weight, plastic cement to sand. The interior is covered with $\frac{3}{8}$ " gypsum lath with 1" hexagonal mesh of No. 20-gage woven wire lath furred out $\frac{5}{16}$ " and 1" perlite or vermiculite gypsum plaster. Lath nailed with $1\frac{1}{8}$ " by No. 13 gage by $\frac{19}{64}$ " head plasterboard glued nails spaced 5" on center. Mesh attached by $1\frac{3}{4}$ " by No.12 gage by $\frac{3}{8}$ " head nails with $\frac{3}{8}$ " furrings, spaced 8" on center. The plaster mix shall not exceed 100 pounds of gypsum to $2\frac{1}{2}$ cubic feet of aggregate.	—	—	$8\frac{3}{8}$	—
	15-1.9	4" No. 18 gage, nonload-bearing metal studs, 16" on center, with 1" Portland cement lime plaster (measured from the back side of the $\frac{3}{4}$ -pound expanded metal lath) on the exterior surface. Interior surface to be covered with 1" of gypsum plaster on $\frac{3}{4}$ -pound expanded metal lath proportioned by weight—1:2 for scratch coat, 1:3 for brown, gypsum to sand. Lath on one side of the partition fastened to $\frac{1}{4}$ " diameter pencil rods supported by No. 20 gage metal clips, located 16" on center vertically, on each stud. 3" thick mineral fiber insulating batts friction fitted between the studs.	—	—	$6\frac{1}{2}$ <sup>d</sup>	—
	15-1.10	Steel studs 0.060" thick, 4" deep or 6" at 16" or 24" centers, with $\frac{1}{2}$ " glass fiber-reinforced concrete (GFRC) on the exterior surface. GFRC is attached with flex anchors at 24" on center, with 5" leg welded to studs with two $\frac{1}{2}$ "-long flare-bevel welds, and 4" foot attached to the GFRC skin with $\frac{5}{8}$ "-thick GFRC bonding pads that extend $2\frac{1}{2}$ " beyond the flex anchor foot on both sides. Interior surface to have two layers of $\frac{1}{2}$ " Type X gypsum wallboard. <sup>e</sup> The first layer of wallboard to be attached with 1"-long Type S buglehead screws spaced 24" on center and the second layer is attached with $1\frac{5}{8}$ "-long Type S screws spaced at 12" on center. Cavity is to be filled with 5" of 4 pcf (nominal) mineral fiber batts. GFRC has $1\frac{1}{2}$ " returns packed with mineral fiber and caulked on the exterior.	—	—	$6\frac{1}{2}$	—
	15-1.11	Steel studs 0.060" thick, 4" deep or 6" at 16" or 24" centers, respectively, with $\frac{1}{2}$ " glass fiber-reinforced concrete (GFRC) on the exterior surface. GFRC is attached with flex anchors at 24" on center, with 5" leg welded to studs with two $\frac{1}{2}$ "-long flare-bevel welds, and 4" foot attached to the GFRC skin with $\frac{5}{8}$ "-thick GFRC bonding pads that extend $2\frac{1}{2}$ " beyond the flex anchor foot on both sides. Interior surface to have one layer of $\frac{5}{8}$ " Type X gypsum wallboard <sup>e</sup> , attached with $1\frac{1}{4}$ "-long Type S buglehead screws spaced 12" on center. Cavity is to be filled with 5" of 4 pcf (nominal) mineral fiber batts. GFRC has $1\frac{1}{2}$ " returns packed with mineral fiber and caulked on the exterior.	—	—	—	$6\frac{1}{8}$
	15-1.12 <sup>a</sup>	2" × 6" wood studs at 16" with double top plates, single bottom plate; interior and exterior sides covered with $\frac{5}{8}$ " Type X gypsum wallboard, 4' wide, applied horizontally or vertically with vertical joints over studs, and fastened with $2\frac{1}{4}$ " Type S drywall screws, spaced 12" on center. Cavity to be filled with $5\frac{1}{2}$ " mineral wool insulation.	—	—	—	$6\frac{3}{4}$

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
15. Exterior or interior walls (continued)	15-1.13 <sup>q</sup>	2" × 6" wood studs at 16" with double top plates, single bottom plate; interior and exterior sides covered with 5/8" Type X gypsum wallboard, 4' wide, applied vertically with all joints over framing or blocking and fastened with 2 1/4" Type S drywall screws, spaced 12" on center. R-19 mineral fiber insulation installed in stud cavity.	—	—	—	6 3/4
	15-1.14 <sup>q</sup>	2" × 6" wood studs at 16" with double top plates, single bottom plate; interior and exterior sides covered with 5/8" Type X gypsum wallboard, 4' wide, applied horizontally or vertically with vertical joints over studs, and fastened with 2 1/4" Type S drywall screws, spaced 7" on center.	—	—	—	6 3/4
	15-1.15 <sup>q</sup>	2" × 4" wood studs at 16" with double top plates, single bottom plate; interior and exterior sides covered with 5/8" Type X gypsum wallboard and sheathing, respectively, 4' wide, applied horizontally or vertically with vertical joints over studs, and fastened with 2 1/4" Type S drywall screws, spaced 12" on center. Cavity to be filled with 3 1/2" mineral wool insulation.	—	—	—	4 3/4
	15-1.16 <sup>q</sup>	2" × 6" wood studs at 24" centers with double top plates, single bottom plate; interior and exterior side covered with two layers of 5/8" Type X gypsum wallboard, 4' wide, applied horizontally with vertical joints over studs. Base layer fastened with 2 1/4" Type S drywall screws, spaced 24" on center and face layer fastened with Type S drywall screws, spaced 8" on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound. Cavity to be filled with 5 1/2" mineral wool insulation.	—	—	8	—
	15-2.1 <sup>d</sup>	3 5/8" No. 16 gage steel studs at 24" on center or 2" × 4" wood studs at 24" on center. Metal lath attached to the exterior side of studs with minimum 1" long No. 6 drywall screws at 6" on center and covered with minimum 3/4" thick Portland cement plaster. Thin veneer brick units of clay or shale complying with ASTM C1088, Grade TBS or better, installed in running bond in accordance with Section 1404.10. Combined total thickness of the Portland cement plaster, mortar and thin veneer brick units shall be not less than 1 3/4". Interior side covered with one layer of 5/8"-thick Type X gypsum wallboard attached to studs with 1" long No. 6 drywall screws at 12" on center.	—	—	—	6
	15-2.2 <sup>d</sup>	3 5/8" No. 16 gage steel studs at 24" on center or 2" × 4" wood studs at 24" on center. Metal lath attached to the exterior side of studs with minimum 1" long No. 6 drywall screws at 6" on center and covered with minimum 3/4" thick Portland cement plaster. Thin veneer brick units of clay or shale complying with ASTM C1088, Grade TBS or better, installed in running bond in accordance with Section 1404.10. Combined total thickness of the Portland cement plaster, mortar and thin veneer brick units shall be not less than 2". Interior side covered with two layers of 5/8"-thick Type X gypsum wallboard. Bottom layer attached to studs with 1"-long No. 6 drywall screws at 24" on center. Top layer attached to studs with 1 5/8"-long No. 6 drywall screws at 12" on center.	—	—	6 7/8	—
	15-2.3 <sup>d</sup>	3 5/8" No. 16 gage steel studs at 16" on center or 2" × 4" wood studs at 16" on center. Where metal lath is used, attach to the exterior side of studs with minimum 1"-long No. 6 drywall screws at 6" on center. Brick units of clay or shale not less than 2 5/8" thick complying with ASTM C216 installed in accordance with Section 1404.6 with a minimum 1" airspace. Interior side covered with one layer of 5/8"-thick Type X gypsum wallboard attached to studs with 1"-long No. 6 drywall screws at 12" on center.	—	—	—	7 7/8

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

MATERIAL	ITEM NUMBER	CONSTRUCTION	MINIMUM FINISHED THICKNESS FACE-TO-FACE <sup>b</sup> (inches)			
			4 hours	3 hours	2 hours	1 hour
15. Exterior or interior walls	15-2.4 <sup>d</sup>	3 <sup>5</sup> / <sub>8</sub> " No. 16 gage steel studs at 16" on center or 2" × 4" wood studs at 16" on center. Where metal lath is used, attach to the exterior side of studs with minimum 1"-long No. 6 drywall screws at 6" on center. Brick units of clay or shale not less than 2 <sup>5</sup> / <sub>8</sub> " thick complying with ASTM C216 installed in accordance with Section 1404.6 with a minimum 1" airspace. Interior side covered with two layers of <sup>5</sup> / <sub>8</sub> "-thick Type X gypsum wallboard. Bottom layer attached to studs with 1"-long No. 6 drywall screws at 24" on center. Top layer attached to studs with 1 <sup>5</sup> / <sub>8</sub> "-long No. 6 drywall screws at 12" on center.	—	—	8 <sup>1</sup> / <sub>2</sub>	—
16. Exterior walls rated for fire resistance from the inside only in accordance with Section 705.5.	16-1.1 <sup>q</sup>	2" × 4" wood studs at 16" centers with double top plates, single bottom plate; interior side covered with <sup>5</sup> / <sub>8</sub> " Type X gypsum wallboard, 4' wide, applied horizontally unblocked, and fastened with 2 <sup>1</sup> / <sub>4</sub> " Type S drywall screws, spaced 12" on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound. Exterior covered with <sup>3</sup> / <sub>8</sub> " wood structural panels, applied vertically, horizontal joints blocked and fastened with 6d common nails (bright)—12" on center in the field, and 6" on center panel edges. Cavity to be filled with 3 <sup>1</sup> / <sub>2</sub> " mineral wool insulation. Rating established for exposure from interior side only.	—	—	—	4 <sup>1</sup> / <sub>2</sub>
	16-1.2 <sup>q</sup>	2" × 6" wood studs at 16" centers with double top plates, single bottom plate; interior side covered with <sup>5</sup> / <sub>8</sub> " Type X gypsum wallboard, 4' wide, applied horizontally or vertically with vertical joints over studs and fastened with 2 <sup>1</sup> / <sub>4</sub> " Type S drywall screws, spaced 12" on center, wallboard joints covered with paper tape and joint compound, fastener heads covered with joint compound, exterior side covered with <sup>7</sup> / <sub>16</sub> " wood structural panels fastened with 6d common nails (bright) spaced 12" on center in the field and 6" on center along the panel edges. Cavity to be filled with 5 <sup>1</sup> / <sub>2</sub> " mineral wool insulation. Rating established from the gypsum-covered side only.	—	—	—	6 <sup>9</sup> / <sub>16</sub>
	16-1.3 <sup>q</sup>	2" × 6" wood studs at 16" centers with double top plates, single bottom plates; interior side covered with <sup>5</sup> / <sub>8</sub> " Type X gypsum wallboard, 4' wide, applied vertically with all joints over framing or blocking and fastened with 2 <sup>1</sup> / <sub>4</sub> " Type S drywall screws spaced 7" on center. Joints to be covered with tape and joint compound. Exterior covered with <sup>3</sup> / <sub>8</sub> " wood structural panels, applied vertically with edges over framing or blocking and fastened with 6d common nails (bright) at 12" on center in the field and 6" on center on panel edges. R-19 mineral fiber insulation installed in stud cavity. Rating established from the gypsum-covered side only.	—	—	—	6 <sup>1</sup> / <sub>2</sub>

For SI: 1 inch = 25.4 mm, 1 square inch = 645.2 mm<sup>2</sup>, 1 cubic foot = 0.0283 m<sup>3</sup>.

- Staples with equivalent holding power and penetration shall be permitted to be used as alternate fasteners to nails for attachment to wood framing.
- Thickness shown for brick and clay tile is nominal thicknesses unless plastered, in which case thicknesses are net. Thickness shown for concrete masonry and clay masonry is equivalent thickness defined in Section 722.3.1 for concrete masonry and Section 722.4.1.1 for clay masonry. Where all cells are solid grouted or filled with silicone-treated perlite loose-fill insulation; vermiculite loose-fill insulation; or expanded clay, shale or slate lightweight aggregate, the equivalent thickness shall be the thickness of the block or brick using specified dimensions as defined in Chapter 21. Equivalent thickness shall include the thickness of applied plaster and lath or gypsum wallboard, where specified.
- For units in which the net cross-sectional area of cored brick in any plane parallel to the surface containing the cores is not less than 75 percent of the gross cross-sectional area measured in the same plane.
- Shall be used for nonbearing purposes only.
- For all of the construction with gypsum wallboard described in this table, gypsum base for veneer plaster of the same size, thickness and core type shall be permitted to be substituted for gypsum wallboard, provided that attachment is identical to that specified for the wallboard, and the joints on the face layer are reinforced and the entire surface is covered with not less than <sup>1</sup>/<sub>16</sub>"-inch gypsum veneer plaster.
- The fire-resistance time period for concrete masonry units meeting the equivalent thicknesses required for a 2-hour fire-resistance rating in Item 3, and having a thickness of not less than 7<sup>5</sup>/<sub>8</sub> inches is 4 hours where cores that are not grouted are filled with silicone-treated perlite loose-fill insulation; vermiculite loose-fill insulation; or expanded clay, shale or slate lightweight aggregate, sand or slag having a maximum particle size of <sup>3</sup>/<sub>8</sub> inch.
- The fire-resistance rating of concrete masonry units composed of a combination of aggregate types or where plaster is applied directly to the concrete masonry shall be determined in accordance with ACI 216.1/TMS 0216. Lightweight aggregates shall have a maximum combined density of 65 pounds per cubic foot.
- See Note b. The equivalent thickness shall be permitted to include the thickness of cement plaster or 1.5 times the thickness of gypsum plaster applied in accordance with the requirements of Chapter 25.

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(2)—continued**  
**RATED FIRE-RESISTANCE PERIODS FOR VARIOUS WALLS AND PARTITIONS** <sup>a, o, p</sup>

- i. Concrete walls shall be reinforced with horizontal and vertical temperature reinforcement as required by Chapter 19.
- j. Studs are welded truss wire studs with 0.18 inch (No. 7 B.W. gage) flange wire and 0.18 inch (No. 7 B.W. gage) truss wires.
- k. Nailable metal studs consist of two channel studs spot welded back to back with a crimped web forming a nailing groove.
- l. Wood structural panels shall be permitted to be installed between the fire protection and the wood studs on either the interior or exterior side of the wood frame assemblies in this table, provided that the length of the fasteners used to attach the fire protection is increased by an amount not less than the thickness of the wood structural panel.
- m. For studs with a slenderness ratio,  $l/d$ , greater than 33, the design stress shall be reduced to 78 percent of allowable  $F'_c$ . For studs with a slenderness ratio,  $l/d$ , not exceeding 33, the design stress shall be reduced to 78 percent of the adjusted stress  $F'_c$  calculated for studs having a slenderness ratio  $l/d$  of 33.
- n. For properties of cooler or wallboard nails, see ASTM C514, ASTM C547 or ASTM F1667.
- o. Generic fire-resistance ratings (those not designated as PROPRIETARY\* in the listing) in the GA-600 shall be accepted as if herein specified.
- p. NCMA TEK 5-8A shall be permitted for the design of fire walls.
- q. The design stress of studs shall be equal to not more than 100 percent of the allowable  $F'_c$  calculated in accordance with Section 2306.

**TABLE 721.1(3)**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS** <sup>a, q</sup>

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
1. Siliceous aggregate concrete	1-1.1	Slab (ceiling not required). Minimum cover over nonprestressed reinforcement shall be not less than $\frac{3}{4}$ " <sup>b</sup> .	7.0	6.2	5.0	3.5	—	—	—	—
2. Carbonate aggregate concrete	2-1.1		6.6	5.7	4.6	3.2	—	—	—	—
3. Sand-light-weight concrete	3-1.1		5.4	4.6	3.8	2.7	—	—	—	—
4. Lightweight concrete	4-1.1		5.1	4.4	3.6	2.5	—	—	—	—
5. Reinforced concrete	5-1.1	Slab with suspended ceiling of vermiculite gypsum plaster over metal lath attached to $\frac{3}{4}$ " cold-rolled channels spaced 12" on center. Ceiling located 6" minimum below joists.	3	2	—	—	1	$\frac{3}{4}$	—	—
	5-2.1	$\frac{5}{8}$ " Type X gypsum wallboard <sup>c</sup> attached to 0.018 inch (No.25 carbon sheet steel gage) by $\frac{7}{8}$ " deep by $2\frac{5}{8}$ " hat-shaped galvanized steel channels with 1"-long No. 6 screws. The channels are spaced 24" on center, span 35" and are supported along their length at 35" intervals by 0.033" (No. 21 galvanized sheet gage) galvanized steel flat strap hangers having formed edges that engage the lips of the channel. The strap hangers are attached to the side of the concrete joists with $\frac{5}{32}$ " by $1\frac{1}{4}$ "-long power-driven fasteners. The wallboard is installed with the long dimension perpendicular to the channels. End joints occur on channels and supplementary channels are installed parallel to the main channels, 12" each side, at end joint occurrences. The finished ceiling is located approximately 12" below the soffit of the floor slab.	—	—	$2\frac{1}{2}$	—	—	—	$\frac{5}{8}$	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
6. Steel joists constructed with a poured reinforced concrete slab on metal lath forms or steel form units. <sup>d, e</sup>	6-1.1	Gypsum plaster on metal lath attached to the bottom cord with single No. 16 gage or doubled No. 18 gage wire ties spaced 6" on center. Plaster mixed 1:2 for scratch coat, 1:3 for brown coat, by weight, gypsum-to-sand aggregate for 2-hour system. For 3-hour system plaster is neat.	—	—	2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>4</sub>	—	—	3 <sup>3</sup> / <sub>4</sub>	5 <sup>5</sup> / <sub>8</sub>
	6-2.1	Vermiculite gypsum plaster on metal lath attached to the bottom chord with single No. 16 gage or doubled 0.049-inch (No. 18 B.W. gage) wire ties 6" on center.	—	2	—	—	—	5 <sup>5</sup> / <sub>8</sub>	—	—
	6-3.1	Cement plaster over metal lath attached to the bottom chord of joists with single No. 16 gage or doubled 0.049" (No. 18 B.W. gage) wire ties spaced 6" on center. Plaster mixed 1:2 for scratch coat, 1:3 for brown coat for 1-hour system and 1:1 for scratch coat, 1:1 <sup>1</sup> / <sub>2</sub> for brown coat for 2-hour system, by weight, cement to sand.	—	—	—	2	—	—	—	5 <sup>5</sup> / <sub>8</sub> <sup>f</sup>
	6-4.1	Ceiling of 5 <sup>5</sup> / <sub>8</sub> " Type X wallboard <sup>c</sup> attached to 7 <sup>7</sup> / <sub>8</sub> " deep by 2 <sup>5</sup> / <sub>8</sub> " by 0.021 inch (No. 25 carbon sheet steel gage) hat-shaped furring channels 12" on center with 1"-long No. 6 wallboard screws at 8" on center. Channels wire tied to bottom chord of joists with doubled 0.049 inch (No. 18 B.W. gage) wire or suspended below joists on wire hangers. <sup>g</sup>	—	—	2 <sup>1</sup> / <sub>2</sub>	—	—	—	5 <sup>5</sup> / <sub>8</sub>	—
	6-5.1	Wood-fibered gypsum plaster mixed 1:1 by weight gypsum to sand aggregate applied over metal lath. Lath tied 6" on center to 3 <sup>3</sup> / <sub>4</sub> " channels spaced 13 <sup>1</sup> / <sub>2</sub> " on center. Channels secured to joists at each intersection with two strands of 0.049 inch (No. 18 B.W. gage) galvanized wire.	—	—	2 <sup>1</sup> / <sub>2</sub>	—	—	—	3 <sup>3</sup> / <sub>4</sub>	—
7. Reinforced concrete slabs and joists with hollow clay tile fillers laid end to end in rows 2 <sup>1</sup> / <sub>2</sub> " or more apart; reinforcement placed between rows and concrete cast around and over tile.	7-1.1	5 <sup>5</sup> / <sub>8</sub> " gypsum plaster on bottom of floor or roof construction.	—	—	8 <sup>h</sup>	—	—	—	5 <sup>5</sup> / <sub>8</sub>	—
	7-1.2	None	—	—	—	5 <sup>1</sup> / <sub>2</sub> <sup>i</sup>	—	—	—	—
8. Steel joists constructed with a reinforced concrete slab on top poured on a 1 <sup>1</sup> / <sub>2</sub> "-deep steel deck. <sup>e</sup>	8-1.1	Vermiculite gypsum plaster on metal lath attached to 3 <sup>3</sup> / <sub>4</sub> " cold-rolled channels with 0.049" (No. 18 B.W. gage) wire ties spaced 6" on center.	2 <sup>1</sup> / <sub>2</sub> <sup>j</sup>	—	—	—	3 <sup>3</sup> / <sub>4</sub>	—	—	—

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
9. 3"-deep cellular steel deck with concrete slab on top. Slab thickness measured to top.	9-1.1	Suspended ceiling of vermiculite gypsum plaster base coat and vermiculite acoustical plaster on metal lath attached at 6" intervals to $\frac{3}{4}$ " cold-rolled channels spaced 12" on center and secured to $1\frac{1}{2}$ " cold-rolled channels spaced 36" on center with 0.065" (No. 16 B.W. gage) wire. $1\frac{1}{2}$ " channels supported by No. 8 gage wire hangers at 36" on center. Beams within envelope and with a $2\frac{1}{2}$ " airspace between beam soffit and lath have a 4-hour rating.	$2\frac{1}{2}$	—	—	—	$1\frac{1}{8}$ <sup>k</sup>	—	—	—
10. $1\frac{1}{2}$ "-deep steel roof deck on steel framing. Insulation board, 30 pcf density, composed of wood fibers with cement binders of thickness shown bonded to deck with unified asphalt adhesive. Covered with a Class A or B roof covering.	10-1.1	Ceiling of gypsum plaster on metal lath. Lath attached to $\frac{3}{4}$ " furring channels with 0.049" (No. 18 B.W. gage) wire ties spaced 6" on center. $\frac{3}{4}$ " channel saddle tied to 2" channels with doubled 0.065" (No. 16 B.W. gage) wire ties. 2" channels spaced 36" on center suspended 2" below steel framing and saddle tied with 0.165" (No. 8 B.W. gage) wire. Plaster mixed 1:2 by weight, gypsum-to-sand aggregate.	—	—	$1\frac{7}{8}$	1	—	—	$\frac{3}{4}$ <sup>1</sup>	$\frac{3}{4}$ <sup>1</sup>
11. $1\frac{1}{2}$ "-deep steel roof deck on steel-framing wood fiber insulation board, 17.5 pcf density on top applied over a 15-lb asphalt-saturated felt. Class A or B roof covering.	11-1.1	Ceiling of gypsum plaster on metal lath. Lath attached to $\frac{3}{4}$ " furring channels with 0.049" (No. 18 B.W. gage) wire ties spaced 6" on center. $\frac{3}{4}$ " channels saddle tied to 2" channels with doubled 0.065" (No. 16 B.W. gage) wire ties. 2" channels spaced 36" on center suspended 2" below steel framing and saddle tied with 0.165" (No. 8 B.W. gage) wire. Plaster mixed 1:2 for scratch coat and 1:3 for brown coat, by weight, gypsum-to-sand aggregate for 1-hour system. For 2-hour system, plaster mix is 1:2 by weight, gypsum-to-sand aggregate.	—	—	$1\frac{1}{2}$	1	—	—	$\frac{7}{8}$ <sup>g</sup>	$\frac{3}{4}$ <sup>1</sup>

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
12. 1½" deep steel roof deck on steel-framing insulation of rigid board consisting of expanded perlite and fibers impregnated with integral asphalt water-proofing; density 9 to 12 pcf secured to metal roof deck by ½"-wide ribbons of waterproof, cold-process liquid adhesive spaced 6" apart. Steel joist or light steel construction with metal roof deck, insulation, and Class A or B built-up roof covering. <sup>e</sup>	12-1.1	Gypsum-vermiculite plaster on metal lath wire tied at 6" intervals to ¾" furring channels spaced 12" on center and wire tied to 2" runner channels spaced 32" on center. Runners wire tied to bottom chord of steel joists.	—	—	1	—	—	—	7/8	—
13. Double wood floor over wood joists spaced 16" on center. <sup>m, n</sup>	13-1.1	Gypsum plaster over 3/8" Type X gypsum lath. Lath initially applied with not less than four 1½" by No. 13 gage by 19/64" head plasterboard blued nails per bearing. Continuous stripping over lath along all joist lines. Stripping consists of 3"-wide strips of metal lath attached by 1½" by No. 11 gage by ½" head roofing nails spaced 6" on center. Alternate stripping consists of 3"-wide 0.049" diameter wire stripping weighing 1 pound per square yard and attached by No. 16 gage by 1½" by 3/4" crown width staples, spaced 4" on center. Where alternate stripping is used, the lath nailing shall consist of two nails at each end and one nail at each intermediate bearing. Plaster mixed 1:2 by weight, gypsum-to-sand aggregate.	—	—	—	—	—	—	—	7/8
	13-1.2	Cement or gypsum plaster on metal lath. Lath fastened with 1½" by No. 11 gage by 7/16" head barbed shank roofing nails spaced 5" on center. Plaster mixed 1:2 for scratch coat and 1:3 for brown coat, by weight, cement to sand aggregate.	—	—	—	—	—	—	—	5/8
	13-1.3	Perlite or vermiculite gypsum plaster on metal lath secured to joists with 1½" by No. 11 gage by 7/16" head barbed shank roofing nails spaced 5" on center.	—	—	—	—	—	—	—	5/8
	13-1.4	½" Type X gypsum wallboard <sup>c</sup> nailed to joists with 5d cooler <sup>o</sup> or wallboard <sup>o</sup> nails at 6" on center. End joints of wallboard centered on joists.	—	—	—	—	—	—	—	1/2

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
14. Plywood stressed skin panels consisting of $\frac{5}{8}$ "-thick interior C-D (exterior glue) top stressed skin on 2" $\times$ 6" nominal (minimum) stringers. Adjacent panel edges joined with 8d common wire nails spaced 6" on center. Stringers spaced 12" maximum on center.	14-1.1	$\frac{1}{2}$ "-thick wood fiberboard weighing 15 to 18 pounds per cubic foot installed with long dimension parallel to stringers or $\frac{3}{8}$ " C-D (exterior glue) plywood glued and/or nailed to stringers. Nailing to be with 5d cooler <sup>o</sup> or wallboard <sup>o</sup> nails at 12" on center. Second layer of $\frac{1}{2}$ " Type X gypsum wallboard <sup>c</sup> applied with long dimension perpendicular to joists and attached with 8d cooler <sup>o</sup> or wallboard <sup>o</sup> nails at 6" on center at end joints and 8" on center elsewhere. Wallboard joints staggered with respect to <i>fiberboard</i> joints.	—	—	—	—	—	—	—	1
15. Vermiculite concrete slab proportioned 1:4 (Portland cement to vermiculite aggregate) on a 1 $\frac{1}{2}$ "-deep steel deck supported on individually protected steel framing. Maximum span of deck 6'-10" where deck is less than 0.019 inch (No. 26 carbon steel sheet gage) or greater. Slab reinforced with 4" $\times$ 8" 0.109/0.083" (No. $\frac{12}{14}$ B.W. gage) welded wire mesh.	15-1.1	None	—	—	—	3 <sup>j</sup>	—	—	—	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
16. Perlite concrete slab proportioned 1:6 (Portland cement to perlite aggregate) on a 1 <sup>1</sup> / <sub>4</sub> "-deep steel deck supported on individually protected steel framing. Slab reinforced with 4" × 8" 0.109/0.083" (No. 12 <sup>1</sup> / <sub>14</sub> B.W. gage) welded wire mesh.	16-1.1	None	—	—	—	3 <sup>1</sup> / <sub>2</sub> <sup>j</sup>	—	—	—	—
17. Perlite concrete slab proportioned 1:6 (Portland cement to perlite aggregate) on a 9 <sup>1</sup> / <sub>16</sub> "-deep steel deck supported by steel joists 4' on center. Class A or B roof covering on top.	17-1.1	Perlite gypsum plaster on metal lath wire tied to 3 <sup>3</sup> / <sub>4</sub> " furring channels attached with 0.065" (No. 16 B.W. gage) wire ties to lower chord of joists.	—	2 <sup>p</sup>	2 <sup>p</sup>	—	—	7 <sup>7</sup> / <sub>8</sub>	3 <sup>3</sup> / <sub>4</sub>	—

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
18. Perlite concrete slab proportioned 1:6 (Portland cement to perlite aggregate) on 1 $\frac{1}{4}$ "-deep steel deck supported on individually protected steel framing. Maximum span of deck 6'-10" where deck is less than 0.019" (No. 26 carbon sheet steel gage) and 8'-0" where deck is 0.019" (No. 26 carbon sheet steel gage) or greater. Slab reinforced with 0.042" (No. 19 B.W. gage) hexagonal wire mesh. Class A or B roof covering on top.	18-1.1	None	—	2 $\frac{1}{4}$ <sup>p</sup>	2 $\frac{1}{4}$ <sup>p</sup>	—	—	—	—	—
19. Floor and beam construction consisting of 3"-deep cellular steel floor unit mounted on steel members with 1:4 (proportion of Portland cement to perlite aggregate) perlite-concrete floor slab on top.	19-1.1	Suspended envelope ceiling of perlite gypsum plaster on metal lath attached to $\frac{3}{4}$ " cold-rolled channels, secured to 1 $\frac{1}{2}$ " cold-rolled channels spaced 42" on center supported by 0.203 inch (No. 6 B.W. gage) wire 36" on center. Beams in envelope with 3" minimum airspace between beam soffit and lath have a 4-hour rating.	2 <sup>p</sup>	—	—	—	1 <sup>l</sup>	—	—	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
20. Perlite concrete proportioned 1:6 (Portland cement to perlite aggregate) poured to $\frac{1}{8}$ " thickness above top of corrugations of $1\frac{5}{16}$ "-deep galvanized steel deck maximum span 8'-0" for 0.024" (No. 24 galvanized sheet gage) or 6'-0" for 0.019" (No. 26 galvanized sheet gage) with deck supported by individually protected steel framing. Approved polystyrene foam plastic insulation board having a flame spread not exceeding 75 (1" to 4" thickness) with vent holes that approximate 3 percent of the board surface area placed on top of perlite slurry. A 2' by 4' insulation board contains six $2\frac{3}{4}$ " diameter holes. Board covered with $2\frac{1}{4}$ " minimum perlite concrete slab. Slab reinforced with mesh consisting of 0.042" (No. 19 B.W. gage) galvanized steel wire twisted together to form 2" hexagons with straight 0.065" (No. 16 B.W. gage) galvanized steel wire woven into mesh and spaced 3". Alternate slab reinforcement shall be permitted to consist of 4" $\times$ 8", 0.109/0.238" (No. 12/4 B.W. gage), or 2" $\times$ 2", 0.083/0.083" (No. 14/14 B.W. gage) welded wire fabric. Class A or B roof covering on top.	20-1.1	None	—	—	Varies	—	—	—	—	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
21. Wood joists, wood I-joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" wood structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with 8 dnails. The wood structural panel thickness shall be not less than nominal 1/2" nor less than required by Chapter 23.	21-1.1	Base layer 5/8" Type X gypsum wallboard applied at right angles to joist or truss 24" o.c. with 1 1/4" Type S or Type W drywall screws 24" o.c. Face layer 5/8" Type X gypsum wallboard or veneer base applied at right angles to joist or truss through base layer with 1 7/8" Type S or Type W drywall screws 12" o.c. at joints and intermediate joist or truss. Face layer Type G drywall screws placed 2" back on either side of face layer end joints, 12" o.c.	—	—	—	Varies	—	—	—	1 1/4
22. Steel joists, floor trusses and flat or pitched roof trusses spaced a maximum 24" o.c. with 1/2" wood structural panels with exterior glue applied at right angles to top of joist or top chord of trusses with No. 8 screws. The wood structural panel thickness shall be not less than nominal 1/2" nor less than required by Chapter 23.	22-1.1	Base layer 5/8" Type X gypsum board applied at right angles to steel framing 24" on center with 1" Type S dry wall screws spaced 24" on center. Face layer 5/8" Type X gypsum board applied at right angles to steel framing attached through base layer with 1 5/8" Type S dry wall screws 12" on center at end joints and intermediate joints and 1 1/2" Type G dry wall screws 12 inches on center placed 2" back on either side of face layer end joints. Joints of the face layer are offset 24" from the joints of the base layer.	—	—	—	Varies	—	—	—	1 1/4
23. Wood I-joist (minimum joist depth 9 1/4" with a minimum flange depth of 1 5/16" and a minimum flange cross-sectional area of 2.25 square inches) at 24" o.c. spacing with a minimum 1 x 4 (3/4" x 3.5" actual) ledger strip applied parallel to and covering the bottom of the bottom flange of each member, tacked in place. 2" mineral wool insulation, 3.5 pcf (nominal) installed adjacent to the bottom flange of the I-joist and supported by the 1 x 4 ledger strip.	23-1.1	1/2"-deep single-leg resilient channel 16" on center (channels doubled at wallboard end joints), placed perpendicular to the furring strip and joist and attached to each joist by 1 7/8" Type S drywall screws. 5/8" Type C gypsum wallboard applied perpendicular to the channel with end joints staggered not less than 4' and fastened with 1 1/8" Type S drywall screws spaced 7" on center. Wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	5/8

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
24. Wood I-joist (minimum I-joist depth 9 <sup>1</sup> / <sub>4</sub> " with a minimum flange depth of 1 <sup>1</sup> / <sub>2</sub> " and a minimum flange cross-sectional area of 5.25 square inches; minimum web thickness of <sup>3</sup> / <sub>8</sub> " @ 24" o.c., 1 <sup>1</sup> / <sub>2</sub> " mineral wool insulation (2.5 pcf-nominal) resting on hat-shaped furring channels.	24-1.1	Minimum 0.026" thick hat-shaped channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 <sup>1</sup> / <sub>4</sub> " Type S drywall screws. <sup>5</sup> / <sub>8</sub> " Type C gypsum wallboard applied perpendicular to the channel with end joints staggered and fastened with 1 <sup>1</sup> / <sub>8</sub> " Type S drywall screws spaced 12" o.c. in the field and 8" o.c. at the wallboard ends. Wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	<sup>5</sup> / <sub>8</sub>
25. Wood I-joist (minimum I-joist depth 9 <sup>1</sup> / <sub>4</sub> " with a minimum flange depth of 1 <sup>1</sup> / <sub>2</sub> " and a minimum flange cross-sectional area of 5.25 square inches; minimum web thickness of <sup>7</sup> / <sub>16</sub> " @ 24" o.c., 1 <sup>1</sup> / <sub>2</sub> " mineral wool insulation (2.5 pcf-nominal) resting on resilient channels.	25-1.1	Minimum 0.019"-thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1 <sup>5</sup> / <sub>8</sub> " Type S drywall screws. <sup>5</sup> / <sub>8</sub> " Type C gypsum wallboard applied perpendicular to the channel with end joints staggered and fastened with 1" Type S drywall screws spaced 12" o.c. in the field and 8" o.c. at the wallboard ends. Wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	<sup>5</sup> / <sub>8</sub>
26. Wood I-joist (minimum I-joist depth 9 <sup>1</sup> / <sub>4</sub> " with a minimum flange thickness of 1 <sup>1</sup> / <sub>2</sub> " and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of <sup>3</sup> / <sub>8</sub> " @ 24" o.c.	26-1.1	Two layers of <sup>1</sup> / <sub>2</sub> " Type X gypsum wallboard applied with the long dimension perpendicular to the I-joists with end joints staggered. The base layer is fastened with 1 <sup>5</sup> / <sub>8</sub> " Type S dry wall screws spaced 12" o.c. and the face layer is fastened with 2" Type S drywall screws spaced 12" o.c. in the field and 8" o.c. on the edges. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with 1 <sup>1</sup> / <sub>2</sub> " Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	1

(continued)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
27. Wood I-joist (minimum I-joist depth 9½" with a minimum flange depth of 1⅝" and a minimum flange cross-sectional area of 1.95 square inches; minimum web thickness of ⅜") @ 24" o.c.	27-1.1	Minimum 0.019" thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1¼" Type S drywall screws. Two layers of ½" Type X gypsum wallboard applied with the long dimension perpendicular to the resilient channels with end joints staggered. The base layer is fastened with 1¼" Type S drywall screws spaced 12" o.c. and the face layer is fastened with 1⅝" Type S drywall screws spaced 12" o.c. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to also be attached to base layer with 1½" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	1
28. Wood I-joist (minimum I-joist depth 9¼" with a minimum flange depth of 1½" and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of ⅜") @ 24" o.c. Unfaced fiberglass insulation or mineral wool insulation is installed between the I-joists supported on the upper surface of the flange by stay wires spaced 12" o.c.	28-1.1	Base layer of ⅝" Type C gypsum wallboard attached directly to I-joists with 1⅝" Type S drywall screws spaced 12" o.c. with ends staggered. Minimum 0.0179"-thick hat-shaped ⅞"-inch furring channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joist and attached to each joist by 1⅝" Type S drywall screws after the base layer of gypsum wallboard has been applied. The middle and face layers of ⅝" Type C gypsum wallboard applied perpendicular to the channel with end joints staggered. The middle layer is fastened with 1" Type S drywall screws spaced 12" o.c. The face layer is applied parallel to the middle layer but with the edge joints offset 24" from those of the middle layer and fastened with 1⅝" Type S drywall screws 8" o.c. The joints shall be taped and covered with joint compound.	—	—	—	Varies	—	—	2¾	—
29. Channel-shaped 18 gage steel joists (minimum depth 8") spaced a maximum 24" o.c. supporting tongue-and-groove wood structural panels (nominal minimum ¾"-thick) applied perpendicular to framing members. Structural panels attached with 1⅝" Type S-12 screws spaced 12" o.c.	29-1.1	Base layer ⅝" Type X gypsum board applied perpendicular to bottom of framing members with 1⅞" Type S-12 screws spaced 12" o.c. Second layer ⅝" Type X gypsum board attached perpendicular to framing members with 1⅝" Type S-12 screws spaced 12" o.c. Second layer joints offset 24" from base layer. Third layer ⅝" Type X gypsum board attached perpendicular to framing members with 2⅜" Type S-12 screws spaced 12" o.c. Third layer joints offset 12" from second layer joints. Hat-shaped ⅞"-inch rigid furring channels applied at right angles to framing members over third layer with two 2⅜" Type S-12 screws at each framing member. Face layer ⅝" Type X gypsum board applied at right angles to furring channels with 1⅞" Type S screws spaced 12" o.c.	—	—	Varies	—	—	—	3⅜	—

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 721.1(3)—continued**  
**MINIMUM PROTECTION FOR FLOOR AND ROOF SYSTEMS<sup>a, q</sup>**

FLOOR OR ROOF CONSTRUCTION	ITEM NUMBER	CEILING CONSTRUCTION	THICKNESS OF FLOOR OR ROOF SLAB (inches)				MINIMUM THICKNESS OF CEILING (inches)			
			4 hours	3 hours	2 hours	1 hour	4 hours	3 hours	2 hours	1 hour
30. Wood I-joist (minimum I-joist depth 9½" with a minimum flange depth of 1½" and a minimum flange cross-sectional area of 2.25 square inches; minimum web thickness of ⅜") @ 24" o.c. Fiber-glass insulation placed between I-joists supported by the resilient channels.	30-1.1	Minimum 0.019"-thick resilient channel 16" o.c. (channels doubled at wallboard end joints), placed perpendicular to the joists and attached to each joist by 1¼" Type S dry wall screws. Two layers of ½" Type X gypsum wallboard applied with the long dimension perpendicular to the resilient channels with end joints staggered. The base layer is fastened with 1¼" Type S drywall screws spaced 12" o.c. and the face layer is fastened with 1⅝" Type S drywall screws spaced 12" o.c. Face layer end joints shall not occur on the same I-joist as base layer end joints and edge joints shall be offset 24" from base layer joints. Face layer to be attached to base layer with 1½" Type G drywall screws spaced 8" o.c. placed 6" from face layer end joints. Face layer wallboard joints to be taped and covered with joint compound.	—	—	—	Varies	—	—	—	1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 0.454 kg, 1 cubic foot = 0.0283 m<sup>3</sup>,

1 pound per square inch = 6.895 kPa, 1 pound per linear foot = 1.4882 kg/m.

- a. Staples with equivalent holding power and penetration shall be permitted to be used as alternate fasteners to nails for attachment to wood framing.
- b. Where the slab is in an unrestrained condition, minimum reinforcement cover shall be not less than 1⅝ inches for 4 hours (siliceous aggregate only); 1¼ inches for 4 and 3 hours; 1 inch for 2 hours (siliceous aggregate only); and ¾ inch for all other restrained and unrestrained conditions.
- c. For all of the construction with gypsum wallboard described in this table, gypsum base for veneer plaster of the same size, thickness and core type shall be permitted to be substituted for gypsum wallboard, provided that attachment is identical to that specified for the wallboard, and the joints on the face layer are reinforced and the entire surface is covered with not less than ⅛-inch gypsum veneer plaster.
- d. Slab thickness over steel joists measured at the joists for metal lath form and at the top of the form for steel form units.
- e. (a) The maximum allowable stress level for H-Series joists shall not exceed 22,000 psi.  
 (b) The allowable stress for K-Series joists shall not exceed 26,000 psi, the nominal depth of such joist shall be not less than 10 inches and the nominal joist weight shall be not less than 5 pounds per linear foot.
- f. Cement plaster with 15 pounds of hydrated lime and 3 pounds of approved additives or admixtures per bag of cement.
- g. Gypsum wallboard ceilings attached to steel framing shall be permitted to be suspended with 1½-inch cold-formed carrying channels spaced 48 inches on center, that are suspended with No. 8 SWG galvanized wire hangers spaced 48 inches on center. Cross-furring channels are tied to the carrying channels with No. 18 SWG galvanized wire hangers spaced 48 inches on center. Cross-furring channels are tied to the carrying channels with No. 18 SWG galvanized wire (double strand) and spaced as required for direct attachment to the framing. This alternative is applicable to those steel framing assemblies recognized under Note q.
- h. Six-inch hollow clay tile with 2-inch concrete slab above.
- i. Four-inch hollow clay tile with 1½-inch concrete slab above.
- j. Thickness measured to bottom of steel form units.
- k. Five-eighths inch of vermiculite gypsum plaster plus ½ inch of approved vermiculite acoustical plastic.
- l. Furring channels spaced 12 inches on center.
- m. Double wood floor shall be permitted to be either of the following:
  - (a) Subfloor of 1-inch nominal boarding, a layer of asbestos paper weighing not less than 14 pounds per 100 square feet and a layer of 1-inch nominal tongue-and-groove finished flooring.
  - (b) Subfloor of 1-inch nominal tongue-and-groove boarding or ⅝-inch wood structural panels with exterior glue and a layer of 1-inch nominal tongue-and-groove finished flooring or ⅝-inch wood structural panel finish flooring or a layer of Type I Grade M-1 particleboard not less than ⅝-inch thick.
- n. The ceiling shall be permitted to be omitted over unusable space, and flooring shall be permitted to be omitted where unusable space occurs above.
- o. For properties of cooler or wallboard nails, see ASTM C514, ASTM C547 or ASTM F1667.
- p. Thickness measured on top of steel deck unit.
- q. Generic fire-resistance ratings (those not designated as PROPRIETARY\* in the listing) in the GA-600 shall be accepted as if herein specified.

## SECTION 722

### CALCULATED FIRE RESISTANCE

**722.1 General.** The provisions of this section contain procedures by which the *fire resistance* of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated *fire resistance* of specific materials or combinations of materials shall be established by one of the following:

1. *Concrete*, concrete *masonry* and clay *masonry* assemblies shall be permitted in accordance with ACI 216.1/TMS 0216.
2. Precast and precast, prestressed *concrete* assemblies shall be permitted in accordance with PCI 124.
3. Steel assemblies shall be permitted in accordance with Chapter 5 of ASCE 29.
4. Exposed wood members and wood decking shall be permitted in accordance with Chapter 16 of ANSI/AWC NDS.

**722.2 Concrete assemblies.** The provisions of this section contain procedures by which the *fire-resistance ratings* of concrete assemblies are established by calculations.

**722.2.1 Concrete walls.** Cast-in-place and precast concrete walls shall comply with Section 722.2.1.1. Multiwythe concrete walls shall comply with Section 722.2.1.2. Joints between precast panels shall comply with Section 722.2.1.3. Concrete walls with *gypsum wallboard* or plaster finish shall comply with Section 722.2.1.4.

**722.2.1.1 Cast-in-place or precast walls.** The minimum equivalent thicknesses of cast-in-place or precast concrete walls for *fire-resistance ratings* of 1 hour to 4 hours are shown in Table 722.2.1.1. For solid walls with flat vertical surfaces, the equivalent thickness is the same as the actual thickness. The values in Table 722.2.1.1 apply to plain, reinforced or prestressed concrete walls.

**TABLE 722.2.1.1**  
**MINIMUM EQUIVALENT THICKNESS OF**  
**CAST-IN-PLACE OR PRECAST CONCRETE WALLS,**  
**LOAD-BEARING OR NONLOAD-BEARING**

CONCRETE TYPE	MINIMUM SLAB THICKNESS (inches) FOR FIRE-RESISTANCE RATING OF				
	1 hour	1½ hours	2 hours	3 hours	4 hours
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

For SI: 1 inch = 25.4 mm.

**722.2.1.1.1 Hollow-core precast wall panels.** For hollow-core precast concrete wall panels in which the cores are of constant cross section throughout the length, calculation of the equivalent thickness by dividing the net cross-sectional area (the gross cross section minus the area of the cores) of the panel by its width shall be permitted

**722.2.1.1.2 Core spaces filled.** Where all of the core spaces of hollow-core wall panels are filled with loose-fill material, such as expanded shale, clay or slag, or vermiculite or perlite, the *fire-resistance rating* of the wall is the same as that of a solid wall of the same concrete type and of the same overall thickness.

**722.2.1.1.3 Tapered cross sections.** The thickness of panels with tapered cross sections shall be that determined at a distance  $2t$  or 6 inches (152 mm), whichever is less, from the point of minimum thickness, where  $t$  is the minimum thickness.

**722.2.1.1.4 Ribbed or undulating surfaces.** The equivalent thickness of panels with ribbed or undulating surfaces shall be determined by one of the following expressions:

For  $s \geq 4t$ , the thickness to be used shall be  $t$

For  $s \leq 2t$ , the thickness to be used shall be  $t_e$

For  $4t > s > 2t$ , the thickness to be used shall be

$$t + \left(\frac{4t}{s} - 1\right)(t_e - t) \quad (\text{Equation 7-3})$$

where:

$s$  = Spacing of ribs or undulations.

$t$  = Minimum thickness.

$t_e$  = Equivalent thickness of the panel calculated as the net cross-sectional area of the panel divided by the width, in which the maximum thickness used in the calculation shall not exceed  $2t$ .

**722.2.1.2 Multiwythe walls.** For walls that consist of two *wythes* of different types of concrete, the *fire-resistance ratings* shall be permitted to be determined from Figure 722.2.1.2.

**722.2.1.2.1 Two or more wythes.** The *fire-resistance rating* for wall panels consisting of two or more *wythes* shall be permitted to be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \dots + R_n^{0.59})^{1.7} \quad (\text{Equation 7-4})$$

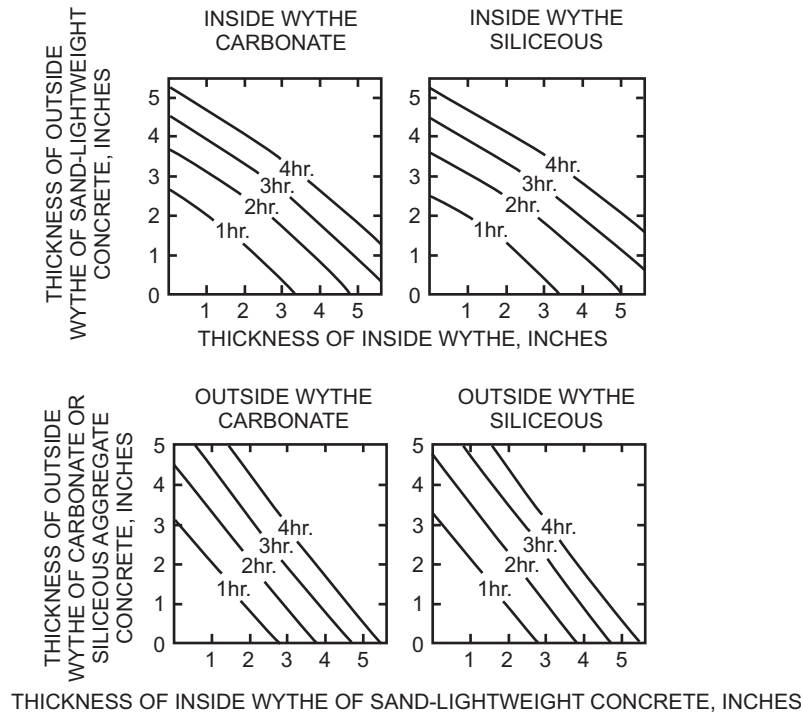
where:

$R$  = The fire endurance of the assembly, minutes.

$R_1$ ,  $R_2$ , and  $R_n$  = The fire endurances of the individual *wythes*, minutes. Values of  $R_n^{0.59}$  for use in Equation 7-4 are given in Table 722.2.1.2(1). Calculated *fire-resistance ratings* are shown in Table 722.2.1.2(2).

**722.2.1.2.2 Foam plastic insulation.** The *fire-resistance ratings* of precast concrete wall panels consisting of a layer of foam plastic insulation sandwiched between two *wythes* of concrete shall be permitted to be determined by use of Equation 7-4. Foam plastic insulation with a total thickness of less than 1 inch (25 mm) shall be disregarded. The  $R_n$  value for thickness of foam plastic insulation of 1 inch (25 mm) or greater, for use in the calculation, is 5 minutes; therefore  $R_n^{0.59} = 2.5$ .

# FIRE AND SMOKE PROTECTION FEATURES



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.1.2**  
**FIRE-RESISTANCE RATINGS OF TWO-WYTHE CONCRETE WALLS**

**TABLE 722.2.1.2(1)**  
**VALUES OF  $R_n^{0.59}$  FOR USE IN EQUATION 7-4**

TYPE OF MATERIAL	THICKNESS OF MATERIAL (inches)											
	1½	2	2½	3	3½	4	4½	5	5½	6	6½	7
Siliceous aggregate concrete	5.3	6.5	8.1	9.5	11.3	13.0	14.9	16.9	18.8	20.7	22.8	25.1
Carbonate aggregate concrete	5.5	7.1	8.9	10.4	12.0	14.0	16.2	18.1	20.3	21.9	24.7	27.2 <sup>c</sup>
Sand-lightweight concrete	6.5	8.2	10.5	12.8	15.5	18.1	20.7	23.3	26.0 <sup>c</sup>	Note c	Note c	Note c
Lightweight concrete	6.6	8.8	11.2	13.7	16.5	19.1	21.9	24.7	27.8 <sup>c</sup>	Note c	Note c	Note c
Insulating concrete <sup>a</sup>	9.3	13.3	16.6	18.3	23.1	26.5 <sup>c</sup>	Note c	Note c	Note c	Note c	Note c	Note c
Airspace <sup>b</sup>	—	—	—	—	—	—	—	—	—	—	—	—

For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 16.02 kg/m<sup>3</sup>.

a. Dry unit weight of 35 pcf or less and consisting of cellular, perlite or vermiculite concrete.

b. The  $R_n^{0.59}$  value for one ½" to 3½" airspace is 3.3. The  $R_n^{0.59}$  value for two ½" to 3½" airspaces is 6.7.

c. The fire-resistance rating for this thickness exceeds 4 hours.

**TABLE 722.2.1.2(2)**  
**FIRE-RESISTANCE RATINGS BASED ON  $R^{0.59}$**

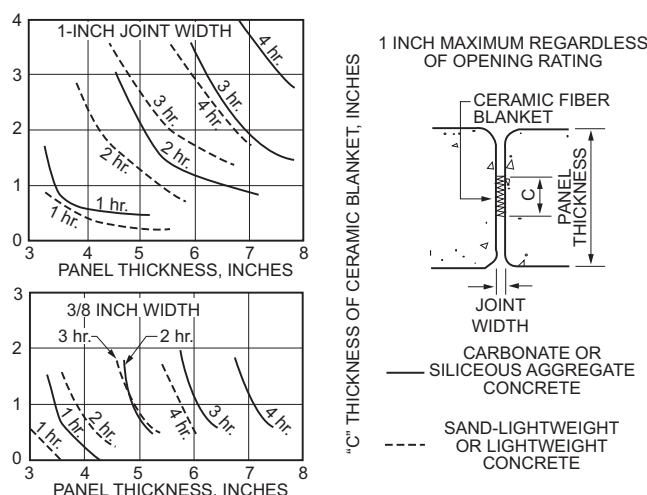
$R^a$ , MINUTES	$R^{0.59}$
60	11.20
120	16.85
180	21.41
240	25.37

a. Based on Equation 7-4.



**722.2.1.3 Joints between precast wall panels.** Joints between precast concrete wall panels that are not insulated as required by this section shall be considered as openings in walls. Uninsulated joints shall be included in determining the percentage of openings permitted by Table 705.8. Where openings are not permitted or are required by this code to be protected, the provisions of this section shall be used to determine the amount of joint insulation required. Insulated joints shall not be considered openings for purposes of determining compliance with the allowable percentage of openings in Table 705.8.

**722.2.1.3.1 Ceramic fiber joint protection.** Figure 722.2.1.3.1 shows thicknesses of *ceramic fiber blankets* to be used to insulate joints between precast concrete wall panels for various panel thicknesses



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.1.3.1  
CERAMIC FIBER JOINT PROTECTION**

and for joint widths of  $\frac{3}{8}$  inch (9.5 mm) and 1 inch (25 mm) for *fire-resistance ratings* of 1 hour to 4 hours. For joint widths between  $\frac{3}{8}$  inch (9.5 mm) and 1 inch (25 mm), the thickness of *ceramic fiber blanket* is allowed to be determined by direct interpolation. Other tested and labeled materials are acceptable in place of *ceramic fiber blankets*.

**722.2.1.4 Walls with gypsum wallboard or plaster finishes.** The *fire-resistance rating* of cast-in-place or precast concrete walls with finishes of *gypsum wallboard* or plaster applied to one or both sides shall be permitted to be calculated in accordance with the provisions of this section.

**722.2.1.4.1 Nonfire-exposed side.** Where the finish of *gypsum wallboard* or plaster is applied to the side of the wall not exposed to fire, the contribution of the finish to the total *fire-resistance rating* shall be determined as follows: The thickness of the finish shall first be corrected by multiplying the actual thickness of the finish by the applicable factor determined from Table 722.2.1.4(1) based on the type of aggregate in the concrete. The corrected thickness of finish shall then be added to the actual or equivalent thickness of concrete and *fire-resistance rating* of the concrete and finish determined from Tables 722.2.1.1 and 722.2.1.2(1) and Figure 722.2.1.2.

**722.2.1.4.2 Fire-exposed side.** Where *gypsum wallboard* or plaster is applied to the fire-exposed side of the wall, the contribution of the finish to the total *fire-resistance rating* shall be determined as follows: The time assigned to the finish as established by Table 722.2.1.4(2) shall be added to the *fire-resistance rating* determined from Tables 722.2.1.1 and 722.2.1.2(1) and Figure 722.2.1.2 for the concrete alone, or to the rating determined in Section 722.2.1.4.1 for the concrete and finish on the nonfire-exposed side.

**TABLE 722.2.1.4(1)  
MULTIPLYING FACTOR FOR FINISHES ON NONFIRE-EXPOSED SIDE OF WALL**

TYPE OF FINISH APPLIED TO CONCRETE OR CONCRETE MASONRY WALL	TYPE OF AGGREGATE USED IN CONCRETE OR CONCRETE MASONRY			
	Concrete: siliceous or carbonate concrete masonry: siliceous or carbonate; solid clay brick	Concrete: sand-lightweight concrete masonry: clay tile; hollow clay brick; concrete masonry units of expanded shale and < 20% sand	Concrete: lightweight concrete masonry: concrete masonry units of expanded shale, expanded clay, expanded slag, or pumice < 20% sand	Concrete masonry: concrete masonry units of expanded slag, expanded clay, or pumice
Portland cement-sand plaster	1.00	0.75 <sup>a</sup>	0.75 <sup>a</sup>	0.50 <sup>a</sup>
Gypsum-sand plaster	1.25	1.00	1.00	1.00
Gypsum-vermiculite or perlite plaster	1.75	1.50	1.25	1.25
Gypsum wallboard	3.00	2.25	2.25	2.25

For SI: 1 inch = 25.4 mm.

a. For Portland cement-sand plaster  $\frac{5}{8}$  inch or less in thickness and applied directly to the concrete or concrete masonry on the nonfire-exposed side of the wall, the multiplying factor shall be 1.00.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.2.1.4(2)**  
**TIME ASSIGNED TO FINISH MATERIALS**  
**ON FIRE-EXPOSED SIDE OF WALL**

FINISH DESCRIPTION	TIME (minutes)
Gypsum wallboard	
$\frac{3}{8}$ inch	10
$\frac{1}{2}$ inch	15
$\frac{5}{8}$ inch	20
2 layers of $\frac{3}{8}$ inch	25
1 layer of $\frac{3}{8}$ inch, 1 layer of $\frac{1}{2}$ inch	35
2 layers of $\frac{1}{2}$ inch	40
Type X gypsum wallboard	
$\frac{1}{2}$ inch	25
$\frac{5}{8}$ inch	40
Portland cement-sand plaster applied directly to concrete masonry	See Note a
Portland cement-sand plaster on metal lath	
$\frac{3}{4}$ inch	20
$\frac{7}{8}$ inch	25
1 inch	30
Gypsum sand plaster on $\frac{3}{8}$ -inch gypsum lath	
$\frac{1}{2}$ inch	35
$\frac{5}{8}$ inch	40
$\frac{3}{4}$ inch	50
Gypsum sand plaster on metal lath	
$\frac{3}{4}$ inch	50
$\frac{7}{8}$ inch	60
1 inch	80

For SI: 1 inch = 25.4 mm.

- a. The actual thickness of Portland cement-sand plaster, provided that it is  $\frac{5}{8}$  inch or less in thickness, shall be permitted to be included in determining the equivalent thickness of the masonry for use in Table 722.3.2.

**722.2.1.4.3 Nonsymmetrical assemblies.** For a wall without finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of Sections 722.2.1.4.1 and 722.2.1.4.2 shall be performed twice, assuming either side of the wall to be the fire-exposed side. The *fire-resistance rating* of the wall shall not exceed the lower of the two values.

**Exception:** For an *exterior* wall with a *fire separation distance* greater than 5 feet (1524 mm) the fire shall be assumed to occur on the interior side only.

**722.2.1.4.4 Minimum concrete fire-resistance rating.** Where finishes applied to one or both sides of a concrete wall contribute to the *fire-resistance rating*, the concrete alone shall provide not less than one-half of the total required *fire-resistance rating*. Additionally, the contribution to the *fire resistance* of the finish on the nonfire-exposed side of a *load-*

*bearing wall* shall not exceed one-half the contribution of the concrete alone.

**722.2.1.4.5 Concrete finishes.** Finishes on concrete walls that are assumed to contribute to the total *fire-resistance rating* of the wall shall comply with the installation requirements of Section 722.3.2.5.

**722.2.2 Concrete floor and roof slabs.** Reinforced and prestressed floors and roofs shall comply with Section 722.2.2.1. Multicourse floors and roofs shall comply with Sections 722.2.2.2 and 722.2.2.3, respectively.

**722.2.2.1 Reinforced and prestressed floors and roofs.** The minimum thicknesses of reinforced and prestressed concrete floor or roof slabs for *fire-resistance ratings* of 1 hour to 4 hours are shown in Table 722.2.2.1.

**Exception:** Minimum thickness shall not be required for floors and *ramps* within parking garages constructed in accordance with Sections 406.5 and 406.6.

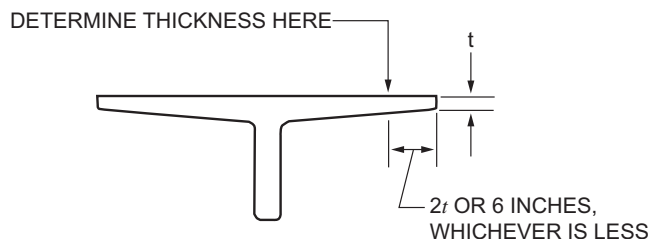
**TABLE 722.2.2.1**  
**MINIMUM SLAB THICKNESS (inches)**

CONCRETE TYPE	FIRE-RESISTANCE RATING (hours)				
	1	1½	2	3	4
Siliceous	3.5	4.3	5	6.2	7
Carbonate	3.2	4	4.6	5.7	6.6
Sand-lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

For SI: 1 inch = 25.4 mm.

**722.2.2.1.1 Hollow-core prestressed slabs.** For hollow-core prestressed concrete slabs in which the cores are of constant cross section throughout the length, the equivalent thickness shall be permitted to be obtained by dividing the net cross-sectional area of the slab including grout in the joints, by its width.

**722.2.2.1.2 Slabs with sloping soffits.** The thickness of slabs with sloping soffits (see Figure 722.2.2.1.2) shall be determined at a distance  $2t$  or 6 inches (152 mm), whichever is less, from the point of minimum thickness, where  $t$  is the minimum thickness.



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.2.1.2**  
**DETERMINATION OF SLAB**  
**THICKNESS FOR SLOPING SOFFITS**

**722.2.2.1.3 Slabs with ribbed soffits.** The thickness of slabs with ribbed or undulating soffits (see Figure 722.2.2.1.3) shall be determined by one of the following expressions, whichever is applicable:

For  $s > 4t$ , the thickness to be used shall be  $t$

For  $s \leq 2t$ , the thickness to be used shall be  $t_e$

For  $4t > s > 2t$ , the thickness to be used shall be

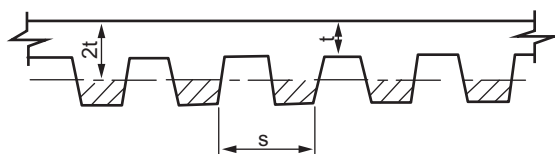
$$t + \left( \frac{4t}{s} - 1 \right) (t_e - t) \quad (\text{Equation 7-5})$$

where:

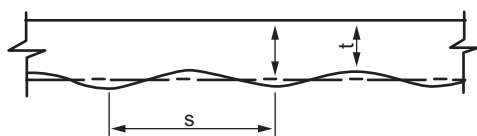
$s$  = Spacing of ribs or undulations.

$t$  = Minimum thickness.

$t_e$  = Equivalent thickness of the slab calculated as the net area of the slab divided by the width, in which the maximum thickness used in the calculation shall not exceed  $2t$ .



NEGLECT SHADED AREA IN CALCULATION OF EQUIVALENT THICKNESS



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.2.1.3**  
**SLABS WITH RIBBED OR UNDULATING SOFFITS**

**722.2.2.1.4 Flat plate concrete slabs with uniformly spaced hollow voids.** Table 722.2.2.1 shall be used to determine the 1- and 2-hour fire-resistance ratings for flat plate concrete slabs with uniformly spaced hollow voids. The equivalent thickness of the slab shall be determined by dividing the net concrete volume of the slab by the floor area. The net concrete volume of the slab shall be equal to the volume of concrete of a solid slab minus the average concrete volume displaced by the hollow voids.

**722.2.2.2 Multicourse floors.** The *fire-resistance ratings* of floors that consist of a base slab of concrete with a topping (overlay) of a different type of concrete shall comply with Figure 722.2.2.2.

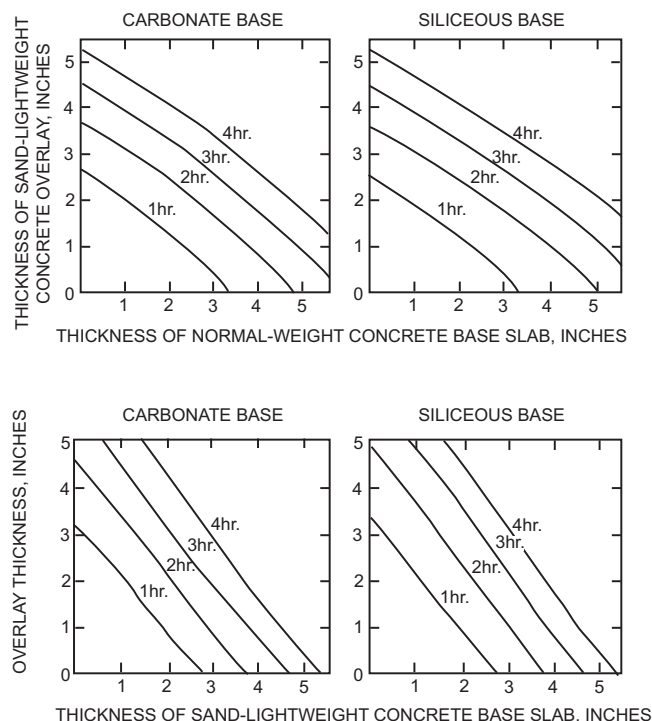
**722.2.2.3 Multicourse roofs.** The *fire-resistance ratings* of roofs that consist of a base slab of concrete with a topping (overlay) of an insulating concrete or with an insulating board and built-up roofing shall comply with Figures 722.2.2.3(1) and 722.2.2.3(2).

**722.2.2.3.1 Heat transfer.** For the transfer of heat, three-ply built-up roofing contributes 10 minutes to the *fire-resistance rating*. The *fire-resistance rating* for concrete assemblies such as those shown in Figure 722.2.2.3(1) shall be increased by 10 minutes. This increase is not applicable to those shown in Figure 722.2.2.3(2).

**722.2.2.4 Joints in precast slabs.** Joints between adjacent precast concrete slabs need not be considered in calculating the slab thickness provided that a concrete topping not less than 1 inch (25 mm) thick is used. Where concrete topping is not used, joints must be grouted to a depth of not less than one-third the slab thickness at the joint, but not less than 1 inch (25 mm), or the joints must be made fire resistant by other *approved* methods.

**722.2.3 Concrete cover over reinforcement.** The minimum thickness of concrete cover over reinforcement in concrete slabs, reinforced beams and prestressed beams shall comply with this section.

**722.2.3.1 Slab cover.** The minimum thickness of concrete cover to the positive moment reinforcement shall comply with Table 722.2.3(1) for reinforced concrete and Table 722.2.3(2) for prestressed concrete. These tables are applicable for solid or hollow-core one-way or two-way slabs with flat undersurfaces.



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.2.2**  
**FIRE-RESISTANCE RATINGS FOR**  
**TWO-COURSE CONCRETE FLOORS**

FIRE AND SMOKE PROTECTION FEATURES

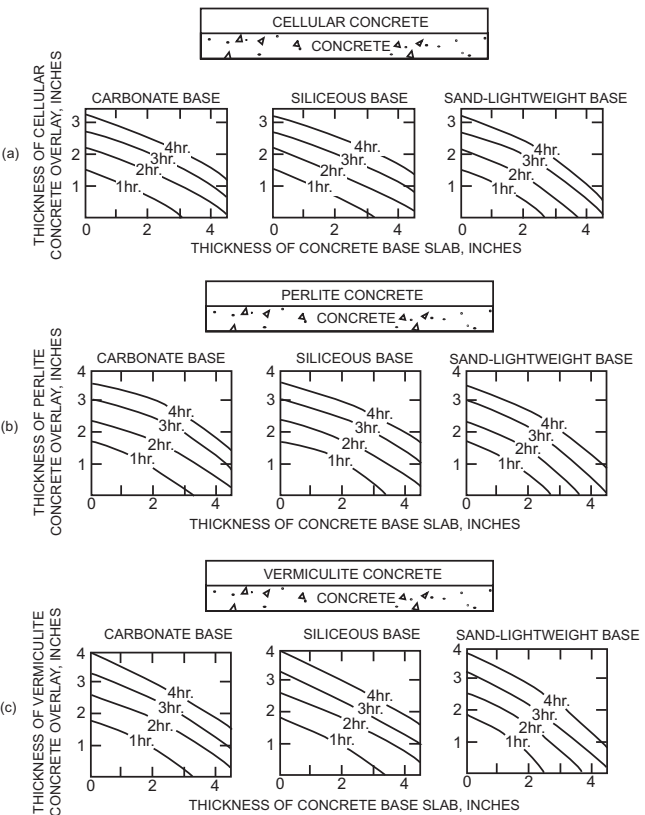
These tables are applicable to slabs that are either cast in place or precast. For precast prestressed concrete not covered elsewhere, the procedures contained in PCI 124 shall be acceptable.

**722.2.3.2 Reinforced beam cover.** The minimum thickness of concrete cover to the positive moment reinforcement (bottom steel) for reinforced concrete beams is shown in Table 722.2.3(3) for *fire-resistance ratings* of 1 hour to 4 hours.

**722.2.3.3 Prestressed beam cover.** The minimum thickness of concrete cover to the positive moment prestressing tendons (bottom steel) for restrained and unrestrained prestressed concrete beams and stemmed units shall comply with the values shown in Tables 722.2.3(4) and 722.2.3(5) for *fire-resistance ratings* of 1 hour to 4 hours. Values in Table 722.2.3(4) apply to beams 8 inches (203 mm) or greater in width. Values in Table 722.2.3(5) apply to beams or stems of any width, provided that the cross-section area is not less than 40 square inches (25 806 mm<sup>2</sup>). In case of differences between the values determined from Table 722.2.3(4) or 722.2.3(5), it is permitted to use the smaller value. The concrete cover shall be calculated in accordance with Section 722.2.3.3.1. The minimum

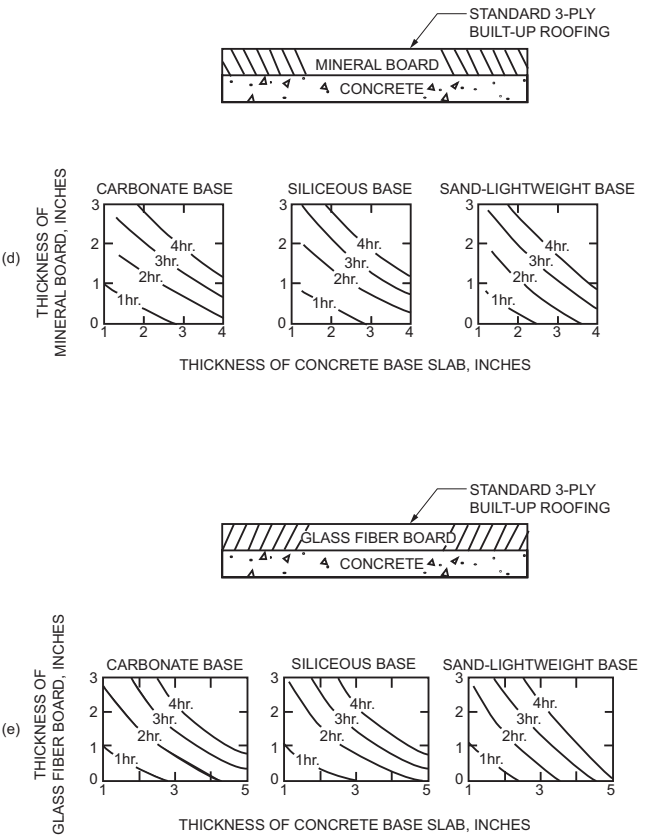
concrete cover for nonprestressed reinforcement in prestressed concrete beams shall comply with Section 722.2.3.2.

**722.2.3.3.1 Calculating concrete cover.** The concrete cover for an individual tendon is the minimum thickness of concrete between the surface of the tendon and the fire-exposed surface of the beam, except that for ungrouted ducts, the assumed cover thickness is the minimum thickness of concrete between the surface of the duct and the fire-exposed surface of the beam. For beams in which two or more tendons are used, the cover is assumed to be the average of the minimum cover of the individual tendons. For corner tendons (tendons equal distance from the bottom and side), the minimum cover used in the calculation shall be one-half the actual value. For stemmed members with two or more prestressing tendons located along the vertical centerline of the stem, the average cover shall be the distance from the bottom of the member to the centroid of the tendons. The actual cover for any individual tendon shall be not less than one-half the smaller value shown in Tables 722.2.3(4) and 722.2.3(5), or 1 inch (25 mm), whichever is greater.



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.2.3(1)  
FIRE-RESISTANCE RATINGS  
FOR CONCRETE ROOF ASSEMBLIES**



For SI: 1 inch = 25.4 mm.

**FIGURE 722.2.2.3(2)  
FIRE-RESISTANCE RATINGS  
FOR CONCRETE ROOF ASSEMBLIES**



## FIRE AND SMOKE PROTECTION FEATURES

**722.2.4 Concrete columns.** Concrete columns shall comply with this section.

**TABLE 722.2.4**  
**MINIMUM DIMENSION OF CONCRETE COLUMNS (inches)**

TYPES OF CONCRETE	FIRE-RESISTANCE RATING (hours)				
	1	1½	2 <sup>a</sup>	3 <sup>a</sup>	4 <sup>b</sup>
Siliceous	8	9	10	12	14
Carbonate	8	9	10	11	12
Sand-lightweight	8	8½	9	10½	12

For SI: 1 inch = 25 mm.

- The minimum dimension is permitted to be reduced to 8 inches for rectangular columns with two parallel sides not less than 36 inches in length.
- The minimum dimension is permitted to be reduced to 10 inches for rectangular columns with two parallel sides not less than 36 inches in length.

**722.2.4.1 Minimum size.** The minimum overall dimensions of reinforced concrete columns for fire-

resistance ratings of 1 hour to 4 hours for exposure to fire on all sides shall comply with this section.

**722.2.4.1.1 Concrete strength less than or equal to 12,000 psi.** For columns made with concrete having a specified compressive strength,  $f'_c$ , of less than or equal to 12,000 psi (82.7 MPa), the minimum dimension shall comply with Table 722.2.4.

**722.2.4.1.2 Concrete strength greater than 12,000 psi.** For columns made with concrete having a specified compressive strength,  $f'_c$ , greater than 12,000 psi (82.7 MPa), for fire-resistance ratings of 1 hour to 4 hours the minimum dimension shall be 24 inches (610 mm).

**722.2.4.2 Minimum cover for R/C columns.** The minimum thickness of concrete cover to the main longitudinal reinforcement in columns, regardless of the type of aggregate used in the concrete and the spec-

**TABLE 722.2.3(1)**  
**COVER THICKNESS FOR REINFORCED CONCRETE FLOOR OR ROOF SLABS (inches)**

CONCRETE AGGREGATE TYPE	FIRE-RESISTANCE RATING (hours)									
	Restrained					Unrestrained				
	1	1½	2	3	4	1	1½	2	3	4
Siliceous	¾	¾	¾	¾	¾	¾	¾	1	1¼	1⅝
Carbonate	¾	¾	¾	¾	¾	¾	¾	¾	1¼	1¼
Sand-lightweight or lightweight	¾	¾	¾	¾	¾	¾	¾	¾	1¼	1¼

For SI: 1 inch = 25.4 mm.

**TABLE 722.2.3(2)**  
**COVER THICKNESS FOR PRESTRESSED CONCRETE FLOOR OR ROOF SLABS (inches)**

CONCRETE AGGREGATE TYPE	FIRE-RESISTANCE RATING (hours)									
	Restrained					Unrestrained				
	1	1½	2	3	4	1	1½	2	3	4
Siliceous	¾	¾	¾	¾	¾	1⅛	1½	1¾	2⅜	2¾
Carbonate	¾	¾	¾	¾	¾	1	1⅜	1⅝	2⅛	2¼
Sand-lightweight or lightweight	¾	¾	¾	¾	¾	1	1⅜	1½	2	2¼

For SI: 1 inch = 25.4 mm.

**TABLE 722.2.3(3)**  
**MINIMUM COVER FOR MAIN REINFORCING BARS OF REINFORCED CONCRETE BEAMS<sup>c</sup>**  
**(APPLICABLE TO ALL TYPES OF STRUCTURAL CONCRETE)**

RESTRAINED OR UNRESTRAINED <sup>a</sup>	BEAM WIDTH <sup>b</sup> (inches)	FIRE-RESISTANCE RATING (hours)				
		1	1½	2	3	4
Restrained	5	¾	¾	¾	1 <sup>a</sup>	1¼ <sup>a</sup>
	7	¾	¾	¾	¾	¾
	≥10	¾	¾	¾	¾	¾
Unrestrained	5	¾	1	1¼	—	—
	7	¾	¾	¾	1¾	3
	≥10	¾	¾	¾	1	1¾

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- Tabulated values for restrained assemblies apply to beams spaced more than 4 feet on center. For restrained beams spaced 4 feet or less on center, minimum cover of ¾ inch is adequate for ratings of 4 hours or less.
- For beam widths between the tabulated values, the minimum cover thickness can be determined by direct interpolation.
- The cover for an individual reinforcing bar is the minimum thickness of concrete between the surface of the bar and the fire-exposed surface of the beam. For beams in which several bars are used, the cover for corner bars used in the calculation shall be reduced to one-half of the actual value. The cover for an individual bar must be not less than one-half of the value given in Table 722.2.3(3) nor less than ¾ inch.

## FIRE AND SMOKE PROTECTION FEATURES

ified compressive strength of concrete,  $f'_c$ , shall be not less than 1 inch (25 mm) times the number of hours of required *fire resistance* or 2 inches (51 mm), whichever is less.

**722.2.4.3 Tie and spiral reinforcement.** For concrete columns made with concrete having a specified compressive strength,  $f'_c$ , greater than 12,000 psi (82.7 MPa), tie and spiral reinforcement shall comply with the following:

1. The free ends of rectangular ties shall terminate with a 135-degree (2.4 rad) standard tie hook.
2. The free ends of circular ties shall terminate with a 90-degree (1.6 rad) standard tie hook.
3. The free ends of spirals, including at lap splices, shall terminate with a 90-degree (1.6 rad) standard tie hook.

The hook extension at the free end of ties and spirals shall be the larger of six bar diameters and the

extension required by Section 25.3.2 of ACI 318. Hooks shall project into the core of the column.

**722.2.4.4 Columns built into walls.** The minimum dimensions of Table 722.2.4 do not apply to a reinforced concrete column that is built into a concrete or masonry wall provided that all of the following are met:

1. The *fire-resistance rating* for the wall is equal to or greater than the required rating of the column.
2. The main longitudinal reinforcing in the column has cover not less than that required by Section 722.2.4.2.
3. Openings in the wall are protected in accordance with Section 716.

Where openings in the wall are not protected as required by Section 716, the minimum dimension of columns required to have a *fire-resistance rating* of 3 hours or less shall be 8 inches (203 mm), and 10 inches

**TABLE 722.2.3(4)**  
**MINIMUM COVER FOR PRESTRESSED CONCRETE BEAMS 8 INCHES OR GREATER IN WIDTH<sup>b</sup>**

RESTRAINED OR UNRESTRAINED <sup>a</sup>	CONCRETE AGGREGATE TYPE	BEAM WIDTH (inches)	FIRE-RESISTANCE RATING (hours)				
			1	1½	2	3	4
Restrained	Carbonate or siliceous	8	1½	1½	1½	1¾ <sup>a</sup>	2½ <sup>a</sup>
	Carbonate or siliceous	≥ 12	1½	1½	1½	1½	1¾ <sup>a</sup>
	Sand lightweight	8	1½	1½	1½	1½	2 <sup>a</sup>
	Sand lightweight	≥ 12	1½	1½	1½	1½	1⅝ <sup>a</sup>
Unrestrained	Carbonate or siliceous	8	1½	1¾	2½	5 <sup>c</sup>	—
	Carbonate or siliceous	≥ 12	1½	1½	1¾ <sup>a</sup>	2½	3
	Sand lightweight	8	1½	1½	2	3¼	—
	Sand lightweight	≥ 12	1½	1½	1⅝	2	2½

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Tabulated values for restrained assemblies apply to beams spaced more than 4 feet on center. For restrained beams spaced 4 feet or less on center, minimum cover of ¾ inch is adequate for 4-hour ratings or less.
- b. For beam widths between 8 inches and 12 inches, minimum cover thickness can be determined by direct interpolation.
- c. Not practical for 8-inch-wide beam but shown for purposes of interpolation.

**TABLE 722.2.3(5)**  
**MINIMUM COVER FOR PRESTRESSED CONCRETE BEAMS OF ALL WIDTHS**

RESTRAINED OR UNRESTRAINED <sup>a</sup>	CONCRETE AGGREGATE TYPE	BEAM AREA <sup>b</sup> A (square inches)	FIRE-RESISTANCE RATING (hours)				
			1	1½	2	3	4
Restrained	All	40 ≤ A ≤ 150	1½	1½	2	2½	—
	Carbonate or siliceous	150 < A ≤ 300	1½	1½	1½	1¾	2½
		300 < A	1½	1½	1½	1½	2
	Sand lightweight	150 < A	1½	1½	1½	1½	2
Unrestrained	All	40 ≤ A ≤ 150	2	2½	—	—	—
	Carbonate or siliceous	150 < A ≤ 300	1½	1¾	2½	—	—
		300 < A	1½	1½	2	3 <sup>c</sup>	4 <sup>c</sup>
	Sand lightweight	150 < A	1½	1½	2	3 <sup>c</sup>	4 <sup>c</sup>

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch = 645.2 mm<sup>2</sup>.

- a. Tabulated values for restrained assemblies apply to beams spaced more than 4 feet on center. For restrained beams spaced 4 feet or less on center, minimum cover of ¾ inch is adequate for 4-hour ratings or less.
- b. The cross-sectional area of a stem is permitted to include a portion of the area in the flange, provided that the width of the flange used in the calculation does not exceed three times the average width of the stem.
- c. U-shaped or hooped stirrups spaced not to exceed the depth of the member and having a minimum cover of 1 inch shall be provided.

(254 mm) for columns required to have a *fire-resistance rating* of 4 hours, regardless of the type of aggregate used in the concrete.

**722.2.4.5 Precast cover units for steel columns.** See Section 722.5.1.4.

**722.3 Concrete masonry.** The provisions of this section contain procedures by which the *fire-resistance ratings* of concrete masonry are established by calculations.

**722.3.1 Equivalent thickness.** The equivalent thickness of concrete masonry construction shall be determined in accordance with the provisions of this section.

**722.3.1.1 Concrete masonry unit plus finishes.** The equivalent thickness of concrete masonry assemblies,  $T_{ea}$ , shall be computed as the sum of the equivalent thickness of the concrete masonry unit,  $T_e$ , as determined by Section 722.3.1.2, 722.3.1.3 or 722.3.1.4, plus the equivalent thickness of finishes,  $T_{ef}$ , determined in accordance with Section 722.3.2:

$$T_{ea} = T_e + T_{ef} \quad (\text{Equation 7-6})$$

**722.3.1.2 UngROUTED or partially grouted construction.**  $T_e$  shall be the value obtained for the concrete masonry unit determined in accordance with ASTM C140.

**722.3.1.3 Solid grouted construction.** The equivalent thickness,  $T_e$ , of solid grouted concrete masonry units is the actual thickness of the unit.

**722.3.1.4 Airspaces and cells filled with loose-fill material.** The equivalent thickness of completely filled hollow concrete masonry is the actual thickness of the unit where loose-fill materials are: sand, pea gravel, crushed stone, or slag that meet ASTM C33 requirements; pumice, scoria, expanded shale, expanded clay, expanded slate, expanded slag, expanded fly ash, or cinders that comply with ASTM C331; or perlite or vermiculite meeting the requirements of ASTM C549 and ASTM C516, respectively.

**722.3.2 Concrete masonry walls.** The *fire-resistance rating* of walls and partitions constructed of concrete masonry units shall be determined from Table 722.3.2. The rating shall be based on the equivalent thickness of the masonry and type of aggregate used.

**722.3.2.1 Finish on nonfire-exposed side.** Where plaster or gypsum wallboard is applied to the side of the wall not exposed to fire, the contribution of the finish to the total *fire-resistance rating* shall be determined as follows: The thickness of gypsum wallboard or plaster shall be corrected by multiplying the actual thickness of the finish by applicable factor determined from Table 722.2.1.4(1). This corrected thickness of finish shall be added to the equivalent thickness of masonry and the *fire-resistance rating* of the masonry and finish determined from Table 722.3.2.

**722.3.2.2 Finish on fire-exposed side.** Where plaster or gypsum wallboard is applied to the fire-exposed side of the wall, the contribution of the finish to the total *fire-resistance rating* shall be determined as follows: The time assigned to the finish as established by Table 722.2.1.4(2) shall be added to the *fire-resistance rating* determined in Section 722.3.2 for the masonry alone, or in Section 722.3.2.1 for the masonry and finish on the nonfire-exposed side.

**722.3.2.3 Nonsymmetrical assemblies.** For a wall without finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of this section shall be performed twice, assuming either side of the wall to be the fire-exposed side. The *fire-resistance rating* of the wall shall not exceed the lower of the two values calculated.

**Exception:** For exterior walls with a *fire separation distance* greater than 5 feet (1524 mm), the fire shall be assumed to occur on the interior side only.

**722.3.2.4 Minimum concrete masonry fire-resistance rating.** Where the finish applied to a concrete masonry wall contributes to its *fire-resistance rating*, the masonry alone shall provide not less than one-half the total required *fire-resistance rating*.

**722.3.2.5 Attachment of finishes.** Installation of finishes shall be as follows:

1. Gypsum wallboard and gypsum lath applied to concrete masonry or concrete walls shall be secured to wood or steel furring members spaced not more than 16 inches (406 mm) on center (o.c.).

**TABLE 722.3.2**  
**MINIMUM EQUIVALENT THICKNESS (inches) OF BEARING OR NONBEARING CONCRETE MASONRY WALLS<sup>a, b, c, d</sup>**

TYPE OF AGGREGATE	FIRE-RESISTANCE RATING (hours)														
	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	3 3/4	4
Pumice or expanded slag	1.5	1.9	2.1	2.5	2.7	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.5	4.7
Expanded shale, clay or slate	1.8	2.2	2.6	2.9	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	4.9	5.1
Limestone, cinders or unexpanded slag	1.9	2.3	2.7	3.1	3.4	3.7	4.0	4.3	4.5	4.8	5.0	5.2	5.5	5.7	5.9
Calcareous or siliceous gravel	2.0	2.4	2.8	3.2	3.6	3.9	4.2	4.5	4.8	5.0	5.3	5.5	5.8	6.0	6.2

For SI: 1 inch = 25.4 mm.

- a. Values between those shown in the table can be determined by direct interpolation.
- b. Where combustible members are framed into the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall be not less than 93 percent of the thickness shown in the table.
- c. Requirements of ASTM C55, ASTM C73, ASTM C90 or ASTM C744 shall apply.
- d. Minimum required equivalent thickness corresponding to the hourly fire-resistance rating for units with a combination of aggregate shall be determined by linear interpolation based on the percent by volume of each aggregate used in manufacture.

## FIRE AND SMOKE PROTECTION FEATURES

2. Gypsum wallboard shall be installed with the long dimension parallel to the furring members and shall have all joints finished.
3. Other aspects of the installation of finishes shall comply with the applicable provisions of Chapters 7 and 25.

**722.3.3 Multiwythe masonry walls.** The *fire-resistance rating* of wall assemblies constructed of multiple wythes of masonry materials shall be permitted to be based on the *fire-resistance rating* period of each wythe and the continuous airspace between each wythe in accordance with the following formula:

$$R_A = (R_1^{0.59} + R_2^{0.59} + \dots + R_n^{0.59} + A_1 + A_2 + \dots + A_n)^{1.7} \quad (\text{Equation 7-7})$$

where:

$R_A$  = Fire-resistance rating of the assembly (hours).

$R_1, R_2, \dots, R_n$  = Fire-resistance rating of wythes for 1, 2,  $n$  (hours), respectively.

$A_1, A_2, \dots, A_n$  = 0.30, factor for each continuous airspace for 1, 2,  $\dots, n$ , respectively, having a depth of  $\frac{1}{2}$  inch (12.7 mm) or more between wythes.

**722.3.4 Concrete masonry lintels.** *Fire-resistance ratings* for concrete masonry lintels shall be determined based on the nominal thickness of the lintel and the minimum thickness of concrete masonry or concrete, or any combination thereof, covering the main reinforcing bars, as determined in accordance with Table 722.3.4, or by *approved* alternate methods.

**TABLE 722.3.4**  
MINIMUM COVER OF LONGITUDINAL  
REINFORCEMENT IN FIRE-RESISTANCE-RATED  
REINFORCED CONCRETE MASONRY LINTELS (inches)

NOMINAL WIDTH OF LINTEL (inches)	FIRE-RESISTANCE RATING (hours)			
	1	2	3	4
6	$1\frac{1}{2}$	2	—	—
8	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	3
10 or greater	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$

For SI: 1 inch = 25.4 mm.

**722.3.5 Concrete masonry columns.** The *fire-resistance rating* of concrete masonry columns shall be determined based on the least plan dimension of the column in accordance with Table 722.3.5 or by *approved* alternate methods.

**TABLE 722.3.5**  
MINIMUM DIMENSION OF CONCRETE  
MASONRY COLUMNS (inches)

FIRE-RESISTANCE RATING (hours)			
1	2	3	4
8 inches	10 inches	12 inches	14 inches

For SI: 1 inch = 25.4 mm.

**722.4 Clay brick and tile masonry.** The provisions of this section contain procedures by which the *fire-resistance*

*ratings* of clay brick and tile masonry are established by calculations.

**722.4.1 Masonry walls.** The *fire-resistance rating* of masonry walls shall be based on the equivalent thickness as calculated in accordance with this section. The calculation shall take into account finishes applied to the wall and airspaces between wythes in multiwythe construction.

**TABLE 722.4.1(3)**  
VALUES OF  $R_n^{0.59}$

$R_n^{0.59}$	$R$ (hours)
1	1.0
2	1.50
3	1.91
4	2.27

**TABLE 722.4.1(4)**  
COEFFICIENTS FOR PLASTER,  $pl^a$

THICKNESS OF PLASTER (inch)	ONE SIDE	TWO SIDES
$\frac{1}{2}$	0.3	0.6
$\frac{5}{8}$	0.37	0.75
$\frac{3}{4}$	0.45	0.90

For SI: 1 inch = 25.4 mm.

a. Values specified in the table are for 1:3 sanded gypsum plaster.

**TABLE 722.4.1(5)**  
REINFORCED MASONRY LINTELS

NOMINAL LINTEL WIDTH (inches)	MINIMUM LONGITUDINAL REINFORCEMENT COVER FOR FIRE RESISTANCE (inches)			
	1 hour	2 hours	3 hours	4 hours
6	$1\frac{1}{2}$	2	NP	NP
8	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$	3
10 or more	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{3}{4}$

For SI: 1 inch = 25.4 mm.

NP = Not Permitted.

**TABLE 722.4.1(6)**  
REINFORCED CLAY MASONRY COLUMNS

COLUMN SIZE	FIRE-RESISTANCE RATING (hours)			
	1	2	3	4
Minimum column dimension (inches)	8	10	12	14

For SI: 1 inch = 25.4 mm.

**722.4.1.1 Equivalent thickness.** The *fire-resistance ratings* of walls or partitions constructed of solid or hollow clay masonry units shall be determined from Table 722.4.1(1) or Table 722.4.1(2). The equivalent thickness of the clay masonry unit shall be determined by Equation 7-8 where using Table 722.4.1(1). The *fire-resistance rating* determined from Table 722.4.1(1) shall be permitted to be used in the calculated *fire-resistance rating* procedure in Section 722.4.2.



## FIRE AND SMOKE PROTECTION FEATURES

$$T_e = V_n / LH \quad (\text{Equation 7-8})$$

where:

$T_e$  = The equivalent thickness of the clay *masonry unit* (inches).

$V_n$  = The net volume of the clay *masonry unit* (inch<sup>3</sup>).

$L$  = The specified length of the clay *masonry unit* (inches).

$H$  = The specified height of the clay *masonry unit* (inches).

**722.4.1.1.1 Hollow clay units.** The equivalent thickness,  $T_e$ , shall be the value obtained for hollow clay units as determined in accordance with Equation 7-8. The net volume,  $V_n$ , of the units shall be determined using the gross volume and percentage of void area determined in accordance with ASTM C67.

**722.4.1.1.2 Solid grouted clay units.** The equivalent thickness of solid grouted clay *masonry units* shall be taken as the actual thickness of the units.

**722.4.1.1.3 Units with filled cores.** The equivalent thickness of the hollow clay *masonry units* is the actual thickness of the unit where completely filled with loose-fill materials of: sand, pea gravel, crushed stone, or slag that meet ASTM C33 requirements; pumice, scoria, expanded shale, expanded clay, expanded slate, expanded slag, expanded fly ash, or cinders in compliance with ASTM C331; or perlite or vermiculite meeting the requirements of ASTM C549 and ASTM C516, respectively.

**722.4.1.2 Plaster finishes.** Where plaster is applied to the wall, the total *fire-resistance rating* shall be determined by the formula:

$$R = (R_n^{0.59} + pl)^{1.7} \quad (\text{Equation 7-9})$$

where:

$R$  = The *fire-resistance rating* of the assembly (hours).

$R_n$  = The *fire-resistance rating* of the individual wall (hours).

$pl$  = Coefficient for thickness of plaster.

**TABLE 722.4.1(1)**  
**FIRE-RESISTANCE PERIODS OF CLAY MASONRY WALLS**

MATERIAL TYPE	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE RESISTANCE <sup>a, b, c</sup> (inches)			
	1 hour	2 hours	3 hours	4 hours
Solid brick of clay or shale <sup>d</sup>	2.7	3.8	4.9	6.0
Hollow brick or tile of clay or shale, unfilled	2.3	3.4	4.3	5.0
Hollow brick or tile of clay or shale, grouted or filled with materials specified in Section 722.4.1.1.3	3.0	4.4	5.5	6.6

For SI: 1 inch = 25.4 mm.

a. Equivalent thickness as determined from Section 722.4.1.1.

b. Calculated fire resistance between the hourly increments specified shall be determined by linear interpolation.

c. Where combustible members are framed in the wall, the thickness of solid material between the end of each member and the opposite face of the wall, or between members set in from opposite sides, shall be not less than 93 percent of the thickness shown.

d. For units in which the net cross-sectional area of cored brick in any plane parallel to the surface containing the cores is not less than 75 percent of the gross cross-sectional area measured in the same plane.

**TABLE 722.4.1(2)**  
**FIRE-RESISTANCE RATINGS FOR BEARING STEEL FRAME BRICK VENEER WALLS OR PARTITIONS**

WALL OR PARTITION ASSEMBLY	PLASTER SIDE EXPOSED (hours)	BRICK FACED SIDE EXPOSED (hours)
Outside facing of steel studs: $\frac{1}{2}$ " wood fiberboard sheathing next to studs, $\frac{3}{4}$ " airspace formed with $\frac{3}{4}$ " $\times$ $1\frac{5}{8}$ " wood strips placed over the fiberboard and secured to the studs; metal or wire lath nailed to such strips, $\frac{3}{4}$ " brick <i>veneer</i> held in place by filling $\frac{3}{4}$ " airspace between the brick and lath with mortar. Inside facing of studs: $\frac{3}{4}$ " unsanded gypsum plaster on metal or wire lath attached to $\frac{5}{16}$ " wood strips secured to edges of the studs.	1.5	4
Outside facing of steel studs: 1" insulation board sheathing attached to studs, 1" airspace, and $\frac{3}{4}$ " brick <i>veneer</i> attached to steel frame with metal ties every 5th course. Inside facing of studs: $\frac{7}{8}$ " sanded gypsum plaster (1:2 mix) applied on metal or wire lath attached directly to the studs.	1.5	4
Same as previous assembly except use $\frac{7}{8}$ " vermiculite-gypsum plaster or 1" sanded gypsum plaster (1:2 mix) applied to metal or wire.	2	4
Outside facing of steel studs: $\frac{1}{2}$ " gypsum sheathing board, attached to studs, and $\frac{3}{4}$ " brick <i>veneer</i> attached to steel frame with metal ties every 5th course. Inside facing of studs: $\frac{1}{2}$ " sanded gypsum plaster (1:2 mix) applied to $\frac{1}{2}$ " perforated gypsum lath securely attached to studs and having strips of metal lath 3 inches wide applied to all horizontal joints of gypsum lath.	2	4

For SI: 1 inch = 25.4 mm.

## FIRE AND SMOKE PROTECTION FEATURES

Values for  $R_n^{0.59}$  for use in Equation 7-9 are given in Table 722.4.1(3). Coefficients for thickness of plaster shall be selected from Table 722.4.1(4) based on the actual thickness of plaster applied to the wall or partition and whether one or two sides of the wall are plastered.

**722.4.1.3 Multiwythe walls with airspace.** Where a continuous airspace separates multiple wythes of the wall or partition, the total *fire-resistance rating* shall be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \dots + R_n^{0.59} + as)^{1.7} \quad (\text{Equation 7-10})$$

where:

$R$  = The *fire-resistance rating* of the assembly (hours).

$R_1, R_2$  and  $R_n$  = The *fire-resistance rating* of the individual wythes (hours).

$as$  = Coefficient for continuous airspace.

Values for  $R_n^{0.59}$  for use in Equation 7-10 are given in Table 722.4.1(3). The coefficient for each continuous airspace of  $\frac{1}{2}$  inch to  $3\frac{1}{2}$  inches (12.7 to 89 mm) separating two individual wythes shall be 0.3.

**722.4.1.4 Nonsymmetrical assemblies.** For a wall without finish on one side or having different types or thicknesses of finish on each side, the calculation procedures of this section shall be performed twice, assuming either side to be the fire-exposed side of the wall. The *fire resistance* of the wall shall not exceed the lower of the two values determined.

**Exception:** For exterior walls with a *fire separation distance* greater than 5 feet (1524 mm), the fire shall be assumed to occur on the interior side only.

**722.4.2 Multiwythe walls.** The *fire-resistance rating* for walls or partitions consisting of two or more dissimilar wythes shall be permitted to be determined by the formula:

$$R = (R_1^{0.59} + R_2^{0.59} + \dots + R_n^{0.59})^{1.7} \quad (\text{Equation 7-11})$$

where:

$R$  = The *fire-resistance rating* of the assembly (hours).

$R_1, R_2$  and  $R_n$  = The *fire-resistance rating* of the individual wythes (hours).

Values for  $R_n^{0.59}$  for use in Equation 7-11 are given in Table 722.4.1(3).

**722.4.2.1 Multiwythe walls of different material.** For walls that consist of two or more wythes of different materials (concrete or concrete masonry units) in combination with clay masonry units, the *fire-resistance rating* of the different materials shall be permitted to be determined from Table 722.2.1.1 for concrete; Table 722.3.2 for concrete masonry units or Table 722.4.1(1) or Table 722.4.1(2) for clay and tile masonry units.

**722.4.3 Reinforced clay masonry lintels.** *Fire-resistance ratings* for clay masonry lintels shall be determined

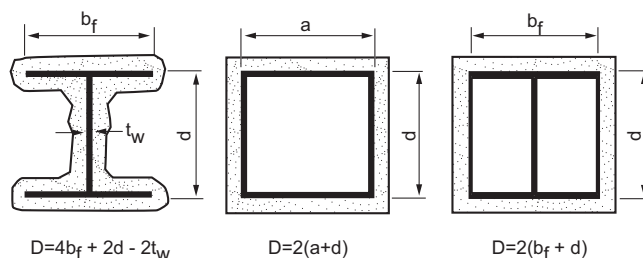
based on the nominal width of the lintel and the minimum covering for the longitudinal reinforcement in accordance with Table 722.4.1(5).

**722.4.4 Reinforced clay masonry columns.** The *fire-resistance ratings* shall be determined based on the last plan dimension of the column in accordance with Table 722.4.1(6). The minimum cover for longitudinal reinforcement shall be 2 inches (51 mm).

**722.5 Steel assemblies.** The provisions of this section contain procedures by which the *fire-resistance ratings* of steel assemblies are established by calculations.

**722.5.1 Structural steel columns.** The *fire-resistance ratings* of structural steel columns shall be based on the size of the element and the type of protection provided in accordance with this section.

**722.5.1.1 General.** These procedures establish a basis for determining the fire resistance of column assemblies as a function of the thickness of fire-resistant material and, the weight,  $W$ , and heated perimeter,  $D$ , of structural steel columns. As used in these sections,  $W$  is the average weight of a structural steel column in pounds per linear foot. The heated perimeter,  $D$ , is the inside perimeter of the fire-resistant material in inches as illustrated in Figure 722.5.1(1).



**FIGURE 722.5.1(1)**  
**DETERMINATION OF THE HEATED PERIMETER OF STRUCTURAL STEEL COLUMNS**

**722.5.1.1.1 Nonload-bearing protection.** The application of these procedures shall be limited to column assemblies in which the fire-resistant material is not designed to carry any of the *load* acting on the column.

**722.5.1.1.2 Embedments.** In the absence of substantiating fire-endurance test results, ducts, conduit, piping, and similar mechanical, electrical, and plumbing installations shall not be embedded in any required fire-resistant materials.

**722.5.1.1.3 Weight-to-perimeter ratio.** Table 722.5.1(1) contains weight-to-heated-perimeter ratios ( $W/D$ ) for both contour and box fire-resistant profiles, for the wide flange shapes most often used as columns. For different fire-resistant protection profiles or column cross sections, the weight-to-heated-perimeter ratios ( $W/D$ ) shall be determined in accordance with the definitions given in this section.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(1)**  
**W/D RATIOS FOR STEEL COLUMNS**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W14 × 233	2.55	3.65
× 211	2.32	3.35
× 193	2.14	3.09
× 176	1.96	2.85
× 159	1.78	2.60
× 145	1.64	2.39
× 132	1.56	2.25
× 120	1.42	2.06
× 109	1.29	1.88
× 99	1.18	1.72
× 90	1.08	1.58
× 82	1.23	1.68
× 74	1.12	1.53
× 68	1.04	1.41
× 61	0.928	1.28
× 53	0.915	1.21
× 48	0.835	1.10
× 43	0.752	0.99
W12 × 190	2.50	3.51
× 170	2.26	3.20
× 152	2.04	2.90
× 136	1.86	2.63
× 120	1.65	2.36
× 106	1.47	2.11
× 96	1.34	1.93
× 87	1.22	1.76
× 79	1.11	1.61
× 72	1.02	1.48
× 65	0.925	1.35
× 58	0.925	1.31
× 53	0.855	1.20
× 50	0.909	1.23
× 45	0.829	1.12
× 40	0.734	1.00
W10 × 112	1.81	2.57
× 100	1.64	2.33
× 88	1.45	2.08
× 77	1.28	1.85
× 68	1.15	1.66
× 60	1.01	1.48
× 54	0.922	1.34
× 49	0.84	1.23
× 45	0.888	1.24
× 39	0.78	1.09
× 33	0.661	0.93

(continued)

**TABLE 722.5.1(1)—continued**  
**W/D RATIOS FOR STEEL COLUMNS**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W8 × 67	1.37	1.94
× 58	1.20	1.71
× 48	1.00	1.44
× 40	0.849	1.23
× 35	0.749	1.08
× 31	0.665	0.97
× 28	0.688	0.96
× 24	0.591	0.83
× 21	0.577	0.77
× 18	0.499	0.67
W6 × 25	0.696	1.00
× 20	0.563	0.82
× 16	0.584	0.78
× 15	0.431	0.63
× 12	0.448	0.60
× 9	0.338	0.46
W5 × 19	0.644	0.93
× 16	0.55	0.80
W4 × 13	0.556	0.79

For SI: 1 pound per linear foot per inch = 0.059 kg/m/mm.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(2)**  
**PROPERTIES OF CONCRETE**

PROPERTY	NORMAL-WEIGHT CONCRETE	STRUCTURAL LIGHTWEIGHT CONCRETE
Thermal conductivity ( $k_c$ )	0.95 Btu/hr × ft × °F	0.35 Btu/hr × ft × °F
Specific heat ( $c_c$ )	0.20 Btu/lb °F	0.20 Btu/lb °F
Density ( $P_c$ )	145 lb/ft <sup>3</sup>	110 lb/ft <sup>3</sup>
Equilibrium (free) moisture content (m) by volume	4%	5%

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 lb/ft<sup>3</sup> = 16.0185 kg/m<sup>3</sup>, Btu/hr × ft × °F = 1.731 W/(m × K).

**TABLE 722.5.1(3)**  
**THERMAL CONDUCTIVITY OF CONCRETE OR CLAY MASONRY UNITS**

DENSITY ( $d_m$ ) OF UNITS (lb/ft <sup>3</sup> )	THERMAL CONDUCTIVITY ( $K$ ) OF UNITS (Btu/hr · ft · °F)
<b>Concrete Masonry Units</b>	
80	0.207
85	0.228
90	0.252
95	0.278
100	0.308
105	0.340
110	0.376
115	0.416
120	0.459
125	0.508
130	0.561
135	0.620
140	0.685
145	0.758
150	0.837
<b>Clay Masonry Units</b>	
120	1.25
130	2.25

For SI: 1 pound per cubic foot = 16.0185 kg/m<sup>3</sup>, Btu/hr × ft × °F = 1.731 W/(m × K)



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(4)**  
**WEIGHT-TO-HEATED-PERIMETER RATIOS (W/D) FOR**  
**TYPICAL WIDE FLANGE BEAM AND GIRDER SHAPES**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W36 × 300	2.50	3.33
× 280	2.35	3.12
× 260	2.18	2.92
× 245	2.08	2.76
× 230	1.95	2.61
× 210	1.96	2.45
× 194	1.81	2.28
× 182	1.72	2.15
× 170	1.60	2.01
× 160	1.51	1.90
× 150	1.43	1.79
× 135	1.29	1.63
W33 × 241	2.13	2.86
× 221	1.97	2.64
× 201	1.79	2.42
× 152	1.53	1.94
× 141	1.43	1.80
× 130	1.32	1.67
× 118	1.21	1.53
W30 × 211	2.01	2.74
× 191	1.85	2.50
× 173	1.66	2.28
× 132	1.47	1.85
× 124	1.39	1.75
× 116	1.30	1.65
× 108	1.21	1.54
× 99	1.12	1.42
W27 × 178	1.87	2.55
× 161	1.70	2.33
× 146	1.55	2.12
× 114	1.39	1.76
× 102	1.24	1.59
× 94	1.15	1.47
× 84	1.03	1.33
W24 × 162	1.88	2.57
× 146	1.70	2.34
× 131	1.54	2.12
× 117	1.38	1.91
× 104	1.24	1.71
× 94	1.28	1.63
× 84	1.15	1.47
× 76	1.05	1.34

(continued)

**TABLE 722.5.1(4)—continued**  
**WEIGHT-TO-HEATED-PERIMETER RATIOS (W/D) FOR**  
**TYPICAL WIDE FLANGE BEAM AND GIRDER SHAPES**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W24 × 68	0.942	1.21
× 62	0.934	1.14
× 55	0.828	1.02
W21 × 147	1.87	2.60
× 132	1.68	2.35
× 122	1.57	2.19
× 111	1.43	2.01
× 101	1.30	1.84
× 93	1.40	1.80
× 83	1.26	1.62
× 73	1.11	1.44
× 68	1.04	1.35
W21 × 62	0.952	1.23
× 57	0.952	1.17
× 50	0.838	1.04
× 44	0.746	0.92
W18 × 119	1.72	2.42
× 106	1.55	2.18
× 97	1.42	2.01
× 86	1.27	1.80
× 76	1.13	1.60
× 71	1.22	1.59
× 65	1.13	1.47
× 60	1.04	1.36
× 55	0.963	1.26
× 50	0.88	1.15
× 46	0.878	1.09
× 40	0.768	0.96
× 35	0.672	0.85
W16 × 100	1.59	2.25
× 89	1.43	2.03
× 77	1.25	1.78
× 67	1.09	1.56
× 57	1.09	1.43
× 50	0.962	1.26
× 45	0.870	1.15
× 40	0.780	1.03
× 36	0.702	0.93
× 31	0.661	0.83
× 26	0.558	0.70
W14 × 132	1.89	3.00
× 120	1.71	2.75
× 109	1.57	2.52

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(4)—continued**  
**WEIGHT-TO-HEATED-PERIMETER RATIOS (W/D) FOR**  
**TYPICAL WIDE FLANGE BEAM AND GIRDER SHAPES**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W14 × 99	1.43	2.31
× 90	1.31	2.11
× 82	1.45	2.12
× 74	1.32	1.93
× 68	1.22	1.78
× 61	1.10	1.61
× 53	1.06	1.48
× 48	0.970	1.35
W14 × 43	0.874	1.22
× 38	0.809	1.09
× 34	0.725	0.98
× 30	0.644	0.87
× 26	0.628	0.79
× 22	0.534	0.68
W12 × 87	1.47	2.34
× 79	1.34	2.14
× 72	1.23	1.97
× 65	1.11	1.79
× 58	1.10	1.69
× 53	1.02	1.55
× 50	1.06	1.54
× 45	0.974	1.40
× 40	0.860	1.25
× 35	0.810	1.11
× 30	0.699	0.96
× 26	0.612	0.84
× 22	0.623	0.77
× 19	0.540	0.67
× 16	0.457	0.57
× 14	0.405	0.50
W10 × 112	2.17	3.38
× 100	1.97	3.07
× 88	1.74	2.75
× 77	1.54	2.45
× 68	1.38	2.20
× 60	1.22	1.97
× 54	1.11	1.79
× 49	1.01	1.64
× 45	1.06	1.59
× 39	0.94	1.40
× 33	0.77	1.20

(continued)

**TABLE 722.5.1(4)—continued**  
**WEIGHT-TO-HEATED-PERIMETER RATIOS (W/D) FOR**  
**TYPICAL WIDE FLANGE BEAM AND GIRDER SHAPES**

STRUCTURAL SHAPE	CONTOUR PROFILE	BOX PROFILE
W10 × 30	0.806	1.12
× 26	0.708	0.98
× 22	0.606	0.84
× 19	0.607	0.78
× 17	0.543	0.70
× 15	0.484	0.63
× 12	0.392	0.51
W8 × 67	1.65	2.55
× 58	1.44	2.26
× 48	1.21	1.91
× 40	1.03	1.63
× 35	0.907	1.44
× 31	0.803	1.29
× 28	0.819	1.24
× 24	0.704	1.07
× 21	0.675	0.96
× 18	0.583	0.84
× 15	0.551	0.74
× 13	0.483	0.65
× 10	0.375	0.51
W6 × 25	0.839	1.33
× 20	0.678	1.09
× 16	0.684	0.96
× 15	0.521	0.83
× 12	0.526	0.75
× 9	0.398	0.57
W5 × 19	0.776	1.24
× 16	0.664	1.07
W4 × 13	0.670	1.05

For SI: 1 pound per linear foot per inch = 0.059 kg/m/mm.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(5)**  
**FIRE RESISTANCE OF CONCRETE**  
**MASONRY PROTECTED STEEL COLUMNS**

COLUMN SIZE	CONCRETE MASONRY DENSITY POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CONCRETE MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours
W14 × 82	80	0.74	1.61	2.36	3.04
	100	0.89	1.85	2.67	3.40
	110	0.96	1.97	2.81	3.57
	120	1.03	2.08	2.95	3.73
W14 × 68	80	0.83	1.70	2.45	3.13
	100	0.99	1.95	2.76	3.49
	110	1.06	2.06	2.91	3.66
	120	1.14	2.18	3.05	3.82
W14 × 53	80	0.91	1.81	2.58	3.27
	100	1.07	2.05	2.88	3.62
	110	1.15	2.17	3.02	3.78
	120	1.22	2.28	3.16	3.94
W14 × 43	80	1.01	1.93	2.71	3.41
	100	1.17	2.17	3.00	3.74
	110	1.25	2.28	3.14	3.90
	120	1.32	2.38	3.27	4.05
W12 × 72	80	0.81	1.66	2.41	3.09
	100	0.91	1.88	2.70	3.43
	110	0.99	1.99	2.84	3.60
	120	1.06	2.10	2.98	3.76
W12 × 58	80	0.88	1.76	2.52	3.21
	100	1.04	2.01	2.83	3.56
	110	1.11	2.12	2.97	3.73
	120	1.19	2.23	3.11	3.89
W12 × 50	80	0.91	1.81	2.58	3.27
	100	1.07	2.05	2.88	3.62
	110	1.15	2.17	3.02	3.78
	120	1.22	2.28	3.16	3.94
W12 × 40	80	1.01	1.94	2.72	3.41
	100	1.17	2.17	3.01	3.75
	110	1.25	2.28	3.14	3.90
	120	1.32	2.39	3.27	4.06
W10 × 68	80	0.72	1.58	2.33	3.01
	100	0.87	1.83	2.65	3.38
	110	0.94	1.95	2.79	3.55
	120	1.01	2.06	2.94	3.72
W10 × 54	80	0.88	1.76	2.53	3.21
	100	1.04	2.01	2.83	3.57
	110	1.11	2.12	2.98	3.73
	120	1.19	2.24	3.12	3.90

(continued)

**TABLE 722.5.1(5)—continued**  
**FIRE RESISTANCE OF CONCRETE**  
**MASONRY PROTECTED STEEL COLUMNS**

COLUMN SIZE	CONCRETE MASONRY DENSITY POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CONCRETE MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours
W10 × 45	80	0.92	1.83	2.60	3.30
	100	1.08	2.07	2.90	3.64
	110	1.16	2.18	3.04	3.80
	120	1.23	2.29	3.18	3.96
W10 × 33	80	1.06	2.00	2.79	3.49
	100	1.22	2.23	3.07	3.80
	110	1.30	2.34	3.20	3.96
	120	1.37	2.44	3.33	4.12
W8 × 40	80	0.94	1.85	2.63	3.33
	100	1.10	2.10	2.93	3.67
	110	1.18	2.21	3.07	3.83
	120	1.25	2.32	3.20	3.99
W8 × 31	80	1.06	2.00	2.78	3.49
	100	1.22	2.23	3.07	3.81
	110	1.29	2.33	3.20	3.97
	120	1.36	2.44	3.33	4.12
W8 × 24	80	1.14	2.09	2.89	3.59
	100	1.29	2.31	3.16	3.90
	110	1.36	2.42	3.28	4.05
	120	1.43	2.52	3.41	4.20
W8 × 18	80	1.22	2.20	3.01	3.72
	100	1.36	2.40	3.25	4.01
	110	1.42	2.50	3.37	4.14
	120	1.48	2.59	3.49	4.28
8 × 8 × 1/2 wall thickness	80	0.77	1.66	2.44	3.13
	100	0.92	1.91	2.75	3.49
	110	1.00	2.02	2.89	3.66
	120	1.07	2.14	3.03	3.82
8 × 8 × 3/8 wall thickness	80	0.91	1.84	2.63	3.33
	100	1.07	2.08	2.92	3.67
	110	1.14	2.19	3.06	3.83
	120	1.21	2.29	3.19	3.98
8 × 8 × 1/4 wall thickness	80	1.10	2.06	2.86	3.57
	100	1.25	2.28	3.13	3.87
	110	1.32	2.38	3.25	4.02
	120	1.39	2.48	3.38	4.17
6 × 6 × 1/2 wall thickness	80	0.82	1.75	2.54	3.25
	100	0.98	1.99	2.84	3.59
	110	1.05	2.10	2.98	3.75
	120	1.12	2.21	3.11	3.91

(continued)

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(5)—continued**  
**FIRE RESISTANCE OF CONCRETE**  
**MASONRY PROTECTED STEEL COLUMNS**

COLUMN SIZE	CONCRETE MASONRY DENSITY POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CONCRETE MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours
$6 \times 6 \times \frac{3}{8}$ wall thickness	80	0.96	1.91	2.71	3.42
	100	1.12	2.14	3.00	3.75
	110	1.19	2.25	3.13	3.90
	120	1.26	2.35	3.26	4.05
$6 \times 6 \times \frac{1}{4}$ wall thickness	80	1.14	2.11	2.92	3.63
	100	1.29	2.32	3.18	3.93
	110	1.36	2.43	3.30	4.08
	120	1.42	2.52	3.43	4.22
$4 \times 4 \times \frac{1}{2}$ wall thickness	80	0.93	1.90	2.71	3.43
	100	1.08	2.13	2.99	3.76
	110	1.16	2.24	3.13	3.91
	120	1.22	2.34	3.26	4.06
$4 \times 4 \times \frac{3}{8}$ wall thickness	80	1.05	2.03	2.84	3.57
	100	1.20	2.25	3.11	3.88
	110	1.27	2.35	3.24	4.02
	120	1.34	2.45	3.37	4.17
$4 \times 4 \times \frac{1}{4}$ wall thickness	80	1.21	2.20	3.01	3.73
	100	1.35	2.40	3.26	4.02
	110	1.41	2.50	3.38	4.16
	120	1.48	2.59	3.50	4.30
6 double extra strong 0.864 wall thickness	80	0.59	1.46	2.23	2.92
	100	0.73	1.71	2.54	3.29
	110	0.80	1.82	2.69	3.47
	120	0.86	1.93	2.83	3.63
6 extra strong 0.432 wall thickness	80	0.94	1.90	2.70	3.42
	100	1.10	2.13	2.98	3.74
	110	1.17	2.22	3.11	3.89
	120	1.24	2.34	3.24	4.04
6 standard 0.280 wall thickness	80	1.14	2.12	2.93	3.64
	100	1.29	2.33	3.19	3.94
	110	1.36	2.43	3.31	4.08
	120	1.42	2.53	3.43	4.22
5 double extra strong 0.750 wall thickness	80	0.70	1.61	2.40	3.12
	100	0.85	1.86	2.71	3.47
	110	0.91	1.97	2.85	3.63
	120	0.98	2.02	2.99	3.79
5 extra strong 0.375 wall thickness	80	1.04	2.01	2.83	3.54
	100	1.19	2.23	3.09	3.85
	110	1.26	2.34	3.22	4.00
	20	1.32	2.44	3.34	4.14

(continued)

**TABLE 722.5.1(5)—continued**  
**FIRE RESISTANCE OF CONCRETE**  
**MASONRY PROTECTED STEEL COLUMNS**

COLUMN SIZE	CONCRETE MASONRY DENSITY POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CONCRETE MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours
5 standard 0.258 wall thickness	80	1.20	2.19	3.00	3.72
	100	1.34	2.39	3.25	4.00
	110	1.41	2.49	3.37	4.14
	120	1.47	2.58	3.49	4.28
4 double extra strong 0.674 wall thickness	80	0.80	1.75	2.56	3.28
	100	0.95	1.99	2.85	3.62
	110	1.02	2.10	2.99	3.78
	120	1.09	2.20	3.12	3.93
4 extra strong 0.337 wall thickness	80	1.12	2.11	2.93	3.65
	100	1.26	2.32	3.19	3.95
	110	1.33	2.42	3.31	4.09
	120	1.40	2.52	3.43	4.23
4 standard 0.237 wall thickness	80	1.26	2.25	3.07	3.79
	100	1.40	2.45	3.31	4.07
	110	1.46	2.55	3.43	4.21
	120	1.53	2.64	3.54	4.34

For SI: 1 inch = 25.4 mm, 1 pound per cubic feet = 16.02 kg/m<sup>3</sup>.**Note:** Tabulated values assume 1-inch air gap between masonry and steel section.



## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(6)**  
**FIRE RESISTANCE OF CLAY MASONRY PROTECTED STEEL COLUMNS**

COLUMN SIZE	CLAY MASONRY DENSITY, POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CLAY MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)				COLUMN SIZE	CLAY MASONRY DENSITY, POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CLAY MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours			1 hour	2 hours	3 hours	4 hours
W14 × 82	120	1.23	2.42	3.41	4.29	W10 × 68	120	1.27	2.46	3.26	4.35
	130	1.40	2.70	3.78	4.74		130	1.44	2.75	3.83	4.80
W14 × 68	120	1.34	2.54	3.54	4.43	W10 × 54	120	1.40	2.61	3.62	4.51
	130	1.51	2.82	3.91	4.87		130	1.58	2.89	3.98	4.95
W14 × 53	120	1.43	2.65	3.65	4.54	W10 × 45	120	1.44	2.66	3.67	4.57
	130	1.61	2.93	4.02	4.98		130	1.62	2.95	4.04	5.01
W14 × 43	120	1.54	2.76	3.77	4.66	W10 × 33	120	1.59	2.82	3.84	4.73
	130	1.72	3.04	4.13	5.09		130	1.77	3.10	4.20	5.13
W12 × 72	120	1.32	2.52	3.51	4.40	W8 × 40	120	1.47	2.70	3.71	4.61
	130	1.50	2.80	3.88	4.84		130	1.65	2.98	4.08	5.04
W12 × 58	120	1.40	2.61	3.61	4.50	W8 × 31	120	1.59	2.82	3.84	4.73
	130	1.57	2.89	3.98	4.94		130	1.77	3.10	4.20	5.17
W12 × 50	120	1.43	2.65	3.66	4.55	W8 × 24	120	1.66	2.90	3.92	4.82
	130	1.61	2.93	4.02	4.99		130	1.84	3.18	4.28	5.25
W12 × 40	120	1.54	2.77	3.78	4.67	W8 × 18	120	1.75	3.00	4.01	4.91
	130	1.72	3.05	4.14	5.10		130	1.93	3.27	4.37	5.34
STEEL TUBING						STEEL PIPE					
NOMINAL TUBE SIZE (inches)	CLAY MASONRY DENSITY, POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CLAY MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)				NOMINAL PIPE SIZE (inches)	CLAY MASONRY DENSITY, POUNDS PER CUBIC FOOT	MINIMUM REQUIRED EQUIVALENT THICKNESS FOR FIRE-RESISTANCE RATING OF CLAY MASONRY PROTECTION ASSEMBLY, $T_e$ (inches)			
		1 hour	2 hours	3 hours	4 hours			1 hour	2 hours	3 hours	4 hours
4 × 4 × 1/2 wall thickness	120	1.44	2.72	3.76	4.68	4 double extra strong 0.674 wall thickness	120	1.26	2.55	3.60	4.52
	130	1.62	3.00	4.12	5.11		130	1.42	2.82	3.96	4.95
4 × 4 × 3/8 wall thickness	120	1.56	2.84	3.88	4.78	4 extra strong 0.337 wall thickness	120	1.60	2.89	3.92	4.83
	130	1.74	3.12	4.23	5.21		130	1.77	3.16	4.28	5.25
4 × 4 × 1/4 wall thickness	120	1.72	2.99	4.02	4.92	4 standard 0.237 wall thickness	120	1.74	3.02	4.05	4.95
	130	1.89	3.26	4.37	5.34		130	1.92	3.29	4.40	5.37
6 × 6 × 1/2 wall thickness	120	1.33	2.58	3.62	4.52	5 double extra strong 0.750 wall thickness	120	1.17	2.44	3.48	4.40
	130	1.50	2.86	3.98	4.96		130	1.33	2.72	3.84	4.83
6 × 6 × 3/8 wall thickness	120	1.48	2.74	3.76	4.67	5 extra strong 0.375 wall thickness	120	1.55	2.82	3.85	4.76
	130	1.65	3.01	4.13	5.10		130	1.72	3.09	4.21	5.18
6 × 6 × 1/4 wall thickness	120	1.66	2.91	3.94	4.84	5 standard 0.258 wall thickness	120	1.71	2.97	4.00	4.90
	130	1.83	3.19	4.30	5.27		130	1.88	3.24	4.35	5.32
8 × 8 × 1/2 wall thickness	120	1.27	2.50	3.52	4.42	6 double extra strong 0.864 wall thickness	120	1.04	2.28	3.32	4.23
	130	1.44	2.78	3.89	4.86		130	1.19	2.60	3.68	4.67
8 × 8 × 3/8 wall thickness	120	1.43	2.67	3.69	4.59	6 extra strong 0.432 wall thickness	120	1.45	2.71	3.75	4.65
	130	1.60	2.95	4.05	5.02		130	1.62	2.99	4.10	5.08
8 × 8 × 1/4 wall thickness	120	1.62	2.87	3.89	4.78	6 standard 0.280 wall thickness	120	1.65	2.91	3.94	4.84
	130	1.79	3.14	4.24	5.21		130	1.82	3.19	4.30	5.27

For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 16.02 kg/m<sup>3</sup>.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(7)**  
**MINIMUM COVER (inch) FOR STEEL COLUMNS**  
**ENCASED IN NORMAL-WEIGHT CONCRETE<sup>a</sup>**  
**[FIGURE 722.5.1(6)(c)]**

STRUCTURAL SHAPE	FIRE-RESISTANCE RATING (hours)				
	1	1½	2	3	4
W14 × 233	1	1	1	1½	2
× 176				2	2½
× 132			2		
× 90				1½	
× 61		3			
× 48					
× 43					
W12 × 152	1	1	1	2	2½
× 96		1½	1½	2½	3
× 65					
× 50					
× 40					
W10 × 88	1	1½	1½	2	3
× 49	1			2½	
× 45					
× 39					
× 33			2		
W8 × 67	1	1	1½	2½	3
× 58		1½	2	3	3½
× 48					
× 31					
× 21					
× 18					
W6 × 25	1	1½	2	3	3½
× 20		2	2½	3½	4
× 16					
× 15					
× 9					
	1½				

For SI: 1 inch = 25.4 mm.

- a. The tabulated thicknesses are based on the assumed properties of normal-weight concrete given in Table 722.5.1(2).

**TABLE 722.5.1(8)**  
**MINIMUM COVER (inch) FOR STEEL COLUMNS**  
**ENCASED IN STRUCTURAL LIGHTWEIGHT CONCRETE<sup>a</sup>**  
**[FIGURE 722.5.1(6)(c)]**

STRUCTURAL SHAPE	FIRE-RESISTANCE RATING (HOURS)				
	1	1½	2	3	4
W14 × 233	1	1	1	1	1½
× 193				1½	
× 74					2½
× 61			2		
× 43				1½	2
W12 × 65	1	1	1	1½	2
× 53			1½	2	2½
× 40					
W10 × 112	1	1	1	1½	2
× 88				2	2½
× 60					
× 33			1½		
W8 × 35	1	1	1½	2	2½
× 28				2½	3
× 24					
× 18		1½			

For SI: 1 inch = 25.4 mm.

- a. The tabulated thicknesses are based on the assumed properties of structural lightweight concrete given in Table 722.5.1(2).

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.5.1(9)**  
**MINIMUM COVER (inch) FOR STEEL COLUMNS**  
**IN NORMAL-WEIGHT PRECAST COVERS<sup>a</sup>**  
**[FIGURE 722.5.1 (6)(a)]**

STRUCTURAL SHAPE	FIRE-RESISTANCE RATING (hours)				
	1	1½	2	3	4
W14 × 233	1½	1½	1½	2½	3
× 211			2	3	3½
× 176					
× 145		2	2½	4	
× 109					
× 99				3½	
× 61					
× 43					4½
W12 × 190	1½	1½	1½	2½	3½
× 152			2	3	4
× 120					
× 96		2	2½	3½	
× 87					
× 58					
× 40					
W10 × 112		1½	1½	2	3
× 88	2			2½	3½
× 77					
× 54			4½		
× 33					
W8 × 67	1½	1½	2	3	4
× 58		2	2½	3½	
× 48					
× 28					4½
× 21		2½	3	4	
× 18					
W6 × 25	1½	2	2½	3½	4½
× 20		2½	3	4	
× 16					
× 12					
× 9	2				5

For SI: 1 inch = 25.4 mm.

- a. The tabulated thicknesses are based on the assumed properties of normal-weight concrete given in Table 722.5.1(2).

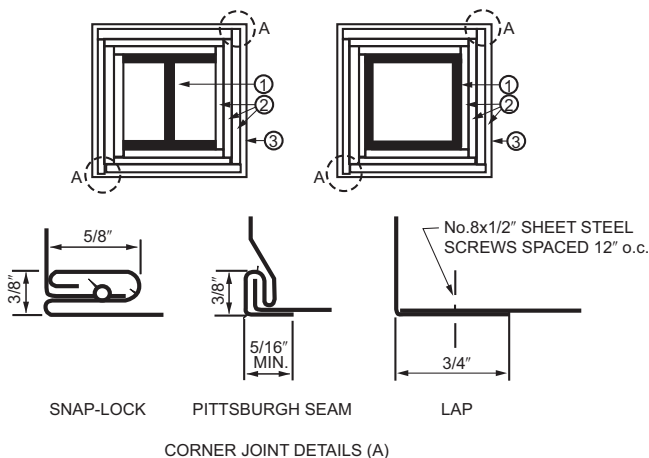
**TABLE 722.5.1(10)**  
**MINIMUM COVER (inch) FOR STEEL COLUMNS**  
**IN STRUCTURAL LIGHTWEIGHT PRECAST COVERS<sup>a</sup>**  
**[FIGURE 722.5.1 (6)(a)]**

STRUCTURAL SHAPE	FIRE-RESISTANCE RATING (hours)					
	1	1½	2	3	4	
W14 × 233	1½	1½	1½	2	2½	
× 176				2½	3	
× 145						
× 132						
× 109						
× 99			2	3½		
× 68						
× 43			3			
W12 × 190	1½	1½	1½	2	2½	
× 152				2½	3	
× 136						
× 106						
× 96						
× 87			2	3½		
× 65						
× 40			3			
W10 × 112	1½	1½	1½	2	3	
× 100				2½		3½
× 88						
× 77						
× 60			2	3½		
× 39						
× 33			2			
W8 × 67			1½	1½	1½	2½
× 48	2	3			3½	
× 35						
× 28						
× 18	2	2½		4		
W6 × 25	1½	2	2	3	3½	
× 15			2½	3½	4	
× 9						

For SI: 1 inch = 25.4 mm.

- a. The tabulated thicknesses are based on the assumed properties of structural lightweight concrete given in Table 722.5.1(2).

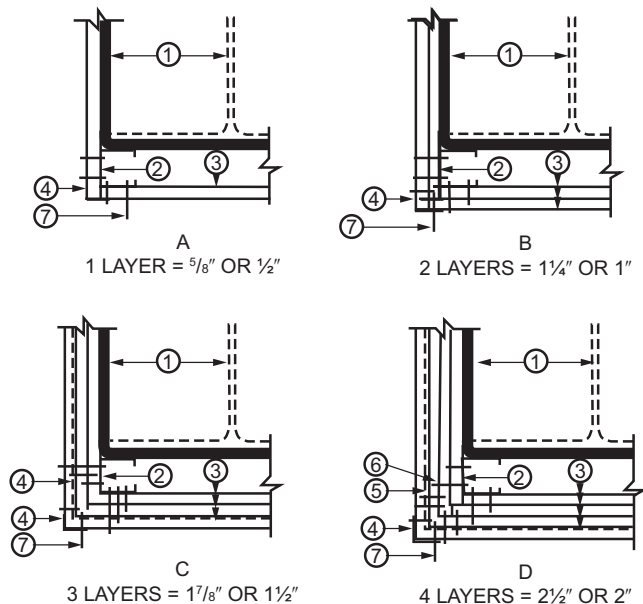
## FIRE AND SMOKE PROTECTION FEATURES



For SI: 1 inch = 25.4 mm, 1 foot = 305 mm.

1. Structural steel column, either wide flange or tubular shapes.
2. Type X gypsum board or gypsum panel products in accordance with ASTM C1177, C1178, C1278, C1396 or C1658. The total thickness of gypsum board or gypsum panel products calculated as  $h$  in Section 722.5.1.2 shall be applied vertically to an individual column using one of the following methods:
  1. As a single layer without horizontal joints.
  2. As multiple layers with horizontal joints not permitted in any layer.
  3. As multiple layers with horizontal joints staggered not less than 12 inches vertically between layers and not less than 8 feet vertically in any single layer. The total required thickness of gypsum board or gypsum panel products shall be determined on the basis of the specified fire-resistance rating and the weight-to-heated-perimeter ratio (W/D) of the column. For fire-resistance ratings of 2 hours or less, one of the required layers of gypsum board or gypsum panel product may be applied to the exterior of the sheet steel column covers with 1-inch long Type S screws spaced 1 inch from the wallboard edge and 8 inches on center. For such installations, 0.0149-inch minimum thickness galvanized steel corner beads with  $1\frac{1}{2}$ -inch legs shall be attached to the wallboard with Type S screws spaced 12 inches on center.
3. For fire-resistance ratings of 3 hours or less, the column covers shall be fabricated from 0.0239-inch minimum thickness galvanized or stainless steel. For 4-hour fire-resistance ratings, the column covers shall be fabricated from 0.0239-inch minimum thickness stainless steel. The column covers shall be erected with the Snap Lock or Pittsburgh joint details. For fire-resistance ratings of 2 hours or less, column covers fabricated from 0.0269-inch minimum thickness galvanized or stainless steel shall be permitted to be erected with lap joints. The lap joints shall be permitted to be located anywhere around the perimeter of the column cover. The lap joints shall be secured with  $\frac{1}{2}$ -inch-long No. 8 sheet metal screws spaced 12 inches on center. The column covers shall be provided with a minimum expansion clearance of  $\frac{1}{8}$  inch per linear foot between the ends of the cover and any restraining construction.

**FIGURE 722.5.1(2)**  
**GYPSUM-PROTECTED STRUCTURAL**  
**STEEL COLUMNS WITH SHEET STEEL COLUMN COVERS**



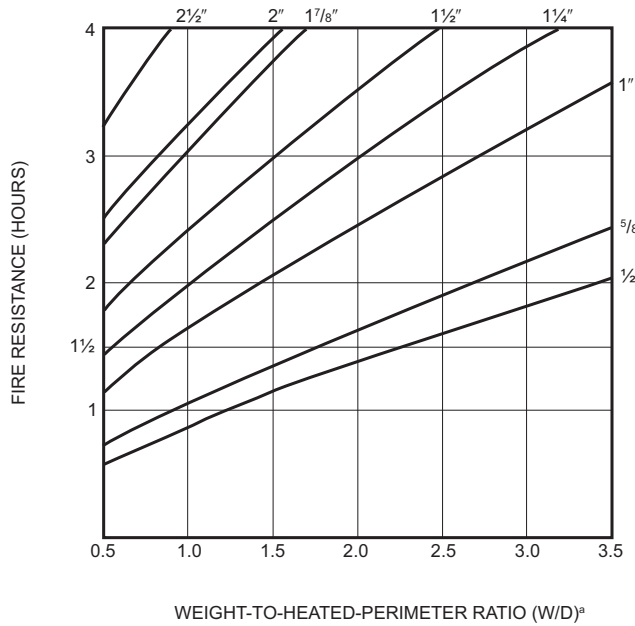
For SI: 1 inch = 25.4 mm, 1 foot = 305 mm.

1. Structural steel column, either wide flange or tubular shapes.
2.  $1\frac{5}{8}$ -inch deep studs fabricated from 0.0179-inch minimum thickness galvanized steel with  $1\frac{5}{16}$  or  $1\frac{7}{16}$ -inch legs. The length of the steel studs shall be  $\frac{1}{2}$  inch less than the height of the assembly.
3. Type X gypsum board or gypsum panel products in accordance with ASTM C1177, C1178, C1278, C1396 or C1658. The total thickness of gypsum board or gypsum panel products calculated as  $h$  in Section 722.5.1.2 shall be applied vertically to an individual column using one of the following methods:
  1. As a single layer without horizontal joints.
  2. As multiple layers with horizontal joints not permitted in any layer.
  3. As multiple layers with horizontal joints staggered not less than 12 inches vertically between layers and not less than 8 feet vertically in any single layer. The total required thickness of gypsum board or gypsum panel products shall be determined on the basis of the specified fire-resistance rating and the weight-to-heated-perimeter ratio (W/D) of the column.
4. Galvanized 0.0149-inch minimum thickness steel corner beads with  $1\frac{1}{2}$ -inch legs attached to the gypsum board or gypsum panel products with 1-inch-long Type S screws spaced 12 inches on center.
5. No. 18 SWG steel tie wires spaced 24 inches on center.
6. Sheet metal angles with 2-inch legs fabricated from 0.0221-inch minimum thickness galvanized steel.
7. Type S screws, 1 inch long, shall be used for attaching the first layer of gypsum board or gypsum panel product to the steel studs and the third layer to the sheet metal angles at 24 inches on center. Type S screws  $1\frac{3}{4}$  inches long shall be used for attaching the second layer of gypsum board or gypsum panel product to the steel studs and the fourth layer to the sheet metal angles at 12 inches on center. Type S screws  $2\frac{1}{4}$  inches long shall be used for attaching the third layer of gypsum board or gypsum panel product to the steel studs at 12 inches on center.

**FIGURE 722.5.1(3)**  
**GYPSUM-PROTECTED STRUCTURAL STEEL COLUMNS**  
**WITH STEEL STUD/SCREW ATTACHMENT SYSTEM**

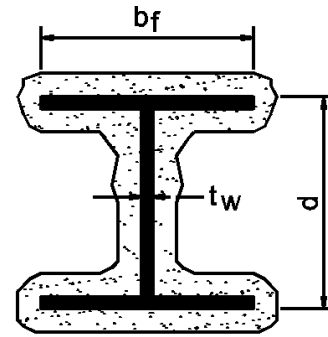


## FIRE AND SMOKE PROTECTION FEATURES



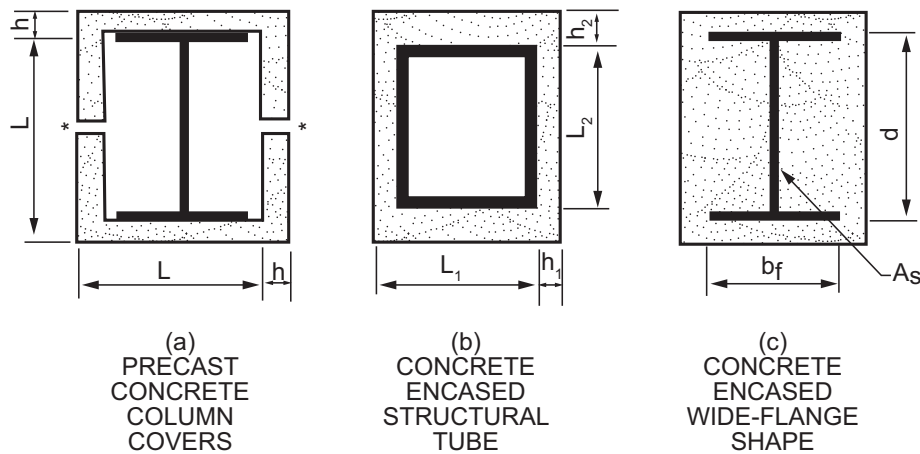
For SI: 1 inch = 25.4 mm, 1 pound per linear foot/inch = 0.059 kg/m/mm.

- a. The W/D ratios for typical wide flange columns are listed in Table 722.5.1(1). For other column shapes, the W/D ratios shall be determined in accordance with Section 722.5.1.1.



**FIGURE 722.5.1(5)**  
**WIDE FLANGE STRUCTURAL STEEL COLUMNS WITH**  
**SPRAYED FIRE-RESISTANT MATERIALS**

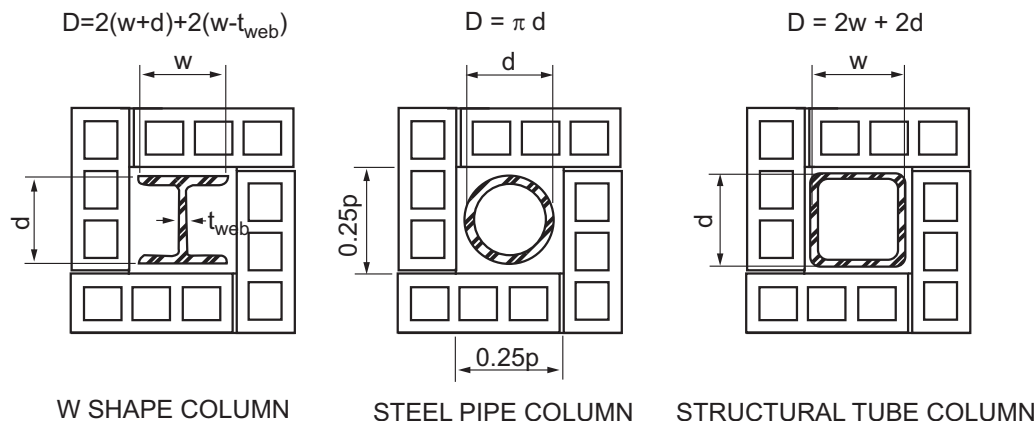
**FIGURE 722.5.1(4)**  
**FIRE RESISTANCE OF STRUCTURAL**  
**STEEL COLUMNS PROTECTED WITH VARIOUS**  
**THICKNESSES OF TYPE X GYPSUM WALLBOARD**



- a. Where the inside perimeter of the concrete protection is not square,  $L$  shall be taken as the average of  $L_1$  and  $L_2$ . Where the thickness of concrete cover is not constant,  $h$  shall be taken of the average of  $h_1$  and  $h_2$ .
- b. Joints shall be protected with not less than a 1-inch thickness of ceramic fiber blanket but in no case less than one-half the thickness of the column cover (see Section 722.2.1.3).

**FIGURE 722.5.1(6)**  
**CONCRETE PROTECTED STRUCTURAL STEEL COLUMNS<sup>a, b</sup>**

## FIRE AND SMOKE PROTECTION FEATURES



For SI: 1 inch = 25.4 mm.

$d$  = Depth of a wide flange column, outside diameter of pipe column, or outside dimension of structural tubing column (inches).

$t_{web}$  = Thickness of web of wide flange column (inches).

$w$  = Width of flange of wide-flange column (inches).

FIGURE 722.5.1(7)  
CONCRETE OR CLAY MASONRY PROTECTED STRUCTURAL STEEL COLUMNS

**722.5.1.2 Gypsum wallboard protection.** The *fire resistance* of structural steel columns with weight-to-heated-perimeter ratios ( $W/D$ ) less than or equal to 3.65 and that are protected with Type X *gypsum wallboard* shall be permitted to be determined from the following expression:

$$R = 130 \left[ \frac{h(W/D)}{2} \right]^{0.75} \quad (\text{Equation 7-12})$$

where:

$R$  = *Fire resistance* (minutes).

$h$  = Total thickness of *gypsum wallboard* (inches).

$D$  = Heated perimeter of the structural steel column (inches).

$W'$  = Total weight of the structural steel column and *gypsum wallboard* protection (pounds per linear foot).

$$W' = W + 50hD/144.$$

**722.5.1.2.1 Attachment.** The *gypsum board* or *gypsum panel products* shall be supported as illustrated in either Figure 722.5.1(2) for *fire-resistance ratings* of 4 hours or less, or Figure 722.5.1(3) for *fire-resistance ratings* of 3 hours or less.

**722.5.1.2.2 Gypsum wallboard equivalent to concrete.** The determination of the *fire resistance* of structural steel columns from Figure 722.5.1(4) is permitted for various thicknesses of *gypsum wallboard* as a function of the weight-to-heated-perimeter ratio ( $W/D$ ) of the column. For structural steel columns with weight-to-heated-perimeter ratios ( $W/D$ ) greater than 3.65, the thickness of *gypsum wallboard* required for specified *fire-resistance ratings* shall be the same as the thickness determined for a W14 × 233 wide flange shape.

**722.5.1.3 Sprayed fire-resistant materials.** The *fire resistance* of wide-flange structural steel columns protected with sprayed fire-resistant materials, as illustrated in Figure 722.5.1(5), shall be permitted to be determined from the following expression:

$$R = [C_1(W/D) + C_2]h \quad (\text{Equation 7-13})$$

where:

$R$  = *Fire resistance* (minutes).

$h$  = Thickness of sprayed fire-resistant material (inches).

$D$  = Heated perimeter of the structural steel column (inches).

$C_1$  and  $C_2$  = Material-dependent constants.

$W$  = Weight of structural steel columns (pounds per linear foot).

The *fire resistance* of structural steel columns protected with intumescent or mastic fire-resistant coatings shall be determined on the basis of *fire-resistance* tests in accordance with Section 703.2.

**722.5.1.3.1 Material-dependent constants.** The material-dependent constants,  $C_1$  and  $C_2$ , shall be determined for specific fire-resistant materials on the basis of standard fire endurance tests in accordance with Section 703.2. Unless evidence is submitted to the *building official* substantiating a broader application, this expression shall be limited to determining the *fire resistance* of structural steel columns with weight-to-heated-perimeter ratios ( $W/D$ ) between the largest and smallest columns for which standard fire-resistance test results are available.

**722.5.1.3.2 Identification.** Sprayed fire-resistant materials shall be identified by density and thickness required for a given *fire-resistance rating*.

**722.5.1.4 Concrete-protected columns.** The *fire resistance* of structural steel columns protected with concrete, as illustrated in Figure 722.5.1(6) illustrations (a) and (b), shall be permitted to be determined from the following expression:

$$R = R_o(1 + 0.03m) \quad (\text{Equation 7-14})$$

where:

$$R_o = 10 (W/D)^{0.7} + 17 (h^{1.6}/k_c^{0.2}) \times [1 + 26 \{H/p_c c_h (L + h)\}^{0.8}]$$

As used in these expressions:

$R$  = Fire endurance at equilibrium moisture conditions (minutes).

$R_o$  = Fire endurance at zero moisture content (minutes).

$m$  = Equilibrium moisture content of the concrete by volume (percent).

$W$  = Average weight of the structural steel column (pounds per linear foot).

$D$  = Heated perimeter of the structural steel column (inches).

$h$  = Thickness of the concrete cover (inches).

$k_c$  = Ambient temperature thermal conductivity of the concrete (Btu/hr ft °F).

$H$  = Ambient temperature thermal capacity of the steel column =  $0.11W$  (Btu/ft °F).

$p_c$  = Concrete density (pounds per cubic foot).

$c_c$  = Ambient temperature specific heat of concrete (Btu/lb °F).

$L$  = Interior dimension of one side of a square concrete box protection (inches).

**722.5.1.4.1 Reentrant space filled.** For wide-flange structural steel columns completely encased in concrete with all reentrant spaces filled Figure 722.5.1(6), illustration (c), the thermal capacity of the concrete within the reentrant spaces shall be permitted to be added to the thermal capacity of the steel column, as follows:

$$H = 0.11 W + (p_c c_c / 144) (b_f d - A_s) \quad (\text{Equation 7-15})$$

where:

$b_f$  = Flange width of the structural steel column (inches).

$d$  = Depth of the structural steel column (inches).

$A_s$  = Cross-sectional area of the steel column (square inches).

**722.5.1.4.2 Concrete properties unknown.** If specific data on the properties of concrete are not available, the values given in Table 722.5.1(2) are permitted.

**722.5.1.4.3 Minimum concrete cover.** For structural steel column encased in concrete with all reentrant spaces filled, Figure 722.5.1(6), illustration

(c) and Tables 722.5.1(7) and 722.5.1(8) indicate the thickness of concrete cover required for various *fire-resistance ratings* for typical wide-flange sections. The thicknesses of concrete indicated in these tables apply to structural steel columns larger than those specified.

**722.5.1.4.4 Minimum precast concrete cover.** For structural steel columns protected with precast concrete column covers as shown in Figure 722.5.1(6), illustration (a), Tables 722.5.1(9) and 722.5.1(10) indicate the thickness of the column covers required for various *fire-resistance ratings* for typical wide-flange shapes. The thicknesses of concrete given in these tables apply to structural steel columns larger than those specified.

**722.5.1.4.5 Masonry protection.** The *fire resistance* of structural steel columns protected with concrete *masonry units* or clay *masonry units* as illustrated in Figure 722.5.1(7) shall be permitted to be determined from the following expression:

$$R = 0.17 (W/D)^{0.7} + [0.285 (T_e^{1.6}/K^{0.2})] [1.0 + 42.7 \{(A_s/d_m T_e)/(0.25p + T_e)\}^{0.8}]$$

(Equation 7-16)

where:

$R$  = *Fire-resistance rating* of column assembly (hours).

$W$  = Average weight of structural steel column (pounds per foot).

$D$  = Heated perimeter of structural steel column (inches) [see Figure 722.5.1(7)].

$T_e$  = Equivalent thickness of concrete or clay *masonry unit* (inches) (see Table 722.3.2, Note a or Section 722.4.1).

$K$  = Thermal conductivity of concrete or clay *masonry unit* (Btu/hr × ft × °F) [see Table 722.5.1(3)].

$A_s$  = Cross-sectional area of structural steel column (square inches).

$d_m$  = Density of the concrete or clay *masonry unit* (pounds per cubic foot).

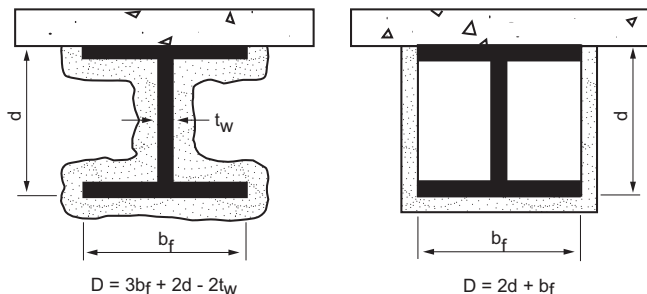
$p$  = Inner perimeter of concrete or clay masonry protection (inches) [see Figure 722.5.1(7)].

**722.5.1.4.6 Equivalent concrete masonry thickness.** For structural steel columns protected with concrete masonry, Table 722.5.1(5) gives the equivalent thickness of concrete masonry required for various *fire-resistance ratings* for typical column shapes. For structural steel columns protected with clay masonry, Table 722.5.1(6) gives the equivalent thickness of concrete masonry required for various *fire-resistance ratings* for typical column shapes.

**722.5.2 Structural steel beams and girders.** The *fire-resistance ratings* of structural steel beams and girders shall be based on the size of the element and the type of protection provided in accordance with this section.

## FIRE AND SMOKE PROTECTION FEATURES

**722.5.2.1 Determination of fire resistance.** These procedures establish a basis for determining resistance of structural steel beams and girders that differ in size from that specified in *approved* fire-resistance-rated assemblies as a function of the thickness of fire-resistant material and the weight ( $W$ ) and heated perimeter ( $D$ ) of the beam or girder. As used in these sections,  $W$  is the average weight of a *structural steel element* in pounds per linear foot (plf). The heated perimeter,  $D$ , is the inside perimeter of the fire-resistant material in inches as illustrated in Figure 722.5.2.



**FIGURE 722.5.2**  
**DETERMINATION OF THE HEATED PERIMETER OF**  
**STRUCTURAL STEEL BEAMS AND GIRDERS**

**722.5.2.1.1 Weight-to-heated perimeter.** The weight-to-heated-perimeter ratios ( $W/D$ ), for both contour and box fire-resistant protection profiles, for the wide flange shapes most often used as beams or girders are given in Table 722.5.1(4). For different shapes, the weight-to-heated-perimeter ratios ( $W/D$ ) shall be determined in accordance with the definitions given in this section.

**722.5.2.1.2 Beam and girder substitutions.** Except as provided for in Section 722.5.2.2, structural steel beams in *approved* fire-resistance-rated assemblies shall be considered to be the minimum permissible size. Other beam or girder shapes shall be permitted to be substituted provided that the weight-to-heated-perimeter ratio ( $W/D$ ) of the substitute beam is equal to or greater than that of the beam specified in the *approved* assembly.

**722.5.2.2 Sprayed fire-resistant materials.** The provisions in this section apply to structural steel beams and girders protected with sprayed fire-resistant materials. Larger or smaller beam and girder shapes shall be permitted to be substituted for beams specified in *approved* unrestrained or restrained fire-resistance-rated assemblies, provided that the thickness of the fire-resistant material is adjusted in accordance with the following expression:

$$h_2 = h_1 [(W_1 / D_1) + 0.60] / [(W_2 / D_2) + 0.60]$$

(Equation 7-17)

where:

$h$  = Thickness of sprayed fire-resistant material in inches.

$W$  = Weight of the structural steel beam or girder in pounds per linear foot.

$D$  = Heated perimeter of the structural steel beam in inches.

Subscript 1 refers to the beam and fire-resistant material thickness in the *approved* assembly.

Subscript 2 refers to the substitute beam or girder and the required thickness of fire-resistant material.

The *fire resistance* of structural steel beams and girders protected with intumescent or mastic fire-resistant coatings shall be determined on the basis of fire-resistance tests in accordance with Section 703.2.

**722.5.2.2.1 Minimum thickness.** The use of Equation 7-17 is subject to the following conditions:

1. The weight-to-heated-perimeter ratio for the substitute beam or girder ( $W_2/D_2$ ) shall be not less than 0.37.
2. The thickness of fire protection materials calculated for the substitute beam or girder ( $T_1$ ) shall be not less than  $\frac{3}{8}$  inch (9.5 mm).
3. The unrestrained or restrained beam rating shall be not less than 1 hour.
4. Where used to adjust the material thickness for a restrained beam, the use of this procedure is limited to structural steel sections classified as compact in accordance with AISC 360.

**722.5.2.3 Structural steel trusses.** The *fire resistance* of structural steel trusses protected with fire-resistant materials sprayed to each of the individual truss elements shall be permitted to be determined in accordance with this section. The thickness of the fire-resistant material shall be determined in accordance with Section 722.5.1.3. The weight-to-heated-perimeter ratio ( $W/D$ ) of truss elements that can be simultaneously exposed to fire on all sides shall be determined on the same basis as columns, as specified in Section 722.5.1.1. The weight-to-heated-perimeter ratio ( $W/D$ ) of truss elements that directly support floor or roof assembly shall be determined on the same basis as beams and girders, as specified in Section 722.5.2.1.

The *fire resistance* of structural steel trusses protected with intumescent or mastic fire-resistant coatings shall be determined on the basis of *fire resistance* tests in accordance with Section 703.2.

**722.6 Wood assemblies.** The provisions of this section contain procedures by which the *fire-resistance ratings* of wood assemblies are established by calculations.

**722.6.1 General.** This section contains procedures for calculating the *fire-resistance ratings* of walls, floor/ceiling and roof/ceiling assemblies based in part on the standard method of testing referenced in Section 703.2.

**722.6.1.1 Maximum fire-resistance rating.** *Fire-resistance ratings* calculated for assemblies using the



## FIRE AND SMOKE PROTECTION FEATURES

methods in Section 722.6 shall be limited to not more than 1 hour.

**722.6.1.2 Dissimilar membranes.** Where dissimilar membranes are used on a wall assembly that requires consideration of fire exposure from both sides, the calculation shall be made from the least fire-resistant (weaker) side.

**722.6.2 Walls, floors and roofs.** These procedures apply to both load-bearing and nonload-bearing assemblies.

**722.6.2.1 Fire-resistance rating of wood frame assemblies.** The *fire-resistance rating* of a wood frame assembly is equal to the sum of the time assigned to the membrane on the fire-exposed side, the time assigned to the framing members and the time assigned for additional contribution by other protective measures such as insulation. The membrane on the unexposed side shall not be included in determining the *fire resistance* of the assembly.

**722.6.2.2 Time assigned to membranes.** Table 722.6.2(1) indicates the time assigned to membranes on the fire-exposed side.

**722.6.2.3 Exterior walls.** For an *exterior wall* with a *fire separation distance* greater than 10 feet (3048 mm), the wall is assigned a rating dependent on the

interior membrane and the framing as described in Table 722.6.2(1) and Table 722.6.2(2). The membrane on the outside of the nonfire-exposed side of *exterior walls* with a *fire separation distance* greater than 10 feet (3048 mm) shall consist of sheathing, sheathing paper and siding as described in Table 722.6.2(3).

**722.6.2.4 Floors and roofs.** In the case of a floor or roof, the standard test provides only for testing for fire exposure from below. Except as noted in Section 703.2.3, floor or roof assemblies of wood framing shall have an upper membrane consisting of a subfloor and finished floor conforming to Table 722.6.2(4) or any other membrane that has a contribution to *fire resistance* of not less than 15 minutes in Table 722.6.2(1).

**722.6.2.5 Additional protection.** Table 722.6.2(5) indicates the time increments to be added to the *fire resistance* where glass fiber, rockwool, slag *mineral wool* or cellulose insulation is incorporated in the assembly.

**722.6.2.6 Fastening.** Fastening of wood frame assemblies and the fastening of membranes to the wood framing members shall be done in accordance with Chapter 23.

**TABLE 722.6.2(1)**  
**TIME ASSIGNED TO WALLBOARD MEMBRANES<sup>a, b, c, d</sup>**

DESCRIPTION OF FINISH	TIME <sup>e</sup> (minutes)
$\frac{3}{8}$ -inch wood structural panel bonded with exterior glue	5
$\frac{15}{32}$ -inch wood structural panel bonded with exterior glue	10
$\frac{19}{32}$ -inch wood structural panel bonded with exterior glue	15
$\frac{3}{8}$ -inch gypsum wallboard	10
$\frac{1}{2}$ -inch gypsum wallboard	15
$\frac{5}{8}$ -inch gypsum wallboard	30
$\frac{1}{2}$ -inch Type X gypsum wallboard	25
$\frac{5}{8}$ -inch Type X gypsum wallboard	40
Double $\frac{3}{8}$ -inch gypsum wallboard	25
$\frac{1}{2}$ -inch + $\frac{3}{8}$ -inch gypsum wallboard	35
Double $\frac{1}{2}$ -inch gypsum wallboard	40

For SI: 1 inch = 25.4 mm.

- These values apply only where membranes are installed on framing members that are spaced 16 inches o.c. or less.
- Gypsum wallboard installed over framing or furring shall be installed so that all edges are supported, except  $\frac{3}{8}$ -inch Type X gypsum wallboard shall be permitted to be installed horizontally with the horizontal joints staggered 24 inches each side and unsupported but finished.
- On wood frame floor/ceiling or roof/ceiling assemblies, gypsum board shall be installed with the long dimension perpendicular to framing members and shall have all joints finished.
- The membrane on the unexposed side shall not be included in determining the fire resistance of the assembly. Where dissimilar membranes are used on a wall assembly, the calculation shall be made from the least fire-resistant (weaker) side.
- The time assigned is not a finished rating.

**TABLE 722.6.2(2)**  
**TIME ASSIGNED FOR CONTRIBUTION OF WOOD FRAME<sup>a, b, c</sup>**

DESCRIPTION	TIME ASSIGNED TO FRAME (minutes)
Wood studs 16 inches o.c.	20
Wood floor and roof joists 16 inches o.c.	10

For SI: 1 inch = 25.4 mm.

- This table does not apply to studs or joists spaced more than 16 inches o.c.
- All studs shall be nominal  $2 \times 4$  and all joists shall have a nominal thickness of not less than 2 inches.
- Allowable spans for joists shall be determined in accordance with Sections 2308.4.2.1, 2308.7.1 and 2308.7.2.

## FIRE AND SMOKE PROTECTION FEATURES

**TABLE 722.6.2(3)**  
**MEMBRANE<sup>a</sup> ON EXTERIOR FACE OF WOOD STUD WALLS**

SHEATHING	PAPER	EXTERIOR FINISH
$\frac{5}{8}$ -inch T & G lumber $\frac{5}{16}$ -inch exterior glue wood structural panel $\frac{1}{2}$ -inch gypsum wallboard $\frac{5}{8}$ -inch gypsum wallboard $\frac{1}{2}$ -inch fiberboard	Sheathing paper	Lumber siding Wood shingles and shakes $\frac{1}{4}$ -inch fiber-cement lap, panel or shingle siding $\frac{1}{4}$ -inch wood structural panels-exterior type $\frac{1}{4}$ -inch hardboard Metal siding Stucco on metal lath Masonry veneer Vinyl siding
None	—	$\frac{3}{8}$ -inch exterior-grade wood structural panels

For SI: 1 inch = 25.4 mm.

a. Any combination of sheathing, paper and exterior finish is permitted.

**TABLE 722.6.2(4)**  
**FLOORING OR ROOFING OVER WOOD FRAMING<sup>a</sup>**

ASSEMBLY	STRUCTURAL MEMBERS	SUBFLOOR OR ROOF DECK	FINISHED FLOORING OR ROOFING
Floor	Wood	$\frac{15}{32}$ -inch wood structural panels or $\frac{11}{16}$ -inch T & G softwood	Hardwood or softwood flooring on building paper; resilient flooring; parquet floor; felted-synthetic fiber floor coverings, carpeting, or ceramic tile on $\frac{1}{4}$ -inch-thick fiber-cement underlayment or $\frac{3}{8}$ -inch-thick panel-type underlayment; ceramic tile on $1\frac{1}{4}$ -inch mortar bed.
Roof	Wood	$\frac{15}{32}$ -inch wood structural panels or $\frac{11}{16}$ -inch T & G softwood	Finished roofing material with or without insulation

For SI: 1 inch = 25.4 mm.

a. This table applies only to wood joist construction. It is not applicable to wood truss construction.

**TABLE 722.6.2(5)**  
**TIME ASSIGNED FOR ADDITIONAL PROTECTION**

DESCRIPTION OF ADDITIONAL PROTECTION	FIRE RESISTANCE (minutes)
Add to the fire-resistance rating of wood stud walls if the spaces between the studs are completely filled with glass fiber mineral wool batts weighing not less than 2 pounds per cubic foot (0.6 pound per square foot of wall surface) or rockwool or slag material wool batts weighing not less than 3.3 pounds per cubic foot (1 pound per square foot of wall surface), or cellulose insulation having a nominal density not less than 2.6 pounds per cubic foot.	15

For SI: 1 pound/cubic foot = 16.0185 kg/m<sup>3</sup>.

**722.7 Fire-resistance rating for mass timber.** The required fire resistance of mass timber elements in Section 602.4 shall be determined in accordance with Section 703.2. The fire-resistance rating of building elements shall be as required in Tables 601 and 705.5 and as specified elsewhere in this code. The fire-resistance rating of the mass timber elements shall consist of the fire resistance of the unprotected element added to the protection time of the noncombustible protection.

**722.7.1 Minimum required protection.** Where required by Sections 602.4.1 through 602.4.3, noncombustible protection shall be provided for mass timber building elements in accordance with Table 722.7.1(1). The rating, in minutes, contributed by the noncombustible protection of mass timber building elements, components or assemblies, shall be established in accordance with Section

703.6. The protection contributions indicated in Table 722.7.1(2) shall be deemed to comply with this requirement where installed and fastened in accordance with Section 722.7.2.

**722.7.2 Installation of gypsum board noncombustible protection.** Gypsum board complying with Table 722.7.1(2) shall be installed in accordance with this section.

**722.7.2.1 Interior surfaces.** Layers of Type X gypsum board serving as noncombustible protection for interior surfaces of wall and ceiling assemblies determined in accordance with Table 722.7.1(1) shall be installed in accordance with the following:

1. Each layer shall be attached with Type S drywall screws of sufficient length to penetrate

## FIRE AND SMOKE PROTECTION FEATURES

the mass timber at least 1 inch (25 mm) when driven flush with the paper surface of the gypsum board.

**Exception:** The third layer, where determined necessary by Section 722.7, shall be permitted to be attached with 1-inch (25 mm) No. 6 Type S drywall screws to furring channels in accordance with AISI S220.

2. Screws for attaching the base layer shall be 12 inches (305 mm) on center in both directions.
3. Screws for each layer after the base layer shall be 12 inches (305 mm) on center in both directions and offset from the screws of the previous layers by 4 inches (102 mm) in both directions.
4. All panel edges of any layer shall be offset 18 inches (457 mm) from those of the previous layer.
5. All panel edges shall be attached with screws sized and offset as in Items 1 through 4 and placed at least 1 inch (25 mm) but not more than 2 inches (51 mm) from the panel edge.
6. All panels installed at wall-to-ceiling intersections shall be installed such that ceiling panels are installed first and the wall panels are installed after the ceiling panel has been installed and is fitted tight to the ceiling panel. Where multiple layers are required, each layer shall repeat this process.
7. All panels installed at a wall-to-wall intersection shall be installed such that the panels covering an exterior wall or a wall with a greater fire-resistance rating shall be installed first and the panels covering the other wall shall be fitted tight to the panel covering the first wall. Where multiple layers are required, each layer shall repeat this process.
8. Panel edges of the face layer shall be taped and finished with joint compound. Fastener heads shall be covered with joint compound.

9. Panel edges protecting mass timber elements adjacent to unprotected mass timber elements in accordance with Section 602.4.2.2 shall be covered with 1<sup>1</sup>/<sub>4</sub>-inch (32 mm) metal corner bead and finished with joint compound.

**722.7.2.2 Exterior surfaces.** Layers of Type X gypsum board serving as *noncombustible protection* for the outside of the exterior *mass timber* walls determined in accordance with Table 722.7.1(1) shall be fastened 12 inches (305 mm) on center each way and 6 inches (152 mm) on center at all joints or ends. All panel edges shall be attached with fasteners located at least 1 inch (25 mm) but not more than 2 inches (51 mm) from the panel edge. Fasteners shall comply with one of the following:

1. Galvanized nails of minimum 12 gage with a <sup>7</sup>/<sub>16</sub>-inch (11 mm) head of sufficient length to penetrate the mass timber a minimum of 1 inch (25 mm).
2. Screws that comply with ASTM C1002 (Type S, W or G) of sufficient length to penetrate the mass timber a minimum of 1 inch (25 mm).

**TABLE 722.7.1(1)**  
**PROTECTION REQUIRED FROM NONCOMBUSTIBLE COVERING MATERIAL**

REQUIRED FIRE-RESISTANCE RATING OF BUILDING ELEMENT PER TABLE 601 AND TABLE 705.5 (hours)	MINIMUM PROTECTION REQUIRED FROM NONCOMBUSTIBLE PROTECTION (minutes)
1	40
2	80
3 or more	120

**TABLE 722.7.1(2)**  
**PROTECTION PROVIDED BY NONCOMBUSTIBLE COVERING MATERIAL**

NONCOMBUSTIBLE PROTECTION	PROTECTION CONTRIBUTION (minutes)
1 <sup>1</sup> / <sub>2</sub> -inch Type X gypsum board	25
5 <sup>8</sup> / <sub>8</sub> -inch Type X gypsum board	40





## CHAPTER 8

# INTERIOR FINISHES

### User notes:

**About this chapter:** Chapter 8 contains the performance requirements for controlling fire growth and smoke propagation within buildings by restricting interior finish and decorative materials. The provisions of this chapter require materials used as interior finishes and decorations to meet certain flame spread index or flame propagation criteria and smoke development criteria based on the relative fire hazard associated with the occupancy. The performance of the material is evaluated based on test standards.

### SECTION 801 SCOPE

**801.1 Scope.** The provisions of this chapter shall govern the use of materials used as *interior finishes, trim and decorative materials*.

### SECTION 802 GENERAL

**802.1 Interior wall and ceiling finish.** The provisions of Section 803 shall limit the allowable fire performance and smoke development of *interior wall and ceiling finish* materials based on occupancy classification.

**802.2 Interior floor finish.** The provisions of Section 804 shall limit the allowable fire performance of *interior floor finish* materials based on occupancy classification.

**[F] 802.3 Decorative materials and trim.** *Decorative materials and trim* shall be restricted by combustibility, fire performance or flame propagation performance criteria in accordance with Section 806.

**802.4 Applicability.** For buildings in *flood hazard areas* as established in Section 1612.3, *interior finishes, trim and decorative materials* below the elevation required by Section 1612 shall be flood-damage-resistant materials.

**802.5 Application.** Combustible materials shall be permitted to be used as finish for walls, ceilings, floors and other *interior surfaces* of buildings.

**802.6 Windows.** Show windows in the *exterior walls* of the first story above *grade plane* shall be permitted to be of wood or of unprotected metal framing.

**802.7 Foam plastics.** Foam plastics shall not be used as *interior finish* except as provided in Section 803.4. Foam plastics shall not be used as interior *trim* except as provided in Section 806.5 or 2604.2. This section shall apply both to exposed foam plastics and to foam plastics used in conjunction with a textile or vinyl facing or cover.

### SECTION 803 WALL AND CEILING FINISHES

**803.1 General.** *Interior wall and ceiling finish* materials shall be classified for fire performance and smoke development in accordance with Section 803.1.1 or 803.1.2, except

as shown in Sections 803.1.3 through 803.15. Materials tested in accordance with Section 803.1.1 shall not be required to be tested in accordance with Section 803.1.2.

**803.1.1 Interior wall and ceiling finish materials tested in accordance with NFPA 286.** *Interior wall and ceiling finish* materials shall be classified in accordance with NFPA 286 and comply with Section 803.1.1.1. Materials complying with Section 803.1.1.1 shall be considered to also comply with the requirements of Class A.

**803.1.1.1 Acceptance criteria for NFPA 286.** The *interior finish* shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
3. Flashover, as defined in NFPA 286, shall not occur.
4. The peak heat release rate throughout the test shall not exceed 800 kW.
5. The total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

**803.1.2 Interior wall and ceiling finish materials tested in accordance with ASTM E84 or UL 723.** *Interior wall and ceiling finish* materials shall be classified in accordance with ASTM E84 or UL 723. Such *interior finish* materials shall be grouped in the following classes in accordance with their *flame spread* and *smoke-developed indices*.

Class A = *Flame spread index* 0–25; *smoke-developed index* 0–450.

Class B = *Flame spread index* 26–75; *smoke developed index* 0–450.

Class C = *Flame spread index* 76–200; *smoke-developed index* 0–450.

**Exception:** Materials tested in accordance with Section 803.1.1 and as indicated in Sections 803.1.3 through 803.13.

**803.1.3 Interior wall and ceiling finish materials with different requirements.** The materials indicated in Sections 803.2 through 803.13 shall be tested as indicated in the corresponding sections.

## INTERIOR FINISHES

**803.2 Thickness exemption.** Materials having a thickness less than 0.036 inch (0.9 mm) applied directly to the surface of walls or ceilings shall not be required to be tested.

**803.3 Heavy timber exemption.** Exposed portions of *building elements* complying with the requirements for buildings of heavy timber construction in Section 602.4 or Section 2304.11 shall not be subject to *interior finish* requirements except in *interior exit stairways*, *interior exit ramps*, and *exit passageways*.

**803.4 Foam plastics.** Foam plastics shall not be used as *interior finish* except as provided in Section 2603.9. This section shall apply both to exposed foam plastics and to foam plastics used in conjunction with a textile or vinyl facing or cover.

**803.5 Textile wall coverings.** Where used as interior wall finish materials, textile wall coverings, including materials having woven or nonwoven, napped, tufted, looped or similar surface and carpet and similar textile materials, shall be tested in the manner intended for use, using the product-mounting system, including adhesive, and shall comply with the requirements of one of the following: Section 803.1.1, 803.5.1 or 803.5.2.

**803.5.1 Room corner test for textile wall coverings and expanded vinyl wall coverings.** Textile wall coverings and *expanded vinyl wall coverings* shall meet the criteria of Section 803.5.1.1 when tested in the manner intended for use in accordance with the Method B protocol of NFPA 265 using the product-mounting system, including adhesive.

**803.5.1.1 Acceptance criteria for NFPA 265.** The *interior finish* shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremities of the samples on the 8-foot by 12-foot (203 by 305 mm) walls.
3. Flashover, as defined in NFPA 265, shall not occur.
4. The total smoke release throughout the test shall not exceed 1,000 m<sup>2</sup>.

**803.5.2 Acceptance criteria for textile and expanded vinyl wall or ceiling coverings tested to ASTM E84 or UL 723.** Textile wall and ceiling coverings and expanded vinyl wall and ceiling coverings shall have a Class A *flame spread index* in accordance with ASTM E84 or UL 723 and be protected by an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

**803.6 Textile ceiling coverings.** Where used as interior ceiling finish materials, textile ceiling coverings, including materials having woven or nonwoven, napped, tufted, looped or similar surface and carpet and similar textile materials, shall be tested in the manner intended for use, using the product-mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1 or 803.5.2.

**803.7 Expanded vinyl wall coverings.** Where used as interior wall finish materials, *expanded vinyl wall coverings* shall be tested in the manner intended for use, using the product-mounting system, including adhesive, and shall comply with the requirements of one of the following: Section 803.1.1, 803.5.1 or 803.5.2.

**803.8 Expanded vinyl ceiling coverings.** Where used as interior ceiling finish materials, expanded vinyl ceiling coverings shall be tested in the manner intended for use, using the product mounting system, including adhesive, and shall comply with the requirements of Section 803.1.1 or 803.5.2.

**803.9 High-density polyethylene (HDPE) and polypropylene (PP).** Where high-density polyethylene or polypropylene is used as an *interior finish*, it shall comply with Section 803.1.1.

**803.10 Site-fabricated stretch systems.** Where used as interior wall or interior ceiling finish materials, *site-fabricated stretch systems* containing all three components described in the definition in Chapter 2 shall be tested in the manner intended for use, and shall comply with the requirements of Section 803.1.1 or with the requirements of Class A in accordance with Section 803.1.2. If the materials are tested in accordance with ASTM E84 or UL 723, specimen preparation and mounting shall be in accordance with ASTM E2573.

**803.11 Laminated products factory produced with a wood substrate.** Laminated products factory produced with a wood substrate shall comply with one of the following:

1. The laminated product shall meet the criteria of Section 803.1.1.1 when tested in accordance with NFPA 286 using the product-mounting system, including adhesive, as described in Section 5.8 of NFPA 286.
2. The laminated product shall have a Class A, B, or C *flame spread index* and *smoke-developed index*, based on the requirements of Table 803.13, in accordance with ASTM E84 or UL 723. Test specimen preparation and mounting shall be in accordance with ASTM E2579.

**803.12 Facings or wood veneers intended to be applied on site over a wood substrate.** Facings or *veneers* intended to be applied on site over a wood substrate shall comply with one of the following:

1. The facing or *veneer* shall meet the criteria of Section 803.1.1.1 when tested in accordance with NFPA 286 using the product mounting system, including adhesive, as described in Section 5.9 of NFPA 286.
2. The facing or *veneer* shall have a Class A, B or C *flame spread index* and *smoke-developed index*, based on the requirements of Table 803.13, in accordance with ASTM E84 or UL 723. Test specimen preparation and mounting shall be in accordance with ASTM E2404.

**803.13 Interior finish requirements based on occupancy.** *Interior wall and ceiling finish* shall have a *flame spread*

*index* not greater than that specified in Table 803.13 for the group and location designated. *Interior wall and ceiling finish* materials tested in accordance with NFPA 286 and meeting the acceptance criteria of Section 803.1.1.1, shall be permitted to be used where a Class A classification in accordance with ASTM E84 or UL 723 is required.

**803.14 Stability.** *Interior finish* materials regulated by this chapter shall be applied or otherwise fastened in such a manner that such materials will not readily become detached where subjected to room temperatures of 200°F (93°C) for not less than 30 minutes.

**803.15 Application of interior finish materials to fire-resistance-rated or noncombustible building elements.** Where *interior finish* materials are applied on walls, ceilings or structural elements required to have a *fire-resistance rating* or to be of noncombustible construction, these finish materials shall comply with the provisions of this section.

**803.15.1 Direct attachment and furred construction.**

Where walls, ceilings or structural elements are required by any provision in this code to be of fire-resistance-rated

or noncombustible construction, the *interior finish* material shall be applied directly against such construction or to furring strips not exceeding 1<sup>3</sup>/<sub>4</sub> inches (44 mm), applied directly against such surfaces.

**803.15.1.1 Furred construction.** If the *interior finish* material is applied to furring strips, the intervening spaces between such furring strips shall comply with one of the following:

1. Be filled with material that is inorganic or noncombustible.
2. Be filled with material that meets the requirements of a Class A material in accordance with Section 803.1.1 or 803.1.2.
3. Be fireblocked at not greater than 8 feet (2438 mm) in every direction in accordance with Section 718.

**Exception:** Compliance with Item 1, 2 or 3 is not required where the materials used to create the concealed space are noncombustible.

**TABLE 803.13**  
**INTERIOR WALL AND CEILING FINISH REQUIREMENTS BY OCCUPANCY<sup>k</sup>**

GROUP	SPRINKLERED <sup>j</sup>			NONSPRINKLERED		
	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>	Interior exit stairways and ramps and exit passageways <sup>a, b</sup>	Corridors and enclosure for exit access stairways and ramps	Rooms and enclosed spaces <sup>c</sup>
A-1 & A-2	B	B	C	A	A <sup>d</sup>	B <sup>e</sup>
A-3 <sup>f</sup> , A-4, A-5	B	B	C	A	A <sup>d</sup>	C
B, E, M, R-1	B	C <sup>m</sup>	C	A	B	C
R-4	B	C	C	A	B	B
F	C	C	C	B	C	C
H	B	B	C <sup>g</sup>	A	A	B
I-1	B	C	C	A	B	B
I-2	B	B	B <sup>h, i</sup>	A	A	B
I-3	A	A <sup>j</sup>	C	A	A	B
I-4	B	B	B <sup>h, i</sup>	A	A	B
R-2	C	C	C	B	B	C
R-3	C	C	C	C	C	C
S	C	C	C	B	B	C
U	No restrictions			No restrictions		

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Class C interior finish materials shall be permitted for wainscoting or paneling of not more than 1,000 square feet of applied surface area in the grade lobby where applied directly to a noncombustible base or over furring strips applied to a noncombustible base and fireblocked as required by Section 803.15.1.
- b. In other than Group I-3 occupancies in buildings less than three stories above grade plane, Class B interior finish for nonsprinklered buildings and Class C interior finish for sprinklered buildings shall be permitted in interior exit stairways and ramps.
- c. Requirements for rooms and enclosed spaces shall be based on spaces enclosed by partitions. Where a fire-resistance rating is required for structural elements, the enclosing partitions shall extend from the floor to the ceiling. Partitions that do not comply with this shall be considered to be enclosing spaces and the rooms or spaces on both sides shall be considered to be one room or space. In determining the applicable requirements for rooms and enclosed spaces, the specific occupancy thereof shall be the governing factor regardless of the group classification of the building or structure.
- d. Lobby areas in Group A-1, A-2 and A-3 occupancies shall be not less than Class B materials.
- e. Class C interior finish materials shall be permitted in places of assembly with an occupant load of 300 persons or less.
- f. For places of religious worship, wood used for ornamental purposes, trusses, paneling or chancel furnishing shall be permitted.
- g. Class B material is required where the building exceeds two stories.
- h. Class C interior finish materials shall be permitted in administrative spaces.
- i. Class C interior finish materials shall be permitted in rooms with a capacity of four persons or less.
- j. Class B materials shall be permitted as wainscoting extending not more than 48 inches above the finished floor in corridors and exit access stairways and ramps.
- k. Finish materials as provided for in other sections of this code.
- l. Applies when protected by an automatic sprinkler system installed in accordance with Section 903.3.1.1 or 903.3.1.2.
- m. Corridors in ambulatory care facilities shall be provided with Class A or B materials.

## INTERIOR FINISHES

**803.15.2 Set-out construction.** Where walls and ceilings are required to be of fire-resistance-rated or noncombustible construction and walls are set out or ceilings are dropped distances greater than specified in Section 803.15.1, Class A finish materials, in accordance with Section 803.1.1 or 803.1.2, shall be used.

### Exceptions:

1. Where *interior finish* materials are protected on both sides by an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Where *interior finish* materials are attached to noncombustible backing or furring strips installed as specified in Section 803.15.1.1.
3. Where the combustible void is filled with a noncombustible material.

**803.15.2.1 Hangers and assembly members.** The hangers and assembly members of such dropped ceilings that are below the horizontal fire-resistance-rated floor or roof assemblies shall be of noncombustible materials. The construction of each set-out wall and horizontal fire-resistance-rated floor or roof assembly shall be of fire-resistance-rated construction as required elsewhere in this code.

**Exception:** In Types III and V construction, *fire-retardant-treated wood* shall be permitted for use as hangers and assembly members of dropped ceilings.

**803.15.3 Heavy timber construction.** Wall and ceiling finishes of all classes as permitted in this chapter that are installed directly against the wood decking or planking of heavy timber construction in Section 602.4.4.2 or 2304.11 or to wood furring strips applied directly to the wood decking or planking shall be fireblocked as specified in Section 803.15.1.1.

**803.15.4 Materials.** An interior wall or ceiling finish material that is not more than  $\frac{1}{4}$  inch (6.4 mm) thick shall be applied directly onto the wall, ceiling or structural element without the use of furring strips and shall not be suspended away from the building element to which that finish material it is applied.

### Exceptions:

1. Noncombustible *interior finish* materials.
2. Materials that meet the requirements of Class A materials in accordance with Section 803.1.1 or 803.1.2 where the qualifying tests were made with the material furred out from the noncombustible backing shall be permitted to be used with furring strips.
3. Materials that meet the requirements of Class A materials in accordance with Section 803.1.1 or 803.1.2 where the qualifying tests were made with the material suspended away from the noncombustible backing shall be permitted to be used suspended away from the building element.

## SECTION 804 INTERIOR FLOOR FINISH

**804.1 General.** *Interior floor finish* and floor covering materials shall comply with Sections 804.2 through 804.4.2.

**Exception:** Floor finishes and coverings of a traditional type, such as wood, vinyl, linoleum or terrazzo, and resilient floor covering materials that are not composed of fibers.

**804.2 Classification.** *Interior floor finish* and floor covering materials required by Section 804.4.2 to be of Class I or II materials shall be classified in accordance with ASTM E648 or NFPA 253. The classification referred to herein corresponds to the classifications determined by ASTM E648 or NFPA 253 as follows: Class I, 0.45 watts/cm<sup>2</sup> or greater; Class II, 0.22 watts/cm<sup>2</sup> or greater.

**804.3 Testing and identification.** *Interior floor finish* and floor covering materials shall be tested by an agency in accordance with ASTM E648 or NFPA 253 and identified by a hang tag or other suitable method so as to identify the manufacturer or supplier and style, and shall indicate the *interior floor finish* or floor covering classification in accordance with Section 804.2. Carpet-type floor coverings shall be tested as proposed for use, including underlayment. Test reports confirming the information provided in the manufacturer's product identification shall be furnished to the building official on request.

**804.4 Interior floor finish requirements.** Interior floor covering materials shall comply with Sections 804.4.1 and 804.4.2 and *interior floor finish* materials shall comply with Section 804.4.2.

**804.4.1 Test requirement.** In all occupancies, interior floor covering materials shall comply with the requirements of the DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or with ASTM D2859.

**804.4.2 Minimum critical radiant flux.** In all occupancies, *interior floor finish* and floor covering materials in enclosures for *stairways* and *ramps*, exit passageways, *corridors* and rooms or spaces not separated from corridors by partitions extending from the floor to the underside of the ceiling shall withstand a minimum critical radiant flux. The minimum critical radiant flux shall be not less than Class I in Groups I-1, I-2 and I-3 and not less than Class II in Groups A, B, E, H, I-4, M, R-1, R-2 and S.

**Exception:** Where a building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2, Class II materials are permitted in any area where Class I materials are required, and materials complying with DOC FF-1 "pill test" (CPSC 16 CFR Part 1630) or with ASTM D2859 are permitted in any area where Class II materials are required.



## SECTION 805 COMBUSTIBLE MATERIALS IN TYPES I AND II CONSTRUCTION

**805.1 Application.** Combustible materials installed on or embedded in floors of buildings of Type I or II construction shall comply with Sections 805.1.1 through 805.1.3.

**Exception:** *Stages* and *platforms* constructed in accordance with Sections 410.2 and 410.3, respectively.

**805.1.1 Subfloor construction.** Floor sleepers, bucks and nailing blocks shall not be constructed of combustible materials, unless the space between the fire-resistance-rated floor assembly and the flooring is either solidly filled with noncombustible materials or fireblocked in accordance with Section 718, and provided that such open spaces shall not extend under or through permanent partitions or walls.

**805.1.2 Wood finish flooring.** Wood finish flooring is permitted to be attached directly to the embedded or fireblocked wood sleepers and shall be permitted where cemented directly to the top surface of fire-resistance-rated floor assemblies or directly to a wood subfloor attached to sleepers as provided for in Section 805.1.1.

**805.1.3 Insulating boards.** Combustible insulating boards not more than  $\frac{1}{2}$  inch (12.7 mm) thick and covered with finish flooring are permitted where attached directly to a noncombustible floor assembly or to wood subflooring attached to sleepers as provided for in Section 805.1.1.

## SECTION 806 DECORATIVE MATERIALS AND TRIM

**[F] 806.1 General.** The following requirements shall apply to all occupancies:

1. Furnishings or *decorative materials* of an *explosive* or highly flammable character shall not be used.
2. Fire-retardant coatings in existing buildings shall be maintained so as to retain the effectiveness of the treatment under service conditions encountered in actual use.
3. Furnishings or other objects shall not be placed to obstruct exits, access thereto, egress therefrom or visibility thereof.
4. The permissible amount of decorative vegetation and noncombustible *decorative materials* shall not be limited.

**[F] 806.2 Combustible decorative materials.** In Groups A, B, E, I, M and R-1 and in *dormitories* in Group R-2, curtains, draperies, fabric hangings and similar combustible *decorative materials* suspended from walls or ceilings shall comply with Section 806.4 and shall not exceed 10 percent of the specific wall or ceiling area to which such materials are attached.

Fixed or movable walls and partitions, paneling, wall pads and crash pads applied structurally or for decoration, acoustical correction, surface insulation or other purposes

shall be considered to be *interior finish*, shall comply with Section 803 and shall not be considered to be *decorative materials* or furnishings.

### Exceptions:

1. In auditoriums in Group A, the permissible amount of curtains, draperies, fabric hangings and similar combustible *decorative materials* suspended from walls or ceilings shall not exceed 75 percent of the aggregate wall area where the building is equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1, and where the material is installed in accordance with Section 803.15 of this code.
2. In Group R-2 *dormitories*, within sleeping units and dwelling units, the permissible amount of curtains, draperies, fabric hangings and similar *decorative materials* suspended from walls or ceiling shall not exceed 50 percent of the aggregate wall areas where the building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.
3. In Group B and M occupancies, the amount of combustible *fabric partitions* suspended from the ceiling and not supported by the floor shall comply with Section 806.4 and shall not be limited.
4. The 10-percent limit shall not apply to curtains, draperies, fabric hangings and similar combustible *decorative materials* used as window coverings.

**806.3 Occupancy-based requirements.** Occupancy-based requirements for combustible *decorative materials*, other than decorative vegetation, not complying with Section 806.4 shall comply with Sections 807.5.1 through 807.5.6 of the *International Fire Code*.

**[F] 806.4 Acceptance criteria and reports.** Where required to exhibit improved fire performance, curtains, draperies, fabric hangings and similar combustible *decorative materials* suspended from walls or ceilings shall be tested by an *approved agency* and meet the flame propagation performance criteria of Test 1 or 2, as appropriate, of NFPA 701, or exhibit a maximum heat release rate of 100 kW when tested in accordance with NFPA 289, using the 20 kW ignition source. Reports of test results shall be prepared in accordance with the test method used and furnished to the *building official* on request.

**[F] 806.5 Foam plastic.** Foam plastic used as *trim* in any occupancy shall comply with Section 2604.2.

**[F] 806.6 Pyroxylin plastic.** Imitation leather or other material consisting of or coated with a pyroxylin or similarly hazardous base shall not be used in Group A occupancies.

**[F] 806.7 Interior trim.** Material, other than foam plastic used as interior *trim*, shall have a minimum Class C *flame spread* and *smoke-developed index* when tested in accordance with ASTM E84 or UL 723, as described in Section 803.1.2. Combustible *trim*, excluding handrails and guard-

## INTERIOR FINISHES

rails, shall not exceed 10 percent of the specific wall or ceiling area to which it is attached.

**[F] 806.8 Interior floor-wall base.** *Interior floor-wall base* that is 6 inches (152 mm) or less in height shall be tested in accordance with Section 804.2 and shall be not less than Class II. Where a Class I floor finish is required, the floor-wall base shall be Class I.

**Exception:** Interior *trim* materials that comply with Section 806.7.

**[F] 806.9 Combustible lockers.** Where lockers constructed of combustible materials are used, the lockers shall be considered to be *interior finish* and shall comply with Section 803.

**Exception:** Lockers constructed entirely of wood and noncombustible materials shall be permitted to be used wherever interior finish materials are required to meet a Class C classification in accordance with Section 803.1.2.

## SECTION 807 INSULATION

**807.1 Insulation.** Thermal and acoustical insulation shall comply with Section 720.

## SECTION 808 ACOUSTICAL CEILING SYSTEMS

**808.1 Acoustical ceiling systems.** The quality, design, fabrication and erection of metal suspension systems for acoustical tile and lay-in panel ceilings in buildings or structures shall conform to generally accepted engineering practice, the provisions of this chapter and other applicable requirements of this code.

**808.1.1 Materials and installation.** Acoustical materials complying with the *interior finish* requirements of Section 803 shall be installed in accordance with the manufacturer's recommendations and applicable provisions for applying *interior finish*.

**808.1.1.1 Suspended acoustical ceilings.** Suspended acoustical ceiling systems shall be installed in accordance with the provisions of ASTM C635 and ASTM C636.

**808.1.1.2 Fire-resistance-rated construction.** Acoustical ceiling systems that are part of fire-resistance-rated construction shall be installed in the same manner used in the assembly tested and shall comply with the provisions of Chapter 7.

## CHAPTER 9

# FIRE PROTECTION AND LIFE SAFETY SYSTEMS

### User note:

**About this chapter:** Chapter 9 prescribes the minimum requirements for active fire protection equipment systems to perform the functions of detecting a fire, alerting the occupants or fire department of a fire emergency, mass notification, gas detection, controlling smoke and controlling or extinguishing the fire. Generally, the requirements are based on the occupancy, the height and the area of the building, because these are the factors that most affect fire-fighting capabilities and the relative hazard of a specific building or portion thereof. This chapter parallels and is substantially duplicated in Chapter 9 of the International Fire Code®.

### SECTION 901 GENERAL

**901.1 Scope.** The provisions of this chapter shall specify where fire protection and *life safety systems* are required and shall apply to the design, installation and operation of *fire protection and life safety systems*.

**901.2 Fire protection systems.** *Fire protection and life safety systems* shall be installed, repaired, operated and maintained in accordance with this code and the *International Fire Code*.

Any *fire protection or life safety system* for which an exception or reduction to the provisions of this code has been granted shall be considered to be a required system.

**Exception:** Any *fire protection or life safety system* or portion thereof not required by this code shall be permitted to be installed for partial or complete protection provided that such system meets the requirements of this code.

**901.3 Modifications.** Persons shall not remove or modify any *fire protection system* installed or maintained under the provisions of this code or the *International Fire Code* without approval by the *building official*.

**901.4 Threads.** Threads provided for fire department connections to sprinkler systems, standpipes, yard hydrants or any other fire hose connection shall be compatible with the connections used by the local fire department.

**901.5 Acceptance tests.** *Fire protection systems* shall be tested in accordance with the requirements of this code and the *International Fire Code*. Where required, the tests shall be conducted in the presence of the *building official*. Tests required by this code, the *International Fire Code* and the standards listed in this code shall be conducted at the expense of the owner or the owner's authorized agent. It shall be unlawful to occupy portions of a structure until the required *fire protection systems* within that portion of the structure have been tested and *approved*.

**901.6 Supervisory service.** Where required, *fire protection systems* shall be monitored by an approved supervising station in accordance with NFPA 72.

**901.6.1 Automatic sprinkler systems.** *Automatic sprinkler systems* shall be monitored by an *approved* supervising station.

#### Exceptions:

1. A supervising station is not required for *automatic sprinkler systems* protecting one- and two-family dwellings.
2. Limited area systems in accordance with Section 903.3.8.

**[F] 901.6.2 Integrated testing.** Where two or more fire protection or *life safety systems* are interconnected, the intended response of subordinate fire protection and *life safety systems* shall be verified when required testing of the initiating system is conducted. In addition, integrated testing shall be performed in accordance with Sections 901.6.2.1 and 901.6.2.2.

**[F] 901.6.2.1 High-rise buildings.** For high-rise buildings, integrated testing shall comply with NFPA 4, with an integrated test performed prior to issuance of the certificate of occupancy and at intervals not exceeding 10 years, unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4. If an equipment failure is detected during integrated testing, a repeat of the integrated test shall not be required, except as necessary to verify operation of fire protection or life safety functions that are initiated by equipment that was repaired or replaced.

**[F] 901.6.2.2 Smoke control systems.** Where a fire alarm system is integrated with a smoke control system as outlined in Section 909, integrated testing shall comply with NFPA 4, with an integrated test performed prior to issuance of the certificate of occupancy and at intervals not exceeding 10 years, unless otherwise specified by an integrated system test plan prepared in accordance with NFPA 4. If an equipment failure is detected during integrated testing, a repeat of the integrated test shall not be required, except as necessary to verify operation of fire protection or life safety functions that are initiated by equipment that was repaired or replaced.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**901.6.3 Fire alarm systems.** Fire alarm systems required by the provisions of Section 907.2 of this code and Sections 907.2 and 907.9 of the *International Fire Code* shall be monitored by an *approved* supervising station in accordance with Section 907.6.6 of this code.

### Exceptions:

1. Single- and multiple-station smoke alarms required by Section 907.2.11.
2. Smoke detectors in Group I-3 occupancies.
3. Supervisory service is not required for *automatic sprinkler systems* in one- and two-family dwellings.

**901.6.4 Group H.** Supervision and monitoring of emergency alarm, detection and automatic fire-extinguishing systems in Group H occupancies shall be in accordance with the *International Fire Code*.

**901.7 Fire areas.** Where buildings, or portions thereof, are divided into *fire areas* so as not to exceed the limits established for requiring a *fire protection system* in accordance with this chapter, such *fire areas* shall be separated by *fire walls* constructed in accordance with Section 706, *fire barriers* constructed in accordance with Section 707, or *horizontal assemblies* constructed in accordance with Section 711, or a combination thereof having a *fire-resistance rating* of not less than that determined in accordance with Section 707.3.10.

## SECTION 902

### FIRE PUMP AND RISER ROOM SIZE

**[F] 902.1 Pump and riser room size.** Where provided, fire pump rooms and *automatic sprinkler system* riser rooms shall be designed with adequate space for all equipment necessary for the installation, as defined by the manufacturer, with sufficient working room around the stationary equipment. Clearances around equipment to elements of permanent construction, including other installed equipment and appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly. Fire pump and *automatic sprinkler system* riser rooms shall be provided with doors and unobstructed passageways large enough to allow removal of the large piece of equipment.

**[F] 902.1.1 Access.** Automatic sprinkler system risers, fire pumps and controllers shall be provided with ready access. Where located in a fire pump room or *automatic sprinkler system* riser room, the door shall be permitted to be locked provided that the key is available at all times.

**[F] 902.1.2 Marking on access doors.** Access doors for *automatic sprinkler system* riser rooms and fire pump rooms shall be labeled with an approved sign. The lettering shall be in contrasting color to the background. Letters shall have a minimum height of 2 inches (51 mm) with a minimum stroke of  $\frac{3}{8}$  inch (10 mm).

**[F] 902.1.3 Environment.** Automatic sprinkler system riser rooms and fire pump rooms shall be maintained at a

temperature of not less than 40°F (4°C). Heating units shall be permanently installed.

**[F] 902.1.4 Lighting.** Permanently installed artificial illumination shall be provided in the *automatic sprinkler system* riser rooms and fire pump rooms.

## SECTION 903

### AUTOMATIC SPRINKLER SYSTEMS

**[F] 903.1 General.** *Automatic sprinkler systems* shall comply with this section.

**[F] 903.1.1 Alternative protection.** Alternative *automatic fire-extinguishing systems* complying with Section 904 shall be permitted instead of automatic sprinkler protection where recognized by the applicable standard and *approved* by the fire code official.

**[F] 903.2 Where required.** Approved *automatic sprinkler systems* in new buildings and structures shall be provided in the locations described in Sections 903.2.1 through 903.2.12.

**Exception:** Spaces or areas in telecommunications buildings used exclusively for telecommunications equipment, associated electrical power distribution equipment, batteries and standby engines, provided that those spaces or areas are equipped throughout with an *automatic smoke detection system* in accordance with Section 907.2 and are separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or not less than 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 903.2.1 Group A.** An *automatic sprinkler system* shall be provided throughout buildings and portions thereof used as Group A occupancies as provided in this section.

**[F] 903.2.1.1 Group A-1.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-1 occupancies and throughout all stories from the Group A-1 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.
4. The *fire area* contains a multitheater complex.

**[F] 903.2.1.2 Group A-2.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-2 occupancies and throughout all stories from the Group A-2 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).



2. The *fire area* has an *occupant load* of 100 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**[F] 903.2.1.3 Group A-3.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-3 occupancies and throughout all stories from the Group A-3 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**[F] 903.2.1.4 Group A-4.** An *automatic sprinkler system* shall be provided throughout stories containing Group A-4 occupancies and throughout all stories from the Group A-4 occupancy to and including the *levels of exit discharge* serving that occupancy where one of the following conditions exists:

1. The *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. The *fire area* has an *occupant load* of 300 or more.
3. The *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**[F] 903.2.1.5 Group A-5.** An *automatic sprinkler system* shall be provided for all enclosed Group A-5 accessory use areas in excess of 1,000 square feet (93 m<sup>2</sup>).

**[F] 903.2.1.5.1 Spaces under grandstands or bleachers.** Enclosed spaces under *grandstands* or *bleachers* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where either of the following exist:

1. The enclosed area is 1,000 square feet (93 m<sup>2</sup>) or less and is not constructed in accordance with Section 1030.1.1.1.
2. The enclosed area exceeds 1,000 square feet (93 m<sup>2</sup>).

**[F] 903.2.1.6 Assembly occupancies on roofs.** Where an occupied roof has an assembly occupancy with an *occupant load* exceeding 100 for Group A-2 and 300 for other Group A occupancies, all floors between the occupied roof and the *level of exit discharge* shall be equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.

**Exception:** *Open parking garages* of Type I or Type II construction.

**903.2.1.7 Multiple fire areas.** An *automatic sprinkler system* shall be provided where multiple *fire areas* of Group A-1, A-2, A-3 or A-4 occupancies share *exit* or

*exit access components* and the combined *occupant load* of these *fire areas* is 300 or more.

**[F] 903.2.2 Ambulatory care facilities.** An *automatic sprinkler system* shall be installed throughout the entire floor containing an *ambulatory care facility* where either of the following conditions exist at any time:

1. Four or more care recipients are *incapable of self-preservation*.
2. One or more care recipients that are *incapable of self-preservation* are located at other than the *level of exit discharge* serving such a facility.

In buildings where ambulatory care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* shall be installed throughout the entire floor as well as all floors below where such care is provided, and all floors between the level of ambulatory care and the nearest *level of exit discharge*, the *level of exit discharge*, and all floors below the level of *exit discharge*.

**Exception:** Floors classified as an *open parking garage* are not required to be sprinklered.

**[F] 903.2.3 Group E.** An *automatic sprinkler system* shall be provided for Group E occupancies as follows:

1. Throughout all Group E *fire areas* greater than 12,000 square feet (1115 m<sup>2</sup>) in area.
2. The Group E *fire area* is located on a floor other than a *level of exit discharge* serving such occupancies.

**Exception:** In buildings where every classroom has not fewer than one exterior *exit door* at ground level, an *automatic sprinkler system* is not required in any area below the lowest *level of exit discharge* serving that area.

3. The Group E *fire area* has an *occupant load* of 300 or more.

**[F] 903.2.4 Group F-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group F-1 occupancy where one of the following conditions exists:

1. A Group F-1 *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group F-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group F-1 *fire areas* on all floors, including any *mezzanines*, exceeds 24,000 square feet (2230 m<sup>2</sup>).

**[F] 903.2.4.1 Woodworking operations.** An *automatic sprinkler system* shall be provided throughout all Group F-1 occupancy *fire areas* that contain woodworking operations in excess of 2,500 square feet (232 m<sup>2</sup>) in area that generate finely divided combustible waste or use finely divided combustible materials.

**[F] 903.2.4.2 Group F-1 distilled spirits.** An *automatic sprinkler system* shall be provided throughout a

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

Group F-1 *fire area* used for the manufacture of distilled spirits.

**[F] 903.2.4.3 Group F-1 upholstered furniture or mattresses.** An *automatic sprinkler system* shall be provided throughout a Group F-1 *fire area* that exceeds 2,500 square feet (232 m<sup>2</sup>) used for the manufacture of upholstered furniture or mattresses.

**[F] 903.2.5 Group H.** *Automatic sprinkler systems* shall be provided in high-hazard occupancies as required in Sections 903.2.5.1 through 903.2.5.3.

**[F] 903.2.5.1 General.** An *automatic sprinkler system* shall be installed in Group H occupancies.

**[F] 903.2.5.2 Group H-5 occupancies.** An *automatic sprinkler system* shall be installed throughout buildings containing Group H-5 occupancies. The design of the sprinkler system shall be not less than that required by this code for the occupancy hazard classifications in accordance with Table 903.2.5.2.

Where the design area of the sprinkler system consists of a *corridor* protected by one row of sprinklers, the maximum number of sprinklers required to be calculated is 13.

**[F] TABLE 903.2.5.2**

**GROUP H-5 SPRINKLER DESIGN CRITERIA**

LOCATION	OCCUPANCY HAZARD CLASSIFICATION
Fabrication areas	Ordinary Hazard Group 2
Service corridors	Ordinary Hazard Group 2
Storage rooms without dispensing	Ordinary Hazard Group 2
Storage rooms with dispensing	Extra Hazard Group 2
Corridors	Ordinary Hazard Group 2

**[F] 903.2.5.3 Pyroxylin plastics.** An *automatic sprinkler system* shall be provided in buildings, or portions thereof, where cellulose nitrate film or pyroxylin plastics are manufactured, stored or handled in quantities exceeding 100 pounds (45 kg).

**[F] 903.2.6 Group I.** An *automatic sprinkler system* shall be provided throughout buildings with a Group I *fire area*.

**Exceptions:**

1. An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group I-1, Condition 1 facilities.
2. An *automatic sprinkler system* is not required where Group I-4 day care facilities are at the *level of exit discharge* and where every room where care is provided has not fewer than one exterior exit door.
3. In buildings where Group I-4 day care is provided on levels other than the *level of exit discharge*, an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be installed on the entire floor where care is provided, all floors between the level of care and the *level of exit discharge*, and all floors

below the *level of exit discharge* other than areas classified as an open parking garage.

**[F] 903.2.7 Group M.** An *automatic sprinkler system* shall be provided throughout buildings containing a Group M occupancy where one of the following conditions exists:

1. A Group M *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group M *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group M *fire areas* on all floors, including any *mezzanines*, exceeds 24,000 square feet (2230 m<sup>2</sup>).

**[F] 903.2.7.1 High-piled storage.** An *automatic sprinkler system* shall be provided in accordance with the *International Fire Code* in all buildings of Group M where storage of merchandise is in high-piled or rack storage arrays.

**[F] 903.2.7.2 Group M upholstered furniture or mattresses.** An *automatic sprinkler system* shall be provided throughout a Group M *fire area* where the area used for the display and sale of upholstered furniture or mattresses exceeds 5,000 square feet (464 m<sup>2</sup>).

**[F] 903.2.8 Group R.** An *automatic sprinkler system* installed in accordance with Section 903.3 shall be provided throughout all buildings with a Group R *fire area*.

**Exception:** Group R-2 *live/work units* and Group R-3 *lodging houses* with five or fewer guestrooms.

**[F] 903.2.8.1 Group R-3.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-3 occupancies.

**[F] 903.2.8.2 Group R-4, Condition 1.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in Group R-4, Condition 1 occupancies.

**[F] 903.2.8.3 Group R-4, Condition 2.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.2 shall be permitted in Group R-4, Condition 2 occupancies.

**[F] 903.2.8.4 Care facilities.** An *automatic sprinkler system* installed in accordance with Section 903.3.1.3 shall be permitted in care facilities with five or fewer individuals in a single-family dwelling.

**[F] 903.2.9 Group S-1.** An *automatic sprinkler system* shall be provided throughout all buildings containing a Group S-1 occupancy where one of the following conditions exists:

1. A Group S-1 *fire area* exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. A Group S-1 *fire area* is located more than three stories above *grade plane*.
3. The combined area of all Group S-1 *fire areas* on all floors, including any *mezzanines*, exceeds 24,000 square feet (2230 m<sup>2</sup>).

4. A Group S-1 *fire area* used for the storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**[F] 903.2.9.1 Repair garages.** An *automatic sprinkler system* shall be provided throughout all buildings used as *repair garages* in accordance with Section 406, as shown:

1. Buildings having two or more *stories above grade plane*, including basements, with a *fire area* containing a *repair garage* exceeding 10,000 square feet (929 m<sup>2</sup>).
2. Buildings not more than one *story above grade plane*, with a *fire area* containing a *repair garage* exceeding 12,000 square feet (1115 m<sup>2</sup>).
3. Buildings with *repair garages* servicing vehicles parked in basements.
4. A Group S-1 *fire area* used for the repair of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**[F] 903.2.9.2 Bulk storage of tires.** Buildings and structures where the area for the storage of tires exceeds 20,000 cubic feet (566 m<sup>3</sup>) shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**[F] 903.2.9.3 Group S-1 Distilled spirits or wine.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* used for the bulk storage of distilled spirits or wine.

**[F] 903.2.9.4 Group S-1 upholstered furniture and mattresses.** An *automatic sprinkler system* shall be provided throughout a Group S-1 *fire area* where the area used for the storage of upholstered furniture or mattresses exceeds 2,500 square feet (232 m<sup>2</sup>).

**Exception:** Self-service storage facilities not greater than one story above grade plane where all storage spaces can be accessed directly from the exterior. Self-service storage facilities with interior only access not greater than 5,000 square feet (464 m<sup>2</sup>).

**[F] 903.2.10 Group S-2 parking garages.** An *automatic sprinkler system* shall be provided throughout buildings classified as parking garages where any of the following conditions exists:

1. Where the *fire area* of the enclosed parking garage in accordance with Section 406.6 exceeds 12,000 square feet (1115 m<sup>2</sup>).
2. Where the enclosed parking garage in accordance with Section 406.6 is located beneath other groups.

**Exception:** Enclosed parking garages located beneath Group R-3 occupancies.

3. Where the *fire area* of the *open parking garage* in accordance with Section 406.5 exceeds 48,000 square feet (4460 m<sup>2</sup>).

**[F] 903.2.10.1 Commercial parking garages.** An *automatic sprinkler system* shall be provided throughout buildings used for storage of commercial motor vehicles where the *fire area* exceeds 5,000 square feet (464 m<sup>2</sup>).

**[F] 903.2.10.2 Mechanical-access enclosed parking garages.** An *approved automatic sprinkler system* shall be provided throughout buildings used for the storage of motor vehicles in a *mechanical-access enclosed parking garage*. The portion of the building that contains the *mechanical-access enclosed parking garage* shall be protected with a specially engineered *automatic sprinkler system*.

**[F] 903.2.11 Specific building areas and hazards.** In all occupancies other than Group U, an *automatic sprinkler system* shall be installed for building design or hazards in the locations set forth in Sections 903.2.11.1 through 903.2.11.6.

**[F] 903.2.11.1 Stories without openings.** An *automatic sprinkler system* shall be installed throughout all stories, including basements, of all buildings where the floor area exceeds 1,500 square feet (139.4 m<sup>2</sup>) and where the *story* does not comply with the following criteria for *exterior wall* openings:

1. Openings below grade that lead directly to ground level by an exterior *stairway* complying with Section 1011 or an outside *ramp* complying with Section 1012. Openings shall be located in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the *story* on not fewer than one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm).
2. Openings entirely above the adjoining ground level totaling not less than 20 square feet (1.86 m<sup>2</sup>) in each 50 linear feet (15 240 mm), or fraction thereof, of *exterior wall* in the *story* on not fewer than one side. The required openings shall be distributed such that the lineal distance between adjacent openings does not exceed 50 feet (15 240 mm). The height of the bottom of the clear opening shall not exceed 44 inches (1118 mm) measured from the floor.

**[F] 903.2.11.1.1 Opening dimensions and access.** Openings shall have a minimum dimension of not less than 30 inches (762 mm). Access to such openings shall be provided for the fire department from the exterior and shall not be obstructed in a manner such that fire fighting or rescue cannot be accomplished from the exterior.

**[F] 903.2.11.1.2 Openings on one side only.** Where openings in a *story* are provided on only one side and the opposite wall of such *story* is more than 75 feet (22 860 mm) from such openings, the *story* shall be equipped throughout with an *approved automatic sprinkler system*, or openings shall be provided on not fewer than two sides of the *story*.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 903.2.11.1.3 Basements.** Where any portion of a *basement* is located more than 75 feet (22 860 mm) from openings required by Section 903.2.11.1, or where walls, partitions or other obstructions are installed that restrict the application of water from hose streams, the *basement* shall be equipped throughout with an *approved automatic sprinkler system*.

**[F] 903.2.11.2 Rubbish and linen chutes.** An *automatic sprinkler system* shall be installed at the top of rubbish and linen chutes and in their terminal rooms. Chutes shall have additional sprinkler heads installed at alternate floors and at the lowest intake. Where a rubbish chute extends through a building more than one floor below the lowest intake, the extension shall have sprinklers installed that are recessed from the drop area of the chute and protected from freezing in accordance with Section 903.3.1.1. Such sprinklers shall be installed at alternate floors, beginning with the second level below the last intake and ending with the floor above the discharge. *Access* to sprinklers in chutes shall be provided for servicing.

**[F] 903.2.11.3 Buildings 55 feet or more in height.** An *automatic sprinkler system* shall be installed throughout buildings that have one or more stories with an *occupant load* of 30 or more located 55 feet (16 764 mm) or more above the lowest level of fire department vehicle access, measured to the finished floor.

**Exception:** Occupancies in Group F-2.

**[F] 903.2.11.4 Ducts conveying hazardous exhausts.** Where required by the *International Mechanical Code*, automatic sprinklers shall be provided in ducts conveying hazardous exhaust or flammable or combustible materials.

**Exception:** Ducts where the largest cross-sectional diameter of the duct is less than 10 inches (254 mm).

**[F] 903.2.11.5 Commercial cooking operations.** An *automatic sprinkler system* shall be installed in commercial kitchen exhaust hood and duct systems where an *automatic sprinkler system* is used to comply with Section 904.

**[F] 903.2.11.6 Other required fire protection systems.** In addition to the requirements of Section 903.2, the provisions indicated in Table 903.2.11.6 require the installation of a fire protection system for certain buildings and areas.

**[F] 903.2.12 During construction.** *Automatic sprinkler systems* required during construction, alteration and demolition operations shall be provided in accordance with Chapter 33 of the *International Fire Code*.

**[F] 903.3 Installation requirements.** *Automatic sprinkler systems* shall be designed and installed in accordance with Sections 903.3.1 through 903.3.8.

**[F] 903.3.1 Standards.** Sprinkler systems shall be designed and installed in accordance with Section 903.3.1.1 unless otherwise permitted by Sections 903.3.1.2 and 903.3.1.3 and other chapters of this code, as applicable.

**[F] 903.3.1.1 NFPA 13 sprinkler systems.** Where the provisions of this code require that a building or portion thereof be equipped throughout with an *automatic sprinkler system* in accordance with this section, sprinklers shall be installed throughout in accordance with NFPA 13 except as provided in Sections 903.3.1.1.1 and 903.3.1.1.2.

**[F] 903.3.1.1.1 Exempt locations.** Automatic sprinklers shall not be required in the following rooms or areas where such rooms or areas are protected with an *approved* automatic fire detection system in accordance with Section 907.2 that will respond to visible or invisible particles of combustion. Sprinklers shall not be omitted from a room merely because it is damp, of fire-resistance-rated construction or contains electrical equipment.

1. A room where the application of water, or flame and water, constitutes a serious life or fire hazard.
2. A room or space where sprinklers are considered undesirable because of the nature of the contents, where *approved* by the fire code official.
3. Generator and transformer rooms separated from the remainder of the building by walls and floor/ceiling or roof/ceiling assemblies having a *fire-resistance rating* of not less than 2 hours.

**[F]TABLE 903.2.11.6  
ADDITIONAL REQUIRED PROTECTION SYSTEMS**

SECTION	SUBJECT
402.5, 402.6.2	Covered and open mall buildings
403.3	High-rise buildings
404.3	Atriums
405.3	Underground structures
407.7	Group I-2
410.6	Stages
411.3	Special amusement buildings
412.2.4	Airport traffic control towers
412.3.6, 412.3.6.1, 412.5.6	Aircraft hangars
415.11.11	Group H-5 HPM exhaust ducts
416.5	Flammable finishes
417.4	Drying rooms
424.3	Play structures
428	Buildings containing laboratory suites
507	Unlimited area buildings
508.5.7	Live/work units
509.4	Incidental uses
1030.6.2.3	Smoke-protected assembly seating
IFC	Sprinkler system requirements as set forth in Section 903.2.11.6 of the <i>International Fire Code</i>



4. Rooms or areas that are of noncombustible construction with wholly noncombustible contents.
5. Fire service access elevator machine rooms and machinery spaces.
6. Machine rooms, machinery spaces, control rooms and control spaces associated with occupant evacuation elevators designed in accordance with Section 3008.

**[F] 903.3.1.1.2 Bathrooms.** In Group R occupancies sprinklers shall not be required in bathrooms that do not exceed 55 square feet (5 m<sup>2</sup>) in area and are located within individual *dwelling units* or *sleeping units*, provided that walls and ceilings, including the walls and ceilings behind a shower enclosure or tub, are of noncombustible or limited-combustible materials with a 15-minute thermal barrier rating.

**[F] 903.3.1.2 NFPA 13R sprinkler systems.** *Automatic sprinkler systems* in Group R occupancies shall be permitted to be installed throughout in accordance with NFPA 13R where the Group R occupancy meets all of the following conditions:

1. Four stories or fewer above *grade plane*.
2. The floor level of the highest *story* is 30 feet (9144 mm) or less above the lowest level of fire department vehicle access.
3. The floor level of the lowest *story* is 30 feet (9144 mm) or less below the lowest level of fire department vehicle access.

The number of stories of Group R occupancies constructed in accordance with Sections 510.2 and 510.4 shall be measured from *grade plane*.

**[F] 903.3.1.2.1 Balconies and decks.** Sprinkler protection shall be provided for exterior balconies, decks and ground floor patios of *dwelling units* and *sleeping units* where either of the following conditions exists:

1. The building is of Type V construction, provided that there is a roof or deck above.
2. Exterior balconies, decks and ground floor patios of dwelling units and sleeping units are constructed in accordance with Section 705.2.3.1, Exception 3.

Sidewall sprinklers that are used to protect such areas shall be permitted to be located such that their deflectors are within 1 inch (25 mm) to 6 inches (152 mm) below the structural members and a maximum distance of 14 inches (356 mm) below the deck of the exterior balconies and decks that are constructed of open wood joist construction.

**[F] 903.3.1.2.2 Corridors and balconies in the means of egress.** Sprinkler protection shall be provided in *corridors* and for balconies in the *means of egress* where any of the following conditions apply:

1. Corridors with combustible floor or walls.

2. Corridors with an interior change of direction exceeding 45 degrees (0.79 rad).
3. Corridors that are less than 50 percent open to the outside atmosphere at the ends.
4. Open-ended corridors and associated exterior stairways and ramps as specified in Section 1027.6, Exception 3.
5. Egress balconies not complying with Sections 1021.2 and 1021.3.

**[F] 903.3.1.2.3 Attics.** *Attic* protection shall be provided as follows:

1. *Attics* that are used or intended for living purposes or storage shall be protected by an *automatic sprinkler system*.
2. Where fuel-fired equipment is installed in an unsprinklered *attic*, not fewer than one quick-response intermediate temperature sprinkler shall be installed above the equipment.
3. Where located in a building of Type III, Type IV or Type V construction designed in accordance with Section 510.2 or 510.4, attics not required by Item 1 to have sprinklers shall comply with one of the following if the roof assembly is located more than 55 feet (16 764 mm) above the lowest level of fire department vehicle access needed to meet the provisions in Section 503.
  - 3.1. Provide *automatic sprinkler system* protection.
  - 3.2. Construct the *attic* using noncombustible materials.
  - 3.3. Construct the *attic* using *fire-retardant-treated wood* complying with Section 2303.2.
  - 3.4. Fill the *attic* with noncombustible insulation.

The height of the roof assembly shall be determined by measuring the distance from the lowest required fire vehicle access road surface adjacent to the building to the eave of the highest pitched roof, the intersection of the highest roof to the exterior wall, or the top of the highest parapet, whichever yields the greatest distance. For the purpose of this measurement, required fire vehicle access roads shall include only those roads that are necessary for compliance with Section 503 of the *International Fire Code*:

4. Group R-4, Condition 2 occupancy *attics* not required by Item 1 to have sprinklers shall comply with one of the following:
  - 4.1. Provide *automatic sprinkler system* protection.
  - 4.2. Provide a heat detection system throughout the *attic* that is

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

arranged to activate the building fire alarm system.

- 4.3. Construct the *attic* using non-combustible materials.
- 4.4. Construct the *attic* using *fire-retardant-treated wood* complying with Section 2303.2.
- 4.5. Fill the *attic* with noncombustible insulation.

**[F] 903.3.1.3 NFPA 13D sprinkler systems.** *Automatic sprinkler systems* installed in one- and two-family *dwelling*s; Group R-3; Group R-4, Condition 1; and *townhouses* shall be permitted to be installed throughout in accordance with NFPA 13D.

**[F] 903.3.2 Quick-response and residential sprinklers.** Where *automatic sprinkler systems* are required by this code, quick-response or residential automatic sprinklers shall be installed in all of the following areas in accordance with Section 903.3.1 and their listings:

1. Throughout all spaces within a *smoke compartment* containing care recipient *sleeping units* in Group I-2 in accordance with this code.
2. Throughout all spaces within a *smoke compartment* containing gas fireplace appliances and decorative gas appliances in Group I-2.
3. Throughout all spaces within a *smoke compartment* containing treatment rooms in *ambulatory care facilities*.
4. *Dwelling units* and *sleeping units* in Group I-1 and R occupancies.
5. Light-hazard occupancies as defined in NFPA 13.

**[F] 903.3.3 Obstructed locations.** Automatic sprinklers shall be installed with regard to obstructions that will delay activation or obstruct the water distribution pattern and shall be in accordance with the applicable *automatic sprinkler system* standard that is being used. Automatic sprinklers shall be installed in or under covered kiosks, displays, booths, concession stands, or equipment that exceeds 4 feet (1219 mm) in width. Not less than a 3-foot (914 mm) clearance shall be maintained between automatic sprinklers and the top of piles of *combustible fibers*.

**Exception:** Kitchen equipment under exhaust hoods protected with a fire-extinguishing system in accordance with Section 904.

**[F] 903.3.4 Actuation.** *Automatic sprinkler systems* shall be automatically actuated unless specifically provided for in this code.

**[F] 903.3.5 Water supplies.** Water supplies for *automatic sprinkler systems* shall comply with this section and the standards referenced in Section 903.3.1. The potable water supply shall be protected against backflow in accordance with the requirements of this section and the *International Plumbing Code*. For connections to public waterworks systems, the water supply test used for design of fire protection systems shall be adjusted to account for seasonal and daily pressure fluctuations based on infor-

mation from the water supply authority and as approved by the fire code official.

**[F] 903.3.5.1 Domestic services.** Where the domestic service provides the water supply for the *automatic sprinkler system*, the supply shall be in accordance with this section.

**[F] 903.3.5.2 Residential combination services.** A single combination water supply shall be allowed provided that the domestic demand is added to the sprinkler demand as required by NFPA 13R.

**[F] 903.3.6 Hose threads.** Fire hose threads and fittings used in connection with *automatic sprinkler systems* shall be as prescribed by the fire code official.

**[F] 903.3.7 Fire department connections.** Fire department connections for *automatic sprinkler systems* shall be installed in accordance with Section 912.

**[F] 903.3.8 Limited area sprinkler systems.** Limited area sprinkler systems shall be in accordance with the standards listed in Section 903.3.1 except as provided in Sections 903.3.8.1 through 903.3.8.5.

**903.3.8.1 Number of sprinklers.** Limited area sprinkler systems shall not exceed six sprinklers in any single *fire area*.

**903.3.8.2 Occupancy hazard classification.** Only areas classified by NFPA 13 as Light Hazard or Ordinary Hazard Group 1 shall be permitted to be protected by limited area sprinkler systems.

**903.3.8.3 Piping arrangement.** Where a limited area sprinkler system is installed in a building with an automatic wet standpipe system, sprinklers shall be supplied by the standpipe system. Where a limited area sprinkler system is installed in a building without an automatic wet standpipe system, water shall be permitted to be supplied by the plumbing system provided that the plumbing system is capable of simultaneously supplying domestic and sprinkler demands.

**903.3.8.4 Supervision.** Control valves shall not be installed between the water supply and sprinklers unless the valves are of an *approved* indicating type that are supervised or secured in the open position.

**903.3.8.5 Calculations.** Hydraulic calculations in accordance with NFPA 13 shall be provided to demonstrate that the available water flow and pressure are adequate to supply all sprinklers installed in any single *fire area* with discharge densities corresponding to the hazard classification.

**[F] 903.4 Sprinkler system supervision and alarms.** Valves controlling the water supply for *automatic sprinkler systems*, pumps, tanks, water levels and temperatures, critical air pressures and waterflow switches on all sprinkler systems shall be electrically supervised by a *listed* fire alarm control unit.

#### Exceptions:

1. *Automatic sprinkler systems* protecting one- and two-family *dwelling*s.

2. Limited area sprinkler systems in accordance with Section 903.3.8.
3. *Automatic sprinkler systems* installed in accordance with NFPA 13R where a common supply main is used to supply both domestic water and the *automatic sprinkler system*, and a separate shutoff valve for the *automatic sprinkler system* is not provided.
4. Jockey pump control valves that are sealed or locked in the open position.
5. Control valves to commercial kitchen hoods, paint spray booths or dip tanks that are sealed or locked in the open position.
6. Valves controlling the fuel supply to fire pump engines that are sealed or locked in the open position.
7. Trim valves to pressure switches in dry, preaction and deluge sprinkler systems that are sealed or locked in the open position.
8. Underground key or hub gate valves in roadway boxes.

**[F] 903.4.1 Monitoring.** Alarm, supervisory and trouble signals shall be distinctly different and shall be automatically transmitted to an *approved* supervising station or, where *approved* by the fire code official, shall sound an audible signal at a *constantly attended location*.

**Exception:** Backflow prevention device test valves located in limited area sprinkler system supply piping shall be locked in the open position. In occupancies required to be equipped with a fire alarm system, the backflow preventer valves shall be electrically supervised by a tamper switch installed in accordance with NFPA 72 and separately annunciated.

**[F] 903.4.2 Alarms.** An approved audible device, located on the exterior of the building in an approved location, shall be connected to each *automatic sprinkler system*. Such sprinkler waterflow alarm devices shall be activated by water flow equivalent to the flow of a single sprinkler of the smallest orifice size installed in the system. Where a fire alarm system is installed, actuation of the *automatic sprinkler system* shall actuate the building fire alarm system.

**[F] 903.4.3 Floor control valves.** *Approved* supervised indicating control valves shall be provided at the point of connection to the riser on each floor in high-rise buildings.

**[F] 903.5 Testing and maintenance.** Sprinkler systems shall be tested and maintained in accordance with the *International Fire Code*.

## SECTION 904 ALTERNATIVE AUTOMATIC FIRE-EXTINGUISHING SYSTEMS

**[F] 904.1 General.** Automatic fire-extinguishing systems, other than *automatic sprinkler systems*, shall be designed,

installed, inspected, tested and maintained in accordance with the provisions of this section and the applicable referenced standards.

**[F] 904.2 Where permitted.** Automatic fire-extinguishing systems installed as an alternative to the required *automatic sprinkler systems* of Section 903 shall be *approved* by the fire code official.

**[F] 904.2.1 Restriction on using automatic sprinkler system exceptions or reductions.** Automatic fire-extinguishing systems shall not be considered alternatives for the purposes of exceptions or reductions allowed for *automatic sprinkler systems* or by other requirements of this code.

**[F] 904.2.2 Commercial hood and duct systems.** Each required commercial kitchen exhaust hood and duct system required by Section 606 of the *International Fire Code* or Chapter 5 of the *International Mechanical Code* to have a Type I hood shall be protected with an approved automatic fire-extinguishing system installed in accordance with this code.

**[F] 904.3 Installation.** Automatic fire-extinguishing systems shall be installed in accordance with this section.

**[F] 904.3.1 Electrical wiring.** Electrical wiring shall be in accordance with NFPA 70.

**[F] 904.3.2 Actuation.** Automatic fire-extinguishing systems shall be automatically actuated and provided with a manual means of actuation in accordance with Section 904.11.1. Where more than one hazard could be simultaneously involved in fire due to their proximity, all hazards shall be protected by a single system designed to protect all hazards that could become involved.

**Exception:** Multiple systems shall be permitted to be installed if they are designed to operate simultaneously.

**[F] 904.3.3 System interlocking.** Automatic equipment interlocks with fuel shutoffs, ventilation controls, door closers, window shutters, conveyor openings, smoke and heat vents and other features necessary for proper operation of the fire-extinguishing system shall be provided as required by the design and installation standard utilized for the hazard.

**[F] 904.3.4 Alarms and warning signs.** Where alarms are required to indicate the operation of automatic fire-extinguishing systems, distinctive audible and visible alarms and warning signs shall be provided to warn of pending agent discharge. Where exposure to automatic-extinguishing agents poses a hazard to persons and a delay is required to ensure the evacuation of occupants before agent discharge, a separate warning signal shall be provided to alert occupants once agent discharge has begun. Audible signals shall be in accordance with Section 907.5.2.

**[F] 904.3.5 Monitoring.** Where a building fire alarm system is installed, automatic fire-extinguishing systems shall be monitored by the building fire alarm system in accordance with NFPA 72.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 904.4 Inspection and testing.** Automatic fire-extinguishing systems shall be inspected and tested in accordance with the provisions of this section prior to acceptance.

**[F] 904.4.1 Inspection.** Prior to conducting final acceptance tests, all of the following items shall be inspected:

1. Hazard specification for consistency with design hazard.
2. Type, location and spacing of automatic- and manual-initiating devices.
3. Size, placement and position of nozzles or discharge orifices.
4. Location and identification of audible and visible alarm devices.
5. Identification of devices with proper designations.
6. Operating instructions.

**[F] 904.4.2 Alarm testing.** Notification appliances, connections to fire alarm systems and connections to *approved* supervising stations shall be tested in accordance with this section and Section 907 to verify proper operation.

**[F] 904.4.2.1 Audible and visible signals.** The audibility and visibility of notification appliances signaling agent discharge or system operation, where required, shall be verified.

**[F] 904.4.3 Monitor testing.** Connections to protected premises and supervising station fire alarm systems shall be tested to verify proper identification and retransmission of alarms from automatic fire-extinguishing systems.

**[F] 904.5 Wet-chemical systems.** Wet-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17A and their listing. Records of inspections and testing shall be maintained.

**[F] 904.6 Dry-chemical systems.** Dry-chemical extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 17 and their listing. Records of inspections and testing shall be maintained.

**[F] 904.7 Foam systems.** Foam-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 11 and NFPA 16 and their listing. Records of inspections and testing shall be maintained.

**[F] 904.8 Carbon dioxide systems.** Carbon dioxide extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12 and their listing. Records of inspections and testing shall be maintained.

**[F] 904.9 Halon systems.** Halogenated extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 12A and their listing. Records of inspections and testing shall be maintained.

**[F] 904.10 Clean-agent systems.** Clean-agent fire-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 2001 and

their listing. Records of inspections and testing shall be maintained.

**[F] 904.11 Automatic water mist systems.** *Automatic water mist systems* shall be permitted in applications that are consistent with the applicable listing or approvals and shall comply with Sections 904.11.1 through 904.11.3.

**[F] 904.11.1 Design and installation requirements.** *Automatic water mist systems* shall be designed and installed in accordance with Sections 904.11.1.1 through 904.11.1.4.

**[F] 904.11.1.1 General.** *Automatic water mist systems* shall be designed and installed in accordance with NFPA 750 and the manufacturer's instructions.

**[F] 904.11.1.2 Actuation.** *Automatic water mist systems* shall be automatically actuated.

**[F] 904.11.1.3 Water supply protection.** Connections to a potable water supply shall be protected against backflow in accordance with the *International Plumbing Code*.

**[F] 904.11.1.4 Secondary water supply.** Where a secondary water supply is required for an *automatic sprinkler system*, an *automatic water mist system* shall be provided with an *approved* secondary water supply.

**[F] 904.11.2 Water mist system supervision and alarms.** Supervision and alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.

**[F] 904.11.2.1 Monitoring.** Monitoring shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.1.

**[F] 904.11.2.2 Alarms.** Alarms shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.2.

**[F] 904.11.2.3 Floor control valves.** Floor control valves shall be provided as required for *automatic sprinkler systems* in accordance with Section 903.4.3.

**[F] 904.11.3 Testing and maintenance.** *Automatic water mist systems* shall be tested and maintained in accordance with the *International Fire Code*.

**[F] 904.12 Aerosol fire-extinguishing systems.** Aerosol fire-extinguishing systems shall be installed, maintained, periodically inspected and tested in accordance with NFPA 2010, and their listing.

Such devices and appurtenances shall be listed and installed in compliance with manufacturers' instructions.

**[F] 904.13 Commercial cooking systems.** The automatic fire-extinguishing system for commercial cooking systems shall be of a type recognized for protection of commercial cooking equipment and exhaust systems of the type and arrangement protected. Preengineered automatic dry- and wet-chemical extinguishing systems shall be tested in accordance with UL 300 and *listed* and *labeled* for the intended application. Other types of automatic fire-extinguishing systems shall be *listed* and *labeled* for specific use as protection for commercial cooking operations. The system shall be

\*  
\*\*

\*\*



installed in accordance with this code, NFPA 96, its listing and the manufacturer's installation instructions. Automatic fire-extinguishing systems of the following types shall be installed in accordance with the referenced standard indicated, as follows:

1. Carbon dioxide extinguishing systems, NFPA 12.
2. *Automatic sprinkler systems*, NFPA 13.
3. Automatic water mist systems, NFPA 750.
4. Foam-water sprinkler system or foam-water spray systems, NFPA 16.
5. Dry-chemical extinguishing systems, NFPA 17.
6. Wet-chemical extinguishing systems, NFPA 17A.

**Exception:** Factory-built commercial cooking recirculating systems that are tested in accordance with UL 710B and *listed, labeled* and installed in accordance with Section 304.1 of the *International Mechanical Code*.

**[F] 904.13.1 Manual system operation.** A manual actuation device shall be located at or near a *means of egress* from the cooking area not less than 10 feet (3048 mm) and not more than 20 feet (6096 mm) from the kitchen exhaust system. The manual actuation device shall be installed not more than 48 inches (1200 mm) or less than 42 inches (1067 mm) above the floor and shall clearly identify the hazard protected. The manual actuation shall require a maximum force of 40 pounds (178 N) and a maximum movement of 14 inches (356 mm) to actuate the fire suppression system.

**Exception:** *Automatic sprinkler systems* shall not be required to be equipped with manual actuation means.

**[F] 904.13.2 System interconnection.** The actuation of the fire suppression system shall automatically shut down the fuel or electrical power supply to the cooking equipment. The fuel and electrical supply reset shall be manual.

**[F] 904.13.3 Carbon dioxide systems.** Where carbon dioxide systems are used, there shall be a nozzle at the top of the ventilating duct. Additional nozzles that are symmetrically arranged to give uniform distribution shall be installed within vertical ducts exceeding 20 feet (6096 mm) and horizontal ducts exceeding 50 feet (15 240 mm). *Dampers* shall be installed at either the top or the bottom of the duct and shall be arranged to operate automatically upon activation of the fire-extinguishing system. Where the *damper* is installed at the top of the duct, the top nozzle shall be immediately below the *damper*. Automatic carbon dioxide fire-extinguishing systems shall be sufficiently sized to protect against all hazards venting through a common duct simultaneously.

**[F] 904.13.3.1 Ventilation system.** Commercial-type cooking equipment protected by an automatic carbon dioxide-extinguishing system shall be arranged to shut off the ventilation system upon activation.

**[F] 904.13.4 Special provisions for automatic sprinkler systems.** *Automatic sprinkler systems* protecting commercial-type cooking equipment shall be supplied from a separate, indicating-type control valve that is identified. Access to the control valve shall be provided.

**[F] 904.13.4.1 Listed sprinklers.** Sprinklers used for the protection of fryers shall be tested in accordance with UL 199E, *listed* for that application and installed in accordance with their listing.

**[F] 904.14 Domestic cooking facilities.** Cooktops and ranges installed in the following occupancies shall be protected in accordance with Section 904.14.1:

1. In Group I-1 occupancies where domestic cooking facilities are installed in accordance with Section 420.9.
2. In Group I-2 occupancies where domestic cooking facilities are installed in accordance with Section 407.2.7.
3. In Group R-2 college *dormitories* where domestic cooking facilities are installed in accordance with Section 420.11.
4. New and existing day care facilities shall be provided with automatic fire-extinguishing systems for cooking appliances utilizing a cooking surface. Automatic fire-extinguishing systems designed for residential use are allowed for protection of domestic cooking appliances.

**Exception:** In-home day care licensed for 16 or fewer children and all of the following requirements are met:

1. The license holder resides in the home.
2. The licensed care giver resides in the home.
3. A signed agreement to not conduct cooking that produces grease-laden vapors during the hours of day care operation is provided.

**[F] 904.14.1 Protection from fire.** Cooktops and ranges shall be protected in accordance with Section 904.14.1.1 or 904.14.1.2.

**[F] 904.14.1.1 Automatic fire-extinguishing system.** The domestic recirculating or exterior vented cooking hood provided over the cooktop or range shall be equipped with an approved automatic fire-extinguishing system complying with the following:

1. The automatic fire-extinguishing system shall be of a type recognized for protection of domestic cooking equipment. Preengineered automatic fire-extinguishing systems shall be listed and labeled in accordance with UL 300A and installed in accordance with the manufacturer's instructions.
2. Manual actuation of the fire-extinguishing system shall be provided in accordance with Section 904.13.1.
3. Interconnection of the fuel and electric power supply shall be in accordance with Section 904.13.2.

**[F] 904.14.1.2 Ignition prevention.** Cooktops and ranges shall include burners that have been tested and listed to prevent ignition of cooking oil with burners turned on to their maximum heat settings and allowed to operate for 30 minutes.

\*

## SECTION 905 STANDPIPE SYSTEMS

**[F] 905.1 General.** Standpipe systems shall be provided in new buildings and structures in accordance with Sections 905.2 through 905.11. In buildings used for high-piled combustible storage, fire protection shall be in accordance with the *International Fire Code*.

**[F] 905.2 Installation standard.** Standpipe systems shall be installed in accordance with this section and NFPA 14. Fire department connections for standpipe systems shall be in accordance with Section 912.

**[F] 905.3 Required installations.** Standpipe systems shall be installed where required by Sections 905.3.1 through 905.3.8. Standpipe systems are allowed to be combined with *automatic sprinkler systems*.

**Exception:** Standpipe systems are not required in Group R-3 occupancies.

**[F] 905.3.1 Height.** Class III standpipe systems shall be installed throughout buildings where any of the following conditions exist:

1. Four or more stories are above or below *grade plane*.
2. The floor level of the highest *story* is located more than 30 feet (9144 mm) above the lowest level of fire department vehicle access.
3. The floor level of the lowest *story* is located more than 30 feet (9144 mm) below the highest level of fire department vehicle access.

### Exceptions:

1. Class I standpipes are allowed in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
2. Class I standpipes are allowed in Group B and E occupancies.
3. Class I standpipes are allowed in parking garages.
4. Class I standpipes are allowed in basements equipped throughout with an *automatic sprinkler system*.
5. Class I standpipes are allowed in buildings where occupant-use hose lines will not be utilized by trained personnel or the fire department.
6. In determining the lowest level of fire department vehicle access, it shall not be required to consider either of the following:
  - 6.1. Recessed loading docks for four vehicles or less.
  - 6.2. Conditions where topography makes access from the fire department vehicle to the building impractical or impossible.

**[F] 905.3.2 Group A.** Class I automatic wet standpipes shall be provided in nonsprinklered Group A buildings having an *occupant load* exceeding 1,000 persons.

### Exceptions:

1. Open-air-seating spaces without enclosed spaces.
2. Class I automatic dry and semiautomatic dry standpipes or manual wet standpipes are allowed in buildings that are not high-rise buildings.

**[F] 905.3.3 Covered and open mall buildings.** Covered mall and *open mall buildings* shall be equipped throughout with a standpipe system where required by Section 905.3.1. Mall buildings not required to be equipped with a standpipe system by Section 905.3.1 shall be equipped with Class I hose connections connected to the *automatic sprinkler system* sized to deliver water at 250 gallons per minute (946.4 L/min) at the hydraulically most remote hose connection while concurrently supplying the automatic sprinkler system demand. The standpipe system shall be designed to not exceed a 50 pounds per square inch (psi) (345 kPa) residual pressure loss with a flow of 250 gallons per minute (946.4 L/min) from the fire department connection to the hydraulically most remote hose connection. Hose connections shall be provided at each of the following locations:

1. Within the mall at the entrance to each *exit passageway* or *corridor*.
2. At each floor-level landing within *interior exit stairways* opening directly on the mall.
3. At exterior public entrances to the mall of a *covered mall building*.
4. At public entrances at the perimeter line of an *open mall building*.
5. At other locations as necessary so that the distance to reach all portions of a tenant space does not exceed 200 feet (60 960 mm) from a hose connection.

**[F] 905.3.4 Stages.** *Stages* greater than 1,000 square feet in area (93 m<sup>2</sup>) shall be equipped with a Class III wet standpipe system with 1½-inch and 2½-inch (38 mm and 64 mm) hose connections on each side of the stage.

**Exception:** Where the building or area is equipped throughout with an *automatic sprinkler system*, a 1½-inch (38 mm) hose connection shall be installed in accordance with NFPA 13 or in accordance with NFPA 14 for Class II or III standpipes.

**[F] 905.3.4.1 Hose and cabinet.** The 1½-inch (38 mm) hose connections shall be equipped with sufficient lengths of 1½-inch (38 mm) hose to provide fire protection for the stage area. Hose connections shall be equipped with an *approved* adjustable fog nozzle and be mounted in a cabinet or on a rack.

**[F] 905.3.5 Underground buildings.** Underground buildings shall be equipped throughout with a Class I automatic wet or manual wet standpipe system.

**[F] 905.3.6 Helistops and heliports.** Buildings with a rooftop *helistop* or *heliport* shall be equipped with a Class

I or III standpipe system extended to the roof level on which the *helistop* or *heliport* is located in accordance with Section 2007.5 of the *International Fire Code*.

**[F] 905.3.7 Marinas and boatyards.** Standpipes in marinas and boatyards shall comply with Chapter 36 of the *International Fire Code*.

**[F] 905.3.8 Landscaped roofs.** Buildings or structures that have landscaped roofs and that are equipped with a standpipe system shall have the standpipe system extended to the roof level on which the landscaped roof is located.

**[F] 905.4 Location of Class I standpipe hose connections.** Class I standpipe hose connections shall be provided in all of the following locations:

1. In every required *interior exit stairway*, a hose connection shall be provided for each story above and below *grade plane*. Hose connections shall be located at the main floor landing unless otherwise *approved* by the fire code official.

**Exception:** A single hose connection shall be permitted to be installed in the open corridor or open breezeway between open *stairs* that are not greater than 75 feet (22 860 mm) apart.

2. On each side of the wall adjacent to the exit opening of a *horizontal exit*.

**Exception:** Where floor areas adjacent to a *horizontal exit* are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the *horizontal exit*.

3. In every *exit passageway*, at the entrance from the *exit passageway* to other areas of a building.

**Exception:** Where floor areas adjacent to an *exit passageway* are reachable from an *interior exit stairway* hose connection by a 30-foot (9144 mm) hose stream from a nozzle attached to 100 feet (30 480 mm) of hose, a hose connection shall not be required at the entrance from the *exit passageway* to other areas of the building.

4. In covered mall buildings, adjacent to each exterior public entrance to the mall and adjacent to each entrance from an *exit passageway* or *exit corridor* to the mall. In *open mall buildings*, adjacent to each public entrance to the mall at the perimeter line and adjacent to each entrance from an *exit passageway* or *exit corridor* to the mall.
5. Where the roof has a slope less than 4 units vertical in 12 units horizontal (33.3-percent slope), a hose connection shall be located to serve the roof or at the highest landing of an *interior exit stairway* with access to the roof provided in accordance with Section 1011.12.
6. Where the most remote portion of a nonsprinklered floor or *story* is more than 150 feet (45 720 mm) from a hose connection or the most remote portion of

a sprinklered floor or *story* is more than 200 feet (60 960 mm) from a hose connection, the fire code official is authorized to require that additional hose connections be provided in *approved* locations.

**[F] 905.4.1 Protection.** Risers and laterals of Class I standpipe systems not located within an *interior exit stairway* shall be protected by a degree of *fire resistance* equal to that required for vertical enclosures in the building in which they are located.

**Exception:** In buildings equipped throughout with an *approved automatic sprinkler system*, laterals that are not located within an *interior exit stairway* are not required to be enclosed within fire-resistance-rated construction.

**[F] 905.4.2 Interconnection.** In buildings where more than one standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

**[F] 905.5 Location of Class II standpipe hose connections.** Class II standpipe hose connections located so that all portions of the building are within 30 feet (9144 mm) of a nozzle attached to 100 feet (30 480 mm) of hose. Class II standpipe hose connections shall be located where they will have *ready access*.

**[F] 905.5.1 Groups A-1 and A-2.** In Group A-1 and A-2 occupancies having *occupant loads* exceeding 1,000 persons, hose connections shall be located on each side of any stage, on each side of the rear of the auditorium, on each side of the balcony and on each tier of dressing rooms.

**[F] 905.5.2 Protection.** Fire-resistance-rated protection of risers and laterals of Class II standpipe systems is not required.

**[F] 905.5.3 Class II system 1-inch hose.** A minimum 1-inch (25 mm) hose shall be allowed to be used for hose stations in light-hazard occupancies where investigated and *listed* for this service and where *approved* by the fire code official.

**[F] 905.6 Location of Class III standpipe hose connections.** Class III standpipe systems shall have hose connections located as required for Class I standpipes in Section 905.4 and shall have Class II hose connections as required in Section 905.5.

**[F] 905.6.1 Protection.** Risers and laterals of Class III standpipe systems shall be protected as required for Class I systems in accordance with Section 905.4.1.

**[F] 905.6.2 Interconnection.** In buildings where more than one Class III standpipe is provided, the standpipes shall be interconnected in accordance with NFPA 14.

**[F] 905.7 Cabinets.** Cabinets containing fire-fighting equipment such as standpipes, fire hoses, fire extinguishers or fire department valves shall not be blocked from use or obscured from view.

**[F] 905.7.1 Cabinet equipment identification.** Cabinets shall be identified in an *approved* manner by a permanently attached sign with letters not less than 2 inches

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

(51 mm) high in a color that contrasts with the background color, indicating the equipment contained therein.

### Exceptions:

1. Doors not large enough to accommodate a written sign shall be marked with a permanently attached pictogram of the equipment contained therein.
2. Doors that have either an *approved* visual identification clear glass panel or a complete glass door panel are not required to be marked.

**[F] 905.7.2 Locking cabinet doors.** Cabinets shall be unlocked.

### Exceptions:

1. Visual identification panels of glass or other *approved* transparent frangible material that is easily broken and allows access.
2. *Approved* locking arrangements.
3. Group I-3 occupancies.

**[F] 905.8 Dry standpipes.** Dry standpipes shall not be installed.

**Exception:** Where subject to freezing and in accordance with NFPA 14.

**[F] 905.9 Valve supervision.** Valves controlling water supplies shall be supervised in the open position so that a change in the normal position of the valve will generate a supervisory signal at the supervising station required by Section 903.4. Where a fire alarm system is provided, a signal shall be transmitted to the control unit.

### Exceptions:

1. Valves to underground key or hub valves in roadway boxes do not require supervision.
2. Valves locked in the normal position and inspected as provided in this code in buildings not equipped with a fire alarm system.

**[F] 905.10 During construction.** Standpipe systems required during construction and demolition operations shall be provided in accordance with Section 3311.

**[F] 905.11 Locking standpipe outlet caps.** The *fire code official* is authorized to require locking caps on the outlets on standpipes where the responding fire department carries key wrenches for the removal that are compatible with locking FDC connection caps.

## SECTION 906 PORTABLE FIRE EXTINGUISHERS

**[F] 906.1 Where required.** Portable fire extinguishers shall be installed in all of the following locations:

1. In Group A, B, E, F, H, I, M, R-1, R-2, R-4 and S occupancies.

### Exceptions:

1. In Group R-2 occupancies, portable fire extinguishers shall be required only in

locations specified in Items 2 through 6 where each dwelling unit is provided with a portable fire extinguisher having a minimum rating of 1-A:10-B:C.

2. In Group E occupancies, portable fire extinguishers shall be required only in locations specified in Items 2 through 6 where each classroom is provided with a portable fire extinguisher having a minimum rating of 2-A:20-B:C.
3. In storage areas of Group S Occupancies where forklift, powered industrial truck or powered cart operators are the primary occupants, fixed extinguishers, as specified in NFPA 10, shall not be required where in accordance with all of the following:
  - 3.1. Use of vehicle-mounted extinguishers shall be approved by the fire code official.
  - 3.2. Each vehicle shall be equipped with a 10-pound, 40A:80B:C extinguisher affixed to the vehicle using a mounting bracket approved by the extinguisher manufacturer or the fire code official for vehicular use.
  - 3.3. Not less than two spare extinguishers of equal or greater rating shall be available on site to replace a discharged extinguisher.
  - 3.4. Vehicle operators shall be trained in the proper operation, use and inspection of extinguishers.
  - 3.5. Inspections of vehicle-mounted extinguishers shall be performed daily.

2. Within 30 feet (9144 mm) distance of travel from commercial cooking equipment and from domestic cooking equipment in Group I-1; I-2, Condition 1; and R-2 college *dormitory* occupancies.
3. In areas where flammable or *combustible liquids* are stored, used or dispensed.
4. On each floor of structures under construction, except Group R-3 occupancies, in accordance with Section 3315.1 of the *International Fire Code*.
5. Where required by the *International Fire Code* sections indicated in Table 906.1.
6. Special-hazard areas, including but not limited to laboratories, computer rooms and generator rooms, where required by the fire code official.

**Exception:** Portable fire extinguishers are not required at normally unmanned Group U occupancy buildings or structures where a portable fire extinguisher suitable to the hazard of the location is provided on the vehicle of visiting personnel.



**[F] TABLE 906.1**  
**ADDITIONAL REQUIRED PORTABLE**  
**FIRE EXTINGUISHERS IN THE INTERNATIONAL FIRE CODE**

IFC SECTION	SUBJECT
303.5	Asphalt kettles
307.5	Open burning
308.1.3	Open flames—torches
309.4	Powered industrial trucks
1204.10	Portable Generators
2005.2	Aircraft towing vehicles
2005.3	Aircraft welding apparatus
2005.4	Aircraft fuel-servicing tank vehicles
2005.5	Aircraft hydrant fuel-servicing vehicles
2005.6	Aircraft fuel-dispensing stations
2007.7	Heliports and helistops
2108.4	Dry cleaning plants
2305.5	Motor fuel-dispensing facilities
2310.6.4	Marine motor fuel-dispensing facilities
2311.6	Repair garages
2404.4.1	Spray-finishing operations
2405.4.2	Dip-tank operations
2406.4.2	Powder-coating areas
2804.3	Lumberyards/woodworking facilities
2808.8	Recycling facilities
2809.5	Exterior lumber storage
2903.5	Organic-coating areas
3006.3	Industrial ovens
3107.9	Tents and membrane structures
3206.10	High-piled storage
3315.1	Buildings under construction or demolition
3318.3	Roofing operations
3408.2	Tire rebuilding/storage
3504.2.6	Welding and other hot work
3604.4	Marinas
3703.6	Combustible fibers
5703.2.1	Flammable and combustible liquids, general
5704.3.3.1	Indoor storage of flammable and combustible liquids
5704.3.7.5.2	Liquid storage rooms for flammable and combustible liquids
5705.4.9	Solvent distillation units
5706.2.7	Farms and construction sites—flammable and combustible liquids storage
5706.4.10.1	Bulk plants and terminals for flammable and combustible liquids
5706.5.4.5	Commercial, industrial, governmental or manufacturing establishments—fuel dispensing
5706.6.4	Tank vehicles for flammable and combustible liquids
5906.5.7	Flammable solids
6108.2	LP-gas

**[F] 906.2 General requirements.** Portable fire extinguishers shall be selected and installed in accordance with this section and NFPA 10.

**Exceptions:**

1. The distance of travel to reach an extinguisher shall not apply to the spectator seating portions of Group A-5 occupancies.
2. In Group I-3, portable fire extinguishers shall be permitted to be located at staff locations.

**[F] 906.3 Size and distribution.** The size and distribution of portable fire extinguishers shall be in accordance with Sections 906.3.1 through 906.3.4.

**[F] TABLE 906.3(1)**  
**FIRE EXTINGUISHERS FOR CLASS A FIRE HAZARDS**

	<b>LIGHT (Low) HAZARD OCCUPANCY</b>	<b>ORDINARY (Moderate) HAZARD OCCUPANCY</b>	<b>EXTRA (High) HAZARD OCCUPANCY</b>
Minimum-rated single extinguisher	2-A <sup>c</sup>	2-A	4-A <sup>a</sup>
Maximum floor area per unit of A	3,000 square feet	1,500 square feet	1,000 square feet
Maximum floor area for extinguisher <sup>b</sup>	11,250 square feet	11,250 square feet	11,250 square feet
Maximum distance of travel to extinguisher	75 feet	75 feet	75 feet

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929m<sup>2</sup>, 1 gallon = 3.785 L.

- a. Two 2½-gallon water-type extinguishers shall be deemed the equivalent of one 4-A rated extinguisher.
- b. Annex E.3.3 of NFPA 10 provides more details concerning application of the maximum floor area criteria.
- c. Two water-type extinguishers each with a 1-A rating shall be deemed the equivalent of one 2-A rated extinguisher for Light (Low) Hazard Occupancies.

**[F] TABLE 906.3(2)**  
**FIRE EXTINGUISHERS FOR FLAMMABLE OR COMBUSTIBLE LIQUIDS WITH DEPTHS LESS THAN OR EQUAL TO 0.25 INCH<sup>a</sup>**

TYPE OF HAZARD	<b>BASIC MINIMUM EXTINGUISHER RATING</b>	<b>MAXIMUM DISTANCE OF TRAVEL TO EXTINGUISHERS (feet)</b>
Light (Low)	5-B	30
	10-B	50
Ordinary (Moderate)	10-B	30
	20-B	50
Extra (High)	40-B	30
	80-B	50

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. For requirements on water-soluble flammable liquids and alternative sizing criteria, see Section 5.5 of NFPA 10.

**[F] 906.3.1 Class A fire hazards.** The minimum sizes and distribution of portable fire extinguishers for occupancies that involve primarily Class A fire hazards shall comply with Table 906.3(1).

**[F] 906.3.2 Class B fire hazards.** Portable fire extinguishers for occupancies involving flammable or combustible liquids with depths less than or equal to 0.25-inch (6.4 mm) shall be selected and placed in accordance with Table 906.3(2).

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

Portable fire extinguishers for occupancies involving flammable or combustible liquids with a depth of greater than 0.25-inch (6.4 mm) shall be selected and placed in accordance with NFPA 10.

**[F] 906.3.3 Class C fire hazards.** Portable fire extinguishers for Class C fire hazards shall be selected and placed on the basis of the anticipated Class A or B hazard.

**[F] 906.3.4 Class D fire hazards.** Portable fire extinguishers for occupancies involving combustible metals shall be selected and placed in accordance with NFPA 10.

**[F] 906.4 Cooking equipment fires.** Fire extinguishers provided for the protection of cooking equipment shall be of an *approved* type compatible with the automatic fire-extinguishing system agent. Cooking equipment involving solid fuels or vegetable or animal oils and fats shall be protected by a Class K-rated portable extinguisher in accordance with Sections 906.1, Item 2, 906.4.1 and 906.4.2 of the *International Fire Code*, as applicable.

**[F] 906.5 Conspicuous location.** Portable fire extinguishers shall be located in conspicuous locations where they will have *ready access* and be immediately available for use. These locations shall be along normal paths of travel, unless the fire code official determines that the hazard posed indicates the need for placement away from normal paths of travel.

**[F] 906.6 Unobstructed and unobscured.** Portable fire extinguishers shall not be obstructed or obscured from view. In rooms or areas in which visual obstruction cannot be completely avoided, means shall be provided to indicate the locations of extinguishers.

**[F] 906.7 Hangers and brackets.** Hand-held portable fire extinguishers, not housed in cabinets, shall be installed on the hangers or brackets supplied. Hangers or brackets shall be securely anchored to the mounting surface in accordance with the manufacturer's installation instructions.

**[F] 906.8 Cabinets.** Cabinets used to house portable fire extinguishers shall not be locked.

### Exceptions:

1. Where portable fire extinguishers subject to malicious use or damage are provided with a means of ready access.
2. In Group I-3 occupancies and in mental health areas in Group I-2 occupancies, access to portable fire extinguishers shall be permitted to be locked or to be located in staff locations provided that the staff has keys.

**[F] 906.9 Extinguisher installation.** The installation of portable fire extinguishers shall be in accordance with Sections 906.9.1 through 906.9.3.

**[F] 906.9.1 Extinguishers weighing 40 pounds or less.** Portable fire extinguishers having a gross weight not exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 5 feet (1524 mm) above the floor.

**[F] 906.9.2 Extinguishers weighing more than 40 pounds.** Hand-held portable fire extinguishers having a

gross weight exceeding 40 pounds (18 kg) shall be installed so that their tops are not more than 3.5 feet (1067 mm) above the floor.

**[F] 906.9.3 Floor clearance.** The clearance between the floor and the bottom of installed hand-held portable fire extinguishers shall be not less than 4 inches (102 mm).

**[F] 906.10 Wheeled units.** Wheeled fire extinguishers shall be conspicuously located in a designated location.

## SECTION 907

### FIRE ALARM AND DETECTION SYSTEMS

**[F] 907.1 General.** This section covers the application, installation, performance and maintenance of fire alarm systems and their components.

**[F] 907.1.1 Construction documents.** *Construction documents* for fire alarm systems shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code, the *International Fire Code*; and relevant laws, ordinances, rules and regulations, as determined by the fire code official.

**[F] 907.1.2 Fire alarm shop drawings.** Shop drawings for fire alarm systems shall be prepared in accordance with NFPA 72 and submitted for review and approval prior to system installation. Final as-built drawings shall be submitted as required by the authority having jurisdiction. Shop drawings shall include, but not be limited to, all of the following:

1. Project name and address. Owner's name address and phone number.
2. Contractor name, address, phone number, license number, license classification, and license limit.
3. Occupancy classification for building and each area including occupant load.
4. Fire alarm circuit classification (power-limited).
5. Class/style designation of all initiating device circuit (IDC), signaling circuits (SLC), and notification appliance circuits (NAC).
6. Conductor type and size.
7. Sequence of operation input/output matrix as required by NFPA 72.
8. Symbol legend with equipment description (manufacturer's name and model number) and mounting description (surface, semi-flush, flush, and exterior).
9. When required by the fire code official symbols used on the shop drawings shall follow NFPA 170.
10. Site plan.
11. Floor plan drawn to an indicated scale [ $1/8$  inch (3.2 mm) minimum] on sheets of a uniform size showing:
  - a. Point of compass (north arrow).
  - b. Key plans.

- c. Walls, doors, windows, stairs, elevators, high piled storage racks, etc. as needed to indicate all conditions and requirements.
  - d. Room use identification labels.
  - e. Alarm initiating device, notification appliance, and auxiliary controlled or monitored equipment and systems, control and annunciation equipment location(s).
  - f. Conductor/conduit routing and size.
  - g. Location of end-of-line resistors.
  - h. Device address.
  - i. Notification appliance numbering by circuit and device corresponding to the riser and/or one line diagrams.
  - j. Power panels and circuits connections.
  - k. Ceiling heights and construction (i.e., beam, joist, soffit, or projection extending below the ceiling when a ceiling mounted device and/or appliance is used).
12. Mounting height detail for wall mounted device and/or appliance.
13. Riser diagram including the following information:
- a. General arrangement of the system, in building cross section.
  - b. Wall/shaft/stairwell and/or cable ratings when survivability or class A requirements apply.
  - c. Type and number of circuits in each riser.
  - d. Type and number of fire alarm system components/devices on each circuit, on each floor or level.
14. Standardized calculations:
- a. Battery (all panels).
  - b. Load (all notification appliance and auxiliary circuits).
  - c. Voltage drop (all notification appliance circuits, including remote annunciators and auxiliary appliances).
15. Project data submittal including a cover index sheet listing products used by make and model number, manufacturer data sheets and listing information for all equipment, devices, materials, wire and cable.
16. Design number and detail of penetration fire stop system where required.
17. Any additional information determined necessary by the Fire Code Official.

**[F] 907.1.3 Equipment.** Systems and components shall be *listed* and *approved* for the purpose for which they are installed.

**[F] 907.2 Where required—new buildings and structures.** An *approved* fire alarm system installed in accordance with the provisions of this code and NFPA 72

shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.5, unless other requirements are provided by another section of this code.

Not fewer than one manual fire alarm box shall be provided in an *approved* location to initiate a fire *alarm signal* for fire alarm systems employing automatic fire detectors or waterflow detection devices. Where other sections of this code allow elimination of fire alarm boxes due to sprinklers, a single fire alarm box shall be installed.

#### Exceptions:

1. The manual fire alarm box is not required for fire alarm systems dedicated to elevator recall control and supervisory service.
2. The manual fire alarm box is not required for Group R-2 occupancies unless required by the *fire code official* to provide a means for fire watch personnel to initiate an alarm during a sprinkler system impairment event. Where provided, the manual fire alarm box shall not be located in an area that is open to the public.

**[F] 907.2.1 Group A.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group A occupancies where the *occupant load* due to the assembly occupancy is 300 or more, or where the Group A *occupant load* is more than 100 persons above or below the *lowest level of exit discharge*. Group A occupancies not separated from one another in accordance with Section 707.3.10 shall be considered as a single occupancy for the purposes of applying this section. Portions of Group E occupancies occupied for assembly purposes shall be provided with a fire alarm system as required for the Group E occupancy.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**[F] 907.2.1.1 System initiation in Group A occupancies with an occupant load of 1,000 or more.** Activation of the fire alarm in Group A occupancies with an *occupant load* of 1,000 or more shall initiate a signal using an emergency voice/alarm communications system in accordance with Section 907.5.2.2.

**Exception:** Where *approved*, the prerecorded announcement is allowed to be manually deactivated for a period of time, not to exceed 3 minutes, for the sole purpose of allowing a live voice announcement from an *approved, constantly attended location*.

**[F] 907.2.1.2 Emergency voice/alarm communication captions.** Stadiums, arenas and *grandstands* required to caption audible public announcements shall be in accordance with Section 907.5.2.2.4.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 907.2.2 Group B.** A manual fire alarm system, which activates the occupant notification system in accordance with Section 907.5, shall be installed in Group B occupancies where one of the following conditions exists:

1. The combined Group B *occupant load* of all floors is 500 or more.
2. The Group B *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.
3. The *fire area* contains an *ambulatory care facility*.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**[F] 907.2.2.1 Ambulatory care facilities.** *Fire areas* containing *ambulatory care facilities* shall be provided with an electronically supervised automatic smoke detection system installed within the ambulatory care facility and in *public use areas* outside of tenant spaces, including public *corridors* and elevator lobbies.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, provided that the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

**[F] 907.2.3 Group E.** A manual fire alarm system that initiates the occupant notification signal utilizing an emergency voice/alarm communication system meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall be installed in Group E occupancies. Where *automatic sprinkler systems* or smoke detectors are installed, such systems or detectors shall be connected to the building fire alarm system. The provisions of Section 907.2.3.1 through 907.2.3.3 shall apply in rooms normally occupied by preschool or kindergarten students when used for sleeping.

#### Exceptions:

1. A manual fire alarm system shall not be required in Group E occupancies with an *occupant load* of 50 or less.
2. Emergency voice/alarm communication systems meeting the requirements of Section 907.5.2.2 and installed in accordance with Section 907.6 shall not be required in Group E occupancies with *occupant loads* of 100 or less, provided that activation of the manual fire alarm system initiates an *approved* occupant notification signal in accordance with Section 907.5.
3. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:

3.1. Interior *corridors* are protected by smoke detectors.

3.2. Auditoriums, cafeterias, gymnasiums and similar areas are protected by *heat detectors* or other *approved* detection devices.

3.3. Shops and laboratories involving dusts or vapors are protected by *heat detectors* or other *approved* detection devices.

3.4. Manual activation is provided from a normally occupied location.

4. Manual fire alarm boxes shall not be required in Group E occupancies where all of the following apply:

4.1. The building is equipped throughout with an *approved automatic sprinkler system* installed in accordance with Section 903.3.1.1.

4.2. The emergency voice/alarm communication system will activate on sprinkler waterflow.

4.3. Manual activation is provided from a normally occupied location.

**907.2.3.1 Day care facilities.** Day care facilities with an occupant load of 30 or less shall be protected with single or multiple station smoke alarms in the following places:

1. On the ceiling or wall outside of each day care room used for sleeping (in the immediate vicinity of the room).
2. In each day care room used for sleeping.

**907.2.3.2 Interconnection.** Where more than one smoke alarm is required to be installed the smoke detectors shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms. Physical interconnection of smoke alarms shall not be required where listed wireless alarms are installed and all alarms sound upon activation of one alarm.

**907.2.3.3 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery back-up shall be connected to an emergency electrical system. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

[F] **907.2.4 Group F.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group F occupancies where both of the following conditions exist:

1. The Group F occupancy is two or more *stories* in height.
2. The Group F occupancy has a combined *occupant load* of 500 or more above or below the lowest *level of exit discharge*.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

[F] **907.2.5 Group H.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group H-5 occupancies and in occupancies used for the manufacture of organic coatings. An automatic smoke detection system shall be installed for *highly toxic* gases, organic peroxides and oxidizers in accordance with Chapters 60, 62 and 63, respectively, of the *International Fire Code*.

[F] **907.2.6 Group I.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group I occupancies. An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in accordance with Sections 907.2.6.1, 907.2.6.2 and 907.2.6.3.3.

**Exceptions:**

1. Manual fire alarm boxes in sleeping units of Group I-1 and I-2 occupancies shall not be required at *exits* if located at all care providers' control stations or other constantly attended staff locations, provided that such manual fire alarm boxes are visible and provided with *ready access*, and the distances of travel required in Section 907.4.2.1 are not exceeded.
2. Occupant notification systems are not required to be activated where private mode signaling installed in accordance with NFPA 72 is *approved* by the fire code official and staff evacuation responsibilities are included in the fire safety and evacuation plan required by Section 404 of the *International Fire Code*.

[F] **907.2.6.1 Group I-1.** In Group I-1 occupancies, an automatic smoke detection system shall be installed in *corridors*, waiting areas open to corridors and *habitable spaces* other than *sleeping units* and kitchens. The system shall be activated in accordance with Section 907.5.

**Exceptions:**

1. For Group I-1, Condition 1 occupancies, smoke detection in *habitable spaces* is not required where the facility is equipped

throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

2. Smoke detection is not required for exterior balconies.

[F] **907.2.6.1.1 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

[F] **907.2.6.2 Group I-2.** An automatic smoke detection system shall be installed in *corridors* in Group I-2, Condition 1 facilities and spaces permitted to be open to the corridors by Section 407.2. The system shall be activated in accordance with Section 907.4. Group I-2, Condition 2 occupancies shall be equipped with an automatic smoke detection system as required in Section 407.

**Exceptions:**

1. Corridor smoke detection is not required in *smoke compartments* that contain sleeping units where such units are provided with smoke detectors that comply with UL 268. Such detectors shall provide a visual display on the corridor side of each sleeping unit and shall provide an audible and visual alarm at the care providers' station attending each unit.
2. Corridor smoke detection is not required in *smoke compartments* that contain sleeping units where sleeping unit doors are equipped with automatic door-closing devices with integral smoke detectors on the unit sides installed in accordance with their listing, provided that the integral detectors perform the required alerting function.

[F] **907.2.6.3 Group I-3 occupancies.** Group I-3 occupancies shall be equipped with a manual fire alarm system and automatic smoke detection system installed for alerting staff.

[F] **907.2.6.3.1 System initiation.** Actuation of an automatic fire-extinguishing system, *automatic sprinkler system*, a manual fire alarm box or a fire detector shall initiate an approved fire *alarm signal* that automatically notifies staff.

[F] **907.2.6.3.2 Manual fire alarm boxes.** Manual fire alarm boxes are not required to be located in accordance with Section 907.4.2 where the fire alarm boxes are provided at staff-attended locations having direct supervision over areas where manual fire alarm boxes have been omitted.

[F] **907.2.6.3.2.1 Manual fire alarm boxes in detainee areas.** Manual fire alarm boxes are allowed to be locked in areas occupied by detainees, provided that staff members are present within the subject area and have keys readily available to operate the manual fire alarm boxes.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 907.2.6.3.3 Automatic smoke detection system.** An automatic smoke detection system shall be installed throughout resident housing areas, including *sleeping units* and contiguous day rooms, group activity spaces and other common spaces normally open to residents.

### Exceptions:

1. Other *approved* smoke detection arrangements providing equivalent protection, including, but not limited to, placing detectors in exhaust ducts from cells or behind protective guards *listed* for the purpose, are allowed where necessary to prevent damage or tampering.
2. *Sleeping units* in Use Conditions 2 and 3 as described in Section 308.
3. Smoke detectors are not required in *sleeping units* with four or fewer occupants in *smoke compartments* that are equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.

**[F] 907.2.7 Group M.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group M occupancies where one of the following conditions exists:

1. The combined Group M *occupant load* of all floors is 500 or more persons.
2. The Group M *occupant load* is more than 100 persons above or below the lowest *level of exit discharge*.

### Exceptions:

1. A manual fire alarm system is not required in *covered or open mall buildings* complying with Section 402.
2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 and the occupant notification appliances will automatically activate throughout the notification zones upon sprinkler water flow.

**[F] 907.2.7.1 Occupant notification.** During times that the building is occupied, the initiation of a signal from a manual fire alarm box or from a waterflow switch shall not be required to activate the alarm notification appliances when an *alarm signal* is activated at a *constantly attended location* from which evacuation instructions shall be initiated over an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

**[F] 907.2.8 Group R-1.** Fire alarm systems and smoke alarms shall be installed in Group R-1 occupancies as required in Sections 907.2.8.1 through 907.2.8.3.

**[F] 907.2.8.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R- 1 occupancies.

### Exceptions:

1. A manual fire alarm system is not required in buildings not more than two *stories* in height where all individual *sleeping units* and contiguous *attic* and crawl spaces to those units are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each individual *sleeping unit* has an *exit* directly to a *public way*, *egress court* or *yard*.
2. Manual fire alarm boxes are not required throughout the building where all of the following conditions are met:
  - 2.1. The building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
  - 2.2. The notification appliances will activate upon sprinkler water flow.
  - 2.3. Not fewer than one manual fire alarm box is installed at an *approved* location.

**[F] 907.2.8.2 Automatic smoke detection system.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed throughout all interior *corridors* serving *sleeping units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* and where each *sleeping unit* has a *means of egress* door opening directly to an *exit* or to an exterior *exit access* that leads directly to an *exit*.

**[F] 907.2.8.3 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

**[F] 907.2.9 Group R-2.** Fire alarm systems and smoke alarms shall be installed in Group R-2 occupancies as required in Sections 907.2.9.1 through 907.2.9.3.

**[F] 907.2.9.1 Manual fire alarm system.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies where any of the following conditions apply:

1. Any *dwelling unit* or *sleeping unit* is located three or more *stories* above the lowest *level of exit discharge*.
2. Any *dwelling unit* or *sleeping unit* is located more than one *story* below the highest *level of exit discharge* of *exits* serving the *dwelling unit* or *sleeping unit*.

3. The building contains more than 16 *dwelling units* or *sleeping units*.

**Exceptions:**

1. A fire alarm system is not required in buildings not more than two stories in height where all *dwelling units* or *sleeping units* and contiguous *attic* and crawl spaces are separated from each other and public or common areas by not less than 1-hour *fire partitions* and each *dwelling unit* or *sleeping unit* has an *exit* directly to a *public way*, *egress court* or *yard*.
2. Manual fire alarm boxes are not required where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and the occupant notification appliances will automatically activate throughout the notification zones upon a sprinkler water flow.
3. A fire alarm system is not required in buildings that do not have interior *corridors* serving dwelling units and are protected by an approved *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, provided that *dwelling units* either have a *means of egress* door opening directly to an exterior *exit access* that leads directly to the exits or are served by open-ended *corridors* designed in accordance with Section 1027.6, Exception 3.

**[F] 907.2.9.2 Smoke alarms.** Single- and multiple-station smoke alarms shall be installed in accordance with Section 907.2.11.

**[F] 907.2.9.3 Group R-2 college and university buildings.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group R-2 occupancies operated by a college or university for student or staff housing in all of the following locations:

1. Common spaces outside of *dwelling units* and *sleeping units*.
2. Laundry rooms, mechanical equipment rooms and storage rooms.
3. All interior *corridors* serving *sleeping units* or *dwelling units*.

**Exception:** An automatic smoke detection system is not required in buildings that do not have interior *corridors* serving *sleeping units* or *dwelling units* and where each *sleeping unit* or *dwelling unit* either has a *means of egress* door opening directly to an exterior *exit access* that leads directly to an *exit* or a *means of egress* door opening directly to an *exit*.

Required smoke alarms in *dwelling units* and *sleeping units* in Group R-2 occupancies operated by a college or university for student or staff housing shall be interconnected with the fire alarm system in accordance with NFPA 72.

**[F] 907.2.10 Group S.** A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group S public- and self-storage occupancies three stories or greater in height for interior corridors and interior common areas. Visible notification appliances are not required within storage units.

**Exception:** Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1, and the occupant notification appliances will activate throughout the notification zones upon sprinkler water flow.

**[F] 907.2.11 Single- and multiple-station smoke alarms.** Listed single- and multiple-station smoke alarms complying with UL 217 shall be installed in accordance with Sections 907.2.11.1 through 907.2.11.7 and NFPA 72. Every new and existing dwelling, including one- and two-family dwellings, and every new and existing dwelling unit within an apartment house, condominium or townhouse, and every guest and sleeping room in a motel, hotel, or dormitory shall be provided with an approved, listed smoke alarm.

**[F] 907.2.11.1 Group R-1.** Single- or multiple-station smoke alarms shall be installed in all of the following locations in Group R-1:

1. In sleeping areas.
2. In every room in the path of the *means of egress* from the sleeping area to the door leading from the *sleeping unit*.
3. In each *story* within the *sleeping unit*, including basements. For *sleeping units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full *story* below the upper level.

**[F] 907.2.11.2 Groups R-2, R-3, R-4 and I-1.** Single- or multiple-station smoke alarms shall be installed and maintained in Groups R-2, R-3, R-4 and I-1 regardless of *occupant load* at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.
3. In each *story* within a *dwelling unit*, including basements but not including crawl spaces and uninhabitable *attics*. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

for the adjacent lower level provided that the lower level is less than one full *story* below the upper level.

**[F] 907.2.11.3 Installation near cooking appliances.** Smoke alarms shall not be installed in the following locations unless this would prevent placement of a smoke alarm in a location required by Section 907.2.11.1 or 907.2.11.2:

1. Ionization smoke alarms shall not be installed less than 20 feet (6096 mm) horizontally from a permanently installed cooking appliance.
2. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet (3048 mm) horizontally from a permanently installed cooking appliance.
3. Photoelectric smoke alarms shall not be installed less than 6 feet (1829 mm) horizontally from a permanently installed cooking appliance.

**[F] 907.2.11.4 Installation near bathrooms.** Smoke alarms shall be installed not less than 3 feet (914 mm) horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by Section 907.2.11.1 or 907.2.11.2.

**[F] 907.2.11.5 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling unit* or *sleeping unit* in Group R or I-1 occupancies, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. Physical interconnection of smoke alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

**[F] 907.2.11.6 Power source.** In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system in accordance with Section 2702. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection.

**Exception:** Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system that complies with Section 2702.

**[F] 907.2.11.7 Smoke detection system.** Smoke detectors listed in accordance with UL 268 and provided as part of the building *fire alarm system* shall be an acceptable alternative to single- and multiple-

station *smoke alarms* and shall comply with the following:

1. The *fire alarm* system shall comply with all applicable requirements in Section 907.
2. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall initiate alarm notification in the *dwelling unit* or *sleeping unit* in accordance with Section 907.5.2.
3. Activation of a smoke detector in a *dwelling unit* or *sleeping unit* shall not activate alarm notification appliances outside of the *dwelling unit* or *sleeping unit*, provided that a supervisory signal is generated and monitored in accordance with Section 907.6.6.

**[F] 907.2.12 Special amusement buildings.** An automatic smoke detection system shall be provided in *special amusement buildings* in accordance with Sections 907.2.12.1 through 907.2.12.3.

**[F] 907.2.12.1 Alarm.** Activation of any single smoke detector, the *automatic sprinkler system* or any other automatic fire detection device shall immediately activate an audible and visible alarm at the building at a *constantly attended location* from which emergency action can be initiated, including the capability of manual initiation of requirements in Section 907.2.12.2.

**[F] 907.2.12.2 System response.** The activation of two or more smoke detectors, a single smoke detector equipped with an *alarm verification feature*, the *automatic sprinkler system* or other *approved* fire detection device shall automatically do all of the following:

1. Cause illumination of the *means of egress* with light of not less than 1 footcandle (11 lux) at the walking surface level.
2. Stop any conflicting or confusing sounds and visual distractions.
3. Activate an *approved* directional exit marking that will become apparent in an emergency.
4. Activate a prerecorded message, audible throughout the *special amusement building*, instructing patrons to proceed to the nearest exit. Alarm signals used in conjunction with the prerecorded message shall produce a sound that is distinctive from other sounds used during normal operation.

**[F] 907.2.12.3 Emergency voice/alarm communication system.** An emergency voice/alarm communication system, which is allowed to serve as a public address system, shall be installed in accordance with Section 907.5.2.2 and be audible throughout the entire *special amusement building*.

**[F] 907.2.13 High-rise buildings.** High-rise buildings shall be provided with an automatic smoke detection system in accordance with Section 907.2.13.1, a fire department communication system in accordance with



Section 907.2.13.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.

**Exceptions:**

1. Airport traffic control towers in accordance with Sections 412 and 907.2.22.
2. *Open parking garages* in accordance with Section 406.5.
3. Buildings with an occupancy in Group A-5 in accordance with Section 303.1.
4. Low-hazard special occupancies in accordance with Section 503.1.1.
5. Buildings with an occupancy in Group H-1, H-2 or H-3 in accordance with Section 415.
6. In Group I-1 and I-2 occupancies, the alarm shall sound at a *constantly attended location* and occupant notification shall be broadcast by the emergency voice/alarm communication system.

**[F] 907.2.13.1 Automatic smoke detection.** Automatic smoke detection in high-rise buildings shall be in accordance with Sections 907.2.13.1.1 and 907.2.13.1.2.

**[F] 907.2.13.1.1 Area smoke detection.** Area smoke detectors shall be provided in accordance with this section. Smoke detectors shall be connected to an automatic fire alarm system. The activation of any detector required by this section shall activate the emergency voice/alarm communication system in accordance with Section 907.5.2.2. In addition to smoke detectors required by Sections 907.2.1 through 907.2.9, smoke detectors shall be located as follows:

1. In each mechanical equipment, electrical, transformer, telephone equipment or similar room that is not provided with sprinkler protection.
2. In each elevator machine room, machinery space, control room and control space and in elevator lobbies.

**[F] 907.2.13.1.2 Duct smoke detection.** Duct smoke detectors complying with Section 907.3.1 shall be located as follows:

1. In the main return air and exhaust air plenum of each air-conditioning system having a capacity greater than 2,000 cubic feet per minute (cfm) (0.94 m<sup>3</sup>/s). Such detectors shall be located in a serviceable area downstream of the last duct inlet.
2. At each connection to a vertical duct or riser serving two or more stories from a return air duct or plenum of an air-conditioning system. In Group R-1 and R-2 occupancies, a smoke detector is allowed to be used in each return air riser carrying

not more than 5,000 cfm (2.4 m<sup>3</sup>/s) and serving not more than 10 air-inlet openings.

**[F] 907.2.13.2 Fire department communication system.** Where a wired communication system is *approved* in lieu of an in-building two-way emergency responder communication coverage system in accordance with Section 510 of the *International Fire Code*, the wired fire department communication system shall be designed and installed in accordance with NFPA 72 and shall operate between a fire command center complying with Section 911, elevators, elevator lobbies, emergency and standby power rooms, fire pump rooms, *areas of refuge* and inside *interior exit stairways*. The fire department communication device shall be provided at each floor level within the *interior exit stairway*.

**[F] 907.2.13.3 Multiple-channel voice evacuation.** In buildings with an occupied floor more than 120 feet (36 576 mm) above the lowest level of fire department vehicle access, voice evacuation systems for high-rise buildings shall be multiple-channel systems.

**[F] 907.2.14 Atriums connecting more than two stories.** A fire alarm system shall be installed in occupancies with an *atrium* that connects more than two *stories*, with smoke detection installed in locations required by a rational analysis in Section 909.4 and in accordance with the system operation requirements in Section 909.17. The system shall be activated in accordance with Section 907.5. Such occupancies in Group A, E or M shall be provided with an emergency voice/alarm communication system complying with the requirements of Section 907.5.2.2.

**[F] 907.2.15 High-piled combustible storage areas.** An automatic smoke detection system shall be installed throughout high-piled combustible storage areas where required by Section 3206.5 of the *International Fire Code*.

**[F] 907.2.16 Aerosol storage uses.** *Aerosol product* rooms and general-purpose warehouses containing aerosol products shall be provided with an *approved* manual fire alarm system where required by the *International Fire Code*.

**[F] 907.2.17 Lumber, wood structural panel and veneer mills.** Lumber, *wood structural panel* and *veneer* mills shall be provided with a manual fire alarm system.

**[F] 907.2.18 Underground buildings with smoke control systems.** Where a smoke control system is installed in an underground building in accordance with this code, automatic smoke detectors shall be provided in accordance with Section 907.2.18.1.

**[F] 907.2.18.1 Smoke detectors.** Not fewer than one smoke detector *listed* for the intended purpose shall be installed in all of the following areas:

1. Mechanical equipment, electrical, transformer, telephone equipment, elevator machine or similar rooms.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

2. Elevator lobbies.
3. The main return and exhaust air plenum of each air-conditioning system serving more than one *story* and located in a serviceable area downstream of the last duct inlet.
4. Each connection to a vertical duct or riser serving two or more floors from return air ducts or plenums of heating, ventilating and air-conditioning systems, except that in Group R occupancies, a *listed* smoke detector is allowed to be used in each return air riser carrying not more than 5,000 cubic feet per minute (2.4 m<sup>3</sup>/s) and serving not more than 10 air-inlet openings.

**[F] 907.2.18.2 Alarm required.** Activation of the smoke control system shall activate an audible alarm at a *constantly attended location*.

**[F] 907.2.19 Deep underground buildings.** Where the lowest level of a structure is more than 60 feet (18 288 mm) below the finished floor of the lowest *level of exit discharge*, the structure shall be equipped throughout with a manual fire alarm system, including an emergency voice/alarm communication system installed in accordance with Section 907.5.2.2.

**[F] 907.2.20 Covered and open mall buildings.** Where the total floor area exceeds 50,000 square feet (4645 m<sup>2</sup>) within either a *covered mall building* or within the perimeter line of an *open mall building*, an emergency voice/alarm communication system shall be provided. Access to emergency voice/alarm communication systems serving a mall, required or otherwise, shall be provided for the fire department. The system shall be provided in accordance with Section 907.5.2.2.

**[F] 907.2.21 Residential aircraft hangars.** Not fewer than one single-station smoke alarm shall be installed within a *residential aircraft hangar* as defined in Chapter 2 and shall be interconnected into the residential smoke alarm or other sounding device to provide an alarm that will be audible in all sleeping areas of the *dwelling*.

**[F] 907.2.22 Airport traffic control towers.** An automatic smoke detection system that activates the occupant notification system in accordance with Section 907.5 shall be provided in airport control towers in accordance with Sections 907.2.22.1 and 907.2.22.2.

**Exception:** Audible appliances shall not be installed within the control tower cab.

**[F] 907.2.22.1 Airport traffic control towers with multiple exits and automatic sprinklers.** Airport traffic control towers with multiple *exits* and equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.

4. Outside each opening into *interior exit stairways*.
5. Along the single *means of egress* permitted from observation levels.
6. Outside each opening into the single *means of egress* permitted from observation levels.

**[F] 907.2.22.2 Other airport traffic control towers.**

Airport traffic control towers with a single exit or where sprinklers are not installed throughout shall be provided with smoke detectors in all of the following locations:

1. Airport traffic control cab.
2. Electrical and mechanical equipment rooms.
3. Airport terminal radar and electronics rooms.
4. Office spaces incidental to the tower operation.
5. Lounges for employees, including sanitary facilities.
6. *Means of egress*.
7. Utility *shafts* where access to smoke detectors can be provided.

**[F] 907.2.23 Energy storage systems.** An automatic smoke detection system or radiant-energy detection system shall be installed in rooms, areas and walk-in units containing energy storage systems as required in Section 1207.5.4 of the *International Fire Code*.

**[F] 907.3 Fire safety functions.** Automatic fire detectors utilized for the purpose of performing fire safety functions shall be connected to the building's fire alarm control unit where a fire alarm system is required by Section 907.2. Detectors shall, upon actuation, perform the intended function and activate the alarm notification appliances or activate a visible and audible supervisory signal at a *constantly attended location*. In buildings not equipped with a fire alarm system, the automatic fire detector shall be powered by normal electrical service and, upon actuation, perform the intended function. The detectors shall be located in accordance with NFPA 72.

**[F] 907.3.1 Duct smoke detectors.** Smoke detectors installed in ducts shall be *listed* for the air velocity, temperature and humidity present in the duct. Duct smoke detectors shall be connected to the building's fire alarm control unit where a fire alarm system is required by Section 907.2. Activation of a duct smoke detector shall initiate a visible and audible supervisory signal at a *constantly attended location* and shall perform the intended fire safety function in accordance with this code and the *International Mechanical Code*. In facilities that are required to be monitored by a supervising station, duct smoke detectors shall report only as a supervisory signal and not as a fire alarm. They shall not be used as a substitute for required open area detection.

**Exceptions:**

1. The supervisory signal at a *constantly attended location* is not required where duct smoke

detectors activate the building's alarm notification appliances.

2. In occupancies not required to be equipped with a fire alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an *approved* location. Smoke detector trouble conditions shall activate a visible or audible signal in an *approved* location and shall be identified as air duct detector trouble.

**[F] 907.3.2 Special locking systems.** Where special locking systems are installed on *means of egress* doors in accordance with Sections 1010.2.13 or 1010.2.14, an automatic detection system shall be installed as required by that section.

**[F] 907.3.3 Elevator emergency operation.** Automatic fire detectors installed for elevator emergency operation shall be installed in accordance with the provisions of ASME A17.1/CSA B44 and NFPA 72.

**[F] 907.3.4 Wiring.** The wiring to the auxiliary devices and equipment used to accomplish the fire safety functions shall be monitored for integrity in accordance with NFPA 72.

**[F] 907.4 Initiating devices.** Where a fire alarm system is required by another section of this code, occupant notification in accordance with Section 907.5 shall be initiated by one or more of the following. Initiating devices shall be installed in accordance with Sections 907.4.1 through 907.4.3.1.

1. Manual fire alarm boxes.
2. Automatic fire detectors.
3. *Automatic sprinkler system* waterflow devices.
4. Automatic fire-extinguishing systems.

**[F] 907.4.1 Protection of fire alarm control unit.** In areas that are not continuously occupied, a single smoke detector shall be provided at the location of each fire alarm control unit, notification appliance circuit power extenders, and supervising station transmitting equipment.

**Exception:** Where ambient conditions prohibit installation of a smoke detector, a *heat detector* shall be permitted.

**[F] 907.4.2 Manual fire alarm boxes.** Where a manual fire alarm system is required by another section of this code, it shall be activated by fire alarm boxes installed in accordance with Sections 907.4.2.1 through 907.4.2.6.

**[F] 907.4.2.1 Location.** Manual fire alarm boxes shall be located not more than 5 feet (1524 mm) from the entrance to each *exit*. In buildings not protected by an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, additional manual fire alarm boxes shall be located so that the distance of travel to the nearest box does not exceed 200 feet (60 960 mm).

**[F] 907.4.2.2 Height.** The height of the manual fire alarm boxes shall be not less than 42 inches (1067 mm) and not more than 48 inches (1372 mm)

measured vertically, from the floor level to the activating handle or lever of the box.

**[F] 907.4.2.3 Color.** Manual fire alarm boxes shall be red in color.

**[F] 907.4.2.4 Signs.** Where fire alarm systems are not monitored by an *approved* supervising station in accordance with Section 907.6.6, an *approved* permanent sign shall be installed adjacent to each manual fire alarm box that reads: WHEN ALARM SOUNDS CALL FIRE DEPARTMENT.

**Exception:** Where the manufacturer has permanently provided this information on the manual fire alarm box.

**[F] 907.4.2.5 Protective covers.** The fire code official is authorized to require the installation of *listed* manual fire alarm box protective covers to prevent malicious false alarms or to provide the manual fire alarm box with protection from physical damage. The protective cover shall be transparent or red in color with a transparent face to permit visibility of the manual fire alarm box. Each cover shall include proper operating instructions. A protective cover that emits a local *alarm signal* shall not be installed unless *approved*. Protective covers shall not project more than that permitted by Section 1003.3.3.

**[F] 907.4.2.6 Unobstructed and unobscured.** Manual fire alarm boxes shall be provided with ready access, unobstructed, unobscured and visible at all times.

**[F] 907.4.3 Automatic smoke detection.** Where an automatic smoke detection system is required, it shall utilize smoke detectors unless ambient conditions prohibit such an installation. In spaces where smoke detectors cannot be utilized due to ambient conditions, *approved* automatic *heat detectors* shall be permitted.

**[F] 907.4.3.1 Automatic sprinkler system.** For conditions other than specific fire safety functions noted in Section 907.3, in areas where ambient conditions prohibit the installation of smoke detectors, an *automatic sprinkler system* installed in such areas in accordance with Section 903.3.1.1 or 903.3.1.2 and that is connected to the fire alarm system shall be *approved* as automatic heat detection.

**[F] 907.5 Occupant notification.** Occupant notification by fire alarms shall be in accordance with Sections 907.5.1 through 907.5.2.3.3. Occupant notification by smoke alarms in Group R-1 and R-2 occupancies shall comply with Section 907.5.2.1.3.2.

**907.5.1 Alarm activation and annunciation.** Upon activation, fire alarm systems shall initiate occupant notification and shall annunciate at the fire alarm control unit, or where allowed elsewhere by Section 907, at a *constantly attended location*.

**907.5.1.1 Presignal feature.** A presignal feature shall be provided only where *approved*. The presignal shall be annunciated at an *approved, constantly attended location*, having the capability to activate the occupant

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

notification system in the event of fire or other emergency.

**[F] 907.5.2 Alarm notification appliances.** Alarm notification appliances shall be provided and shall be *listed* for their purpose.

**[F] 907.5.2.1 Audible alarms.** Audible alarm notification appliances shall be provided and emit a distinctive sound that is not to be used for any purpose other than that of a fire alarm.

**Exceptions:**

1. Audible alarm notification appliances are not required in critical care areas of Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
2. A visible *alarm notification appliance* installed in a nurses' control station or other continuously attended staff location in a Group I-2, Condition 2 suite shall be an acceptable alternative to the installation of audible alarm notification appliances throughout a suite or unit in Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
3. Where provided, audible notification appliances located in each enclosed occupant evacuation elevator lobby in accordance with Section 3008.9.1 shall be connected to a separate notification zone for manual paging only.

**[F] 907.5.2.1.1 Average sound pressure.** The audible alarm notification appliances shall provide a sound pressure level of 15 decibels (dBA) above the *average ambient sound level* or 5 dBA above the maximum sound level having a duration of not less than 60 seconds, whichever is greater, in every *occupiable space* within the building.

**[F] 907.5.2.1.2 Maximum sound pressure.** The total sound pressure level produced by combining the ambient sound pressure level with all audible notification appliances operating shall not exceed 110 dBA at the minimum hearing distance from the audible appliance. Where the average ambient noise is greater than 105 dBA, visible alarm notification appliances shall be provided in accordance with NFPA 72 and audible alarm notification appliances shall not be required.

**[F] 907.5.2.1.3 Audible signal frequency in Group R-1 and R-2 sleeping rooms.** Audible signal frequency in Group R-1 and R-2 occupancies shall be in accordance with Sections 907.5.2.1.3.1 and 907.5.2.1.3.2.

**[F] 907.5.2.1.3.1 Fire alarm system signal.** In sleeping rooms of Group R-1 and R-2 occupancies, the audible alarm activated by a fire alarm

system shall be a 520-Hz low-frequency signal complying with NFPA 72.

**[F] 907.5.2.1.3.2 Smoke alarm signal in sleeping rooms.** In sleeping rooms of Group R-1 and R-2 occupancies that are required by Section 907.2.8 or 907.2.9 to have a fire alarm system, the audible *alarm signal* activated by single- or multiple-station smoke alarms in the *dwelling unit* or *sleeping unit* shall be a 520-Hz signal complying with NFPA 72. Where a sleeping room smoke alarm is unable to produce a 520-Hz signal, the 520-Hz *alarm signal* shall be provided by a *listed* notification appliance or a smoke detector with an integral 520-Hz sounder.

**[F] 907.5.2.2 Emergency voice/alarm communication systems.** Emergency voice/alarm communication systems required by this code shall be designed and installed in accordance with NFPA 72. The operation of any automatic fire detector, sprinkler waterflow device or manual fire alarm box shall automatically sound an alert tone followed by voice instructions giving *approved* information and directions for a general or staged evacuation in accordance with the building's fire safety and evacuation plans required by Section 404 of the *International Fire Code*. In high-rise buildings, the system shall operate on at least the alarming floor, the floor above and the floor below. Speakers shall be provided throughout the building by paging zones. At a minimum, paging zones shall be provided as follows:

1. Elevator groups.
2. *Interior exit stairways*.
3. Each floor.
4. *Areas of refuge* as defined in Chapter 2.

**Exception:** In Group I-1 and I-2 occupancies, the alarm shall sound in a constantly attended area and a general occupant notification shall be broadcast over the overhead page.

**[F] TABLE 907.5.2.3.2  
VISIBLE ALARMS**

NUMBER OF SLEEPING UNITS	SLEEPING ACCOMMODATIONS WITH VISIBLE ALARMS
6 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000



[F] **907.5.2.2.1 Manual override.** A manual override for emergency voice communication shall be provided on a selective and all-call basis for all paging zones.

[F] **907.5.2.2.2 Live voice messages.** The emergency voice/alarm communication system shall have the capability to broadcast live voice messages by paging zones on a selective and all-call basis.

[F] **907.5.2.2.3 Alternative uses.** The emergency voice/alarm communication system shall be allowed to be used for other announcements, provided that the manual fire alarm use takes precedence over any other use.

[F] **907.5.2.2.4 Emergency voice/alarm communication captions.** Where stadiums, arenas and grandstands have 15,000 fixed seats or more and provide audible public announcements, the emergency/voice alarm communication system shall provide prerecorded or real-time captions. Prerecorded or live emergency captions shall be from an *approved* location constantly attended by personnel trained to respond to an emergency.

[F] **907.5.2.2.5 Standby power.** Emergency voice/alarm communications systems shall be provided with standby power in accordance with Section 2702.

[F] **907.5.2.3 Visible alarms.** Visible alarm notification appliances shall be provided in accordance with Sections 907.5.2.3.1 through 907.5.2.3.3.

**Exceptions:**

1. Visible alarm notification appliances are not required in *alterations*, except where an existing fire alarm system is upgraded or replaced, or a new fire alarm system is installed.
2. Visible alarm notification appliances shall not be required in *exits* as defined in Chapter 2.
3. Visible alarm notification appliances shall not be required in elevator cars.
4. Visual alarm notification appliances are not required in critical care areas of Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.
5. A visible *alarm notification appliance* installed in a nurses' control station or other continuously attended staff location in a Group I-2, Condition 2 suite shall be an acceptable alternative to the installation of visible alarm notification appliances throughout the suite or unit in Group I-2, Condition 2 occupancies that are in compliance with Section 907.2.6, Exception 2.

[F] **907.5.2.3.1 Public use areas and common use areas.** Visible alarm notification appliances shall be provided in *public use areas* and *common use areas*. Areas considered public and common by NFPA, ADAAG, and the Arkansas School Facilities Manual shall be included.

**Exception:** Where *employee work areas* have audible alarm coverage, the notification appliance circuits serving the *employee work areas* shall be initially designed with not less than 20-percent spare capacity to account for the potential of adding visible notification appliances in the future to accommodate hearing-impaired employee(s).

[F] **907.5.2.3.2 Groups I-1 and R-1.** *Habitable spaces* in *dwelling units* and *sleeping units* in Group I-1 and R-1 occupancies in accordance with Table 907.5.2.3.2 shall be provided with visible alarm notification. Visible alarms shall be activated by the in-room smoke alarm and the building fire alarm system.

[F] **907.5.2.3.3 Group R-2.** In Group R-2 occupancies required by Section 907 to have a fire alarm system, each *story* that contains *dwelling units* and *sleeping units* shall be provided with the capability to support future visible alarm notification appliances in accordance with Chapter 11 of ICC A117.1. Such capability shall accommodate wired or wireless equipment.

[F] **907.5.2.3.3.1 Wired equipment.** Where wired equipment is used to comply with the future capability required by Section 907.5.2.3.3, the system shall include one of the following capabilities:

1. The replacement of audible appliances with combination audible/visible appliances or additional visible notification appliances.
2. The future extension of the existing wiring from the unit smoke alarm locations to required locations for visible appliances.
3. For wired equipment, the fire alarm power supply and circuits shall have not less than 5-percent excess capacity to accommodate the future addition of visible alarm notification appliances, and a single access point to such circuits shall be available on every story. Such circuits shall not be required to be extended beyond a single access point on a story. The fire alarm system shop drawings required by Section 907.1.2 shall include the power supply and circuit documentation to accommodate the future addition of visible notification appliances.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 907.6 Installation and monitoring.** A fire alarm system shall be installed and monitored in accordance with Sections 907.6.1 through 907.6.6.3 and NFPA 72.

**[F] 907.6.1 Wiring.** Wiring shall comply with the requirements of NFPA 70 and NFPA 72. Wireless protection systems utilizing radio-frequency transmitting devices shall comply with the special requirements for supervision of low-power wireless systems in NFPA 72.

**[F] 907.6.2 Power supply.** The primary and secondary power supply for the fire alarm system shall be provided in accordance with NFPA 72.

**Exception:** Back-up power for single-station and multiple-station smoke alarms as required in Section 907.2.11.6.

**[F] 907.6.3 Initiating device identification.** The fire alarm system shall identify the specific *initiating device* address, location, device type, floor level where applicable and status including indication of normal, alarm, trouble and supervisory status, as appropriate.

### Exceptions:

1. Fire alarm systems in single-story buildings less than 22,500 square feet (2090 m<sup>2</sup>) in area.
2. Fire alarm systems that only include manual fire alarm boxes, waterflow initiating devices and not more than 10 additional alarm-initiating devices.
3. Special initiating devices that do not support individual device identification.
4. Fire alarm systems or devices that are replacing existing equipment.

**[F] 907.6.3.1 Annunciation.** The *initiating device* status shall be annunciated at an *approved* on-site location.

**[F] 907.6.4 Zones.** Each floor shall be zoned separately and a zone shall not exceed 22,500 square feet (2090 m<sup>2</sup>). The length of any zone shall not exceed 300 feet (91 440 mm) in any direction.

**Exception:** *Automatic sprinkler system* zones shall not exceed the area permitted by NFPA 13.

**[F] 907.6.4.1 Zoning indicator panel.** A zoning indicator panel and the associated controls shall be provided in an *approved* location. The visual zone indication shall lock in until the system is reset and shall not be canceled by the operation of an audible-alarm silencing switch.

**[F] 907.6.4.2 High-rise buildings.** In high-rise buildings, a separate zone by floor shall be provided for each of the following types of alarm-initiating devices where provided:

1. Smoke detectors.
2. Sprinkler waterflow devices.
3. Manual fire alarm boxes.
4. Other *approved* types of automatic *fire protection systems*.

**[F] 907.6.5 Access.** Access shall be provided to each fire alarm device and notification appliance for periodic inspection, maintenance and testing.

**[F] 907.6.6 Monitoring.** Fire alarm systems required by this chapter or by the *International Fire Code* shall be monitored by an *approved* supervising station in accordance with NFPA 72.

**Exception:** Monitoring by a supervising station is not required for:

1. Single- and multiple-station smoke alarms required by Section 907.2.11.
2. Smoke detectors in Group I-3 occupancies.
3. *Automatic sprinkler systems* in one- and two-family dwellings.

**[F] 907.6.6.1 Transmission of alarm signals.** Transmission of alarm signals to a supervising station shall be in accordance with NFPA 72.

**[F] 907.6.6.2 MIY Monitoring.** Direct transmission of alarms associated with monitor it yourself (MIY) transmitters to a public safety answering point (PSAP) shall not be permitted unless *approved* by the *fire code official*.

**[F] 907.6.6.3 Termination of monitoring service.** Termination of fire alarm monitoring services shall be in accordance with Section 901.9 of the *International Fire Code*.

**[F] 907.7 Acceptance tests and completion.** Upon completion of the installation, the fire alarm system and all fire alarm components shall be tested in accordance with NFPA 72.

**[F] 907.7.1 Single- and multiple-station alarm devices.** When the installation of the alarm devices is complete, each device and interconnecting wiring for multiple-station alarm devices shall be tested in accordance with the smoke alarm provisions of NFPA 72.

**[F] 907.7.2 Record of completion.** A record of completion in accordance with NFPA 72 verifying that the system has been installed and tested in accordance with the *approved* plans and specifications shall be provided.

**[F] 907.7.3 Instructions.** Operating, testing and maintenance instructions and *record drawings* ("as-builts") and equipment specifications shall be provided at an *approved* location.

**[F] 907.8 Inspection, testing and maintenance.** The maintenance and testing schedules and procedures for fire alarm and fire detection systems shall be in accordance with Section 907.8 of the *International Fire Code*.

## SECTION 908 EMERGENCY ALARM SYSTEMS

**[F] 908.1 Group H occupancies.** Emergency alarms for the detection and notification of an emergency condition in Group H occupancies shall be provided in accordance with Section 415.5.

[F] **908.2 Group H-5 occupancy.** Emergency alarms for notification of an emergency condition in an HPM facility shall be provided as required in Section 415.11.4.

[F] **908.3 Fire alarm system interface.** Where an emergency alarm system is interfaced with a building's fire alarm system, the signal produced at the fire alarm control unit shall be a supervisory signal.

## SECTION 909 SMOKE CONTROL SYSTEMS

[F] **909.1 Scope and purpose.** This section applies to mechanical or passive smoke control systems where they are required by other provisions of this code. The purpose of this section is to establish minimum requirements for the design, installation and acceptance testing of smoke control systems that are intended to provide a tenable environment for the evacuation or relocation of occupants. These provisions are not intended for the preservation of contents, the timely restoration of operations or for assistance in fire suppression or overhaul activities. Smoke control systems regulated by this section serve a different purpose than the smoke- and heat-removal provisions found in Section 910. Mechanical smoke control systems shall not be considered exhaust systems under Chapter 5 of the *International Mechanical Code*.

[F] **909.2 General design requirements.** Buildings, structures or parts thereof required by this code to have a smoke control system or systems shall have such systems designed in accordance with the applicable requirements of Section 909 and the generally accepted and well-established principles of engineering relevant to the design. The *construction documents* shall include sufficient information and detail to adequately describe the elements of the design necessary for the proper implementation of the smoke control systems. These documents shall be accompanied by sufficient information and analysis to demonstrate compliance with these provisions.

[F] **909.3 Special inspection and test requirements.** In addition to the ordinary inspection and test requirements that buildings, structures and parts thereof are required to undergo, smoke control systems subject to the provisions of Section 909 shall undergo *special inspections* and tests sufficient to verify the proper commissioning of the smoke control design in its final installed condition. The design submission accompanying the *construction documents* shall clearly detail procedures and methods to be used and the items subject to such inspections and tests. Such commissioning shall be in accordance with generally accepted engineering practice and, where possible, based on published standards for the particular testing involved. The *special inspections* and tests required by this section shall be conducted under the same terms in Section 1704.

[F] **909.4 Analysis.** A rational analysis supporting the types of smoke control systems to be employed, their methods of operation, the systems supporting them and the methods of construction to be utilized shall accompany the submitted *construction documents* and shall include, but not be limited to, the items indicated in Sections 909.4.1 through 909.4.7.

[F] **909.4.1 Stack effect.** The system shall be designed such that the maximum probable normal or reverse stack effect will not adversely interfere with the system's capabilities. In determining the maximum probable stack effect, altitude, elevation, weather history and interior temperatures shall be used.

[F] **909.4.2 Temperature effect of fire.** Buoyancy and expansion caused by the design fire in accordance with Section 909.9 shall be analyzed. The system shall be designed such that these effects do not adversely interfere with the system's capabilities.

[F] **909.4.3 Wind effect.** The design shall consider the adverse effects of wind. Such consideration shall be consistent with the wind-loading provisions of Chapter 16.

[F] **909.4.4 HVAC systems.** The design shall consider the effects of the heating, ventilating and air-conditioning (HVAC) systems on both smoke and fire transport. The analysis shall include all permutations of systems status. The design shall consider the effects of the fire on the HVAC systems.

[F] **909.4.5 Climate.** The design shall consider the effects of low temperatures on systems, property and occupants. Air inlets and exhausts shall be located so as to prevent snow or ice blockage.

[F] **909.4.6 Duration of operation.** All portions of active or engineered smoke control systems shall be capable of continued operation after detection of the fire event for a period of not less than either 20 minutes or 1.5 times the calculated egress time, whichever is greater.

**909.4.7 Smoke control system interaction.** The design shall consider the interaction effects of the operation of multiple smoke control systems for all design scenarios.

[F] **909.5 Smoke barrier construction.** *Smoke barriers* required for passive smoke control and a smoke control system using the pressurization method shall comply with Section 709. The maximum allowable leakage area shall be the aggregate area calculated using the following leakage area ratios:

1. Walls  $A/A_w = 0.00100$
2. Interior *exit stairways* and *ramps* and *exit passage-ways*:  $A/A_w = 0.00035$
3. Enclosed *exit access stairways* and *ramps* and all other *shafts*:  $A/A_w = 0.00150$
4. Floors and roofs:  $A/A_F = 0.00050$

where:

$A$  = Total leakage area, square feet (m<sup>2</sup>).

$A_F$  = Unit floor or roof area of barrier, square feet (m<sup>2</sup>).

$A_w$  = Unit wall area of barrier, square feet (m<sup>2</sup>).

The leakage area ratios shown do not include openings due to gaps around doors and operable windows. The total leakage area of the *smoke barrier* shall be determined in accordance with Section 909.5.1 and tested in accordance with Section 909.5.2.



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

**[F] 909.5.1 Total leakage area.** Total leakage area of the barrier is the product of the *smoke barrier* gross area multiplied by the allowable leakage area ratio, plus the area of other openings such as gaps around doors and operable windows.

**[F] 909.5.2 Testing of leakage area.** Compliance with the maximum total leakage area shall be determined by achieving the minimum air pressure difference across the barrier with the system in the smoke control mode for mechanical smoke control systems utilizing the pressurization method. Compliance with the maximum total leakage area of passive smoke control systems shall be verified through methods such as door fan testing or other methods, as *approved* by the fire code official.

**[F] 909.5.3 Opening protection.** Openings in *smoke barriers* shall be protected by automatic-closing devices actuated by the required controls for the mechanical smoke control system. Door openings shall be protected by *fire door assemblies* complying with Section 716.

**Exceptions:**

1. Passive smoke control systems with automatic-closing devices actuated by spot-type smoke detectors *listed* for releasing service installed in accordance with Section 907.3.
2. Fixed openings between smoke zones that are protected utilizing the airflow method.
3. In Group I-1, Condition 2; Group I-2; and *ambulatory care facilities*, where a pair of opposite-swinging doors are installed across a *corridor* in accordance with Section 909.5.3.1, the doors shall not be required to be protected in accordance with Section 716. The doors shall be close-fitting within operational tolerances and shall not have a center mullion or undercuts in excess of  $\frac{3}{4}$  inch (19.1 mm), louvers or grilles. The doors shall have head and jamb stops and astragals or rabbets at meeting edges and, where permitted by the door manufacturer's listing, positive-latching devices are not required.
4. In Group I-2 and *ambulatory care facilities*, where such doors are special-purpose horizontal sliding, accordion or folding door assemblies installed in accordance with Section 1010.3.3 and are automatic closing by smoke detection in accordance with Section 716.2.6.5.
5. Group I-3.
6. Openings between smoke zones with clear ceiling heights of 14 feet (4267 mm) or greater and bank-down capacity of greater than 20 minutes as determined by the design fire size.

**909.5.3.1 Group I-1, Condition 2; Group I-2; and ambulatory care facilities.** In Group I-1, Condition 2; Group I-2; and *ambulatory care facilities*, where doors are installed across a *corridor*, the doors shall be automatic closing by smoke detection in accordance with Section 716.2.6.5 and shall have a vision panel with

fire-protection-rated glazing materials in fire protection-rated frames, the area of which shall not exceed that tested.

**[F] 909.5.3.2 Ducts and air transfer openings.** Ducts and air transfer openings are required to be protected with a minimum Class II, 250°F (121°C) *smoke damper* complying with Section 717.

**[F] 909.6 Pressurization method.** The primary mechanical means of controlling smoke shall be by pressure differences across *smoke barriers*. Maintenance of a tenable environment is not required in the smoke control zone of fire origin.

**[F] 909.6.1 Minimum pressure difference.** The pressure difference across a *smoke barrier* used to separate smoke zones shall be not less than 0.05-inch water gage (0.0124 kPa) in fully sprinklered buildings.

In buildings permitted to be other than fully sprinklered, the smoke control system shall be designed to achieve pressure differences not less than two times the maximum calculated pressure difference produced by the design fire.

**[F] 909.6.2 Maximum pressure difference.** The maximum air pressure difference across a *smoke barrier* shall be determined by required door-opening or closing forces. The actual force required to open exit doors when the system is in the smoke control mode shall be in accordance with Section 1010.1.3. Opening and closing forces for other doors shall be determined by standard engineering methods for the resolution of forces and reactions. The calculated force to set a side-hinged, swinging door in motion shall be determined by:

$$F = F_{dc} + K(WA\Delta P)/2(W-d) \quad \text{(Equation 9-1)}$$

where:

$A$  = Door area, square feet (m<sup>2</sup>).

$d$  = Distance from door handle to latch edge of door, feet (m).

$F$  = Total door opening force, pounds (N).

$F_{dc}$  = Force required to overcome closing device, pounds (N).

$K$  = Coefficient 5.2 (1.0).

$W$  = Door width, feet (m).

$\Delta P$  = Design pressure difference, inches of water (Pa).

**[F] 909.6.3 Pressurized stairways and elevator hoistways.** Where *stairways* or elevator hoistways are pressurized, such pressurization systems shall comply with Section 909 as smoke control systems, in addition to the requirements of Sections 909.20 of this code and 909.21 of the *International Fire Code*.

**[F] 909.7 Airflow design method.** Where *approved* by the fire code official, smoke migration through openings fixed in a permanently open position, which are located between smoke control zones by the use of the airflow method, shall be permitted. The design airflow shall be in accordance with this section. Airflow shall be directed to limit smoke migration from the fire zone. The geometry of openings shall be



considered to prevent flow reversal from turbulent effects. Smoke control systems using the airflow method shall be designed in accordance with NFPA 92.

**[F] 909.7.1 Prohibited conditions.** This method shall not be employed where either the quantity of air or the velocity of the airflow will adversely affect other portions of the smoke control system, unduly intensify the fire, disrupt plume dynamics or interfere with exiting. Airflow toward the fire shall not exceed 200 feet per minute (1.02 m/s). Where the calculated airflow exceeds this limit, the airflow method shall not be used.

**[F] 909.8 Exhaust method.** Where *approved* by the fire code official, mechanical smoke control for large enclosed volumes, such as in *atriums* or malls, shall be permitted to utilize the exhaust method. Smoke control systems using the exhaust method shall be designed in accordance with NFPA 92.

**[F] 909.8.1 Smoke layer.** The height of the lowest horizontal surface of the smoke layer interface shall be maintained not less than 6 feet (1829 mm) above a walking surface that forms a portion of a required egress system within the smoke zone.

**[F] 909.9 Design fire.** The design fire shall be based on a rational analysis performed by the *registered design professional* and *approved* by the fire code official. The design fire shall be based on the analysis in accordance with Section 909.4 and this section.

**[F] 909.9.1 Factors considered.** The engineering analysis shall include the characteristics of the fuel, fuel load, effects included by the fire and whether the fire is likely to be steady or unsteady.

**[F] 909.9.2 Design fire fuel.** Determination of the design fire shall include consideration of the type of fuel, fuel spacing and configuration.

**[F] 909.9.3 Heat-release assumptions.** The analysis shall make use of best available data from *approved* sources and shall not be based on excessively stringent limitations of combustible material.

**[F] 909.9.4 Sprinkler effectiveness assumptions.** A documented engineering analysis shall be provided for conditions that assume fire growth is halted at the time of sprinkler activation.

**[F] 909.10 Equipment.** Equipment including, but not limited to, fans, ducts, automatic *dampers* and balance *dampers*, shall be suitable for its intended use, suitable for the probable exposure temperatures that the rational analysis indicates and as *approved* by the fire code official.

**[F] 909.10.1 Exhaust fans.** Components of exhaust fans shall be rated and certified by the manufacturer for the probable temperature rise to which the components will be exposed. This temperature rise shall be computed by:

$$T_s = (Q_c/mc) + (T_a) \quad \text{(Equation 9-2)}$$

where:

$c$  = Specific heat of smoke at smoke layer temperature, Btu/lb°F (kJ/kg × K).

$m$  = Exhaust rate, pounds per second (kg/s).

$Q_c$  = Convective heat output of fire, Btu/s (kW).

$T_a$  = Ambient temperature, °F (K).

$T_s$  = Smoke temperature, °F (K).

**Exception:** Reduced  $T_s$  as calculated based on the assurance of adequate dilution air.

**[F] 909.10.2 Ducts.** Duct materials and joints shall be capable of withstanding the probable temperatures and pressures to which they are exposed as determined in accordance with Section 909.10.1. Ducts shall be constructed and supported in accordance with the *International Mechanical Code*. Ducts shall be leak tested to 1.5 times the maximum design pressure in accordance with nationally accepted practices. Measured leakage shall not exceed 5 percent of design flow. Results of such testing shall be a part of the documentation procedure. Ducts shall be supported directly from fire-resistance-rated structural elements of the building by substantial, noncombustible supports.

**Exception:** Flexible connections, for the purpose of vibration isolation, complying with the *International Mechanical Code* and that are constructed of *approved* fire-resistance-rated materials.

**[F] 909.10.3 Equipment, inlets and outlets.** Equipment shall be located so as to not expose uninvolved portions of the building to an additional fire hazard. Outside air inlets shall be located so as to minimize the potential for introducing smoke or flame into the building. Exhaust outlets shall be so located as to minimize reintroduction of smoke into the building and to limit exposure of the building or adjacent buildings to an additional fire hazard.

**[F] 909.10.4 Automatic dampers.** Automatic *dampers*, regardless of the purpose for which they are installed within the smoke control system, shall be listed and conform to the requirements of *approved*, recognized standards.

**[F] 909.10.5 Fans.** In addition to other requirements, belt-driven fans shall have 1.5 times the number of belts required for the design duty, with the minimum number of belts being two. Fans shall be selected for stable performance based on normal temperature and, where applicable, elevated temperature. Calculations and manufacturer's fan curves shall be part of the documentation procedures. Fans shall be supported and restrained by noncombustible devices in accordance with the requirements of Chapter 16.

Motors driving fans shall not be operated beyond their nameplate horsepower (kilowatts), as determined from measurement of actual current draw, and shall have a minimum service factor of 1.15.

**[F] 909.11 Standby power.** Smoke control systems shall be provided with standby power in accordance with Section 2702.

**909.11.1 Equipment room.** The standby power source and its transfer switches shall be in a room separate from the normal power transformers and switch gears and venti-

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

lated directly to and from the exterior. The room shall be enclosed with not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 909.11.2 Power sources and power surges.** Elements of the smoke control system relying on volatile memories or the like shall be supplied with uninterruptible power sources of sufficient duration to span 15-minute primary power interruption. Elements of the smoke control system susceptible to power surges shall be suitably protected by conditioners, suppressors or other *approved* means.

**[F] 909.12 Detection and control systems.** Fire detection systems providing control input or output signals to mechanical smoke control systems or elements thereof shall comply with the requirements of Section 907. Such systems shall be equipped with a control unit complying with UL 864 and *listed* as smoke control equipment.

**909.12.1 Verification.** Control systems for mechanical smoke control systems shall include provisions for verification. Verification shall include positive confirmation of actuation, testing, manual override and the presence of power downstream of all disconnects. A preprogrammed weekly test sequence shall report abnormal conditions audibly, visually and by printed report. The preprogrammed weekly test shall operate all devices, equipment and components used for smoke control.

**Exception:** Where verification of individual components tested through the preprogrammed weekly testing sequence will interfere with, and produce unwanted effects to, normal building operation, such individual components are permitted to be bypassed from the preprogrammed weekly testing, where *approved* by the building official and in accordance with both of the following:

1. Where the operation of components is bypassed from the preprogrammed weekly test, presence of power downstream of all disconnects shall be verified weekly by a *listed* control unit.
2. Testing of all components bypassed from the preprogrammed weekly test shall be in accordance with Section 909.20.6 of the *International Fire Code*.

**[F] 909.12.2 Wiring.** In addition to meeting requirements of NFPA 70, all wiring, regardless of voltage, shall be fully enclosed within continuous raceways.

**[F] 909.12.3 Activation.** Smoke control systems shall be activated in accordance with this section.

**[F] 909.12.3.1 Pressurization, airflow or exhaust method.** Mechanical smoke control systems using the pressurization, airflow or exhaust method shall have completely automatic control.

**[F] 909.12.3.2 Passive method.** Passive smoke control systems actuated by *approved* spot-type detectors *listed* for releasing service shall be permitted.

**[F] 909.12.4 Automatic control.** Where completely automatic control is required or used, the automatic-control sequences shall be initiated from an appropriately zoned *automatic sprinkler system* complying with Section 903.3.1.1, manual controls provided with *ready access* for the fire department and any smoke detectors required by engineering analysis.

**[F] 909.13 Control air tubing.** Control air tubing shall be of sufficient size to meet the required response times. Tubing shall be flushed clean and dry prior to final connections and shall be adequately supported and protected from damage. Tubing passing through concrete or masonry shall be sleeved and protected from abrasion and electrolytic action.

**[F] 909.13.1 Materials.** Control-air tubing shall be hard-drawn copper, Type L, ACR in accordance with ASTM B42, ASTM B43, ASTM B68/B68M, ASTM B88, ASTM B251 and ASTM B280. Fittings shall be wrought copper or brass, solder type in accordance with ASME B16.18 or ASME B16.22. Changes in direction shall be made with appropriate tool bends. Brass compression-type fittings shall be used at final connection to devices; other joints shall be brazed using a BCuP-5 brazing alloy with solidus above 1,100°F (593°C) and liquids below 1,500°F (816°C). Brazing flux shall be used on copper-to-brass joints only.

**Exception:** Nonmetallic tubing used within control panels and at the final connection to devices provided that all of the following conditions are met:

1. Tubing shall comply with the requirements of Section 602.2.1.3 of the *International Mechanical Code*.
2. Tubing and connected devices shall be completely enclosed within a galvanized or paint-grade steel enclosure having a minimum thickness of 0.0296 inch (0.7534 mm) (No. 22 gage). Entry to the enclosure shall be by copper tubing with a protective grommet of neoprene or Teflon or by suitable brass compression to male barbed adapter.
3. Tubing shall be identified by appropriately documented coding.
4. Tubing shall be neatly tied and supported within the enclosure. Tubing bridging cabinets and doors or moveable devices shall be of sufficient length to avoid tension and excessive stress. Tubing shall be protected against abrasion. Tubing connected to devices on doors shall be fastened along hinges.

**[F] 909.13.2 Isolation from other functions.** Control tubing serving other than smoke control functions shall be isolated by automatic isolation valves or shall be an independent system.

**[F] 909.13.3 Testing.** Control air tubing shall be tested at three times the operating pressure for not less than 30 minutes without any noticeable loss in gauge pressure prior to final connection to devices.

**[F] 909.14 Marking and identification.** The detection and control systems shall be clearly marked at all junctions, accesses and terminations.

**[F] 909.15 Control diagrams.** Identical control diagrams showing all devices in the system and identifying their location and function shall be maintained current and kept on file with the fire code official, the fire department and in the fire command center in a format and manner *approved* by the *fire code official*.

**[F] 909.16 Fire fighter's smoke control panel.** A fire fighter's smoke control panel for fire department emergency response purposes only shall be provided and shall include manual control or override of automatic control for mechanical smoke control systems. The panel shall be located in a fire command center complying with Section 911 in high-rise buildings or buildings with smoke-protected assembly seating. In all other buildings, the fire fighter's smoke control panel shall be installed in an *approved* location adjacent to the fire alarm control panel. The fire fighter's smoke control panel shall comply with Sections 909.16.1 through 909.16.3.

**[F] 909.16.1 Smoke control systems.** Fans within the building shall be shown on the fire fighter's control panel. A clear indication of the direction of airflow and the relationship of components shall be displayed. Status indicators shall be provided for all smoke control equipment, annunciated by fan and zone, and by pilot-lamp-type indicators as follows:

1. Fans, *dampers* and other operating equipment in their normal status—WHITE.
2. Fans, *dampers* and other operating equipment in their off or closed status—RED.
3. Fans, *dampers* and other operating equipment in their on or open status—GREEN.
4. Fans, *dampers* and other operating equipment in a fault status—YELLOW/AMBER.

**[F] 909.16.2 Smoke control panel.** The fire fighter's control panel shall provide control capability over the complete smoke control system equipment within the building as follows:

1. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can be controlled from other sources within the building. This includes *stairway* pressurization fans; smoke exhaust fans; supply, return and exhaust fans; elevator *shaft* fans and other operating equipment used or intended for smoke control purposes.
2. OPEN-AUTO-CLOSE control over individual *dampers* relating to smoke control and that are controlled from other sources within the building.
3. ON-OFF or OPEN-CLOSE control over smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the fire fighter's control panel.

**Exceptions:**

1. Complex systems, where *approved*, where the controls and indicators are combined to control

and indicate all elements of a single smoke zone as a unit.

2. Complex systems, where *approved*, where the control is accomplished by computer interface using *approved*, plain English commands.

**[F] 909.16.3 Control action and priorities.** The fire-fighter's control panel actions shall be as follows:

1. ON-OFF and OPEN-CLOSE control actions shall have the highest priority of any control point within the building. Once issued from the fire fighter's control panel, automatic or manual control from any other control point within the building shall not contradict the control action. Where automatic means are provided to interrupt normal, nonemergency equipment operation or produce a specific result to safeguard the building or equipment including, but not limited to, duct freezestats, duct smoke detectors, high-temperature cutouts, temperature-actuated linkage and similar devices, such means shall be capable of being overridden by the fire fighter's control panel. The last control action as indicated by each fire fighter's control panel switch position shall prevail. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

**Exception:** Power disconnects required by NFPA 70.

2. Only the AUTO position of each three-position fire-fighter's control panel switch shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the NORMAL, nonemergency, building control position. Where a fire fighter's control panel is in the AUTO position, the actual status of the device (on, off, open, closed) shall continue to be indicated by the status indicator described in Section 909.16.1. Where directed by an automatic signal to assume an emergency condition, the NORMAL position shall become the emergency condition for that device or group of devices within the zone. Control actions shall not require the smoke control system to assume more than one configuration at any one time.

**[F] 909.17 System response time.** Smoke-control system activation shall be initiated immediately after receipt of an appropriate automatic or manual activation command. Smoke control systems shall activate individual components (such as *dampers* and fans) in the sequence necessary to prevent physical damage to the fans, *dampers*, ducts and other equipment. For purposes of smoke control, the fire fighter's control panel response time shall be the same for automatic or manual smoke control action initiated from any other building control point. The total response time, including that necessary for detection, shutdown of operating equipment and smoke control system startup, shall allow for full operational mode to be achieved before the conditions in the space exceed the design smoke condition. Upon receipt



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

of an alarm condition at the fire alarm control panel, fans, dampers and automatic doors shall have achieved their proper operating state and the final status shall be indicated at the smoke control panel within 90 seconds. The system response time for each component and their sequential relationships shall be detailed in the required rational analysis and verification of their installed condition reported in the required final report.

**[F] 909.18 Acceptance testing.** Devices, equipment, components and sequences shall be individually tested. These tests, in addition to those required by other provisions of this code, shall consist of determination of function, sequence and, where applicable, capacity of their installed condition.

**[F] 909.18.1 Detection devices.** Smoke or fire detectors that are a part of a smoke control system shall be tested in accordance with Chapter 9 in their installed condition. Where applicable, this testing shall include verification of airflow in both minimum and maximum conditions.

**[F] 909.18.2 Ducts.** Ducts that are part of a smoke control system shall be traversed using generally accepted practices to determine actual air quantities.

**[F] 909.18.3 Dampers.** *Dampers* shall be tested for function in their installed condition.

**[F] 909.18.4 Inlets and outlets.** Inlets and outlets shall be read using generally accepted practices to determine air quantities.

**[F] 909.18.5 Fans.** Fans shall be examined for correct rotation. Measurements of voltage, amperage, revolutions per minute (rpm) and belt tension shall be made.

**[F] 909.18.6 Smoke barriers.** Measurements using inclined manometers or other *approved* calibrated measuring devices shall be made of the pressure differences across *smoke barriers*. Such measurements shall be conducted for each possible smoke control condition.

**[F] 909.18.7 Controls.** Each smoke zone equipped with an automatic-initiation device shall be put into operation by the actuation of one such device. Each additional device within the zone shall be verified to cause the same sequence without requiring the operation of fan motors in order to prevent damage. Control sequences shall be verified throughout the system, including verification of override from the fire fighter's control panel and simulation of standby power conditions.

**[F] 909.18.8 Testing for smoke control.** Smoke control systems shall be tested by a *special inspector* in accordance with Section 1705.19.

**[F] 909.18.8.1 Scope of testing.** Testing shall be conducted in accordance with the following:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure-difference testing, flow measurements, and detection and control verification.

**[F] 909.18.8.2 Qualifications.** *Approved* agencies for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

**[F] 909.18.8.3 Reports.** A complete report of testing shall be prepared by the *approved* agency. The report shall include identification of all devices by manufacturer, nameplate data, design values, measured values and identification tag or *mark*. The report shall be reviewed by the responsible *registered design professional* and, when satisfied that the design intent has been achieved, the responsible *registered design professional* shall sign, seal and date the report.

**[F] 909.18.8.3.1 Report filing.** A copy of the final report shall be filed with the fire code official and an identical copy shall be maintained in an *approved* location at the building.

**[F] 909.18.9 Identification and documentation.** Charts, drawings and other documents identifying and locating each component of the smoke control system, and describing its proper function and maintenance requirements, shall be maintained on file at the building as an attachment to the report required by Section 909.18.8.3. Devices shall have an *approved* identifying tag or *mark* on them consistent with the other required documentation and shall be dated indicating the last time they were successfully tested and by whom.

**[F] 909.19 System acceptance.** Buildings, or portions thereof, required by this code to comply with this section shall not be issued a certificate of occupancy until such time that the fire code official determines that the provisions of this section have been fully complied with and that the fire department has received satisfactory instruction on the operation, both automatic and manual, of the system and a written maintenance program complying with the requirements of Section 909.20.1 of the *International Fire Code* has been submitted and approved by the fire code official.

**Exception:** In buildings of phased construction, a temporary certificate of occupancy, as *approved* by the fire code official, shall be allowed provided that those portions of the building to be occupied meet the requirements of this section and that the remainder does not pose a significant hazard to the safety of the proposed occupants or adjacent buildings.

**909.20 Smokeproof enclosures.** Where required by Section 1023.12, a *smokeproof enclosure* shall be constructed in accordance with this section. A *smokeproof enclosure* shall consist of an *interior exit stairway* or *ramp* that is enclosed in accordance with the applicable provisions of Section 1023 and an open exterior balcony, ventilated vestibule or pressurized *stair* and pressurized entrance vestibule meeting the requirements of this section. Where access to the roof is required by the *International Fire Code*, such access shall be from the *smokeproof enclosure* where a *smokeproof enclosure* is required.

**909.20.1 Access.** Access to the *stairway* or *ramp* shall be by way of a vestibule or an open exterior balcony. The minimum dimension of the vestibule shall be not less than



the required width of the *corridor* leading to the vestibule but shall not have a width of less than 44 inches (1118 mm) and shall not have a length of less than 72 inches (1829 mm) in the direction of egress travel.

**909.20.2 Construction.** The *smokeproof enclosure* shall be separated from the remainder of the building by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. Openings are not permitted other than the required *means of egress* doors. The vestibule shall be separated from the *stairway* or *ramp* by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. The open exterior balcony shall be constructed in accordance with the *fire-resistance rating* requirements for floor assemblies.

**909.20.2.1 Door closers.** Doors in a *smokeproof enclosure* shall be self- or automatic closing by actuation of a smoke detector in accordance with Section 716.2.6.6 and shall be installed at the floor-side entrance to the *smokeproof enclosure*. The actuation of the smoke detector on any door shall activate the closing devices on all doors in the *smokeproof enclosure* at all levels. Smoke detectors shall be installed in accordance with Section 907.3.

**909.20.3 Natural ventilation alternative.** The provisions of Sections 909.20.3.1 through 909.20.3.3 shall apply to ventilation of *smokeproof enclosures* by natural means.

**909.20.3.1 Balcony doors.** Where access to the *stairway* or *ramp* is by way of an open exterior balcony, the door assembly into the enclosure shall be a *fire door assembly* in accordance with Section 716.

**909.20.3.2 Vestibule doors.** Where access to the *stairway* or *ramp* is by way of a vestibule, the door assembly into the vestibule shall be a *fire door assembly* complying with Section 716. The door assembly from the vestibule to the *stairway* shall have not less than a 20-minute *fire protection rating* complying with Section 716.

**909.20.3.3 Vestibule ventilation.** Each vestibule shall have a minimum net area of 16 square feet (1.5 m<sup>2</sup>) of opening in a wall facing an outer *court*, *yard* or *public way* that is not less than 20 feet (6096 mm) in width.

**909.20.4 Mechanical ventilation alternative.** The provisions of Sections 909.20.4.1 through 909.20.4.4 shall apply to ventilation of *smokeproof enclosures* by mechanical means.

**909.20.4.1 Vestibule doors.** The door assembly from the building into the vestibule shall be a *fire door assembly* complying with Section 716.2.2.1. The door assembly from the vestibule to the *stairway* or *ramp* shall not have less than a 20-minute *fire protection rating* and shall meet the requirements for a smoke door assembly in accordance with Section 716.2.2.1. The door shall be installed in accordance with NFPA 105.

**909.20.4.2 Vestibule ventilation.** The vestibule shall be supplied with not less than one air change per

minute and the exhaust shall be not less than 150 percent of supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate, tightly constructed ducts used only for that purpose. Supply air shall enter the vestibule within 6 inches (152 mm) of the floor level. The top of the exhaust register shall be located at the top of the smoke trap but not more than 6 inches (152 mm) down from the top of the trap, and shall be entirely within the smoke trap area. Doors in the open position shall not obstruct duct openings. Duct openings with controlling *dampers* are permitted where necessary to meet the design requirements, but *dampers* are not otherwise required.

#### **909.20.4.2.1 Engineered ventilation system.**

Where a specially engineered system is used, the system shall exhaust a quantity of air equal to not less than 90 air changes per hour from any vestibule in emergency operation mode and shall be sized to handle three vestibules simultaneously. Smoke detectors shall be located at the floor-side entrance to each vestibule and shall activate the system for the affected vestibule. Smoke detectors shall be installed in accordance with Section 907.3.

**909.20.4.3 Smoke trap.** The vestibule ceiling shall be not less than 20 inches (508 mm) higher than the door opening into the vestibule to serve as a smoke and heat trap and to provide an upward-moving air column. The height shall not be decreased unless *approved* and justified by design and test.

**909.20.4.4 Stairway or ramp shaft air movement system.** The *stairway* or *ramp shaft* shall be provided with a dampered relief opening and supplied with sufficient air to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) in the *shaft* relative to the vestibule with all doors closed.

**909.20.5 Stairway and ramp pressurization alternative.** Where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the vestibule is not required, provided that each *interior exit stairway* or *ramp* is pressurized to not less than 0.10 inch of water (25 Pa) and not more than 0.35 inches of water (87 Pa) in the *shaft* relative to the building measured with all *interior exit stairway* and *ramp* doors closed under maximum anticipated conditions of stack effect and wind effect.

**909.20.6 Pressurized stair and vestibule alternative.** The provisions of Sections 909.20.6.1 through 909.20.6.3 shall apply to *smokeproof enclosures* using a pressurized *stair* and pressurized entrance vestibule.

**909.20.6.1 Vestibule doors.** The door assembly from the building into the vestibule shall be a *fire door assembly* complying with Section 716.2.2.1. The door assembly from the vestibule to the *stairway* shall have not less than a 20-minute *fire protection rating* and meet the requirements for a smoke door assembly in accordance with Section 716.2.2.1. The door shall be installed in accordance with NFPA 105.

**909.20.6.2 Pressure difference.** The stair enclosure shall be pressurized to not less than 0.05 inch of water gage (12.44 Pa) positive pressure relative to the vestibule with all *stairway* doors closed under the maximum anticipated stack pressures. The vestibule, with doors closed, shall have not less than 0.05 inch of water gage (12.44 Pa) positive pressure relative to the fire floor. The pressure difference across doors shall not exceed 30 pounds (133-N) maximum force to begin opening the door.

**909.20.6.3 Dampered relief opening.** A controlled relief vent having the capacity to discharge not less than 2,500 cubic feet per minute (1180 L/s) of air at the design pressure difference shall be located in the upper portion of the pressurized exit enclosure.

**909.20.7 Ventilating equipment.** The activation of ventilating equipment required by the alternatives in Sections 909.20.4, 909.20.5 and 909.20.6 shall be by smoke detectors installed at each floor level at an *approved* location at the entrance to the *smokeproof enclosure*. When the closing device for the *stairway* and *ramp shaft* and vestibule doors is activated by smoke detection or power failure, the mechanical equipment shall activate and operate at the required performance levels. Smoke detectors shall be installed in accordance with Section 907.3.

**909.20.7.1 Ventilation systems.** *Smokeproof enclosure* ventilation systems shall be independent of other building ventilation systems. The equipment, control wiring, power wiring and ductwork shall comply with one of the following:

1. Equipment, control wiring, power wiring and ductwork shall be located exterior to the building and directly connected to the *smokeproof enclosure* or connected to the *smokeproof enclosure* by ductwork enclosed by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.
2. Equipment, control wiring, power wiring and ductwork shall be located within the *smokeproof enclosure* with intake or exhaust directly from and to the outside or through ductwork enclosed by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.
3. Equipment, control wiring, power wiring and ductwork shall be located within the building if separated from the remainder of the building, including other mechanical equipment, by not less than 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**Exception:**

1. Control wiring and power wiring located outside of a 2-hour fire barrier construc-

tion shall be protected using any one of the following methods:

- 1.1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 2 hours.
- 1.2. Where encased with not less than 2 inches (51 mm) of concrete.
- 1.3. *Electrical circuit protective systems* shall have a *fire-resistance rating* of not less than 2 hours. *Electrical circuit protective systems* shall be installed in accordance with their listing requirements.

**909.20.7.2 Standby power.** Mechanical vestibule and *stairway* and *ramp shaft* ventilation systems and automatic fire detection systems shall be provided with standby power in accordance with Section 2702.

**909.20.7.3 Acceptance and testing.** Before the mechanical equipment is *approved*, the system shall be tested in the presence of the *building official* to confirm that the system is operating in compliance with these requirements.

**909.21 Elevator hoistway pressurization alternative.** Where elevator hoistway pressurization is provided in lieu of required enclosed elevator lobbies, the pressurization system shall comply with Sections 909.21.1 through 909.21.11.

**909.21.1 Pressurization requirements.** Elevator hoistways shall be pressurized to maintain a minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to adjacent occupied space on all floors. This pressure shall be measured at the midpoint of each hoistway door, with all elevator cars at the floor of recall and all hoistway doors on the floor of recall open and all other hoistway doors closed. The pressure differentials shall be measured between the hoistway and the adjacent elevator landing. The opening and closing of hoistway doors at each level must be demonstrated during this test. The supply air intake shall be from an outside, uncontaminated source located a minimum distance of 20 feet (6096 mm) from any air exhaust system or outlet.

**Exceptions:**

1. On floors containing only Group R occupancies, the pressure differential is permitted to be measured between the hoistway and a *dwelling unit* or *sleeping unit*.
2. Where an elevator opens into a lobby enclosed in accordance with Section 3007.6 or 3008.6, the pressure differential is permitted to be measured between the hoistway and the space immediately outside the door(s) from the floor to the enclosed lobby.

3. The pressure differential is permitted to be measured relative to the outdoor atmosphere on floors other than the following:
  - 3.1. The fire floor.
  - 3.2. The two floors immediately below the fire floor.
  - 3.3. The floor immediately above the fire floor.
4. The minimum positive pressure of 0.10 inch of water (25 Pa) and a maximum positive pressure of 0.25 inch of water (67 Pa) with respect to occupied floors are not required at the floor of recall with the doors open.

**909.21.1.1 Use of ventilation systems.** Ventilation systems, other than hoistway supply air systems, are permitted to be used to exhaust air from adjacent spaces on the fire floor, two floors immediately below and one floor immediately above the fire floor to the building's exterior where necessary to maintain positive pressure relationships as required in Section 909.21.1 during operation of the elevator *shaft* pressurization system.

**909.21.2 Rational analysis.** A rational analysis complying with Section 909.4 shall be submitted with the *construction documents*.

**909.21.3 Ducts for system.** Any duct system that is part of the pressurization system shall be protected with the same *fire-resistance rating* as required for the elevator *shaft* enclosure.

**909.21.4 Fan system.** The fan system provided for the pressurization system shall be as required by Sections 909.21.4.1 through 909.21.4.4.

**909.21.4.1 Fire resistance.** Where located within the building, the fan system that provides the pressurization shall be protected with the same *fire-resistance rating* required for the elevator *shaft* enclosure.

**909.21.4.2 Smoke detection.** The fan system shall be equipped with a smoke detector that will automatically shut down the fan system when smoke is detected within the system.

**909.21.4.3 Separate systems.** A separate fan system shall be used for each elevator hoistway.

**909.21.4.4 Fan capacity.** The supply fan shall be either adjustable with a capacity of not less than 1,000 cubic feet per minute (0.4719 m<sup>3</sup>/s) per door, or that specified by a *registered design professional* to meet the requirements of a designed pressurization system.

**909.21.5 Standby power.** The pressurization system shall be provided with standby power in accordance with Section 2702.

**909.21.6 Activation of pressurization system.** The elevator pressurization system shall be activated upon activation of either the building fire alarm system or the elevator lobby smoke detectors. Where both a building fire alarm system and elevator lobby smoke detectors are

present, each shall be independently capable of activating the pressurization system.

**909.21.7 Testing.** Testing for performance shall be required in accordance with Section 909.18.8. System acceptance shall be in accordance with Section 909.19.

**909.21.8 Marking and identification.** Detection and control systems shall be marked in accordance with Section 909.14.

**909.21.9 Control diagrams.** Control diagrams shall be provided in accordance with Section 909.15.

**909.21.10 Control panel.** A control panel complying with Section 909.16 shall be provided.

**909.21.11 System response time.** Hoistway pressurization systems shall comply with the requirements for smoke control system response time in Section 909.17.

## SECTION 910 SMOKE AND HEAT REMOVAL

**[F] 910.1 General.** Where required by this code, smoke and heat vents or mechanical smoke removal systems shall conform to the requirements of this section.

**[F] 910.2 Where required.** Smoke and heat vents or a mechanical smoke removal system shall be installed as required by Sections 910.2.1 and 910.2.2.

### Exceptions:

1. Frozen food warehouses used solely for storage of Class I and II commodities where protected by an *approved automatic sprinkler system*.
2. Smoke and heat removal shall not be required in areas of buildings equipped with early suppression fast-response (ESFR) sprinklers.
3. Smoke and heat removal shall not be required in areas of buildings equipped with control mode special application sprinklers with a response time index of 50 (m × s)<sup>1/2</sup> or less that are listed to control a fire in stored commodities with 12 or fewer sprinklers.

**910.2.1 Group F-1 or S-1.** Smoke and heat vents installed in accordance with Section 910.3 or a mechanical smoke removal system installed in accordance with Section 910.4 shall be installed in buildings and portions thereof used as a Group F-1 or S-1 occupancy having more than 50,000 square feet (4645 m<sup>2</sup>) of undivided area. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 where the upper surface of the *story* is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

**Exception:** Group S-1 aircraft repair hangars.

**[F] 910.2.2 High-piled combustible storage.** Smoke and heat removal required by Table 3206.2 of the *International Fire Code* for buildings and portions thereof containing high-piled combustible storage shall be



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

installed in accordance with Section 910.3 in unsprinklered buildings. In buildings and portions thereof containing high-piled combustible storage equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, a smoke and heat removal system shall be installed in accordance with Section 910.3 or 910.4. In occupied portions of a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, where the upper surface of the *story* is not a roof assembly, a mechanical smoke removal system in accordance with Section 910.4 shall be installed.

**[F] 910.3 Smoke and heat vents.** The design and installation of smoke and heat vents shall be in accordance with Sections 910.3.1 through 910.3.3.

**[F] 910.3.1 Listing and labeling.** Smoke and heat vents shall be *listed* and labeled to indicate compliance with UL 793 or FM 4430.

**[F] 910.3.2 Smoke and heat vent locations.** Smoke and heat vents shall be located 20 feet (6096 mm) or more from adjacent *lot lines* and *fire walls* and 10 feet (3048 mm) or more from *fire barriers*. Vents shall be uniformly located within the roof in the areas of the building where the vents are required to be installed by Section 910.2 with consideration given to roof pitch, sprinkler location and structural members.

**910.3.3 Smoke and heat vents area.** The required aggregate area of smoke and heat vents shall be calculated as follows:

For buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1:

$$A_{VR} = V/9000 \quad (\text{Equation 9-3})$$

where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$V$  = Volume (ft<sup>3</sup>) of the area that requires smoke removal.

For unsprinklered buildings:

$$A_{VR} = A_{FA}/50 \quad (\text{Equation 9-4})$$

where:

$A_{VR}$  = The required aggregate vent area (ft<sup>2</sup>).

$A_{FA}$  = The area of the floor in the area that requires smoke removal.

**[F] 910.3.4 Vent operation.** Smoke and heat vents shall be capable of being operated by *approved* automatic and manual means.

**[F] 910.3.5 Fusible link temperature rating.** Where vents are installed in areas provided with automatic fire sprinklers and the vents operate by fusible link, the fusible link shall have a temperature rating of 360°F (182°C).

**[F] 910.4 Mechanical smoke removal systems.** Mechanical smoke removal systems shall be designed and installed in accordance with Sections 910.4.1 through 910.4.7.

**910.4.1 Automatic sprinklers required.** The building shall be equipped throughout with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

**910.4.2 Exhaust fan construction.** Exhaust fans that are part of a mechanical smoke removal system shall be rated for operation at 221°F (105°C). Exhaust fan motors shall be located outside of the exhaust fan air stream.

**910.4.3 System design criteria.** The mechanical smoke removal system shall be sized to exhaust the building at a minimum rate of two air changes per hour based on the volume of the building or portion thereof without contents. The capacity of each exhaust fan shall not exceed 30,000 cubic feet per minute (14.2 m<sup>3</sup>/s).

**910.4.3.1 Makeup air.** Makeup air openings shall be provided within 6 feet (1829 mm) of the floor level. Operation of makeup air openings shall be manual or automatic. The minimum gross area of makeup air inlets shall be 8 square feet per 1,000 cubic feet per minute (0.74 m<sup>2</sup> per 0.4719 m<sup>3</sup>/s) of smoke exhaust.

**910.4.4 Activation.** The mechanical smoke removal system shall be activated by manual controls only.

**910.4.5 Manual control location.** Manual controls shall be located where they are able to be accessed by the fire service from an exterior door of the building and separated from the remainder of the building by not less than 1-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**[F] 910.4.6 Control wiring.** Wiring for operation and control of mechanical smoke removal systems shall be connected ahead of the main disconnect in accordance with Section 701.12E of NFPA 70 and be protected against interior fire exposure to temperatures in excess of 1,000°F (538°C) for a period of not less than 15 minutes.

**[F] 910.4.7 Controls.** Where building air-handling and mechanical smoke removal systems are combined or where independent building air-handling systems are provided, fans shall automatically shut down in accordance with the *International Mechanical Code*. The manual controls provided for the smoke removal system shall have the capability to override the automatic shut-down of fans that are part of the smoke removal system.

**910.5 Maintenance.** Smoke and heat vents and mechanical smoke removal systems shall be maintained in accordance with the *International Fire Code*.

## SECTION 911 FIRE COMMAND CENTER

**[F] 911.1 General.** Where required by other sections of this code, in buildings classified as high-rise buildings by this code and in all F-1 and S-1 occupancies with a building footprint of over 500,000 square feet (46 452 m<sup>2</sup>), a fire command center for fire department operations shall be provided and shall comply with Sections 911.1.1 through 911.1.7.



**[F] 911.1.1 Location and access.** The location and access to the fire command center shall be *approved* by the *fire code official*.

**[F] 911.1.2 Separation.** The fire command center shall be separated from the remainder of the building by not less than a 1-hour *fire barrier* constructed in accordance with Section 707 or *horizontal assembly* constructed in accordance with Section 711, or both.

**[F] 911.1.3 Size.** The fire command center shall be not less than 0.015 percent of the total building area of the facility served or 200 square feet (19 m<sup>2</sup>) in area, whichever is greater, with a minimum dimension of 0.7 times the square root of the room area or 10 feet (3048 mm), whichever is greater. Where a fire command is required for Group F-1 and S-1 occupancies with a building footprint greater than 500,000 square feet (46 452 m<sup>2</sup>) in area, the fire command center shall have a minimum size of 96 square feet (9 m<sup>2</sup>) with a minimum dimension of 8 feet (2348 mm) where *approved* by the *fire code official*.

**[F] 911.1.4 Layout approval.** A layout of the fire command center and all features required by this section to be contained therein shall be submitted for approval prior to installation.

**[F] 911.1.5 Storage.** Storage unrelated to operation of the fire command center shall be prohibited.

**[F] 911.1.6 Required features.** The fire command center shall comply with NFPA 72 and shall contain all of the following features:

1. The emergency voice/alarm communication system control unit.
2. The fire department communications system.
3. Fire detection and alarm system *annunciator*.
4. *Annunciator* unit visually indicating the location of the elevators and whether they are operational.
5. Status indicators and controls for air distribution systems.
6. The fire fighter's control panel required by Section 909.16 for smoke control systems installed in the building.
7. Controls for unlocking *interior exit stairway* doors simultaneously.
8. Sprinkler valve and waterflow detector display panels.
9. Emergency and standby power status indicators.
10. A telephone for fire department use with controlled access to the public telephone system.
11. Fire pump status indicators.
12. Schematic building plans indicating the typical floor plan and detailing the building core, *means of egress*, fire protection systems, fire fighter air replenishment system, fire-fighting equipment and fire department access and the location of *fire walls*, *fire barriers*, *fire partitions*, *smoke barriers* and *smoke partitions*.

13. An *approved* Building Information Card that contains, but is not limited to, the following information:

- 13.1. General building information that includes: property name, address, the number of floors in the building above and below grade, use and occupancy classification (for mixed uses, identify the different types of occupancies on each floor), and the estimated building population during the day, night and weekend.
- 13.2. Building emergency contact information that includes: a list of the building's emergency contacts including but not limited to building manager and building engineer and their respective work phone number, cell phone number, e-mail address.
- 13.3. Building construction information that includes: the type of building construction including but not limited to floors, walls, columns, and roof assembly.
- 13.4. *Exit access* and *exit stairway* information that includes: number of *exit access* and *exit stairways* in the building, each *exit access* and *exit stairway* designation and floors served, location where each *exit access* and *exit stairway* discharges, *interior exit stairways* that are pressurized, *exit stairways* provided with emergency lighting, each *exit stairway* that allows reentry, *exit stairways* providing roof access; elevator information that includes: number of elevator banks, elevator bank designation, elevator car numbers and respective floors that they serve; location of elevator machine rooms, control rooms and control spaces; location of sky lobby, location of freight elevator banks.
- 13.5. Building services and system information that includes: location of mechanical rooms, location of building management system, location and capacity of all fuel oil tanks, location of emergency generator, location of natural gas service.
- 13.6. Fire protection system information that includes: location of standpipes, location of fire pump room, location of fire department connections, floors protected by automatic sprinklers, location of different types of *automatic sprinkler systems* installed including, but not limited to, dry, wet and pre-action.
- 13.7. Hazardous material information that includes: location of hazardous material, quantity of hazardous material.

14. Work table.

## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

15. Generator supervision devices, manual start and transfer features.
16. Public address system, where specifically required by other sections of this code.
17. Elevator fire recall switch in accordance with ASME A17.1/CSA B44.
18. Elevator emergency or standby power selector switch(es), where emergency or standby power is provided.

**[F] 911.1.7 Fire command center identification.** The *fire command center* shall be identified by a permanent easily visible sign reading "FIRE COMMAND CENTER" located on the door to the *fire command center*.

### SECTION 912 FIRE DEPARTMENT CONNECTIONS

**[F] 912.1 Installation.** Fire department connections shall be installed in accordance with the NFPA standard applicable to the system design and shall comply with Sections 912.2 through 912.6.

**[F] 912.2 Location.** With respect to hydrants, driveways, buildings and landscaping, fire department connections shall be so located that fire apparatus and hose connected to supply the system will not obstruct access to the buildings for other fire apparatus. The location of fire department connections shall be *approved* by the *fire code official*.

**[F] 912.2.1 Visible location.** Fire department connections shall be located on the street side of buildings or facing approved fire apparatus access roads, fully visible and recognizable from the street, fire apparatus access road or nearest point of fire department vehicle access or as otherwise *approved* by the *fire code official*.

**[F] 912.2.2 Existing buildings.** On existing buildings, wherever the fire department connection is not visible to approaching fire apparatus, the fire department connection shall be indicated by an *approved* sign mounted on the street front or on the side of the building. Such sign shall have the letters "FDC" not less than 6 inches (152 mm) high and words in letters not less than 2 inches (51 mm) high or an arrow to indicate the location. Such signs shall be subject to the approval of the *fire code official*.

**[F] 912.3 Fire hose threads.** Fire hose threads used in connection with standpipe systems shall be *approved* and shall be compatible with fire department hose threads.

**[F] 912.4 Access.** Immediate access to fire department connections shall be maintained at all times and without obstruction by fences, bushes, trees, walls or any other fixed or moveable object. Access to fire department connections shall be *approved* by the *fire code official*.

**Exception:** Fences, where provided with an access gate equipped with a sign complying with the legend requirements of this section and a means of emergency operation. The gate and the means of emergency operation shall be *approved* by the *fire code official* and maintained operational at all times.

**[F] 912.4.1 Locking fire department connection caps.** The fire code official is authorized to require locking caps on fire department connections for water-based *fire protection systems* where the responding fire department carries appropriate key wrenches for removal.

**[F] 912.4.2 Clear space around connections.** A working space of not less than 36 inches (762 mm) in width, 36 inches (914 mm) in depth and 78 inches (1981 mm) in height shall be provided and maintained in front of and to the sides of wall-mounted fire department connections and around the circumference of free-standing fire department connections, except as otherwise required or *approved* by the *fire code official*.

**[F] 912.4.3 Physical protection.** Where fire department connections are subject to impact by a motor vehicle, vehicle impact protection shall be provided in accordance with Section 312 of the *International Fire Code*.

**[F] 912.5 Signs.** A metal sign with raised letters not less than 1 inch (25 mm) in size shall be mounted on all fire department connections serving automatic sprinklers, standpipes or fire pump connections. Such signs shall read: "AUTOMATIC SPRINKLERS," "STANDPIPES," or "TEST CONNECTION," or a combination thereof as applicable. Where the fire department connection does not serve the entire building, a sign shall be provided indicating the portions of the building served.

**[P] 912.6 Backflow protection.** The potable water supply to automatic sprinkler and standpipe systems shall be protected against backflow as required by the *International Plumbing Code*.

### SECTION 913 FIRE PUMPS

**[F] 913.1 General.** Where provided, fire pumps for fire protection systems shall be installed in accordance with this section and NFPA 20.

**Exception:** Pumps for automatic sprinkler systems installed in accordance with Section 903.3.1.3, or Section P2904 of the *International Residential Code*.

**[F] 913.2 Protection against interruption of service.** The fire pump, driver and controller shall be protected in accordance with NFPA 20 against possible interruption of service through damage caused by explosion, fire, *flood*, earthquake, rodents, insects, windstorm, freezing, vandalism and other adverse conditions.

**913.2.1 Protection of fire pump rooms.** Fire pumps shall be located in rooms that are separated from all other areas of the building by 2-hour *fire barriers* constructed in accordance with Section 707 or 2-hour *horizontal assemblies* constructed in accordance with Section 711, or both.

#### Exceptions:

1. In other than high-rise buildings, separation by 1-hour *fire barriers* constructed in accordance with Section 707 or 1-hour *horizontal assemblies* constructed in accordance with Section

711, or both, shall be permitted in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.

2. Separation is not required for fire pumps physically separated in accordance with NFPA 20.

**[F] 913.2.2 Circuits supplying fire pumps.** Cables used for survivability of circuits supplying fire pumps shall be protected using one of the following methods:

1. Cables used for survivability of required critical circuits shall be *listed* in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 1 hour.
2. *Electrical circuit protective systems* shall have a *fire-resistance rating* of not less than 1 hour. *Electrical circuit protective systems* shall be installed in accordance with their listing requirements.
3. Construction having a *fire-resistance rating* of not less than 1 hour.
4. The cable or raceway is encased in a minimum of 2 inches (51 mm) of concrete.

**Exception:** This section shall not apply to cables, or portions of cables, located within a fire pump room or generator room which is separated from the remainder of the occupancy with *fire-resistance-rated* construction.

**[F] 913.3 Temperature of pump room.** Suitable means shall be provided for maintaining the temperature of a pump room or pump house, where required, above 40°F (5°C).

**[F] 913.3.1 Engine manufacturer's recommendation.** Temperature of the pump room, pump house or area where engines are installed shall never be less than the minimum recommended by the engine manufacturer. The engine manufacturer's recommendations for oil heaters shall be followed.

**[F] 913.4 Valve supervision.** Where provided, the fire pump suction, discharge and bypass valves, and isolation valves on the backflow prevention device or assembly shall be supervised open by one of the following methods:

1. Central-station, proprietary or remote-station signaling service.
2. Local signaling service that will cause the sounding of an audible signal at a *constantly attended location*.
3. Locking valves open.
4. Sealing of valves and *approved* weekly recorded inspection where valves are located within fenced enclosures under the control of the owner.

**[F] 913.4.1 Test outlet valve supervision.** Fire pump test outlet valves shall be supervised in the closed position.

**[F] 913.5 Acceptance test.** Acceptance testing shall be done in accordance with the requirements of NFPA 20.

**913.6 Supervisory conditions.** The following conditions shall be supervised by the fire alarm system as appropriate for the type of pump supervised:

1. Pump room temperature.

2. Phase loss.
3. Phase reversal.
4. Pump in manual mode.

## SECTION 914 EMERGENCY RESPONDER SAFETY FEATURES

**[F] 914.1 Shaftway markings.** Vertical *shafts* shall be identified as required by Sections 914.1.1 and 914.1.2.

**[F] 914.1.1 Exterior access to shaftways.** Outside openings accessible to the fire department and that open directly on a hoistway or shaftway communicating between two or more floors in a building shall be plainly marked with the word "SHAFTWAY" in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible from the outside of the building.

**[F] 914.1.2 Interior access to shaftways.** Door or window openings to a hoistway or shaftway from the interior of the building shall be plainly marked with the word "SHAFTWAY" in red letters not less than 6 inches (152 mm) high on a white background. Such warning signs shall be placed so as to be readily discernible.

**Exception:** Markings shall not be required on shaftway openings that are readily discernible as openings onto a shaftway by the construction or arrangement.

**[F] 914.2 Equipment room identification.** Fire protection equipment shall be identified in an *approved* manner. Rooms containing controls for air-conditioning systems, sprinkler risers and valves or other fire detection, suppression or control elements shall be identified for the use of the fire department. *Approved* signs required to identify fire protection equipment and equipment location shall be constructed of durable materials, permanently installed and readily visible.

## SECTION 915 CARBON MONOXIDE DETECTION

**[F] 915.1 General.** Carbon monoxide detection shall be installed in new buildings in accordance with Sections 915.1.1 through 915.6. Carbon monoxide detection shall be installed in existing buildings in accordance with Chapter 11 of the *International Fire Code*.

**[F] 915.1.1 Where required.** Carbon monoxide detection shall be provided in Group I-1, I-2, I-4 and R occupancies and in classrooms in Group E occupancies in the locations specified in Section 915.2 where any of the conditions in Sections 915.1.2 through 915.1.6 exist.

**[F] 915.1.2 Fuel-burning appliances and fuel-burning fireplaces.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms that contain a fuel-burning appliance or a fuel-burning fireplace.

**[F] 915.1.3 Fuel burning, forced-air furnaces.** Carbon monoxide detection shall be provided in dwelling units,



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

sleeping units and classrooms served by a fuel-burning, forced-air furnace.

**Exception:** Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms if a carbon monoxide detector is provided in the first room or area served by each main duct leaving the furnace, and the carbon monoxide alarm signals are automatically transmitted to an approved location.

**[F] 915.1.4 Fuel-burning appliances outside of dwelling units, sleeping units and classrooms.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms located in buildings that contain fuel-burning appliances or fuel-burning fireplaces.

### Exceptions:

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms where a carbon monoxide detector is provided in one of the following locations:
  - 2.1. In an *approved* location between the fuel-burning appliance or fuel-burning fireplace and the *dwelling unit*, *sleeping unit* or classroom.
  - 2.2. On the ceiling of the room containing the fuel-burning appliance or fuel-burning fireplace.

**[F] 915.1.5 Private garages.** Carbon monoxide detection shall be provided in *dwelling units*, *sleeping units* and classrooms in buildings with attached *private garages*.

### Exceptions:

1. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms without communicating openings between the *private garage* and the *dwelling unit*, *sleeping unit* or classroom.
2. Carbon monoxide detection shall not be required in *dwelling units*, *sleeping units* and classrooms located more than one *story* above or below a *private garage*.
3. Carbon monoxide detection shall not be required where the *private garage* connects to the building through an *open-ended corridor*.
4. Where a carbon monoxide detector is provided in an *approved* location between openings to a *private garage* and *dwelling units*, *sleeping units* or classrooms.

**[F] 915.1.6 Exempt garages.** For determining compliance with Section 915.1.5, an *open parking garage* complying with Section 406.5 or an enclosed parking

garage complying with Section 406.6 shall not be considered a *private garage*.

**[F] 915.2 Locations.** Where required by Section 915.1.1, carbon monoxide detection shall be installed in the locations specified in Sections 915.2.1 through 915.2.3.

**[F] 915.2.1 Dwelling units.** Carbon monoxide detection shall be installed in *dwelling units* outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning appliance is located within a bedroom or its attached bathroom, carbon monoxide detection shall be installed within the bedroom.

**[F] 915.2.2 Sleeping units.** Carbon monoxide detection shall be installed in *sleeping units*.

**Exception:** Carbon monoxide detection shall be allowed to be installed outside of each separate sleeping area in the immediate vicinity of the *sleeping unit* where the *sleeping unit* or its attached bathroom does not contain a fuel-burning appliance and is not served by a forced air furnace.

**[F] 915.2.3 Group E occupancies.** Carbon monoxide detectors shall be installed in classrooms in Group E occupancies. Carbon monoxide alarm signals shall be automatically transmitted to an on-site location that is staffed by school personnel.

**Exception:** Carbon monoxide alarm signals shall not be required to be automatically transmitted to an on-site location that is staffed by school personnel in Group E occupancies with an *occupant load* of 30 or less.

**[F] 915.3 Carbon monoxide detection.** Carbon monoxide detection required by Sections 915.1 through 915.2.3 shall be provided by carbon monoxide alarms complying with Section 915.4 or carbon monoxide detection systems complying with Section 915.5.

**[F] 915.4 Carbon monoxide alarms.** Carbon monoxide alarms shall comply with Sections 915.4.1 through 915.4.4.

**[F] 915.4.1 Power source.** Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source, and when primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than that required for overcurrent protection.

**Exception:** Where installed in buildings without commercial power, battery-powered carbon monoxide alarms shall be an acceptable alternative.

**[F] 915.4.2 Listings.** Carbon monoxide alarms shall be listed in accordance with UL 2034.

**[F] 915.4.3 Locations.** Carbon monoxide alarms shall only be installed in *dwelling units* and in *sleeping units*. They shall not be installed in locations where the code requires carbon monoxide detectors to be used.

**[F] 915.4.4 Combination alarms.** Combination carbon monoxide/smoke alarms shall be an acceptable alternative to carbon monoxide alarms. Combination carbon



## FIRE PROTECTION AND LIFE SAFETY SYSTEMS

monoxide/smoke alarms shall be listed in accordance with UL 217 and UL 2034.

**[F] 915.5 Carbon monoxide detection systems.** Carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide alarms and shall comply with Sections 915.5.1 through 915.5.3.

**[F] 915.5.1 General.** Carbon monoxide detection systems shall comply with NFPA 720. Carbon monoxide detectors shall be *listed* in accordance with UL 2075.

**[F] 915.5.2 Locations.** Carbon monoxide detectors shall be installed in the locations specified in Section 915.2. These locations supersede the locations specified in NFPA 720.

**[F] 915.5.3 Combination detectors.** Combination carbon monoxide/smoke detectors installed in carbon monoxide detection systems shall be an acceptable alternative to carbon monoxide detectors, provided that they are listed in accordance with UL 268 and UL 2075.

**[F] 915.6 Maintenance.** Carbon monoxide alarms and carbon monoxide detection systems shall be maintained in accordance with the *International Fire Code*.

## SECTION 916 GAS DETECTION SYSTEMS

**[F] 916.1 Gas detection systems.** Gas detection systems required by this code shall comply with Sections 916.2 through 916.11.

**[F] 916.2 Permits.** Permits shall be required as set forth in Section 105.6.10 of the *International Fire Code*.

**[F] 916.2.1 Construction documents.** Documentation of the gas detection system design and equipment to be used that demonstrates compliance with the requirements of this code and the *International Fire Code* shall be provided with the application for permit.

**[F] 916.3 Equipment.** Gas detection system equipment shall be designed for use with the gases being detected and shall be installed in accordance with manufacturer's instructions.

**[F] 916.4 Power connections.** Gas detection systems shall be permanently connected to the building electrical power supply or shall be permitted to be cord connected to an unswitched receptacle using an *approved* restraining means that secures the plug to the receptacle.

**[F] 916.5 Emergency and standby power.** Standby or emergency power shall be provided or the gas detection system shall initiate a trouble signal at an *approved* location if the power supply is interrupted.

**[F] 916.6 Sensor locations.** Sensors shall be installed in *approved* locations where leaking gases are expected to accumulate.

**[F] 916.7 Gas sampling.** Gas sampling shall be performed continuously. Sample analysis shall be processed immediately after sampling, except as follows:

1. For HPM gases, sample analysis shall be performed at intervals not exceeding 30 minutes.

2. For toxic gases that are not HPM, sample analysis shall be performed at intervals not exceeding 5 minutes in accordance with Section 6004.2.2.7 of the *International Fire Code*.

3. Where a less frequent or delayed sampling interval is *approved*.

**[F] 916.8 System activation.** A gas detection alarm shall be initiated where any sensor detects a concentration of gas exceeding the following thresholds:

1. For flammable gases, a gas concentration exceeding 25 percent of the lower flammability limit (LFL).
2. For nonflammable gases, a gas concentration exceeding one-half of the IDLH, unless a different threshold is specified by the section of this code requiring a gas detection system.

Upon activation of a gas detection alarm, alarm signals or other required responses shall be as specified by the section of this code requiring a gas detection system. Audible and visible alarm signals associated with a gas detection alarm shall be distinct from fire alarm and carbon monoxide alarm signals.

**[F] 916.9 Signage.** Signs shall be provided adjacent to gas detection system alarm signaling devices that advise occupants of the nature of the signals and actions to take in response to the signal.

**[F] 916.10 Fire alarm system connections.** Gas sensors and gas detection systems shall not be connected to fire alarm systems unless approved and connected in accordance with the fire alarm equipment manufacturer's instructions.

**[F] 916.11 Inspection, testing and sensor calibration.** Gas detection systems and sensors shall be inspected, tested and calibrated in accordance with the *International Fire Code*.

## SECTION 917 MASS NOTIFICATION SYSTEMS

**[F] 917.1 College and university campuses.** Prior to construction of a new building requiring a fire alarm system on a multiple-building college or university campus having a cumulative building *occupant load* of 1,000 or more, a mass notification risk analysis shall be conducted in accordance with NFPA 72. Where the risk analysis determines a need for mass notification, an *approved* mass notification system shall be provided in accordance with the findings of the risk analysis.

## SECTION 918 EMERGENCY RESPONDER COMMUNICATION COVERAGE

**[F] 918.1 General.** In-building two-way emergency responder communication coverage shall be provided in all new buildings in accordance with Section 510 of the *International Fire Code*.



# CHAPTER 10

## MEANS OF EGRESS

### User notes:

**About this chapter:** Chapter 10 provides the general criteria for designing the means of egress established as the primary method for protection of people in buildings by allowing timely relocation or evacuation of building occupants. Both prescriptive and performance language is utilized in this chapter to provide for a basic approach in the determination of a safe exiting system for all occupancies. It addresses all portions of the egress system (exit access, exits and exit discharge) and includes design requirements as well as provisions regulating individual components. The requirements detail the size, arrangement, number and protection of means of egress components. Functional and operational characteristics that will permit the safe use of components without special knowledge or effort are specified.

The means of egress protection requirements work in coordination with other sections of the code, such as protection of vertical openings (see Chapter 7), interior finish (see Chapter 8), fire suppression and detection systems (see Chapter 9) and numerous others, all having an impact on life safety. Chapter 10 is subdivided into four main sections: general (Sections 1003–1015), exit access (Sections 1016–1021), exit (Sections 1022–1027) and exit discharge (Sections 1028–1029). Special allowances for the unique requirements for assembly spaces (Section 1030) and emergency escape and rescue openings (Section 1031) complete the chapter. Chapter 10 of this code is duplicated in Chapter 10 of the International Fire Code®; however, the International Fire Code contains one additional section on maintenance of the means of egress system in existing buildings.

Section 1010 was extensively reorganized for the 2021 edition. For complete information, see the moved sections table in the preface information for the International Building Code.

### SECTION 1001 ADMINISTRATION

**1001.1 General.** Buildings or portions thereof shall be provided with a *means of egress* system as required by this chapter. The provisions of this chapter shall control the design, construction and arrangement of *means of egress* components required to provide an *approved means of egress* from structures and portions thereof.

**1001.2 Minimum requirements.** It shall be unlawful to alter a building or structure in a manner that will reduce the number of *exits* or the minimum width or required capacity of the *means of egress* to less than required by this code.

### [F] SECTION 1002 MAINTENANCE AND PLANS

[F] **1002.1 Maintenance.** *Means of egress* shall be maintained in accordance with the *International Fire Code*.

[F] **1002.2 Fire safety and evacuation plans.** Fire safety and evacuation plans shall be provided for all occupancies and buildings where required by the *International Fire Code*. Such fire safety and evacuation plans shall comply with the applicable provisions of Sections 401.2 and 404 of the *International Fire Code*.

### SECTION 1003 GENERAL MEANS OF EGRESS

**1003.1 Applicability.** The general requirements specified in Sections 1003 through 1015 shall apply to all three elements of the *means of egress* system, in addition to those specific

requirements for the *exit access*, the *exit* and the *exit discharge* detailed elsewhere in this chapter.

**1003.2 Ceiling height.** The *means of egress* shall have a ceiling height of not less than 7 feet 6 inches (2286 mm) above the finished floor.

#### Exceptions:

1. Sloped ceilings in accordance with Section 1208.2.
2. Ceilings of *dwelling units* and *sleeping units* within residential occupancies in accordance with Section 1208.2.
3. Allowable projections in accordance with Section 1003.3.
4. *Stair* headroom in accordance with Section 1011.3.
5. Door height in accordance with Section 1010.1.1.
6. *Ramp* headroom in accordance with Section 1012.5.2.
7. The clear height of floor levels in vehicular and pedestrian traffic areas of public and private parking garages in accordance with Section 406.2.2.
8. Areas above and below *mezzanine* floors in accordance with Section 505.2.

**1003.3 Protruding objects.** Protruding objects on *circulation paths* shall comply with the requirements of Sections 1003.3.1 through 1003.3.4.

**1003.3.1 Headroom.** Protruding objects are permitted to extend below the minimum ceiling height required by Section 1003.2 where a minimum headroom of 80 inches

## MEANS OF EGRESS

(2032 mm) is provided over any circulation paths, including walks, *corridors*, *aisles* and passageways. Not more than 50 percent of the ceiling area of a *means of egress* shall be reduced in height by protruding objects.

**Exception:** Door closers and stops shall not reduce headroom to less than 78 inches (1981 mm).

A barrier shall be provided where the vertical clearance above a *circulation path* is less than 80 inches (2032 mm) high above the finished floor. The leading edge of such a barrier shall be located 27 inches (686 mm) maximum above the finished floor.

**1003.3.2 Post-mounted objects.** A free-standing object mounted on a post or pylon shall not overhang that post or pylon more than 4 inches (102 mm) where the lowest point of the leading edge is more than 27 inches (686 mm) and less than 80 inches (2032 mm) above the finished floor. Where a sign or other obstruction is mounted between posts or pylons and the clear distance between the posts or pylons is greater than 12 inches (305 mm), the lowest edge of such sign or obstruction shall be 27 inches (686 mm) maximum or 80 inches (2032 mm) minimum above the finished floor or ground.

**Exception:** These requirements shall not apply to sloping portions of *handrails* between the top and bottom riser of *stairs* and above the *ramp* run.

**1003.3.3 Horizontal projections.** Objects with leading edges more than 27 inches (685 mm) and not more than 80 inches (2030 mm) above the finished floor shall not project horizontally more than 4 inches (102 mm) into the *circulation path*.

**Exception:** *Handrails* are permitted to protrude 4½ inches (114 mm) from the wall or *guard*.

**1003.3.4 Clear width.** Protruding objects shall not reduce the minimum clear width of *accessible routes*.

**1003.4 Slip-resistant surface.** Circulation paths of the *means of egress* shall have a slip-resistant surface and be securely attached.

**1003.5 Elevation change.** Where changes in elevation of less than 12 inches (305 mm) exist in the *means of egress*, sloped surfaces shall be used. Where the slope is greater than one unit vertical in 20 units horizontal (5-percent slope), *ramps* complying with Section 1012 shall be used. Where the difference in elevation is 6 inches (152 mm) or less, the *ramp* shall be equipped with either *handrails* or floor finish materials that contrast with adjacent floor finish materials.

### Exceptions:

1. Steps at exterior doors complying with Section 1010.1.4.
2. A *stair* with a single riser or with two risers and a tread is permitted at locations not required to be *accessible* by Chapter 11 where the risers and treads comply with Section 1011.5, the minimum depth of the tread is 13 inches (330 mm) and not less than one *handrail* complying with Section 1014 is provided within 30 inches (762 mm) of the

centerline of the normal path of egress travel on the *stair*.

3. A step is permitted in *aisles* serving seating that has a difference in elevation less than 12 inches (305 mm) at locations not required to be *accessible* by Chapter 11, provided that the risers and treads comply with Section 1030.14 and the *aisle* is provided with a *handrail* complying with Section 1030.16.

Throughout a *story* in a Group I-2 occupancy, any change in elevation in portions of the *means of egress* that serve nonambulatory persons shall be by means of a *ramp* or sloped walkway.

**1003.6 Means of egress continuity.** The path of egress travel along a *means of egress* shall not be interrupted by a building element other than a *means of egress* component as specified in this chapter. Obstructions shall not be placed in the minimum width or required capacity of a *means of egress* component except projections permitted by this chapter. The minimum width or required capacity of a *means of egress* system shall not be diminished along the path of egress travel.

**1003.7 Elevators, escalators and moving walks.** Elevators, escalators and moving walks shall not be used as a component of a required *means of egress* from any other part of the building.

**Exception:** Elevators used as an *accessible* means of egress in accordance with Section 1009.4.

## SECTION 1004 OCCUPANT LOAD

**1004.1 Design occupant load.** In determining *means of egress* requirements, the number of occupants for whom *means of egress* facilities are provided shall be determined in accordance with this section.

**1004.2 Cumulative occupant loads.** Where the path of egress travel includes intervening rooms, areas or spaces, cumulative *occupant loads* shall be determined in accordance with this section.

**1004.2.1 Intervening spaces or accessory areas.** Where occupants egress from one or more rooms, areas or spaces through others, the design *occupant load* shall be the combined *occupant load* of interconnected accessory or intervening spaces. Design of egress path capacity shall be based on the cumulative portion of *occupant loads* of all rooms, areas or spaces to that point along the path of egress travel.

**1004.2.2 Adjacent levels for mezzanines.** That portion of the *occupant load* of a *mezzanine* with required egress through a room, area or space on an adjacent level shall be added to the *occupant load* of that room, area or space.

**1004.2.3 Adjacent stories.** Other than for the egress components designed for convergence in accordance with Section 1005.6, the *occupant load* from separate stories shall not be added.



**1004.3 Multiple function occupant load.** Where an area under consideration contains multiple functions having different *occupant load* factors, the design *occupant load* for such area shall be based on the floor area of each function calculated independently.

**1004.4 Multiple occupancies.** Where a building contains two or more occupancies, the *means of egress* requirements shall apply to each portion of the building based on the occupancy of that space. Where two or more occupancies utilize portions of the same *means of egress* system, those egress components shall meet the more stringent requirements of all occupancies that are served.

**1004.5 Areas without fixed seating.** The number of occupants shall be computed at the rate of one occupant per unit of area as prescribed in Table 1004.5. For areas without *fixed seating*, the *occupant load* shall be not less than that number determined by dividing the floor area under consideration by the *occupant load* factor assigned to the function of the space as set forth in Table 1004.5. Where an intended function is not *listed* in Table 1004.5, the *building official* shall establish a function based on a *listed* function that most nearly resembles the intended function.

**Exception:** Where *approved* by the *building official*, the actual number of occupants for whom each occupied space, floor or building is designed, although less than those determined by calculation, shall be permitted to be used in the determination of the design *occupant load*.

**1004.5.1 Increased occupant load.** The *occupant load* permitted in any building, or portion thereof, is permitted to be increased from that number established for the occupancies in Table 1004.5, provided that all other requirements of the code are met based on such modified number and the *occupant load* does not exceed one occupant per 7 square feet (0.65 m<sup>2</sup>) of occupiable floor space. Where required by the *building official*, an *approved aisle*, seating or fixed equipment diagram substantiating any increase in *occupant load* shall be submitted. Where required by the *building official*, such diagram shall be posted.

**1004.6 Fixed seating.** For areas having *fixed seats* and *aisles*, the *occupant load* shall be determined by the number of *fixed seats* installed therein. The *occupant load* for areas in which *fixed seating* is not installed, such as waiting spaces, shall be determined in accordance with Section 1004.5 and added to the number of *fixed seats*.

The *occupant load* of *wheelchair spaces* and the associated companion seat shall be based on one occupant for each *wheelchair space* and one occupant for the associated companion seat provided in accordance with Section 1109.2.3.

For areas having *fixed seating* without dividing arms, the *occupant load* shall be not less than the number of seats based on one person for each 18 inches (457 mm) of seating length.

The *occupant load* of seating booths shall be based on one person for each 24 inches (610 mm) of booth seat length measured at the backrest of the seating booth.

**TABLE 1004.5  
MAXIMUM FLOOR AREA ALLOWANCES PER OCCUPANT**

FUNCTION OF SPACE	OCCUPANT LOAD FACTOR <sup>a</sup>
Accessory storage areas, mechanical equipment room	300 gross
Agricultural building	300 gross
Aircraft hangars	500 gross
Airport terminal	
Baggage claim	20 gross
Baggage handling	300 gross
Concourse	100 gross
Waiting areas	15 gross
Assembly	
Gaming floors (keno, slots, etc.)	11 gross
Exhibit gallery and museum	30 net
Assembly with fixed seats	See Section 1004.6
Assembly without fixed seats	
Concentrated (chairs only—not fixed)	7 net
Standing space	5 net
Unconcentrated (tables and chairs)	15 net
Bowling centers, allow 5 persons for each lane including 15 feet of runway, and for additional areas	7 net
Business areas	150 gross
Concentrated business use areas	See Section 1004.8
Courtrooms—other than fixed seating areas	40 net
Day care	35 net
Dormitories	50 gross
Educational	
Classroom area	20 net
Shops and other vocational room areas	50 net
Exercise rooms	50 gross
Group H-5 fabrication and manufacturing areas	200 gross
Industrial areas	100 gross
Institutional areas	
Inpatient treatment areas	240 gross
Outpatient areas	100 gross
Sleeping areas	120 gross
Kitchens, commercial	200 gross
Library	
Reading rooms	50 net
Stack area	100 gross
Locker rooms	50 gross
Mall buildings—covered and open	See Section 402.8.2
Mercantile	60 gross
Storage, stock, shipping areas	300 gross
Parking garages	200 gross
Residential	200 gross
Skating rinks, swimming pools	
Rink and pool	50 gross
Decks	15 gross
Stages and platforms	15 net
Warehouses	500 gross

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. Floor area in square feet per occupant.

## MEANS OF EGRESS

**1004.7 Outdoor areas.** Yards, patios, occupied roofs, courts and similar outdoor areas accessible to and usable by the building occupants shall be provided with *means of egress* as required by this chapter. The *occupant load* of such outdoor areas shall be assigned by the *building official* in accordance with the anticipated use. Where outdoor areas are to be used by persons in addition to the occupants of the building, and the path of egress travel from the outdoor areas passes through the building, *means of egress* requirements for the building shall be based on the sum of the *occupant loads* of the building plus the outdoor areas.

### Exceptions:

1. Outdoor areas used exclusively for service of the building need only have one *means of egress*.
2. Both outdoor areas associated with Group R-3 and individual dwelling units of Group R-2.

**1004.8 Concentrated business use areas.** The *occupant load* factor for concentrated business use shall be applied to telephone call centers, trading floors, electronic data processing centers and similar business use areas with a higher density of occupants than would normally be expected in a typical business occupancy environment. Where approved by the *building official*, the *occupant load* for concentrated business use areas shall be the actual *occupant load*, but not less than one occupant per 50 square feet (4.65 m<sup>2</sup>) of gross occupiable floor space.

**1004.9 Posting of occupant load.** Every room or space that is an assembly occupancy shall have the *occupant load* of the room or space posted in a conspicuous place, near the main *exit* or *exit access doorway* from the room or space, for the intended configurations. Posted signs shall be of an approved legible permanent design and shall be maintained by the owner or the owner's authorized agent.

## SECTION 1005 MEANS OF EGRESS SIZING

**1005.1 General.** All portions of the *means of egress* system shall be sized in accordance with this section.

**Exception:** Aisles and aisle accessways in rooms or spaces used for assembly purposes complying with Section 1030.

**1005.2 Minimum width based on component.** The minimum width, in inches (mm), of any *means of egress* components shall be not less than that specified for such component, elsewhere in this code.

**1005.3 Required capacity based on occupant load.** The required capacity, in inches (mm), of the *means of egress* for any room, area, space or *story* shall be not less than that determined in accordance with Sections 1005.3.1 and 1005.3.2.

**1005.3.1 Stairways.** The capacity, in inches, of means of egress *stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a *means of egress* capacity factor of 0.3 inch (7.6 mm) per occupant. Where *stairways* serve more than one *story*, only the *occupant load* of each *story* considered individually shall

be used in calculating the required capacity of the *stairways* serving that *story*.

### Exceptions:

1. For other than Group H and I-2 occupancies, the capacity, in inches, of means of egress *stairways* shall be calculated by multiplying the *occupant load* served by such *stairways* by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an *emergency voice/alarm communication system* in accordance with Section 907.5.2.2.
2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1030.6.2 indicated for stepped *aisles* for *exit access* or *exit stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
3. Facilities with *open-air assembly seating* shall be permitted to the capacity factors in Section 1030.6.3 indicated for stepped *aisles* for *exit access* or *exit stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is open to the outdoors.

**1005.3.2 Other egress components.** The capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a means of egress capacity factor of 0.2 inch (5.1 mm) per occupant.

### Exceptions:

1. For other than Group H and I-2 occupancies, the capacity, in inches, of *means of egress* components other than *stairways* shall be calculated by multiplying the *occupant load* served by such component by a means of egress capacity factor of 0.15 inch (3.8 mm) per occupant in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2 and an emergency voice/alarm communication system in accordance with Section 907.5.2.2.
2. Facilities with *smoke-protected assembly seating* shall be permitted to use the capacity factors in Table 1030.6.2 indicated for level or ramped *aisles* for *means of egress* components other than *stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is provided with a smoke control system complying with Section 909.
3. Facilities with *open-air assembly seating* shall be permitted to the capacity factors in Section 1030.6.3 indicated for level or ramped *aisles* for *means of egress* components other than

*stairways* where the entire path for *means of egress* from the seating to the *exit discharge* is open to the outdoors.

**1005.4 Continuity.** The minimum width or required capacity of the *means of egress* required from any *story* of a building shall not be reduced along the path of egress travel until arrival at the *public way*.

**1005.5 Distribution of minimum width and required capacity.** Where more than one *exit*, or access to more than one *exit*, is required, the *means of egress* shall be configured such that the loss of any one *exit*, or access to one *exit*, shall not reduce the available capacity or width to less than 50 percent of the required capacity or width.

**1005.6 Egress convergence.** Where the *means of egress* from stories above and below converge at an intermediate level, the capacity of the *means of egress* from the point of convergence shall be not less than the largest minimum width or the sum of the required capacities for the *stairways* or *ramps* serving the two adjacent stories, whichever is larger.

**1005.7 Encroachment.** Encroachments into the required *means of egress* width shall be in accordance with the provisions of this section.

**1005.7.1 Doors.** Doors, when fully opened, shall not reduce the required width by more than 7 inches (178 mm). Doors in any position shall not reduce the required width by more than one-half.

**Exceptions:**

1. Surface-mounted latch release hardware shall be exempt from inclusion in the 7-inch maximum (178 mm) encroachment where both of the following conditions exist:
  - 1.1. The hardware is mounted to the side of the door facing away from the adjacent wall where the door is in the open position.
  - 1.2. The hardware is mounted not less than 34 inches (865 mm) nor more than 48 inches (1219 mm) above the finished floor.
2. The restrictions on door swing shall not apply to doors within individual *dwelling units* and *sleeping units* of Group R-2 occupancies and *dwelling units* of Group R-3 occupancies.

**1005.7.2 Other projections.** *Handrail* projections shall be in accordance with the provisions of Section 1014.8. Other nonstructural projections such as *trim* and similar decorative features shall be permitted to project into the required width not more than 1½ inches (38 mm) on each side.

**Exception:** Projections are permitted in *corridors* within Group I-2, Condition 1 in accordance with Section 407.4.3.

**1005.7.3 Protruding objects.** Protruding objects shall comply with the applicable requirements of Section 1003.3.

## SECTION 1006 NUMBER OF EXITS AND EXIT ACCESS DOORWAYS

**1006.1 General.** The number of *exits* or *exit access doorways* required within the *means of egress* system shall comply with the provisions of Section 1006.2 for spaces, including *mezzanines*, and Section 1006.3 for *stories* or occupied roofs.

**1006.2 Egress from spaces.** Rooms, areas or spaces, including *mezzanines*, within a *story* or *basement* shall be provided with the number of *exits* or access to *exits* in accordance with this section.

**1006.2.1 Egress based on occupant load and common path of egress travel distance.** Two *exits* or *exit access doorways* from any space shall be provided where the design *occupant load* or the *common path of egress* travel distance exceeds the values listed in Table 1006.2.1. The cumulative *occupant load* from adjacent rooms, areas or spaces shall be determined in accordance with Section 1004.2.

**Exceptions:**

1. The number of *exits* from foyers, lobbies, vestibules or similar spaces need not be based on cumulative *occupant loads* for areas discharging through such spaces, but the capacity of the *exits* from such spaces shall be based on applicable cumulative *occupant loads*.
2. *Care suites* in Group I-2 occupancies complying with Section 407.4.
3. Unoccupied mechanical rooms and *penthouses* are not required to comply with the common path of egress travel distance measurement.

**1006.2.1.1 Three or more exits or exit access doorways.** Three *exits* or *exit access doorways* shall be provided from any space with an *occupant load* of 501 to 1,000. Four *exits* or *exit access doorways* shall be provided from any space with an *occupant load* greater than 1,000.

**1006.2.2 Egress based on use.** The numbers, configuration and types of components of *exits* or access to *exits* shall be provided in the uses described in Sections 1006.2.2.1 through 1006.2.2.6.

**1006.2.2.1 Boiler, incinerator and furnace rooms.** Two *exit access doorways* are required in boiler, incinerator and furnace rooms where the area is over 500 square feet (46 m²) and any fuel-fired equipment exceeds 400,000 British thermal units (Btu) (422 000 KJ) input capacity. Where two *exit access doorways* are required, one is permitted to be a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the length of the maximum overall diagonal dimension of the room.

**1006.2.2.2 Refrigeration machinery rooms.** Machinery rooms larger than 1,000 square feet (93 m²) shall have not less than two *exits* or *exit access doorways*. Where two *exit access doorways* are required, one such

## MEANS OF EGRESS

doorway is permitted to be served by a fixed ladder or an *alternating tread device*. *Exit access doorways* shall be separated by a horizontal distance equal to one-half the maximum horizontal dimension of the room.

All portions of machinery rooms shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway*. An increase in *exit access* travel distance is permitted in accordance with Section 1017.1.

*Exit* and *exit access doorways* shall swing in the direction of egress travel and shall be equipped with *panic hardware*, regardless of the *occupant load* served. *Exit* and *exit access doorways* shall be tight fitting and *self-closing*.

**1006.2.2.3 Refrigerated rooms or spaces.** Rooms or spaces having a floor area larger than 1,000 square feet (93 m<sup>2</sup>), containing a refrigerant evaporator and maintained at a temperature below 68°F (20°C), shall have access to not less than two *exits* or *exit access doorways*.

*Exit access* travel distance shall be determined as specified in Section 1017.1, but all portions of a refrigerated room or space shall be within 150 feet (45 720 mm) of an *exit* or *exit access doorway* where such rooms are not protected by an *approved automatic*

*sprinkler system*. Egress is allowed through adjoining refrigerated rooms or spaces.

**Exception:** Where using refrigerants in quantities limited to the amounts based on the volume set forth in the *International Mechanical Code*.

**1006.2.2.4 Electrical rooms.** The location and number of *exit* or *exit access doorways* shall be provided for electrical rooms in accordance with Section 110.26 of NFPA 70 for electrical equipment rated 1,000 volts or less, and Section 110.33 of NFPA 70 for electrical equipment rated over 1,000 volts. Panic hardware shall be provided where required in accordance with Section 1010.2.9.2.

**1006.2.2.5 Vehicular ramps.** Vehicular *ramps* shall not be considered as an *exit access ramp* unless pedestrian facilities are provided.

**1006.2.2.6 Groups R-3 and R-4.** Where Group R-3 occupancies are permitted by Section 903.2.8 to be protected by an *automatic sprinkler system* installed in accordance with Section 903.3.1.3, the *exit access* travel distance for Group R-3 shall be not more than 125 feet (38 100 mm). Where Group R-4 occupancies are permitted by Section 903.2.8 to be protected by an *automatic sprinkler system* installed in accordance with

**TABLE 1006.2.1**  
**SPACES WITH ONE EXIT OR EXIT ACCESS DOORWAY**

OCCUPANCY	MAXIMUM OCCUPANT LOAD OF SPACE	MAXIMUM COMMON PATH OF EGRESS TRAVEL DISTANCE (feet)		
		Without Sprinkler System (feet)		With Sprinkler System (feet)
		Occupant Load		
		OL ≤ 30	OL > 30	
A <sup>c</sup> , E, M	49	75	75	75 <sup>a</sup>
B	49	100	75	100 <sup>a</sup>
F	49	75	75	100 <sup>a</sup>
H-1, H-2, H-3	3	NP	NP	25 <sup>b</sup>
H-4, H-5	10	NP	NP	75 <sup>b</sup>
I-1, I-2 <sup>d</sup> , I-4	10	NP	NP	75 <sup>a</sup>
I-3	10	NP	NP	100 <sup>a</sup>
R-1	10	NP	NP	75 <sup>a</sup>
R-2	20	NP	NP	125 <sup>a</sup>
R-3 <sup>e</sup>	20	NP	NP	125 <sup>a, g</sup>
R-4 <sup>e</sup>	20	NP	NP	125 <sup>a, g</sup>
S <sup>f</sup>	29	100	75	100 <sup>a</sup>
U	49	100	75	75 <sup>a</sup>

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

- Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.
- Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.
- For a room or space used for assembly purposes having fixed seating, see Section 1030.8.
- For the travel distance limitations in Group I-2, see Section 407.4.
- The common path of egress travel distance shall only apply in a Group R-3 occupancy located in a mixed occupancy building.
- The length of common path of egress travel distance in a Group S-2 open parking garage shall be not more than 100 feet.
- For the travel distance limitations in Groups R-3 and R-4 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3, see Section 1006.2.2.6.



Section 903.3.1.3, the *exit access* travel distance for Group R-4 shall be not more than 75 feet (22 860 mm).

**1006.3 Egress from stories or occupied roofs.** The *means of egress* system serving any *story* or occupied roof shall be provided with the number of separate and distinct *exits* or access to *exits* based on the aggregate *occupant load* served in accordance with this section.

**1006.3.1 Occupant load.** Where *stairways* serve more than one *story*, or more than one *story* and an occupied roof, only the *occupant load* of each *story* or occupied roof, considered individually, shall be used when calculating the required number of *exits* or access to *exits* serving that *story*.

**1006.3.2 Path of egress travel.** The path of egress travel to an *exit* shall not pass through more than one adjacent *story*.

**Exception:** The path of egress travel to an *exit* shall be permitted to pass through more than one adjacent *story* in any of the following:

1. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual dwelling unit, sleeping unit or live/work unit.
2. *Exit access stairways* serving and contained within a Group R-3 congregate residence or a Group R-4 facility.
3. *Exit access stairways* and *ramps* within an atrium complying with Section 404.
4. *Exit access stairways* and *ramps* in open parking garages that serve only the parking garage.
5. *Exit access stairways* and *ramps* serving open-air assembly seating complying with the exit access travel distance requirements of Section 1030.7.
6. *Exit access stairways* and *ramps* between the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, places of religious worship, auditoriums and sports facilities.
7. Exterior *exit access stairways* and *ramps* between occupied roofs.

**1006.3.3 Egress based on occupant load.** Each *story* and occupied roof shall have the minimum number of separate and distinct *exits*, or access to *exits*, as specified in Table 1006.3.3. A single *exit* or access to a single *exit* shall be permitted in accordance with Section 1006.3.4. The required number of *exits*, or *exit access stairways* or *ramps* providing access to *exits*, from any *story* or occupied roof shall be maintained until arrival at the *exit discharge* or a public way.

**TABLE 1006.3.3**  
**MINIMUM NUMBER OF EXITS OR**  
**ACCESS TO EXITS PER STORY**

OCCUPANT LOAD PER STORY	MINIMUM NUMBER OF EXITS OR ACCESS TO EXITS FROM STORY
1-500	2
501-1,000	3
More than 1,000	4

**1006.3.4 Single exits.** A single *exit* or access to a single *exit* shall be permitted from any *story* or occupied roof where one of the following conditions exists:

1. The *occupant load*, number of *dwelling units* and exit access travel distance do not exceed the values in Table 1006.3.4(1) or 1006.3.4(2).
2. Rooms, areas and spaces complying with Section 1006.2.1 with *exits* that discharge directly to the exterior at the *level of exit discharge*, are permitted to have one *exit* or access to a single *exit*.
3. Parking garages where vehicles are mechanically parked shall be permitted to have one *exit* or access to a single *exit*.
4. Group R-3 and R-4 occupancies shall be permitted to have one *exit* or access to a single *exit*.
5. Individual single-story or multistory *dwelling units* shall be permitted to have a single *exit* or access to a single *exit* from the *dwelling unit* provided that both of the following criteria are met:
  - 5.1. The *dwelling unit* complies with Section 1006.2.1 as a space with one *means of egress*.
  - 5.2. Either the exit from the *dwelling unit* discharges directly to the exterior at the *level of exit discharge*, or the *exit access* outside the *dwelling unit's* entrance door provides access to not less than two approved independent *exits*.

**1006.3.4.1 Mixed occupancies.** Where one *exit*, or *exit access stairway* or *ramp* providing access to exits at other stories, is permitted to serve individual stories, mixed occupancies shall be permitted to be served by single *exits* provided that each individual occupancy complies with the applicable requirements of Table 1006.3.4(1) or 1006.3.4(2) for that occupancy. Where applicable, cumulative *occupant loads* from adjacent occupancies shall be considered to be in accordance with the provisions of Section 1004.1. In each *story* of a mixed occupancy building, the maximum number of occupants served by a single exit shall be such that the sum of the ratios of the calculated number of occupants of the space divided by the allowable number of occupants indicated in Table 1006.3.4(2) for each occupancy does not exceed one. Where *dwelling units* are located on a story with other occupancies, the actual number of *dwelling units* divided by four plus the ratio from the other occupancy does not exceed one.

## MEANS OF EGRESS

**TABLE 1006.3.4(1)**  
**STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR R-2 OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM NUMBER OF DWELLING UNITS	MAXIMUM EXIT ACCESS TRAVEL DISTANCE
Basement, first, second or third story above grade plane	R-2 <sup>a, b</sup>	4 dwelling units	125 feet
Fourth story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

a. Buildings classified as Group R-2 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with emergency escape and rescue openings in accordance with Section 1031.

b. This table is used for R-2 occupancies consisting of dwelling units. For R-2 occupancies consisting of sleeping units, use Table 1006.3.4(2).

**TABLE 1006.3.4(2)**  
**STORIES WITH ONE EXIT OR ACCESS TO ONE EXIT FOR OTHER OCCUPANCIES**

STORY	OCCUPANCY	MAXIMUM OCCUPANT LOAD PER STORY	MAXIMUM EXIT ACCESS TRAVEL DISTANCE (feet)
First story above or below grade plane	A, B <sup>b</sup> , E, F <sup>b</sup> , M, U	49	75
	H-2, H-3	3	25
	H-4, H-5, I, R-1, R-2 <sup>a, c</sup>	10	75
	S <sup>b, d</sup>	29	75
Second story above grade plane	B, F, M, S <sup>d</sup>	29	75
Third story above grade plane and higher	NP	NA	NA

For SI: 1 foot = 304.8 mm.

NP = Not Permitted.

NA = Not Applicable.

a. Buildings classified as Group R-2 equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 and provided with emergency escape and rescue openings in accordance with Section 1031.

b. Group B, F and S occupancies in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 shall have a maximum exit access travel distance of 100 feet.

c. This table is used for R-2 occupancies consisting of sleeping units. For R-2 occupancies consisting of dwelling units, use Table 1006.3.4(1).

d. The length of exit access travel distance in a Group S-2 open parking garage shall be not more than 100 feet.

## SECTION 1007 EXIT AND EXIT ACCESS DOORWAY CONFIGURATION

**1007.1 General.** *Exits, exit access doorways, and exit access stairways and ramps* serving spaces, including individual building *stories*, shall be separated in accordance with the provisions of this section.

**1007.1.1 Two exits or exit access doorways.** Where two *exits, exit access doorways, exit access stairways or ramps*, or any combination thereof, are required from any portion of the *exit access*, they shall be placed a distance apart equal to not less than one-half of the length of the maximum overall diagonal dimension of the building or area to be served measured in a straight line between them. Interlocking or *scissor stairways* shall be counted as one *exit stairway*.

### Exceptions:

- Where interior *exit stairways* or *ramps* are interconnected by a 1-hour fire-resistance-rated *corridor* conforming to the requirements of Section 1020, the required exit separation shall be measured along the shortest direct line of travel within the corridor.
- Where a building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2, the separation distance shall be not less than one-third of the length of the maximum overall diagonal dimension of the area served.

tion distance shall be not less than one-third of the length of the maximum overall diagonal dimension of the area served.

**1007.1.1.1 Measurement point.** The separation distance required in Section 1007.1.1 shall be measured in accordance with the following:

- The separation distance to *exit* or *exit access doorways* shall be measured to any point along the width of the doorway.
- The separation distance to *exit access stairways* shall be measured to the closest riser.
- The separation distance to *exit access ramps* shall be measured to the start of the *ramp* run.

**1007.1.2 Three or more exits or exit access doorways.** Where access to three or more *exits* is required, not less than two *exit* or *exit access doorways* shall be arranged in accordance with the provisions of Section 1007.1.1. Additional required *exit* or *exit access doorways* shall be arranged a reasonable distance apart so that if one becomes blocked, the others will be available.

**1007.1.3 Remoteness of exit access stairways or ramps.** Where two *exit access stairways* or *ramps* provide the required *means of egress* to *exits* at another *story*, the required separation distance shall be maintained for all portions of such *exit access stairways* or *ramps*.

**1007.1.3.1 Three or more exit access stairways or ramps.** Where more than two *exit access stairways* or *ramps* provide the required *means of egress*, not less than two shall be arranged in accordance with Section 1007.1.3.

## SECTION 1008 MEANS OF EGRESS ILLUMINATION

**1008.1 Means of egress illumination.** Illumination shall be provided in the *means of egress* in accordance with Section 1008.2. Under emergency power, *means of egress* illumination shall comply with Section 1008.3.

**1008.2 Illumination required.** The *means of egress* serving a room or space shall be illuminated at all times that the room or space is occupied.

### Exceptions:

1. Occupancies in Group U.
2. *Aisle accessways* in Group A.
3. *Dwelling units* and *sleeping units* in Groups R-1, R-2 and R-3.
4. *Sleeping units* of Group I occupancies.

**1008.2.1 Illumination level under normal power.** The *means of egress* illumination level shall be not less than 1 footcandle (11 lux) at the walking surface. Along *exit access stairways*, exit stairways and at their required landings, the illumination level shall not be less than 10 footcandles (108 lux) at the walking surface when the *stairway* is in use.

**Exception:** For auditoriums, theaters, concert or opera halls and similar assembly occupancies, the illumination at the walking surface is permitted to be reduced during performances by one of the following methods provided that the required illumination is automatically restored upon activation of a premises' *fire alarm system*:

1. Externally illuminated walking surfaces shall be permitted to be illuminated to not less than 0.2 footcandle (2.15 lux).
2. Steps, landings and the sides of *ramps* shall be permitted to be marked with *self-luminous* materials in accordance with Sections 1025.2.1, 1025.2.2 and 1025.2.4 by systems listed in accordance with UL 1994.

**1008.2.2 Group I-2.** In Group I-2 occupancies where two or more *exits* are required, on the exterior landings required by Section 1010.1.5, means of egress illumination levels for the exit discharge shall be provided such that failure of a single lamp in a luminaire shall not reduce the illumination level on that landing to less than 1 footcandle (11 lux).

**1008.2.3 Exit discharge.** Illumination shall be provided along the path of travel for the exit discharge from each exit to the *public way*.

**Exception:** Illumination shall not be required where the path of the exit discharge meets both of the following requirements:

1. The path of exit discharge is illuminated from the exit to a safe dispersal area complying with Section 1028.5.
2. A dispersal area shall be illuminated to a level not less than 1 footcandle (11 lux) at the walking surface.

**1008.3 Emergency power for illumination.** The power supply for *means of egress* illumination shall normally be provided by the premises' electrical supply.

**1008.3.1 General.** In the event of power supply failure in rooms and spaces that require two or more *exits* or access to exits, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Aisles*.
2. *Corridors*.
3. *Exit access stairways* and *ramps*.

**1008.3.2 Buildings.** In the event of power supply failure in buildings that require two or more *exits* or access to exits, an emergency electrical system shall automatically illuminate all of the following areas:

1. *Interior exit access stairways* and *ramps*.
2. *Interior* and *exterior exit stairways* and *ramps*.
3. *Exit passageways*.
4. Vestibules and areas on the level of discharge used for *exit discharge* in accordance with Section 1028.2.
5. Exterior landings as required by Section 1010.1.5 for *exit doorways* that lead directly to the *exit discharge*.

**1008.3.3 Rooms and spaces.** In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:

1. Electrical equipment rooms.
2. Fire command centers.
3. Fire pump rooms.
4. Generator rooms.
5. Public restrooms with an area greater than 300 square feet (27.87 m<sup>2</sup>).

**1008.3.4 Duration.** The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Section 2702.

## MEANS OF EGRESS

### 1008.3.5 Illumination level under emergency power.

Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of 1 footcandle (11 lux) and a minimum at any point of 0.1 footcandle (1 lux) measured along the path of egress at floor level. Illumination levels shall be permitted to decline to 0.6 footcandle (6 lux) average and a minimum at any point of 0.06 footcandle (0.6 lux) at the end of the emergency lighting time duration. A maximum-to-minimum illumination uniformity ratio of 40 to 1 shall not be exceeded. In Group I-2 occupancies, failure of a single lamp in a luminaire shall not reduce the illumination level to less than 0.2 footcandle (2.2 lux).

## SECTION 1009 ACCESSIBLE MEANS OF EGRESS

**1009.1 Accessible means of egress required.** *Accessible* means of egress shall comply with this section. *Accessible* spaces shall be provided with not less than one accessible means of egress. Where more than one *means of egress* is required by Section 1006.2 or 1006.3 from any accessible space, each *accessible* portion of the space shall be served by not less than two accessible means of egress.

### Exceptions:

1. One *accessible means of egress* is required from an *accessible mezzanine* level in accordance with Section 1009.3, 1009.4 or 1009.5.
2. In assembly areas with ramped *aisles* or stepped *aisles*, one *accessible means of egress* is permitted where the *common path of egress travel* is *accessible* and meets the requirements in Section 1030.8.

**1009.2 Continuity and components.** Each required *accessible means of egress* shall be continuous to a *public way* and shall consist of one or more of the following components:

1. *Accessible routes* complying with Section 1104.
2. *Interior exit stairways* complying with Sections 1009.3 and 1023.
3. *Exit access stairways* complying with Sections 1009.3 and 1019.3 or 1019.4.
4. *Exterior exit stairways* complying with Sections 1009.3 and 1027 and serving levels other than the *level of exit discharge*.
5. Elevators complying with Section 1009.4.
6. Platform lifts complying with Section 1009.5.
7. *Horizontal exits* complying with Section 1026.
8. *Ramps* complying with Section 1012.
9. *Areas of refuge* complying with Section 1009.6.
10. Exterior areas for assisted rescue complying with Section 1009.7 serving *exits* at the *level of exit discharge*.

**1009.2.1 Elevators required.** In buildings where a required accessible floor or occupied roof is four or more stories above or below a *level of exit discharge*, not less

than one required *accessible means of egress* shall be an elevator complying with Section 1009.4.

### Exceptions:

1. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be required on floors provided with a *horizontal exit* and located at or above the *levels of exit discharge*.
2. In buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, the elevator shall not be required on floors provided with a *ramp* conforming to the provisions of Section 1012.

**1009.3 Stairways.** In order to be considered part of an *accessible means of egress*, a *stairway* between *stories* shall comply with Sections 1009.3.1 through 1009.3.3.

**1009.3.1 Exit access stairways.** *Exit access stairways* that connect levels in the same *story* are not permitted as part of an *accessible means of egress*.

**Exception:** *Exit access stairways* providing *means of egress* from *mezzanines* are permitted as part of an *accessible means of egress*.

**1009.3.2 Stairway width.** *Stairways* shall have a clear width of 48 inches (1219 mm) minimum between *handrails*.

### Exceptions:

1. The clear width of 48 inches (1219 mm) between *handrails* is not required in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
2. The clear width of 48 inches (1219 mm) between *handrails* is not required for *stairways* accessed from a *refuge area* in conjunction with a *horizontal exit*.

**1009.3.3 Area of refuge.** *Stairways* shall either incorporate an *area of refuge* within an enlarged floor-level landing or shall be accessed from an *area of refuge* complying with Section 1009.6.

### Exceptions:

1. *Areas of refuge* are not required at *exit access stairways* where two-way communication is provided at the elevator landing in accordance with Section 1009.8.
2. *Areas of refuge* are not required at *stairways* in buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. *Areas of refuge* are not required at *stairways* serving *open parking garages*.
4. *Areas of refuge* are not required for *smoke-protected* or *open-air assembly seating areas*.



complying with Sections 1030.6.2 and 1030.6.3.

5. *Areas of refuge* are not required at *stairways* in Group R-2 occupancies.
6. *Areas of refuge* are not required for *stairways* accessed from a *refuge area* in conjunction with a *horizontal exit*.

**1009.4 Elevators.** In order to be considered part of an *accessible means of egress*, an elevator shall comply with Sections 1009.4.1 and 1009.4.2.

**1009.4.1 Standby power.** The elevator shall meet the emergency operation and signaling device requirements of Section 2.27 of ASME A17.1/CSA B44. Standby power shall be provided in accordance with Chapter 27 and Section 3003.

**1009.4.2 Area of refuge.** The elevator shall be accessed from an *area of refuge* complying with Section 1009.6.

**Exceptions:**

1. *Areas of refuge* are not required at the elevator in *open parking garages*.
2. *Areas of refuge* are not required in buildings and facilities equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.
3. *Areas of refuge* are not required at elevators not required to be located in a *shaft* in accordance with Section 712.
4. *Areas of refuge* are not required at elevators serving *smoke-protected or open-air assembly seating areas* complying with Sections 1030.6.2 and 1030.6.3.
5. *Areas of refuge* are not required for elevators accessed from a *refuge area* in conjunction with a *horizontal exit*.

**1009.5 Platform lifts.** Platform lifts shall be permitted to serve as part of an *accessible means of egress* where allowed as part of a required *accessible route* in Section 1110.9 except for Item 10. Standby power for the platform lift shall be provided in accordance with Chapter 27.

**1009.6 Areas of refuge.** Every required *area of refuge* shall be accessible from the space it serves by an *accessible means of egress*.

**1009.6.1 Travel distance.** The maximum travel distance from any accessible space to an *area of refuge* shall not exceed the *exit access* travel distance permitted for the occupancy in accordance with Section 1017.1.

**1009.6.2 Stairway or elevator access.** Every required *area of refuge* shall have *direct access* to a *stairway* complying with Sections 1009.3 and 1023 or an elevator complying with Section 1009.4.

**Exception:** An interior *area of refuge* at the level of exit discharge that provides direct access to an exterior exit door.

**1009.6.3 Size.** Each *area of refuge* shall be sized to accommodate one *wheelchair space* of 30 inches by 52

inches (762 mm by 1320 mm) for each 200 occupants or portion thereof, based on the *occupant load* of the *area of refuge* and areas served by the *area of refuge*. Such *wheelchair spaces* shall not reduce the *means of egress* minimum width or required capacity. Access to any of the required *wheelchair spaces* in an *area of refuge* shall not be obstructed by more than one adjoining *wheelchair space*.

**1009.6.4 Separation.** Each *area of refuge* shall be separated from the remainder of the *story* by a *smoke barrier* complying with Section 709 or a *horizontal exit* complying with Section 1026. Each *area of refuge* shall be designed to minimize the intrusion of smoke.

**Exceptions:**

1. *Areas of refuge* located within an enclosure for *interior exit stairways* complying with Section 1023.
2. *Areas of refuge* in outdoor facilities where *exit access* is essentially open to the outside.

**1009.6.5 Two-way communication.** *Areas of refuge* shall be provided with a two-way communication system complying with Sections 1009.8.1 and 1009.8.2.

**1009.7 Exterior areas for assisted rescue.** Exterior areas for assisted rescue shall be accessed by an *accessible route* from the area served.

Where the *exit discharge* does not include an *accessible route* from an exit located on the *level of exit discharge* to a *public way*, an exterior area of assisted rescue shall be provided on the exterior landing in accordance with Sections 1009.7.1 through 1009.7.4.

**1009.7.1 Size.** Each exterior area for assisted rescue shall be sized to accommodate *wheelchair spaces* in accordance with Section 1009.6.3.

**1009.7.2 Separation.** Exterior walls separating the exterior area of assisted rescue from the interior of the building shall have a minimum *fire-resistance rating* of 1 hour, rated for exposure to fire from the inside. The fire-resistance-rated *exterior wall* construction shall extend horizontally not less than 10 feet (3048 mm) beyond the landing on either side of the landing or equivalent fire-resistance-rated construction is permitted to extend out perpendicular to the *exterior wall* not less than 4 feet (1219 mm) on the side of the landing. The *fire-resistance-rated* construction shall extend vertically from the ground to a point not less than 10 feet (3048 mm) above the floor level of the area for assisted rescue or to the roof line, whichever is lower. Openings within such *fire-resistance-rated exterior walls* shall be protected in accordance with Section 716.

**Exception:** The *fire-resistance rating* and opening protectives are not required in the *exterior wall* where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**1009.7.3 Openness.** The exterior area for assisted rescue shall be open to the outside air. The sides other than the

## MEANS OF EGRESS

separation walls shall be not less than 50 percent open, and the open area shall be distributed so as to minimize the accumulation of smoke or toxic gases.

**1009.7.4 Stairways.** *Stairways* that are part of the *means of egress* for the exterior area for assisted rescue shall provide a minimum clear width of 48 inches (1219 mm) between *handrails*.

**Exception:** The minimum clear width of 48 inches (1219 mm) between *handrails* is not required at *stairways* serving buildings equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2.

**1009.8 Two-way communication.** A two-way communication system complying with Sections 1009.8.1 and 1009.8.2 shall be provided at the landing serving each elevator or bank of elevators on each accessible floor that is one or more stories above or below the *level of exit discharge*.

### Exceptions:

1. Two-way communication systems are not required at the landing serving each elevator or bank of elevators where the two-way communication system is provided within *areas of refuge* in accordance with Section 1009.6.5.
2. Two-way communication systems are not required on floors provided with *ramps* conforming to the provisions of Section 1012.
3. Two-way communication systems are not required at the landings serving only service elevators that are not designated as part of the *accessible means of egress* or serve as part of the required *accessible route* into a facility.
4. Two-way communication systems are not required at the landings serving only freight elevators.
5. Two-way communication systems are not required at the landing serving a private residence elevator.
6. Two-way communication systems are not required in Group I-2 or I-3 facilities.

**1009.8.1 System requirements.** Two-way communication systems shall provide communication between each required location and the *fire command center* or a central control point location *approved* by the fire department. Where the central control point is not a *constantly attended location*, the two-way communication system shall have timed, automatic telephone dial-out capability that provides two-way communication with an approved supervising station or 9-1-1. The two-way communication system shall include both audible and visible signals.

**1009.8.2 Directions.** Directions for the use of the two-way communication system, instructions for summoning assistance via the two-way communication system and written identification of the location shall be posted adjacent to the two-way communication system. Signage shall comply with the ICC A117.1 requirements for visual characters.

**1009.9 Signage.** Signage indicating special accessibility provisions shall be provided as shown:

1. Each door providing access to an *area of refuge* from an adjacent floor area shall be identified by a sign stating, "AREA OF REFUGE."
2. Each door providing access to an exterior area for assisted rescue shall be identified by a sign stating, "EXTERIOR AREA FOR ASSISTED RESCUE."

Signage shall comply with the ICC A117.1 requirements for visual characters and include the International Symbol of Accessibility. Where exit sign illumination is required by Section 1013.3, the signs shall be illuminated. Additionally, visual characters, raised character and braille signage complying with ICC A117.1 shall be located at each door to an *area of refuge* and exterior area for assisted rescue in accordance with Section 1013.4.

**1009.10 Directional signage.** Directional signage indicating the location of all other *means of egress* and which of those are *accessible* means of egress shall be provided at the following:

1. At *exits* serving a required accessible space but not providing an *approved accessible means of egress*.
2. At elevator landings.
3. Within *areas of refuge*.

**1009.11 Instructions.** In *areas of refuge* and exterior areas for assisted rescue, instructions on the use of the area under emergency conditions shall be posted. Signage shall comply with the ICC A117.1 requirements for visual characters. The instructions shall include all of the following:

1. Persons able to use the *exit stairway* do so as soon as possible, unless they are assisting others.
2. Information on planned availability of assistance in the use of *stairs* or supervised operation of elevators and how to summon such assistance.
3. Directions for use of the two-way communication system where provided.

## SECTION 1010 DOORS, GATES AND TURNSTILES

**1010.1 General.** Doors in the *means of egress* shall comply with the requirements of Sections 1010.1.1 through 1010.3.4. Exterior *exit* doors shall also comply with the requirements of Section 1022.2. Gates in the *means of egress* shall comply with the requirements of Sections 1010.4 and 1010.4.1. Turnstiles in the *means of egress* shall comply with the requirements of Sections 1010.5 through 1010.5.4.

Doors, gates and turnstiles provided for egress purposes in numbers greater than required by this code shall comply with the requirements of this section.

Doors in the *means of egress* shall be readily distinguishable from the adjacent construction and finishes such that the doors are easily recognizable as doors. Mirrors or similar reflecting materials shall not be used on *means of egress* doors. *Means of egress* doors shall not be concealed by curtains, drapes, decorations or similar materials.

**1010.1.1 Size of doors.** The required capacity of each door opening shall be sufficient for the *occupant load* thereof and shall provide a minimum clear opening width of 32 inches (813 mm). The clear opening width of doorways with swinging doors shall be measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). Where this section requires a minimum clear opening width of 32 inches (813 mm) and a door opening includes two door leaves without a mullion, one leaf shall provide a minimum clear opening width of 32 inches (813 mm). In Group I-2, doors serving as means of egress doors where used for the movement of beds shall provide a minimum clear opening width of 41½ inches (1054 mm). The minimum clear opening height of doors shall be not less than 80 inches (2032 mm).

**Exceptions:**

1. In Group R-2 and R-3 *dwelling and sleeping units* that are not required to be an *Accessible unit*, *Type A unit* or *Type B unit*, the minimum width shall not apply to door openings that are not part of the required *means of egress*.
2. In Group I-3, door openings to resident *sleeping units* that are not required to be an *Accessible unit* shall have a minimum clear opening width of 28 inches (711 mm).
3. Door openings to storage closets less than 10 square feet (0.93 m<sup>2</sup>) in area shall not be limited by the minimum clear opening width.
4. The maximum width of door leaves in revolving doors that comply with Section 1010.3.1 shall not be limited.
5. The maximum width of door leaves in *power-operated doors* that comply with Section 1010.3.2 shall not be limited.
6. Door openings within a *dwelling unit* or *sleeping unit* shall have a minimum clear opening height of 78 inches (1981 mm).
7. In *dwelling and sleeping units* that are not required to be *Accessible*, *Type A* or *Type B units*, exterior door openings other than the required *exit* door shall have a minimum clear opening height of 76 inches (1930 mm).
8. In Groups I-1, R-2, R-3 and R-4, in *dwelling and sleeping units* that are not required to be *Accessible*, *Type A* or *Type B units*, the minimum clear opening widths shall not apply to interior egress doors.
9. Door openings required to be *accessible* within *Type B units* intended for user passage shall have a minimum clear opening width of 31.75 inches (806 mm).
10. Doors to walk-in freezers and coolers less than 1,000 square feet (93 m<sup>2</sup>) in area shall have a maximum width of 60 inches (1524 mm) nominal.

11. Doors serving nonaccessible single-user shower or sauna compartments, toilet stalls or dressing, fitting or changing rooms shall have a minimum clear opening width of 20 inches (508 mm).

**1010.1.1.1 Projections into clear opening.** There shall not be projections into the required clear opening width lower than 34 inches (864 mm) above the floor or ground. Projections into the clear opening width between 34 inches (864 mm) and 80 inches (2032 mm) above the floor or ground shall not exceed 4 inches (102 mm).

**Exception:** Door closers, overhead door stops, power door operators, and electromagnetic door locks shall be permitted to be 78 inches (1980 mm) minimum above the floor.

**1010.1.2 Egress door types.** Egress doors shall be of the side-hinged swinging door, pivoted door, or *balanced door* types.

**Exceptions:**

1. *Private garages*, office areas, factory and storage areas with an *occupant load* of 10 or less.
2. Group I-3 occupancies used as a place of detention.
3. Critical or intensive care patient rooms within suites of health care facilities.
4. Doors within or serving a single *dwelling unit* in Groups R-2 and R-3.
5. In other than Group H occupancies, revolving doors complying with Section 1010.3.1.
6. In other than Group H occupancies, special purpose horizontal sliding, accordion or folding door assemblies complying with Section 1010.3.3.
7. *Power-operated* doors in accordance with Section 1010.3.2.
8. Doors serving a bathroom within an individual *sleeping unit* in Group R-1.
9. In other than Group H occupancies, manually operated horizontal sliding doors are permitted in a *means of egress* from spaces with an *occupant load* of 10 or less.

**1010.1.2.1 Direction of swing.** Side-hinged swinging doors, pivoted doors and balanced doors shall swing in the direction of egress travel where serving a room or area containing an *occupant load* of 50 or more persons or a Group H occupancy.

**1010.1.3 Forces to unlatch and open doors.** The forces to unlatch doors shall comply with the following:

1. Where door hardware operates by push or pull, the operational force to unlatch the door shall not exceed 15 pounds (67 N).
2. Where door hardware operates by rotation, the operational force to unlatch the door shall not exceed 28 inch-pounds (315 N-cm).



## MEANS OF EGRESS

The force to open doors shall comply with the following:

1. For interior swinging egress doors that are manually operated, other than doors required to be fire rated, the force for pushing or pulling open the door shall not exceed 5 pounds (22 N).
2. For other swinging doors, sliding doors or folding doors, and doors required to be fire rated, the door shall require not more than a 30-pound (133 N) force to be set in motion and shall move to a full-open position when subjected to not more than a 15-pound (67 N) force.

**1010.1.3.1 Location of applied forces.** Forces shall be applied to the latch side of the door.

**1010.1.3.2 Manual horizontal sliding doors.** Where a manual horizontal sliding door is required to latch, the latch or other mechanism shall prevent the door from rebounding into a partially open position when the door is closed.

**1010.1.4 Floor elevation.** There shall be a floor or landing on each side of a door. Such floor or landing shall be at the same elevation on each side of the door. Landings shall be level except for exterior landings, which are permitted to have a slope not to exceed 0.25 unit vertical in 12 units horizontal (2-percent slope).

### Exceptions:

1. At doors serving individual dwelling units or sleeping units in Groups R-2 and R-3 : a door is permitted to open at the top step of an interior *flight* of stairs, provided that the door does not swing over the top step.
2. At exterior doors serving Groups F, H, R-2 and S and where such doors are not part of an accessible route, the landing at an exterior door shall not be more than 7 inches (178 mm) below the landing on the egress side of the door, provided that the door, other than an exterior storm or screen door, does not swing over the landing.
3. At exterior doors serving Group U and individual dwelling units and sleeping units in Groups R-2 and R-3, and where such units are not required to be Accessible units, Type A units or Type B units, the landing at an exterior doorway shall be not more than 7<sup>3</sup>/<sub>4</sub> inches (197 mm) below the landing on the egress side of the door. Such doors, including storm or screen doors, shall be permitted to swing over either landing.
4. Variations in elevation due to differences in finish materials, but not more than 1/2 inch (12.7 mm).
5. Exterior decks, patios or balconies that are part of Type B *dwelling units* or sleeping units, that have impervious surfaces and that are not more than 4 inches (102 mm) below the finished floor level of the adjacent interior space of the *dwelling unit* or *sleeping unit*.

6. Doors serving equipment spaces not required to be *accessible* in accordance with Section 1103.2.9 and serving an *occupant load* of five or less shall be permitted to have a landing on one side to be not more than 7 inches (178 mm) above or below the landing on the egress side of the door.

**1010.1.5 Landings at doors.** Landings shall have a width not less than the width of the *stairway* or the door, whichever is greater. Doors in the fully open position shall not reduce a required dimension by more than 7 inches (178 mm). Where a landing serves an *occupant load* of 50 or more, doors in any position shall not reduce the landing to less than one-half its required width. Landings shall have a length measured in the direction of travel of not less than 44 inches (1118 mm).

**Exception:** Landing length in the direction of travel in Groups R-3 and U and within individual units of Group R-2 need not exceed 36 inches (914 mm).

**1010.1.6 Thresholds.** Thresholds at doorways shall not exceed 3/4 inch (19.1 mm) in height above the finished floor or landing for sliding doors serving *dwelling units* or 1/2 inch (12.7 mm) above the finished floor or landing for other doors. Raised thresholds and floor level changes greater than 1/4 inch (6.4 mm) at doorways shall be beveled with a slope not greater than one unit vertical in two units horizontal (50-percent slope).

### Exceptions:

1. In occupancy Group R-2 or R-3, threshold heights for sliding and side-hinged exterior doors shall be permitted to be up to 7<sup>3</sup>/<sub>4</sub> inches (197 mm) in height if all of the following apply:
  - 1.1. The door is not part of the required *means of egress*.
  - 1.2. The door is not part of an *accessible route* as required by Chapter 11.
  - 1.3. The door is not part of an *Accessible unit, Type A unit* or *Type B unit*.
2. In *Type B units*, where Exception 5 to Section 1010.1.4 permits a 4-inch (102 mm) elevation change at the door, the threshold height on the exterior side of the door shall not exceed 4<sup>3</sup>/<sub>4</sub> inches (120 mm) in height above the exterior deck, patio or balcony for sliding doors or 4<sup>1</sup>/<sub>2</sub> inches (114 mm) above the exterior deck, patio or balcony for other doors.

**1010.1.7 Door arrangement.** Space between two doors in a series shall be 48 inches (1219 mm) minimum plus the width of a door swinging into the space. Doors in a series shall swing either in the same direction or away from the space between the doors.

### Exceptions:

1. The minimum distance between horizontal sliding *power-operated* doors in a series shall be 48 inches (1219 mm).



2. Storm and screen doors serving individual *dwelling units* in Groups R-2 and R-3 need not be spaced 48 inches (1219 mm) from the other door.
3. Doors within individual *dwelling units* in Groups R-2 and R-3 other than within Type A *dwelling units*.

**1010.2 Door operations.** Except as specifically permitted by this section, egress doors shall be readily openable from the egress side without the use of a key or special knowledge or effort.

**1010.2.1 Unlatching.** The unlatching of any door or leaf for egress shall require not more than one motion in a single linear or rotational direction to release all latching and all locking devices.

**Exceptions:**

1. Places of detention or restraint.
2. Where manually operated bolt locks are permitted by Section 1010.2.5.
3. Doors with automatic flush bolts as permitted by Section 1010.2.4, Item 4.
4. Doors from individual *dwelling units* and *sleeping units* of Group R occupancies as permitted by Section 1010.2.4, Item 5.

**1010.2.2 Hardware.** Door handles, pulls, latches, locks and other operating devices on doors required to be *accessible* by Chapter 11 shall not require tight grasping, tight pinching or twisting of the wrist to operate.

**1010.2.3 Hardware height.** Door handles, pulls, latches, locks and other operating devices shall be installed 34 inches (864 mm) minimum and 48 inches (1219 mm) maximum above the finished floor. Locks used only for security purposes and not used for normal operation are permitted at any height.

**Exception:** Access doors or gates in barrier walls and fences protecting pools, spas and hot tubs shall be permitted to have operable parts of the latch release on self-latching devices at 54 inches (1370 mm) maximum above the finished floor or ground, provided that the self-latching devices are not also self-locking devices operated by means of a key, electronic opener or integral combination lock.

**1010.2.4 Locks and latches.** Locks and latches shall be permitted to prevent operation of doors where any of the following exist:

1. Places of detention or restraint.
2. In Group I-1, Condition 2 and Group I-2 occupancies where the clinical needs of persons receiving care require containment or where persons receiving care pose a security threat, provided that all clinical staff can readily unlock doors at all times, and all such locks are keyed to keys carried by all clinical staff at all times or all clinical staff have the codes or other means necessary to operate the locks at all times.

3. In buildings in occupancy Group A having an *occupant load* of 300 or less, Groups B, F, M and S, and in *places of religious worship*, the main door or doors are permitted to be equipped with key-operated locking devices from the egress side provided:

- 3.1. The locking device is readily distinguishable as locked.
- 3.2. A readily visible durable sign is posted on the egress side on or adjacent to the door stating: THIS DOOR TO REMAIN UNLOCKED WHEN THIS SPACE IS OCCUPIED. The sign shall be in letters 1 inch (25 mm) high on a contrasting background.
- 3.3. The use of the key-operated locking device is revocable by the *building official* for due cause.

4. Where egress doors are used in pairs, *approved* automatic flush bolts shall be permitted to be used, provided that the door leaf having the automatic flush bolts does not have a doorknob or surface-mounted hardware.
5. Doors from individual *dwelling* or *sleeping units* of Group R occupancies having an *occupant load* of 10 or less are permitted to be equipped with a night latch, dead bolt or security chain, provided such devices are openable from the inside without the use of a key or tool.
6. *Fire doors* after the minimum elevated temperature has disabled the unlatching mechanism in accordance with *listed fire door* test procedures.
7. Doors serving roofs not intended to be occupied shall be permitted to be locked preventing entry to the building from the roof.
8. Other than egress *courts*, where occupants must egress from an exterior space through the building for *means of egress*, exit access doors shall be permitted to be equipped with an approved locking device where installed and operated in accordance with all of the following:
  - 8.1. The maximum *occupant load* shall be posted where required by Section 1004.9. Such signage shall be permanently affixed inside the building and shall be posted in a conspicuous space near all the exit access doorways.
  - 8.2. A weatherproof telephone or two-way communication system installed in accordance with Sections 1009.8.1 and 1009.8.2 shall be located adjacent to not less than one required exit access door on the exterior side.
  - 8.3. The egress door locking device is readily distinguishable as locked and shall be a key-operated locking device.

## MEANS OF EGRESS

- 8.4. A clear window or glazed door opening, not less than 5 square feet (0.46 m<sup>2</sup>) in area, shall be provided at each exit access door to determine if there are occupants using the outdoor area.
- 8.5. A readily visible, durable sign shall be posted on the interior side on or adjacent to each locked required exit access door serving the exterior area stating, "THIS DOOR TO REMAIN UNLOCKED WHEN THE OUTDOOR AREA IS OCCUPIED." The letters on the sign shall be not less than 1 inch (25.4 mm) high on a contrasting background.
- 8.6. The *occupant load* of the occupied exterior area shall not exceed 300 occupants in accordance with Section 1004.
9. Locking devices are permitted on doors to balconies, decks or other exterior spaces serving individual dwelling or sleeping units.
10. Locking devices are permitted on doors to balconies, decks or other exterior spaces of 250 square feet (23.23 m<sup>2</sup>) or less serving a private office space.

**1010.2.5 Bolt locks.** Manually operated flush bolts or surface bolts are not permitted.

**Exceptions:**

1. On doors not required for egress in individual *dwelling units* or *sleeping units*.
2. Where a pair of doors serves a storage or equipment room, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf.
3. Where a pair of doors serves an *occupant load* of less than 50 persons in a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf. The inactive leaf shall not contain doorknobs, *panic* bars or similar operating hardware.
4. Where a pair of doors serves a Group B, F or S occupancy, manually operated edge- or surface-mounted bolts are permitted on the inactive leaf provided that such inactive leaf is not needed to meet egress capacity requirements and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1. The inactive leaf shall not contain doorknobs, *panic* bars or similar operating hardware.
5. Where a pair of doors serves patient care rooms in Group I-2 occupancies, self-latching edge- or surface-mounted bolts are permitted on the inactive leaf provided that the inactive leaf is not needed to meet egress capacity requirements and the inactive leaf shall not contain

doorknobs, *panic* bars or similar operating hardware.

**1010.2.6 Closet doors.** Closet doors that latch in the closed position shall be openable from inside the closet.

**1010.2.7 Stairway doors.** Interior *stairway* means of egress doors shall be openable from both sides without the use of a key or special knowledge or effort.

**Exceptions:**

1. *Stairway* discharge doors shall be openable from the egress side and shall only be locked from the opposite side.
2. This section shall not apply to doors arranged in accordance with Section 403.5.3.
3. *Stairway* exit doors are permitted to be locked from the side opposite the egress side, provided that they are openable from the egress side and capable of being unlocked simultaneously without unlatching upon a signal from the *fire command center*, if present, or a signal by emergency personnel from a single location inside the main entrance to the building.
4. *Stairway exit* doors shall be openable from the egress side and shall only be locked from the opposite side in Group B, F, M and S occupancies where the only interior access to the tenant space is from a single *exit stairway* where permitted in Section 1006.3.4.
5. *Stairway* exit doors shall be openable from the egress side and shall only be locked from the opposite side in Group R-2 occupancies where the only interior access to the *dwelling unit* is from a single *exit stairway* where permitted in Section 1006.3.4.

**1010.2.8 Locking arrangements in educational occupancies.** In Group E occupancies, Group B educational occupancies and Group I-4 occupancies, egress doors from classrooms, offices and other occupied rooms with locking arrangements designed to keep intruders from entering the room shall comply with all of the following conditions:

1. The door shall be capable of being unlocked from outside the room with a key or other *approved* means.
2. The door shall be openable from within the room in accordance with Section 1010.2.
3. Modifications shall not be made to listed *panic hardware*, *fire door* hardware or door closers.
4. Modifications to *fire door assemblies* shall be in accordance with NFPA 80.

Remote locking or unlocking of doors from an approved location shall be permitted in addition to the unlocking operation in Item 1.

**1010.2.9 Panic and fire exit hardware.** Swinging doors serving a Group H occupancy and swinging doors serving rooms or spaces with an *occupant load* of 50 or more in a

Group A or E occupancy shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*.

**Exceptions:**

1. A main exit of a Group A occupancy shall be permitted to have locking devices in accordance with Section 1010.2.4, Item 3.
2. Doors provided with *panic hardware* or *fire exit hardware* and serving a Group A or E occupancy shall be permitted to be electrically locked in accordance with Section 1010.2.11 or 1010.2.12.
3. Exit access doors serving occupied exterior areas shall be permitted to be locked in accordance with Section 1010.2.4, Item 8.
4. Courtrooms shall be permitted to be locked in accordance with Section 1010.2.13, Item 3.

**1010.2.9.1 Refrigeration machinery room.** Refrigeration machinery rooms larger than 1,000 square feet (93 m<sup>2</sup>) shall have not less than two exit or exit access doorways that swing in the direction of egress travel and shall be equipped with *panic hardware* or *fire exit hardware*.

**1010.2.9.2 Rooms with electrical equipment.** Exit or exit access doors serving transformer vaults, rooms designated for batteries or energy storage systems, or modular data centers shall be equipped with panic hardware or fire exit hardware. Rooms containing electrical equipment rated 800 amperes or more that contain overcurrent devices, switching devices or control devices and where the exit or exit access door is less than 25 feet (7620 mm) from the equipment working space as required by NFPA 70, such doors shall not be provided with a latch or lock other than *panic hardware* or *fire exit hardware*. The doors shall swing in the direction of egress travel.

**1010.2.9.3 Installation.** Where panic or *fire exit hardware* is installed, it shall comply with the following:

1. *Panic hardware* shall be *listed* in accordance with UL 305.
2. *Fire exit hardware* shall be *listed* in accordance with UL 10C and UL 305.
3. The actuating portion of the releasing device shall extend not less than one-half of the door leaf width.
4. The maximum unlatching force shall not exceed 15 pounds (67 N).

**1010.2.9.4 Balanced doors.** If *balanced doors* are used and *panic hardware* is required, the *panic hardware* shall be the push-pad type and the pad shall not extend more than one-half the width of the door measured from the latch side.

**1010.2.10 Monitored or recorded egress.** Where electrical systems that monitor or record egress activity are incorporated, the locking system shall comply with Section 1010.2.11, 1010.2.12, 1010.2.13, 1010.2.14 or

1010.2.15 or shall be readily openable from the egress side without the use of a key or special knowledge or effort.

**1010.2.11 Door hardware release of electrically locked egress doors.** Door hardware release of electric locking systems shall be permitted on doors in the *means of egress* in any occupancy except Group H where installed and operated in accordance with all of the following:

1. The door hardware that is affixed to the door leaf has an obvious method of operation that is readily operated under all lighting conditions.
2. The door hardware is capable of being operated with one hand and shall comply with Section 1010.2.1.
3. Operation of the door hardware directly interrupts the power to the electric lock and unlocks the door immediately.
4. Loss of power to the electric locking system automatically unlocks the door.
5. Where *panic* or *fire exit hardware* is required by Section 1010.2.9, operation of the *panic* or *fire exit hardware* also releases the electric lock.
6. The locking system units shall be *listed* in accordance with UL 294.

**1010.2.12 Sensor release of electrically locked egress doors.** Sensor release of electric locking systems shall be permitted on doors located in the *means of egress* in any occupancy except Group H where installed and operated in accordance with all of the following criteria:

1. The sensor shall be installed on the egress side, arranged to detect an occupant approaching the doors, and shall cause the electric locking system to unlock.
2. The electric locks shall be arranged to unlock by a signal from or loss of power to the sensor.
3. Loss of power to the lock or locking system shall automatically unlock the electric locks.
4. The doors shall be arranged to unlock from a manual unlocking device located 40 inches to 48 inches (1016 mm to 1219 mm) vertically above the floor and within 5 feet (1524 mm) of the secured doors. Ready access shall be provided to the manual unlocking device and the device shall be clearly identified by a sign that reads "PUSH TO EXIT." When operated, the manual unlocking device shall result in direct interruption of power to the electric lock—independent of other electronics—and the electric lock shall remain unlocked for not less than 30 seconds.
5. Activation of the building *fire alarm system*, where provided, shall automatically unlock the electric lock, and the electric lock shall remain unlocked until the *fire alarm system* has been reset.
6. Activation of the building *automatic sprinkler system* or fire detection system, where provided,

## MEANS OF EGRESS

shall automatically unlock the electric lock. The electric lock shall remain unlocked until the *fire alarm system* has been reset.

7. Emergency lighting shall be provided on the egress side of the door.
8. The door locking system units shall be *listed* in accordance with UL 294.

**1010.2.13 Delayed egress.** Delayed egress locking systems shall be permitted to be installed on doors serving the following occupancies in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved automatic smoke or heat detection system* installed in accordance with Section 907.

1. Group B, F, I, M, R, S and U occupancies.
2. Group E classrooms with an *occupant load* of less than 50.
3. In courtrooms in Group A-3 and B occupancies, delayed egress locking systems shall be permitted to be installed on exit or *exit access* doors, other than the main exit or *exit access* door, in buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**1010.2.13.1 Delayed egress locking system.** The delayed egress locking system shall be installed and operated in accordance with all of the following:

1. The delay electronics of the delayed egress locking system shall deactivate upon actuation of the *automatic sprinkler system* or *automatic fire detection system*, allowing immediate free egress.
2. The delay electronics of the delayed egress locking system shall deactivate upon loss of power controlling the lock or lock mechanism, allowing immediate free egress.
3. The delayed egress locking system shall have the capability of being deactivated at the *fire command center* and other *approved* locations.
4. An attempt to egress shall initiate an irreversible process that shall allow such egress in not more than 15 seconds when a physical effort to exit is applied to the egress side door hardware for not more than 3 seconds. Initiation of the irreversible process shall activate an audible signal in the vicinity of the door. Once the delay electronics have been deactivated, rearming the delay electronics shall be by manual means only.

**Exception:** Where *approved*, a delay of not more than 30 seconds is permitted on a delayed egress door.

5. The egress path from any point shall not pass through more than one delayed egress locking system.

### Exceptions:

1. In Group I-1, Condition 2, Group I-2 or I-3 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided that the combined delay does not exceed 30 seconds.
2. In Group I-1, Condition 1 or Group I-4 occupancies, the egress path from any point in the building shall pass through not more than two delayed egress locking systems provided the combined delay does not exceed 30 seconds and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
6. A sign shall be provided on the door and shall be located above and within 12 inches (305 mm) of the door exit hardware:

**Exception:** Where *approved*, in Group I occupancies, the installation of a sign is not required where care recipients who because of clinical needs require restraint or containment as part of the function of the treatment area.

- 6.1. For doors that swing in the direction of egress, the sign shall read, "PUSH UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS."
- 6.2. For doors that swing in the opposite direction of egress, the sign shall read, "PULL UNTIL ALARM SOUNDS. DOOR CAN BE OPENED IN 15 [30] SECONDS."
- 6.3. The sign shall comply with the visual character requirements in ICC A117.1.
7. Emergency lighting shall be provided on the egress side of the door.
8. The delayed egress locking system units shall be *listed* in accordance with UL 294.



**1010.2.14 Controlled egress doors in Groups I-1 and I-2.**

Electric locking systems, including electro-mechanical locking systems and electromagnetic locking systems, shall be permitted to be locked in the *means of egress* in Group I-1 or I-2 occupancies where the clinical needs of persons receiving care require their containment. Controlled egress doors shall be permitted in such occupancies where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or an *approved automatic smoke detection system* installed in accordance with Section 907, provided that the doors are installed and operate in accordance with all of the following:

1. The door locks shall unlock on actuation of the *automatic sprinkler system* or *automatic smoke detection system*.
2. The door locks shall unlock on loss of power controlling the lock or lock mechanism.
3. The door locking system shall be installed to have the capability of being unlocked by a switch located at the *fire command center*, a nursing station or other *approved* location. The switch shall directly break power to the lock.
4. A building occupant shall not be required to pass through more than one door equipped with a controlled egress locking system before entering an *exit*.
5. The procedures for unlocking the doors shall be described and *approved* as part of the emergency planning and preparedness required by Chapter 4 of the *International Fire Code*.
6. All clinical staff shall have the keys, codes or other means necessary to operate the locking systems.
7. Emergency lighting shall be provided at the door.
8. The door locking system units shall be *listed* in accordance with UL 294.

**Exceptions:**

1. Items 1 through 4 shall not apply to doors to areas occupied by persons who, because of clinical needs, require restraint or containment as part of the function of a psychiatric or cognitive treatment area.
2. Items 1 through 4 shall not apply to doors to areas where a *listed* egress control system is utilized to reduce the risk of child abduction from nursery and obstetric areas of a Group I-2 hospital.

**1010.2.15 Locking arrangements in buildings within correctional facilities.** In *buildings* within correctional and detention facilities, doors in *means of egress* serving rooms or spaces occupied by persons whose movements are controlled for security reasons shall be permitted to be locked where equipped with egress control devices that

shall unlock manually and by not less than one of the following means:

1. Activation of an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. Activation of an *approved manual fire alarm box*.
3. A signal from a *constantly attended location*.

**1010.3 Special doors.** Special doors and security grilles shall comply with the requirements of Sections 1010.3.1 through 1010.3.4.

**1010.3.1 Revolving doors.** Revolving doors shall comply with the following:

1. Revolving doors shall comply with BHMA A156.27 and shall be installed in accordance with the manufacturer's instructions.
2. Each revolving door shall be capable of *breakout* in accordance with BHMA A156.27 and shall provide an aggregate width of not less than 36 inches (914 mm).
3. A revolving door shall not be located within 10 feet (3048 mm) of the foot or top of *stairways* or escalators. A dispersal area shall be provided between the *stairways* or escalators and the revolving doors.
4. The revolutions per minute (rpm) for a revolving door shall not exceed the maximum rpm as specified in BHMA A156.27. Manual revolving doors shall comply with Table 1010.3.1(1). Automatic or *power-operated* revolving doors shall comply with Table 1010.3.1(2).
5. An emergency stop switch shall be provided near each entry point of power or automatic operated revolving doors within 48 inches (1219 mm) of the door and between 34 inches (864 mm) and 48 inches (1219 mm) above the floor. The activation area of the emergency stop switch button shall be not less than 1 inch (25 mm) in diameter and shall be red.
6. Each revolving door shall have a side-hinged swinging door that complies with Section 1010.1 in the same wall and within 10 feet (3048 mm) of the revolving door.
7. Revolving doors shall not be part of an *accessible route* required by Section 1009 and Chapter 11.

**TABLE 1010.3.1(1)  
MAXIMUM DOOR SPEED MANUAL REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
6-0	12
7-0	11
8-0	10
9-0	9
10-0	8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

## MEANS OF EGRESS

**TABLE 1010.3.1(2)**  
**MAXIMUM DOOR SPEED AUTOMATIC OR POWER-OPERATED**  
**REVOLVING DOORS**

REVOLVING DOOR MAXIMUM NOMINAL DIAMETER (FT-IN)	MAXIMUM ALLOWABLE REVOLVING DOOR SPEED (RPM)
8-0	7.2
9-0	6.4
10-0	5.7
11-0	5.2
12-0	4.8
12-6	4.6
14-0	4.1
16-0	3.6
17-0	3.4
18-0	3.2
20-0	2.9
24-0	2.4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**1010.3.1.1 Egress component.** A revolving door used as a component of a *means of egress* shall comply with Section 1010.3.1 and the following three conditions:

1. Revolving doors shall not be given credit for more than 50 percent of the minimum width or required capacity.
2. Each revolving door shall be credited with a capacity based on not more than a 50-person *occupant load*.
3. Each revolving door shall provide for egress in accordance with BHMA A156.27 with a *breakout* force of not more than 130 pounds (578 N).

**1010.3.1.2 Other than egress component.** A revolving door used as other than a component of a *means of egress* shall comply with Section 1010.3.1. The *breakout* force of a revolving door not used as a component of a *means of egress* shall not be more than 180 pounds (801 N).

**Exception:** A *breakout* force in excess of 180 pounds (801 N) is permitted if the *breakout* force is reduced to not more than 130 pounds (578 N) when not less than one of the following conditions is satisfied:

1. There is a power failure or power is removed to the device holding the door wings in position.
2. There is an actuation of the *automatic sprinkler system* where such system is provided.
3. There is an actuation of a smoke detection system that is installed in accordance with Section 907 to provide coverage in areas within the building that are within 75 feet (22 860 mm) of the revolving doors.

4. There is an actuation of a manual control switch, in an *approved* location and clearly identified, that reduces the *breakout* force to not more than 130 pounds (578 N).

**1010.3.2 Power-operated doors.** Where means of egress doors are operated or assisted by power, the design shall be such that in the event of power failure, the door is capable of being opened manually to permit means of egress travel or closed where necessary to safeguard *means of egress*. The forces required to open these doors manually shall not exceed those specified in Section 1010.1.3, except that the force to set the door in motion shall not exceed 50 pounds (220 N). The door shall be capable of opening from any position to the full width of the opening in which such door is installed when a force is applied to the door on the side from which egress is made. *Power-operated* swinging doors, *power-operated* sliding doors and *power-operated* folding doors shall comply with BHMA A156.10. *Power-assisted* swinging doors and low-energy *power-operated* swinging doors shall comply with BHMA A156.19. Low-energy *power-operated* sliding doors and low-energy *power-operated* folding doors shall comply with BHMA A156.38.

**Exceptions:**

1. Occupancies in Group I-3.
2. Special purpose horizontal sliding, accordion or folding doors complying with Section 1010.3.3.
3. For a biparting door in the emergency *breakout* mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 32-inch (813 mm) single-leaf requirement of Section 1010.1.1, provided that a minimum 32-inch (813 mm) clear opening is provided when the two biparting leaves meeting in the center are broken out.

**1010.3.3 Special purpose horizontal sliding, accordion or folding doors.** In other than Group H occupancies, special purpose horizontal sliding, accordion or folding door assemblies permitted to be a component of a *means of egress* in accordance with Exception 6 to Section 1010.1.2 shall comply with all of the following criteria:

1. The doors shall be power operated and shall be capable of being operated manually in the event of power failure.
2. The doors shall be openable by a simple method without special knowledge or effort from the egress side or sides.
3. The force required to operate the door shall not exceed 30 pounds (133 N) to set the door in motion and 15 pounds (67 N) to close the door or open it to the minimum required width.
4. The door shall be openable with a force not to exceed 15 pounds (67 N) when a force of 250 pounds (1100 N) is applied perpendicular to the door adjacent to the operating device.

5. The door assembly shall comply with the applicable *fire protection rating* and, where rated, shall be *self-closing* or automatic closing by smoke detection in accordance with Section 716.2.6.6, shall be installed in accordance with NFPA 80 and shall comply with Section 716.
6. The door assembly shall have an integrated standby power supply.
7. The door assembly power supply shall be electrically supervised.
8. The door shall open to the minimum required width within 10 seconds after activation of the operating device.

**1010.3.4 Security grilles.** In Groups B, F, M and S, horizontal sliding or vertical security grilles are permitted at the main *exit* and shall be openable from the inside without the use of a key or special knowledge or effort during periods that the space is occupied. The grilles shall remain secured in the full-open position during the period of occupancy by the general public. Where two or more exits or access to exits are required, not more than one-half of the *exits* or *exit access doorways* shall be equipped with horizontal sliding or vertical security grilles.

**1010.4 Gates.** Gates serving the *means of egress* system shall comply with the requirements of this section. Gates used as a component in a *means of egress* shall conform to the applicable requirements for doors.

**Exception:** Horizontal sliding or swinging gates exceeding the 4-foot (1219 mm) maximum leaf width limitation are permitted in fences and walls surrounding a stadium.

**1010.4.1 Stadiums.** *Panic hardware* is not required on gates surrounding stadiums where such gates are under constant immediate supervision while the public is present, and where safe dispersal areas based on 3 square feet (0.28 m<sup>2</sup>) per occupant are located between the fence and enclosed space. Such required safe dispersal areas shall not be located less than 50 feet (15 240 mm) from the enclosed space. See Section 1028.5 for *means of egress* from safe dispersal areas.

**1010.5 Turnstiles and similar devices.** Turnstiles or similar devices that restrict travel to one direction shall not be placed so as to obstruct any required *means of egress*, except where permitted in accordance with Sections 1010.5.1, 1010.5.2 and 1010.5.3.

**1010.5.1 Capacity.** Each turnstile or similar device shall be credited with a capacity based on not more than a 50-person *occupant load* where all of the following provisions are met:

1. Each device shall turn free in the direction of egress travel when primary power is lost and on the manual release by an employee in the area.
2. Such devices are not given credit for more than 50 percent of the required egress capacity or width.
3. Each device is not more than 39 inches (991 mm) high.

4. Each device has not less than 16<sup>1</sup>/<sub>2</sub> inches (419 mm) clear width at and below a height of 39 inches (991 mm) and not less than 22 inches (559 mm) clear width at heights above 39 inches (991 mm).

**1010.5.1.1 Clear width.** Where located as part of an *accessible* route, turnstiles shall have not less than 36 inches (914 mm) clear width at and below a height of 34 inches (864 mm), not less than 32 inches (813 mm) clear width between 34 inches (864 mm) and 80 inches (2032 mm) and shall consist of a mechanism other than a revolving device.

**1010.5.2 Security access turnstiles.** Security access turnstiles that inhibit travel in the direction of egress utilizing a physical barrier shall be permitted to be considered as a component of the *means of egress*, provided that all of the following criteria are met:

1. The building is protected throughout by an approved, supervised *automatic sprinkler system* in accordance with Section 903.3.1.1.
2. Each security access turnstile lane configuration has a minimum clear passage width of 22 inches (559 mm).
3. Any security access turnstile lane configuration providing a clear passage width of less than 32 inches (810 mm) shall be credited with a maximum egress capacity of 50 persons.
4. Any security access turnstile lane configuration providing a clear passage width of 32 inches (810 mm) or more shall be credited with a maximum egress capacity as calculated in accordance with Section 1005.
5. Each secured physical barrier shall automatically retract or swing to an unobstructed open position in the direction of egress, under each of the following conditions:
  - 5.1. Upon loss of power to the turnstile or any part of the access control system that secures the physical barrier.
  - 5.2. Upon actuation of a clearly identified manual release device with ready access that results in direct interruption of power to each secured physical barrier, after which such barriers remain in the open position for not less than 30 seconds. The manual release device shall be positioned at one of the following locations:
    - 5.2.1. On the egress side of each security access turnstile lane.
    - 5.2.2. At an *approved* location where it can be actuated by an employee assigned to the area at all times that the building is occupied.
  - 5.3. Upon actuation of the building *fire alarm system*, if provided, after which the physi-

## MEANS OF EGRESS

cal barrier remains in the open position until the *fire alarm system* is manually reset.

**Exception:** Actuation of a manual fire alarm box.

- 5.4. Upon actuation of the building automatic sprinkler system or fire detection system, after which the physical barrier remains in the open position until the *fire alarm system* is manually reset.

**1010.5.3 High turnstile.** Turnstiles more than 39 inches (991 mm) high shall meet the requirements for revolving doors or the requirements of Section 1010.5.2 for security access turnstiles.

**1010.5.4 Additional door.** Where serving an *occupant load* greater than 300, each turnstile that is not portable shall have a side-hinged swinging door that conforms to Section 1010.1 within 50 feet (15 240 mm).

**Exception:** A side-hinged swinging door is not required at security access turnstiles that comply with Section 1010.5.2.

## SECTION 1011 STAIRWAYS

**1011.1 General.** *Stairways* serving occupied portions of a building shall comply with the requirements of Sections 1011.2 through 1011.13. *Alternating tread devices* shall comply with Section 1011.14. Ship's ladders shall comply with Section 1011.15. Ladders shall comply with Section 1011.16.

**Exception:** Within rooms or spaces used for assembly purposes, stepped *aisles* shall comply with Section 1030.

**1011.2 Width and capacity.** The required capacity of *stairways* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm). See Section 1009.3 for *accessible means of egress stairways*.

### Exceptions:

1. *Stairways* serving an *occupant load* of less than 50 shall have a width of not less than 36 inches (914 mm).
2. *Spiral stairways* as provided for in Section 1011.10.
3. Where an incline platform lift or *stairway* chairlift is installed on *stairways* serving occupancies in Group R-3, or within *dwelling units* in occupancies in Group R-2, a clear passage width not less than 20 inches (508 mm) shall be provided. Where the seat and platform can be folded when not in use, the distance shall be measured from the folded position.

**1011.3 Headroom.** *Stairways* shall have a headroom clearance of not less than 80 inches (2032 mm) measured vertically from a line connecting the edge of the *nosings*. Such headroom shall be continuous above the *stairway* to the

point where the line intersects the landing below, one tread depth beyond the bottom riser. The minimum clearance shall be maintained the full width of the *stairway* and landing.

### Exceptions:

1. *Spiral stairways* complying with Section 1011.10 are permitted a 78-inch (1981 mm) headroom clearance.
2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; where the *nosings* of treads at the side of a *flight* extend under the edge of a floor opening through which the *stair* passes, the floor opening shall be allowed to project horizontally into the required headroom not more than  $4\frac{3}{4}$  inches (121 mm).

**1011.4 Walkline.** The walkline across *winder* treads shall be concentric to the direction of travel through the turn and located 12 inches (305 mm) from the side where the *winders* are narrower. The 12-inch (305 mm) dimension shall be measured from the widest point of the clear *stair* width at the walking surface of the *winder*. Where *winders* are adjacent within the *flight*, the point of the widest clear *stair* width of the adjacent *winders* shall be used.

**1011.5 Stair treads and risers.** *Stair* treads and risers shall comply with Sections 1011.5.1 through 1011.5.3.

**1011.5.1 Dimension reference surfaces.** For the purpose of this section, all dimensions are exclusive of carpets, rugs or runners.

**1011.5.2 Riser height and tread depth.** *Stair* riser heights shall be 7 inches (178 mm) maximum and 4 inches (102 mm) minimum. The riser height shall be measured vertically between the *nosings* of adjacent treads or between the *stairway* landing and the adjacent tread. Rectangular tread depths shall be 11 inches (279 mm) minimum measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's *nosing*. *Winder* treads shall have a minimum tread depth of 11 inches (279 mm) between the vertical planes of the foremost projection of adjacent treads at the intersections with the walkline and a minimum tread depth of 10 inches (254 mm) within the clear width of the stair.

### Exceptions:

1. *Spiral stairways* in accordance with Section 1011.10.
2. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to use the riser/tread dimension in Section 1030.14.2.
3. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; the maximum riser height shall be  $7\frac{3}{4}$  inches (197



mm); the minimum tread depth shall be 10 inches (254 mm); the minimum *winder* tread depth at the walkline shall be 10 inches (254 mm); and the minimum *winder* tread depth shall be 6 inches (152 mm). A *nosing* projection not less than  $\frac{3}{4}$  inch (19.1 mm) but not more than  $1\frac{1}{4}$  inches (32 mm) shall be provided on *stairways* with solid risers where the tread depth is less than 11 inches (279 mm).

4. See Section 503.1 of the *International Existing Building Code* for the replacement of existing *stairways*.
5. In Group I-3 facilities, *stairways* providing access to guard towers, observation stations and control rooms, not more than 250 square feet (23 m<sup>2</sup>) in area, shall be permitted to have a maximum riser height of 8 inches (203 mm) and a minimum tread depth of 9 inches (229 mm).

**1011.5.3 Winder treads.** *Winder* treads are not permitted in *means of egress stairways* except within a *dwelling unit*.

**Exceptions:**

1. Curved *stairways* in accordance with Section 1011.9.
2. *Spiral stairways* in accordance with Section 1011.10.

**1011.5.4 Dimensional uniformity.** *Stair* treads and risers shall be of uniform size and shape. The tolerance between the largest and smallest riser height or between the largest and smallest tread depth shall not exceed  $\frac{3}{8}$  inch (9.5 mm) in any *flight of stairs*. The greatest *winder* tread depth at the walkline within any *flight of stairs* shall not exceed the smallest by more than  $\frac{3}{8}$  inch (9.5 mm).

**Exceptions:**

1. *Stairways* connecting stepped *aisles* to cross *aisles* or concourses shall be permitted to comply with the dimensional nonuniformity in Section 1030.14.2.
2. Consistently shaped *winders*, complying with Section 1011.5, differing from rectangular treads in the same *flight of stairs*.
3. Nonuniform riser dimension complying with Section 1011.5.4.1.

**1011.5.4.1 Nonuniform height risers.** Where the bottom or top riser adjoins a sloping *public way*, walkway or driveway having an established grade and serving as a landing, the bottom or top riser is permitted to be reduced along the slope to less than 4 inches (102 mm) in height, with the variation in height of the bottom or top riser not to exceed one unit vertical in 12 units horizontal (8-percent slope) of *stair* width. The *nosings* or leading edges of treads at such nonuniform height risers shall have a distinctive marking stripe, different from any other *nosing* marking provided on the *stair flight*. The distinctive marking stripe shall be

visible in descent of the *stair* and shall have a slip-resistant surface. Marking stripes shall have a width of not less than 1 inch (25 mm) but not more than 2 inches (51 mm).

**1011.5.5 Nosing and riser profile.** *Nosings* shall have a curvature or bevel of not less than  $\frac{1}{16}$  inch (1.6 mm) but not more than  $\frac{9}{16}$  inch (14.3 mm) from the foremost projection of the tread. Risers shall be solid and vertical or sloped under the tread above from the underside of the *nosing* above at an angle not more than 30 degrees (0.52 rad) from the vertical.

**1011.5.5.1 Nosing projection size.** The leading edge (*nosings*) of treads shall project not more than  $1\frac{1}{4}$  inches (32 mm) beyond the tread below.

**1011.5.5.2 Nosing projection uniformity.** *Nosing* projections of the leading edges shall be of uniform size, including the projections of the *nosings*'s leading edge of the floor at the top of a *flight*.

**1011.5.5.3 Solid risers.** Risers shall be solid.

**Exceptions:**

1. Solid risers are not required for *stairways* that are not required to comply with Section 1009.3, provided that the opening between treads does not permit the passage of a sphere with a diameter of 4 inches (102 mm).
2. Solid risers are not required for occupancies in Group I-3 or in Group F, H and S occupancies other than areas accessible to the public. The size of the opening in the riser is not restricted.
3. Solid risers are not required for *spiral stairways* constructed in accordance with Section 1011.10.

**1011.6 Stairway landings.** There shall be a floor or landing at the top and bottom of each *stairway*. The width of landings, measured perpendicularly to the direction of travel, shall be not less than the width of *stairways* served. Every landing shall have a minimum depth, measured parallel to the direction of travel, equal to the width of the *stairway* or 48 inches (1219 mm), whichever is less. Doors opening onto a landing shall not reduce the landing to less than one-half the required width. When fully open, the door shall not project more than 7 inches (178 mm) into the required width of a landing. Where wheelchair spaces are required on the *stairway* landing in accordance with Section 1009.6.3, the *wheelchair space* shall not be located in the required width of the landing and doors shall not swing over the *wheelchair spaces*.

**Exceptions:**

1. Where *stairways* connect stepped *aisles* to cross *aisles* or concourses, *stairway* landings are not required at the transition between *stairways* and stepped *aisles* constructed in accordance with Section 1030.

## MEANS OF EGRESS

2. Where curved *stairways* of constant radius have intermediate landings, the landing depth shall be measured horizontally between the intersection of the walkline of the lower *flight* at the landing *nosing* and the intersection of the walkline of the upper *flight* at the *nosing* of the lowest tread of the upper *flight*.
3. Where a landing turns 90 degrees (1.57 rad) or more, the minimum landing depth in accordance with this section shall not be required where the landing provided is not less than that described by an arc with a radius equal to the width of the *flight* served.

**1011.7 Stairway construction.** *Stairways* shall be built of materials consistent with the types permitted for the type of construction of the building.

**Exceptions:**

1. Wood handrails shall be permitted in all types of construction.
2. Interior exit stairways in accordance with Section 510.2.

**1011.7.1 Stairway walking surface.** The walking surface of treads and landings of a *stairway* shall not be sloped steeper than one unit vertical in 48 units horizontal (2-percent slope) in any direction. *Stairway* treads and landings shall have a solid surface. Finish floor surfaces shall be securely attached.

**Exceptions:**

1. Openings in *stair* walking surfaces shall be a size that does not permit the passage of  $\frac{1}{2}$ -inch-diameter (12.7 mm) sphere. Elongated openings shall be placed so that the long dimension is perpendicular to the direction of travel.
2. In Group F, H and S occupancies, other than areas of parking structures accessible to the public, openings in treads and landings shall not be prohibited provided that a sphere with a diameter of  $1\frac{1}{8}$  inches (29 mm) cannot pass through the opening.

**1011.7.2 Outdoor conditions.** Outdoor *stairways* and outdoor approaches to *stairways* shall be designed so that water will not accumulate on walking surfaces.

**1011.7.3 Enclosures under interior stairways.** The walls and soffits within enclosed usable spaces under enclosed and unenclosed *stairways* shall be protected by 1-hour fire-resistance-rated construction or the *fire-resistance rating* of the *stairway* enclosure, whichever is greater. Access to the enclosed space shall not be directly from within the *stairway* enclosure.

**Exception:** Spaces under *stairways* serving and contained within a single residential *dwelling unit* in Group R-2 or R-3 shall be permitted to be protected on the enclosed side with  $\frac{1}{2}$ -inch (12.7 mm) *gypsum board*.

**1011.7.4 Enclosures under exterior stairways.** There shall not be enclosed usable space under exterior exit *stairways* unless the space is completely enclosed in 1-hour fire-resistance-rated construction. The open space under exterior *stairways* shall not be used for any purpose.

**1011.8 Vertical rise.** A *flight* of *stairs* shall not have a vertical rise greater than 12 feet (3658 mm) between floor levels or landings.

**Exception:** Spiral *stairways* used as a *means of egress* from *technical production areas*.

**1011.9 Curved stairways.** Curved *stairways* with *winder* treads shall have treads and risers in accordance with Section 1011.5 and the smallest radius shall be not less than twice the minimum width or required capacity of the *stairway*.

**Exception:** The radius restriction shall not apply to curved *stairways* in Group R-3 and within individual dwelling units in Group R-2.

**1011.10 Spiral stairways.** *Spiral stairways* are permitted to be used as a component in the *means of egress* only within *dwelling units* or from a space not more than 250 square feet (23 m<sup>2</sup>) in area and serving not more than five occupants, or from *technical production areas* in accordance with Section 410.5.

A *spiral stairway* shall have a  $6\frac{3}{4}$ -inch (171 mm) minimum clear tread depth at a point 12 inches (305 mm) from the narrow edge. The risers shall be sufficient to provide a headroom of 78 inches (1981 mm) minimum, but riser height shall not be more than  $9\frac{1}{2}$  inches (241 mm). The minimum *stairway* clear width at and below the *handrail* shall be 26 inches (660 mm).

**1011.11 Handrails.** *Flights of stairways* shall have *handrails* on each side and shall comply with Section 1014. Where glass is used to provide the *handrail*, the *handrail* shall comply with Section 2407.

**Exceptions:**

1. *Flights of stairways* within *dwelling units* and *flights of spiral stairways* are permitted to have a *handrail* on one side only.
2. Decks, patios and walkways that have a single change in elevation where the landing depth on each side of the change of elevation is greater than what is required for a landing do not require *handrails*.
3. In Group R-3 occupancies, a change in elevation consisting of a single riser at an entrance or egress door does not require *handrails*.
4. Changes in room elevations of three or fewer risers within *dwelling units* and *sleeping units* in Groups R-2 and R-3 do not require *handrails*.
5. Where a platform lift is in a stationary position and the floor of the platform lift serves as the upper landing of a *stairway*, *handrails* shall not be

required on the *stairway*, provided that all of the following criteria are met:

- 5.1. The *stairway* contains not more than two risers.
- 5.2. A handhold, positioned horizontally or vertically, is located on one side of the *stairway* adjacent to the top landing.
- 5.3. The handhold is located not less than 34 inches (864 mm) and not more than 42 inches (1067 mm) above the bottom landing of the *stairway*.
- 5.4. The handhold gripping surface complies with Section 1014.3, and is not less than 4.5 inches (114 mm) in length.

**1011.12 Stairway to roof.** In buildings four or more stories above grade plane, one *stairway* shall extend to the roof surface unless the roof has a slope steeper than four units vertical in 12 units horizontal (33-percent slope).

**Exception:** Other than where required by Section 1011.12.1, in buildings without an occupied roof access to the roof from the top *story* shall be permitted to be by an *alternating tread device*, a ships ladder or a permanent ladder.

**1011.12.1 Stairway to elevator equipment.** Roofs and *penthouses* containing elevator equipment that must be accessed for maintenance are required to be accessed by a *stairway*.

**1011.12.2 Roof access.** Where a *stairway* is provided to a roof, access to the roof shall be provided through a *penthouse* complying with Section 1511.2.

**Exception:** In buildings without an occupied roof, access to the roof shall be permitted to be a roof hatch or trap door not less than 16 square feet (1.5 m<sup>2</sup>) in area and having a minimum dimension of 2 feet (610 mm).

**1011.13 Guards.** *Guards* shall be provided along *stairways* and landings where required by Section 1015 and shall be constructed in accordance with Section 1015. Where the roof hatch opening providing the required access is located within 10 feet (3049 mm) of the roof edge, such roof access or roof edge shall be protected by *guards* installed in accordance with Section 1015.

**1011.14 Alternating tread devices.** *Alternating tread devices* are limited to an element of a *means of egress* in buildings of Groups F, H and S from a *mezzanine* not more than 250 square feet (23 m<sup>2</sup>) in area and that serves not more than five occupants; in buildings of Group I-3 from a guard tower, observation station or control room not more than 250 square feet (23 m<sup>2</sup>) in area and for access to unoccupied roofs. *Alternating tread devices* used as a *means of egress* shall not have a rise greater than 20 feet (6096 mm) between floor levels or landings.

**1011.14.1 Handrails of alternating tread devices.** *Handrails* shall be provided on both sides of *alternating tread devices* and shall comply with Section 1014.

**1011.14.2 Treads of alternating tread devices.** *Alternating tread devices* shall have a minimum tread depth of 5 inches (127 mm), a minimum projected tread depth of 8½ inches (216 mm), a minimum tread width of 7 inches (178 mm) and a maximum riser height of 9½ inches (241 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projections of adjacent treads. The riser height shall be measured vertically between the leading edges of adjacent treads. The riser height and tread depth provided shall result in an angle of ascent from the horizontal of between 50 and 70 degrees (0.87 and 1.22 rad). The initial tread of the device shall begin at the same elevation as the platform, landing or floor surface.

**Exception:** *Alternating tread devices* used as an element of a *means of egress* in buildings from a *mezzanine* area not more than 250 square feet (23 m<sup>2</sup>) in area that serves not more than five occupants shall have a minimum tread depth of 3 inches (76 mm) with a minimum projected tread depth of 10½ inches (267 mm). The rise to the next alternating tread surface shall not exceed 8 inches (203 mm).

**1011.15 Ship's ladders.** Ship's ladders are permitted to be used in Group I-3 as a component of a *means of egress* to and from control rooms or elevated facility observation stations not more than 250 square feet (23 m<sup>2</sup>) with not more than three occupants and for access to unoccupied roofs. The minimum clear width at and below the *handrails* shall be 20 inches (508 mm). Ship's ladders shall be designed for the live loads indicated in Section 1607.17.

**1011.15.1 Handrails of ship's ladders.** *Handrails* shall be provided on both sides of ship's ladders.

**1011.15.2 Treads of ship's ladders.** Ship's ladders shall have a minimum tread depth of 5 inches (127 mm). The tread shall be projected such that the total of the tread depth plus the *nosing* projection is not less than 8½ inches (216 mm). The maximum riser height shall be 9½ inches (241 mm).

**1011.16 Ladders.** Permanent ladders shall not serve as a part of the *means of egress* from occupied spaces within a building. Permanent ladders shall be constructed in accordance with Section 306.5 of the *International Mechanical Code* and designed for the live loads indicated in Section 1607.17. Permanent ladders shall be permitted to provide access to the following areas:

1. Spaces frequented only by personnel for maintenance, repair or monitoring of equipment.
2. Nonoccupiable spaces accessed only by catwalks, crawl spaces, freight elevators or very narrow passageways.
3. Raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to, observation galleries, prison guard towers, fire towers or lifeguard stands.
4. Elevated levels in Group U not open to the general public.



## MEANS OF EGRESS

5. Nonoccupied roofs that are not required to have *stairway* access in accordance with Section 1011.12.1.
6. Where permitted to access equipment and appliances in accordance with Section 306.5 of the *International Mechanical Code*.

### SECTION 1012 RAMPS

**1012.1 Scope.** The provisions of this section shall apply to *ramps* used as a component of a *means of egress*.

#### Exceptions:

1. Ramped *aisles* within assembly rooms or spaces shall comply with the provisions in Section 1030.
2. Curb ramps shall comply with ICC A117.1.
3. Vehicle ramps in parking garages for pedestrian *exit access* shall not be required to comply with Sections 1012.3 through 1012.10 where they are not an *accessible* route serving accessible parking spaces, other required accessible elements or part of an *accessible means of egress*.

**1012.2 Slope.** *Ramps* used as part of a *means of egress* shall have a running slope not steeper than 1 unit vertical in 12 units horizontal (8.3-percent slope). The slope of other pedestrian *ramps* shall not be steeper than 1 unit vertical in 8 units horizontal (12.5-percent slope).

**1012.3 Cross slope.** The slope measured perpendicular to the direction of travel of a *ramp* shall not be steeper than one unit vertical in 48 units horizontal (2-percent slope).

**1012.4 Vertical rise.** The rise for any *ramp* run shall be 30 inches (762 mm) maximum.

**1012.5 Minimum dimensions.** The minimum dimensions of *means of egress ramps* shall comply with Sections 1012.5.1 through 1012.5.3.

**1012.5.1 Width and capacity.** The minimum width and required capacity of a *means of egress ramp* shall be not less than that required for *corridors* by Section 1020.3. The clear width of a *ramp* between *handrails*, if provided, or other permissible projections shall be 36 inches (914 mm) minimum.

**1012.5.2 Headroom.** The minimum headroom in all parts of the *means of egress ramp* shall be not less than 80 inches (2032 mm) above the finished floor of the *ramp* run and any intermediate landings. The minimum clearance shall be maintained for the full width of the *ramp* and landing.

**1012.5.3 Restrictions.** *Means of egress ramps* shall not reduce in width in the direction of egress travel. Projections into the required *ramp* and landing width are prohibited. Doors opening onto a landing shall not reduce the clear width to less than 42 inches (1067 mm).

**1012.6 Landings.** *Ramps* shall have landings at the bottom and top of each *ramp*, points of turning, entrance, *exits* and at doors. Landings shall comply with Sections 1012.6.1 through 1012.6.5.

**1012.6.1 Slope.** Landings shall have a slope not steeper than one unit vertical in 48 units horizontal (2-percent slope) in any direction. Changes in level are not permitted.

**1012.6.2 Width.** The landing width shall be not less than the width of the widest *ramp* run adjoining the landing.

**1012.6.3 Length.** The landing length shall be 60 inches (1525 mm) minimum.

#### Exceptions:

1. In Group R-2 and R-3 individual dwelling and *sleeping units* that are not required to be *Accessible units, Type A units* or *Type B units* in accordance with Section 1108, landings are permitted to be 36 inches (914 mm) minimum.
2. Where the *ramp* is not a part of an *accessible* route, the length of the landing shall not be required to be more than 48 inches (1219 mm) in the direction of travel.

**1012.6.4 Change in direction.** Where changes in direction of travel occur at landings provided between *ramp* runs, the landing shall be 60 inches by 60 inches (1524 mm by 1524 mm) minimum.

**Exception:** In Group R-2 and R-3 individual *dwelling* or *sleeping units* that are not required to be *Accessible units, Type A units* or *Type B units* in accordance with Section 1108, landings are permitted to be 36 inches by 36 inches (914 mm by 914 mm) minimum.

**1012.6.5 Doorways.** Where doorways are located adjacent to a *ramp* landing, maneuvering clearances required by ICC A117.1 are permitted to overlap the required landing area.

**1012.7 Ramp construction.** *Ramps* shall be built of materials consistent with the types permitted for the type of construction of the building, except that wood *handrails* shall be permitted for all types of construction.

**1012.7.1 Ramp surface.** The surface of *ramps* shall be of slip-resistant materials that are securely attached.

**1012.7.2 Outdoor conditions.** Outdoor *ramps* and outdoor approaches to *ramps* shall be designed so that water will not accumulate on walking surfaces.

**1012.8 Handrails.** *Ramps* with a rise greater than 6 inches (152 mm) shall have *handrails* on both sides. *Handrails* shall comply with Section 1014.

**1012.9 Guards.** *Guards* shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015.



**1012.10 Edge protection.** Edge protection complying with Section 1012.10.1 or 1012.10.2 shall be provided on each side of *ramp* runs and at each side of *ramp* landings.

**Exceptions:**

1. Edge protection is not required on *ramps* that are not required to have *handrails*, provided they have flared sides that comply with the *ICC A117.1* curb *ramp* provisions.
2. Edge protection is not required on the sides of *ramp* landings serving an adjoining *ramp* run or *stairway*.
3. Edge protection is not required on the sides of *ramp* landings having a vertical dropoff of not more than  $\frac{1}{2}$  inch (12.7 mm) within 10 inches (254 mm) horizontally of the required landing area.

**1012.10.1 Curb, rail, wall or barrier.** A curb, rail, wall or barrier shall be provided to serve as edge protection. A curb shall be not less than 4 inches (102 mm) in height. Barriers shall be constructed so that the barrier prevents the passage of a 4-inch-diameter (102 mm) sphere, where any portion of the sphere is within 4 inches (102 mm) of the floor or ground surface.

**1012.10.2 Extended floor or ground surface.** The floor or ground surface of the *ramp* run or landing shall extend 12 inches (305 mm) minimum beyond the inside face of a *handrail* complying with Section 1014.

## SECTION 1013 EXIT SIGNS

**1013.1 Where required.** Exits and *exit access* doors shall be marked by an *approved* exit sign readily visible from any direction of egress travel. The path of egress travel to *exits* and within *exits* shall be marked by readily visible exit signs to clearly indicate the direction of egress travel in cases where the exit or the path of egress travel is not immediately visible to the occupants. Intervening means of egress doors within *exits* shall be marked by exit signs. Exit sign placement shall be such that any point in an *exit access corridor* or *exit passageway* is within 100 feet (30 480 mm) or the *listed* viewing distance of the sign, whichever is less, from the nearest visible *exit* sign.

**Exceptions:**

1. Exit signs are not required in rooms or areas that require only one exit or *exit access*.
2. Main exterior exit doors or gates that are obviously and clearly identifiable as *exits* need not have exit signs where *approved* by the building official.
3. Exit signs are not required in occupancies in Group U and individual *sleeping units* or *dwelling units* in Group R-1, R-2 or R-3.
4. Exit signs are not required in dayrooms, sleeping rooms or *dormitories* in occupancies in Group I-3.

5. In occupancies in Groups A-4 and A-5, exit signs are not required on the seating side of vomitories or openings into seating areas where exit signs are provided in the concourse that are readily apparent from the vomitories. Egress lighting is provided to identify each vomitory or opening within the seating area in an emergency.

**1013.2 Low-level exit signs in Group R-1.** Where exit signs are required in Group R-1 occupancies by Section 1013.1, additional low-level exit signs shall be provided in all areas serving guest rooms in Group R-1 occupancies and shall comply with Section 1013.5.

The bottom of the sign shall be not less than 10 inches (254 mm) nor more than 18 inches (455 mm) above the floor level. The sign shall be flush mounted to the door or wall. Where mounted on the wall, the edge of the sign shall be within 4 inches (102 mm) of the door frame on the latch side.

**1013.3 Illumination.** Exit signs shall be internally or externally illuminated.

**Exception:** Tactile signs required by Section 1013.4 need not be provided with illumination.

**1013.4 Raised character and braille exit signs.** Where exit signs are provided at an *area of refuge* with *direct access* to a *stairway*, an exterior area for assisted rescue, an *exit stairway* or *ramp*, an *exit passageway*, a *horizontal exit* and the *exit discharge*, a sign stating "EXIT" in visual characters, raised characters and braille and complying with ICC A117.1 shall be provided.

**1013.5 Internally illuminated exit signs.** Electrically powered, *self-luminous* and *photoluminescent* exit signs shall be *listed* and labeled in accordance with UL 924 and shall be installed in accordance with the manufacturer's instructions and Chapter 27. Exit signs shall be illuminated at all times.

**1013.6 Externally illuminated exit signs.** Externally illuminated exit signs shall comply with Sections 1013.6.1 through 1013.6.3.

**1013.6.1 Graphics.** Every exit sign and directional exit sign shall have plainly legible letters not less than 6 inches (152 mm) high with the principal strokes of the letters not less than  $\frac{3}{4}$  inch (19.1 mm) wide. The word "EXIT" shall have letters having a width not less than 2 inches (51 mm) wide, except the letter "I," and the minimum spacing between letters shall be not less than  $\frac{3}{8}$  inch (9.5 mm). Signs larger than the minimum established in this section shall have letter widths, strokes and spacing in proportion to their height.

The word "EXIT" shall be in high contrast with the background and shall be clearly discernible when the means of exit sign illumination is or is not energized. If a chevron directional indicator is provided as part of the exit sign, the construction shall be such that the direction of the chevron directional indicator cannot be readily changed.

## MEANS OF EGRESS

**1013.6.2 Exit sign illumination.** The face of an exit sign illuminated from an external source shall have an intensity of not less than 5 footcandles (54 lux).

**1013.6.3 Power source.** Exit signs shall be illuminated at all times. To ensure continued illumination for a duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Chapter 27. Group I-2, Condition 2 exit sign illumination shall not be provided by unit equipment batteries only.

**Exception:** *Approved* exit sign illumination types that provide continuous illumination independent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.

### SECTION 1014 HANDRAILS

**1014.1 Where required.** *Handrails* serving *flights of stairways*, *ramps*, stepped *aisles* and ramped *aisles* shall be adequate in strength and attachment in accordance with Section 1607.9. *Handrails* required for flights of *stairways* by Section 1011.11 shall comply with Sections 1014.2 through 1014.9. *Handrails* required for *ramps* by Section 1012.8 shall comply with Sections 1014.2 through 1014.8. *Handrails* for stepped *aisles* and ramped *aisles* required by Section 1030.16 shall comply with Sections 1014.2 through 1014.8.

**1014.2 Height.** *Handrail* height, measured above *stair tread nosings*, or finish surface of *ramp slope*, shall be uniform, not less than 34 inches (864 mm) and not more than 38 inches (965 mm). *Handrail* height of *alternating tread devices* and ships ladders, measured above tread *nosings*, shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

#### Exceptions:

1. Where *handrail* fittings or bendings are used to provide continuous transition between flights, the fittings or bendings shall be permitted to exceed the maximum height.
2. In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are associated with a Group R-3 occupancy or associated with individual *dwelling units* in Group R-2 occupancies; where *handrail* fittings or bendings are used to provide continuous transition between flights, transition at *winder* treads, transition from *handrail* to guard, or where used at the start of a *flight*, the *handrail* height at the fittings or bendings shall be permitted to exceed the maximum height.
3. *Handrails* on top of a *guard* where permitted along stepped *aisles* and ramped *aisles* in accordance with Section 1030.16.

**1014.3 Handrail graspability.** Required *handrails* shall comply with Section 1014.3.1 or shall provide equivalent graspability.

**Exception:** In Group R-3 occupancies; within *dwelling units* in Group R-2 occupancies; and in Group U occupancies that are accessory to a Group R-3 occupancy or accessory to individual *dwelling units* in Group R-2 occupancies; *handrails* shall be Type I in accordance with Section 1014.3.1, Type II in accordance with Section 1014.3.2 or shall provide equivalent graspability.

**1014.3.1 Type I.** *Handrails* with a circular cross section shall have an outside diameter of not less than  $1\frac{1}{4}$  inches (32 mm) and not greater than 2 inches (51 mm). Where the *handrail* is not circular, it shall have a perimeter dimension of not less than 4 inches (102 mm) and not greater than  $6\frac{1}{4}$  inches (160 mm) with a maximum cross-sectional dimension of  $2\frac{1}{4}$  inches (57 mm) and minimum cross-sectional dimension of 1 inch (25 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

**1014.3.2 Type II.** *Handrails* with a perimeter greater than  $6\frac{1}{4}$  inches (160 mm) shall provide a graspable finger recess area on both sides of the profile. The finger recess shall begin within a distance of  $\frac{3}{4}$  inch (19 mm) measured vertically from the tallest portion of the profile and achieve a depth of not less than  $\frac{5}{16}$  inch (8 mm) within  $\frac{7}{8}$  inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than  $\frac{3}{8}$  inch (10 mm) to a level that is not less than  $1\frac{3}{4}$  inches (45 mm) below the tallest portion of the profile. The width of the *handrail* above the recess shall be not less than  $1\frac{1}{4}$  inches (32 mm) to not greater than  $2\frac{3}{4}$  inches (70 mm). Edges shall have a minimum radius of 0.01 inch (0.25 mm).

**1014.4 Continuity.** *Handrail* gripping surfaces shall be continuous, without interruption by newel posts or other obstructions.

#### Exceptions:

1. *Handrails* within *dwelling units* are permitted to be interrupted by a newel post at a turn or landing.
2. Within a *dwelling unit*, the use of a volute, turn-out, starting easing or starting newel is allowed over the lowest tread.
3. Handrail brackets or balusters attached to the bottom surface of the *handrail* that do not project horizontally beyond the sides of the *handrail* within  $1\frac{1}{2}$  inches (38 mm) of the bottom of the *handrail* shall not be considered obstructions. For each  $\frac{1}{2}$  inch (12.7 mm) of additional *handrail* perimeter dimension above 4 inches (102 mm), the vertical clearance dimension of  $1\frac{1}{2}$  inches (38 mm) shall be permitted to be reduced by  $\frac{1}{8}$  inch (3.2 mm).
4. Where *handrails* are provided along walking surfaces with slopes not steeper than 1:20, the bottoms of the *handrail* gripping surfaces shall be permitted to be obstructed along their entire length

where they are integral to crash rails or bumper guards.

5. *Handrails* serving stepped *aisles* or ramped *aisles* are permitted to be discontinuous in accordance with Section 1030.16.1.

**1014.5 Fittings.** *Handrails* shall not rotate within their fittings.

**1014.6 Handrail extensions.** *Handrails* shall return to a wall, *guard* or the walking surface or shall be continuous to the *handrail* of an adjacent *flight of stairs* or *ramp* run. Where *handrails* are not continuous between flights, the *handrails* shall extend horizontally not less than 12 inches (305 mm) beyond the top riser and continue to slope for the depth of one tread beyond the bottom riser. At *ramps* where *handrails* are not continuous between runs, the *handrails* shall extend horizontally above the landing 12 inches (305 mm) minimum beyond the top and bottom of *ramp* runs. The extensions of *handrails* shall be in the same direction of the flights of *stairs* at *stairways* and the *ramp* runs at *ramps*.

**Exceptions:**

1. *Handrails* within a *dwelling unit* that is not required to be *accessible* need extend only from the top riser to the bottom riser.
2. *Handrails* serving *aisles* in rooms or spaces used for assembly purposes are permitted to comply with the *handrail* extensions in accordance with Section 1030.16.
3. *Handrails* for *alternating tread devices* and ships ladders are permitted to terminate at a location vertically above the top and bottom risers. *Handrails* for *alternating tread devices* are not required to be continuous between flights or to extend beyond the top or bottom risers.

**1014.7 Clearance.** Clear space between a *handrail* and a wall or other surface shall be not less than 1½ inches (38 mm). A *handrail* and a wall or other surface adjacent to the *handrail* shall be free of any sharp or abrasive elements.

**1014.8 Projections.** On *ramps* and on ramped *aisles* that are part of an *accessible* route, the clear width between *handrails* shall be 36 inches (914 mm) minimum. Projections into the required width of *aisles*, *stairways* and *ramps* at each side shall not exceed 4½ inches (114 mm) at or below the *handrail* height. Projections into the required width shall not be limited above the minimum headroom height required in Section 1011.3. Projections due to intermediate *handrails* shall not constitute a reduction in the egress width. Where a pair of intermediate *handrails* are provided within the *stairway* width without a walking surface between the pair of intermediate *handrails* and the distance between the pair of intermediate *handrails* is greater than 6 inches (152 mm), the available egress width shall be reduced by the distance between the closest edges of each such intermediate pair of *handrails* that is greater than 6 inches (152 mm).

**1014.9 Intermediate handrails.** *Stairways* shall have intermediate *handrails* located in such a manner that all portions of the *stairway* minimum width or required capacity are within 30 inches (762 mm) of a *handrail*. On monumental

*stairs*, *handrails* shall be located along the most direct path of egress travel.

## SECTION 1015 GUARDS

**1015.1 General.** *Guards* shall comply with the provisions of Sections 1015.2 through 1015.7. Operable windows with sills located more than 72 inches (1829 mm) above finished grade or other surface below shall comply with Section 1015.8.

**1015.2 Where required.** *Guards* shall be located along open-sided walking surfaces, including *mezzanines*, equipment platforms, *aisles*, *stairs*, *ramps* and landings that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) horizontally to the edge of the open side. *Guards* shall be adequate in strength and attachment in accordance with Section 1607.9.

**Exceptions:** *Guards* are not required for the following locations:

1. On the loading side of loading docks or piers.
2. On the audience side of *stages* and raised *platforms*, including *stairs* leading up to the *stage* and raised *platforms*.
3. On raised *stage* and *platform* floor areas, such as runways, *ramps* and side *stages* used for entertainment or presentations.
4. At vertical openings in the performance area of *stages* and *platforms*.
5. At elevated walking surfaces appurtenant to *stages* and *platforms* for access to and utilization of special lighting or equipment.
6. Along vehicle service pits not accessible to the public.
7. In assembly seating areas at cross *aisles* in accordance with Section 1030.17.2.
8. On the loading side of station platforms on fixed guideway transit or passenger rail systems.

**1015.2.1 Glazing.** Where glass is used to provide a *guard* or as a portion of the *guard* system, the *guard* shall comply with Section 2407. Where the glazing provided does not meet the strength and attachment requirements of Section 1607.9, complying *guards* shall be located along glazed sides of open-sided walking surfaces.

**1015.3 Height.** Required *guards* shall be not less than 42 inches (1067 mm) high, measured vertically as follows:

1. From the adjacent walking surfaces.
2. On *stairways* and stepped *aisles*, from the line connecting the leading edges of the tread *nosings*.
3. On *ramps* and ramped *aisles*, from the *ramp* surface at the *guard*.

**Exceptions:**

1. For occupancies in Group R-3 not more than three stories above grade in height and within individual



## MEANS OF EGRESS

*dwelling units* in occupancies in Group R-2 not more than three stories above grade in height with separate *means of egress*, required *guards* shall be not less than 36 inches (914 mm) in height measured vertically above the adjacent walking surfaces.

2. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, *guards* on the open sides of *stairs* shall have a height not less than 34 inches (864 mm) measured vertically from a line connecting the leading edges of the treads.
3. For occupancies in Group R-3, and within individual *dwelling units* in occupancies in Group R-2, where the top of the *guard* serves as a *handrail* on the open sides of *stairs*, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) measured vertically from a line connecting the leading edges of the treads.
4. The *guard* height in assembly seating areas shall comply with Section 1030.17 as applicable.
5. Along *alternating tread devices* and ships ladders, *guards* where the top rail serves as a *handrail* shall have height not less than 30 inches (762 mm) and not more than 34 inches (864 mm), measured vertically from the leading edge of the device tread *nosing*.
6. In Group F occupancies where *exit access stairways* serve fewer than three stories and such *stairways* are not open to the public, and where the top of the *guard* also serves as a *handrail*, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) measured vertically from a line connecting the leading edges of the treads.

**1015.4 Opening limitations.** Required *guards* shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter from the walking surface to the required *guard* height.

### Exceptions:

1. From a height of 36 inches (914 mm) to 42 inches (1067 mm), *guards* shall not have openings that allow passage of a sphere  $4\frac{3}{8}$  inches (111 mm) in diameter.
2. The triangular openings at the open sides of a *stair*, formed by the riser, tread and bottom rail shall not allow passage of a sphere 6 inches (152 mm) in diameter.
3. At elevated walking surfaces for access to and use of electrical, mechanical or plumbing systems or equipment, *guards* shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.
4. In areas that are not open to the public within occupancies in Group I-3, F, H or S, and for *alternating tread devices* and ships ladders, *guards*

shall not have openings that allow passage of a sphere 21 inches (533 mm) in diameter.

5. In assembly seating areas, *guards* required at the end of *aisles* in accordance with Section 1030.17.4 shall not have openings that allow passage of a sphere 4 inches (102 mm) in diameter up to a height of 26 inches (660 mm). From a height of 26 inches (660 mm) to 42 inches (1067 mm) above the adjacent walking surfaces, *guards* shall not have openings that allow passage of a sphere 8 inches (203 mm) in diameter.
6. Within individual *dwelling units* and *sleeping units* in Group R-2 and R-3 occupancies, *guards* on the open sides of *stairs* shall not have openings that allow passage of a sphere  $4\frac{3}{8}$  (111 mm) inches in diameter.

**1015.5 Screen porches.** Porches and decks that are enclosed with insect screening shall be provided with *guards* where the walking surface is located more than 30 inches (762 mm) above the floor or grade below.

**1015.6 Mechanical equipment, systems and devices.** *Guards* shall be provided where various components that require service are located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall extend not less than 30 inches (762 mm) beyond each end of such components. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where personal fall arrest anchorage connector devices that comply with ANSI/ASSE Z 359.1 are installed.

**1015.7 Roof access.** *Guards* shall be provided where the roof hatch opening is located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The *guard* shall extend not less than 30 inches (762 mm) beyond each end of the hatch parallel to the roof edge. The *guard* shall be constructed so as to prevent the passage of a sphere 21 inches (533 mm) in diameter.

**Exception:** *Guards* are not required where personal fall arrest anchorage connector devices that comply with ANSI/ASSE Z 359.1 are installed.

**1015.8 Window openings.** Windows in Group R-2 and R-3 buildings including *dwelling units*, where the bottom of the clear opening of an operable window is located less than 36 inches (914 mm) above the finished floor and more than 72 inches (1829 mm) above the finished grade or other surface below on the exterior of the building, shall comply with one of the following:

1. Operable windows where the top of the sill of the opening is located more than 75 feet (22 860 mm) above the finished grade or other surface below and that are provided with window fall prevention devices that comply with ASTM F2006.



## MEANS OF EGRESS

2. Operable windows where the openings will not allow a 4-inch-diameter (102 mm) sphere to pass through the opening when the window is in its largest opened position.
3. Operable windows where the openings are provided with window fall prevention devices that comply with ASTM F2090.
4. Operable windows that are provided with window opening control devices that comply with Section 1015.8.1.

**1015.8.1 Window opening control devices.** Window opening control devices shall comply with ASTM F2090. The window opening control device, after operation to release the control device allowing the window to fully open, shall not reduce the minimum net clear opening area of the window unit to less than the area required by Section 1031.3.1.

## SECTION 1016 EXIT ACCESS

**1016.1 General.** The *exit access* shall comply with the applicable provisions of Sections 1003 through 1015. *Exit access* arrangement shall comply with Sections 1016 through 1021.

**1016.2 Egress through intervening spaces.** Egress through intervening spaces shall comply with this section.

1. *Exit access* through an enclosed elevator lobby is permitted. Where access to two or more exits or exit access doorways is required in Section 1006.2.1, access to not less than one of the required *exits* shall be provided without travel through the enclosed elevator lobbies required by Section 3006. Where the path of *exit access* travel passes through an enclosed elevator lobby, the level of protection required for the enclosed elevator lobby is not required to be extended to the *exit* unless direct access to an *exit* is required by other sections of this code.
2. Egress from a room or space shall not pass through adjoining or intervening rooms or areas, except where such adjoining rooms or areas and the area served are accessory to one or the other, are not a Group H occupancy and provide a discernible path of egress travel to an exit.

**Exception:** *Means of egress* are not prohibited through adjoining or intervening rooms or spaces in a Group H, S or F occupancy where the adjoining or intervening rooms or spaces are the same or a lesser hazard occupancy group.

3. An *exit access* shall not pass through a room that can be locked to prevent egress.
4. *Means of egress* from *dwelling units* or sleeping areas shall not lead through other sleeping areas, toilet rooms or bathrooms.

5. Egress shall not pass through kitchens, storage rooms, closets or spaces used for similar purposes.

### Exceptions:

1. *Means of egress* are not prohibited through a kitchen area serving adjoining rooms constituting part of the same *dwelling unit* or *sleeping unit*.
2. *Means of egress* are not prohibited through stockrooms in Group M occupancies where all of the following are met:
  - 2.1. The stock is of the same hazard classification as that found in the main retail area.
  - 2.2. Not more than 50 percent of the *exit access* is through the stockroom.
  - 2.3. The stockroom is not subject to locking from the egress side.
  - 2.4. There is a demarcated, minimum 44-inch-wide (1118 mm) *aisle* defined by full- or partial-height fixed walls or similar construction that will maintain the required width and lead directly from the retail area to the exit without obstructions.

**1016.2.1 Multiple tenants.** Where more than one tenant occupies any one floor of a building or structure, each tenant space, *dwelling unit* and *sleeping unit* shall be provided with access to the required *exits* without passing through adjacent tenant spaces, *dwelling units* and *sleeping units*.

**Exception:** The *means of egress* from a smaller tenant space shall not be prohibited from passing through a larger adjoining tenant space where such rooms or spaces of the smaller tenant occupy less than 10 percent of the area of the larger tenant space through which they pass; are the same or similar occupancy group; a discernible path of egress travel to an *exit* is provided; and the *means of egress* into the adjoining space is not subject to locking from the egress side. A required *means of egress* serving the larger tenant space shall not pass through the smaller tenant space or spaces.

## SECTION 1017 EXIT ACCESS TRAVEL DISTANCE

**1017.1 General.** Travel distance within the *exit access* portion of the *means of egress* system shall be in accordance with this section.

## MEANS OF EGRESS

**1017.2 Limitations.** *Exit access* travel distance shall not exceed the values given in Table 1017.2.

**TABLE 1017.2**  
**EXIT ACCESS TRAVEL DISTANCE<sup>a</sup>**

OCCUPANCY	WITHOUT SPRINKLER SYSTEM (feet)	WITH SPRINKLER SYSTEM (feet)
A, E, F-1, M, R, S-1	200 <sup>c</sup>	250 <sup>b</sup>
I-1	Not Permitted	250 <sup>b</sup>
B	200	300 <sup>c</sup>
F-2, S-2, U	300	400 <sup>c</sup>
H-1	Not Permitted	75 <sup>d</sup>
H-2	Not Permitted	100 <sup>d</sup>
H-3	Not Permitted	150 <sup>d</sup>
H-4	Not Permitted	175 <sup>d</sup>
H-5	Not Permitted	200 <sup>c</sup>
I-2, I-3	Not Permitted	200 <sup>c</sup>
I-4	150	200 <sup>c</sup>

For SI: 1 foot = 304.8 mm.

a. See the following sections for modifications to *exit access* travel distance requirements:

Section 402.8: For the distance limitation in malls.

Section 407.4: For the distance limitation in Group I-2.

Sections 408.6.1 and 408.8.1: For the distance limitations in Group I-3.

Section 411.2: For the distance limitation in special amusement areas.

Section 412.6: For the distance limitations in aircraft manufacturing facilities.

Section 1006.2.2.2: For the distance limitation in refrigeration machinery rooms.

Section 1006.2.2.3: For the distance limitation in refrigerated rooms and spaces.

Section 1006.3.4: For buildings with one exit.

Section 1017.2.2: For increased distance limitation in Groups F-1 and S-1.

Section 1030.7: For increased limitation in assembly seating.

Section 3103.4: For temporary structures.

Section 3104.9: For pedestrian walkways.

b. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2. See Section 903 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.2.

c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.

d. Group H occupancies equipped throughout with an automatic sprinkler system in accordance with Section 903.2.5.1.

e. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

**1017.2.1 Exterior egress balcony increase.** *Exit access* travel distances specified in Table 1017.2 shall be increased up to an additional 100 feet (30 480 mm) provided that the last portion of the *exit access* leading to the exit occurs on an exterior egress balcony constructed in accordance with Section 1021. The length of such balcony shall be not less than the amount of the increase taken.

**1017.2.2 Groups F-1 and S-1 increase.** The maximum *exit access* travel distance shall be 400 feet (122 m) in Group F-1 or S-1 occupancies where all of the following conditions are met:

1. The portion of the building classified as Group F-1 or S-1 is limited to one *story* in height.
2. The minimum height from the finished floor to the bottom of the ceiling or roof slab or deck is 24 feet (7315 mm).
3. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**1017.3 Measurement.** *Exit access* travel distance shall be measured from the most remote point of each room, area or space along the natural and unobstructed path of horizontal and vertical egress travel to the entrance to an *exit*. Where more than one exit is required, *exit access* travel distance shall be measured to the nearest exit.

### Exceptions:

1. In *open parking garages*, *exit access* travel distance is permitted to be measured to the closest riser of an *exit access stairway* or the closest slope of an *exit access ramp*.
2. In smoke protected seating and open air assembly seating, *exit access* travel distance shall be measured in accordance with Section 1030.7.

**1017.3.1 Exit access stairways and ramps.** Travel distance on *exit access stairways* or *ramps* shall be included in the *exit access* travel distance measurement. The measurement along *stairways* shall be made on a plane parallel and tangent to the *stair tread nosings* in the center of the *stair* and landings. The measurement along *ramps* shall be made on the walking surface in the center of the *ramp* and landings.

**1017.3.2 Atriums.** Exit access travel distance for areas open to an *atrium* shall comply with the requirements of Sections 1017.3.2.1 through 1017.3.2.3.

**1017.3.2.1 Egress not through the atrium.** Where required access to the exits is not through the *atrium*, *exit access* travel distance shall comply with Section 1017.2.

**1017.3.2.2 Exit access travel distance at the level of exit discharge.** Where the path of egress travel is through an *atrium* space, *exit access* travel distance at the *level of exit discharge* shall be determined in accordance with Section 1017.2.

**1017.3.2.3 Exit access travel distance at other than the level of exit discharge.** Where the path of egress travel is not at the *level of exit discharge* from the *atrium*, that portion of the total permitted *exit access* travel distance that occurs within the *atrium* shall be not greater than 200 feet (60 960 mm).

## SECTION 1018 AISLES

**1018.1 General.** *Aisles* and *aisle accessways* serving as a portion of the *exit access* in the *means of egress* system shall comply with the requirements of this section. *Aisles* or *aisle accessways* shall be provided from all occupied portions of the *exit access* that contain seats, tables, furnishings, displays and similar fixtures or equipment. The minimum width or required capacity of *aisles* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**1018.2 Aisles in assembly spaces.** *Aisles* and *aisle accessways* serving a room or space used for assembly purposes shall comply with Section 1030.

**1018.3 Aisles in Groups B and M.** In Group B and M occupancies, the minimum clear aisle width shall be determined by Section 1005.1 for the *occupant load* served, but shall be not less than that required for *corridors* by Section 1020.3.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be *accessible* by Chapter 11 need not exceed 28 inches (711 mm) in width.

**1018.4 Aisle accessways in Group M.** An *aisle accessway* shall be provided on not less than one side of each element within the *merchandise pad*. The minimum clear width for an *aisle accessway* not required to be *accessible* shall be 30 inches (762 mm). The required clear width of the *aisle accessway* shall be measured perpendicular to the elements and merchandise within the *merchandise pad*. The 30-inch (762 mm) minimum clear width shall be maintained to provide a path to an adjacent *aisle* or *aisle accessway*. The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any point in the *merchandise pad*.

**Exception:** For areas serving not more than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).

**1018.5 Aisles in other than assembly spaces and Groups B and M.** In other than rooms or spaces used for assembly purposes and Group B and M occupancies, the minimum clear aisle capacity shall be determined by Section 1005.1 for the *occupant load* served, but the width shall be not less than that required for *corridors* by Section 1020.3.

**Exception:** Nonpublic *aisles* serving less than 50 people and not required to be *accessible* by Chapter 11 need not exceed 28 inches (711 mm) in width.

## SECTION 1019 EXIT ACCESS STAIRWAYS AND RAMPS

**1019.1 General.** *Exit access stairways* and *ramps* serving as an *exit access* component in a *means of egress* system shall comply with the requirements of this section. The number of stories connected by *exit access stairways* and *ramps* shall include *basements*, but not *mezzanines*.

**1019.2 All occupancies.** *Exit access stairways* and *ramps* that serve floor levels within a single *story* are not required to be enclosed.

**1019.3 Occupancies other than Groups I-2 and I-3.** In other than Group I-2 and I-3 occupancies, floor openings containing *exit access stairways* or *ramps* shall be enclosed with a shaft enclosure constructed in accordance with Section 713.

### Exceptions:

1. *Exit access stairways* and *ramps* that serve or atmospherically communicate between only two adjacent stories. Such interconnected stories shall not be open to other stories.
2. In Group R-1, R-2 or R-3 occupancies, *exit access stairways* and *ramps* connecting four stories or less serving and contained within an individual dwelling unit or sleeping unit or live/work unit.
3. *Exit access stairways* serving and contained within a Group R-3 congregate residence or a Group R-4 facility are not required to be enclosed.
4. *Exit access stairways* and *ramps* in buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, where the area of the vertical opening between stories does not exceed twice the horizontal projected area of the stairway or *ramp* and the opening is protected by a draft curtain and closely spaced sprinklers in accordance with NFPA 13. In other than Group B and M occupancies, this provision is limited to openings that do not connect more than four stories.
5. *Exit access stairways* and *ramps* within an *atrium* complying with the provisions of Section 404.
6. *Exit access stairways* and *ramps* in *open parking garages* that serve only the parking garage.
7. *Exit access stairways* and *ramps* serving smoke-protected or *open-air assembly seating* complying with the *exit access travel distance* requirements of Section 1030.7.
8. *Exit access stairways* and *ramps* between the balcony, gallery or press box and the main assembly floor in occupancies such as theaters, *places of religious worship*, auditoriums and sports facilities.
9. Exterior *exit access stairways* or *ramps* between occupied roofs.

**1019.4 Group I-2 and I-3 occupancies.** In Group I-2 and I-3 occupancies, floor openings between stories containing *exit access stairways* or *ramps* are required to be enclosed with a shaft enclosure constructed in accordance with Section 713.

**Exception:** In Group I-3 occupancies, *exit access stairways* or *ramps* constructed in accordance with Section 408 are not required to be enclosed.

## MEANS OF EGRESS

SECTION 1020  
CORRIDORS

**1020.1 General.** Corridors serving as an exit access component in a *means of egress* system shall comply with the requirements of Sections 1020.2 through 1020.7.

**1020.2 Construction.** Corridors shall be fire-resistance rated in accordance with Table 1020.2. The *corridor* walls required to be fire-resistance rated shall comply with Section 708 for *fire partitions*.

**Exceptions:**

1. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group E where each room that is used for instruction has not less than one door opening directly to the exterior and rooms for assembly purposes have not less than one-half of the required means of egress doors opening directly to the exterior. Exterior doors specified in this exception are required to be at ground level.
2. A *fire-resistance rating* is not required for *corridors* contained within a *dwelling unit* or *sleeping unit* in an occupancy in Groups I-1 and R.
3. A *fire-resistance rating* is not required for *corridors* in *open parking garages*.
4. A *fire-resistance rating* is not required for *corridors* in an occupancy in Group B that is a space requiring only a single *means of egress* complying with Section 1006.2.
5. *Corridors* adjacent to the *exterior walls* of buildings shall be permitted to have unprotected openings on unrated *exterior walls* where unrated walls are permitted by Table 705.5 and unprotected openings are permitted by Table 705.8.

**TABLE 1020.2**  
**CORRIDOR FIRE-RESISTANCE RATING**

OCCUPANCY	OCCUPANT LOAD SERVED BY CORRIDOR	REQUIRED FIRE-RESISTANCE RATING (hours)	
		Without sprinkler system	With sprinkler system
H-1, H-2, H-3	All	Not Permitted	1 <sup>c</sup>
H-4, H-5	Greater than 30	Not Permitted	1 <sup>c</sup>
A, B, E, F, M, S, U	Greater than 30	1	0
R	Greater than 10	Not Permitted	0.5 <sup>c</sup> /1 <sup>d</sup>
I-2 <sup>a</sup>	All	Not Permitted	0
I-1, I-3	All	Not Permitted	1 <sup>b, c</sup>
I-4	All	1	0

a. For requirements for occupancies in Group I-2, see Sections 407.2 and 407.3.

b. For a reduction in the fire-resistance rating for occupancies in Group I-3, see Section 408.8.

c. Buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1 or 903.3.1.2 where allowed.

d. Group R-3 and R-4 buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.3. See Section 903.2.8 for occupancies where automatic sprinkler systems are permitted in accordance with Section 903.3.1.3.

**1020.2.1 Hoistway opening protection.** Elevator hoistway openings shall be protected in accordance with Section 3006.2.1.

**1020.3 Width and capacity.** The required capacity of *corridors* shall be determined as specified in Section 1005.1, but the minimum width shall be not less than that specified in Table 1020.3.

**Exception:** In Group I-2 occupancies, *corridors* are not required to have a clear width of 96 inches (2438 mm) in areas where there will not be stretcher or bed movement for access to care or as part of the *defend-in-place* strategy.

**TABLE 1020.3**  
**MINIMUM CORRIDOR WIDTH**

OCCUPANCY	MINIMUM WIDTH (inches)
Any facility not listed in this table	44
Access to and utilization of mechanical, plumbing or electrical systems or equipment	24
With an occupant load of less than 50	36
Within a dwelling unit	36
In Group E with a corridor having an occupant load of 100 or more	72
In corridors and areas serving stretcher traffic in ambulatory care facilities	72
Group I-2 in areas where required for bed movement	96

For SI: 1 inch = 25.4 mm.

**1020.4 Obstruction.** The minimum width or required capacity of *corridors* shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**1020.5 Dead ends.** Where more than one *exit* or *exit access doorway* is required, the *exit access* shall be arranged such that dead-end *corridors* do not exceed 20 feet (6096 mm) in length.

**Exceptions:**

1. In Group I-3, Condition 2, 3 or 4, occupancies, the dead end in a *corridor* shall not exceed 50 feet (15 240 mm).
2. In occupancies in Groups B, E, F, I-1, M, R-1, R-2, S and U, where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the length of the dead-end *corridors* shall not exceed 50 feet (15 240 mm).
3. A dead-end *corridor* shall not be limited in length where the length of the dead-end *corridor* is less than 2.5 times the least width of the dead-end *corridor*.
4. In Group I-2, Condition 2 occupancies, the length of dead-end *corridors* that do not serve patient rooms or patient treatment spaces shall not exceed 30 feet (9144 mm).



**1020.6 Air movement in corridors.** *Corridors* shall not serve as supply, return, exhaust, relief or ventilation air ducts.

**Exceptions:**

1. Use of a *corridor* as a source of makeup air for exhaust systems in rooms that open directly onto such corridors, including toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall be permitted, provided that each such *corridor* is directly supplied with outdoor air at a rate greater than the rate of makeup air taken from the corridor.
2. Where located within a *dwelling unit*, the use of *corridors* for conveying return air shall not be prohibited.
3. Where located within tenant spaces of 1,000 square feet (93 m<sup>2</sup>) or less in area, utilization of *corridors* for conveying return air is permitted.
4. Transfer air movement required to maintain the pressurization difference within health care facilities in accordance with ASHRAE 170.

**1020.6.1 Corridor ceiling.** Use of the space between the corridor ceiling and the floor or roof structure above as a return air plenum is permitted for one or more of the following conditions:

1. The *corridor* is not required to be of *fire-resistance-rated* construction.
2. The *corridor* is separated from the plenum by *fire-resistance-rated* construction.
3. The air-handling system serving the *corridor* is shut down upon activation of the air-handling unit smoke detectors required by the *International Mechanical Code*.
4. The air-handling system serving the *corridor* is shut down upon detection of sprinkler water flow where the building is equipped throughout with an automatic sprinkler system.
5. The space between the corridor ceiling and the floor or roof structure above the *corridor* is used as a component of an *approved* engineered smoke control system.

**1020.7 Corridor continuity.** *Fire-resistance-rated corridors* shall be continuous from the point of entry to an *exit*, and shall not be interrupted by intervening rooms. Where the path of egress travel within a *fire-resistance-rated corridor* to the *exit* includes travel along unenclosed *exit access stairways* or *ramps*, the *fire-resistance rating* shall be continuous for the length of the *stairway* or *ramp* and for the length of the connecting *corridor* on the adjacent floor leading to the *exit*.

**Exceptions:**

1. Foyers, lobbies or reception rooms constructed as required for *corridors* shall not be construed as intervening rooms.

2. Enclosed elevator lobbies as permitted by Item 1 of Section 1016.2 shall not be construed as intervening rooms.

## SECTION 1021 EGRESS BALCONIES

**1021.1 General.** Balconies used for egress purposes shall conform to the same requirements as *corridors* for minimum width, required capacity, headroom, dead ends and projections.

**1021.2 Wall separation.** Exterior egress balconies shall be separated from the interior of the building by walls and opening protectives as required for *corridors*.

**Exception:** Separation is not required where the exterior egress balcony is served by not less than two *stairways* and a dead-end travel condition does not require travel past an unprotected opening to reach a *stairway*.

**1021.3 Openness.** The long side of an egress balcony shall be not less than 50 percent open, and the open area above the *guards* shall be so distributed as to minimize the accumulation of smoke or toxic gases.

**1021.4 Location.** Exterior egress balconies shall have a minimum *fire separation distance* of 10 feet (3048 mm) measured at right angles from the exterior edge of the egress balcony to the following:

1. Adjacent *lot lines*.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 based on *fire separation distance*.

For the purposes of this section, other portions of the building shall be treated as separate buildings.

## SECTION 1022 EXITS

**1022.1 General.** *Exits* shall comply with Sections 1022 through 1027 and the applicable requirements of Sections 1003 through 1015. An *exit* shall not be used for any purpose that interferes with its function as a *means of egress*. Once a given level of *exit* protection is achieved, such level of protection shall not be reduced until arrival at the *exit discharge*. Exits shall be continuous from the point of entry into the *exit* to the *exit discharge*.

**1022.2 Exterior exit doors.** Buildings or structures used for human occupancy shall have not less than one exterior door that meets the requirements of Section 1010.1.1.

**1022.2.1 Detailed requirements.** Exterior *exit* doors shall comply with the applicable requirements of Section 1010.1.

**1022.2.2 Arrangement.** Exterior *exit* doors shall lead directly to the *exit discharge* or the *public way*.

## MEANS OF EGRESS

## SECTION 1023

### INTERIOR EXIT STAIRWAYS AND RAMPS

**1023.1 General.** *Interior exit stairways and ramps* serving as an exit component in a *means of egress* system shall comply with the requirements of this section. *Interior exit stairways and ramps* shall be enclosed and lead directly to the exterior of the building or shall be extended to the exterior of the building with an *exit passageway* conforming to the requirements of Section 1024, except as permitted in Section 1028.2. An *interior exit stairway or ramp* shall not be used for any purpose other than as a *means of egress* and a *circulation path*.

**1023.2 Construction.** Enclosures for interior exit stairways and ramps shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both. *Interior exit stairway and ramp* enclosures shall have a *fire-resistance rating* of not less than 2 hours where connecting four stories or more and not less than 1 hour where connecting less than four stories. The number of stories connected by the interior exit stairways or ramps shall include any *basements*, but not any *mezzanines*. Enclosures for interior exit stairways and ramps shall have a *fire-resistance rating* not less than the floor assembly penetrated, but need not exceed 2 hours.

#### Exceptions:

1. *Interior exit stairways and ramps* in Group I-3 occupancies in accordance with the provisions of Section 408.3.8.
2. *Interior exit stairways* within an *atrium* enclosed in accordance with Section 404.6.
3. *Interior exit stairways* in accordance with Section 510.2.

**1023.3 Termination.** *Interior exit stairways and ramps* shall terminate at an *exit discharge* or a *public way*.

**Exception:** A combination of *interior exit stairways, interior exit ramps and exit passageways*, constructed in accordance with Sections 1023.2, 1023.3.1 and 1024, respectively, and forming a continuous protected enclosure, shall be permitted to extend an *interior exit stairway or ramp* to the *exit discharge* or a *public way*.

**1023.3.1 Extension.** Where *interior exit stairways and ramps* are extended to an *exit discharge* or a *public way* by an *exit passageway*, the *interior exit stairway and ramp* shall be separated from the *exit passageway* by a *fire barrier* constructed in accordance with Section 707 or a *horizontal assembly* constructed in accordance with Section 711, or both. The *fire-resistance rating* shall be not less than that required for the *interior exit stairway and ramp*. A *fire door assembly* complying with Section 716 shall be installed in the *fire barrier* to provide a

*means of egress* from the *interior exit stairway and ramp* to the *exit passageway*. Openings in the *fire barrier* other than the *fire door assembly* are prohibited. Penetrations of the *fire barrier* are prohibited.

#### Exceptions:

1. Penetrations of the *fire barrier* in accordance with Section 1023.5 shall be permitted.
2. Separation between an *interior exit stairway or ramp* and the *exit passageway* extension shall not be required where there are no openings into the *exit passageway* extension.
3. Separation between an *interior exit stairway or ramp* and the *exit passageway* extension shall not be required where the *interior exit stairway* and the *exit passageway* extension are pressurized in accordance with Section 909.20.5.

**1023.4 Openings.** *Interior exit stairway and ramp* opening protectives shall be in accordance with the requirements of Section 716.

Openings in *interior exit stairways and ramps* other than unprotected exterior openings shall be limited to those required for *exit access* to the enclosure from normally occupied spaces and for egress from the enclosure.

Elevators shall not open into *interior exit stairways and ramps*.

**1023.5 Penetrations.** Penetrations into or through interior exit stairways and ramps are prohibited except for the following:

1. Equipment and ductwork necessary for independent ventilation or pressurization.
2. *Fire protection systems*.
3. Security systems.
4. Two-way communication systems.
5. Electrical raceway for fire department communication systems.
6. Electrical raceway serving the *interior exit stairway and ramp* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>).
7. Structural elements supporting the *interior exit stairway or ramp* or enclosure, such as beams or joists.

Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communication openings, whether protected or not, between adjacent interior exit stairways and ramps.

**Exception:** *Membrane penetrations* shall be permitted on the outside of the *interior exit stairway and ramp*. Such penetrations shall be protected in accordance with Section 714.4.2.

**1023.6 Ventilation.** Equipment and ductwork for *interior exit stairway* and *ramp* ventilation as permitted by Section 1023.5 shall comply with one of the following items:

1. Such equipment and ductwork shall be located exterior to the building and shall be directly connected to the *interior exit stairway* and *ramp* by ductwork enclosed in construction as required for *shafts*.
2. Where such equipment and ductwork is located within the *interior exit stairway* and *ramp*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or such air shall be conveyed through ducts enclosed in construction as required for *shafts*.
3. Where located within the building, such equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for *shafts*.

In each case, openings into the fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 for shaft enclosures.

The *interior exit stairway* and *ramp* ventilation systems shall be independent of other building ventilation systems.

**1023.7 Interior exit stairway and ramp exterior walls.** *Exterior walls* of the *interior exit stairway* or *ramp* shall comply with the requirements of Section 705 for *exterior walls*. Where nonrated walls or unprotected openings enclose the exterior of the *stairway* or *ramps* and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building *exterior walls* within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the topmost landing of the *stairway* or *ramp*, or to the roof line, whichever is lower.

**1023.8 Barrier at level of exit discharge.** An *interior exit stairway* and *ramp* shall not continue below its *level of exit discharge* unless an *approved* barrier is provided at the *level of exit discharge* to prevent persons from unintentionally continuing into levels below. Directional exit signs shall be provided as specified in Section 1013.

**1023.9 Stairway identification signs.** A sign shall be provided at each floor landing in an *interior exit stairway* and *ramp* connecting more than three stories designating the floor level, the terminus of the top and bottom of the *interior exit stairway* and *ramp* and the identification of the *stairway* or *ramp*. The signage shall state the story of and direction to the *exit discharge*, and the availability of roof access from the *interior exit stairway* and *ramp* for the fire department. The bottom of the sign shall be located not less than 5 feet (1524 mm) above the floor landing in a position that is readily visible when the doors are in the open and closed positions.

**1023.9.1 Signage requirements.** *Stairway* identification signs shall comply with all of the following requirements:

1. The signs shall be a minimum size of 18 inches (457 mm) by 12 inches (305 mm).
2. The letters designating the identification of the *interior exit stairway* and *ramp* shall be not less than  $1\frac{1}{2}$  inches (38 mm) in height.
3. The number designating the floor level shall be not less than 5 inches (127 mm) in height and located in the center of the sign.
4. Other lettering and numbers shall be not less than 1 inch (25 mm) in height.
5. Characters and their background shall have a nonglare finish. Characters shall contrast with their background, with either light characters on a dark background or dark characters on a light background.
6. Where signs required by Section 1023.9 are installed in the *interior exit stairways* and *ramps* of buildings subject to Section 1025, the signs shall be made of the same materials as required by Section 1025.4.

**1023.10 Elevator lobby identification signs.** At landings in *interior exit stairways* where two or more doors lead to the floor level, any door with direct access to an enclosed elevator lobby shall be identified by signage located on the door or directly adjacent to the door stating "Elevator Lobby." Signage shall be in accordance with Section 1023.9.1, Items 4, 5 and 6.

**1023.11 Tactile floor-level signs.** Where floor level signs are provided in *interior exit stairways* and *ramps*, a floor-level sign identifying the floor level in visual characters, raised characters and braille complying with ICC A117.1 shall be located at each floor-level landing adjacent to the door leading from the *interior exit stairway* and *ramp* into the corridor.

**1023.12 Smokeproof enclosures.** Where required by Section 403.5.4, 405.7.2 or 412.2.2.1, *interior exit stairways* and *ramps* shall be *smokeproof enclosures* in accordance with Section 909.20.

**1023.12.1 Termination and extension.** A *smokeproof enclosure* shall terminate at an *exit discharge* or a *public way*. The *smokeproof enclosure* shall be permitted to be extended by an *exit passageway* in accordance with Section 1023.3. The *exit passageway* shall be without openings other than the *fire door assembly* required by Section 1023.3.1 and those necessary for egress from the *exit passageway*. The *exit passageway* shall be separated from the remainder of the building by 2-hour *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

#### Exceptions:

1. Openings in the *exit passageway* serving a *smokeproof enclosure* are permitted where the *exit passageway* is protected and pressurized in



## MEANS OF EGRESS

the same manner as the *smokeproof enclosure*, and openings are protected as required for access from other floors.

2. The *fire barrier* separating the *smokeproof enclosure* from the *exit passageway* is not required, provided that the *exit passageway* is protected and pressurized in the same manner as the *smokeproof enclosure*.
3. A *smokeproof enclosure* shall be permitted to egress through areas on the *level of exit discharge* or vestibules as permitted by Section 1028.

**1023.12.2 Enclosure access.** Access to the *stairway* or *ramp* within a *smokeproof enclosure* shall be by way of a vestibule or an open exterior balcony.

**Exception:** Access is not required by way of a vestibule or exterior balcony for *stairways* and *ramps* using the pressurization alternative complying with Section 909.20.5.

**1023.13 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1024 EXIT PASSAGEWAYS

**1024.1 General.** Exit passageways serving as an exit component in a *means of egress* system shall comply with the requirements of this section. An *exit passageway* shall not be used for any purpose other than as a *means of egress* and a *circulation path*.

**1024.2 Width and capacity.** The required capacity of exit passageways shall be determined as specified in Section 1005.1 but the minimum width shall be not less than 44 inches (1118 mm), except that exit passageways serving an *occupant load* of less than 50 shall be not less than 36 inches (914 mm) in width. The minimum width or required capacity of exit passageways shall be unobstructed.

**Exception:** Encroachments complying with Section 1005.7.

**1024.3 Construction.** *Exit passageway* enclosures shall have walls, floors and ceilings of not less than a 1-hour *fire-resistance rating*, and not less than that required for any connecting *interior exit stairway* or *ramp*. Exit passageways shall be constructed as *fire barriers* in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both.

**1024.4 Termination.** Exit passageways on the *level of exit discharge* shall terminate at an *exit discharge*. Exit passageways on other levels shall terminate at an exit.

**1024.5 Openings.** *Exit passageway* opening protectives shall be in accordance with the requirements of Section 716.

Except as permitted in Section 402.8.7, openings in exit passageways other than unprotected exterior openings shall be limited to those necessary for *exit access* to the *exit*

*passageway* from normally occupied spaces and for egress from the *exit passageway*.

Where an *interior exit stairway* or *ramp* is extended to an *exit discharge* or a *public way* by an *exit passageway*, the *exit passageway* shall comply with Section 1023.3.1.

Elevators shall not open into an *exit passageway*.

**1024.6 Penetrations.** Penetrations into or through an *exit passageway* are prohibited except for the following:

1. Equipment and ductwork necessary for independent ventilation or pressurization.
2. Fire protection systems.
3. Security systems.
4. Two-way communication systems.
5. Electrical raceway for fire department communication.
6. Electrical raceway serving the *exit passageway* and terminating at a steel box not exceeding 16 square inches (0.010 m<sup>2</sup>).

Such penetrations shall be protected in accordance with Section 714. There shall not be penetrations or communicating openings, whether protected or not, between adjacent exit passageways.

**Exception:** *Membrane penetrations* shall be permitted on the outside of the *exit passageway*. Such penetrations shall be protected in accordance with Section 714.4.2.

**1024.7 Ventilation.** Equipment and ductwork for *exit passageway* ventilation as permitted by Section 1024.6 shall comply with one of the following:

1. The equipment and ductwork shall be located exterior to the building and shall be directly connected to the *exit passageway* by ductwork enclosed in construction as required for *shafts*.
2. Where the equipment and ductwork is located within the *exit passageway*, the intake air shall be taken directly from the outdoors and the exhaust air shall be discharged directly to the outdoors, or the air shall be conveyed through ducts enclosed in construction as required for *shafts*.
3. Where located within the building, the equipment and ductwork shall be separated from the remainder of the building, including other mechanical equipment, with construction as required for *shafts*.

In each case, openings into the fire-resistance-rated construction shall be limited to those needed for maintenance and operation and shall be protected by opening protectives in accordance with Section 716 for shaft enclosures.

*Exit passageway* ventilation systems shall be independent of other building ventilation systems.

**1024.8 Exit passageway exterior walls.** *Exterior walls* of the *exit passageway* shall comply with Section 705. Where nonrated walls or unprotected openings enclose the exterior of the *exit passageway* and the walls or openings are exposed



by other parts of the building at an angle of less than 180 degrees (3.14 rad), the building *exterior walls* within 10 feet (3048 mm) horizontally of a nonrated wall or unprotected opening shall have a *fire-resistance rating* of not less than 1 hour. Openings within such *exterior walls* shall be protected by opening protectives having a *fire protection rating* of not less than  $\frac{3}{4}$  hour. This construction shall extend vertically from the ground to a point 10 feet (3048 mm) above the floor of the *exit passageway*, or to the roof line, whichever is lower.

**1024.9 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1025 LUMINOUS EGRESS PATH MARKINGS

**1025.1 General.** *Approved* luminous egress path markings delineating the exit path shall be provided in *high-rise buildings* of Group A, B, E, I-1, M or R-1 occupancies in accordance with this section.

**Exception:** Luminous egress path markings shall not be required on the *level of exit discharge* in lobbies that serve as part of the exit path in accordance with Section 1028.2, Exception 1.

**1025.2 Markings within exit components.** Egress path markings shall be provided in *interior exit stairways*, interior exit *ramps* and exit passageways, in accordance with Sections 1025.2.1 through 1025.2.6.3.

**1025.2.1 Steps.** A solid and continuous stripe shall be applied to the horizontal leading edge of each step and shall extend for the full length of the step. Outlining stripes shall have a minimum horizontal width of 1 inch (25 mm) and a maximum width of 2 inches (51 mm). The leading edge of the stripe shall be placed not more than  $\frac{1}{2}$  inch (12.7 mm) from the leading edge of the step and the stripe shall not overlap the leading edge of the step by not more than  $\frac{1}{2}$  inch (12.7 mm) down the vertical face of the step.

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**1025.2.2 Landings.** The leading edge of landings shall be marked with a stripe consistent with the dimensional requirements for steps.

**1025.2.3 Handrails.** *Handrails* and *handrail* extensions shall be marked with a solid and continuous stripe having a minimum width of 1 inch (25 mm). The stripe shall be placed on the top surface of the *handrail* for the entire length of the *handrail*, including extensions and newel post caps. Where *handrails* or *handrail* extensions bend or turn corners, the stripe shall not have a gap of more than 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**1025.2.4 Perimeter demarcation lines.** *Stair* landings and other floor areas within *interior exit stairways*, interior exit *ramps* and exit passageways, with the exception of the sides of steps, shall be provided with solid and continuous demarcation lines on the floor or on the walls or a combination of both. The stripes shall be 1 to 2 inches (25 mm to 51 mm) wide with interruptions not exceeding 4 inches (102 mm).

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to outlining stripes *listed* in accordance with UL 1994.

**1025.2.4.1 Floor-mounted demarcation lines.** Perimeter demarcation lines shall be placed within 4 inches (102 mm) of the wall and shall extend to within 2 inches (51 mm) of the markings on the leading edge of landings. The demarcation lines shall continue across the floor in front of all doors.

**Exception:** Demarcation lines shall not extend in front of exit discharge doors that lead out of an exit and through which occupants must travel to complete the exit path.

**1025.2.4.2 Wall-mounted demarcation lines.** Perimeter demarcation lines shall be placed on the wall with the bottom edge of the stripe not more than 4 inches (102 mm) above the finished floor. At the top or bottom of the *stairs*, demarcation lines shall drop vertically to the floor within 2 inches (51 mm) of the step or landing edge. Demarcation lines on walls shall transition vertically to the floor and then extend across the floor where a line on the floor is the only practical method of outlining the path. Where the wall line is broken by a door, demarcation lines on walls shall continue across the face of the door or transition to the floor and extend across the floor in front of such door.

**Exception:** Demarcation lines shall not extend in front of exit discharge doors that lead out of an exit and through which occupants must travel to complete the exit path.

**1025.2.4.3 Transition.** Where a wall-mounted demarcation line transitions to a floor-mounted demarcation line, or vice versa, the wall-mounted demarcation line shall drop vertically to the floor to meet a complementary extension of the floor-mounted demarcation line, thus forming a continuous marking.

**1025.2.5 Obstacles.** Obstacles at or below 6 feet 6 inches (1981 mm) in height and projecting more than 4 inches (102 mm) into the egress path shall be outlined with markings not less than 1 inch (25 mm) in width comprised of a pattern of alternating equal bands, of luminous material and black, with the alternating bands not more than 2 inches (51 mm) thick and angled at 45 degrees (0.79 rad). Obstacles shall include, but are not limited to, standpipes, hose cabinets, wall projections and restricted height areas. However, such markings shall not conceal any required information or indicators including

## MEANS OF EGRESS

but not limited to instructions to occupants for the use of standpipes.

**Exception:** The minimum width of 1 inch (25 mm) shall not apply to markings *listed* in accordance with UL 1994.

**1025.2.6 Doors within the exit path.** Doors through which occupants must pass in order to complete the exit path shall be provided with markings complying with Sections 1025.2.6.1 through 1025.2.6.3.

**1025.2.6.1 Emergency exit symbol.** The doors shall be identified by a low-location luminous emergency exit symbol complying with NFPA 170. The exit symbol shall be not less than 4 inches (102 mm) in height and shall be mounted on the door, centered horizontally, with the top of the symbol not higher than 18 inches (457 mm) above the finished floor.

**1025.2.6.2 Door hardware markings.** Door hardware shall be marked with not less than 16 square inches (10323 mm<sup>2</sup>) of luminous material. This marking shall be located behind, immediately adjacent to, or on the door handle or escutcheon. Where a *panic* bar is installed, such material shall be not less than 1 inch (25 mm) wide for the entire length of the actuating bar or touchpad.

**1025.2.6.3 Door frame markings.** The top and sides of the door frame shall be marked with a solid and continuous 1-inch- to 2-inch-wide (25 mm to 51 mm) stripe. Where the door molding does not provide sufficient flat surface on which to locate the stripe, the stripe shall be permitted to be located on the wall surrounding the frame.

**1025.3 Uniformity.** Placement and dimensions of markings shall be consistent and uniform throughout the same enclosure.

**1025.4 Self-luminous and photoluminescent.** Luminous egress path markings shall be permitted to be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminance. Such materials shall include, but not be limited to, *self-luminous* materials and *photoluminescent* materials. Materials shall comply with either of the following standards:

1. UL 1994.
2. ASTM E2072, except that the charging source shall be 1 footcandle (11 lux) of fluorescent illumination for 60 minutes, and the minimum luminance shall be 30 milicandelas per square meter at 10 minutes and 5 milicandelas per square meter after 90 minutes.

**1025.5 Illumination.** Where *photoluminescent* exit path markings are installed, they shall be provided with not less than 1 footcandle (11 lux) of illumination for not less than 60 minutes prior to periods when the building is occupied and continuously during occupancy.

## SECTION 1026 HORIZONTAL EXITS

**1026.1 General.** Horizontal *exits* serving as an *exit* in a *means of egress* system shall comply with the requirements of this section. A *horizontal exit* shall not serve as the only exit from a portion of a building, and where two or more *exits* are required, not more than one-half of the total number of *exits* or total exit minimum width or required capacity shall be horizontal *exits*.

### Exceptions:

1. Horizontal *exits* are permitted to comprise two-thirds of the required *exits* from any building or floor area for occupancies in Group I-2.
2. Horizontal *exits* are permitted to comprise 100 percent of the *exits* required for occupancies in Group I-3. Not less than 6 square feet (0.6 m<sup>2</sup>) of accessible space per occupant shall be provided on each side of the *horizontal exit* for the total number of people in adjoining compartments.

**1026.2 Separation.** The separation between buildings or refuge areas connected by a *horizontal exit* shall be provided by a *fire wall* complying with Section 706; or by a *fire barrier* complying with Section 707 or a *horizontal assembly* complying with Section 711, or both. The minimum *fire-resistance rating* of the separation shall be 2 hours. Opening protectives in horizontal *exits* shall also comply with Section 716. Duct and air transfer openings in a *fire wall* or *fire barrier* that serves as a *horizontal exit* shall also comply with Section 717. The *horizontal exit* separation shall extend vertically through all levels of the building unless floor assemblies have a *fire-resistance rating* of not less than 2 hours and do not have unprotected openings.

**Exception:** A *fire-resistance rating* is not required at horizontal *exits* between a building area and an above-grade *pedestrian walkway* constructed in accordance with Section 3104, provided that the distance between connected buildings is more than 20 feet (6096 mm).

Horizontal *exits* constructed as *fire barriers* shall be continuous from *exterior wall* to *exterior wall* so as to divide completely the floor served by the *horizontal exit*.

**1026.3 Opening protectives.** *Fire doors* in horizontal *exits* shall be *self-closing* or automatic-closing when activated by a smoke detector in accordance with Section 716.2.6.6. Doors, where located in a *cross-corridor* condition, shall be automatic-closing by activation of a smoke detector installed in accordance with Section 716.2.6.6.

**1026.4 Refuge area.** The refuge area of a *horizontal exit* shall be a space occupied by the same tenant or a public area and each such refuge area shall be adequate to accommodate the original *occupant load* of the refuge area plus the *occupant load* anticipated from the adjoining compartment. The anticipated *occupant load* from the adjoining compartment shall be based on the capacity of the *horizontal exit doors* entering the refuge area or the total *occupant load* of the adjoining compartment, whichever is less.

**1026.4.1 Capacity.** The capacity of the refuge area shall be computed based on a *net floor area* allowance of 3 square feet (0.2787 m<sup>2</sup>) for each occupant to be accommodated therein. Where the *horizontal exit* also forms a *smoke compartment*, the capacity of the refuge area for Group I-1, I-2 and I-3 occupancies and Group B ambulatory care facilities shall comply with Sections 407.5.3, 408.6.2, 420.6.1 and 422.3.2 as applicable.

**1026.4.2 Number of exits.** The refuge area into which a *horizontal exit* leads shall be provided with *exits* adequate to meet the occupant requirements of this chapter, but not including the added *occupant load* imposed by persons entering the refuge area through *horizontal exits* from other areas. Not less than one refuge area exit shall lead directly to the exterior or to an *interior exit stairway* or ramp.

**Exception:** The adjoining compartment shall not be required to have a *stairway* or door leading directly outside, provided that the refuge area into which a *horizontal exit* leads has *stairways* or doors leading directly outside and are so arranged that egress shall not require the occupants to return through the compartment from which egress originates.

**1026.5 Standpipes.** Standpipes and standpipe hose connections shall be provided where required by Sections 905.3 and 905.4.

## SECTION 1027 EXTERIOR EXIT STAIRWAYS AND RAMPS

**1027.1 General.** Exterior exit stairways and ramps serving as an exit component in a *means of egress* system shall comply with the requirements of this section.

**1027.2 Use in a means of egress.** *Exterior exit stairways* shall not be used as an element of a required *means of egress* for Group I-2 occupancies. For occupancies in other than Group I-2, *exterior exit stairways* and *ramps* shall be permitted as an element of a required *means of egress* for buildings not exceeding six stories above grade plane or that are not *high-rise buildings*.

**1027.3 Open side.** *Exterior exit stairways* and *ramps* serving as an element of a required *means of egress* shall be open on not less than one side, except for required structural columns, beams, *handrails* and *guards*. An open side shall have not less than 35 square feet (3.3 m<sup>2</sup>) of aggregate open area adjacent to each floor level and the level of each intermediate landing. The required open area shall be located not less than 42 inches (1067 mm) above the adjacent floor or landing level.

**1027.4 Side yards.** The open areas adjoining *exterior exit stairways* or *ramps* shall be either *yards*, *courts* or *public ways*; the remaining sides are permitted to be enclosed by the *exterior walls* of the building.

**1027.5 Location.** *Exterior exit stairways* and *ramps* shall have a minimum *fire separation distance* of 10 feet (3048

mm) measured at right angles from the exterior edge of the *stairway* or *ramps*, including landings, to:

1. Adjacent *lot lines*.
2. Other portions of the building.
3. Other buildings on the same lot unless the adjacent building *exterior walls* and openings are protected in accordance with Section 705 based on *fire separation distance*.

For the purposes of this section, other portions of the building shall be treated as separate buildings.

**Exception:** *Exterior exit stairways* and *ramps* serving individual *dwelling units* of Group R-3 shall have a minimum *fire separation distance* of 5 feet (1525 mm).

**1027.6 Exterior exit stairway and ramp protection.** *Exterior exit stairways* and *ramps* shall be separated from the interior of the building as required in Section 1023.2. Openings shall be limited to those necessary for egress from normally occupied spaces. Where a vertical plane projecting from the edge of an *exterior exit stairway* or *ramp* and landings is exposed by other parts of the building at an angle of less than 180 degrees (3.14 rad), the *exterior wall* shall be rated in accordance with Section 1023.7.

### Exceptions:

1. Separation from the interior of the building is not required for occupancies, other than those in Group R-1 or R-2, in buildings that are not more than two stories above grade plane where a *level of exit discharge* serving such occupancies is the first story above grade plane.
2. Separation from the interior of the building is not required where the *exterior exit stairway* or *ramp* is served by an *exterior exit ramp* or balcony that connects two remote exterior exit *stairways* or other *approved exits* with a perimeter that is not less than 50 percent open. To be considered open, the opening shall be not less than 50 percent of the height of the enclosing wall, with the top of the openings not less than 7 feet (2134 mm) above the top of the balcony.
3. Separation from the open-ended *corridor* of the building is not required for *exterior exit stairways* or *ramps*, provided that Items 3.1 through 3.5 are met:
  - 3.1. The building, including open-ended *corridors*, and *stairways* and *ramps*, shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
  - 3.2. The open-ended *corridors* comply with Section 1020.
  - 3.3. The open-ended *corridors* are connected on each end to an *exterior exit stairway* or *ramp* complying with Section 1027.



## MEANS OF EGRESS

- 3.4. The *exterior walls* and openings adjacent to the *exterior exit stairway* or *ramp* comply with Section 1023.7.
- 3.5. At any location in an open-ended *corridor* where a change of direction exceeding 45 degrees (0.79 rad) occurs, a clear opening of not less than 35 square feet (3.3 m<sup>2</sup>) or an *exterior stairway* or *ramp* shall be provided. Where clear openings are provided, they shall be located so as to minimize the accumulation of smoke or toxic gases.
4. In Group R-3 occupancies not more than four stories in height, *exterior exit stairways* and *ramps* serving individual *dwelling units* are not required to be separated from the interior of the building where the *exterior exit stairway* or *ramp* discharges directly to grade.

### SECTION 1028 EXIT DISCHARGE

**1028.1 General.** The exit discharge shall comply with Sections 1028 and 1029 and the applicable requirements of Sections 1003 through 1015.

**1028.2 Exit discharge.** *Exits* shall discharge directly to the exterior of the building. The *exit discharge* shall be at grade or shall provide a direct path of egress travel to grade. The *exit discharge* shall not reenter a building. The combined use of Exceptions 1 and 2 shall not exceed 50 percent of the number and minimum width or required capacity of the required *exits*.

#### Exceptions:

1. Not more than 50 percent of the number and minimum width or required capacity of *interior exit stairways* and *ramps* is permitted to egress through areas, including *atriums*, on the level of discharge provided that all of the following conditions are met:
  - 1.1. Discharge of *interior exit stairways* and *ramps* shall be provided with a free and unobstructed path of travel to an exterior *exit* door and such *exit* is readily visible and identifiable from the point of termination of the enclosure.
  - 1.2. The entire area of the *level of exit discharge* is separated from areas below by construction conforming to the *fire-resistance rating* for the enclosure.
  - 1.3. The egress path from the *interior exit stairway* and *ramp* on the *level of exit discharge* is protected throughout by an *approved automatic sprinkler system*. Portions of the *level of exit discharge* with access to the egress path shall be either equipped throughout with an *automatic*

*sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2, or separated from the egress path in accordance with the requirements for the enclosure of *interior exit stairways* or *ramps*.

- 1.4. Where a required *interior exit stairway* or *ramp* and an *exit access stairway* or *ramp* serve the same floor level and terminate at the same *level of exit discharge*, the termination of the *exit access stairway* or *ramp* and the *exit discharge* door of the *interior exit stairway* or *ramp* shall be separated by a distance of not less than 30 feet (9144 mm) or not less than one-fourth the length of the maximum overall diagonal dimension of the building, whichever is less. The distance shall be measured in a straight line between the *exit discharge* door from the *interior exit stairway* or *ramp* and the last tread of the *exit access stairway* or termination of slope of the *exit access ramp*.
2. Not more than 50 percent of the number and minimum width or required capacity of the *interior exit stairways* and *ramps* is permitted to egress through a vestibule provided that all of the following conditions are met:
  - 2.1. The entire area of the vestibule is separated from areas below by construction conforming to the *fire-resistance rating* of the *interior exit stairway* or *ramp enclosure*.
  - 2.2. The depth from the exterior of the building is not greater than 10 feet (3048 mm) and the length is not greater than 30 feet (9144 mm).
  - 2.3. The area is separated from the remainder of the *level of exit discharge* by a *fire partition* constructed in accordance with Section 708.
 

**Exception:** The maximum transmitted temperature rise is not required.
  - 2.4. The area is used only for *means of egress* and *exits* directly to the outside.
3. *Horizontal exits* complying with Section 1026 shall not be required to discharge directly to the exterior of the building.

**1028.3 Exit discharge width or capacity.** The minimum width or required capacity of the *exit discharge* shall be not less than the minimum width or required capacity of the *exits* being served.

**1028.4 Exit discharge components.** *Exit discharge* components shall be sufficiently open to the exterior so as to minimize the accumulation of smoke and toxic gases.

\*



**1028.5 Access to a public way.** The *exit discharge* shall provide a direct and unobstructed access to a *public way*.

**Exception:** Where access to a *public way* cannot be provided, a safe dispersal area shall be provided where all of the following are met:

1. The area shall be of a size to accommodate not less than 5 square feet (0.46 m<sup>2</sup>) for each person.
2. The area shall be located on the same lot not less than 50 feet (15 240 mm) away from the building requiring egress.
3. The area shall be permanently maintained and identified as a safe dispersal area.
4. The area shall be provided with a safe and unobstructed path of travel from the building.

\*\*

## SECTION 1029 EGRESS COURTS

**1029.1 General.** *Egress courts* serving as an *exit discharge* component in the *means of egress* system shall comply with the requirements in this section.

**1029.2 Width or capacity.** The required capacity of egress courts shall be determined as specified in Section 1005.1, but the minimum width shall be not less than 44 inches (1118 mm), except as specified herein. Egress courts serving Group R-3 and U occupancies shall be not less than 36 inches (914 mm) in width. The required capacity and width of egress courts shall be unobstructed to a height of 7 feet (2134 mm). The width of the egress court shall be not less than the required capacity.

**Exception:** Encroachments complying with Section 1005.7.

**1029.3 Construction and openings.** Where an *egress court* serving a building or portion thereof is less than 10 feet (3048 mm) in width, the *egress court* walls shall have not less than 1-hour *fire-resistance-rated* construction for a distance of 10 feet (3048 mm) above the floor of the *egress court*. Openings within such walls shall be protected by opening protectives having a *fire protection rating* of not less than <sup>3</sup>/<sub>4</sub> hour.

**Exceptions:**

1. *Egress courts* serving an *occupant load* of less than 10.
2. *Egress courts* serving Group R-3.

## SECTION 1030 ASSEMBLY

**1030.1 General.** A room or space used for assembly purposes that contains seats, tables, displays, equipment or other material shall comply with this section.

**1030.1.1 Bleachers.** *Bleachers*, *grandstands* and *folding and telescopic seating*, that are not building elements, shall comply with ICC 300.

**1030.1.1.1 Spaces under grandstands and bleachers.** Spaces under *grandstands* or *bleachers* shall be separated by *fire barriers* complying with Section 707 and *horizontal assemblies* complying with Section 711 with not less than 1-hour *fire-resistance-rated* construction.

**Exceptions:**

1. Ticket booths less than 100 square feet (9.29 m<sup>2</sup>) in area.
2. Toilet rooms.
3. Other accessory use areas 1,000 square feet (92.9 m<sup>2</sup>) or less in area and equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**1030.2 Assembly main exit.** A building, room or space used for assembly purposes that has an *occupant load* of greater than 300 and is provided with a main *exit*, that main *exit* shall be of sufficient capacity to accommodate not less than one-half of the *occupant load*, but such capacity shall be not less than the total required capacity of all *means of egress* leading to the *exit*. Where the building is classified as a Group A occupancy, the main *exit* shall front on not less than one street or an unoccupied space of not less than 10 feet (3048 mm) in width that adjoins a street or *public way*. In a building, room or space used for assembly purposes where there is not a well-defined main *exit* or where multiple main *exits* are provided, *exits* shall be permitted to be distributed around the perimeter of the building provided that the total capacity of egress is not less than 100 percent of the required capacity.

**1030.3 Assembly other exits.** In addition to having access to a main *exit*, each level in a building used for assembly purposes having an *occupant load* greater than 300 and provided with a main *exit*, shall be provided with additional *means of egress* that shall provide an egress capacity for not less than one-half of the total *occupant load* served by that level and shall comply with Section 1007.1. In a building used for assembly purposes where there is not a well-defined main *exit* or where multiple main *exits* are provided, *exits* for each level shall be permitted to be distributed around the perimeter of the building, provided that the total width of egress is not less than 100 percent of the required width.

**1030.4 Foyers and lobbies.** In Group A-1 occupancies, where persons are admitted to the building at times when seats are not available, such persons shall be allowed to wait in a lobby or similar space, provided that such lobby or similar space shall not encroach on the minimum width or required capacity of the *means of egress*. Such foyer, if not directly connected to a public street by all the main entrances or *exits*, shall have a straight and unobstructed corridor or path of travel to every such main entrance or *exit*.

**1030.5 Interior balcony and gallery means of egress.** For balconies, galleries or press boxes having a seating capacity of 50 or more located in a building, room or space used for assembly purposes, not less than two *means of egress* shall be provided, with one from each side of every balcony, gallery or press box.

## MEANS OF EGRESS

**1030.6 Capacity of aisle for assembly.** The required capacity of *aisles* shall be not less than that determined in accordance with Section 1030.6.1 where *smoke-protected assembly seating* is not provided, Section 1030.6.2 where *smoke-protected assembly seating* is provided and Section 1030.6.3 where *open-air assembly seating* is provided.

**1030.6.1 Without smoke protection.** The required capacity in inches (mm) of the *aisles* for assembly seating without smoke protection shall be not less than the *occupant load* served by the egress element in accordance with all of the following, as applicable:

1. Not less than 0.3 inch (7.6 mm) of aisle capacity for each occupant served shall be provided on stepped *aisles* having riser heights 7 inches (178 mm) or less and tread depths 11 inches (279 mm) or greater, measured horizontally between tread *nosings*.
2. Not less than 0.005 inch (0.127 mm) of additional aisle capacity for each occupant shall be provided for each 0.10 inch (2.5 mm) of riser height above 7 inches (178 mm).
3. Where egress requires stepped aisle descent, not less than 0.075 inch (1.9 mm) of additional aisle capacity for each occupant shall be provided on those portions of aisle capacity that do not have a *handrail* within a horizontal distance of 30 inches (762 mm).
4. Ramped *aisles*, where slopes are steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.22 inch (5.6 mm) of clear aisle capacity for each occupant served. Level or ramped *aisles*, where slopes are not steeper than one unit vertical in 12 units horizontal (8-percent slope), shall have not less than 0.20 inch (5.1 mm) of clear aisle capacity for each occupant served.

**1030.6.2 Smoke-protected assembly seating.** The required capacity in inches (mm) of the *aisle* for *smoke-protected assembly seating* shall be not less than the *occupant load* served by the egress element multiplied by the appropriate factor in Table 1030.6.2. The total number of seats specified shall be those within the space exposed to the same smoke-protected environment. Interpolation is permitted between the specific values shown. A life

safety evaluation, complying with NFPA 101, shall be done for a facility utilizing the reduced width requirements of Table 1030.6.2 for *smoke-protected assembly seating*.

**1030.6.2.1 Smoke control.** *Aisles* and *aisle accessways* serving a *smoke-protected assembly seating* area shall be provided with a smoke control system complying with Section 909 or natural ventilation designed to maintain the smoke level not less than 6 feet (1829 mm) above the floor of the *means of egress*.

**1030.6.2.2 Roof height.** A *smoke-protected assembly seating* area with a roof shall have the lowest portion of the *roof deck* not less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway*.

**Exception:** A roof canopy in an outdoor stadium shall be permitted to be less than 15 feet (4572 mm) above the highest *aisle* or *aisle accessway* provided that there are no objects less than 80 inches (2032 mm) above the highest *aisle* or *aisle accessway*.

**1030.6.2.3 Automatic sprinklers.** Enclosed areas with walls and ceilings in buildings or structures containing *smoke-protected assembly seating* shall be protected with an *approved automatic sprinkler system* in accordance with Section 903.3.1.1.

### Exceptions:

1. The floor area used for contests, performances or entertainment provided that the roof construction is more than 50 feet (15 240 mm) above the floor level and the use is restricted to low fire hazard uses.
2. Press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area.

**1030.6.3 Open-air assembly seating.** In *open-air assembly seating*, the required capacity in inches (mm) of *aisles* shall be not less than the total *occupant load* served by the egress element multiplied by 0.08 (2.0 mm) where egress is by stepped *aisle* and multiplied by 0.06 (1.52 mm) where egress is by level *aisles* and ramped *aisles*.

**Exception:** The required capacity in inches (mm) of *aisles* shall be permitted to comply with Section 1030.6.2 for the number of seats in the *open-air assembly seating* where Section 1030.6.2 permits less capacity.

**TABLE 1030.6.2**  
**CAPACITY FOR AISLES FOR SMOKE-PROTECTED ASSEMBLY**

TOTAL NUMBER OF SEATS IN THE SMOKE-PROTECTED ASSEMBLY SEATING	INCHES OF CAPACITY PER SEAT SERVED			
	Stepped aisles with handrails within 30 inches	Stepped aisles without handrails within 30 inches	Level aisles or ramped aisles not steeper than 1 in 10 in slope	Ramped aisles steeper than 1 in 10 in slope
Equal to or less than 5,000	0.200	0.250	0.150	0.165
10,000	0.130	0.163	0.100	0.110
15,000	0.096	0.120	0.070	0.077
20,000	0.076	0.095	0.056	0.062
Equal to or greater than 25,000	0.060	0.075	0.044	0.048

For SI: 1 inch = 25.4 mm.

**1030.6.3.1 Automatic sprinklers.** Enclosed areas with walls and ceilings in buildings or structures containing *open-air assembly seating* shall be protected with an approved automatic sprinkler system in accordance with Section 903.3.1.1.

**Exceptions:**

1. The floor area used for contests, performances or entertainment, provided that the roof construction is more than 50 feet (15 240 mm) above the floor level and the use is restricted to low fire hazard uses.
2. Press boxes and storage facilities less than 1,000 square feet (93 m<sup>2</sup>) in area.
3. Open-air assembly seating facilities where seating and the means of egress in the seating area are essentially open to the outside.

**1030.7 Travel distance.** The *exit access* travel distance shall comply with Section 1017. Where *aisles* are provided for seating, the distance shall be measured along the *aisles* and *aisle accessways* without travel over or on the seats.

**Exceptions:**

1. In facilities with *smoke-protected assembly seating*, the total *exit access* travel distance shall be not greater than 400 feet (122 m). That portion of the total permitted *exit access* travel distance from each seat to the nearest entrance to a vomitory or concourse shall not exceed 200 feet (60 960 mm). The portion of the total permitted *exit access* travel distance from the entrance to the vomitory or concourse to one of the following shall not exceed 200 feet (60 960 mm):
  - 1.1. The closest riser of an *exit access stairway*.
  - 1.2. The closest slope of an *exit access ramp*.
  - 1.3. An exit.
2. In facilities with *open-air assembly seating* of Type III, IV or V construction, the total *exit access* travel distance to one of the following shall not exceed 400 feet (122 m):
  - 2.1. The closest riser of an *exit access stairway*.
  - 2.2. The closest slope of an *exit access ramp*.
  - 2.3. An exit.
3. In facilities with *open-air assembly seating* of Type I or II construction, the total *exit access* travel distance shall not be limited.

**1030.8 Common path of egress travel.** The *common path of egress travel* shall not exceed 30 feet (9144 mm) from any seat to a point where an occupant has a choice of two paths of egress travel to two *exits*.

**Exceptions:**

1. For areas serving less than 50 occupants, the *common path of egress travel* shall not exceed 75 feet (22 860 mm).

2. For *smoke-protected* or *open-air assembly seating*, the *common path of egress travel* shall not exceed 50 feet (15 240 mm).

**1030.8.1 Path through adjacent row.** Where one of the two paths of travel is across the *aisle* through a row of seats to another *aisle*, there shall be not more than 24 seats between the two aisles, and the minimum clear width between rows for the row between the two *aisles* shall be 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row between aisles.

**Exception:** For *smoke-protected* or *open-air assembly seating* there shall be not more than 40 seats between the two *aisles* and the minimum clear width shall be 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat.

**1030.9 Assembly aisles are required.** Every occupied portion of any building, room or space used for assembly purposes that contains seats, tables, displays, similar fixtures or equipment shall be provided with *aisles* leading to *exits* or *exit access doorways* in accordance with this section.

**1030.9.1 Minimum aisle width.** The minimum clear width for *aisles* shall comply with one of the following:

1. Forty-eight inches (1219 mm) for stepped *aisles* having seating on both sides.
 

**Exception:** Thirty-six inches (914 mm) where the stepped *aisles* serve less than 50 seats.
2. Thirty-six inches (914 mm) for stepped *aisles* having seating on only one side.
 

**Exception:** Twenty-three inches (584 mm) between a stepped aisle *handrail* and seating where a stepped *aisle* does not serve more than five rows on one side.
3. Twenty-three inches (584 mm) between a stepped aisle *handrail* or *guard* and seating where the stepped *aisle* is subdivided by a mid-aisle *handrail*.
4. Forty-two inches (1067 mm) for level or ramped *aisles* having seating on both sides.

**Exceptions:**

1. Thirty-six inches (914 mm) where the *aisle* serves less than 50 seats.
2. Thirty inches (762 mm) where the *aisle* serves less than 15 seats and does not serve as part of an *accessible* route.
5. Thirty-six inches (914 mm) for level or ramped *aisles* having seating on only one side.

**Exception:** Thirty inches (762 mm) where the *aisle* serves fewer than 15 seats and does not serve as part of an *accessible* route.

**1030.9.2 Aisle catchment area.** The *aisle* shall provide sufficient capacity for the number of persons accommodated by the catchment area served by the *aisle*. The catchment area served by an *aisle* is that portion of the



## MEANS OF EGRESS

total space served by that section of the *aisle*. In establishing catchment areas, the assumption shall be made that there is a balanced use of all *means of egress*, with the number of persons in proportion to egress capacity.

**1030.9.3 Converging aisles.** Where *aisles* converge to form a single path of egress travel, the required capacity of that path shall be not less than the combined required capacity of the converging aisles.

**1030.9.4 Uniform width and capacity.** Those portions of *aisles*, where egress is possible in either of two directions, shall be uniform in minimum width or required capacity.

**1030.9.5 Dead-end aisles.** Each end of an *aisle* shall be continuous to a cross *aisle*, foyer, doorway, vomitory, concourse or *stairway* in accordance with Section 1030.9.7 having access to an *exit*.

### Exceptions:

1. Dead-end *aisles* shall be not greater than 20 feet (6096 mm) in length.
2. Dead-end *aisles* longer than 16 rows are permitted where seats beyond the 16th row dead-end *aisle* are not more than 24 seats from another *aisle*, measured along a row of seats having a minimum clear width of 12 inches (305 mm) plus 0.6 inch (15.2 mm) for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.
3. For *smoke-protected* or *open-air assembly seating*, the dead-end *aisle* length of vertical *aisles* shall not exceed a distance of 21 rows.
4. For *smoke-protected* or *open-air assembly seating*, a longer dead-end *aisle* is permitted where seats beyond the 21-row dead-end *aisle* are not more than 40 seats from another *aisle*, measured along a row of seats having an *aisle* accessway with a minimum clear width of 12 inches (305 mm) plus 0.3 inch (7.6 mm) for each additional seat above seven in the row where seats have backrests or beyond 10 where seats are without backrests in the row.

**1030.9.6 Aisle measurement.** The clear width for *aisles* shall be measured to walls, edges of seating and tread edges except for permitted projections.

**Exception:** The clear width of *aisles* adjacent to seating at tables shall be permitted to be measured in accordance with Section 1030.13.1.

**1030.9.6.1 Assembly aisle obstructions.** There shall not be obstructions in the minimum width or required capacity of *aisles*.

**Exception:** *Handrails* are permitted to project into the required width of stepped *aisles* and ramped *aisles* in accordance with Section 1014.8.

**1030.9.7 Stairways connecting to stepped aisles.** A *stairway* that connects a stepped *aisle* to a cross *aisle* or

concourse shall be permitted to comply with the assembly aisle walking surface requirements of Section 1030.14. Transitions between *stairways* and stepped *aisles* shall comply with Section 1030.10.

**1030.9.8 Stairways connecting to vomitories.** A *stairway* that connects a vomitory to a cross *aisle* or concourse shall be permitted to comply with the assembly aisle walking surface requirements of Section 1030.14. Transitions between *stairways* and stepped *aisles* shall comply with Section 1030.10.

**1030.10 Transitions.** Transitions between *stairways* and stepped *aisles* shall comply with either Section 1030.10.1 or 1030.10.2.

**1030.10.1 Transitions to stairways that maintain stepped aisle riser and tread dimensions.** Stepped *aisles*, transitions and *stairways* that maintain the stepped aisle riser and tread dimensions shall comply with Section 1030.14 as one *exit access* component.

**1030.10.2 Transitions to stairways that do not maintain stepped aisle riser and tread dimensions.** Transitions between *stairways* and stepped *aisles* having different riser and tread dimensions shall comply with Sections 1030.10.2.1 through 1030.10.3.

**1030.10.2.1 Stairways and stepped aisles in a straight run.** Where *stairways* and stepped *aisles* are in a straight run, transitions shall have one of the following:

1. A depth of not less than 22 inches (559 mm) where the treads on the descending side of the transition have greater depth.
2. A depth of not less than 30 inches (762 mm) where the treads on the descending side of the transition have lesser depth.

**1030.10.2.2 Stairways that change direction from stepped aisles.** Transitions where the *stairway* changes direction from the stepped *aisle* shall have a minimum depth of 11 inches (280 mm) or the stepped aisle tread depth, whichever is greater, between the stepped *aisle* and *stairway*.

**1030.10.3 Transition marking.** A distinctive marking stripe shall be provided at each *nosing* or leading edge adjacent to the transition. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the stepped *aisle* contrasting marking stripe.

**1030.11 Stepped aisles at vomitories.** Stepped *aisles* that change direction at vomitories shall comply with Section 1030.11.1 Transitions between a stepped *aisle* above a vomitory and a stepped *aisle* to the side of a vomitory shall comply with Section 1030.11.2.

**1030.11.1 Stepped aisles that change direction at vomitories.** Stepped aisle treads where the stepped *aisle* changes direction at a vomitory shall have a depth of not less than 11 inches (280 mm) or the stepped aisle tread depth, whichever is greater. The height of a stepped aisle



tread above a transition at a vomitory shall comply with Section 1030.14.2.2.

**1030.11.2 Stepped aisle transitions at the top of vomitories.** Transitions between the stepped *aisle* above a vomitory and stepped *aisles* to the side of a vomitory shall have a depth of not less than 11 inches (280 mm) or the stepped aisle tread depth, whichever is greater.

**1030.12 Construction.** *Aisles*, stepped *aisles* and ramped *aisles* shall be built of materials consistent with the types permitted for the type of construction of the building.

**Exception:** Wood *handrails* shall be permitted for all types of construction.

**1030.12.1 Walking surface.** The surface of *aisles*, stepped *aisles* and ramped *aisles* shall be of slip-resistant materials that are securely attached. The surface for stepped *aisles* shall comply with Section 1011.7.1.

**1030.12.2 Outdoor conditions.** Outdoor *aisles*, stepped *aisles* and ramped *aisles* and outdoor approaches to *aisles*, stepped *aisles* and ramped *aisles* shall be designed so that water will not accumulate on the walking surface.

**1030.13 Aisle accessways.** *Aisle accessways* for seating at tables shall comply with Section 1030.13.1. *Aisle accessways* for seating in rows shall comply with Section 1030.13.2.

**1030.13.1 Seating at tables.** Where seating is located at a table or counter and is adjacent to an *aisle* or *aisle accessway*, the measurement of required clear width of the *aisle* or *aisle accessway* shall be made to a line 19 inches (483 mm) away from and parallel to the edge of the table or counter. The 19-inch (483 mm) distance shall be measured perpendicular to the side of the table or counter. In the case of other side boundaries for *aisles* or *aisle accessways*, the clear width shall be measured to walls, edges of seating and tread edges.

**Exception:** Where tables or counters are served by fixed seats, the width of the *aisle* or *aisle accessway* shall be measured from the back of the seat.

**1030.13.1.1 Aisle accessway capacity and width for seating at tables.** *Aisle accessways* serving arrangements of seating at tables or counters shall comply with the capacity requirements of Section 1005.1 but shall not have less than 12 inches (305 mm) of width plus  $\frac{1}{2}$  inch (12.7 mm) of width for each additional 1 foot (305 mm), or fraction thereof, beyond 12 feet (3658 mm) of aisle accessway length measured from the center of the seat farthest from an *aisle*.

**Exception:** Portions of an *aisle accessway* having a length not exceeding 6 feet (1829 mm) and used by a total of not more than four persons.

**1030.13.1.2 Seating at table aisle accessway length.** The length of travel along the *aisle accessway* shall not exceed 30 feet (9144 mm) from any seat to the point where a person has a choice of two or more paths of egress travel to separate *exits*.

**1030.13.2 Clear width of aisle accessways serving seating in rows.** Where seating rows have 14 or fewer seats,

the minimum clear aisle accessway width shall be not less than 12 inches (305 mm) measured as the clear horizontal distance from the back of the row ahead and the nearest projection of the row behind. Where chairs have automatic or self-rising seats, the measurement shall be made with seats in the raised position. Where any chair in the row does not have an automatic or self-rising seat, the measurements shall be made with the seat in the down position. For seats with folding tablet arms, row spacing shall be determined with the tablet arm in the used position.

**Exception:** For seats with folding tablet arms, row spacing is permitted to be determined with the tablet arm in the stored position where the tablet arm when raised manually to vertical position in one motion automatically returns to the stored position by force of gravity.

**1030.13.2.1 Dual access.** For rows of seating served by *aisles* or doorways at both ends, there shall be not more than 100 seats per row. The minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.3 inch (7.6 mm) for every additional seat beyond 14 seats where seats have backrests or beyond 21 where seats are without backrests. The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected* or *open-air assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the aisle accessway minimum clear width shall be increased, are in Table 1030.13.2.1.

**1030.13.2.2 Single access.** For rows of seating served by an *aisle* or doorway at only one end of the row, the minimum clear width of 12 inches (305 mm) between rows shall be increased by 0.6 inch (15.2 mm) for every additional seat beyond seven seats where seats have backrests or beyond 10 where seats are without backrests. The minimum clear width is not required to exceed 22 inches (559 mm).

**Exception:** For *smoke-protected* or *open-air assembly seating*, the row length limits for a 12-inch-wide (305 mm) *aisle accessway*, beyond which the aisle accessway minimum clear width shall be increased, are in Table 1030.13.2.1.

**1030.14 Assembly aisle walking surfaces.** Ramped *aisles* shall comply with Sections 1030.14.1 through 1030.14.1.3. Stepped *aisles* shall comply with Sections 1030.14.2 through 1030.14.2.4.

**1030.14.1 Ramped aisles.** *Aisles* that are sloped more than 1 unit vertical in 20 units horizontal (5-percent slope) shall be considered to be a ramped *aisle*. Ramped *aisles* that serve as part of an *accessible route* in accordance with Sections 1009 and 1109.2 shall have a maximum slope of 1 unit vertical in 12 units horizontal (8-percent slope). The slope of other ramped *aisles* shall not exceed 1 unit vertical in 8 units horizontal (12.5-percent slope).

## MEANS OF EGRESS

**TABLE 1030.13.2.1**  
**SMOKE-PROTECTED OR OPEN-AIR ASSEMBLY AISLE ACCESSWAYS**

NUMBER OF SEATS IN THE SMOKE-PROTECTED OR OPEN-AIR ASSEMBLY SEATING	MAXIMUM NUMBER OF SEATS PER ROW PERMITTED TO HAVE A MINIMUM 12-INCH CLEAR WIDTH AISLE ACCESSWAY			
	Aisle or doorway at both ends of row		Aisle or doorway at one end of row only	
	Seats with backrests	Seats without backrests	Seats with backrests	Seats without backrests
Less than 4,000	14	21	7	10
4,000 to 6,999	15	22	7	10
7,000 to 9,999	16	23	8	11
10,000 to 12,999	17	24	8	11
13,000 to 15,999	18	25	9	12
16,000 to 18,999	19	26	9	12
19,000 to 21,999	20	27	10	13
22,000 and greater	21	28	11	14

For SI: 1 inch = 25.4 mm.

**1030.14.1.1 Cross slope.** The slope measured perpendicular to the direction of travel of a ramped *aisle* shall not be steeper than 1 unit vertical in 48 units horizontal (2-percent slope).

**1030.14.1.2 Landings.** Ramped *aisles* shall have landings in accordance with Sections 1012.6 through 1012.6.5. Landings for ramped *aisles* shall be permitted to overlap required *aisles* or cross *aisles*.

**1030.14.1.3 Edge protection.** Ramped *aisles* shall have edge protection in accordance with Sections 1012.10 and 1012.10.1.

**Exception:** In assembly spaces with *fixed seating*, edge protection is not required on the sides of ramped *aisles* where the ramped *aisles* provide access to the adjacent seating and *aisle accessways*.

**1030.14.2 Stepped aisles.** *Aisles* with a slope exceeding one unit vertical in eight units horizontal (12.5-percent slope) shall consist of a series of risers and treads that extends across the full width of *aisles* and complies with Sections 1030.14.2.1 through 1030.14.2.4.

**1030.14.2.1 Treads.** Tread depths shall be not less than 11 inches (279 mm) and shall have dimensional uniformity.

**Exception:** The tolerance between adjacent treads shall not exceed  $\frac{3}{16}$  inch (4.8 mm).

**1030.14.2.2 Risers.** Where the gradient of stepped *aisles* is to be the same as the gradient of adjoining seating areas, the riser height shall be not less than 4 inches (102 mm) nor more than 8 inches (203 mm) and shall be uniform within each *flight*.

**Exceptions:**

1. Riser height nonuniformity shall be limited to the extent necessitated by changes in the gradient of the adjoining seating area to maintain adequate sightlines. Where nonuniformities exceed  $\frac{3}{16}$  inch (4.8 mm) between adjacent risers, the

exact location of such nonuniformities shall be indicated with a distinctive marking stripe on each tread at the *nosing* or leading edge adjacent to the nonuniform risers. Such stripe shall be not less than 1 inch (25 mm), and not more than 2 inches (51 mm), wide. The edge marking stripe shall be distinctively different from the contrasting marking stripe.

2. Riser heights not exceeding 9 inches (229 mm) shall be permitted where they are necessitated by the slope of the adjacent seating areas to maintain sightlines.

**1030.14.2.2.1 Construction tolerances.** The tolerance between adjacent risers on a stepped *aisle* that were designed to be equal height shall not exceed  $\frac{3}{16}$  inch (4.8 mm). Where the stepped *aisle* is designed in accordance with Exception 1 of Section 1030.14.2.2, the stepped *aisle* shall be constructed so that each riser of unequal height, determined in the direction of descent, is not more than  $\frac{3}{8}$  inch (9.5 mm) in height different from adjacent risers where stepped *aisle* treads are less than 22 inches (560 mm) in depth and  $\frac{3}{4}$  inch (19.1 mm) in height different from adjacent risers where stepped *aisle* treads are 22 inches (560 mm) or greater in depth.

**1030.14.2.3 Tread contrasting marking stripe.** A contrasting marking stripe shall be provided on each tread at the *nosing* or leading edge such that the location of each tread is readily apparent when viewed in descent. Such stripe shall be not less than 1 inch (25 mm) and not more than 2 inches (51 mm) wide.

**Exception:** The contrasting marking stripe is permitted to be omitted where tread surfaces are such that the location of each tread is readily apparent when viewed in descent.

**1030.14.2.4 Nosing and profile.** *Nosing* and riser profile shall comply with Sections 1011.5.5 through 1011.5.5.3.

**1030.15 Seat stability.** In a building, room or space used for assembly purposes, the seats shall be securely fastened to the floor.

**Exceptions:**

1. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating and with 200 or fewer seats, the seats shall not be required to be fastened to the floor.
2. In a building, room or space used for assembly purposes or portions thereof with seating at tables and without ramped or tiered floors for seating, the seats shall not be required to be fastened to the floor.
3. In a building, room or space used for assembly purposes or portions thereof without ramped or tiered floors for seating and with greater than 200 seats, the seats shall be fastened together in groups of not less than three or the seats shall be securely fastened to the floor.
4. In a building, room or space used for assembly purposes where flexibility of the seating arrangement is an integral part of the design and function of the space and seating is on tiered levels, not more than 200 seats shall not be required to be fastened to the floor. Plans showing seating, tiers and aisles shall be submitted for approval.
5. Groups of seats within a building, room or space used for assembly purposes separated from other seating by railings, guards, partial height walls or similar barriers with level floors and having not more than 14 seats per group shall not be required to be fastened to the floor.
6. Seats intended for musicians or other performers and separated by railings, guards, partial height walls or similar barriers shall not be required to be fastened to the floor.

**1030.16 Handrails.** Ramped aisles having a slope exceeding one unit vertical in 15 units horizontal (6.7-percent slope) and stepped aisles shall be provided with handrails in compliance with Section 1014 located either at one or both sides of the aisle or within the aisle width. Where stepped aisles have seating on one side and the aisle width is 74 inches (1880 mm) or greater, two handrails are required. Where two handrails are required, one of the handrails shall be within 30 inches (762 mm) horizontally of the stepped aisle.

**Exceptions:**

1. Handrails are not required for ramped aisles with seating on both sides.
2. Handrails are not required where, at the side of the aisle, there is a guard with a top surface that complies with the graspability requirements of handrails in accordance with Section 1014.3.

3. Handrail extensions are not required at the top and bottom of stepped aisles and ramped aisles to permit crossovers within the aisles.

**1030.16.1 Discontinuous mid-aisle handrails.** Where there is seating on both sides of the aisle, the mid-aisle handrails shall be discontinuous. Where a stepped aisle is required to have two handrails, the mid-aisle handrails shall be discontinuous. Gaps or breaks shall be provided at intervals not exceeding five rows to facilitate access to seating and to permit crossing from one side of the aisle to the other. These gaps or breaks shall have a clear width of not less than 22 inches (559 mm) and not greater than 36 inches (914 mm), measured horizontally, and the mid-aisle handrail shall have rounded terminations or bends.

**1030.16.2 Handrail termination.** Handrails located on the side of stepped aisles shall return to a wall, guard or the walking surface or shall be continuous to the handrail of an adjacent stepped aisle flight.

**1030.16.3 Mid-aisle termination.** Mid-aisle handrails shall not extend beyond the lowest riser and shall terminate within 18 inches (381 mm), measured horizontally, from the lowest riser. Handrail extensions are not required.

**Exception:** Mid-aisle handrails shall be permitted to extend beyond the lowest riser where the handrail extensions do not obstruct the width of the cross aisle.

**1030.16.4 Rails.** Where mid-aisle handrails are provided in stepped aisles, there shall be an additional rail located approximately 12 inches (305 mm) below the handrail. The rail shall be adequate in strength and attachment in accordance with Section 1607.9.1.2.

**1030.17 Assembly guards.** Guards adjacent to seating in a building, room or space used for assembly purposes shall be provided where required by Section 1015 and shall be constructed in accordance with Section 1015 except where provided in accordance with Sections 1030.17.1 through 1030.17.4. At bleachers, grandstands and folding and telescopic seating, guards must be provided where required by ICC 300 and Section 1030.17.1.

**1030.17.1 Perimeter guards.** Perimeter guards shall be provided where the footboards or walking surface of seating facilities are more than 30 inches (762 mm) above the floor or grade below. Where the seatboards are adjacent to the perimeter, guard height shall be 42 inches (1067 mm) high minimum, measured from the seatboard. Where the seats are self-rising, guard height shall be 42 inches (1067 mm) high minimum, measured from the floor surface. Where there is an aisle between the seating and the perimeter, the guard height shall be measured in accordance with Section 1015.3.

**Exceptions:**

1. Guards that impact sightlines shall be permitted to comply with Section 1030.17.3.
2. Bleachers, grandstands and folding and telescopic seating shall not be required to have

## MEANS OF EGRESS

perimeter *guards* where the seating is located adjacent to a wall and the space between the wall and the seating is less than 4 inches (102 mm).

**1030.17.2 Cross aisles.** Cross *aisles* located more than 30 inches (762 mm) above the floor or grade below shall have *guards* in accordance with Section 1015.

Where an elevation change of 30 inches (762 mm) or less occurs between a cross *aisle* and the adjacent floor or grade below, *guards* not less than 26 inches (660 mm) above the *aisle* floor shall be provided.

**Exception:** Where the backs of seats on the front of the cross *aisle* project 24 inches (610 mm) or more above the adjacent floor of the *aisle*, a *guard* need not be provided.

**1030.17.3 Sightline-constrained guard heights.** Unless subject to the requirements of Section 1030.17.4, a fascia or railing system in accordance with the *guard* requirements of Section 1015 and having a minimum height of 26 inches (660 mm) shall be provided where the floor or footboard elevation is more than 30 inches (762 mm) above the floor or grade below and the fascia or railing would otherwise interfere with the sightlines of immediately adjacent seating.

**1030.17.4 Guards at the end of aisles.** A fascia or railing system complying with the *guard* requirements of Section 1015 shall be provided for the full width of the *aisle* where the foot of the *aisle* is more than 30 inches (762 mm) above the floor or grade below. The fascia or railing shall be not less than 36 inches (914 mm) high and shall provide not less than 42 inches (1067 mm) measured diagonally between the top of the rail and the *nosing* of the nearest tread.

## SECTION 1031 EMERGENCY ESCAPE AND RESCUE

**1031.1 General.** *Emergency escape and rescue openings* shall comply with the requirements of this section.

**1031.2 Where required.** In addition to the *means of egress* required by this chapter, *emergency escape and rescue openings* shall be provided in the following occupancies:

1. Group R-2 occupancies located in stories with only one *exit* or *access* to only one *exit* as permitted by Tables 1006.3.4(1) and 1006.3.4(2).
2. Group R-3 and R-4 occupancies.

*Basements* and sleeping rooms below the fourth *story above grade plane* shall have not fewer than one *emergency escape and rescue opening* in accordance with this section. Where *basements* contain one or more sleeping rooms, an *emergency escape and rescue opening* shall be required in each sleeping room, but shall not be required in adjoining

areas of the *basement*. Such openings shall open directly into a *public way* or to a *yard* or *court* that opens to a *public way*.

### Exceptions:

1. *Basements* with a ceiling height of less than 80 inches (2032 mm) shall not be required to have *emergency escape and rescue openings*.
2. *Emergency escape and rescue openings* are not required from *basements* or sleeping rooms that have an *exit* door or *exit access* door that opens directly into a *public way* or to a *yard*, *court* or exterior egress balcony that opens to a *public way*.
3. *Basements* without *habitable spaces* and having not more than 200 square feet (18.6 m<sup>2</sup>) in floor area shall not be required to have *emergency escape and rescue openings*.
4. *Storm shelters* are not required to comply with this section where the shelter is constructed in accordance with ICC 500.
5. Within individual *dwelling* and *sleeping units* in Groups R-2 and R-3, where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1, 903.3.1.2 or 903.3.1.3, *sleeping rooms* in *basements* shall not be required to have *emergency escape and rescue openings* provided that the basement has one of the following:
  - 5.1. One *means of egress* and one *emergency escape and rescue opening*.
  - 5.2. Two *means of egress*.

**1031.2.1 Operational constraints and opening control devices.** *Emergency escape and rescue openings* shall be operational from inside the room without the use of keys or tools. Window-opening control devices complying with ASTM F2090 shall be permitted for use on windows serving as a required *emergency escape and rescue opening*.

**1031.3 Emergency escape and rescue openings.** *Emergency escape and rescue openings* shall comply with Sections 1031.3.1 through 1031.3.3.

**1031.3.1 Minimum size.** *Emergency escape and rescue openings* shall have a minimum net clear opening of 5.7 square feet (0.53 m<sup>2</sup>).

**Exception:** The minimum net clear opening for grade-floor *emergency escape and rescue openings* shall be 5 square feet (0.46 m<sup>2</sup>).

**1031.3.2 Minimum dimensions.** The minimum net clear opening height dimension shall be 24 inches (610 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening dimensions shall be the result of normal operation of the opening.



**1031.3.3 Maximum height from floor.** *Emergency escape and rescue openings* shall have the bottom of the clear opening not greater than 44 inches (1118 mm) measured from the floor.

**1031.4 Emergency escape and rescue doors.** Where a door is provided as the required *emergency escape and rescue opening*, it shall be a swinging door or a sliding door.

**1031.5 Area wells.** An *emergency escape and rescue opening* with the bottom of the clear opening below the adjacent grade shall be provided with an area well in accordance with Sections 1031.5.1 through 1031.5.3.

**1031.5.1 Minimum size.** The minimum horizontal area of the area well shall be 9 square feet (0.84 m<sup>2</sup>), with a horizontal projection and width of not less than 36 inches (914 mm). The area well shall allow the *emergency escape and rescue opening* to be fully opened.

**Exception:** The ladder or steps required by Section 1031.5.2 shall be permitted to encroach not more than 6 inches (152 mm) into the required dimensions of the area well.

**1031.5.2 Ladders or steps.** Area wells with a vertical depth of more than 44 inches (1118 mm) shall be equipped with an *approved* permanently affixed ladder or steps. The ladder or steps shall not be obstructed by the *emergency escape and rescue opening* when the window or door is in the open position. Ladders or steps required by this section shall not be required to comply with Section 1011.

**1031.5.2.1 Ladders.** Ladders or rungs shall have an inside width of at least 12 inches (305 mm), shall project at least 3 inches (76 mm) from the wall and shall be spaced not more than 18 inches (457 mm) on center (o.c.) vertically for the full height of the area well.

**1031.5.2.2 Steps.** Steps shall have an inside width of not less than 12 inches (305 mm), shall have treads greater than 5 inches (127 mm) in depth and a riser height not greater than 18 inches (457 mm) for the full height of the area well.

**1031.5.3 Drainage.** Area wells shall be designed for proper drainage by connecting to the building's foundation drainage system required by Section 1805.

**Exception:** A drainage system for area wells is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, in accordance with Section 1803.5.1.

**1031.6 Bars, grilles, covers and screens.** Where bars, grilles, covers, screens or similar devices are placed over *emergency escape and rescue openings* or area wells that serve such openings, the minimum net clear opening size shall comply with Sections 1031.3 and 1031.5. Such devices shall be releasable or removable from the inside without the use of a key, tool or force greater than that which is required for normal operation of the *emergency escape and rescue opening*.



# CHAPTER 11

## ACCESSIBILITY

### User note:

**About this chapter:** Chapter 11 contains provisions that set forth requirements for accessibility of buildings and their associated sites and facilities for people with physical disabilities. The fundamental philosophy of the code on the subject of accessibility is that everything is required to be accessible. This is reflected in the basic applicability requirement (see Section 1103.1). The code's scoping requirements then address the conditions under which accessibility is not required in terms of exceptions to this general mandate. While the IBC contains scoping provisions for accessibility (for example, what, where and how many), ICC A117.1, *Accessible and Usable Buildings and Facilities*, is the referenced standard for the technical provisions (in other words, how). Accessibility criteria for existing buildings are addressed in the International Existing Building Code®. The International Residential Code® references Chapter 11 for accessibility provisions; therefore, this chapter may be applicable to housing covered under the International Residential Code. The provisions in the I-Codes are intended to meet or exceed the requirements in the federal accessibility requirement found in the Americans with Disabilities Act and the Fair Housing Act.

There are many accessibility issues that not only benefit people with disabilities, but also provide a tangible benefit to people without disabilities. This type of requirement can be set forth in the code as generally applicable without necessarily identifying it specifically as an accessibility-related issue. Such a requirement would then be considered as having been "mainstreamed." For example, visible alarms are located in Chapter 9 and accessible means of egress and ramp requirements are addressed in Chapter 10.

### SECTION 1101 GENERAL

**1101.1 Scope.** The provisions of this chapter shall control the design and construction of facilities for accessibility for individuals with disabilities.

### SECTION 1102 COMPLIANCE

**1102.1 Design.** Buildings and facilities shall be designed and constructed to be *accessible* in accordance with this code and ICC A117.1.

### SECTION 1103 SCOPING REQUIREMENTS

**1103.1 Where required.** *Sites*, buildings, *structures*, *facilities*, elements and spaces, temporary or permanent, shall be accessible to individuals with disabilities.

**1103.2 General exceptions.** *Sites*, buildings, *structures*, *facilities*, elements and spaces shall be exempt from this chapter to the extent specified in this section.

**1103.2.1 Specific requirements.** *Accessibility* is not required in buildings and *facilities*, or portions thereof, to the extent permitted by Sections 1104 through 1112.

**1103.2.2 Employee work areas.** Spaces and elements within *employee work areas* shall only be required to comply with Sections 907.5.2.3.1, 1009 and 1104.3.1 and shall be designed and constructed so that individuals with disabilities can approach, enter and exit the work area. Work areas, or portions of work areas, other than raised courtroom stations in accordance with Section 1109.4.1.4, that are less than 300 square feet (30 m<sup>2</sup>) in area and located 7 inches (178 mm) or more above or below the ground or finished floor where the change in

elevation is essential to the function of the space shall be exempt from all requirements.

**1103.2.3 Detached dwellings.** Detached one- and two-family *dwellings*, their accessory structures and their associated *sites* and *facilities* are not required to comply with this chapter.

**1103.2.4 Utility buildings.** Group U occupancies are not required to comply with this chapter other than the following:

1. In agricultural buildings, access is required to paved work areas and areas open to the general public.
2. *Private garages* or carports that contain required accessible parking.

**1103.2.5 Construction sites.** Structures, *sites* and equipment directly associated with the actual processes of construction including, but not limited to, scaffolding, bridging, materials hoists, materials storage or construction trailers are not required to comply with this chapter.

**1103.2.6 Raised areas.** Raised areas used primarily for purposes of security, life safety or fire safety including, but not limited to, observation galleries, prison guard towers, fire towers or lifeguard stands are not required to comply with this chapter.

**1103.2.7 Limited access spaces.** Spaces accessed only by ladders, catwalks, crawl spaces, freight elevators or very narrow passageways are not required to comply with this chapter.

**1103.2.8 Areas in places of religious worship.** Raised or lowered areas, or portions of areas, in *places of religious worship* that are less than 300 square feet (30 m<sup>2</sup>) in area and located 7 inches (178 mm) or more above or below the finished floor and used primarily for the performance of religious ceremonies are not required to comply with this chapter.

## ACCESSIBILITY

**1103.2.9 Equipment spaces.** Spaces frequented only by service personnel for maintenance, repair or occasional monitoring of equipment are not required to comply with this chapter.

**1103.2.10 Highway tollbooths.** Highway tollbooths where the access is provided only by bridges above the vehicular traffic or underground tunnels are not required to comply with this chapter.

**1103.2.11 Residential Group R-1.** Buildings of Group R-1 containing not more than five *sleeping units* for rent or hire that are also occupied as the residence of the proprietor are not required to comply with this chapter.

**1103.2.12 Day care facilities.** Where a day care facility is part of a *dwelling unit*, only the portion of the structure utilized for the day care facility is required to comply with this chapter.

**1103.2.13 Detention and correctional facilities.** In detention and correctional facilities, common use areas that are used only by inmates or detainees and security personnel, and that do not serve holding *cells* or housing *cells* required to be *Accessible units*, are not required to comply with this chapter.

**1103.2.14 Walk-in coolers and freezers.** Walk-in cooler and freezer equipment accessed only from *employee work areas* is not required to comply with this chapter.

## SECTION 1104 ACCESSIBLE ROUTE

**1104.1 Site arrival points.** At least one *accessible route* within the *site* shall be provided from public transportation stops, accessible parking, accessible passenger loading zones, and public streets or sidewalks to the accessible building entrance served.

**Exception:** Other than in buildings or *facilities* containing or serving *Type B units*, an *accessible route* shall not be required between *site* arrival points and the building or *facility* entrance if the only means of access between them is a vehicular way not providing for pedestrian access.

**1104.2 Within a site.** At least one *accessible route* shall connect accessible buildings, accessible facilities, accessible elements and accessible spaces that are on the same *site*.

### Exceptions:

1. An *accessible route* is not required between accessible buildings, accessible facilities, accessible elements and accessible spaces that have, as the only means of access between them, a vehicular way not providing for pedestrian access.
2. An *accessible route* to recreational facilities shall only be required to the extent specified in Section 1111.

**1104.3 Connected spaces.** Where a building or portion of a building is required to be *accessible*, at least one *accessible*

route shall be provided to each portion of the building, to accessible building entrances connecting accessible *pedestrian walkways* and to the *public way*.

### Exceptions:

1. *Stories* and *mezzanines* exempted by Section 1104.4.
2. In a building, room or space used for assembly purposes with *fixed seating*, an *accessible route* shall not be required to serve levels where *wheel-chair spaces* are not provided.
3. Vertical access to elevated employee work stations within a courtroom complying with Section 1109.4.1.4.
4. An *accessible route* to recreational facilities shall only be required to the extent specified in Section 1111.

**1104.3.1 Employee work areas.** *Common use circulation paths* within *employee work areas* shall be *accessible routes*.

### Exceptions:

1. *Common use circulation paths*, located within *employee work areas* that are less than 1,000 square feet (93 m<sup>2</sup>) in size and defined by permanently installed partitions, counters, casework or furnishings, shall not be required to be *accessible routes*.
2. *Common use circulation paths*, located within *employee work areas*, that are an integral component of equipment, shall not be required to be *accessible routes*.
3. *Common use circulation paths*, located within exterior *employee work areas* that are fully exposed to the weather, shall not be required to be *accessible routes*.

**1104.3.2 Press boxes.** Press boxes in a building, room or space used for assembly purposes shall be on an *accessible route*.

### Exceptions:

1. An *accessible route* shall not be required to press boxes in *bleachers* that have a single point of entry from the *bleachers*, provided that the aggregate area of all press boxes for each playing field is not more than 500 square feet (46 m<sup>2</sup>).
2. An *accessible route* shall not be required to free-standing press boxes that are more than 12 feet (3660 mm) above grade provided that the aggregate area of all press boxes for each playing field is not more than 500 square feet (46 m<sup>2</sup>).

**1104.4 Multistory buildings and facilities.** At least one *accessible route* shall connect each accessible *story*, *mezza-*



nine and occupied roofs in multilevel buildings and facilities.

#### Exceptions:

1. An *accessible route* is not required to *stories*, *mezzanines* and occupied roofs that have an aggregate area of not more than 3,000 square feet (278.7 m<sup>2</sup>) and are located above and below accessible levels. This exception shall not apply to:
  - 1.1. Multiple tenant facilities of Group M occupancies containing five or more tenant spaces used for the sales or rental of goods and where at least one such tenant space is located on a floor level above or below the accessible levels.
  - 1.2. *Stories* or *mezzanines* containing offices of health care providers (Group B or I).
  - 1.3. Passenger transportation facilities and airports (Group A-3 or B).
  - 1.4. Government buildings.
  - 1.5. Structures with four or more dwelling units.
2. *Stories*, *mezzanines* or occupied roofs that do not contain accessible elements or other spaces as determined by Section 1108 or 1109 are not required to be served by an accessible route from an *accessible level*.
3. In air traffic control towers, an *accessible route* is not required to serve the cab and the floor immediately below the cab.
4. Where a two-story building or facility has one *story* or *mezzanine* with an *occupant load* of five or fewer persons that does not contain *public use* space, that *story* or *mezzanine* shall not be required to be connected by an *accessible route* to the *story* above or below.

**1104.5 Location.** *Accessible routes* shall coincide with or be located in the same area as a general *circulation path*. Where the *circulation path* is interior, the *accessible route* shall be interior. Where only one *accessible route* is provided, the *accessible route* shall not pass through kitchens, storage rooms, restrooms, closets or similar spaces.

#### Exceptions:

1. *Accessible routes* from parking garages contained within and serving *Type B units* are not required to be interior.
2. A single *accessible route* is permitted to pass through a kitchen or storage room in an *Accessible unit*, *Type A unit* or *Type B unit*.

**1104.6 Security barriers.** Security barriers including, but not limited to, security bollards and security check points shall not obstruct a required *accessible route* or accessible means of egress.

**Exception:** Where security barriers incorporate elements that cannot comply with these requirements, such as certain metal detectors, fluoroscopes or other similar

devices, the *accessible route* shall be permitted to be provided adjacent to security screening devices. The *accessible route* shall permit persons with disabilities passing around security barriers to maintain visual contact with their personal items to the same extent provided others passing through the security barrier.

## SECTION 1105 ACCESSIBLE ENTRANCES

**1105.1 Public entrances.** In addition to accessible entrances required by Sections 1105.1.2 through 1105.1.8, at least 60 percent of all *public entrances* shall be *accessible*.

#### Exceptions:

1. An accessible entrance is not required to areas not required to be *accessible*.
2. Loading and *service entrances* that are not the only entrance to a tenant space.

**1105.1.1 Automatic doors.** In facilities with the occupancies and building *occupant loads* indicated in Table 1105.1.1, *public entrances* that are required to be *accessible* shall have one door be either a full *power-operated door* or a *low-energy power-operated door*. Where the *public entrance* includes a vestibule, at least one door into and one door out of the vestibule shall meet the requirements of this section.

TABLE 1105.1.1  
PUBLIC ENTRANCE WITH POWER-OPERATED DOOR<sup>a</sup>

OCCUPANCY	BUILDING OCCUPANT LOAD GREATER THAN
A-1, A-2, A-3, A-4	300
B, M, R-1	500

a. In mixed-use facilities where the total sum of the building occupant load is greater than those listed, the most restrictive building occupant load shall apply.

**1105.1.2 Parking garage entrances.** Where provided, direct access for pedestrians from parking structures to buildings or facility entrances shall be *accessible*.

**1105.1.3 Entrances from tunnels or elevated walkways.** Where direct access is provided for pedestrians from a pedestrian tunnel or elevated walkway to a building or facility, at least one entrance to the building or facility from each tunnel or walkway shall be *accessible*.

**1105.1.4 Restricted entrances.** Where *restricted entrances* are provided to a building or facility, at least one *restricted entrance* to the building or facility shall be *accessible*.

**1105.1.5 Entrances for inmates or detainees.** Where entrances used only by inmates or detainees and security personnel are provided at judicial facilities, detention facilities or correctional facilities, at least one such entrance shall be *accessible*.

**1105.1.6 Service entrances.** If a *service entrance* is the only entrance to a building or a tenant space in a facility, that entrance shall be *accessible*.

## ACCESSIBILITY

**1105.1.7 Tenant spaces.** At least one accessible entrance shall be provided to each tenant in a facility.

**Exception:** An accessible entrance is not required to *self-service storage facilities* that are not required to be *accessible*.

**1105.1.8 Dwelling units and sleeping units.** At least one accessible entrance shall be provided to each *dwelling unit* and *sleeping unit* in a facility.

**Exception:** An accessible entrance is not required to *dwelling units* and *sleeping units* that are not required to be *Accessible units*, *Type A units* or *Type B units*.

### SECTION 1106

#### PARKING AND PASSENGER LOADING FACILITIES

**1106.1 General.** Parking shall comply with Sections 1106.2 through 1106.8. Passenger loading zones shall comply with Section 1106.9.

**1106.2 Required.** Where parking is provided, accessible parking spaces shall be provided in compliance with Table 1106.2, except as required by Sections 1106.3 through 1106.5. Where more than one parking facility is provided on a site, the number of parking spaces required to be *accessible* shall be calculated separately for each parking facility.

**Exception:** This section does not apply to parking spaces used exclusively for buses, trucks, other delivery vehicles, law enforcement vehicles or vehicular impound and motor pools where lots accessed by the public are provided with an accessible passenger loading zone.

**TABLE 1106.2**  
**ACCESSIBLE PARKING SPACES**

TOTAL PARKING SPACES PROVIDED IN PARKING FACILITIES	REQUIRED MINIMUM NUMBER OF ACCESSIBLE SPACES
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1,000	2% of total
1,001 and over	20, plus one for each 100, or fraction thereof, over 1,000

**1106.3 Groups I-1, R-1, R-2, R-3 and R-4.** *Accessible* parking spaces shall be provided in Group I-1, R-1, R-2, R-3 and R-4 occupancies in accordance with Items 1 through 4 as applicable.

1. In Group R-2, R-3 and R-4 occupancies that are required to have *Accessible*, *Type A* or *Type B dwelling units* or *sleeping units*, at least 2 percent, but not

less than one, of each type of parking space provided shall be *accessible*.

2. In Group I-1 and R-1 occupancies, accessible parking shall be provided in accordance with Table 1106.2.
3. Where at least one parking space is provided for each *dwelling unit* or *sleeping unit*, at least one *accessible* parking space shall be provided for each *Accessible* and *Type A unit*.
4. Where parking is provided within or beneath a building, *accessible* parking spaces shall be provided within or beneath the building.

**1106.4 Hospital outpatient facilities.** At least 10 percent, but not less than one, of care recipient and visitor parking spaces provided to serve *hospital* outpatient facilities shall be *accessible*.

**1106.5 Rehabilitation facilities and outpatient physical therapy facilities.** At least 20 percent, but not less than one, of the portion of care recipient and visitor parking spaces serving rehabilitation facilities specializing in treating conditions that affect mobility and outpatient physical therapy facilities shall be *accessible*.

**1106.6 Van spaces.** For every six or fraction of six accessible parking spaces, at least one shall be a van-accessible parking space.

**Exception:** In Group U *private garages* that serve Group R-2 and R-3 occupancies, van-accessible spaces shall be permitted to have vehicular routes, entrances, parking spaces and access aisles with a minimum vertical clearance of 7 feet (2134 mm).

**1106.7 Location.** Accessible parking spaces shall be located on the shortest accessible route of travel from adjacent parking to an accessible building entrance. In parking facilities that do not serve a particular building, accessible parking spaces shall be located on the shortest route to an accessible pedestrian entrance to the parking facility. Where buildings have multiple accessible entrances with adjacent parking, *accessible* parking spaces shall be dispersed and located near the accessible entrances.

#### Exceptions:

1. In multilevel parking structures, van-accessible parking spaces are permitted on one level.
2. *Accessible* parking spaces shall be permitted to be located in different parking facilities if substantially equivalent or greater accessibility is provided in terms of distance from an *accessible* entrance or entrances, parking fee and user convenience.

**1106.8 Parking meters and pay stations.** Where parking meters and pay stations serve accessible parking spaces, such parking meters and pay stations shall be *accessible*.

**1106.9 Passenger loading zones.** Passenger loading zones shall be *accessible*.

**1106.9.1 Continuous loading zones.** Where passenger loading zones are provided, one passenger loading zone

in every continuous 100 linear feet (30.4 m) maximum of loading zone space shall be *accessible*.

**1106.9.2 Medical facilities.** A passenger loading zone shall be provided at an accessible entrance to licensed medical and long-term care facilities where people receive physical or medical treatment or care and where the period of stay exceeds 24 hours.

**1106.9.3 Valet parking.** A passenger loading zone shall be provided at valet parking services.

**1106.9.4 Mechanical access parking garages.** Mechanical access parking garages shall provide at least one passenger loading zone at vehicle drop-off and vehicle pick-up areas.

## SECTION 1107 MOTOR-VEHICLE-RELATED FACILITIES

**1107.1 General.** Electrical vehicle charging stations shall comply with Section 1107.2. Fuel-dispensing systems shall comply with Section 1107.3.

**1107.2 Electrical vehicle charging stations.** Electrical vehicle charging stations shall comply with Sections 1107.2.1 and 1107.2.2.

**Exception:** Electrical vehicle charging stations provided to serve Group R-2, R-3 and R-4 occupancies are not required to comply with this section.

**1107.2.1 Number of accessible vehicle spaces.** Not less than 5 percent of vehicle spaces on the site served by electrical vehicle charging systems, but not fewer than one for each type of electric vehicle charging system, shall be accessible.

**1107.2.2 Vehicle space size.** Accessible vehicle spaces shall comply with the requirements for a van accessible parking space that is 132 inches (3350 mm) minimum in width with an adjoining access aisle that is 60 inches (1525 mm) minimum in width.

**1107.3 Fuel-dispensing systems.** Fuel-dispensing systems shall be *accessible*.

## SECTION 1108 DWELLING UNITS AND SLEEPING UNITS

**1108.1 General.** In addition to the other requirements of this chapter, occupancies having *dwelling units* or *sleeping units* shall be provided with accessible features in accordance with this section.

**1108.2 Design.** *Dwelling units* and *sleeping units* that are required to be *Accessible units*, *Type A units* and *Type B units* shall comply with the applicable portions of Chapter 11 of ICC A117.1. Units required to be *Type A units* are permitted to be designed and constructed as *Accessible units*. Units required to be *Type B units* are permitted to be designed and constructed as *Accessible units* or as *Type A units*.

**1108.3 Accessible spaces.** Rooms and spaces available to the general public or available for use by residents and serv-

ing *Accessible units*, *Type A units* or *Type B units* shall be *accessible*. *Accessible spaces* shall include toilet and bathing rooms, kitchen, living and dining areas and any exterior spaces, including patios, terraces and balconies.

### Exceptions:

1. *Stories* and *mezzanines* exempted by Section 1108.4.
2. Recreational facilities in accordance with Section 1111.2.
3. Exterior decks, patios or balconies that are part of *Type B units* and have impervious surfaces, and that are not more than 4 inches (102 mm) below the finished floor level of the adjacent interior space of the unit.

**1108.4 Accessible route.** Not fewer than one accessible route shall connect accessible building or facility entrances with the primary entrance of each *Accessible unit*, *Type A unit* and *Type B unit* within the building or facility and with those exterior and interior spaces and facilities that serve the units.

### Exceptions:

1. If due to circumstances outside the control of the owner, either the slope of the finished ground level between accessible facilities and buildings exceeds one unit vertical in 12 units horizontal (1:12), or where physical barriers or legal restrictions prevent the installation of an *accessible route*, a vehicular route with parking that complies with Section 1106 at each *public* or common use facility or building is permitted in place of the *accessible route*.
2. In Group I-3 facilities, an *accessible route* is not required to connect *stories* or *mezzanines* where *Accessible units*, all common use areas serving *Accessible units* and all *public use* areas are on an *accessible route*.
3. In Group R-2 facilities with *Type A units* complying with Section 1108.6.2.2.1, an *accessible route* is not required to connect *stories* or *mezzanines* where *Type A units*, all common use areas serving *Type A units* and all public use areas are on an *accessible route*.
4. In other than Group R-2 *dormitory* housing provided by places of education, in Group R-2 facilities with *Accessible units* complying with Section 1108.6.2.3.1, an *accessible route* is not required to connect *stories* or *mezzanines* where *Accessible units*, all common use areas serving *Accessible units* and all *public use* areas are on an *accessible route*.
5. In Group R-1, an *accessible route* is not required to connect *stories* or *mezzanines* within individual units, provided the *accessible* level meets the provisions for *Accessible units* and sleeping accommodations for two persons minimum and a toilet facility are provided on that level.

## ACCESSIBILITY

6. In congregate residences in Groups R-3 and R-4, an *accessible route* is not required to connect *stories* or *mezzanines* where *Accessible units* or *Type B units*, all common use areas serving *Accessible units* and *Type B units* and all *public use* areas serving *Accessible units* and *Type B units* are on an *accessible route*.
7. An *accessible route* between *stories* is not required where *Type B units* are exempted by Section 1108.7.

**1108.5 Group I.** *Accessible units* and *Type B units* shall be provided in Group I occupancies in accordance with Sections 1108.5.1 through 1108.5.5.

**1108.5.1 Group I-1.** *Accessible units* and *Type B units* shall be provided in Group I-1 occupancies in accordance with Sections 1108.5.1.1 and 1108.5.1.3.

**1108.5.1.1 Accessible units.** In Group I-1, Condition 1, at least 4 percent, but not less than one, of the *dwelling units* and *sleeping units* shall be *Accessible units*. Accessible dwelling units and sleeping units shall be dispersed among the various classes of units.

**Exceptions:**

1. Water closets shall not be required to comply with ICC A117.1 where such water closets comply with Section 1110.2.2, in not more than 50 percent of the *Accessible units*.
2. Roll-in-type showers shall not be required to comply with ICC A117.1 where roll-in-type showers comply with Section 1110.2.3, in not more than 50 percent of the *Accessible units*.

**1108.5.1.2 Accessible units in Group I-1, Condition 2.** In Group I-1, Condition 2, at least 10 percent, but not less than one, of the dwelling units and sleeping units shall be *Accessible units*. Accessible dwelling units and sleeping units shall be dispersed among the various classes of units.

**Exceptions:**

1. Water closets shall not be required to comply with ICC A117.1 where such water closets comply with Section 1110.2.2, in not more than 50 percent of the *Accessible units*.
2. Roll-in-type showers shall not be required to comply with ICC A117.1 where roll-in-type showers comply with Section 1110.2.3, in not more than 50 percent of the *Accessible units*.

**1108.5.1.3 Type B units.** In structures with four or more *dwelling units* or *sleeping units intended to be occupied as a residence*, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.5.2 Group I-2 nursing homes.** *Accessible units* and *Type B units* shall be provided in *nursing homes* of Group I-2, Condition 1 occupancies in accordance with Sections 1108.5.2.1 and 1108.5.2.2.

**1108.5.2.1 Accessible units.** At least 50 percent but not less than one of each type of the *dwelling units* and *sleeping units* shall be *Accessible units*.

**Exceptions:**

1. Water closets shall not be required to comply with ICC A117.1 where such water closets comply with Section 1110.2.2, in not more than 90 percent of the *Accessible units*.
2. Roll-in-type showers shall not be required to comply with ICC A117.1 where roll-in-type showers comply with Section 1110.2.3, in not more than 90 percent of the *Accessible units*.

**1108.5.2.2 Type B units.** In structures with four or more *dwelling units* or *sleeping units intended to be occupied as a residence*, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.5.3 Group I-2 hospitals.** *Accessible units* and *Type B units* shall be provided in general-purpose *hospitals*, psychiatric facilities and *detoxification facilities* of Group I-2 occupancies in accordance with Sections 1108.5.3.1 and 1108.5.3.2.

**1108.5.3.1 Accessible units.** At least 10 percent, but not less than one, of the *dwelling units* and *sleeping units* shall be *Accessible units*.

**Exception:** Entry doors to *Accessible dwelling units* or *sleeping units* shall not be required to provide the maneuvering clearance beyond the latch side of the door.

**1108.5.3.2 Type B units.** In structures with four or more *dwelling units* or *sleeping units intended to be occupied as a residence*, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.5.4 Group I-2 rehabilitation facilities.** In *hospitals* and rehabilitation facilities of Group I-2 occupancies that specialize in treating conditions that affect mobility, or units within either that specialize in treating conditions that affect mobility, 100 percent of the *dwelling units* and *sleeping units* shall be *Accessible units*.

**Exceptions:**

1. Water closets shall not be required to comply with ICC A117.1 where such water closets comply with Section 1110.2.2, in not more than 50 percent of *Accessible units*.



2. Roll-in-type showers shall not be required to comply with ICC A117.1 where roll-in-type showers comply with Section 1110.2.3, in not more than 50 percent of *Accessible units*.

**1108.5.5 Group I-3.** *Accessible units* shall be provided in Group I-3 occupancies in accordance with Sections 1108.5.5.1 through 1108.5.5.3.

**1108.5.5.1 Group I-3 sleeping units.** In Group I-3 occupancies, at least 3 percent of the total number of *sleeping units* in the facility, but not less than one unit in each classification level, shall be *Accessible units*.

**1108.5.5.2 Special holding cells and special housing cells or rooms.** In addition to the *Accessible units* required by Section 1108.5.5.1, where special holding *cells* or special housing *cells* or rooms are provided, at least one serving each purpose shall be an *Accessible unit*. *Cells* or rooms subject to this requirement include, but are not limited to, those used for purposes of orientation, protective custody, administrative or disciplinary detention or segregation, detoxification and medical isolation.

**Exception:** *Cells* or rooms specially designed without protrusions and that are used solely for purposes of suicide prevention shall not be required to include grab bars.

**1108.5.5.3 Medical care facilities.** Patient *sleeping units* or *cells* required to be *Accessible units* in medical care facilities shall be provided in addition to any medical isolation *cells* required to comply with Section 1108.5.5.2.

**1108.6 Group R.** *Accessible units*, *Type A units* and *Type B units* shall be provided in Group R occupancies in accordance with Sections 1108.6.1 through 1108.6.4.

**1108.6.1 Group R-1.** *Accessible units* and *Type B units* shall be provided in Group R-1 occupancies in accordance with Sections 1108.6.1.1 and 1108.6.1.2.

**1108.6.1.1 Accessible units.** *Accessible dwelling units* and *sleeping units* shall be provided in accordance

with Table 1108.6.1.1. On a multiple-building site, where structures contain more than 50 *dwelling units* or *sleeping units*, the number of *Accessible units* shall be determined per structure. On a multiple-building site, where structures contain 50 or fewer *dwelling units* or *sleeping units*, all *dwelling units* and *sleeping units* on a site shall be considered to determine the total number of *Accessible units*. *Accessible units* shall be dispersed among the various classes of units.

**1108.6.1.2 Type B units.** In structures with four or more *dwelling units* or *sleeping units intended to be occupied as a residence*, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.6.2 Group R-2.** *Accessible units*, *Type A units* and *Type B units* shall be provided in Group R-2 occupancies in accordance with Sections 1108.6.2.1 through 1108.6.2.3.

**1108.6.2.1 Live/work units.** In *live/work units* constructed in accordance with Section 419, the nonresidential portion is required to be *accessible*. In a structure where there are four or more *live/work units intended to be occupied as a residence*, the residential portion of the *live/work unit* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.6.2.2 Apartment houses, monasteries and convents.** *Type A units* and *Type B units* shall be provided in apartment houses, monasteries and convents in accordance with Sections 1108.6.2.2.1 and 1108.6.2.2.2. Bedrooms in monasteries and convents shall be counted as units for the purpose of determining the number of units. Where the bedrooms are grouped in *sleeping units*, only one bedroom in each *sleeping unit* shall count toward the number of required *Type A units*.

TABLE 1108.6.1.1  
ACCESSIBLE DWELLING UNITS AND SLEEPING UNITS

TOTAL NUMBER OF UNITS PROVIDED	MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITHOUT ROLL-IN SHOWERS	MINIMUM REQUIRED NUMBER OF ACCESSIBLE UNITS WITH ROLL-IN SHOWERS	TOTAL NUMBER OF REQUIRED ACCESSIBLE UNITS
1 to 25	1	0	1
26 to 50	2	0	2
51 to 75	3	1	4
76 to 100	4	1	5
101 to 150	5	2	7
151 to 200	6	2	8
201 to 300	7	3	10
301 to 400	8	4	12
401 to 500	9	4	13
501 to 1,000	2% of total	1% of total	3% of total
Over 1,000	20, plus 1 for each 100, or fraction thereof, over 1,000	10 plus 1 for each 100, or fraction thereof, over 1,000	30 plus 2 for each 100, or fraction thereof, over 1,000

## ACCESSIBILITY

**1108.6.2.2.1 Type A units.** In Group R-2 occupancies containing more than 20 *dwelling units* or *sleeping units*, at least 2 percent but not less than one of the units shall be a *Type A unit*. All Group R-2 units on a site shall be considered to determine the total number of units and the required number of *Type A units*. *Type A units* shall be dispersed among the various classes of units.

**Exceptions:**

1. The number of *Type A units* is permitted to be reduced in accordance with Section 1108.7.
2. *Existing structures* on a site shall not contribute to the total number of units on a site.

**1108.6.2.2.2 Type B units.** Where there are four or more *dwelling units* or *sleeping units intended to be occupied as a residence* in a single structure, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.6.2.3 Group R-2 other than live/work units, apartment houses, monasteries and convents.** In Group R-2 occupancies, other than *live/work units*, apartment houses, monasteries and convents falling within the scope of Sections 1108.6.2.1 and 1108.6.2.2, *Accessible units* and *Type B units* shall be provided in accordance with Sections 1108.6.2.3.1 and 1108.6.2.3.2. Bedrooms within *congregate living facilities, dormitories, sororities, fraternities and boarding houses* shall be counted as *sleeping units* for the purpose of determining the number of units. Where the *bedrooms* are grouped into *dwelling* or *sleeping units*, only one *bedroom* in each *dwelling* or *sleeping unit* shall be permitted to count toward the number of required *Accessible units*.

**1108.6.2.3.1 Accessible units.** *Accessible dwelling units* and *sleeping units* shall be provided in accordance with Table 1108.6.1.1.

**1108.6.2.3.2 Type B units.** Where there are four or more *dwelling units* or *sleeping units intended to be occupied as a residence* in a single structure, every *dwelling unit* and every *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.6.3 Group R-3.** In Group R-3 occupancies where there are four or more *dwelling units* or *sleeping units intended to be occupied as a residence* in a single structure, every *dwelling unit* and *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*. Bedrooms within *congregate living facilities, dormitories, sororities, fraternities, and boarding houses* shall be counted as

*sleeping units* for the purpose of determining the number of units.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.6.4 Group R-4.** *Accessible units* and *Type B units* shall be provided in Group R-4 occupancies in accordance with Sections 1108.6.4.1 and 1108.6.4.2. Bedrooms in Group R-4 facilities shall be counted as *sleeping units* for the purpose of determining the number of units.

**1108.6.4.1 Accessible units.** In Group R-4, Condition 1, at least one of the *sleeping units* shall be an *Accessible unit*. In Group R-4, Condition 2, at least two of the *sleeping units* shall be an *Accessible unit*.

**1108.6.4.2 Type B units.** In structures with four or more *sleeping units intended to be occupied as a residence*, every *sleeping unit intended to be occupied as a residence* shall be a *Type B unit*.

**Exception:** The number of *Type B units* is permitted to be reduced in accordance with Section 1108.7.

**1108.7 General exceptions.** Where specifically permitted by Section 1108.5 or 1108.6, the required number of *Type A units* and *Type B units* is permitted to be reduced in accordance with Sections 1108.7.1 through 1108.7.5.

**1108.7.1 Structures without elevator service.** Where elevator service is not provided in a structure, only the *dwelling units* and *sleeping units* that are located on stories indicated in Sections 1108.7.1.1 and 1108.7.1.2 are required to be *Type A units* and *Type B units*, respectively. The number of *Type A units* shall be determined in accordance with Section 1108.6.2.2.1.

**1108.7.1.1 One story with Type B units required.** At least one *story* containing *dwelling units* or *sleeping units intended to be occupied as a residence* shall be provided with an accessible entrance from the exterior of the structure and all units *intended to be occupied as a residence* on that *story* shall be *Type B units*.

**1108.7.1.2 Additional stories with Type B units.** Where stories have entrances not included in determining compliance with Section 1108.7.1.1, and such entrances are proximate to arrival points intended to serve units on that *story*, as indicated in Items 1 and 2, all *dwelling units* and *sleeping units intended to be occupied as a residence* served by that entrance on that *story* shall be *Type B units*.

1. Where the slopes of the undisturbed site measured between the planned entrance and all vehicular or pedestrian arrival points within 50 feet (15 240 mm) of the planned entrance are 10 percent or less.
2. Where the slopes of the planned finished grade measured between the entrance and all vehicular or pedestrian arrival points within 50 feet (15 240 mm) of the planned entrance are 10 percent or less.

Where arrival points are not within 50 feet (15 240 mm) of the entrance, the closest arrival point shall be used to determine access unless that arrival point serves the *story* required by Section 1108.7.1.1.

**1108.7.2 Multistory units.** A *multistory dwelling unit* or *sleeping unit* that is not provided with elevator service is not required to be a *Type B unit*. Where a *multistory unit* is provided with external elevator service to only one floor, the floor provided with elevator service shall be the primary entry to the unit, shall comply with the requirements for a *Type B unit* and, where provided within the unit, a living area, a kitchen and a toilet facility shall be provided on that floor.

**1108.7.3 Elevator service to the lowest story with units.** Where elevator service in the building provides an *accessible route* only to the lowest *story* containing *dwelling units* or *sleeping units intended to be occupied as a residence*, only the units on that *story* that are *intended to be occupied as a residence* are required to be *Type B units*.

**1108.7.4 Site impracticability.** On a site with multiple nonelevator buildings, the number of units required by Section 1108.7.1 to be *Type B units* is permitted to be reduced to a percentage that is equal to the percentage of the entire site having grades, prior to development, that are less than 10 percent, provided that all of the following conditions are met:

1. Not less than 20 percent of the units required by Section 1108.7.1 on the site are *Type B units*.
2. Units required by Section 1108.7.1, where the slope between the building entrance serving the units on that *story* and a pedestrian or vehicular arrival point is not greater than 8.33 percent, are *Type B units*.
3. Units required by Section 1108.7.1, where an elevated walkway is planned between a building entrance serving the units on that *story* and a pedestrian or vehicular arrival point and the slope between them is 10 percent or less, are *Type B units*.
4. Units served by an elevator in accordance with Section 1108.7.3 are *Type B units*.

**1108.7.5 Flood hazard areas.** *Type A units* and *Type B units* shall not be required for buildings without elevator service that are located in *flood hazard areas* as established in Section 1612.3, where the minimum required elevation of the *lowest floor* or lowest supporting horizontal structural member, as applicable, results in all of the following:

1. A difference in elevation between the minimum required floor elevation at the primary entrances and vehicular and pedestrian arrival points within 50 feet (15 240 mm) exceeding 30 inches (762 mm).
2. A slope exceeding 10 percent between the minimum required floor elevation at the primary

entrances and vehicular and pedestrian arrival points within 50 feet (15 240 mm).

Where such arrival points are not within 50 feet (15 240 mm) of the primary entrances, the closest arrival points shall be used.

## SECTION 1109 SPECIAL OCCUPANCIES

**1109.1 General.** In addition to the other requirements of this chapter, the requirements of Sections 1109.2 through 1109.4 shall apply to specific occupancies.

**1109.2 Assembly area seating.** A building, room or space used for assembly purposes with *fixed seating* shall comply with Sections 1109.2.1 through 1109.2.5. Lawn seating shall comply with Section 1109.2.6. Assistive listening systems shall comply with Section 1109.2.7. Performance areas viewed from assembly seating areas shall comply with Section 1109.2.8. Dining areas shall comply with Section 1109.2.9.

**1109.2.1 Services.** If a service or facility is provided in an area that is not *accessible*, the same service or facility shall be provided on an accessible level and shall be *accessible*.

**1109.2.2 Wheelchair spaces.** In rooms and spaces used for assembly purposes with *fixed seating*, accessible *wheelchair spaces* shall be provided in accordance with Sections 1109.2.2.1 through 1109.2.2.3.

**1109.2.2.1 General seating.** *Wheelchair spaces* shall be provided in accordance with Table 1109.2.2.1.

TABLE 1109.2.2.1  
ACCESSIBLE WHEELCHAIR SPACES

CAPACITY OF SEATING IN ASSEMBLY AREAS	MINIMUM REQUIRED NUMBER OF WHEELCHAIR SPACES
4 to 25	1
26 to 50	2
51 to 100	4
101 to 300	5
301 to 500	6
501 to 5,000	6, plus 1 for each 150, or fraction thereof, between 501 through 5,000
5,001 and over	36 plus 1 for each 200, or fraction thereof, over 5,000

**1109.2.2.2 Luxury boxes, club boxes and suites.** In each luxury box, club box and suite within arenas, stadiums and *grandstands*, *wheelchair spaces* shall be provided in accordance with Table 1109.2.2.1.

**1109.2.2.3 Other boxes.** In boxes other than those required to comply with Section 1109.2.2.2, the total number of *wheelchair spaces* provided shall be determined in accordance with Table 1109.2.2.1. *Wheelchair spaces* shall be located in not less than 20 percent of all boxes provided.

## ACCESSIBILITY

**1109.2.3 Companion seats.** At least one companion seat shall be provided for each *wheelchair space* required by Sections 1109.2.2.1 through 1109.2.2.3.

**1109.2.4 Dispersion of wheelchair spaces in multilevel assembly seating areas.** In *multilevel assembly seating areas*, *wheelchair spaces* shall be provided on the main floor level and on one of each two additional floor or *mezzanine* levels. *Wheelchair spaces* shall be provided in each luxury box, club box and suite within assembly facilities.

### Exceptions:

1. In *multilevel assembly seating areas* utilized for worship services where the second floor or *mezzanine* level contains 25 percent or less of the total seating capacity, *wheelchair spaces* shall be permitted to all be located on the main level.
2. In *multilevel assembly seating areas* where the second floor or *mezzanine* level provides 25 percent or less of the total seating capacity and 300 or fewer seats, all *wheelchair spaces* shall be permitted to be located on the main level.
3. *Wheelchair spaces* in team or player seating serving *areas of sport activity* are not required to be dispersed.

**1109.2.5 Designated aisle seats.** At least 5 percent, but not less than one, of the total number of aisle seats provided shall be designated aisle seats and shall be the aisle seats located closest to *accessible routes*.

**Exception:** Designated aisle seats are not required in team or player seating serving *areas of sport activity*.

**1109.2.6 Lawn seating.** Lawn seating areas and exterior overflow seating areas, where fixed seats are not provided, shall connect to an *accessible route*.

**1109.2.7 Assistive listening systems.** Each building, room or space used for assembly purposes where audible communications are integral to the use of the space shall have an assistive listening system.

**Exception:** Other than in courtrooms, an assistive listening system is not required where there is no audio amplification system.

**1109.2.7.1 Receivers.** The number and type of receivers shall be provided for assistive listening systems in accordance with Table 1109.2.7.1.

### Exceptions:

1. Where a building contains more than one room or space used for assembly purposes, the total number of required receivers shall be permitted to be calculated based on the total number of seats in the building, provided that all receivers are usable with all systems and if the rooms or spaces used for assembly purposes required to provide assistive listening are under one management.
2. Where all seats in a building, room or space used for assembly purposes are served by an induction loop assistive listening system, the minimum number of receivers required by Table 1109.2.7.1 to be hearing-aid compatible shall not be required.

**1109.2.7.2 Ticket windows.** Where ticket windows are provided in stadiums and arenas, at least one window at each location shall have an assistive listening system.

**1109.2.7.3 Public address systems.** Where stadiums, arenas and *grandstands* have 15,000 fixed seats or more and provide audible public announcements, they shall also provide prerecorded or real-time captions of those audible public announcements.

**1109.2.8 Performance areas.** An *accessible route* shall directly connect the performance area to the assembly seating area where a *circulation path* directly connects a performance area to an assembly seating area. An *accessible route* shall be provided from performance areas to ancillary areas or facilities used by performers.

**1109.2.9 Dining and drinking areas.** In dining and drinking areas, all interior and exterior floor areas shall be *accessible* and be on an accessible route.

### Exceptions:

1. An accessible route between *accessible* levels and stories above or below is not required where permitted by Section 1104.4, Exception 1.

TABLE 1109.2.7.1  
RECEIVERS FOR ASSISTIVE LISTENING SYSTEMS

CAPACITY OF SEATING IN ASSEMBLY AREAS	MINIMUM REQUIRED NUMBER OF RECEIVERS	MINIMUM NUMBER OF RECEIVERS TO BE HEARING-AID COMPATIBLE
50 or less	2	2
51 to 200	2, plus 1 per 25 seats over 50 seats*	2
201 to 500	2, plus 1 per 25 seats over 50 seats*	1 per 4 receivers*
501 to 1,000	20, plus 1 per 33 seats over 500 seats*	1 per 4 receivers*
1,001 to 2,000	35, plus 1 per 50 seats over 1,000 seats*	1 per 4 receivers*
Over 2,000	55, plus 1 per 100 seats over 2,000 seats*	1 per 4 receivers*

**Note:** \* = or fraction thereof



2. An accessible route to dining and drinking areas in a *mezzanine* is not required, provided that the *mezzanine* contains less than 25 percent of the total combined area for dining and drinking and the same services, and decor are provided in the *accessible* area.
3. In sports facilities, tiered dining areas providing seating required to be *accessible* shall be required to have *accessible routes* serving at least 25 percent of the dining area, provided that *accessible routes* serve *accessible* seating and where each tier is provided with the same services.
4. Employee-only work areas shall comply with Sections 1103.2.2 and 1104.3.1.

**1109.2.9.1 Dining surfaces.** Where dining surfaces for the consumption of food or drink are provided, at least 5 percent, but not less than one, of the dining surfaces for the seating and standing spaces shall be *accessible* and be distributed throughout the facility and located on a level accessed by an *accessible route*.

**1109.3 Self-service storage facilities.** *Self-service storage facilities* shall provide accessible individual self-storage spaces in accordance with Table 1109.3.

**TABLE 1109.3**  
**ACCESSIBLE SELF-SERVICE STORAGE FACILITIES**

TOTAL SPACES IN FACILITY	MINIMUM NUMBER OF REQUIRED ACCESSIBLE SPACES
1 to 200	5%, but not less than 1
Over 200	10, plus 2% of total number of units over 200

**1109.3.1 Dispersion.** Accessible individual self-service storage spaces shall be dispersed throughout the various classes of spaces provided. Where more classes of spaces are provided than the number of required accessible spaces, the number of *accessible* spaces shall not be required to exceed that required by Table 1109.3. *Accessible* spaces are permitted to be dispersed in a single building of a multiple-building facility.

**1109.4 Judicial facilities.** Judicial facilities shall comply with Sections 1109.4.1 and 1109.4.2.

**1109.4.1 Courtrooms.** Each courtroom shall be accessible and comply with Sections 1109.4.1.1 through 1109.4.1.5.

**1109.4.1.1 Jury box.** A *wheelchair space* shall be provided within the jury box.

**Exception:** Adjacent companion seating is not required.

**1109.4.1.2 Gallery seating.** *Wheelchair spaces* shall be provided in accordance with Table 1109.2.2.1. Designated aisle seats shall be provided in accordance with Section 1109.2.5.

**1109.4.1.3 Assistive listening systems.** An assistive listening system must be provided. Receivers shall be provided for the assistive listening system in accordance with Section 1109.2.7.1.

**1109.4.1.4 Employee work stations.** The judge's bench, clerk's station, bailiff's station, deputy clerk's

station and court reporter's station shall be located on an *accessible route*. The vertical access to elevated employee work stations within a courtroom is not required at the time of initial construction, provided a *ramp*, lift or elevator can be installed without requiring reconfiguration or extension of the courtroom or extension of the electrical system.

**1109.4.1.5 Other work stations.** The litigant's and counsel stations, including the lectern, shall be *accessible*.

**1109.4.2 Holding cells.** Central holding *cells* and court-floor holding *cells* shall comply with Sections 1109.4.2.1 and 1109.4.2.2.

**1109.4.2.1 Central holding cells.** Where separate central holding *cells* are provided for adult males, juvenile males, adult females or juvenile females, one of each type shall be *accessible*. Where central holding *cells* are provided and are not separated by age or sex, at least one accessible cell shall be provided.

**1109.4.2.2 Court-floor holding cells.** Where separate court-floor holding *cells* are provided for adult males, juvenile males, adult females or juvenile females, each courtroom shall be served by one accessible cell of each type. Where court-floor holding *cells* are provided and are not separated by age or sex, courtrooms shall be served by at least one accessible cell. *Accessible cells* shall be permitted to serve more than one courtroom.

## SECTION 1110 OTHER FEATURES AND FACILITIES

**1110.1 General.** *Accessible* building features and facilities shall be provided in accordance with Sections 1110.2 through 1110.16.

**Exception:** *Accessible units*, *Type A units* and *Type B units* shall comply with Chapter 10 of ICC A117.1.

**1110.2 Toilet and bathing facilities.** Each toilet room and bathing room shall be *accessible*. Where a floor level is not required to be connected by an *accessible route*, the only toilet rooms or bathing rooms provided within the facility shall not be located on the inaccessible floor. Except as provided for in Sections 1110.2.4 and 1110.2.5, at least one of each type of fixture, element, control or dispenser in each accessible toilet room and bathing room shall be *accessible*.

### Exceptions:

1. Toilet rooms or bathing rooms accessed only through a private office, not for *common* or *public use* and intended for use by a single occupant, shall be permitted to comply with the specific exceptions in ICC A117.1.
2. This section is not applicable to toilet and bathing rooms that serve *dwelling units* or *sleeping units* that are not required to be *accessible* by Section 1108.
3. Where multiple single-user toilet rooms or bathing rooms are clustered at a single location, at least 50 percent but not less than one room for each use at each cluster shall be *accessible*.

## ACCESSIBILITY

4. Where no more than one urinal is provided in a toilet room or bathing room, the urinal is not required to be *accessible*.
5. Toilet rooms or bathing rooms that are part of critical care or intensive care patient sleeping rooms serving *Accessible units* are not required to be *accessible*.
6. Toilet rooms or bathing rooms designed for bariatrics patients are not required to comply with the toilet room and bathing room requirement in ICC A117.1. The *sleeping units* served by bariatrics toilet or bathing rooms shall not count toward the required number of *Accessible sleeping units*.
7. Where permitted in Section 1108, in toilet rooms or bathrooms serving *Accessible units*, water closets designed for assisted toileting shall comply with Section 1110.2.2.
8. Where permitted in Section 1108, in bathrooms serving *Accessible units*, showers designed for assisted bathing shall comply with Section 1110.2.3.
9. Where toilet facilities are primarily for children's use, required *accessible* water closets, toilet compartments and lavatories shall be permitted to comply with children's provision of ICC A117.1.

**1110.2.1 Family or assisted-use toilet and bathing rooms.** In assembly and mercantile occupancies, an accessible family or assisted-use toilet room shall be provided where an aggregate of six or more male and female water closets is required. In buildings of mixed occupancy, only those water closets required for the assembly or mercantile occupancy shall be used to determine the family or assisted-use toilet room requirement. In recreational facilities where separate-sex bathing rooms are provided, an accessible family or assisted-use bathing room shall be provided. Fixtures located within family or assisted-use toilet and bathing rooms shall be included in determining the number of fixtures provided in an occupancy.

**Exception:** Where each separate-sex bathing room has only one shower or bathtub fixture, and is designed in accordance with 1110.2.1.2 through 1110.2.1.7, a family or assisted-use bathing room is not required.

**1110.2.1.1 Standard.** Family or assisted-use toilet and bathing rooms shall comply with Sections 1110.2.1.2 through 1110.2.1.6.

**1110.2.1.2 Family or assisted-use toilet rooms.** Family or assisted-use toilet rooms shall include only one water closet and only one lavatory, immediately adjacent to an adult changing station counter. A family or assisted-use bathing room in accordance with Section 1110.2.1.3 shall be considered to be a family or assisted-use toilet room.

**Exception:** The following additional fixtures shall be permitted in a family or assisted-use toilet room:

1. A urinal.
2. A child-height water closet.
3. A child-height lavatory.

#### 1110.2.1.3 Family or assisted-use bathing rooms.

Family or assisted-use bathing rooms shall include only one shower or bathtub fixture. Family or assisted-use bathing rooms shall also include one water closet and one lavatory adjacent to an adult changing station counter. Where storage facilities are provided for separate-sex bathing rooms, accessible storage facilities shall be provided for family or assisted-use bathing rooms.

**1110.2.1.4 Location.** Family or assisted-use toilet and bathing rooms shall be located on an *accessible route*. Family or assisted-use toilet rooms shall be located immediately adjacent to separate-sex toilet rooms in new construction or not more than one *story* above or below separate-sex toilet rooms. The *accessible route* from any separate-sex toilet room to a family or assisted-use toilet room shall not exceed 500 feet (152 m).

**1110.2.1.5 Prohibited location.** In passenger transportation facilities and airports, the *accessible route* from separate-sex toilet rooms to a family or assisted-use toilet room shall not pass through security checkpoints.

**1110.2.1.6 Privacy.** Doors to family or assisted-use toilet and bathing rooms shall be securable from within the room and be provided with an "occupied" indicator.

**1110.2.1.7 Adult Changing Counter.** Each Family or assisted-use toilet and bathing room shall include an adult changing station counter adjacent to the lavatory not less than 30 inches by 62 inches. A 36 inch grab bar or other equivalent edge protection shall be provided along the front of the counter.

**Exception:** A manufactured changing station may be used in lieu of a permanent counter where size, weight capacity, and required floor space are maintained with the station in the down position.

**1110.2.2 Water closets designed for assisted toileting.** Water closets designed for assisted toileting shall comply with Sections 1110.2.2.1 through 1110.2.2.6.

**1110.2.2.1 Location.** The centerline of the water closet shall be not less than 24 inches (610 mm) and not greater than 26 inches (660 mm) from one side of the required clearance.

**1110.2.2.2 Clearance.** Clearance around the water closet shall comply with Sections 1110.2.2.2.1 through 1110.2.2.2.3.

**1110.2.2.2.1 Clearance width.** Clearance around a water closet shall be not less than 66 inches (1675 mm) in width, measured perpendicularly from the side of the clearance that is not less than 24 inches (610 mm) and not greater than 26 inches (660 mm) from the water closet centerline.

**1110.2.2.2.2 Clearance depth.** Clearance around the water closet shall be not less than 78 inches (1980 mm) in depth, measured perpendicularly from the rear wall

**1110.2.2.2.3 Clearance overlap.** The required clearance around the water closet shall permit overlaps per ICC A117.1, Section 604.3.3

**1110.2.2.3 Height.** The height of the water closet seats shall comply with ICC A117.1, Section 604.4.

**1110.2.2.4 Swing-up grab bars.** Swing-up grab bars shall comply with ICC A117.1, Sections 609.2 and 609.8. Swing-up grab bars shall be provided on both sides of the water closet and shall comply with all of the following:

1. The centerline of the grab bar shall be not less than 14 inches (356 mm) and not greater than 16 inches (405 mm) from the centerline of the water closet.
2. The length of the grab bar is not less than 36 inches (915 mm) in length, measured from the rear wall to the end of the grab bar.
3. The top of the grab bar in the down position is not less than 30 inches (760 mm) and not greater than 34 inches (865 mm) above the floor.

**1110.2.2.5 Flush controls.** Flush controls shall comply with ICC A117.1, Section 604.6.

**1110.2.2.6 Dispensers** Toilet paper dispensers shall be mounted on at least one of the swing-up grab bars and the outlet of the dispenser shall be located not less than 24 inches (610 mm) and not greater than 36 inches (915 mm) from the rear wall.

**1110.2.3 Standard roll-in-type shower compartment designed for assisted bathing.** Standard roll-in-type shower compartments designed for assisted bathing shall comply with Sections 1110.2.3.1 through 1110.2.3.9.

**1110.2.3.1 Size.** Standard roll-in-type shower compartments shall have a clear inside dimension of not less than 60 inches (1525 mm) in width and 30 inches (760 mm) in depth, measured at the center point of opposing sides. An entry not less than 60 inches (1525 mm) in width shall be provided.

**1110.2.3.2 Clearance.** A clearance of not less than 60 inches (1525 mm) in length adjacent to the 60-inch (1525 mm) width of the open face of the shower compartment, and not less than 30 inches (760 mm) in depth, shall be provided.

**Exceptions:**

1. A lavatory complying with ICC A117.1, Section 606 shall be permitted at one end of the clearance.
2. Where the shower compartment exceeds minimum sizes, the clear floor space shall be placed adjacent to the grab bars and not less than 30 inches (762 mm) from the back wall.

**1110.2.3.3 Grab bars.** Grab bars shall comply with ICC A117.1, Section 609 and shall be provided in accordance with Sections 1110.2.3.3.1 and 1110.2.3.3.2. In standard roll-in-type shower compartments, grab bars shall be provided on three walls. Where multiple grab bars are used, required horizontal grab bars shall be installed at the same height above

the floor. Grab bars can be separate bars or one continuous bar.

**1110.2.3.3.1 Back-wall grab bar.** The back-wall grab bar shall extend the length of the back wall and extend within 6 inches (150 mm) maximum from the two adjacent sidewalls.

**Exception:** The back-wall grab bar shall not be required to exceed 48 inches (1220 mm) in length. The rear grab bar shall be located with one end within 6 inches maximum of a sidewall with a grab bar complying with Section 1110.2.3.3.2.

**1110.2.3.3.2 Sidewall grab bars.** The sidewall grab bars shall extend the length of the wall and extend within 6 inches (150 mm) of the adjacent back wall.

**Exceptions:**

1. The sidewall grab bar shall not be required to exceed 30 inches (760 mm) in length. The side grab bar shall be located with one end within 6 inches (152 mm) of the back wall with a grab bar complying with Section 1110.2.3.3.1.
2. Where the sidewalls are located 72 inches (1830 mm) or greater apart, a grab bar is not required on one of the sidewalls.

**1110.2.3.4 Seats.** Wall-mounted folding seats shall not be installed.

**1110.2.3.5 Controls and hand showers.** In standard roll-in-type showers, the controls and hand shower shall be located not less than 38 inches (965 mm) and not greater than 48 inches (1220 mm) above the shower floor. Controls shall be located to facilitate caregiver access.

**1110.2.3.6 Hand showers.** Hand showers shall comply with ICC A117.1, Section 608.5.

**1110.2.3.7 Thresholds.** Thresholds shall comply with ICC A117.1, Section 608.6.

**1110.2.3.8 Shower enclosures.** Shower compartment enclosures for shower compartments shall comply with ICC A117.1, Section 608.7.

**1110.2.3.9 Water temperature.** Water temperature shall comply with ICC A117.1, Section 608.8.

**1110.2.4 Water closet compartment.** Where water closet compartments are provided in a toilet room or bathing room, at least 5 percent of the total number of compartments shall be wheelchair accessible. Where the combined total water closet compartments and urinals provided in a toilet room or bathing room is six or more, at least 5 percent of the total number of compartments shall be ambulatory accessible, provided in addition to the wheelchair-accessible compartment.

**1110.2.5 Lavatories.** Where lavatories are provided, at least 5 percent, but not less than one, shall be *accessible*. Where an accessible lavatory is located within the accessible water closet compartment at least one additional



## ACCESSIBILITY

accessible lavatory shall be provided in the multicompart-ment toilet room outside the water closet compartment. Where the total lavatories provided in a toilet room or bathing facility is six or more, at least one lavatory with enhanced reach ranges shall be provided.

**1110.3 Sinks.** Where sinks are provided, at least 5 percent but not less than one provided in accessible spaces shall be *accessible*.

**Exception:** Mop or service sinks are not required to be *accessible*.

**1110.4 Kitchens and kitchenettes.** Where kitchens and kitchenettes are provided in accessible spaces or rooms, they shall be *accessible*.

**1110.5 Drinking fountains.** Where drinking fountains are provided on an exterior site, on a floor or within a secured area, the drinking fountains shall be provided in accordance with Sections 1110.5.1 and 1110.5.2.

**1110.5.1 Minimum number.** Not fewer than two drinking fountains shall be provided. One drinking fountain shall comply with the requirements for people who use a wheelchair and one drinking fountain shall comply with the requirements for standing persons.

### Exceptions:

1. A single drinking fountain with two separate spouts that complies with the requirements for people who use a wheelchair and standing persons shall be permitted to be substituted for two separate drinking fountains.
2. Where drinking fountains are primarily for children's use, drinking fountains for people using wheelchairs shall be permitted to comply with the children's provisions in ICC A117.1 and drinking fountains for standing children shall be permitted to provide the spout at 30 inches (762 mm) minimum above the floor.

**1110.5.2 More than the minimum number.** Where more than the minimum number of drinking fountains specified in Section 1110.5.1 is provided, 50 percent of the total number of drinking fountains provided shall comply with the requirements for persons who use a wheelchair and 50 percent of the total number of drinking fountains provided shall comply with the requirements for standing persons.

### Exceptions:

1. Where 50 percent of the drinking fountains yields a fraction, 50 percent shall be permitted to be rounded up or down, provided that the total number of drinking fountains complying with this section equals 100 percent of the drinking fountains.
2. Where drinking fountains are primarily for children's use, drinking fountains for people using wheelchairs shall be permitted to comply with the children's provisions in ICC A117.1 and drinking fountains for standing children

shall be permitted to provide the spout at 30 inches (762 mm) minimum above the floor.

**1110.6 Bottle-filling stations.** Where bottle-filling stations are provided, they shall be *accessible*.

**Exception:** Bottle-filling stations over drinking fountains for standing persons are not required to be *accessible*, provided that bottle-filling stations are also located over the drinking fountains for persons using wheelchairs.

**1110.7 Saunas and steam rooms.** Where provided, saunas and steam rooms shall be *accessible*.

**Exception:** Where saunas or steam rooms are clustered at a single location, at least 5 percent of the saunas and steam rooms, but not less than one, of each type in each cluster shall be *accessible*.

**1110.8 Elevators.** Passenger elevators on an *accessible route* shall be *accessible* and comply with Chapter 30.

**1110.9 Lifts.** Platform (wheelchair) lifts are permitted to be a part of a required *accessible route* in new construction where indicated in Items 1 through 10. Platform (wheelchair) lifts shall be installed in accordance with ASME A18.1.

1. An *accessible route* to a performing area and speaker platforms.
2. An *accessible route* to *wheelchair spaces* required to comply with the wheelchair space dispersion requirements of Sections 1109.2.2 through 1109.2.6.
3. An *accessible route* to spaces that are not open to the general public with an *occupant load* of not more than five.
4. An *accessible route* within an individual *dwelling unit* or *sleeping unit* required to be an *Accessible unit*, *Type A unit* or *Type B unit*.
5. An *accessible route* to jury boxes and witness stands; raised courtroom stations including judges' benches, clerks' stations, bailiffs' stations, deputy clerks' stations and court reporters' stations; and to depressed areas such as the well of the court.
6. An *accessible route* to load and unload areas serving amusement rides.
7. An *accessible route* to play components or *soft contained play structures*.
8. An *accessible route* to team or player seating areas serving *areas of sport activity*.
9. An *accessible route* instead of gangways serving recreational boating facilities and fishing piers and platforms.
10. An *accessible route* where existing exterior site constraints make use of a *ramp* or elevator infeasible.

**1110.10 Storage.** Where fixed or built-in storage elements such as cabinets, coat hooks, shelves, medicine cabinets, lockers, closets and drawers are provided in required accessible spaces, at least 5 percent, but not less than one of each type shall be *accessible*.



**1110.10.1 Equity.** Accessible facilities and spaces shall be provided with the same storage elements as provided in the similar nonaccessible facilities and spaces.

**1110.10.2 Shelving and display units.** Self-service shelves and display units shall be located on an *accessible route*. Such shelving and display units shall not be required to comply with reach-range provisions.

**1110.11 Detectable warnings.** Passenger transit platform edges bordering a drop-off and not protected by platform screens or *guards* shall have a *detectable warning*.

**Exception:** *Detectable warnings* are not required at bus stops.

**1110.12 Seating at tables, counters and work surfaces.** Where seating or standing space at fixed or built-in tables, counters or work surfaces is provided in accessible spaces, at least 5 percent of the seating and standing spaces, but not less than one, shall be *accessible*.

**Exception:** Check-writing surfaces at check-out aisles not required to comply with Section 1110.13.1 are not required to be *accessible*.

**1110.12.1 Dispersion.** Accessible fixed or built-in seating at tables, counters or work surfaces shall be distributed throughout the space or facility containing such elements and located on a level accessed by an *accessible route*.

**1110.12.2 Visiting areas.** Visiting areas in judicial facilities and Group I-3 shall comply with Sections 1110.12.2.1 and 1110.12.2.2.

**1110.12.2.1 Cubicles and counters.** At least 5 percent, but not less than one of the cubicles, shall be *accessible* on both the visitor and detainee sides. Where counters are provided, at least one shall be *accessible* on both the visitor and detainee sides.

**Exception:** This requirement shall not apply to the detainee side of cubicles or counters at noncontact visiting areas not serving *Accessible unit* holding cells.

**1110.12.2.2 Partitions.** Where solid partitions or security glazing separate visitors from detainees, at least one of each type of cubicle or counter partition shall be *accessible*.

**1110.13 Service facilities.** Service facilities shall provide for accessible features in accordance with Sections 1110.13.1 through 1110.13.4.

**1110.13.1 Check-out aisles.** Where check-out aisles are provided, accessible check-out aisles shall be provided in accordance with Table 1110.13.1. Where check-out aisles serve different functions, accessible check-out aisles shall be provided in accordance with Table 1110.13.1 for each function. Where check-out aisles are dispersed throughout the building or facility, accessible check-out aisles shall also be dispersed. Traffic control devices, security devices and turnstiles located in accessible check-out aisles or lanes shall be *accessible*.

**Exception:** Where the public use area is under 5,000 square feet (465 m<sup>2</sup>) not more than one accessible check-out aisle shall be required.

**TABLE 1110.13.1  
ACCESSIBLE CHECK-OUT AISLES**

TOTAL CHECK-OUT AISLES OF EACH FUNCTION	MINIMUM NUMBER OF ACCESSIBLE CHECK-OUT AISLES OF EACH FUNCTION
1 to 4	1
5 to 8	2
9 to 15	3
Over 15	3, plus 20% of additional aisles

**1110.13.2 Sales and service counters and windows.**

Where counters or windows are provided for sale or distribution of goods or services, at least one of each type of counter and window provided shall be *accessible*. Where such counters or windows are dispersed throughout the building or facility, accessible counters or windows shall also be dispersed.

**1110.13.3 Food service lines.** Food service lines shall be *accessible*. Where self-service shelves are provided, at least 50 percent, but not less than one, of each type provided shall be *accessible*.

**1110.13.4 Queue and waiting lines.** Queue and waiting lines servicing accessible counters or check-out aisles shall be *accessible*.

**1110.14 Dressing, fitting and locker rooms.** Where dressing rooms, fitting rooms or locker rooms are provided, at least 5 percent, but not less than one, of each type of use in each cluster provided shall be *accessible*.

**1110.15 Controls, operating mechanisms and hardware.** Controls, operating mechanisms and hardware intended for operation by the occupant, including switches that control lighting and ventilation and electrical convenience outlets, in accessible spaces, along accessible routes or as parts of *accessible* elements shall be *accessible*.

#### Exceptions:

- Operable parts that are intended for use only by service or maintenance personnel shall not be required to be *accessible*.
- Access doors or gates in barrier walls and fences protecting pools, spas and hot tubs shall be permitted to comply with Section 1010.2.3.
- Operable parts exempted in accordance with ICC A117.1 are not required to be *accessible*.

**1110.16 Gaming machines and gaming tables.** At least two percent of the total, but not fewer than one, of each *gaming machine type* and *gaming table type* shall be *accessible*. Where multiple *gaming areas* occur, accessible gaming machines and gaming tables shall be distributed throughout.

## SECTION 1111 RECREATIONAL FACILITIES

**1111.1 General.** Recreational facilities shall be provided with accessible features in accordance with Sections 1111.2 through 1111.4.

## ACCESSIBILITY

**1111.2 Facilities serving Group R-2, R-3 and R-4 occupancies.** Recreational facilities that serve Group R-2, R-3 and Group R-4 occupancies shall comply with Sections 1111.2.1 through 1111.2.3, as applicable.

**1111.2.1 Facilities serving Accessible units.** In Group R-2 and R-4 occupancies where recreational facilities serve *Accessible units*, every recreational facility of each type serving *Accessible units* shall be *accessible*.

**1111.2.2 Facilities serving Type A and Type B units in a single building.** In Group R-2, R-3 and R-4 occupancies where recreational facilities serve a single building containing *Type A units* or *Type B units*, 25 percent, but not less than one, of each type of recreational facility shall be *accessible*. Every recreational facility of each type on a site shall be considered to determine the total number of each type that is required to be *accessible*.

**1111.2.3 Facilities serving Type A and Type B units in multiple buildings.** In Group R-2, R-3 and R-4 occupancies on a single site where multiple buildings containing *Type A units* or *Type B units* are served by recreational facilities, 25 percent, but not less than one, of each type of recreational facility serving each building shall be *accessible*. The total number of each type of recreational facility that is required to be *accessible* shall be determined by considering every recreational facility of each type serving each building on the site.

**1111.3 Other occupancies.** Recreational facilities not falling within the purview of Section 1111.2 shall be *accessible*.

**1111.4 Recreational facilities.** Recreational facilities shall be *accessible* and shall be on an *accessible route* to the extent specified in this section.

**1111.4.1 Area of sport activity.** Each *area of sport activity* shall be on an *accessible route* and shall not be required to be *accessible* except as provided for in Sections 1111.4.2 through 1111.4.15.

**1111.4.2 Team or player seating.** At least one wheelchair space shall be provided in team or player seating areas serving *areas of sport activity*.

**Exception:** Wheelchair spaces shall not be required in team or player seating areas serving bowling lanes that are not required to be *accessible* in accordance with Section 1111.4.3.

**1111.4.3 Bowling lanes.** An *accessible route* shall be provided to at least 5 percent, but not less than one, of each type of bowling lane.

**1111.4.4 Court sports.** In court sports, at least one *accessible route* shall directly connect both sides of the court.

**1111.4.5 Raised boxing or wrestling rings.** Raised boxing or wrestling rings are not required to be *accessible* or to be on an *accessible route*.

**1111.4.6 Raised refereeing, judging and scoring areas.** Raised structures used solely for refereeing, judging or scoring a sport are not required to be *accessible* or to be on an *accessible route*.

**1111.4.7 Animal containment areas.** Animal containment areas that are not within public use areas are not required to be *accessible* or to be on an *accessible route*.

**1111.4.8 Amusement rides.** Amusement rides that move persons through a fixed course within a defined area shall comply with Sections 1111.4.8.1 through 1111.4.8.3.

**Exception:** Mobile or portable amusement rides shall not be required to be *accessible*.

**1111.4.8.1 Load and unload areas.** Load and unload areas serving amusement rides shall be *accessible* and be on an *accessible route*. Where load and unload areas have more than one loading or unloading position, at least one loading and unloading position shall be on an *accessible route*.

**1111.4.8.2 Wheelchair spaces, ride seats designed for transfer and transfer devices.** Where amusement rides are in the load and unload position, the following shall be on an *accessible route*.

1. The position serving a wheelchair space.
2. Amusement ride seats designed for transfer.
3. Transfer devices.

**1111.4.8.3 Minimum number.** Amusement rides shall provide at least one wheelchair space, amusement ride seat designed for transfer or transfer device.

**Exceptions:**

1. Amusement rides that are controlled or operated by the rider are not required to comply with this section.
2. Amusement rides designed primarily for children, where children are assisted on and off the ride by an adult, are not required to comply with this section.
3. Amusement rides that do not provide seats that are built-in or mechanically fastened shall not be required to comply with this section.

**1111.4.9 Recreational boating facilities.** Boat slips required to be *accessible* by Sections 1111.4.9.1 and 1111.4.9.2 and boarding piers at boat launch ramps required to be *accessible* by Section 1111.4.9.3 shall be on an *accessible route*.

**1111.4.9.1 Boat slips.** Accessible boat slips shall be provided in accordance with Table 1111.4.9.1. All units on the site shall be combined to determine the number of *accessible* boat slips required. Where the number of boat slips is not identified, each 40 feet (12 m) of boat slip edge provided along the perimeter of the pier shall be counted as one boat slip for the purpose of this section.

**Exception:** Boat slips not designed for embarking or disembarking are not required to be *accessible* or be on an *accessible route*.

**TABLE 1111.4.9.1  
BOAT SLIPS**

TOTAL NUMBER OF BOAT SLIPS PROVIDED	MINIMUM NUMBER OF REQUIRED ACCESSIBLE BOAT SLIPS
1 to 25	1
26 to 50	2
51 to 100	3
101 to 150	4
151 to 300	5
301 to 400	6
401 to 500	7
501 to 600	8
601 to 700	9
701 to 800	10
801 to 900	11
901 to 1,000	12
1,001 and over	12, plus 1 for every 100, or fraction thereof, over 1,000

**1111.4.9.2 Dispersion.** Accessible boat slips shall be dispersed throughout the various types of boat slips provided. Where the minimum number of *accessible* boat slips has been met, further dispersion shall not be required.

**1111.4.9.3 Boarding piers at boat launch ramps.** Where boarding piers are provided at boat launch ramps, at least 5 percent, but not less than one, of the boarding piers shall be *accessible*.

**1111.4.10 Exercise machines and equipment.** At least one of each type of exercise machine and equipment shall be on an *accessible route*.

**1111.4.11 Fishing piers and platforms.** Fishing piers and platforms shall be *accessible* and be on an *accessible route*.

**1111.4.12 Miniature golf facilities.** Miniature golf facilities shall comply with Sections 1111.4.12.1 through 1111.4.12.3.

**1111.4.12.1 Minimum number.** At least 50 percent of holes on miniature golf courses shall be *accessible*.

**1111.4.12.2 Miniature golf course configuration.** Miniature golf courses shall be configured so that the accessible holes are consecutive. Miniature golf courses shall provide an accessible route from the last *accessible* hole to the course entrance or exit without requiring travel through any other holes on the course.

**Exception:** One break in the sequence of consecutive holes shall be permitted provided that the last hole on the miniature golf course is the last hole in the sequence.

**1111.4.12.3 Accessible route.** Holes required to comply with Section 1111.4.12.1, including the start of play, shall be on an *accessible route*.

**1111.4.13 Play areas.** Play areas containing play components designed and constructed for children shall be located on an *accessible route*.

**1111.4.14 Swimming pools, wading pools, cold baths, hot tubs and spas.** *Swimming pools*, wading pools, cold baths, hot tubs and spas shall be *accessible* and be on an accessible route.

**Exceptions:**

1. Catch pools or a designated section of a pool used as a terminus for a water slide flume shall not be required to provide an *accessible* means of entry, provided that a portion of the catch pool edge is on an *accessible route*.
2. Where spas, cold baths or hot tubs are provided in a cluster, at least 5 percent, but not less than one of each type of spa, cold bath or hot tub in each cluster, shall be accessible and be on an *accessible route*.
3. *Swimming pools*, wading pools, spas, cold baths and hot tubs that are required to be *accessible* by Sections 1111.2.2 and 1111.2.3 are not required to provide *accessible* means of entry into the water.

**1111.4.14.1 Raised diving boards and diving platforms.** Raised diving boards and diving platforms are not required to be *accessible* or to be on an *accessible route*.

**1111.4.14.2 Water slides.** Water slides are not required to be *accessible* or to be on an *accessible route*.

**1111.4.15 Shooting facilities with firing positions.** Where shooting facilities with firing positions are designed and constructed at a site, at least 5 percent, but not less than one, of each type of firing position shall be *accessible* and be on an *accessible route*.

**Exception:** Shooting facilities with firing positions on free-standing platforms that are elevated more than 12 feet (3660 mm) above grade, provided that the aggregate area of the elevated firing positions is not more than 500 square feet (46 m<sup>2</sup>), are not required to be accessible.

## SECTION 1112 SIGNAGE

**1112.1 Signs.** Required accessible elements shall be identified by the International Symbol of Accessibility at the following locations.

1. Accessible parking spaces required by Section 1106.2.

**Exception:** Where the total number of parking spaces provided is four or less, identification of accessible parking spaces is not required.

## ACCESSIBILITY

2. *Accessible* parking spaces required by Section 1106.3.

**Exception:** In Group I-1, R-2, R-3 and R-4 facilities, where parking spaces are assigned to specific *dwelling units* or *sleeping units*, identification of *accessible* parking spaces is not required.

3. *Accessible* passenger loading zones.
4. *Accessible* toilet or bathing rooms where not all toilet or bathing rooms are *accessible*.
5. *Accessible* entrances where not all entrances are *accessible*.
6. *Accessible* check-out aisles where not all aisles are *accessible*. The sign, where provided, shall be above the check-out aisle in the same location as the check-out aisle number or type of check-out identification.
7. *Accessible* dressing, fitting and locker rooms where not all such rooms are *accessible*.
8. *Accessible areas of refuge* in accordance with Section 1009.9.
9. Exterior areas for assisted rescue in accordance with Section 1009.9.
10. In recreational facilities, lockers that are required to be *accessible* in accordance with Section 1110.10.

**1112.2 Signs identifying toilet or bathing rooms.** Signs required in Section 403.4 of the *International Plumbing Code* identifying toilet rooms and bathing rooms shall be visual characters, raised characters and braille complying with ICC A117.1. Where pictograms are provided as designations for toilet rooms and bathing rooms, the pictograms shall have visual characters, raised characters and braille complying with ICC A117.1.

**1112.3 Directional signage.** Directional signage indicating the route to the nearest like accessible element shall be provided at the following locations. These directional signs shall include the International Symbol of Accessibility and sign characters shall meet the visual character requirements in accordance with ICC A117.1.

1. Inaccessible building entrances.
2. Inaccessible public toilets and bathing facilities.
3. Elevators not serving an accessible route.
4. At each separate-sex toilet and bathing room indicating the location of the nearest family/assisted use toilet or bathing room where provided in accordance with Section 1110.2.1.
5. At *exits* and *exit stairways* serving a required *accessible* space, but not providing an *approved* accessible means of egress, signage shall be provided in accordance with Section 1009.10.
6. Where drinking fountains for persons using wheel-chairs and drinking fountains for standing persons are not located adjacent to each other, directional signage shall be provided indicating the location of the other drinking fountains.

**1112.4 Other signs.** Signage indicating special accessibility provisions shall be provided as shown.

1. Each assembly area required to comply with Section 1109.2.7 shall provide a sign notifying patrons of the availability of assistive listening systems. The sign shall comply with ICC A117.1 requirements for visual characters and include the International Symbol of Access for Hearing Loss.

**Exception:** Where ticket offices or windows are provided, signs are not required at each assembly area provided that signs are displayed at each ticket office or window informing patrons of the availability of assistive listening systems.

2. At each door to an *area of refuge* providing *direct access* to a *stairway*, exterior area for assisted rescue, *exit stairway*, *exit passageway* or *exit discharge*, signage shall be provided in accordance with Section 1013.4.
3. At *areas of refuge*, signage shall be provided in accordance with Section 1009.11.
4. At exterior areas for assisted rescue, signage shall be provided in accordance with Section 1009.11.
5. At two-way communication systems, signage shall be provided in accordance with Section 1009.8.2.
6. In *interior exit stairways* and *ramps*, floor level signage shall be provided in accordance with Section 1023.9.
7. Signs identifying the type of access provided on amusement rides required to be *accessible* by Section 1111.4.8 shall be provided at entries to queues and waiting lines. In addition, where accessible unload areas also serve as accessible load areas, signs indicating the location of the accessible load and unload areas shall be provided at entries to queues and waiting lines. These directional sign characters shall meet the visual character requirements in accordance with ICC A117.1.

**1112.5 Variable message signs.** Where provided in the locations in Sections 1112.5.1 and 1112.5.2, variable message signs shall comply with the variable message sign requirements of ICC A117.1.

**1112.5.1 Transportation facilities.** Where provided in transportation facilities, variable message signs conveying transportation-related information shall comply with Section 1112.5.

**1112.5.2 Emergency shelters.** Where provided in buildings that are designated as emergency shelters, variable message signs conveying emergency-related information shall comply with Section 1112.5.

**Exception:** Where equivalent information is provided in an audible manner, variable message signs are not required to comply with ICC A117.1.



## CHAPTER 12

# INTERIOR ENVIRONMENT

### User note:

**About this chapter:** Chapter 12 provides minimum provisions for the interior of buildings—the occupied environment. Ventilation, lighting, and space heating are directly regulated in this chapter and in conjunction with the International Mechanical Code® and the International Energy Conservation Code®. Minimum room size, maximum room-to-room sound transmission and classroom acoustics are set for educational occupancies.

### SECTION 1201 GENERAL

**1201.1 Scope.** The provisions of this chapter shall govern ventilation, temperature control, lighting, yards and courts, sound transmission, room dimensions, surrounding materials and rodentproofing associated with the interior spaces of buildings.

### SECTION 1202 VENTILATION

**1202.1 General.** Buildings shall be provided with natural ventilation in accordance with Section 1202.5, or mechanical ventilation in accordance with the *International Mechanical Code*.

Where the air infiltration rate in a dwelling unit is less than 5 air changes per hour where tested with a blower door at a pressure 0.2 inch w.c. (50 Pa) in accordance with Section R402.4.1.2 of the *International Energy Conservation Code—Residential Provisions*, the dwelling unit shall be ventilated by mechanical means in accordance with Section 403 of the *International Mechanical Code*. Ambulatory care facilities and Group I-2 occupancies shall be ventilated by mechanical means in accordance with Section 407 of the *International Mechanical Code*.

**1202.2 Roof ventilation.** Roof assemblies shall be ventilated in accordance with this section or shall comply with Section 1202.3.

**1202.2.1 Ventilated attics and rafter spaces.** Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof framing members shall have cross ventilation for each separate space by ventilation openings protected against the entrance of rain and snow. Blocking and bridging shall be arranged so as not to interfere with the movement of air. An airspace of not less than 1 inch (25 mm) shall be provided between the insulation and the roof sheathing. The net free ventilating area shall be not less than  $\frac{1}{150}$  of the area of the space ventilated. Ventilators shall be installed in accordance with manufacturer's installation instructions.

**Exception:** The net free cross-ventilation area shall be permitted to be reduced to  $\frac{1}{300}$  provided both of the following conditions are met:

1. In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.

2. At least 40 percent and not more than 50 percent of the required venting area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically, with the balance of the ventilation provided by eave or cornice vents. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

**1202.2.2 Openings into attic.** Exterior openings into the attic space of any building intended for human occupancy shall be protected to prevent the entry of birds, squirrels, rodents, snakes and other similar creatures. Openings for ventilation having a least dimension of not less than  $\frac{1}{16}$  inch (1.6 mm) and not more than  $\frac{1}{4}$  inch (6.4 mm) shall be permitted. Openings for ventilation having a least dimension larger than  $\frac{1}{4}$  inch (6.4 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, perforated vinyl or similar material with openings having a least dimension of not less than  $\frac{1}{16}$  inch (1.6 mm) and not more than  $\frac{1}{4}$  inch (6.4 mm). Where combustion air is obtained from an attic area, it shall be in accordance with Chapter 7 of the *International Mechanical Code*.

**1202.3 Unvented attic and unvented enclosed rafter assemblies.** Unvented attics and unvented enclosed roof framing assemblies created by ceilings applied directly to the underside of the roof framing members/rafters and the structural roof sheathing at the top of the roof framing members shall be permitted where all of the following conditions are met:

1. The unvented attic space is completely within the building thermal envelope.
2. No interior Class I vapor retarders are installed on the ceiling side (attic floor) of the unvented attic assembly or on the ceiling side of the unvented enclosed roof framing assembly.
3. Where wood shingles or shakes are used, not less than a  $\frac{1}{4}$ -inch (6.4 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.

## INTERIOR ENVIRONMENT

4. In Climate Zones 5, 6, 7 and 8, any *air-impermeable insulation* shall be a Class II vapor retarder or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.

5. Insulation shall comply with either Item 5.1 or 5.2, and additionally Item 5.3.

5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.

5.1.1. Where only *air-impermeable insulation* is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.

5.1.2. Where air-permeable insulation is provided inside the building thermal envelope, it shall be installed in accordance with Item 5.1.1. In addition to the air-permeable insulation installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the *R*-values in Table 1202.3 for condensation control.

5.1.3. Where both air-impermeable and air-permeable insulation are provided, the *air-impermeable insulation* shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the *R*-values in Table 1202.3 for condensation control. The *air-permeable insulation* shall be installed directly under the *air-impermeable insulation*.

5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside

of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

5.2. In Climate Zones 1, 2 and 3, air-permeable insulation installed in unvented attics shall meet the following requirements:

5.2.1. A vapor diffusion port shall be installed not more than 12 inches (305 mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.

5.2.2. The port area shall be greater than or equal to  $\frac{1}{600}$  of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.

5.2.3. The vapor permeable membrane in the vapor diffusion port shall have a vapor permeance rating of greater than or equal to 20 perms when tested in accordance with Procedure A of ASTM E96.

5.2.4. The vapor diffusion port shall serve as an air barrier between the attic and the exterior of the building.

5.2.5. The vapor diffusion port shall protect the attic against the entrance of rain and snow.

5.2.6. Framing members and blocking shall not block the free flow of water vapor to the port. Not less than a 2-inch (50 mm) space shall be provided between any blocking and the roof sheathing. Air-permeable insulation shall be permitted within that space.

**TABLE 1202.3**  
**INSULATION FOR CONDENSATION CONTROL**

CLIMATE ZONE	MINIMUM <i>R</i> -VALUE OF AIR-IMPERMEABLE INSULATION <sup>a</sup>
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

a. Contributes to, but does not supersede, thermal resistance requirements for attic and roof assemblies in Section C402.2.1 of the *International Energy Conservation Code*.

- 5.2.7. The roof slope shall be greater than or equal to 3 units vertical in 12 units horizontal (3:12).
  - 5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top the attic floor, or on top of the ceiling.
  - 5.2.9. Where only air-permeable insulation is used and is installed directly below the structural roof sheathing, air shall be supplied at a flow rate greater than or equal to 50 cubic feet per minute (23.6 L/s) per 1,000 square feet (93 m<sup>2</sup>) of ceiling.
- 5.3. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

#### Exceptions:

1. Section 1202.3 does not apply to special use structures or enclosures such as swimming pool enclosures, data processing centers, hospitals or art galleries.
2. Section 1202.3 does not apply to enclosures in Climate Zones 5 through 8 that are humidified beyond 35 percent during the three coldest months.

**1202.4 Under-floor ventilation.** The space between the bottom of the floor joists and the earth under any building except spaces occupied by basements or cellars shall be provided with ventilation in accordance with Section 1202.4.1, 1202.4.2 or 1202.4.3.

**1202.4.1 Ventilation openings.** Ventilation openings through foundation walls shall be provided. The openings shall be placed so as to provide cross ventilation of the under-floor space. The net area of ventilation openings shall be in accordance with Section 1202.4.1.1 or 1202.4.1.2. Ventilation openings shall be covered for their height and width with any of the following materials, provided that the least dimension of the covering shall be not greater than  $\frac{1}{4}$  inch (6.4 mm):

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grilles or gratings.
4. Extruded load-bearing vents.
5. Hardware cloth of 0.035-inch (0.89 mm) wire or heavier.

6. Corrosion-resistant wire mesh, with the least dimension not greater than  $\frac{1}{8}$  inch (3.2 mm).
7. Operable louvers, where ventilation is provided in accordance with Section 1202.4.1.2.

**1202.4.1.1 Ventilation area for crawl spaces with open earth floors.** The net area of ventilation openings for crawl spaces with uncovered earth floors shall be not less than 1 square foot for each 150 square feet (0.67 m<sup>2</sup> for each 100 m<sup>2</sup>) of crawl space area.

**1202.4.1.2 Ventilation area for crawl spaces with covered floors.** The net area of ventilation openings for crawl spaces with the ground surface covered with a Class I vapor retarder shall be not less than 1 square foot for each 1,500 square feet (0.67 m<sup>2</sup> for each 1000 m<sup>2</sup>) of crawl space area.

**1202.4.2 Ventilation in cold climates.** In extremely cold climates, where a ventilation opening will cause a detrimental loss of energy, ventilation openings to the interior of the structure shall be provided.

**1202.4.3 Mechanical ventilation.** Mechanical ventilation shall be provided to crawl spaces where the ground surface is covered with a Class I vapor retarder. Ventilation shall be in accordance with Section 1202.4.3.1 or 1202.4.3.2.

**1202.4.3.1 Continuous mechanical ventilation.** Continuously operated mechanical ventilation shall be provided at a rate of 1.0 cubic foot per minute (cfm) for each 50 square feet (1.02 L/s for each 10 m<sup>2</sup>) of crawl space ground surface area and the ground surface shall be covered with a Class I vapor retarder.

**1202.4.3.2 Conditioned space.** The crawl space shall be conditioned in accordance with the *International Mechanical Code* and the walls of the crawl space shall be insulated in accordance with the *International Energy Conservation Code*.

**1202.4.4 Flood hazard areas.** For buildings in *flood hazard areas* as established in Section 1612.3, the openings for under-floor ventilation shall be deemed as meeting the flood opening requirements of ASCE 24 provided that the ventilation openings are designed and installed in accordance with ASCE 24.

**1202.5 Natural ventilation.** Natural *ventilation* of an occupied space shall be through windows, doors, louvers or other openings to the outdoors. The operating mechanism for such openings shall be provided with ready access so that the openings are readily controllable by the building occupants.

**1202.5.1 Ventilation area required.** The openable area of the openings to the outdoors shall be not less than 4 percent of the floor area being ventilated.

**1202.5.1.1 Adjoining spaces.** Where rooms and spaces without openings to the outdoors are ventilated through an adjoining room, the opening to the adjoining room shall be unobstructed and shall have an area of not less than 8 percent of the floor area of the interior room or space, but not less than 25 square feet (2.3

## INTERIOR ENVIRONMENT

m<sup>2</sup>). The openable area of the openings to the outdoors shall be based on the total floor area being ventilated.

**Exception:** Exterior openings required for *ventilation* shall be allowed to open into a *sunroom* with *thermal isolation* or a patio cover provided that the openable area between the *sunroom* addition or patio cover and the interior room shall have an area of not less than 8 percent of the floor area of the interior room or space, but not less than 20 square feet (1.86 m<sup>2</sup>). The openable area of the openings to the outdoors shall be based on the total floor area being ventilated.

**1202.5.1.2 Openings below grade.** Where openings below grade provide required natural *ventilation*, the outside horizontal clear space measured perpendicular to the opening shall be one and one-half times the depth of the opening. The depth of the opening shall be measured from the average adjoining ground level to the bottom of the opening.

**1202.5.2 Contaminants exhausted.** Contaminant sources in naturally ventilated spaces shall be removed in accordance with the *International Mechanical Code* and the *International Fire Code*.

**1202.5.2.1 Bathrooms.** Rooms containing bathtubs, showers, spas and similar bathing fixtures shall be mechanically ventilated in accordance with the *International Mechanical Code*.

**1202.5.3 Openings on yards or courts.** Where natural *ventilation* is to be provided by openings onto *yards* or *courts*, such *yards* or *courts* shall comply with Section 1205.

**1202.6 Other ventilation and exhaust systems.** *Ventilation* and exhaust systems for occupancies and operations involving flammable or combustible hazards or other contaminant sources as covered in the *International Mechanical Code* or the *International Fire Code* shall be provided as required by both codes.

### SECTION 1203 TEMPERATURE CONTROL

**1203.1 Equipment and systems.** Interior spaces intended for human occupancy shall be provided with active or passive space heating systems capable of maintaining an indoor temperature of not less than 68°F (20°C) at a point 3 feet (914 mm) above the floor on the design heating day.

**Exceptions:** Space heating systems are not required for:

1. Interior spaces where the primary purpose of the space is not associated with human comfort.
2. Group F, H, S or U occupancies.

### SECTION 1204 LIGHTING

**1204.1 General.** Every space intended for human occupancy shall be provided with natural light by means of exterior

glazed openings in accordance with Section 1204.2 or shall be provided with artificial light in accordance with Section 1204.3. Exterior glazed openings shall open directly onto a *public way* or onto a *yard* or *court* in accordance with Section 1205.

**1204.2 Natural light.** The minimum net glazed area shall be not less than 8 percent of the floor area of the room served.

**1204.2.1 Adjoining spaces.** For the purpose of natural lighting, any room is permitted to be considered as a portion of an adjoining room where one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the floor area of the interior room or 25 square feet (2.32 m<sup>2</sup>), whichever is greater.

**Exception:** Openings required for natural light shall be permitted to open into a *sunroom* with *thermal isolation* or a patio cover where the common wall provides a glazed area of not less than one-tenth of the floor area of the interior room or 20 square feet (1.86 m<sup>2</sup>), whichever is greater.

**1204.2.2 Exterior openings.** Exterior openings required by Section 1204.2 for natural light shall open directly onto a *public way*, *yard* or *court*, as set forth in Section 1205.

#### Exceptions:

1. Required exterior openings are permitted to open into a roofed porch where the porch meets all of the following criteria:
  - 1.1. Abuts a *public way*, *yard* or *court*.
  - 1.2. Has a ceiling height of not less than 7 feet (2134 mm).
  - 1.3. Has a longer side at least 65 percent open and unobstructed.
2. Skylights are not required to open directly onto a *public way*, *yard* or *court*.

**1204.3 Artificial light.** Artificial light shall be provided that is adequate to provide an average illumination of 10 footcandles (107 lux) over the area of the room at a height of 30 inches (762 mm) above the floor level.

**1204.4 Stairway illumination.** *Stairways* within *dwelling units* and *exterior stairways* serving a *dwelling unit* shall have an illumination level on tread runs of not less than 1 footcandle (11 lux). *Stairways* in other occupancies shall be governed by Chapter 10.

**1204.4.1 Controls.** The control for activation of the required *stairway* lighting shall be in accordance with NFPA 70.

**1204.5 Emergency egress lighting.** The *means of egress* shall be illuminated in accordance with Section 1008.1.

### SECTION 1205 YARDS OR COURTS

**1205.1 General.** This section shall apply to *yards* and *courts* adjacent to exterior openings that provide natural light or



ventilation. Such *yards* and *courts* shall be on the same *lot* as the building.

**1205.2 Yards.** *Yards* shall be not less than 3 feet (914 mm) in width for buildings two *stories* or less above *grade plane*. For buildings more than two *stories above grade plane*, the minimum width of the *yard* shall be increased at the rate of 1 foot (305 mm) for each additional *story*. For buildings exceeding 14 *stories above grade plane*, the required width of the *yard* shall be computed on the basis of 14 *stories above grade plane*.

**1205.3 Courts.** *Courts* shall be not less than 3 feet (914 mm) in width. *Courts* having windows opening on opposite sides shall be not less than 6 feet (1829 mm) in width. *Courts* shall be not less than 10 feet (3048 mm) in length unless bounded on one end by a *public way* or *yard*. For buildings more than two *stories above grade plane*, the *court* shall be increased 1 foot (305 mm) in width and 2 feet (610 mm) in length for each additional *story*. For buildings exceeding 14 *stories above grade plane*, the required dimensions shall be computed on the basis of 14 *stories above grade plane*.

**1205.3.1 Court access.** Access shall be provided to the bottom of *courts* for cleaning purposes.

**1205.3.2 Air intake.** *Courts* more than two *stories* in height shall be provided with a horizontal air intake at the bottom not less than 10 square feet (0.93 m<sup>2</sup>) in area and leading to the exterior of the building unless abutting a *yard* or *public way*.

**1205.3.3 Court drainage.** The bottom of every *court* shall be properly graded and drained to a public sewer or other *approved* disposal system complying with the *International Plumbing Code*.

## SECTION 1206 SOUND TRANSMISSION

**1206.1 Scope.** This section shall apply to common interior walls, partitions and floor/ceiling assemblies between adjacent *dwelling units* and *sleeping units* or between *dwelling units* and *sleeping units* and adjacent public areas.

**1206.2 Airborne sound.** Walls, partitions and floor-ceiling assemblies separating *dwelling units* and *sleeping units* from each other or from public or service areas shall have a sound transmission class of not less than 50 where tested in accordance with ASTM E90, or have a Normalized Noise Isolation Class (NNIC) rating of not less than 45 if field tested, in accordance with ASTM E336 for airborne noise. Alternatively, the sound transmission class of walls, partitions and floor-ceiling assemblies shall be established by engineering analysis based on a comparison of walls, partitions and floor-ceiling assemblies having sound transmission class ratings as determined by the test procedures set forth in ASTM E90. Penetrations or openings in construction assemblies for piping; electrical devices; recessed cabinets; bathtubs; soffits; or heating, ventilating or exhaust ducts shall be sealed, lined, insulated or otherwise treated to maintain the required ratings. This requirement shall not apply to entrance doors; however, such doors shall be tight fitting to the frame and sill.

**1206.2.1 Masonry.** The sound transmission class of concrete masonry and clay masonry assemblies shall be calculated in accordance with TMS 302 or determined through testing in accordance with ASTM E90.

**1206.3 Structure-borne sound.** Floor-ceiling assemblies between *dwelling units* and *sleeping units* or between a *dwelling unit* or *sleeping unit* and a public or service area within the structure shall have an impact insulation class rating of not less than 50 where tested in accordance with ASTM E492, or have a Normalized Impact Sound Rating (NISR) of not less than 45 if field tested in accordance with ASTM E1007. Alternatively, the impact insulation class of floor-ceiling assemblies shall be established by engineering analysis based on a comparison of floor-ceiling assemblies having impact insulation class ratings as determined by the test procedures in ASTM E492.

## SECTION 1207 ENHANCED CLASSROOM ACOUSTICS

**1207.1 General.** Enhanced classroom acoustics, where required by this section, shall comply with Section 808 of ICC A117.1.

**1207.2 Where required.** In Group E occupancies, enhanced classroom acoustics shall be provided in all classrooms with a volume of 20,000 cubic feet (566 m<sup>3</sup>) or less.

## SECTION 1208 INTERIOR SPACE DIMENSIONS

**1208.1 Minimum room widths.** *Habitable* spaces, other than a kitchen, shall be not less than 7 feet (2134 mm) in any plan dimension. Kitchens shall have a clear passageway of not less than 3 feet (914 mm) between counter fronts and appliances or counter fronts and walls.

**1208.2 Minimum ceiling heights.** *Occupiable spaces*, *habitable spaces* and corridors shall have a ceiling height of not less than 7 feet 6 inches (2286 mm) above the finished floor. Bathrooms, toilet rooms, kitchens, storage rooms and laundry rooms shall have a ceiling height of not less than 7 feet (2134 mm) above the finished floor.

### Exceptions:

1. In one- and two-family *dwelling*s, beams or girders spaced not less than 4 feet (1219 mm) on center shall be permitted to project not more than 6 inches (152 mm) below the required ceiling height.
2. If any room in a building has a sloped ceiling, the prescribed ceiling height for the room is required in one-half the area thereof. Any portion of the room measuring less than 5 feet (1524 mm) from the finished floor to the ceiling shall not be included in any computation of the minimum area thereof.
3. The height of *mezzanines* and spaces below *mezzanines* shall be in accordance with Section 505.2.

## INTERIOR ENVIRONMENT

4. Corridors contained within a *dwelling unit* or *sleeping unit* in a Group R occupancy shall have a ceiling height of not less than 7 feet (2134 mm) above the finished floor.

**1208.2.1 Furred ceiling.** Any room with a furred ceiling shall be required to have the minimum ceiling height in two-thirds of the area thereof, but in no case shall the height of the furred ceiling be less than 7 feet (2134 mm).

**1208.3 Room area.** Every *dwelling unit* shall have not less than one room that shall have not less than 120 square feet (11.2 m<sup>2</sup>) of *net floor area*. Other habitable rooms shall have a *net floor area* of not less than 70 square feet (6.5 m<sup>2</sup>).

**Exception:** Kitchens are not required to be of a minimum floor area.

**1208.4 Efficiency dwelling units.** *Efficiency dwelling units* shall conform to the requirements of the code except as modified herein:

1. The unit shall have a living room of not less than 190 square feet (17.7 m<sup>2</sup>) of floor area.
2. The unit shall be provided with a separate closet.
3. For other than *Accessible*, Type A and Type B dwelling units, the unit shall be provided with a kitchen sink, cooking appliance and refrigerator, each having a clear working space of not less than 30 inches (762 mm) in front. Light and *ventilation* conforming to this code shall be provided.
4. The unit shall be provided with a separate bathroom containing a water closet, lavatory and bathtub or shower.

### SECTION 1209 ACCESS TO UNOCCUPIED SPACES

**1209.1 Crawl spaces.** Crawl spaces shall be provided with not less than one access opening that shall be not less than 18 inches by 24 inches (457 mm by 610 mm).

**1209.2 Attic spaces.** An opening not less than 20 inches by 30 inches (559 mm by 762 mm) shall be provided to any *attic* area having a clear height of over 30 inches (762 mm). Clear headroom of not less than 30 inches (762 mm) shall be provided in the *attic* space at or above the access opening.

**1209.3 Mechanical appliances.** Access to mechanical appliances installed in under-floor areas, in *attic* spaces and on roofs or elevated structures shall be in accordance with the *International Mechanical Code*.

### SECTION 1210 TOILET AND BATHROOM REQUIREMENTS

**[P] 1210.1 Required fixtures.** The number and type of plumbing fixtures provided in any occupancy shall comply with Chapter 29.

**[P] 1210.2 Finish materials.** Walls, floors and partitions in toilet and bathrooms shall comply with Sections 1210.2.1 through 1210.2.4.

**[P] 1210.2.1 Floors and wall bases.** In other than *dwelling units*, toilet, bathing and shower room floor finish materials shall have a smooth, hard, nonabsorbent surface. The intersections of such floors with walls shall have a smooth, hard, nonabsorbent vertical base that extends upward onto the walls not less than 4 inches (102 mm).

**[P] 1210.2.2 Walls and partitions.** Walls and partitions within 2 feet (610 mm) of service sinks, urinals and water closets shall have a smooth, hard, nonabsorbent surface, to a height of not less than 4 feet (1219 mm) above the floor, and except for structural elements, the materials used in such walls shall be of a type that is not adversely affected by moisture.

**Exception:** This section does not apply to the following buildings and spaces:

1. Dwelling units and *sleeping units*.
2. Toilet rooms that are not accessible to the public and that have not more than one water closet.

Accessories such as grab bars, towel bars, paper dispensers and soap dishes, provided on or within walls, shall be installed and sealed to protect structural elements from moisture.

**[P] 1210.2.3 Showers.** Shower compartments and walls above bathtubs with installed shower heads shall be finished with a smooth, nonabsorbent surface to a height not less than 72 inches (1829 mm) above the drain inlet.

**[P] 1210.2.4 Waterproof joints.** Built-in tubs with showers shall have waterproof joints between the tub and adjacent wall.

**[P] 1210.3 Privacy.** Public restrooms shall be visually screened from outside entry or exit doorways to ensure user privacy within the restroom. This provision shall also apply where mirrors would compromise personal privacy. Privacy at water closets and urinals shall be provided in accordance with Sections 1210.3.1 and 1210.3.2.

**Exception:** Visual screening shall not be required for single-occupant toilet rooms with a lockable door.

**[P] 1210.3.1 Water closet compartment.** Each water closet utilized by the public or employees shall occupy a separate compartment with walls or partitions and a door enclosing the fixtures to ensure privacy.

#### Exceptions:

1. Water closet compartments shall not be required in a single-occupant toilet room with a lockable door.
2. Toilet rooms located in child day care facilities and containing two or more water closets shall be permitted to have one water closet without an enclosing compartment.
3. This provision is not applicable to toilet areas located within Group I-3 occupancy housing areas.

**[P] 1210.3.2 Urinal partitions.** Each urinal utilized by the public or employees shall occupy a separate area with walls or partitions to provide privacy. The walls or partitions shall begin at a height not more than 12 inches (305 mm) from and extend not less than 60 inches (1524 mm) above the finished floor surface. The walls or partitions shall extend from the wall surface at each side of the urinal not less than 18 inches (457 mm) or to a point not less than 6 inches (152 mm) beyond the outermost front lip of the urinal measured from the finished backwall surface, whichever is greater.

**Exceptions:**

1. Urinal partitions shall not be required in a single-occupant or family or assisted-use toilet room with a lockable door.
2. Toilet rooms located in child day care facilities and containing two or more urinals shall be permitted to have one urinal without partitions.





## CHAPTER 13

# ENERGY EFFICIENCY

---

### User notes:

**About this chapter:** The purpose of Chapter 13 is to provide minimum design requirements that will promote efficient energy utilization in buildings. The requirements address the building thermal envelope, the selection of HVAC and lighting equipment, and the installation of controls that dictate efficient operation. Also promoted is efficient use of power where providing water and lighting to the users of the space.

**Code development reminder:** Code change proposals to this chapter will be considered by the International Energy Conservation Code Development Committee during the 2022 (Group B) Code Development Cycle.

---



---

### SECTION 1301 GENERAL

[E] **1301.1 Scope.** This chapter governs the design and construction of buildings for energy efficiency.

[E] **1301.1.1 Criteria.** Buildings shall be designed and constructed in accordance with the *International Energy Conservation Code*.



## CHAPTER 14

# EXTERIOR WALLS

### User notes:

**About this chapter:** Chapter 14 addresses requirements for exterior walls of buildings. Minimum standards for wall covering materials, such as material performance and fire resistance, installation of wall coverings and the ability of the wall to provide weather protection are provided. This chapter also contains limitations on the areas and heights of combustible wall coverings based on fire separation distances, radiant heat exposure and surface burning characteristics.

**Code development reminder:** Code change proposals to sections preceded by the designation [BS] will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 1401 GENERAL

**1401.1 Scope.** The provisions of this chapter shall establish the minimum requirements for *exterior walls*; *exterior wall coverings*; *exterior wall openings*; exterior windows and doors; and architectural *trim*.

### SECTION 1402 PERFORMANCE REQUIREMENTS

**1402.1 General.** The provisions of this section shall apply to *exterior walls*, wall coverings and components thereof.

**1402.2 Weather protection.** *Exterior walls* shall provide the building with a weather-resistant *exterior wall envelope*. The *exterior wall envelope* shall include flashing, as described in Section 1404.4. The *exterior wall envelope* shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a *water-resistive barrier* behind the exterior *veneer*, as described in Section 1403.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the *exterior wall* assembly shall be provided in accordance with Section 1404.3.

#### Exceptions:

1. A weather-resistant *exterior wall envelope* shall not be required over concrete or masonry walls designed in accordance with Chapters 19 and 21, respectively.
2. Compliance with the requirements for a means of drainage, and the requirements of Sections 1403.2 and 1404.4, shall not be required for an *exterior wall envelope* that has been demonstrated through testing to resist wind-driven rain, including joints, penetrations and intersections with dissimilar materials, in accordance with ASTM E331 under the following conditions:

The *exterior wall envelope* design shall be considered to resist wind-driven rain where the results of testing indicate that water did not penetrate control joints in the *exterior wall*

*envelope*, joints at the perimeter of openings or intersections of terminations with dissimilar materials.

- 2.1. *Exterior wall envelope* test assemblies shall include not fewer than one opening, one control joint, one wall/eave interface and one wall sill. Tested openings and penetrations shall be representative of the intended end-use configuration.
- 2.2. *Exterior wall envelope* test assemblies shall be not less than 4 feet by 8 feet (1219 mm by 2438 mm) in size.
- 2.3. *Exterior wall envelope* assemblies shall be tested at a minimum differential pressure of 6.24 pounds per square foot (0.297 kN/m<sup>2</sup>).
- 2.4. *Exterior wall envelope* assemblies shall be subjected to a minimum test exposure duration of 2 hours.
3. *Exterior insulation and finish systems* (EIFS) complying with Section 1407.4.1.

**[BS] 1402.3 Structural.** *Exterior walls*, and the associated openings, shall be designed and constructed to resist safely the superimposed *loads* required by Chapter 16.

**1402.4 Fire resistance.** *Exterior walls* shall be fire-resistance rated as required by other sections of this code with opening protection as required by Chapter 7.

**1402.5 Water-resistive barriers.** *Exterior walls* on buildings of Type I, II, III or IV construction that are greater than 40 feet (12 192 mm) in height above grade plane and contain a combustible *water-resistive barrier* shall be tested in accordance with and comply with the acceptance criteria of NFPA 285. Combustibility shall be determined in accordance with Section 703.3. For the purposes of this section, *fenestration* products, flashing of *fenestration* products and *water-resistive-barrier* flashing and accessories at other locations, including through wall flashings, shall not be considered part of the *water-resistive barrier*.

#### Exceptions:

1. Walls in which the *water-resistive barrier* is the only combustible component and the *exterior wall*

## EXTERIOR WALLS

has a wall covering of brick, concrete, stone, terra cotta, stucco or steel with minimum thicknesses in accordance with Table 1404.2.

2. Walls in which the *water-resistive barrier* is the only combustible component and the *water-resistive barrier* complies with the following:

- 2.1. A peak heat release rate of less than 150 kW/m<sup>2</sup>, a total heat release of less than 20 MJ/m<sup>2</sup> and an effective heat of combustion of less than 18 MJ/kg when tested on specimens at the thickness intended for use, in accordance with ASTM E1354, in the horizontal orientation and at an incident radiant heat flux of 50 kW/m<sup>2</sup>.
- 2.2. A flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E84 or UL 723, with test specimen preparation and mounting in accordance with ASTM E2404.

**[BS] 1402.6 Flood resistance.** For buildings in *flood hazard areas* as established in Section 1612.3, *exterior walls* extending below the elevation required by Section 1612 shall be constructed with flood-damage-resistant materials.

**[BS] 1402.7 Flood resistance for coastal high-hazard areas and coastal A zones.** For buildings in *coastal high-hazard areas* and coastal A zones as established in Section 1612.3, electrical, mechanical and plumbing system components shall not be mounted on or penetrate through *exterior walls* that are designed to break away under *flood loads*.

## SECTION 1403 MATERIALS

**1403.1 General.** Materials used for the construction of *exterior walls* shall comply with the provisions of this section. Materials not prescribed herein shall be permitted, provided that any such alternative has been *approved*.

**1403.2 Water-resistive barrier.** Not fewer than one layer of *water-resistive barrier* material shall be attached to the studs or sheathing, with flashing as described in Section 1404.4, in such a manner as to provide a continuous *water-resistive barrier* behind the exterior wall *veneer*.

*Water-resistive barriers* shall comply with one of the following:

1. No. 15 felt complying with ASTM D226, Type 1.
2. ASTM E2556, Type I or II.
3. ASTM E331 in accordance with Section 1402.2.
4. Other approved materials installed in accordance with the manufacturer's installation instructions.

**[BS] 1403.3 Wood.** *Exterior walls* of wood construction shall be designed and constructed in accordance with Chapter 23.

**[BS] 1403.3.1 Basic hardboard.** Basic *hardboard* shall conform to the requirements of ANSI A135.4.

**[BS] 1403.3.2 Hardboard siding.** *Hardboard siding* shall conform to the requirements of ANSI A135.6 and, where used structurally, shall be so identified by the *label* of an *approved agency*.

**[BS] 1403.4 Masonry.** *Exterior walls* of masonry construction shall be designed and constructed in accordance with this section and Chapter 21. *Masonry units*, *mortar* and metal accessories used in anchored and adhered *veneer* shall meet the physical requirements of Chapter 21. The backing of anchored and adhered *veneer* shall be of concrete, masonry, steel framing or wood framing. Continuous insulation meeting the applicable requirements of this code shall be permitted between the backing and the masonry *veneer*.

**[BS] 1403.5 Metal.** *Exterior walls* constructed of cold-formed or structural steel shall be designed in accordance with Chapter 22. *Exterior walls* constructed of aluminum shall be designed in accordance with Chapter 20.

**[BS] 1403.5.1 Aluminum siding.** Aluminum siding shall conform to the requirements of AAMA 1402.

**[BS] 1403.5.2 Cold-rolled copper.** Copper shall conform to the requirements of ASTM B370.

**[BS] 1403.5.3 Lead-coated copper.** Lead-coated copper shall conform to the requirements of ASTM B101.

**[BS] 1403.6 Concrete.** *Exterior walls* of concrete construction shall be designed and constructed in accordance with Chapter 19.

**[BS] 1403.7 Glass-unit masonry** *Exterior walls* of glass-unit masonry shall be designed and constructed in accordance with Chapter 21.

**1403.8 Plastics.** Plastic panel, apron or spandrel walls as defined in this code shall not be limited in thickness, provided that such plastics and their assemblies conform to the requirements of Chapter 26 and are constructed of *approved* weather-resistant materials of adequate strength to resist the wind *loads* for cladding specified in Chapter 16.

**1403.9 Vinyl siding.** Vinyl siding shall be certified and labeled as conforming to the requirements of ASTM D3679 by an *approved* quality control agency.

**1403.10 Fiber-cement siding.** *Fiber-cement siding* shall conform to the requirements of ASTM C1186, Type A (or ISO 8336, Category A), and shall be so identified on labeling listing an *approved* quality control agency.

**1403.11 Exterior insulation and finish systems.** *Exterior insulation and finish systems* (EIFS) and *exterior insulation and finish systems (EIFS) with drainage* shall comply with Section 1407.

**1403.12 Polypropylene siding.** *Polypropylene siding* shall be certified and labeled as conforming to the requirements of ASTM D7254 and those of Section 1403.12.1 or 1403.12.2 by an *approved* quality control agency. *Polypropylene siding* shall be installed in accordance with the requirements of Section 1404.18 and in accordance with the manufacturer's instructions. *Polypropylene siding* shall be secured to the building so as to provide weather protection for the *exterior walls* of the building.



**1403.12.1 Flame spread index.** The certification of the *flame spread index* shall be accompanied by a test report stating that all portions of the test specimen ahead of the flame front remained in position during the test in accordance with ASTM E84 or UL 723.

**1403.12.2 Fire separation distance.** The *fire separation distance* between a building with *polypropylene siding* and the adjacent building shall be not less than 10 feet (3048 mm).

**1403.13 Foam plastic insulation.** Foam plastic insulation used in *exterior wall covering* assemblies shall comply with Chapter 26.

**1403.14 Attachments through insulation.** *Exterior wall coverings* attached to the building structure through foam plastic insulating sheathing shall comply with the attachment requirements of Section 2603.11, 2603.12, or 2603.13.

## SECTION 1404 INSTALLATION OF WALL COVERINGS

**1404.1 General.** *Exterior wall coverings* shall be designed and constructed in accordance with the applicable provisions of this section.

**1404.2 Weather protection.** *Exterior walls* shall provide weather protection for the building. The materials of the minimum nominal thickness specified in Table 1404.2 shall be acceptable as *approved* weather coverings.

**1404.3 Vapor retarders.** Vapor retarder materials shall be classified in accordance with Table 1404.3(1). A vapor retarder shall be provided on the interior side of frame walls in accordance with Tables 1404.3(2) and 1404.3(3), or an approved design using accepted engineering practice for hygrothermal analysis. The appropriate climate zone shall be selected in accordance with Chapter 3 of the *International Energy Conservation Code*.

Where a Class II vapor retarder is used in combination with foam plastic insulating sheathing installed as continuous insulation on the exterior side of frame walls, the continuous insulation shall comply with Table 1404.3(4) and the Class II vapor retarder shall have a vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B). Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.

### Exceptions:

1. Basement walls.
2. Below-grade portion of any wall.
3. Construction where accumulation, condensation or freezing of moisture will not damage the materials.
4. Class I and II vapor retarders with vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B) shall be allowed on the interior side of any frame wall in all climate zones.

**TABLE 1404.2  
MINIMUM THICKNESS OF WEATHER COVERINGS**

COVERING TYPE	MINIMUM THICKNESS (inches)
Adhered masonry veneer	0.25
Aluminum siding	0.019
Anchored masonry veneer	
Stone (natural)	2.0
Architectural cast stone	2.5
Other	2.0
Asbestos-cement boards	0.125
Asbestos shingles	0.156
Cold-rolled copper <sup>d</sup>	0.0216 nominal
Copper shingles <sup>d</sup>	0.0162 nominal
Exterior plywood (with sheathing)	0.313
Exterior plywood (without sheathing)	See Section 2304.6
Fiber cement lap siding	0.25 <sup>c</sup>
Fiber cement panel siding	0.25 <sup>c</sup>
Fiberboard siding	0.5
Glass-fiber reinforced concrete panels	0.375
Hardboard siding <sup>c</sup>	0.25
High-yield copper <sup>d</sup>	0.0162 nominal
Lead-coated copper <sup>d</sup>	0.0216 nominal
Lead-coated high-yield copper	0.0162 nominal
Marble slabs	1
Particleboard (with sheathing)	See Section 2304.6
Particleboard (without sheathing)	See Section 2304.6
Porcelain tile	0.125 nominal
Steel (approved corrosion resistant)	0.0149
Structural glass	0.344
Stucco or exterior cement plaster	
Three-coat work over:	
Metal plaster base	0.875 <sup>b</sup>
Unit masonry	0.625 <sup>b</sup>
Cast-in-place or precast concrete	0.625 <sup>b</sup>
Two-coat work over:	
Unit masonry	0.5 <sup>b</sup>
Cast-in-place or precast concrete	0.375 <sup>b</sup>
Terra cotta (anchored)	1
Terra cotta (adhered)	0.25
Vinyl siding	0.035
Wood shingles	0.375
Wood siding (without sheathing) <sup>a</sup>	0.5

For SI: 1 inch = 25.4 mm, 1 ounce = 28.35 g, 1 square foot = 0.093 m<sup>2</sup>.

a. Wood siding of thicknesses less than 0.5 inch shall be placed over sheathing that conforms to Section 2304.6.

b. Exclusive of texture.

c. As measured at the bottom of decorative grooves.

d. 16 ounces per square foot for cold-rolled copper and lead-coated copper, 12 ounces per square foot for copper shingles, high-yield copper and lead-coated high-yield copper.

## EXTERIOR WALLS

**TABLE 1404.3(1)**  
**VAPOR RETARDER MATERIALS AND CLASSES**

VAPOR RETARDER CLASS	ACCEPTABLE MATERIALS
I	Sheet polyethylene, nonperforated aluminum foil, or other approved materials with a perm rating of less than or equal to 0.1
II	Kraft-faced fiberglass batts or vapor retarder paint or other approved materials, applied in accordance with the manufacturer's instructions for a perm rating greater than 0.1 and less than or equal to 1.0
III	Latex paint, enamel paint, or other approved materials, applied in accordance with the manufacturer's instructions for a perm rating of greater than 1.0 and less than or equal to 10

**TABLE 1404.3(2)**  
**VAPOR RETARDER OPTIONS**

CLIMATE ZONE	VAPOR RETARDER CLASS		
	I	II	III <sup>a</sup>
1, 2	Not permitted	Not Permitted	Permitted
3	Not permitted	Permitted	Permitted
4 (except Marine)	Not permitted	Permitted	See Table 1404.3(3)
Marine 4, 5, 6, 7, 8	Permitted	Permitted	See Table 1404.3(3)

a. See also Sections 1404.3.1 and 1404.3.2.

**TABLE 1404.3(3)**  
**CLASS III VAPOR RETARDERS**

ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR: <sup>a, b</sup>
4	Vented cladding over wood structural panels Vented cladding over fiberboard Vented cladding over gypsum Continuous insulation with $R$ -value $\geq R-2.5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-3.75$ over $2 \times 6$ wall
5	Vented cladding over wood structural panels Vented cladding over fiberboard Vented cladding over gypsum Continuous insulation with $R$ -value $\geq R-5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-7.5$ over $2 \times 6$ wall
6	Vented cladding over fiberboard Vented cladding over gypsum Continuous insulation with $R$ -value $\geq R-7.5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-11.25$ over $2 \times 6$ wall
7	Continuous insulation with $R$ -value $\geq R-10$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-15$ over $2 \times 6$ wall
8	Continuous insulation with $R$ -value $\geq R-12.5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-20$ over $2 \times 6$ wall

a. Vented cladding shall include vinyl lap siding, polypropylene, or horizontal aluminum siding, brick veneer with airspace as specified in this code, and other approved vented claddings.

b. The requirements in this table apply only to insulation used to control moisture in order to permit the use of Class III vapor retarders. The insulation materials used to satisfy this option also contribute to but do not supersede the thermal envelope requirements of the *International Energy Conservation Code*.

**TABLE 1404.3(4)**  
**CONTINUOUS INSULATION WITH CLASS II VAPOR RETARDER**

CLIMATE ZONE	PERMITTED CONDITIONS <sup>a</sup>
3	Continuous insulation with $R$ -value $\geq R-2$
4, 5, 6	Continuous insulation with $R$ -value $\geq R-3$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-5$ over $2 \times 6$ wall
7	Continuous insulation with $R$ -value $\geq R-5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-7.5$ over $2 \times 6$ wall
8	Continuous insulation with $R$ -value $\geq R-7.5$ over $2 \times 4$ wall Continuous insulation with $R$ -value $\geq R-10$ over $2 \times 6$ wall

a. In addition to the vapor retarder, spray foam with a maximum permeance of 1.5 perms at the installed thickness, applied to the interior cavity side of wood structural panels, fiberboard, insulating sheathing or gypsum is deemed to comply with the continuous insulation requirement only for the moisture control purposes of this table where the spray foam  $R$ -value plus any continuous insulation  $R$ -value provided equals or exceeds the specified continuous insulation  $R$ -value.

**1404.3.1 Spray foam plastic insulation for moisture control with Class III vapor retarders.** For purposes of compliance with Table 1404.3(3), spray foam with a maximum permeance of 1.5 perms at the installed thickness applied to the interior cavity side of wood structural panels, fiberboard, insulating sheathing or gypsum shall be deemed to meet the continuous insulation moisture control requirement where the spray foam  $R$ -value meets or exceeds the specified continuous insulation  $R$ -value.

**1404.3.2 Hybrid insulation for moisture control with Class III vapor retarders.** For the purposes of compliance with Table 1404.3(3), the combined moisture control of spray foam plastic insulation and continuous insulation shall be permitted to be counted toward the continuous  $R$ -value requirement.

**1404.4 Flashing.** Flashing shall be installed in such a manner so as to prevent moisture from entering the wall or to redirect that moisture to the surface of the exterior wall finish or to a *water-resistive barrier* complying with Section 1403.2 and that is part of a means of drainage complying with Section 1402.2. Flashing shall be installed at the perimeters of exterior door and window assemblies, penetrations and terminations of *exterior wall* assemblies, *exterior wall* intersections with roofs, chimneys, porches, decks, balconies and similar projections and at built-in gutters and similar locations where moisture could enter the wall. Flashing with projecting flanges shall be installed on both sides and the ends of copings, under sills and continuously above projecting trim. Where self-adhered membranes are used as flashings of *fenestration* in wall assemblies, those self-adhered flashings shall comply with AAMA 711. Where fluid applied membranes are used as flashing for *exterior wall* openings, those fluid applied membrane flashings shall comply with AAMA 714.

**1404.4.1 Exterior wall pockets.** In *exterior walls* of buildings or structures, wall pockets or crevices in which moisture can accumulate shall be avoided or protected with caps or drips, or other *approved* means shall be provided to prevent water damage.

**1404.4.2 Masonry.** Flashing and weep holes in anchored *veneer* designed in accordance with Section 1404.6 shall be located not more than 10 inches (254 mm) above finished ground level above the foundation wall or slab. At other points of support including structural floors, shelf angles and lintels, flashing and weep holes shall be located in the first course of masonry above the support.

**1404.5 Wood veneers.** Wood *veneers* on exterior walls of buildings of Types I, II, III and IV construction shall be not less than 1 inch (25 mm) nominal thickness, 0.438-inch (11.1 mm) exterior *hardboard* siding or 0.375-inch (9.5 mm) exterior-type *wood structural panels* or particleboard and shall conform to the following:

1. The *veneer* shall not exceed 40 feet (12 190 mm) in height above grade. Where *fire-retardant-treated wood* is used, the height shall not exceed 60 feet (18 290 mm) in height above grade.
2. The *veneer* is attached to or furred from a noncombustible backing that is fire-resistance rated as required by other provisions of this code.
3. Where open or spaced wood *veneers* (without concealed spaces) are used, they shall not project more than 24 inches (610 mm) from the building wall.

[BS] **1404.6 Anchored masonry veneer.** *Anchored masonry veneer* shall comply with the provisions of Sections 1404.6 through 1404.9 and Sections 12.1 and 12.2 of TMS 402.

[BS] **1404.6.1 Tolerances.** *Anchored masonry veneers* in accordance with Chapter 14 are not required to meet the tolerances in Article 3.3 F1 of TMS 602.

[BS] **1404.6.2 Seismic requirements.** *Anchored masonry veneer* located in *Seismic Design Category C, D, E or F* shall conform to the requirements of Section 12.2.2.11 of TMS 402.

[BS] **1404.7 Stone veneer.** Anchored stone *veneer* units not exceeding 10 inches (254 mm) in thickness shall be anchored directly to masonry, concrete or to stud construction by one of the following methods:

1. With concrete or masonry backing, anchor ties shall be not less than 0.1055-inch (2.68 mm) corrosion-resistant wire, or *approved* equal, formed beyond the base of the backing. The legs of the loops shall be not less than 6 inches (152 mm) in length bent at right angles and laid in the *mortar* joint, and spaced so that the eyes or loops are 12 inches (305 mm) maximum on center in both directions. There shall be provided not less than a 0.1055-inch (2.68 mm) corrosion-resistant wire tie, or *approved* equal, threaded through the exposed loops for every 2 square feet (0.2 m<sup>2</sup>) of stone *veneer*. This tie shall be a loop having legs not less than 15 inches (381 mm) in length bent so that the tie will lie in the stone *veneer mortar* joint. The last 2 inches (51 mm) of each wire leg shall have a right-angle bend. One-inch (25 mm) minimum thickness of cement grout shall be placed between the backing and the stone *veneer*.

2. With wood stud backing, a 2-inch by 2-inch (51 by 51 mm) 0.0625-inch (1.59 mm) zinc-coated or nonmetallic coated wire mesh with two layers of *water-resistive barrier* in accordance with Section 1403.2 shall be applied directly to wood studs spaced not more than 16 inches (406 mm) on center. On studs, the mesh shall be attached with 2-inch-long (51 mm) corrosion-resistant steel wire furring nails at 4 inches (102 mm) on center providing a minimum 1.125-inch (29 mm) penetration into each stud and with 8d annular threaded nails at 8 inches (203 mm) on center, into top and bottom plates or with equivalent wire ties. There shall be not less than a 0.1055-inch (2.68 mm) zinc-coated or nonmetallic coated wire, or approved equal, attached to the stud with not smaller than an 8d (0.120 in. diameter) annular threaded nail for every 2 square feet (0.2 m<sup>2</sup>) of stone *veneer*. This tie shall be a loop having legs not less than 15 inches (381 mm) in length, so bent that the tie will lie in the stone *veneer mortar* joint. The last 2 inches (51 mm) of each wire leg shall have a right-angle bend. One-inch (25 mm) minimum thickness of cement grout shall be placed between the backing and the stone *veneer*.

3. With cold-formed steel stud backing, a 2-inch by 2-inch (51 by 51 mm) 0.0625-inch (1.59 mm) zinc-coated or nonmetallic coated wire mesh with two layers of *water-resistive barrier* in accordance with Section 1403.2 shall be applied directly to steel studs spaced a not more than 16 inches (406 mm) on center. The mesh shall be attached with corrosion-resistant #8 self-drilling, tapping screws at 4 inches (102 mm) on center, and at 8 inches (203 mm) on center into top and bottom tracks or with equivalent wire ties. Screws shall extend through the steel connection not fewer than three exposed threads. There shall be not less than a 0.1055-inch (2.68 mm) corrosion-resistant wire, or approved equal, attached to the stud with not smaller than a #8 self-drilling, tapping screw extending through the steel framing not fewer than three exposed threads for every 2 square feet (0.2 m<sup>2</sup>) of stone *veneer*. This tie shall be a loop having legs not less than 15 inches (381 mm) in length, so bent that the tie will lie in the stone *veneer mortar* joint. The last 2 inches (51 mm) of each wire leg shall have a right-angle bend. Cement grout not less than 1 inch (25 mm) in thickness shall be placed between the backing and the stone *veneer*. The cold-formed steel framing members shall have a minimum bare steel thickness of 0.0428 inches (1.087 mm).

[BS] **1404.8 Slab-type veneer.** Anchored slab-type *veneer* units not exceeding 2 inches (51 mm) in thickness shall be anchored directly to masonry, concrete or *light-frame construction*. For *veneer* units of marble, travertine, granite or other stone units of slab form, ties of corrosion-resistant dowels in drilled holes shall be located in the middle third of the edge of the units, spaced not more than 24 inches (610 mm) apart around the periphery of each unit with not less



## EXTERIOR WALLS

than four ties per *veneer* unit. Units shall not exceed 20 square feet (1.9 m<sup>2</sup>) in area. If the dowels are not tight fitting, the holes shall be drilled not more than 0.063 inch (1.6 mm) larger in diameter than the dowel, with the hole countersunk to a diameter and depth equal to twice the diameter of the dowel in order to provide a tight-fitting key of cement *mortar* at the dowel locations where the *mortar* in the joint has set. *Veneer* ties shall be corrosion-resistant metal capable of resisting, in tension or compression, a force equal to two times the weight of the attached *veneer*. If made of sheet metal, *veneer* ties shall be not smaller in area than 0.0336 by 1 inch (0.853 by 25 mm) or, if made of wire, not smaller in diameter than 0.1483-inch (3.76 mm) wire.

**[BS] 1404.9 Terra cotta.** Anchored terra cotta or ceramic units not less than 1<sup>5</sup>/<sub>8</sub> inches (41 mm) thick shall be anchored directly to masonry, concrete or stud construction. Tied terra cotta or ceramic *veneer* units shall be not less than 1<sup>5</sup>/<sub>8</sub> inches (41 mm) thick with projecting dovetail webs on the back surface spaced approximately 8 inches (203 mm) on center. The facing shall be tied to the backing wall with corrosion-resistant metal anchors of not less than No. 8 gage wire installed at the top of each piece in horizontal *bed joints* not less than 12 inches (305 mm) nor more than 18 inches (457 mm) on center; these anchors shall be secured to 1/4-inch (6.4 mm) corrosion-resistant pencil rods that pass through the vertical aligned loop anchors in the backing wall. The *veneer* ties shall have sufficient strength to support the full weight of the *veneer* in tension. The facing shall be set with not less than a 2-inch (51 mm) space from the backing wall and the space shall be filled solidly with Portland cement grout and pea gravel. Immediately prior to setting, the backing wall and the facing shall be drenched with clean water and shall be distinctly damp when the grout is poured.

**[BS] 1404.10 Adhered masonry veneer.** *Adhered masonry veneer* shall comply with the applicable requirements in this section and Sections 12.1 and 12.3 of TMS 402.

**[BS] 1404.10.1 Exterior adhered masonry veneer.** Exterior *adhered masonry veneer* shall be installed in accordance with Section 1404.10 and the manufacturer's instructions.

**[BS] 1404.10.1.1 Water-resistive barriers.** *Water-resistive barriers* shall be installed as required in Section 2510.6.

**[BS] 1404.10.1.2 Flashing.** Flashing shall comply with the applicable requirements of Sections 1404.4 and 1404.10.1.2.1.

**[BS] 1404.10.1.2.1 Flashing at foundation.** A corrosion-resistant screed or flashing of a minimum 0.019-inch (0.48 mm) or 26 gage galvanized or plastic with a minimum vertical attachment flange of 3<sup>1</sup>/<sub>2</sub> inches (89 mm) shall be installed to extend not less than 1 inch (25 mm) below the foundation plate line on exterior stud walls in accordance with Section 1404.4. The *water-resistive barrier* shall lap over the exterior of the attachment flange of the screed or flashing.

**[BS] 1404.10.1.3 Clearances.** On exterior stud walls, *adhered masonry veneer* shall be installed not less than

4 inches (102 mm) above the earth, or not less than 2 inches (51 mm) above paved areas, or not less than 1/2 inch (12.7 mm) above exterior walking surfaces that are supported by the same foundation that supports the *exterior wall*.

**[BS] 1404.10.1.4 Adhered masonry veneer installed with lath and mortar.** Exterior *adhered masonry veneer* installed with lath and *mortar* shall comply with the following.

**[BS] 1404.10.1.4.1 Lathing.** Lathing shall comply with the requirements of Section 2510.

**[BS] 1404.10.1.4.2 Scratch coat.** A nominal 1/2-inch-thick (12.7 mm) layer of *mortar* complying with the material requirements of Sections 2103 and 2512.2 shall be applied, encapsulating the lathing. The surface of this *mortar* shall be scored horizontally, resulting in a scratch coat.

**[BS] 1404.10.1.4.3 Adhering veneer.** The masonry *veneer* units shall be adhered to the *mortar* scratch coat with a nominal 1/2-inch-thick (12.7 mm) setting bed of *mortar* complying with Sections 2103 and 2512.2 applied to create a full setting bed for the back of the masonry *veneer* units. The masonry *veneer* units shall be worked into the setting bed resulting in a nominal 3/8-inch (9.5 mm) setting bed after the masonry *veneer* units are applied.

**[BS] 1404.10.1.5 Adhered masonry veneer applied directly to masonry and concrete.** *Adhered masonry veneer* applied directly to masonry or concrete shall comply with the applicable requirements of Section 1404.10 and with the requirements of Section 1404.10.1.4 or 2510.7.

**[BS] 1404.10.1.6 Cold weather construction.** Cold weather construction of *adhered masonry veneer* shall comply with the requirements of Sections 2104 and 2512.4.

**[BS] 1404.10.1.7 Hot weather construction.** Hot weather construction of *adhered masonry veneer* shall comply with the requirements of Section 2104.

**[BS] 1404.10.2 Exterior adhered masonry veneers—porcelain tile.** Adhered units weighing more than 3.5 pounds per square foot (0.17 kN/m<sup>2</sup>) shall not exceed 48 inches (1219 mm) in any face dimension nor more than 9 square feet (0.8 m<sup>2</sup>) in total face area and shall not weigh more than 6 pounds per square foot (0.29 kN/m<sup>2</sup>). Adhered units weighing less than or equal to 3.5 pounds per square foot (0.17 kN/m<sup>2</sup>) shall not exceed 72 inches (1829 mm) in any face dimension nor more than 17.5 square feet (1.6 m<sup>2</sup>) in total face area. Porcelain tile shall be adhered to an approved backing system.

**[BS] 1404.10.3 Interior adhered masonry veneers.** Interior *adhered masonry veneers* shall have a maximum weight of 20 psf (0.958 kg/m<sup>2</sup>) and shall be installed in accordance with Section 1404.10. Where the interior *adhered masonry veneer* is supported by wood construction, the supporting members shall be designed to limit deflection to 1/600 of the span of the supporting members.



**[BS] 1404.11 Metal veneers.** *Veneers* of metal shall be fabricated from *approved* corrosion-resistant materials or shall be protected front and back with porcelain enamel, or otherwise be treated to render the metal resistant to corrosion. Such *veneers* shall be not less than 0.0149-inch (0.378 mm) nominal thickness sheet steel mounted on wood or metal furring strips or approved sheathing on *light-frame construction*.

**[BS] 1404.11.1 Attachment.** Exterior metal *veneer* shall be securely attached to the supporting masonry or framing members with corrosion-resistant fastenings, metal ties or by other *approved* devices or methods. The spacing of the fastenings or ties shall not exceed 24 inches (610 mm) either vertically or horizontally, but where units exceed 4 square feet (0.4 m<sup>2</sup>) in area there shall be not less than four attachments per unit. The metal attachments shall have a cross-sectional area not less than provided by W 1.7 wire. Such attachments and their supports shall be designed and constructed to resist the wind *loads* as specified in Section 1609 for components and cladding.

**1404.11.2 Weather protection.** Metal supports for exterior metal *veneer* shall be protected by painting, galvanizing or by other equivalent coating or treatment. Wood studs, furring strips or other wood supports for exterior metal *veneer* shall be *approved* pressure-treated wood or protected as required in Section 1402.2. Joints and edges exposed to the weather shall be caulked with *approved* durable waterproofing material or by other *approved* means to prevent penetration of moisture.

**1404.11.3 Backup.** Masonry backup shall not be required for metal *veneer* unless required by the fire-resistance requirements of this code.

**1404.11.4 Grounding.** Grounding of metal *veneers* on buildings shall comply with the requirements of Chapter 27 of this code.

**[BS] 1404.12 Glass veneer.** The area of a single section of thin exterior structural glass *veneer* shall not exceed 10 square feet (0.93 m<sup>2</sup>) where that section is not more than 15 feet (4572 mm) above the level of the sidewalk or grade level directly below, and shall not exceed 6 square feet (0.56 m<sup>2</sup>) where it is more than 15 feet (4572 mm) above that level.

**[BS] 1404.12.1 Length and height.** The length or height of any section of thin exterior structural glass *veneer* shall not exceed 48 inches (1219 mm).

**[BS] 1404.12.2 Thickness.** The thickness of thin exterior structural glass *veneer* shall be not less than 0.344 inch (8.7 mm).

**[BS] 1404.12.3 Application.** Thin exterior structural glass *veneer* shall be set only after backing is thoroughly dry and after application of an *approved* bond coat uniformly over the entire surface of the backing so as to effectively seal the surface. Glass shall be set in place with an *approved* mastic cement in sufficient quantity so that not less than 50 percent of the area of each glass unit is directly bonded to the backing by mastic not less than

$\frac{1}{4}$  inch (6.4 mm) thick and not more than  $\frac{5}{8}$  inch (15.9 mm) thick. The bond coat and mastic shall be evaluated for compatibility and shall bond firmly together.

**[BS] 1404.12.4 Installation at sidewalk level.** Where glass extends to a sidewalk surface, each section shall rest in an *approved* metal molding, and be set not less than  $\frac{1}{4}$  inch (6.4 mm) above the highest point of the sidewalk. The space between the molding and the sidewalk shall be thoroughly caulked and made watertight.

**[BS] 1404.12.4.1 Installation above sidewalk level.**

Where thin exterior structural glass *veneer* is installed above the level of the top of a bulkhead facing, or at a level more than 36 inches (914 mm) above the sidewalk level, the mastic cement binding shall be supplemented with *approved* nonferrous metal shelf angles located in the horizontal joints in every course. Such shelf angles shall be not less than 0.0478-inch (1.2 mm) thick and not less than 2 inches (51 mm) long and shall be spaced at *approved* intervals, with not less than two angles for each glass unit. Shelf angles shall be secured to the wall or backing with expansion bolts, toggle bolts or by other *approved* methods.

**[BS] 1404.12.5 Joints.** Unless otherwise specifically *approved* by the *building official*, abutting edges of thin exterior structural glass *veneer* shall be ground square. Mitered joints shall not be used except where specifically *approved* for wide angles. Joints shall be uniformly buttered with an *approved* jointing compound and horizontal joints shall be held to not less than 0.063 inch (1.6 mm) by an *approved* nonrigid substance or device. Where thin exterior structural glass *veneer* abuts nonresilient material at sides or top, expansion joints not less than  $\frac{1}{4}$  inch (6.4 mm) wide shall be provided.

**[BS] 1404.12.6 Mechanical fastenings.** Thin exterior structural glass *veneer* installed above the level of the heads of show windows and *veneer* installed more than 12 feet (3658 mm) above sidewalk level shall, in addition to the mastic cement and shelf angles, be held in place by the use of fastenings at each vertical or horizontal edge, or at the four corners of each glass unit. Fastenings shall be secured to the wall or backing with expansion bolts, toggle bolts or by other methods. Fastenings shall be so designed as to hold the glass *veneer* in a vertical plane independent of the mastic cement. Shelf angles providing both support and fastenings shall be permitted.

**[BS] 1404.12.7 Flashing.** Exposed edges of thin exterior structural glass *veneer* shall be flashed with overlapping corrosion-resistant metal flashing and caulked with a waterproof compound in a manner to effectively prevent the entrance of moisture between the glass *veneer* and the backing.

**1404.13 Exterior windows and doors.** Windows and doors installed in *exterior walls* shall conform to the testing and performance requirements of Section 1709.5.

**1404.13.1 Installation.** Windows and doors shall be installed in accordance with *approved* manufacturer's instructions. Fastener size and spacing shall be provided

## EXTERIOR WALLS

in such instructions and shall be calculated based on maximum *loads* and spacing used in the tests.

**[BS] 1404.14 Vinyl siding.** Vinyl siding conforming to the requirements of this section and complying with ASTM D3679 shall be permitted on *exterior walls* where the design wind pressure determined in accordance with Section 1609 does not exceed 30 pounds per square foot (1.44 kN/m<sup>2</sup>). Where the design wind pressure exceeds 30 pounds per square foot (1.44 kN/m<sup>2</sup>), tests or calculations indicating compliance with Chapter 16 shall be submitted. Vinyl siding shall be secured to the building so as to provide weather protection for the *exterior walls* of the building.

**[BS] 1404.14.1 Application.** The siding shall be applied over sheathing or materials listed in Section 2304.6. Siding shall be applied to conform to the *water-resistive barrier* requirements in Section 1402. Siding and accessories shall be installed in accordance with the *approved* manufacturer's instructions.

**1404.14.1.1 Fasteners and fastener penetration for wood construction.** Unless otherwise specified in the approved manufacturer's instructions, nails used to fasten the siding and accessories shall be corrosion resistant and have not less than a 0.313-inch (7.9 mm) head diameter and 1/8-inch (3.18 mm) shank diameter. The penetration into nailable substrate shall be not less than 1 1/4 inches (32 mm).

**1404.14.1.2 Fasteners and fastener penetration for cold-formed steel light-frame construction.** For cold-formed steel light-frame construction, corrosion-resistant fasteners shall be used. Screw fasteners shall penetrate through the steel with not fewer than three exposed threads. Other fasteners shall be installed in accordance with the approved construction documents and manufacturer's instructions.

**1404.14.1.3 Fastener spacing.** Unless specified otherwise by the approved manufacturer's instructions, fasteners shall be installed in the middle third of the slots of the nail hem and spacing between fasteners shall be not greater than 16 inches (406 mm) for horizontal siding and 12 inches (305 mm) for vertical siding.

**[BS] 1404.15 Cement plaster.** *Cement plaster* applied to *exterior walls* shall conform to the requirements specified in Chapter 25.

**[BS] 1404.16 Fiber-cement siding.** *Fiber-cement siding* complying with Section 1403.10 shall be permitted on *exterior walls* of Types I, II, III, IV and V construction for wind pressure resistance or wind speed exposures as indicated by the manufacturer's listing and *label* and *approved* installation instructions. Where specified, the siding shall be installed over sheathing or materials listed in Section 2304.6 and shall be installed to conform to the *water-resistive barrier* requirements in Section 1402. Siding and accessories shall be installed in accordance with *approved* manufacturer's instructions. Unless otherwise specified in the *approved* manufacturer's instructions, nails used to fasten

the siding to wood studs shall be corrosion-resistant round head smooth shank and shall be long enough to penetrate the studs not less than 1 inch (25 mm). For cold-formed steel *light-frame construction*, corrosion-resistant fasteners shall be used. Screw fasteners shall penetrate the cold-formed steel framing not fewer than three exposed full threads. Other fasteners shall be installed in accordance with the approved construction documents and manufacturer's instructions.

**[BS] 1404.16.1 Panel siding.** *Fiber-cement* panels shall comply with the requirements of ASTM C1186, Type A, minimum Grade II (or ISO 8336, Category A, minimum Class 2). Panels shall be installed with the long dimension either parallel or perpendicular to framing. Vertical and horizontal joints shall occur over framing members and shall be protected with caulking, with battens or flashing, or be vertical or horizontal shiplap or otherwise designed to comply with Section 1402.2. Panel siding shall be installed with fasteners in accordance with the *approved* manufacturer's instructions.

**[BS] 1404.16.2 Lap siding.** *Fiber-cement* lap siding having a maximum width of 12 inches (305 mm) shall comply with the requirements of ASTM C1186, Type A, minimum Grade II (or ISO 8336, Category A, minimum Class 2). Lap siding shall be lapped not less than 1 1/4 inches (32 mm) and lap siding not having tongue-and-groove end joints shall have the ends protected with caulking, covered with an H-section joint cover, located over a strip of flashing or shall be otherwise designed to comply with Section 1402.2. Lap siding courses shall be installed with the fastener heads exposed or concealed in accordance with the *approved* manufacturer's instructions.

**[BS] 1404.17 Fastening.** Weather boarding and wall coverings shall be securely fastened with aluminum, copper, zinc, zinc-coated or other *approved* corrosion-resistant fasteners in accordance with the nailing schedule in Table 2304.10.2 or the *approved* manufacturer's instructions. Shingles and other weather coverings shall be attached with appropriate standard-shingle nails to furring strips securely nailed to studs, or with *approved* mechanically bonding nails, except where sheathing is of wood not less than 1-inch (25 mm) nominal thickness or of *wood structural panels* as specified in Table 2308.6.3(3).

**[BS] 1404.18 Polypropylene siding.** *Polypropylene siding* conforming to the requirements of this section and complying with Section 1403.12 shall be limited to *exterior walls* located in areas where the wind speed specified in Chapter 16 does not exceed 100 miles per hour (45 m/s) and the building height is less than or equal to 40 feet (12 192 mm) in Exposure C. Where construction is located in areas where the basic wind speed exceeds 100 miles per hour (45 m/s), or building heights are in excess of 40 feet (12 192 mm), tests or calculations indicating compliance with Chapter 16 shall be submitted. *Polypropylene siding* shall be installed in accordance with the manufacturer's instructions. *Polypropylene siding* shall be secured to the building so as to provide weather protection for the *exterior walls* of the building.

## SECTION 1405 COMBUSTIBLE MATERIALS ON THE EXTERIOR SIDE OF EXTERIOR WALLS

**1405.1 Combustible exterior wall coverings.** Combustible *exterior wall coverings* shall comply with this section.

**Exception:** Plastics complying with Chapter 26.

**1405.1.1 Types I, II, III and IV construction.** On buildings of Types I, II, III and IV construction, *exterior wall coverings* shall be permitted to be constructed of combustible materials, complying with the following limitations:

1. Combustible *exterior wall coverings* shall not exceed 10 percent of an *exterior wall* surface area where the *fire separation distance* is 5 feet (1524 mm) or less.
2. Combustible *exterior wall coverings* shall be limited to 40 feet (12 192 mm) in height above *grade plane*.
3. Combustible *exterior wall coverings* constructed of *fire-retardant-treated wood* complying with Section 2303.2 for exterior installation shall not be limited in wall surface area where the *fire separation distance* is 5 feet (1524 mm) or less and shall be permitted up to 60 feet (18 288 mm) in height above *grade plane* regardless of the *fire separation distance*.
4. Wood *veneers* shall comply with Section 1404.5.

**1405.1.1.1 Ignition resistance.** Where permitted by Section 1405.1.1, combustible *exterior wall coverings* shall be tested in accordance with NFPA 268.

### Exceptions:

1. Wood or wood-based products.
2. Other combustible materials covered with an exterior weather covering, other than vinyl sidings, included in and complying with the thickness requirements of Table 1404.2.
3. Aluminum having a minimum thickness of 0.019 inch (0.48 mm).

**1405.1.1.1.1 Fire separation 5 feet or less.** Where installed on *exterior walls* having a *fire separation distance* of 5 feet (1524 mm) or less, combustible *exterior wall coverings* shall not exhibit sustained flaming as defined in NFPA 268.

**1405.1.1.1.2 Fire separation greater than 5 feet.** For *fire separation distances* greater than 5 feet (1524 mm), any *exterior wall covering* shall be permitted that has been exposed to a reduced level of incident radiant heat flux in accordance with the NFPA 268 test method without exhibiting sustained flaming. The minimum *fire separation distance* required for the *exterior wall covering* shall be determined from Table 1405.1.1.1.2 based on the maximum tolerable level of incident radiant heat flux that does not cause sustained flaming of the *exterior wall covering*.

TABLE 1405.1.1.1.2  
MINIMUM FIRE SEPARATION FOR  
COMBUSTIBLE EXTERIOR WALL COVERINGS

FIRE SEPARATION DISTANCE (feet)	TOLERABLE LEVEL INCIDENT RADIANT HEAT ENERGY (kW/m <sup>2</sup> )
5	12.5
6	11.8
7	11.0
8	10.3
9	9.6
10	8.9
11	8.3
12	7.7
13	7.2
14	6.7
15	6.3
16	5.9
17	5.5
18	5.2
19	4.9
20	4.6
21	4.4
22	4.1
23	3.9
24	3.7
25	3.5

For SI: 1 foot = 304.8 mm, 1 Btu/H<sup>2</sup> × °F = 0.0057 kW/m<sup>2</sup> × K.

**1405.1.2 Location.** Combustible *exterior wall coverings* located along the top of *exterior walls* shall be completely backed up by the *exterior wall* and shall not extend over or above the top of the *exterior wall*.

**1405.1.3 Fireblocking.** Where the combustible *exterior wall covering* is furred out from the *exterior wall* and forms a solid surface, the distance between the back of the *exterior wall covering* and the *exterior wall* shall not exceed 1<sup>5</sup>/<sub>8</sub> inches (41 mm). The concealed space thereby created shall be fireblocked in accordance with Section 718.

**Exception:** The distance between the back of the *exterior wall covering* and the *exterior wall* shall be permitted to exceed 1<sup>5</sup>/<sub>8</sub> inches (41 mm) where the concealed space is not required to be fireblocked by Section 718.

## SECTION 1406 METAL COMPOSITE MATERIALS (MCM)

**1406.1 General.** The provisions of this section shall govern the materials, construction and quality of *metal composite materials (MCM)* for use as *exterior wall coverings* in addition to other applicable requirements of Chapters 14 and 16.

**1406.2 Exterior wall covering.** MCM used as *exterior wall covering* or as elements of balconies and similar projections



## EXTERIOR WALLS

and bay and oriel windows to provide cladding or weather resistance shall comply with Sections 1406.4 through 1406.13.

**1406.3 Architectural trim and embellishments.** MCM used as architectural trim or embellishments shall comply with Sections 1406.7 through 1406.13.

**1406.4 Structural design.** MCM systems shall be designed and constructed to resist wind *loads* as required by Chapter 16 for components and cladding.

**1406.5 Approval.** Results of *approved* tests or an engineering analysis shall be submitted to the *building official* to verify compliance with the requirements of Chapter 16 for wind *loads*.

**1406.6 Weather resistance.** MCM systems shall comply with Section 1402 and shall be designed and constructed to resist wind and rain in accordance with this section and the manufacturer's installation instructions.

**1406.7 Durability.** MCM systems shall be constructed of *approved* materials that maintain the performance characteristics required in Section 1406 for the duration of use.

**1406.8 Fire-resistance rating.** Where MCM systems are used on *exterior walls* required to have a *fire-resistance rating* in accordance with Section 705, evidence shall be submitted to the *building official* that the required *fire-resistance rating* is maintained.

**Exception:** MCM systems that are part of an *exterior wall envelope* not containing foam plastic insulation and are installed on the outer surface of a fire-resistance-rated *exterior wall* in a manner such that the attachments do not penetrate through the entire *exterior wall* assembly, shall not be required to comply with this section.

**1406.9 Surface-burning characteristics.** Unless otherwise specified, MCM shall have a *flame spread index* of 75 or less and a *smoke-developed index* of 450 or less when tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723.

**1406.10 Types I, II, III and IV construction.** Where installed on buildings of Types I, II, III and IV construction, *metal composite material* (MCM) shall comply with Sections 1406.10.1 and 1406.10.2 for installations up to 40 feet (12 192 mm) above *grade plane*. Where installed on buildings of Types I, II, III and IV construction, MCMs and MCM systems shall comply with Sections 1406.10.1 through 1406.10.3, for installations greater than 40 feet (12 192 mm) above *grade plane*.

**1406.10.1 Surface-burning characteristics.** MCM shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723.

**1406.10.2 Thermal barriers.** MCM shall be separated from the interior of a building by an approved thermal barrier consisting of  $\frac{1}{2}$ -inch (12.7 mm) *gypsum wall-board* or material that is tested in accordance with and

meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

### Exceptions:

1. The MCM system is specifically approved based on tests conducted in accordance with NFPA 286 and with the acceptance criteria of Section 803.1.1.1, UL 1040 or UL 1715. Such testing shall be performed with the MCM in the maximum thickness intended for use. The MCM system shall include seams, joints and other typical details used in the installation and shall be tested in the manner intended for use.
2. The MCM is used as elements of balconies and similar projections, architectural trim or embellishments.

**1406.10.3 Full-scale tests.** The MCM system shall be tested in accordance with, and comply with, the acceptance criteria of NFPA 285. Such testing shall be performed on the MCM system with the MCM in the maximum thickness intended for use.

**1406.11 Type V construction.** MCM shall be permitted to be installed on buildings of Type V construction.

**1406.12 Foam plastic insulation.** Where MCM systems are included in an exterior wall envelope containing foam plastic insulation, the exterior wall envelope shall also comply with the requirements of Section 2603.

**1406.13 Labeling.** MCM shall be labeled in accordance with Section 1703.5.

## SECTION 1407 EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)

**1407.1 General.** The provisions of this section shall govern the materials, construction and quality of *exterior insulation and finish systems* (EIFS) for use as *exterior wall coverings* in addition to other applicable requirements of Chapters 7, 14, 16, 17 and 26.

**1407.2 Performance characteristics.** EIFS shall be constructed such that it meets the performance characteristics required in ASTM E2568.

**[BS] 1407.3 Structural design.** The underlying structural framing and substrate shall be designed and constructed to resist *loads* as required by Chapter 16.

**1407.4 Weather resistance.** EIFS shall comply with Section 1402 and shall be designed and constructed to resist wind and rain in accordance with this section and the manufacturer's application instructions.

**1407.4.1 EIFS with drainage.** EIFS with drainage shall have an average minimum drainage efficiency of 90 percent when tested in accordance with the requirements of ASTM E2273 and is required on framed walls of Type V construction, Group R1, R2, R3 and R4 occupancies.



**1407.4.1.1 Water-resistive barrier.** For EIFS with drainage, the *water-resistive barrier* shall comply with Section 1403.2 or ASTM E2570.

**1407.5 Installation.** Installation of the EIFS and EIFS with drainage shall be in accordance with the EIFS manufacturer's instructions.

**1407.6 Special inspections.** EIFS installations shall comply with the provisions of Sections 1704.2 and 1705.17.

## SECTION 1408 HIGH-PRESSURE DECORATIVE EXTERIOR- GRADE COMPACT LAMINATES (HPL)

**1408.1 General.** The provisions of this section shall govern the materials, construction and quality of High-Pressure Decorative *Exterior-Grade Compact Laminates (HPL)* for use as *exterior wall coverings* in addition to other applicable requirements of Chapters 14 and 16.

**1408.2 Exterior wall covering.** HPL used as *exterior wall covering* or as elements of balconies and similar projections and bay and oriel windows to provide cladding or weather resistance shall comply with Sections 1408.4 through 1408.14.

**1408.3 Architectural trim and embellishments.** HPL used as architectural trim or embellishments shall comply with Sections 1408.7 through 1408.14.

**[BS] 1408.4 Structural design.** HPL systems shall be designed and constructed to resist wind *loads* as required by Chapter 16 for components and cladding.

**1408.5 Approval.** Results of approved tests or an engineering analysis shall be submitted to the building official to verify compliance with the requirements of Chapter 16 for wind *loads*.

**1408.6 Weather resistance.** HPL systems shall comply with Section 1402 and shall be designed and constructed to resist wind and rain in accordance with this section and the manufacturer's instructions.

**1408.7 Durability.** HPL systems shall be constructed of approved materials that maintain the performance characteristics required in Section 1408 for the duration of use.

**1408.8 Fire-resistance rating.** Where HPL systems are used on *exterior walls* required to have a *fire-resistance rating* in accordance with Section 705, evidence shall be submitted to the building official that the required *fire-resistance rating* is maintained.

**Exception:** HPL systems not containing foam plastic insulation, which are installed on the outer surface of a fire-resistance-rated *exterior wall* in a manner such that the attachments do not penetrate through the entire *exterior wall* assembly, shall not be required to comply with this section.

**1408.9 Surface-burning characteristics.** Unless otherwise specified, HPL shall have a *flame spread index* of 75 or less and a *smoke-developed index* of 450 or less when tested in

the minimum and maximum thicknesses intended for use in accordance with ASTM E84 or UL 723.

**1408.10 Types I, II, III and IV construction.** Where installed on buildings of Types I, II, III and IV construction, HPL systems shall comply with Sections 1408.10.1 through 1408.10.4, or Section 1408.11.

**1408.10.1 Surface-burning characteristics.** HPL shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450 when tested in the minimum and maximum thicknesses intended for use in accordance with ASTM E84 or UL 723.

**1408.10.2 Thermal barriers.** HPL shall be separated from the interior of a building by an approved thermal barrier consisting of  $\frac{1}{2}$ -inch (12.7 mm) *gypsum wall-board* or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

**1408.10.3 Thermal barrier not required.** The thermal barrier specified for HPL in Section 1408.10.2 is not required where:

1. The HPL system is specifically approved based on tests conducted in accordance with NFPA 286, and with the acceptance criteria of Section 803.1.1.1, or with UL 1040 or UL 1715. Such testing shall be performed with the HPL in the minimum and maximum thicknesses intended for use. The HPL system shall include seams, joints and other typical details used in the installation and shall be tested in the manner intended for use.
2. The HPL is used as elements of balconies and similar projections, architectural trim or embellishments.

**1408.10.4 Full-scale tests.** The HPL system shall be tested in accordance with, and comply with, the acceptance criteria of NFPA 285. Such testing shall be performed on the HPL system with the HPL in the minimum and maximum thicknesses intended for use.

**1408.11 Alternate conditions.** HPL and HPL systems shall not be required to comply with Sections 1408.10.1 through 1408.10.4 provided that such systems comply with Section 1408.11.1.

**1408.11.1 Installations up to 40 feet in height.** HPL shall be permitted to be installed up to 40 feet (12 190 mm) in height above *grade plane* where installed in accordance with Section 1408.11.1.1 or 1408.11.1.2.

**1408.11.1.1 Fire separation distance of 5 feet or less.** Where the *fire separation distance* is 5 feet (1524 mm) or less, the area of HPL shall not exceed 10 percent of the *exterior wall* surface.

**1408.11.1.2 Fire separation distance greater than 5 feet.** Where the *fire separation distance* is greater than 5 feet (1524 mm), the area of *exterior wall* surface coverage using HPL shall not be limited.

## EXTERIOR WALLS

**1408.12 Type V construction.** HPL shall be permitted to be installed on buildings of Type V construction.

**1408.13 Foam plastic insulation.** HPL systems containing foam plastic insulation shall comply with the requirements of Section 2603.

**1408.14 Labeling.** HPL shall be labeled in accordance with Section 1703.5.

## SECTION 1409 PLASTIC COMPOSITE DECKING

**1409.1 Plastic composite decking.** Exterior deck boards, *stair* treads, *handrails* and *guards* constructed of plastic composites, including plastic lumber, shall comply with Section 2612.

## CHAPTER 15

# ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

### User notes:

**About this chapter:** Chapter 15 provides minimum requirements for the design and construction of roof assemblies and rooftop structures. The criteria address the weather-protective barrier at the roof and, in most circumstances, a fire-resistant barrier. The chapter is largely prescriptive in nature and is based on decades of experience with various traditional materials, but it also recognizes newer products. Section 1511 addresses rooftop structures, which include penthouses, tanks, towers and spires. Rooftop penthouses larger than prescribed in this chapter must be treated as a story under Chapter 5.

**Code development reminder:** Code change proposals to sections preceded by the designation [BF], [BG] or [P] will be considered by one of the code development committees meeting during the 2021 (Group A) Code Development Cycle. All other code change proposals will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 1501 GENERAL

**1501.1 Scope.** The provisions of this chapter shall govern the design, materials, construction and quality of *roof assemblies*, and *rooftop structures*.

### SECTION 1502 ROOF DRAINAGE

**[P] 1502.1 General.** Design and installation of roof drainage systems shall comply with this section, Section 1611 of this code and Chapter 11 of the *International Plumbing Code*.

**[P] 1502.2 Secondary (emergency overflow) drains or scuppers.** Where roof drains are required, secondary (emergency overflow) roof drains or scuppers shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. The installation and sizing of secondary emergency overflow drains, leaders and conductors shall comply with Section 1611 of this code and Chapter 11 of the *International Plumbing Code*.

**1502.3 Scuppers.** Where *scuppers* are used for secondary (emergency overflow) roof drainage, the quantity, size, location and inlet elevation of the *scuppers* shall be sized to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 1611.1. *Scuppers* shall not have an opening dimension of less than 4 inches (102 mm). The flow through the primary system shall not be considered when locating and sizing *scuppers*.

**1502.4 Gutters.** Gutters and leaders placed on the outside of buildings, other than Group R-3, *private garages* and buildings of Type V construction, shall be of noncombustible material or not less than Schedule 40 plastic pipe.

### SECTION 1503 WEATHER PROTECTION

**1503.1 General.** *Roof decks* shall be covered with *approved roof coverings* secured to the building or structure in accordance with the provisions of this chapter. *Roof coverings*

shall be designed in accordance with this code, and installed in accordance with this code and the manufacturer's *approved* instructions.

**1503.2 Flashing.** Flashing shall be installed in such a manner so as to prevent water from entering the wall and roof through joints in copings, through moisture-permeable materials and at intersections with *parapet walls* and other penetrations through the roof plane.

**1503.2.1 Locations.** Flashing shall be installed at wall and roof intersections, at gutters, wherever there is a change in roof slope or direction and around roof openings. Where flashing is of metal, the metal shall be corrosion resistant with a thickness of not less than 0.019 inch (0.483 mm) (No. 26 galvanized sheet).

**1503.3 Parapet walls.** Parapet walls shall be coped or covered in accordance with Sections 1503.3.1 and 1503.3.2. The top surface of the parapet wall shall provide positive drainage.

**1503.3.1 Fire-resistance-rated parapet walls.** *Parapet walls* required by Section 705.11 shall be coped or covered with weatherproof materials of a width not less than the thickness of the *parapet wall* such that the *fire-resistance rating* of the wall is not decreased.

**1503.3.2 Other parapet walls.** *Parapet walls* meeting one of the exceptions in Section 705.11 shall be coped or covered with weatherproof materials of a width not less than the thickness of the *parapet wall*.

**1503.4 Attic and rafter ventilation.** Intake and exhaust vents shall be provided in accordance with Section 1202.2 and the vent product manufacturer's installation instructions.

**1503.5 Crickets and saddles.** A cricket or saddle shall be installed on the ridge side of any chimney or penetration greater than 30 inches (762 mm) wide as measured perpendicular to the slope. Cricket or saddle coverings shall be sheet metal or of the same material as the *roof covering*.

**Exception:** *Unit skylights* installed in accordance with Section 2405.5 and flashed in accordance with the manufacturer's instructions shall be permitted to be installed without a cricket or saddle.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

## SECTION 1504

### PERFORMANCE REQUIREMENTS

**1504.1 Wind resistance of roofs.** *Roof decks* and *roof coverings* shall be designed for wind *loads* in accordance with Chapter 16 and Sections 1504.2, 1504.3, 1504.4 and 1504.5

**1504.2 Wind resistance of asphalt shingles.** Asphalt shingles shall be tested in accordance with ASTM D7158. Asphalt shingles shall meet the classification requirements of Table 1504.2 for the appropriate maximum basic wind speed. Asphalt shingle packaging shall bear a label to indicate compliance with ASTM D7158 and the required classification in Table 1504.2.

**Exception:** Asphalt shingles not included in the scope of ASTM D7158 shall be tested and labeled in accordance with ASTM D3161. Asphalt shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table 1504.2.

**1504.3 Wind resistance of clay and concrete tile.** Wind *loads* on clay and concrete tile roof coverings shall be in accordance with Section 1609.5.

**1504.3.1 Testing.** Testing of concrete and clay roof tiles shall be in accordance with Sections 1504.3.1.1, 1504.3.1.2 and 1504.3.1.3.

**1504.3.1.1 Overturning resistance.** Concrete and clay roof tiles shall be tested to determine their resistance to overturning due to wind in accordance with Chapter 15 and either SBCCI SSTD 11 or ASTM C1568.

**1504.3.1.2 Wind tunnel testing.** Where concrete and clay roof tiles do not satisfy the limitations in Chapter 16 for rigid tile, a wind tunnel test shall be used to determine the wind characteristics of the concrete or clay tile *roof covering* in accordance with Chapter 15 and either SBCCI SSTD 11 or ASTM C1569.

**1504.3.1.3 Air permeability testing.** The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined in accordance with SBCCI SSTD 11 or ASTM C1570.

**1504.4 Wind resistance of nonballasted roofs.** *Roof coverings* installed on roofs in accordance with Section 1507 that are mechanically attached or adhered to the *roof deck* shall be designed to resist the design wind *load* pressures for components and cladding in accordance with Section 1609.5.2. The wind *load* on the *roof covering* shall be permitted to be determined using *allowable stress design*.

**1504.4.1 Other roof systems.** Built-up, modified bitumen, fully adhered or mechanically attached single-ply roof systems, metal panel roof systems applied to a solid or closely fitted deck and other types of membrane *roof coverings* shall be tested in accordance with FM 4474, UL 580 or UL 1897.

**1504.4.2 Structural metal panel roof systems.** Where the *metal roof panel* functions as the *roof deck* and *roof covering* and it provides both weather protection and support for *loads*, the structural metal panel roof system shall comply with this section. Structural standing-seam metal panel roof systems shall be tested in accordance with ASTM E1592 or FM 4474. Structural through-fastened metal panel roof systems shall be tested in accordance with ASTM E1592, FM 4474 or UL 580.

#### Exceptions:

1. Metal roofs constructed of cold-formed steel shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2210.1.
2. Metal roofs constructed of aluminum shall be permitted to be designed and tested in accordance with the applicable referenced structural design standard in Section 2002.1.

**1504.4.3 Metal roof shingles.** *Metal roof shingles* applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580 or UL 1897. *Metal roof shingles* tested in accordance with ASTM D3161 shall meet the classification requirements of Table 1504.2 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a label to indicate compliance with ASTM D3161 and the required classification in Table 1504.2.

TABLE 1504.2  
CLASSIFICATION OF STEEP SLOPE ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161 OR D7158

MAXIMUM BASIC WIND SPEED, $V$ , FROM FIGURES 1609.3(1)–(8) OR ASCE 7(mph)	MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED, $V_{asd}$ , FROM Table 1609.3.1 (mph)	ASTM D7158 <sup>a</sup> CLASSIFICATION	ASTM D3161 or UL 7103 CLASSIFICATION
110	85	D, G or H	A, D or F
116	90	D, G or H	A, D or F
129	100	G or H	A, D or F
142	110	G or H	F
155	120	G or H	F
168	130	H	F
181	140	H	F
194	150	H	F

For SI: 1 foot = 304.8 mm; 1 mph = 0.447 m/s.

a. The standard calculations contained in ASTM D7158 assume Exposure Category B or C and building height of 60 feet or less. Additional calculations are required for conditions outside of these assumptions.



**1504.5 Ballasted low-slope single-ply roof systems.** Ballasted low-slope (roof slope < 2:12) single-ply roof system coverings installed in accordance with Section 1507.12 shall be designed in accordance with ANSI/SPRI RP-4.

**1504.6 Edge systems for low-slope roofs.** Metal edge systems, except gutters and counterflashing, installed on built-up, modified bitumen and single-ply roof systems having a slope less than 2 units vertical in 12 units horizontal (2:12) shall be designed and installed for wind loads in accordance with Chapter 16 and tested for resistance in accordance with Test Methods RE-1, RE-2 and RE-3 of ANSI/SPRI ES-1, except basic design wind speed, V, shall be determined from Figures 1609.3(1) through 1609.3(12) as applicable.

**1504.6.1 Gutter securement for low-slope roofs.**

Gutters that are used to secure the perimeter edge of the roof membrane on low-slope (less than 2:12 slope) built-up, modified bitumen, and single-ply roofs, shall be designed, constructed and installed to resist wind loads in accordance with Section 1609 and shall be tested in accordance with Test Methods G-1 and G-2 of SPRI GT-1.

**1504.7 Physical properties.** Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall demonstrate physical integrity over the working life of the roof based on 2,000 hours of exposure to accelerated weathering tests conducted in accordance with ASTM G152, ASTM G154 or ASTM G155. Those roof

coverings that are subject to cyclical flexural response due to wind loads shall not demonstrate any significant loss of tensile strength for unreinforced membranes or breaking strength for reinforced membranes when tested as herein required.

**1504.8 Impact resistance.** Roof coverings installed on low-slope roofs (roof slope < 2:12) in accordance with Section 1507 shall resist impact damage based on the results of tests conducted in accordance with ASTM D3746, ASTM D4272 or the "Resistance to Foot Traffic Test" in FM 4470.

**1504.9 Wind resistance of aggregate-surfaced roofs.** Parapets shall be provided for aggregate surfaced roofs and shall comply with Table 1504.9.

## SECTION 1505 FIRE CLASSIFICATION

**[BF] 1505.1 General.** Roof assemblies shall be divided into the classes defined in this section. Class A, B and C roof assemblies and roof coverings required to be listed by this section shall be tested in accordance with ASTM E108 or UL 790. In addition, fire-retardant-treated wood roof coverings shall be tested in accordance with ASTM D2898. The minimum roof coverings installed on buildings shall comply with Table 1505.1 based on the type of construction of the building.

**Exception:** Skylights and sloped glazing that comply with Chapter 24 or Section 2610.

**TABLE 1504.9  
MINIMUM REQUIRED PARAPET HEIGHT (INCHES) FOR AGGREGATE SURFACED ROOFS<sup>a, b, c</sup>**

AGGREGATE SIZE	MEAN ROOF HEIGHT (ft)	WIND EXPOSURE AND BASIC DESIGN WIND SPEED (MPH)																	
		Exposure B									Exposure C <sup>d</sup>								
		≤ 95	100	105	110	115	120	130	140	150	≤ 95	100	105	110	115	120	130	140	150
ASTM D1863 (No. 7 or No. 67)	15	2	2	2	2	12	12	16	20	24	2	13	15	18	20	23	27	32	37
	20	2	2	2	2	12	14	18	22	26	12	15	17	19	22	24	29	34	39
	30	2	2	2	13	15	17	21	25	30	14	17	19	22	24	27	32	37	42
	50	12	12	14	16	18	21	25	30	35	17	19	22	25	28	30	36	41	47
	100	14	16	19	21	24	27	32	37	42	21	24	26	29	32	35	41	47	53
	150	17	19	22	25	27	30	36	41	46	23	26	29	32	35	38	44	50	56
ASTM D1863 (No. 6)	15	2	2	2	2	12	12	12	15	18	2	2	2	13	15	17	22	26	30
	20	2	2	2	2	12	12	13	17	21	2	2	12	15	17	19	23	28	32
	30	2	2	2	2	12	12	16	20	24	2	12	14	17	19	21	26	31	35
	50	12	12	12	12	14	16	20	24	28	12	15	17	19	22	24	29	34	39
	100	12	12	14	16	19	21	26	30	35	16	18	21	24	26	29	34	39	45
	150	12	14	17	19	22	24	29	34	39	18	21	23	26	29	32	37	43	48

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.

a. Interpolation shall be permitted for mean roof height and parapet height.

b. Basic design wind speed, V, and wind exposure shall be determined in accordance with Section 1609.

c. Where the minimum required parapet height is indicated to be 2 inches (51 mm), a gravel stop shall be permitted and shall extend not less than 2 inches (51 mm) from the roof surface and not less than the height of the aggregate.

d. For Exposure D, add 8 inches (203 mm) to the parapet height required for Exposure C and the parapet height shall not be less than 12 inches (305 mm).

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**TABLE 1505.1**  
**MINIMUM ROOF COVERING**  
**CLASSIFICATION FOR TYPES OF CONSTRUCTION<sup>a, b</sup>**

IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB
B	B	B	C <sup>c</sup>	B	C <sup>c</sup>	B	B	C <sup>c</sup>

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

- a. Unless otherwise required in accordance with the *International Wild-land-Urban Interface Code* or due to the location of the building within a fire district in accordance with Appendix D.
- b. Nonclassified roof coverings shall be permitted on buildings of Group R-3 and Group U occupancies, where there is a minimum fire-separation distance of 6 feet measured from the leading edge of the roof.
- c. Buildings that are not more than two stories above grade plane and having not more than 6,000 square feet of projected roof area and where there is a minimum 10-foot fire-separation distance from the leading edge of the roof to a lot line on all sides of the building, except for street fronts or public ways, shall be permitted to have roofs of No. 1 cedar or redwood shakes and No. 1 shingles constructed in accordance with Section 1505.7.

**[BF] 1505.2 Class A roof assemblies.** Class A *roof assemblies* are those that are effective against severe fire test exposure. Class A *roof assemblies* and *roof coverings* shall be *listed* and identified as Class A by an *approved* testing agency. Class A *roof assemblies* shall be permitted for use in buildings or structures of all types of construction.

**Exceptions:**

1. Class A *roof assemblies* include those with coverings of brick, masonry or an exposed concrete roof deck.
2. Class A *roof assemblies* also include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile or slate installed on noncombustible decks or ferrous, copper or metal sheets installed without a roof deck on noncombustible framing.
3. Class A *roof assemblies* include minimum 16 ounce per square foot (0.0416 kg/m<sup>2</sup>) copper sheets installed over combustible decks.
4. Class A *roof assemblies* include slate installed over ASTM D226, Type II *underlayment* over combustible decks.

**[BF] 1505.3 Class B roof assemblies.** Class B *roof assemblies* are those that are effective against moderate fire-test exposure. Class B *roof assemblies* and *roof coverings* shall be *listed* and identified as Class B by an *approved* testing agency.

**[BF] 1505.4 Class C roof assemblies.** Class C *roof assemblies* are those that are effective against light fire-test exposure. Class C *roof assemblies* and *roof coverings* shall be *listed* and identified as Class C by an *approved* testing agency.

**[BF] 1505.5 Nonclassified roofing.** Nonclassified roofing is *approved* material that is not *listed* as a Class A, B or C *roof covering*.

**[BF] 1505.6 Fire-retardant-treated wood shingles and shakes.** *Fire-retardant-treated wood* shakes and shingles shall be treated by impregnation with chemicals by the full-cell vacuum-pressure process, in accordance with AWPA C1. Each bundle shall be marked to identify the manufactured unit and the manufacturer, and shall be *labeled* to

identify the classification of the material in accordance with the testing required in Section 1505.1, the treating company and the quality control agency.

**[BF] 1505.7 Special purpose roofs.** Special purpose wood shingle or wood shake roofing shall conform to the grading and application requirements of Section 1507.8 or 1507.9. In addition, an *underlayment* of <sup>5</sup>/<sub>8</sub>-inch (15.9 mm) Type X water-resistant gypsum backing board or *gypsum sheathing* shall be placed under minimum nominal <sup>1</sup>/<sub>2</sub>-inch-thick (12.7 mm) *wood structural panel* solid sheathing or 1-inch (25 mm) nominal spaced sheathing.

**[BF] 1505.8 Building-integrated photovoltaic (BIPV) products.** *BIPV products* installed as the roof covering shall be tested, *listed* and *labeled* for fire classification in accordance with Section 1505.1.

**[BF] 1505.9 Rooftop mounted photovoltaic (PV) panel systems.** Rooftop mounted *photovoltaic (PV) panel systems* shall be tested, *listed* and identified with a fire classification in accordance with UL 2703. Listed systems shall be installed in accordance with the manufacturer's installation instructions and their listing. The fire classification shall comply with Table 1505.1 based on the type of construction of the building.

**[BF] 1505.10 Landscaped roofs.** Landscaped roofs shall comply with Sections 1505.1 and 1507.15 and shall be installed in accordance with ANSI/SPRI VF-1.

## SECTION 1506 MATERIALS

**1506.1 Scope.** The requirements set forth in this section shall apply to the application of roof-covering materials specified herein. *Roof coverings* shall be applied in accordance with this chapter and the *roof covering* listing as required by Section 1505. Installation of *roof coverings* shall comply with the applicable provisions of Section 1507.

**1506.2 Material specifications and physical characteristics.** Roof-covering materials shall conform to the applicable standards listed in this chapter.

**1506.3 Product identification.** Roof-covering materials shall be delivered in packages bearing the manufacturer's identifying marks and *approved* testing agency labels required in accordance with Section 1505. Bulk shipments of materials shall be accompanied with the same information issued in the form of a certificate or on a bill of lading by the manufacturer.

## SECTION 1507 REQUIREMENTS FOR ROOF COVERINGS

**1507.1 Scope.** *Roof coverings* shall be applied in accordance with the applicable provisions of this section and the manufacturer's installation instructions.

**1507.1.1 Underlayment.** Underlayment for asphalt shingles, clay and concrete tile, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes, metal roof panels and *photovoltaic*

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

*shingles* shall conform to the applicable standards listed in this chapter. Underlayment materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a label indicating compliance with the standard designation and, if applicable, type classification indicated in Table 1507.1.1(1). Underlayment shall be applied in accordance with Table 1507.1.1(2). Underlayment shall be attached in accordance with Table 1507.1.1(3).

➔ **Exceptions:**

1. As an alternative, a minimum 4-inch-wide (102 mm) strip of self-adhering polymer modified bitumen membrane complying with ASTM D1970 and installed in accordance with the manufacturer's installation instructions for the deck material shall be applied over all joints in the roof decking. An approved underlayment for the applicable roof covering for design wind speeds less than 120 mph (54 m/s) shall be applied over the 4-inch-wide (102 mm) membrane strips.
2. As an alternative, two layers of underlayment complying with ASTM D226 Type II or ASTM D4869 Type IV shall be permitted to be installed as follows: Apply a 19-inch (483 mm) strip of underlayment parallel with the eave. Starting at the eave, apply 36-inch-wide (914 mm) strips of underlayment felt, overlapping successive sheets 19 inches (483 mm). The underlayment shall be attached with corrosion-resistant fasteners in a grid pattern of 12 inches (305 mm) between side laps with a 6-inch (152 mm) spacing at side and end laps. End laps

shall be 4 inches (102 mm) and shall be offset by 6 feet (1829 mm). Underlayment shall be attached using metal or plastic cap nails with a nominal cap diameter of not less than 1 inch (25.4 mm). Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a thickness of not less than 0.010 inch (0.254 mm). Thickness of the outside edge of plastic caps shall be not less than 0.035 inch (0.89 mm). The cap nail shank shall be not less than 0.083 inch (2.1 mm) for ring shank cap nails and 0.091 inch (2.3 mm) for smooth shank cap nails. The cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than  $\frac{3}{4}$  inch (19.1 mm) into the roof sheathing.

3. Structural metal panels that do not require a substrate or underlayment.

**1507.1.2 Ice barriers.** In areas where there has been a history of ice forming along the eaves causing a backup of water, an ice barrier shall be installed for asphalt shingles, *metal roof shingles*, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles, and wood shakes. The ice barrier shall consist of not less than two layers of *underlayment* cemented together, or a self-adhering polymer modified bitumen sheet shall be used in place of normal *underlayment* and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the *exterior wall* line of the building.

**Exception:** Detached accessory structures that do not contain conditioned floor area.

**TABLE 1507.1.1(1)  
UNDERLAYMENT TYPES**

ROOF COVERING	SECTION	MAXIMUM BASIC DESIGN WIND SPEED, V < 140 MPH	MAXIMUM BASIC DESIGN WIND SPEED, V ≥ 140 MPH
Asphalt shingles	1507.2	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV ASTM D6757	ASTM D226 Type II ASTM D4869 Type IV ASTM D6757
Clay and concrete tiles	1507.3	ASTM D226 Type II ASTM D2626 Type I ASTM D6380 Class M mineral surfaced roll roofing	ASTM D226 Type II ASTM D2626 Type I ASTM D6380 Class M mineral surfaced roll roofing
Metal roof panels	1507.4	Manufacturer's instructions	ASTM D226 Type II ASTM D4869 Type IV
Metal roof shingles	1507.5	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type IV
Mineral-surfaced roll roofing	1507.6	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type IV
Slate shingles	1507.7	ASTM D226 Type II ASTM D4869 Type III or IV	ASTM D226 Type II ASTM D4869 Type IV
Wood shingles	1507.8	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type IV
Wood shakes	1507.9	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type IV
Photovoltaic shingles	1507.16	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV ASTM D6757	ASTM D226 Type II ASTM D4869 Type IV ASTM D6757

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**TABLE 1507.1.1(2)**  
**UNDERLAYMENT APPLICATION**

ROOF COVERING	SECTION	MAXIMUM BASIC DESIGN WIND SPEED, $V < 140$ MPH	MAXIMUM BASIC DESIGN WIND SPEED, $V \geq 140$ MPH
Asphalt shingles	1507.2	For roof slopes from 2 units vertical in 12 units horizontal (2:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be two layers applied as follows: Apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied as follows: Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.	Same as Maximum Basic Design Wind Speed, $V < 140$ mph except all laps shall be not less than 4 inches
Clay and concrete tile	1507.3	For roof slopes from $2\frac{1}{2}$ units vertical in 12 units horizontal ( $2\frac{1}{2}$ :12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be not fewer than two layers applied as follows: Starting at the eave, a 19-inch strip of underlayment shall be applied parallel with the eave. Starting at the eave, a 36-inch-wide strip of underlayment felt shall be applied, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied as follows: Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches. End laps shall be 4 inches and shall be offset by 6 feet.	Same as Maximum Basic Design Wind Speed, $V < 140$ mph except all laps shall be not less than 4 inches
Metal roof panels	1507.4	Apply in accordance with the manufacturer's installation instructions	For roof slopes from 2 units vertical in 12 units horizontal (2:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be two layers applied as follows: Apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied as follows: Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 4 inches. End laps shall be 4 inches and shall be offset by 6 feet.
Metal roof shingles	1507.5		
Mineral-surfaced roll roofing	1507.6		
Slate shingles	1507.7		
Wood shingles	1507.8		
Wood shakes	1507.9		
Photovoltaic shingles	1507.16	For roof slopes from 3 units vertical in 12 units horizontal (3:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be two layers applied as follows: Apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied as follows: Underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.	Same as Maximum Basic Design Wind Speed, $V < 140$ mph except all laps shall be not less than 4 inches

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.



**TABLE 1507.1.1(3)**  
**UNDERLAYMENT ATTACHMENT**

ROOF COVERING	SECTION	MAXIMUM BASIC DESIGN WIND SPEED, $V < 140$ MPH	MAXIMUM BASIC DESIGN WIND SPEED, $V \geq 140$ MPH
Asphalt shingles	1507.2	Fastened sufficiently to hold in place	The underlayment shall be attached with corrosion-resistant fasteners in a grid pattern of 12 inches between side laps with a 6-inch spacing at side and end laps. Underlayment shall be attached using metal or plastic cap nails or cap staples with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage (0.0134 inch) sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Staples shall be not less than 21 gage (0.032 inch). The cap nail shank and cap staple legs shall have a length sufficient to penetrate through the roof sheathing or not less than $\frac{3}{4}$ inch into the roof sheathing.
Clay and concrete tile	1507.3		
Photovoltaic shingles	1507.16		
Metal roof panels	1507.4	Manufacturer's installation instructions	The underlayment shall be attached with corrosion-resistant fasteners in a grid pattern of 12 inches between side laps with a 6-inch spacing at side and end laps. Underlayment shall be attached using metal or plastic cap nails or cap staples with a nominal cap diameter of not less than 1 inch. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch for ring shank cap nails and 0.091 inch for smooth shank cap nails. Staples shall be not less than 21 gage. The cap nail shank and cap staple legs shall have a length sufficient to penetrate through the roof sheathing or not less than $\frac{3}{4}$ inch into the roof sheathing.
Metal roof shingles	1507.5		
Mineral-surfaced roll roofing	1507.6		
Slate shingles	1507.7		
Wood shingles	1507.8		
Wood shakes	1507.9		

For SI: 1 inch = 25.4 mm; 1 mile per hour = 0.447 m/s.

**1507.2 Asphalt shingles.** The installation of asphalt shingles shall comply with the provisions of this section.

**1507.2.1 Deck requirements.** Asphalt shingles shall be fastened to solidly sheathed decks.

**1507.2.2 Slope.** Asphalt shingles shall only be used on roof slopes of 2 units vertical in 12 units horizontal (17-percent slope) or greater. For roof slopes from 2 units vertical in 12 units horizontal (17-percent slope) up to 4 units vertical in 12 units horizontal (33-percent slope), double *underlayment* application is required in accordance with Section 1507.2.8.

**1507.2.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.2.4 Asphalt shingles.** Asphalt shingles shall comply with ASTM D3462.

**1507.2.5 Fasteners.** Fasteners for asphalt shingles shall be galvanized, stainless steel, aluminum or copper roofing nails, minimum 12-gage [0.105 inch (2.67 mm)] shank with a minimum  $\frac{3}{8}$ -inch-diameter (9.5 mm) head, of a length to penetrate through the roofing materials and not less than  $\frac{3}{4}$  inch (19.1 mm) into the roof sheathing. Where the roof sheathing is less than  $\frac{3}{4}$  inch (19.1 mm) thick, the nails shall penetrate through the sheathing. Fasteners shall comply with ASTM F1667.

**1507.2.6 Attachment.** Asphalt shingles shall have the minimum number of fasteners required by the manufac-

turer, but not less than four fasteners per strip shingle or two fasteners per individual shingle. Where the roof slope exceeds 21 units vertical in 12 units horizontal (21:12), shingles shall be installed as required by the manufacturer.

**1507.2.7 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.2.8 Flashings.** Flashing for asphalt shingles shall comply with this section. Flashing shall be applied in accordance with this section and the asphalt shingle manufacturer's printed instructions.

**1507.2.8.1 Base and cap flashing.** Base and cap flashing shall be installed in accordance with the manufacturer's instructions. Base flashing shall be of either corrosion-resistant metal of minimum nominal 0.019-inch (0.483 mm) thickness or mineral-surfaced roll roofing weighing not less than 77 pounds per 100 square feet (3.76 kg/m<sup>2</sup>). Cap flashing shall be corrosion-resistant metal of minimum nominal 0.019-inch (0.483 mm) thickness.

**1507.2.8.2 Valleys.** Valley linings shall be installed in accordance with the manufacturer's instructions before applying shingles. Valley linings of the following types shall be permitted:

1. For open valleys (valley lining exposed) lined with metal, the valley lining shall be not less than 24 inches (610 mm) wide and of any of

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

the corrosion-resistant metals in Table 1507.2.8.2.

2. For open valleys, valley lining of two plies of mineral-surfaced roll roofing complying with ASTM D3909 or ASTM D6380 shall be permitted. The bottom layer shall be 18 inches (457 mm) and the top layer not less than 36 inches (914 mm) wide.
3. For closed valleys (valleys covered with shingles), valley lining of one ply of smooth roll roofing complying with ASTM D6380, and not less than 36 inches (914 mm) wide or types as described in Item 1 or 2 above shall be permitted. Self-adhering polymer modified bitumen *underlayment* bearing a label indicating compliance with ASTM D1970 shall be permitted in lieu of the lining material.

**1507.2.8.3 Drip edge.** A drip edge shall be provided at eaves and rake edges of shingle roofs. Adjacent segments of the drip edge shall be lapped not less than 2 inches (51 mm). The vertical leg of drip edges shall be not less than  $1\frac{1}{2}$  inches (38 mm) in width and shall extend not less than  $\frac{1}{4}$  inch (6.4 mm) below sheathing. The drip edge shall extend back on the roof not less than 2 inches (51 mm). *Underlayment* shall be installed over drip edges along eaves. Drip edges shall be installed over *underlayment* along rake edges. Drip edges shall be mechanically fastened at intervals not greater than 12 inches (305 mm) on center.

**1507.3 Clay and concrete tile.** The installation of clay and concrete tile shall comply with the provisions of this section.

**1507.3.1 Deck requirements.** Concrete and clay tile shall be installed only over solid sheathing.

**Exception:** Spaced lumber sheathing shall be permitted in *Seismic Design Categories A, B and C*.

**1507.3.2 Deck slope.** Clay and concrete roof tile shall be installed on roof slopes of  $2\frac{1}{2}$  units vertical in 12 units horizontal (21-percent slope) or greater. For roof slopes from  $2\frac{1}{2}$  units vertical in 12 units horizontal (21-percent slope) to 4 units vertical in 12 units horizontal (33-percent slope), double *underlayment* application is required in accordance with Section 1507.3.3.

**1507.3.3 Underlayment.** Unless otherwise noted, required *underlayment* shall conform to: ASTM D226, Type II; ASTM D2626 or ASTM D6380, Class M mineral-surfaced roll roofing.

**1507.3.4 Clay tile.** Clay roof tile shall comply with ASTM C1167.

**1507.3.5 Concrete tile.** Concrete roof tile shall comply with ASTM C1492.

**1507.3.6 Fasteners.** Tile fasteners shall be corrosion resistant and not less than 11-gage, [0.120 inch (3 mm)],  $\frac{5}{16}$ -inch (8.0 mm) head, and of sufficient length to penetrate the deck not less than  $\frac{3}{4}$  inch (19.1 mm) or through the thickness of the deck, whichever is less. Attaching wire for clay or concrete tile shall not be smaller than 0.083 inch (2.1 mm). Perimeter fastening areas include three tile courses but not less than 36 inches (914 mm) from either side of hips or ridges and edges of eaves and gable rakes.

**1507.3.7 Attachment.** Clay and concrete roof tiles shall be fastened in accordance with Table 1507.3.7.

**1507.3.8 Application.** Tile shall be applied according to the manufacturer's installation instructions, based on the following:

1. Climatic conditions.
2. Roof slope.
3. *Underlayment* system.
4. Type of tile being installed.

**TABLE 1507.2.8.2  
VALLEY LINING MATERIAL**

MATERIAL	MINIMUM THICKNESS	GAGE	WEIGHT
Aluminum	0.024 in.	—	—
Cold-rolled copper	0.0216 in.	—	ASTM B370, 16 oz. per square ft.
Copper	—	—	16 oz
Galvanized steel	0.0179 in.	26 (zinc-coated G90)	—
High-yield copper	0.0162 in.	—	ASTM B370, 12 oz. per square ft.
Lead	—	—	2.5 pounds
Lead-coated copper	0.0216 in.	—	ASTM B101, 16 oz. per square ft.
Lead-coated high-yield copper	0.0162 in.	—	ASTM B101, 12 oz. per square ft.
Painted terne	—	—	20 pounds
Stainless steel	—	28	—
Zinc alloy	0.027 in.	—	—

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg, 1 ounce = 28.35 g, 1 square foot = 0.0929 m<sup>2</sup>.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**TABLE 1507.3.7**  
**CLAY AND CONCRETE TILE ATTACHMENT<sup>a, b, c</sup>**

GENERAL—CLAY OR CONCRETE ROOF TILE				
Maximum Allowable Stress Design Wind Speed, $V_{asd}$ <sup>f</sup> (mph)	Mean roof height (feet)	Roof slope < 3:12	Roof slope 3:12 and over	
85	0-60	One fastener per tile. Flat tile without vertical laps, two fasteners per tile.	Two fasteners per tile. Only one fastener on slopes of 7:12 and less for tiles with installed weight exceeding 7.5 lbs./sq. ft. having a width not more than 16 inches.	
100	0-40			
100	> 40-60	The head of all tiles shall be nailed. The nose of all eave tiles shall be fastened with approved clips. Rake tiles shall be nailed with two nails. The nose of all ridge, hip and rake tiles shall be set in a bead of roofer's mastic.		
110	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
120	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
130	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
All	> 60	The fastening system shall resist the wind forces in Section 1609.5.3.		
INTERLOCKING CLAY OR CONCRETE ROOF TILE WITH PROJECTING ANCHOR LUGS <sup>d, e</sup> (Installations on spaced/solid sheathing with battens or spaced sheathing)				
Maximum Allowable Stress Design Wind Speed, $V_{asd}$ <sup>f</sup> (mph)	Mean roof height (feet)	Roof slope < 5:12	Roof slope 5:12 < 12:12	Roof slope 12:12 and over
85	0-60	Fasteners are not required. Tiles with installed weight less than 9 lbs./sq. ft. require not fewer than one fastener per tile.	One fastener per tile every other row. Perimeter tiles require one fastener. Tiles with installed weight less than 9 lbs./sq. ft. require not fewer than one fastener per tile.	One fastener required for every tile. Tiles with installed weight less than 9 lbs./sq. ft. require not fewer than one fastener per tile.
100	0-40			
100	> 40-60	The head of all tiles shall be nailed. The nose of all eave tiles shall be fastened with approved clips. Rake tiles shall be nailed with two nails. The nose of all ridge, hip and rake tiles shall be set in a bead of roofer's mastic.		
110	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
120	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
130	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
All	> 60	The fastening system shall resist the wind forces in Section 1609.5.3.		
INTERLOCKING CLAY OR CONCRETE ROOF TILE WITH PROJECTING ANCHOR LUGS (Installations on solid sheathing without battens)				
Maximum Allowable Stress Wind Speed, $V_{asd}$ <sup>f</sup> (mph)	Mean roof height (feet)	All roof slopes		
85	0-60	One fastener per tile.		
100	0-40	One fastener per tile.		
100	> 40-60	The head of all tiles shall be nailed. The nose of all eave tiles shall be fastened with approved clips. Rake tiles shall be nailed with two nails. The nose of all ridge, hip and rake tiles shall be set in a bead of roofer's mastic.		
110	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
120	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
130	0-60	The fastening system shall resist the wind forces in Section 1609.5.3.		
All	> 60	The fastening system shall resist the wind forces in Section 1609.5.3.		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 4.882 kg/m<sup>2</sup>.

- Minimum fastener size. Corrosion-resistant nails not less than No. 11 gage with  $\frac{3}{16}$ -inch head. Fasteners shall be long enough to penetrate into the sheathing  $\frac{3}{4}$  inch or through the thickness of the sheathing, whichever is less. Attaching wire for clay and concrete tile shall not be smaller than 0.083 inch.
- Snow areas. Not fewer than two fasteners per tile are required or battens and one fastener.
- Roof slopes greater than 24:12. The nose of all tiles shall be securely fastened.
- Horizontal battens. Battens shall be not less than 1 inch by 2 inches nominal. Provisions shall be made for drainage by a riser of not less than  $\frac{1}{8}$  inch at each nail or by 4-foot-long battens with not less than a  $\frac{1}{2}$ -inch separation between battens. Horizontal battens are required for slopes over 7:12.
- Perimeter fastening areas include three tile courses but not less than 36 inches from either side of hips or ridges and edges of eaves and gable rakes.
- $V_{asd}$  shall be determined in accordance with Section 1609.3.1.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**1507.3.9 Flashing.** At the juncture of the roof vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions, and where of metal, shall be not less than 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend not less than 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of three units vertical in 12 units horizontal (25-percent slope) and over, the valley flashing shall have a 36-inch-wide (914 mm) *underlayment* of either one layer of Type I *underlayment* running the full length of the valley, or a self-adhering polymer-modified bitumen sheet bearing a label indicating compliance with ASTM D1970, in addition to other required *underlayment*. In areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water, the metal valley flashing *underlayment* shall be solid cemented to the roofing *underlayment* for slopes under seven units vertical in 12 units horizontal (58-percent slope) or self-adhering polymer-modified bitumen sheet shall be installed.

**1507.4 Metal roof panels.** The installation of *metal roof panels* shall comply with the provisions of this section.

**1507.4.1 Deck requirements.** *Metal roof panel roof coverings* shall be applied to a solid or closely fitted deck, except where the *roof covering* is specifically designed to be applied to spaced supports.

**1507.4.2 Deck slope.** Minimum slopes for *metal roof panels* shall comply with the following:

1. The minimum slope for lapped, nonsoldered seam *metal roof panels* without applied lap sealant shall be three units vertical in 12 units horizontal (25-percent slope).
2. The minimum slope for lapped, nonsoldered seam *metal roof panels* with applied lap sealant shall be one-half unit vertical in 12 units horizontal (4-percent slope). Lap sealants shall be applied in accordance with the *approved* manufacturer's installation instructions.
3. The minimum slope for standing-seam *metal roof panel* systems shall be one-quarter unit vertical in 12 units horizontal (2-percent slope).

**1507.4.3 Material standards.** Metal-sheet *roof covering* systems that incorporate supporting structural members shall be designed in accordance with Chapter 22. Metal-sheet *roof coverings* installed over structural decking shall comply with Table 1507.4.3(1). The materials used for metal-sheet *roof coverings* shall be naturally corrosion resistant or provided with *corrosion resistance* in accordance with the standards and minimum thicknesses shown in Table 1507.4.3(2).

**1507.4.4 Attachment.** *Metal roof panels* shall be secured to the supports in accordance with the *approved* manufac-

turer's fasteners. In the absence of manufacturer recommendations, the following fasteners shall be used:

1. Galvanized fasteners shall be used for steel roofs.
2. Copper, brass, bronze, copper alloy or 300 series stainless-steel fasteners shall be used for copper roofs.
3. Stainless-steel fasteners are acceptable for all types of metal roofs.
4. Aluminum fasteners are acceptable for aluminum roofs attached to aluminum supports.

**TABLE 1507.4.3(1)  
METAL ROOF COVERINGS**

ROOF COVERING TYPE	STANDARD APPLICATION RATE/THICKNESS
Aluminum	ASTM B209, 0.024 inch minimum thickness for roll-formed panels and 0.019 inch minimum thickness for press-formed shingles.
Aluminum-zinc alloy coated steel	ASTM A792 AZ 50
Cold-rolled copper	ASTM B370 minimum 16 oz./sq. ft. and 12 oz./sq. ft. high yield copper for metal-sheet roof covering systems; 12 oz./sq. ft. for preformed metal shingle systems.
Copper	16 oz./sq. ft. for metal-sheet roof-covering systems; 12 oz./sq. ft. for preformed metal shingle systems.
Galvanized steel	ASTM A653 G90 zinc-coated <sup>a</sup> .
Hard lead	2 lbs./sq. ft.
Lead-coated copper	ASTM B101
Prepainted steel	ASTM A755
Soft lead	3 lbs./sq. ft.
Stainless steel	ASTM A240, 300 Series Alloys
Steel	ASTM A924
Terne and terne-coated stainless	Terne coating of 40 lbs. per double base box, field painted where applicable in accordance with manufacturer's installation instructions.
Zinc	0.027 inch minimum thickness; 99.995% electrolytic high-grade zinc with alloy additives of copper (0.08% - 0.20%), titanium (0.07% - 0.12%) and aluminum (0.015%).

For SI: 1 ounce per square foot = 0.305 kg/m<sup>2</sup>, 1 pound per square foot = 4.882 kg/m<sup>2</sup>, 1 inch = 25.4 mm, 1 pound = 0.454 kg.

a. For Group U buildings, the minimum coating thickness for ASTM A653 galvanized steel roofing shall be G60.

**TABLE 1507.4.3(2)  
MINIMUM CORROSION RESISTANCE**

55% Aluminum-zinc alloy coated steel	ASTM A792 AZ 50
5% Aluminum alloy-coated steel	ASTM A875 GF60
Aluminum-coated steel	ASTM A463 T2 65
Galvanized steel	ASTM A653 G90
Prepainted steel	ASTM A755 <sup>a</sup>

a. Paint systems in accordance with ASTM A755 shall be applied over steel products with corrosion-resistant coatings complying with ASTM A463, ASTM A653, ASTM A792 or ASTM A875.



**1507.4.5 Underlayment and high wind.** *Underlayment* shall comply with Section 1507.1.1.

**1507.5 Metal roof shingles.** The installation of *metal roof shingles* shall comply with the provisions of this section.

**1507.5.1 Deck requirements.** *Metal roof shingles* shall be applied to a solid or closely fitted deck, except where the *roof covering* is specifically designed to be applied to spaced sheathing.

**1507.5.2 Deck slope.** *Metal roof shingles* shall not be installed on roof slopes below three units vertical in 12 units horizontal (25-percent slope).

**1507.5.3 Underlayment.** Underlayment shall comply with Section 1507.1.1.

**1507.5.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.5.5 Material standards.** *Metal roof shingle roof coverings* shall comply with Table 1507.4.3(1). The materials used for metal-roof shingle *roof coverings* shall be naturally corrosion resistant or provided with *corrosion resistance* in accordance with the standards and minimum thicknesses specified in the standards listed in Table 1507.4.3(2).

**1507.5.6 Attachment.** *Metal roof shingles* shall be secured to the roof in accordance with the *approved* manufacturer's installation instructions.

**1507.5.7 Flashing.** Roof valley flashing shall be of corrosion-resistant metal of the same material as the *roof covering* or shall comply with the standards in Table 1507.4.3(1). The valley flashing shall extend not less than 8 inches (203 mm) from the centerline each way and shall have a splash diverter rib not less than  $\frac{3}{4}$  inch (19.1 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). In areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water, the metal valley flashing shall have a 36-inch-wide (914 mm) *underlayment* directly under it consisting of either one layer of *underlayment* running the full length of the valley or a self-adhering polymer-modified bitumen sheet bearing a label indicating compliance with ASTM D1970, in addition to *underlayment* required for *metal roof shingles*. The metal valley flashing *underlayment* shall be solidly cemented to the roofing *underlayment* for roof slopes under seven units vertical in 12 units horizontal (58-percent slope) or self-adhering polymer-modified bitumen sheet shall be installed.

**1507.6 Mineral-surfaced roll roofing.** The installation of mineral-surfaced roll roofing shall comply with this section.

**1507.6.1 Deck requirements.** Mineral-surfaced roll roofing shall be fastened to solidly sheathed roofs.

**1507.6.2 Deck slope.** Mineral-surfaced roll roofing shall not be applied on roof slopes below one unit vertical in 12 units horizontal (8-percent slope).

**1507.6.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.6.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.6.5 Material standards.** Mineral-surfaced roll roofing shall conform to ASTM D3909 or ASTM D6380.

**1507.7 Slate shingles.** The installation of slate shingles shall comply with the provisions of this section.

**1507.7.1 Deck requirements.** Slate shingles shall be fastened to solidly sheathed roofs.

**1507.7.2 Deck slope.** Slate shingles shall only be used on slopes of four units vertical in 12 units horizontal (4:12) or greater.

**1507.7.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.7.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.7.5 Material standards.** Slate shingles shall comply with ASTM C406.

**1507.7.6 Application.** Minimum headlap for slate shingles shall be in accordance with Table 1507.7.6. Slate shingles shall be secured to the roof with two fasteners per slate.

**TABLE 1507.7.6  
SLATE SHINGLE HEADLAP**

SLOPE	HEADLAP (inches)
4:12 < slope < 8:12	4
8:12 < slope < 20:12	3
slope ≥ 20:12	2

For SI: 1 inch = 25.4 mm.

**1507.7.7 Flashing.** Flashing and counterflashing shall be made with sheet metal. Valley flashing shall be not less than 15 inches (381 mm) wide. Valley and flashing metal shall be a minimum uncoated thickness of 0.0179-inch (0.455 mm) zinc-coated G90. Chimneys, stucco or brick walls shall have not fewer than two plies of felt for a cap flashing consisting of a 4-inch-wide (102 mm) strip of felt set in plastic cement and extending 1 inch (25 mm) above the first felt and a top coating of plastic cement. The felt shall extend over the base flashing 2 inches (51 mm).

**1507.8 Wood shingles.** The installation of wood shingles shall comply with the provisions of this section and Table 1507.8.

**1507.8.1 Deck requirements.** Wood shingles shall be installed on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners.

**1507.8.1.1 Solid sheathing required.** Solid sheathing is required in areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**TABLE 1507.8**  
**WOOD SHINGLE AND SHAKE INSTALLATION**

ROOF ITEM	WOOD SHINGLES	WOOD SHAKES
1. Roof slope	Wood shingles shall be installed on slopes of not less than 3 units vertical in 12 units horizontal (3:12).	Wood shakes shall be installed on slopes of not less than 4 units vertical in 12 units horizontal (4:12).
2. Deck requirement		
Temperate climate	Shingles shall be applied to roofs with solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1" × 4" nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners.	Shakes shall be applied to roofs with solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1" × 4" nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners. Where 1" × 4" spaced sheathing is installed at 10 inches, boards must be installed between the sheathing boards.
In areas where the average daily temperature in January is 25°F or less or where there is a possibility of ice forming along the eaves causing a backup of water.	Solid sheathing is required.	Solid sheathing is required.
3. Interlayment	No requirements.	Interlayment shall comply with ASTM D226, Type 1.
4. Underlayment		
Temperate climate	Underlayment shall comply with Section 1507.1.1.	Underlayment shall comply with Section 1507.1.1.
5. Application		
Attachment	Fasteners for wood shingles shall be hot-dipped galvanized or Type 304 (Type 316 for coastal areas) stainless steel with a minimum penetration of 0.75 inch into the sheathing. For sheathing less than 0.5 inch thick, the fasteners shall extend through the sheathing.	Fasteners for wood shakes shall be hot-dipped galvanized or Type 304 (Type 316 for coastal areas) with a minimum penetration of 0.75 inch into the sheathing. For sheathing less than 0.5 inch thick, the fasteners shall extend through the sheathing.
No. of fasteners	Two per shingle.	Two per shake.
Exposure	Weather exposures shall not exceed those set forth in Table 1507.8.7.	Weather exposures shall not exceed those set forth in Table 1507.9.8.
Method	Shingles shall be laid with a side lap of not less than 1.5 inches between joints in courses, and no two joints in any three adjacent courses shall be in direct alignment. Spacing between shingles shall be 0.25 to 0.375 inch.	Shakes shall be laid with a side lap of not less than 1.5 inches between joints in adjacent courses. Spacing between shakes shall not be less than 0.375 inch or more than 0.625 inch for shakes and taper sawn shakes of naturally durable wood and shall be 0.25 to 0.375 inch for preservative-treated taper sawn shakes.
Flashing	In accordance with Section 1507.8.8.	In accordance with Section 1507.9.9.

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

**1507.8.2 Deck slope.** Wood shingles shall be installed on slopes of not less than three units vertical in 12 units horizontal (25-percent slope).

**1507.8.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.8.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.8.5 Material standards.** Wood shingles shall be of *naturally durable wood* and comply with the requirements of Table 1507.8.5.

**1507.8.6 Attachment.** Fasteners for wood shingles shall be corrosion resistant with a minimum penetration of  $\frac{3}{4}$  inch (19.1 mm) into the sheathing. For sheathing less than  $\frac{1}{2}$  inch (12.7 mm) in thickness, the fasteners shall extend

through the sheathing. Each shingle shall be attached with not fewer than two fasteners.

**TABLE 1507.8.5**  
**WOOD SHINGLE MATERIAL REQUIREMENTS**

MATERIAL	APPLICABLE MINIMUM GRADES	GRADING RULES
Wood shingles of naturally durable wood	1, 2 or 3	CSSB

CSSB = Cedar Shake and Shingle Bureau

**1507.8.7 Application.** Wood shingles shall be laid with a side lap not less than  $1\frac{1}{2}$  inches (38 mm) between joints in adjacent courses, and not be in direct alignment in alternate courses. Spacing between shingles shall be  $\frac{1}{4}$  to  $\frac{3}{8}$  inch (6.4 to 9.5 mm). Weather exposure for wood shingles shall not exceed that set in Table 1507.8.7.

**TABLE 1507.8.7**  
**WOOD SHINGLE WEATHER EXPOSURE AND ROOF SLOPE**

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches)	
			3:12 pitch to < 4:12	4:12 pitch or steeper
Shingles of naturally durable wood	16	No. 1	3.75	5
		No. 2	3.5	4
		No. 3	3	3.5
	18	No. 1	4.25	5.5
		No. 2	4	4.5
		No. 3	3.5	4
	24	No. 1	5.75	7.5
		No. 2	5.5	6.5
		No. 3	5	5.5

For SI: 1 inch = 25.4 mm.

**1507.8.8 Flashing.** At the juncture of the roof and vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions, and where of metal, shall be not less than 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend not less than 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of three units vertical in 12 units horizontal (25-percent slope) and over, the valley flashing shall have a 36-inch-wide (914 mm) *underlayment* of either one layer of Type I *underlayment* running the full length of the valley or a self-adhering polymer-modified bitumen sheet bearing a label indicating compliance with ASTM D1970, in addition to other required *underlayment*. In areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water, the metal valley flashing *underlayment* shall be solidly cemented to the roofing *underlayment* for slopes under seven units vertical in 12 units horizontal (58-percent slope) or self-adhering polymer-modified bitumen sheet shall be installed.

**1507.8.9 Label required.** Each bundle of shingles shall be identified by a label of an approved grading or inspection bureau or agency.

**1507.9 Wood shakes.** The installation of wood shakes shall comply with the provisions of this section and Table 1507.8.

**1507.9.1 Deck requirements.** Wood shakes shall only be used on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners. Where 1-inch by 4-inch (25 mm by 102 mm) spaced sheathing is installed at 10 inches (254 mm) on center, additional 1-inch by 4-inch (25 mm by 102 mm) boards shall be installed between the sheathing boards.

**1507.9.1.1 Solid sheathing required.** Solid sheathing is required in areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water.

**1507.9.2 Deck slope.** Wood shakes shall only be used on slopes of not less than 4 units vertical in 12 units horizontal (33-percent slope).

**1507.9.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.9.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.9.5 Interlayment.** *Interlayment* shall comply with ASTM D226, Type I.

**1507.9.6 Material standards.** Wood shakes shall comply with the requirements of Table 1507.9.6.

**TABLE 1507.9.6**  
**WOOD SHAKE MATERIAL REQUIREMENTS**

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shakes of naturally durable wood	1	CSSB
Taper sawn shakes of naturally durable wood	1 or 2	CSSB
Preservative-treated shakes and shingles of naturally durable wood	1	CSSB
Fire-retardant-treated shakes and shingles of naturally durable wood	1	CSSB
Preservative-treated taper sawn shakes of Southern pine treated in accordance with AWP A U1 (Commodity Specification A, Special Requirement 4.6)	1 or 2	TFS

CSSB = Cedar Shake and Shingle Bureau.

TFS = Forest Products Laboratory of the Texas Forest Services.

**1507.9.7 Attachment.** Fasteners for wood shakes shall be corrosion resistant with a minimum penetration of  $\frac{3}{4}$  inch (19.1 mm) into the sheathing. For sheathing less than  $\frac{1}{2}$  inch (12.7 mm) in thickness, the fasteners shall extend through the sheathing. Each shake shall be attached with not fewer than two fasteners.

**1507.9.8 Application.** Wood shakes shall be laid with a side lap not less than  $1\frac{1}{2}$  inches (38 mm) between joints in adjacent courses. Spacing between shakes in the same course shall be  $\frac{3}{8}$  to  $\frac{5}{8}$  inch (9.5 to 15.9 mm) for shakes and taper sawn shakes of *naturally durable wood* and shall be  $\frac{1}{4}$  to  $\frac{3}{8}$  inch (6.4 to 9.5 mm) for preservative taper sawn shakes. Weather exposure for wood shakes shall not exceed those set in Table 1507.9.8.

**1507.9.9 Flashing.** At the juncture of the roof and vertical surfaces, flashing and counterflashing shall be provided in accordance with the manufacturer's installation instructions, and where of metal, shall be not less than 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

not less than 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) high at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of three units vertical in 12 units horizontal (25-percent slope) and over, the valley flashing shall have a 36-inch-wide (914 mm) *underlayment* of either one layer of Type I *underlayment* running the full length of the valley or a self-adhering polymer-modified bitumen sheet bearing a label indicating compliance with ASTM D1970, in addition to other required *underlayment*. In areas where the average daily temperature in January is 25°F (-4°C) or less or where there is a possibility of ice forming along the eaves causing a backup of water, the metal valley flashing *underlayment* shall be solidly cemented to the roofing *underlayment* for slopes under seven units vertical in 12 units horizontal (58-percent slope) or self-adhering polymer-modified bitumen sheet shall be installed.

**1507.9.10 Label required.** Each bundle of shakes shall be identified by a label of an approved grading or inspection bureau or agency.

**1507.10 Built-up roofs.** The installation of built-up roofs shall comply with the provisions of this section.

**1507.10.1 Slope.** Built-up roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage, except for coal-tar built-up roofs that shall have a design slope of not less than  $\frac{1}{8}$  unit vertical in 12 units horizontal (1-percent slope).

**1507.10.2 Material standards.** *Built-up roof covering* materials shall comply with the standards in Table 1507.10.2 or UL 55A.

**1507.11 Modified bitumen roofing.** The installation of modified bitumen roofing shall comply with the provisions of this section.

**1507.11.1 Slope.** Modified bitumen roofing shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**1507.11.2 Material standards.** Modified bitumen roofing materials shall comply with ASTM D6162, ASTM

D6163, ASTM D6164, ASTM D6222, ASTM D6223, ASTM D6298 or ASTM D6509.

**1507.11.2.1 Base sheet.** A base sheet that complies with the requirements of Section 1507.11.2, ASTM D1970 or ASTM D4601 shall be permitted to be used with a modified bitumen cap sheet.

**TABLE 1507.10.2  
BUILT-UP ROOFING MATERIAL STANDARDS**

MATERIAL STANDARD	STANDARD
Acrylic coatings used in roofing	ASTM D6083
Aggregate surfacing	ASTM D1863
Asphalt adhesive used in roofing	ASTM D3747
Asphalt cements used in roofing	ASTM D2822; D3019; D4586
Asphalt-coated glass fiber base sheet	ASTM D4601
Asphalt coatings used in roofing	ASTM D1227; D2823; D2824; D4479
Asphalt glass felt	ASTM D2178
Asphalt primer used in roofing	ASTM D41
Asphalt-saturated and asphalt-coated organic felt base sheet	ASTM D2626
Asphalt-saturated organic felt (perforated)	ASTM D226
Asphalt used in roofing	ASTM D312
Coal-tar cements used in roofing	ASTM D4022; D5643
Coal-tar saturated organic felt	ASTM D227
Coal-tar pitch used in roofing	ASTM D450; Type I or II
Coal-tar primer used in roofing, dampproofing and waterproofing	ASTM D43
Glass mat, coal tar	ASTM D4990
Glass mat, venting type	ASTM D4897
Mineral-surfaced inorganic cap sheet	ASTM D3909
Thermoplastic fabrics used in roofing	ASTM D5665, D5726

**TABLE 1507.9.8  
WOOD SHAKE WEATHER EXPOSURE AND ROOF SLOPE**

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches) 4:12 PITCH OR STEEPER
Shakes of naturally durable wood	18	No. 1	7.5
	24	No. 1	10 <sup>a</sup>
Preservative-treated taper sawn shakes of Southern yellow pine	18	No. 1	7.5
	24	No. 1	10
	18	No. 2	5.5
	24	No. 2	7.5
Taper sawn shakes of naturally durable wood	18	No. 1	7.5
	24	No. 1	10
	18	No. 2	5.5
	24	No. 2	7.5

For SI: 1 inch = 25.4 mm.

a. For 24-inch by 0.375-inch handsplit shakes, the maximum exposure is 7.5 inches.



**1507.12 Single-ply roofing.** The installation of single-ply roofing shall comply with the provisions of this section.

**1507.12.1 Slope.** Single-ply membrane roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**1507.12.2 Material standards.** Single-ply roof coverings shall comply with the material standards in Table 1507.12.2.

**TABLE 1507.12.2**  
**SINGLE-PLY ROOFING MATERIAL STANDARDS**

MATERIAL	MATERIAL STANDARD
Chlorosulfonated polyethylene (CSPE) or polyisobutylene (PIB)	ASTM D5019
Ethylene propylene diene monomer (EPDM)	ASTM D4637
Ketone Ethylene Ester (KEE)	ASTM D6754
Polyvinyl Chloride (PVC) or (PVC/KEE)	ASTM D4434
Thermoplastic polyolefin (TPO)	ASTM D6878

**1507.12.3 Ballasted low-slope roofs.** Ballasted low-slope roofs (roof slope < 2:12) shall be installed in accordance with this section and Section 1504.5. Stone used as *ballast* shall comply with ASTM D448 or ASTM D7655.

**1507.13 Sprayed polyurethane foam roofing.** The installation of sprayed polyurethane foam roofing shall comply with the provisions of this section.

**1507.13.1 Slope.** Sprayed polyurethane foam roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**1507.13.2 Material standards.** Spray-applied polyurethane foam insulation shall comply with ASTM C1029 Type III or IV or ASTM D7425.

**1507.13.3 Application.** Foamed-in-place roof insulation shall be installed in accordance with the manufacturer's instructions. A liquid-applied protective coating that complies with Table 1507.13.3 shall be applied not less than 2 hours nor more than 72 hours following the application of the foam.

**TABLE 1507.13.3**  
**PROTECTIVE COATING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Silicone coating	ASTM D6694
Moisture-cured polyurethane coating	ASTM D6947

**1507.13.4 Foam plastics.** Foam plastic materials and installation shall comply with Chapter 26.

**1507.14 Liquid-applied roofing.** The installation of liquid-applied roofing shall comply with the provisions of this section.

**1507.14.1 Slope.** Liquid-applied roofing shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope).

**1507.14.2 Material standards.** Liquid-applied roofing shall comply with ASTM C836, ASTM C957 or ASTM D3468.

**1507.15 Vegetative roofs and landscaped roofs.** *Vegetative roofs* and landscaped roofs shall comply with the requirements of this chapter, Section 1607.14.2.2 and the *International Fire Code*.

**[BF] 1507.15.1 Structural fire resistance.** The structural frame and roof construction supporting the load imposed on the roof by the *vegetative roof* or landscaped roofs shall comply with the requirements of Table 601.

**1507.16 Photovoltaic shingles.** The installation of *photovoltaic shingles* shall comply with the provisions of this section.

**1507.16.1 Deck requirements.** *Photovoltaic shingles* shall be applied to a solid or closely fitted deck, except where the shingles are specifically designed to be applied over spaced sheathing.

**1507.16.2 Deck slope.** *Photovoltaic shingles* shall be installed on roof slopes of not less than 2 units vertical in 12 units horizontal (2:12).

**1507.16.3 Underlayment.** *Underlayment* shall comply with Section 1507.1.1.

**1507.16.4 Ice barrier.** Where required, ice barriers shall comply with Section 1507.1.2.

**1507.16.5 Fasteners.** Fasteners for *photovoltaic shingles* shall be galvanized, stainless steel, aluminum or copper roofing nails, minimum 12-gage [0.105 inch (2.67 mm)] shank with a minimum  $\frac{3}{8}$ -inch-diameter (9.5 mm) head, of a length to penetrate through the roofing materials and not less than  $\frac{3}{4}$  inch (19.1 mm) into the roof sheathing. Where the roof sheathing is less than  $\frac{3}{4}$  inch (19.1 mm) thick, the nails shall penetrate through the sheathing. Fasteners shall comply with ASTM F1667.

**1507.16.6 Material standards.** *Photovoltaic shingles* shall be *listed* and labeled in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

**1507.16.7 Attachment.** *Photovoltaic shingles* shall be attached in accordance with the manufacturer's installation instructions.

**1507.16.8 Wind resistance.** *Photovoltaic shingles* shall comply with the classification requirements of Table 1504.2 for the appropriate maximum nominal design wind speed.

**1507.17 Building-integrated photovoltaic roof panels.** The installation of building-integrated photovoltaic (BIPV) roof panels shall comply with the provisions of this section.

**1507.17.1 Deck requirements.** BIPV roof panels shall be applied to a solid or closely fitted deck, except where the *roof covering* is specifically designed to be applied over spaced sheathing.

**1507.17.2 Deck slope.** BIPV roof panels shall be used only on roof slopes of 2 units vertical in 12 units horizontal (2:12) or greater.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**1507.17.3 Underlayment.** *Underlayment* shall comply with ASTM D226, ASTM D4869 or ASTM D6757.

**1507.17.4 Underlayment application.** *Underlayment* shall be applied *shingle fashion*, parallel to and starting from the eave, lapped 2 inches (51 mm) and fastened sufficiently to hold in place.

**1507.17.4.1 High-wind attachment.** *Underlayment* applied in areas subject to high winds [ $V_{asd}$  greater than 110 mph (49 m/s) as determined in accordance with Section 1609.3.1] shall be applied in accordance with the manufacturer's instructions. Fasteners shall be applied along the overlap at not more than 36 inches (914 mm) on center. *Underlayment* installed where  $V_{asd}$  is not less than 120 mph (54 m/s) shall comply with ASTM D226, Type III, ASTM D4869, Type IV or ASTM D6757. The *underlayment* shall be attached in a grid pattern of 12 inches (305 mm) between side laps with a 6-inch (152 mm) spacing at the side laps. The *underlayment* shall be applied in accordance with Section 1507.1.1 except all laps shall be not less than 4 inches (102 mm). *Underlayment* shall be attached using cap nails or cap staples. Caps shall be metal or plastic with a nominal head diameter of not less than 1 inch (25.4 mm). Metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Power-driven metal caps shall have a thickness of not less than 0.010 inch (0.25 mm). Thickness of the outside edge of plastic caps shall be not less than 0.035 inch (0.89 mm). The cap nail shank shall be not less than 0.083 inch (2.11 mm) for ring shank cap nails and 0.091 inch (2.31 mm) for smooth shank cap nails. Staple gage shall be not less than 21 gage [0.02 inch (0.81 mm)]. Cap nail shank and cap staple legs shall have a length sufficient to penetrate through-the-roof sheathing or not less than  $\frac{3}{4}$  inch (19.1 mm) into the roof sheathing.

**Exception:** As an alternative, adhered *underlayment* complying with ASTM D1970 shall be permitted.

**1507.17.4.2 Ice barrier.** In areas where there has been a history of ice forming along the eaves causing a back-up of water, an ice barrier consisting of not fewer than two layers of *underlayment* cemented together or of a self-adhering polymer modified bitumen sheet shall be used instead of normal *underlayment* and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the *exterior wall* line of the building.

**Exception:** Detached accessory structures that do not contain conditioned floor area.

**1507.17.5 Material standards.** BIPV roof panels shall be listed and labeled in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

**1507.17.6 Attachment.** BIPV roof panels shall be attached in accordance with the manufacturer's installation instructions.

## SECTION 1508 ROOF INSULATION

**[BF] 1508.1 General.** The use of above-deck thermal insulation shall be permitted provided that such insulation is covered with an approved *roof covering* and passes the tests of NFPA 276 or UL 1256 when tested as an assembly.

### Exceptions:

1. Foam plastic roof insulation shall conform to the material and installation requirements of Chapter 26.
2. Where a concrete or composite metal and concrete roof deck is used and the above-deck thermal insulation is covered with an approved *roof covering*.

**[BF] 1508.2 Material standards.** Above-deck thermal insulation board shall comply with the standards in Table 1508.2.

**[BF] TABLE 1508.2  
MATERIAL STANDARDS FOR ROOF INSULATION**

Cellular glass board	ASTM C552
Composite boards	ASTM C1289, Type III, IV, V or VII
Expanded polystyrene	ASTM C578
Extruded polystyrene	ASTM C578
Fiber-reinforced gypsum board	ASTM C1278
Glass-faced gypsum board	ASTM C1177
High-density polyisocyanurate board	ASTM C1289, Type II, Class 4
Mineral fiber insulation board	ASTM C726
Perlite board	ASTM C728
Polyisocyanurate board	ASTM C1289, Type I or II
Wood fiberboard	ASTM C208, Type II

## SECTION 1509 ROOF COATINGS

**1509.1 General.** The installation of a *roof coating* on a *roof covering* shall comply with the requirements of Section 1505 and this section.

**1509.2 Material standards.** Roof coating materials shall comply with the standards in Table 1509.2.

**TABLE 1509.2  
ROOF COATING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Asphaltic emulsion coating	ASTM D1227
Asphalt coating	ASTM D2823
Asphalt roof coating	ASTM D4479
Aluminum-pigmented asphalt coating	ASTM D2824
Silicone coating	ASTM D6694
Moisture-cured polyurethane coating	ASTM D6947

## SECTION 1510 RADIANT BARRIERS INSTALLED ABOVE DECK

**[BF] 1510.1 General.** A *radiant barrier* installed above a deck shall comply with Sections 1510.2 through 1510.4.

**[BF] 1510.2 Fire testing.** *Radiant barriers* shall be permitted for use above decks where the *radiant barrier* is covered with an *approved roof covering* and the system consisting of the *radiant barrier* and the *roof covering* complies with the requirements of either FM 4450 or UL 1256.

**[BF] 1510.3 Installation.** The low *emittance* surface of the *radiant barrier* shall face the continuous airspace between the *radiant barrier* and the roof covering.

**[BF] 1510.4 Material standards.** A *radiant barrier* installed above a deck shall comply with ASTM C1313/1313M.

## SECTION 1511 ROOFTOP STRUCTURES

**[BG] 1511.1 General.** The provisions of this section shall govern the construction of *rooftop structures*.

**1511.1.1 Area limitation.** The aggregate area of *penthouses* and other enclosed *rooftop structures* shall not exceed one-third the area of the supporting roof deck. Such *penthouses* and other enclosed *rooftop structures* shall not be required to be included in determining the *building area* or number of stories as regulated by Section 503.1. The area of such *penthouses* shall not be included in determining the *fire area* specified in Section 901.7.

**[BG] 1511.2 Penthouses.** *Penthouses* in compliance with Sections 1511.2.1 through 1511.2.4 shall be considered as a portion of the *story* directly below the *roof deck* on which such *penthouses* are located. Other *penthouses* shall be considered as an additional *story* of the building.

**[BG] 1511.2.1 Height above roof deck.** *Penthouses* constructed on buildings of other than Type I construction shall not exceed 18 feet (5486 mm) in height above the *roof deck* as measured to the average height of the roof of the *penthouse*. *Penthouses* located on the roof of buildings of Type I construction shall not be limited in height.

**Exception:** Where used to enclose tanks or elevators that travel to the roof level, *penthouses* shall be permitted to have a maximum height of 28 feet (8534 mm) above the roof deck.

**[BG] 1511.2.2 Use limitations.** *Penthouses* shall not be used for purposes other than the shelter of mechanical or electrical equipment, tanks, elevators and related machinery, stairways or vertical *shaft* openings in the roof assembly, including ancillary spaces used to access elevators and stairways.

**[BG] 1511.2.3 Weather protection.** Provisions such as louvers, louver blades or flashing shall be made to protect the mechanical and electrical equipment and the building interior from the elements.

**[BG] 1511.2.4 Type of construction.** *Penthouses* shall be constructed of building elements as required for the type

of construction of the building on which such *penthouses* are built.

### Exceptions:

1. On buildings of Type I construction, the *exterior walls* and roofs of *penthouses* with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour *fire-resistance rating*. The *exterior walls* and roofs of *penthouses* with a *fire separation distance* of 20 feet (6096 mm) or greater shall not be required to have a *fire-resistance rating*.
2. On buildings of Type I construction two stories or less in height above *grade plane* or of Type II construction, the *exterior walls* and roofs of *penthouses* with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour *fire-resistance rating* or a lesser *fire-resistance rating* as required by Table 705.5 and be constructed of *fire-retardant-treated wood*. The *exterior walls* and roofs of *penthouses* with a *fire separation distance* of 20 feet (6096 mm) or greater shall be permitted to be constructed of *fire-retardant-treated wood* and shall not be required to have a *fire-resistance rating*. Interior framing and walls shall be permitted to be constructed of *fire-retardant-treated wood*.
3. On buildings of Type III, IV or V construction, the *exterior walls* of *penthouses* with a *fire separation distance* greater than 5 feet (1524 mm) and less than 20 feet (6096 mm) shall be permitted to have not less than a 1-hour *fire-resistance rating* or a lesser *fire-resistance rating* as required by Table 705.5. On buildings of Type III, IV or VA construction, the *exterior walls* of *penthouses* with a *fire separation distance* of 20 feet (6096 mm) or greater shall be permitted to be of heavy timber construction complying with Sections 602.4 and 2304.11 or noncombustible construction or *fire-retardant-treated wood* and shall not be required to have a *fire-resistance rating*.

**[BG] 1511.3 Tanks.** Tanks having a capacity of more than 500 gallons (1893 L) located on the *roof deck* of a building shall be supported on masonry, reinforced concrete, steel or heavy timber construction complying with Section 2304.11 provided that, where such supports are located in the building above the lowest story, the support shall be fire-resistance rated as required for Type IA construction.

**[BG] 1511.3.1 Valve and drain.** In the bottom or on the side near the bottom of the tank, a pipe or outlet, fitted with a suitable quick-opening valve for discharging the contents into a drain in an emergency shall be provided.

**[BG] 1511.3.2 Location.** Tanks shall not be placed over or near a *stairway* or an elevator *shaft*, unless there is a solid roof or floor underneath the tank.



## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**[BG] 1511.3.3 Tank cover.** Unenclosed roof tanks shall have covers sloping toward the perimeter of the tanks.

**[BG] 1511.4 Cooling towers.** Cooling towers located on the *roof deck* of a building and greater than 250 square feet (23.2 m<sup>2</sup>) in base area or greater than 15 feet (4572 mm) in height above the *roof deck*, as measured to the highest point on the cooling tower, where the roof is greater than 50 feet (15 240 mm) in height above *grade plane* shall be constructed of noncombustible materials. The base area of cooling towers shall not exceed one-third the area of the supporting *roof deck*.

**Exception:** Drip boards and the enclosing construction shall be permitted to be of wood not less than 1 inch (25 mm) nominal thickness, provided that the wood is covered on the exterior of the tower with noncombustible material.

**[BG] 1511.5 Towers, spires, domes and cupolas.** Towers, spires, domes and cupolas shall be of a type of construction having *fire-resistance ratings* not less than required for the building on top of which such tower, spire, dome or cupola is built. Towers, spires, domes and cupolas greater than 85 feet (25 908 mm) in height above *grade plane* as measured to the highest point on such structures, and either greater than 200 square feet (18.6 m<sup>2</sup>) in horizontal area or used for any purpose other than a belfry or an architectural embellishment, shall be constructed of and supported on Type I or II construction.

**[BG] 1511.5.1 Noncombustible construction required.**

Towers, spires, domes and cupolas greater than 60 feet (18 288 mm) in height above the highest point at which such structure contacts the roof as measured to the highest point on such structure, or that exceeds 200 square feet (18.6 m<sup>2</sup>) in area at any horizontal section, or which is intended to be used for any purpose other than a belfry or architectural embellishment, or is located on the top of a building greater than 50 feet (15 240 mm) in *building height* shall be constructed of and supported by noncombustible materials and shall be separated from the building below by construction having a *fire-resistance rating* of not less than 1.5 hours with openings protected in accordance with Section 711. Such structures located on the top of a building greater than 50 feet (15 240 mm) in *building height* shall be supported by noncombustible construction.

**[BG] 1511.5.2 Towers and spires.** Enclosed towers and spires shall have *exterior walls* constructed as required for the building on top of which such towers and spires are built. The *roof covering* of spires shall be not less than the same class of *roof covering* required for the building on top of which the spire is located.

**[BG] 1511.6 Mechanical equipment screens.** *Mechanical equipment screens* shall be constructed of the materials specified for the *exterior walls* in accordance with the type of construction of the building. Where the *fire separation distance* is greater than 5 feet (1524 mm), *mechanical equipment screens* shall not be required to comply with the *fire-resistance rating* requirements.

**[BG] 1511.6.1 Height limitations.** *Mechanical equipment screens* shall not exceed 18 feet (5486 mm) in height above the *roof deck*, as measured to the highest point on the *mechanical equipment screen*.

**Exception:** Where located on buildings of Type IA construction, the height of *mechanical equipment screens* shall not be limited.

**[BG] 1511.6.2 Type I, II, III or IV construction.** Regardless of the requirements in Section 1511.6, *mechanical equipment screens* that are located on the *roof decks* of buildings of Type I, II, III or IV construction shall be permitted to be constructed of combustible materials in accordance with any one of the following limitations:

1. The *fire separation distance* shall be not less than 20 feet (6096 mm) and the height of the *mechanical equipment screen* above the roof deck shall not exceed 4 feet (1219 mm) as measured to the highest point on the *mechanical equipment screen*.
2. The *fire separation distance* shall be not less than 20 feet (6096 mm) and the *mechanical equipment screen* shall be constructed of *fire-retardant-treated wood* complying with Section 2303.2 for exterior installation.
3. Where exterior wall covering panels are used, the panels shall have a *flame spread index* of 25 or less when tested in the minimum and maximum thicknesses intended for use, with each face tested independently in accordance with ASTM E84 or UL 723. The panels shall be tested in the minimum and maximum thicknesses intended for use in accordance with, and shall comply with the acceptance criteria of, NFPA 285 and shall be installed as tested. Where the panels are tested as part of an *exterior wall* assembly in accordance with NFPA 285, the panels shall be installed on the face of the *mechanical equipment screen* supporting structure in the same manner as they were installed on the tested *exterior wall* assembly.

**[BG] 1511.6.3 Type V construction.** The height of mechanical equipment screens located on the *roof decks* of buildings of Type V construction, as measured from *grade plane* to the highest point on the *mechanical equipment screen*, shall be permitted to exceed the maximum *building height* allowed for the building by other provisions of this code where complying with any one of the following limitations, provided that the *fire separation distance* is greater than 5 feet (1524 mm):

1. Where the *fire separation distance* is not less than 20 feet (6096 mm), the height above *grade plane* of the *mechanical equipment screen* shall not exceed 4 feet (1219 mm) more than the maximum *building height* allowed.
2. The *mechanical equipment screen* shall be constructed of noncombustible materials.



3. The *mechanical equipment screen* shall be constructed of *fire-retardant-treated wood* complying with Section 2303.2 for exterior installation.
4. Where the *fire separation distance* is not less than 20 feet (6096 mm), the *mechanical equipment screen* shall be constructed of materials having a *flame spread index* of 25 or less when tested in the minimum and maximum thicknesses intended for use with each face tested independently in accordance with ASTM E84 or UL 723.

[BG] **1511.7 Other rooftop structures.** *Rooftop structures* not regulated by Sections 1511.2 through 1511.6 shall comply with Sections 1511.7.1 through 1511.7.5, as applicable.

[BG] **1511.7.1 Aerial supports.** Aerial supports shall be constructed of noncombustible materials.

**Exception:** Aerial supports not greater than 12 feet (3658 mm) in height as measured from the *roof deck* to the highest point on the aerial supports shall be permitted to be constructed of combustible materials.

[BG] **1511.7.2 Bulkheads.** Bulkheads used for the shelter of mechanical or electrical equipment or vertical *shaft* openings in the *roof assembly* shall comply with Section 1511.2 as *penthouses*. Bulkheads used for any other purpose shall be considered as an additional story of the building.

[BG] **1511.7.3 Dormers.** Dormers shall be of the same type of construction as required for the roof in which such dormers are located or the *exterior walls* of the building.

[BG] **1511.7.4 Fences.** Fences and similar structures shall comply with Section 1511.6 as *mechanical equipment screens*.

[BG] **1511.7.5 Flagpoles.** Flagpoles and similar structures shall not be required to be constructed of noncombustible materials and shall not be limited in height or number.

[BG] **1511.8 Structural fire resistance.** The structural frame and roof construction supporting *loads* imposed upon the roof by any *rooftop structure* shall comply with the requirements of Table 601. The fire-resistance reduction permitted by Table 601, Note a, shall not apply to roofs containing *rooftop structures*.

## SECTION 1512 REROOFING

**1512.1 General.** Materials and methods of application used for recovering or replacing an existing *roof covering* shall comply with the requirements of Chapter 15.

### Exceptions:

1. *Roof replacement* or *roof recover* of existing low-slope *roof coverings* shall not be required to meet the minimum design slope requirement of  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) in

Section 1507 for roofs that provide *positive roof drainage*.

2. Recovering or replacing an existing *roof covering* shall not be required to meet the requirement for secondary (emergency overflow) drains or *scuppers* in Section 1502.2 for roofs that provide for *positive roof drainage*. For the purposes of this exception, existing secondary drainage or *scupper* systems required in accordance with this code shall not be removed unless they are replaced by secondary drains or *scuppers* designed and installed in accordance with Section 1502.2.

**1512.2 Roof replacement.** *Roof replacement* shall include the removal of all existing layers of *roof assembly* materials down to the *roof deck*.

**Exception:** Where the existing *roof assembly* includes an ice barrier membrane that is adhered to the *roof deck*, the existing ice barrier membrane shall be permitted to remain in place and covered with an additional layer of ice barrier membrane in accordance with Section 1507.

**1512.2.1 Roof recover.** The installation of a new roof covering over an existing roof covering shall be permitted where any of the following conditions occur:

1. Where the new roof covering is installed in accordance with the roof covering manufacturer's approved instructions.
2. Complete and separate roofing systems, such as standing-seam *metal roof panel* systems, that are designed to transmit the *roof loads* directly to the building's structural system and that do not rely on existing roofs and roof coverings for support, shall not require the removal of existing roof coverings.
3. Metal panel, metal shingle and concrete and clay tile roof coverings shall be permitted to be installed over existing wood shake roofs when applied in accordance with Section 1512.3.
4. The application of a new protective roof coating over an existing protective roof coating, *metal roof panel*, built-up roof, spray polyurethane foam roofing system, *metal roof shingles*, mineral-surfaced roll roofing, modified bitumen roofing or thermoset and thermoplastic single-ply roofing shall be permitted without tear off of existing roof coverings.

**1512.2.1.1 Exceptions.** A *roof recover* shall not be permitted where any of the following conditions occur:

1. Where the existing roof or *roof covering* is water soaked or has deteriorated to the point that the existing roof or *roof covering* is not adequate as a base for additional roofing.
2. Where the existing *roof covering* is slate, clay, cement or asbestos-cement tile.
3. Where the existing roof has two or more applications of any type of *roof covering*.

## ROOF ASSEMBLIES AND ROOFTOP STRUCTURES

**1512.3 Roof recovering.** Where the application of a new *roof covering* over wood shingle or shake roofs creates a combustible concealed space, the entire existing surface shall be covered with *gypsum board*, mineral fiber, glass fiber or other *approved* materials securely fastened in place.

**1512.4 Reinstallation of materials.** Existing slate, clay or cement tile shall be permitted for reinstallation, except that damaged, cracked or broken slate or tile shall not be reinstalled. Existing vent flashing, metal edgings, drain outlets, collars and metal counterflashings shall not be reinstalled where rusted, damaged or deteriorated. Existing *ballast* that is damaged, cracked or broken shall not be reinstalled. Existing aggregate surfacing materials from built-up roofs shall not be reinstalled.

**1512.5 Flashings.** Flashings shall be reconstructed in accordance with *approved* manufacturer's installation instructions. Metal flashing to which bituminous materials are to be adhered shall be primed prior to installation.

# CHAPTER 16

## STRUCTURAL DESIGN

### User notes:

**About this chapter:** Chapter 16 establishes minimum design requirements so that the structural components of buildings are proportioned to resist the loads that are likely to be encountered. In addition, this chapter assigns buildings and structures to risk categories that are indicative of their intended use. The loads specified herein along with the required load combinations have been established through research and service performance of buildings and structures. The application of these loads and adherence to the serviceability criteria enhance the protection of life and property.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 1601 GENERAL

**1601.1 Scope.** The provisions of this chapter shall govern the structural design of buildings, structures and portions thereof regulated by this code.

### SECTION 1602 NOTATIONS

**1602.1 Notations.** The following notations are used in this chapter:

- $D$  = Dead load.
- $D_i$  = Weight of ice in accordance with Chapter 10 of ASCE 7.
- $E$  = Combined effect of horizontal and vertical earthquake induced forces as defined in Section 12.4 of ASCE 7.
- $F$  = Load due to fluids with well-defined pressures and maximum heights.
- $F_a$  = Flood load in accordance with Chapter 5 of ASCE 7.
- $H$  = Load due to lateral earth pressures, ground water pressure or pressure of bulk materials.
- $L$  = Live load.
- $L_r$  = Roof live load.
- $R$  = Rain load.
- $S$  = Snow load.
- $T$  = Cumulative effects of self-straining load forces and effects.
- $V_{asd}$  = Allowable stress design wind speed, miles per hour (mph) (km/hr) where applicable.
- $V$  = Basic design wind speeds, miles per hour (mph) (km/hr) determined from Figures 1609.3(1) through 1609.3(12) or ASCE 7.
- $W$  = Load due to wind pressure.
- $W_i$  = Wind-on-ice in accordance with Chapter 10 of ASCE 7.

### SECTION 1603 CONSTRUCTION DOCUMENTS

**1603.1 General.** *Construction documents* shall show the size, section and relative locations of structural members

with floor levels, column centers and offsets dimensioned. The design loads and other information pertinent to the structural design required by Sections 1603.1.1 through 1603.1.9 shall be indicated on the *construction documents*.

**Exception:** *Construction documents* for buildings constructed in accordance with the *conventional light-frame construction* provisions of Section 2308 shall indicate the following structural design information:

1. Floor and roof dead and live loads.
2. Ground snow load,  $p_g$ .
3. Basic design wind speed,  $V$ , miles per hour (mph) (km/hr) and allowable stress design wind speed,  $V_{asd}$ , as determined in accordance with Section 1609.3.1 and wind exposure.
4. *Seismic design category* and *site class*.
5. Flood design data, if located in *flood hazard areas* established in Section 1612.3.
6. Design load-bearing values of soils.
7. Rain load data.

**1603.1.1 Floor live load.** The uniformly distributed, concentrated and impact floor *live load* used in the design shall be indicated for floor areas. Use of *live load* reduction in accordance with Section 1607.12 shall be indicated for each type of *live load* used in the design.

**1603.1.2 Roof live load.** The *roof live load* used in the design shall be indicated for roof areas (Section 1607.14).

**1603.1.3 Roof snow load data.** The ground snow load,  $p_g$ , shall be indicated. In areas where the ground snow load,  $p_g$ , exceeds 10 pounds per square foot (psf) (0.479 kN/m<sup>2</sup>), the following additional information shall also be provided, regardless of whether snow loads govern the design of the roof:

1. Flat-roof snow load,  $p_f$ .
2. Snow exposure factor,  $C_e$ .
3. Snow load importance factor,  $I_s$ .
4. Thermal factor,  $C_t$ .
5. Slope factor(s),  $C_s$ .

## STRUCTURAL DESIGN

6. Drift surcharge load(s),  $p_d$ , where the sum of  $p_d$  and  $p_f$  exceeds 20 psf (0.96 kN/m<sup>2</sup>).
7. Width of snow drift(s),  $w$ .

**1603.1.4 Wind design data.** The following information related to wind *loads* shall be shown, regardless of whether wind *loads* govern the design of the lateral force-resisting system of the structure:

1. Basic design *wind speed*,  $V$ , miles per hour and *allowable stress design wind speed*,  $V_{asd}$ , as determined in accordance with Section 1609.3.1.
2. *Risk category*.
3. Wind exposure. Applicable wind direction if more than one wind exposure is utilized.
4. Applicable internal pressure coefficient.
5. Design wind pressures and their applicable zones with dimensions to be used for exterior component and cladding materials not specifically designed by the *registered design professional* responsible for the design of the structure, pounds per square foot (kN/m<sup>2</sup>).

**1603.1.5 Earthquake design data.** The following information related to seismic *loads* shall be shown, regardless of whether seismic *loads* govern the design of the lateral force-resisting system of the structure:

1. *Risk category*.
2. Seismic importance factor,  $I_e$ .
3. Mapped spectral response acceleration parameters,  $S_s$  and  $S_1$ .
4. *Site class*.
5. Design spectral response acceleration parameters,  $S_{DS}$  and  $S_{D1}$ .
6. *Seismic design category*.
7. Basic seismic force-resisting system(s).
8. Design base shear(s).
9. Seismic response coefficient(s),  $CS$ .
10. Response modification coefficient(s),  $R$ .
11. Analysis procedure used.

**1603.1.6 Geotechnical information.** The design load-bearing values of soils shall be shown on the *construction documents*.

**1603.1.7 Flood design data.** For buildings located in whole or in part in *flood hazard areas* as established in Section 1612.3, the documentation pertaining to design, if required in Section 1612.4, shall be included and the following information, referenced to the datum on the community's *Flood Insurance Rate Map (FIRM)*, shall be shown, regardless of whether *flood loads* govern the design of the building:

1. *Flood design* class assigned according to ASCE 24.
2. In *flood hazard areas* other than *coastal high hazard areas* or *coastal A zones*, the elevation of the proposed *lowest floor*, including the basement.

3. In *flood hazard areas* other than *coastal high hazard areas* or *coastal A zones*, the elevation to which any nonresidential building will be dry floodproofed.
4. In *coastal high hazard areas* and *coastal A zones*, the proposed elevation of the bottom of the lowest horizontal structural member of the *lowest floor*, including the basement.

**1603.1.8 Special loads.** Special *loads* that are applicable to the design of the building, structure or portions thereof, including but not limited to the *loads* of machinery or equipment, and that are greater than specified floor and roof *loads* shall be specified by their descriptions and locations.

**1603.1.8.1 Photovoltaic panel systems.** The *dead load* of rooftop-mounted *photovoltaic panel systems*, including rack support systems, shall be indicated on the *construction documents*.

**1603.1.9 Roof rain load data.** Rain intensity,  $i$  (in/hr) (cm/hr), shall be shown regardless of whether rain *loads* govern the design.

## SECTION 1604 GENERAL DESIGN REQUIREMENTS

**1604.1 General.** Building, structures and parts thereof shall be designed and constructed in accordance with *strength design*, *load and resistance factor design*, *allowable stress design*, empirical design or conventional construction methods, as permitted by the applicable material chapters and referenced standards.

**1604.2 Strength.** Buildings and *other structures*, and parts thereof, shall be designed and constructed to support safely the *factored loads* in load combinations defined in this code without exceeding the appropriate *strength limit states* for the materials of construction. Alternatively, buildings and *other structures*, and parts thereof, shall be designed and constructed to support safely the *nominal loads* in load combinations defined in this code without exceeding the appropriate specified allowable stresses for the materials of construction.

Loads and forces for occupancies or uses not covered in this chapter shall be subject to the approval of the *building official*.

**1604.3 Serviceability.** Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections as indicated in Table 1604.3.

**1604.3.1 Deflections.** The deflections of structural members shall not exceed the more restrictive of the limitations of Sections 1604.3.2 through 1604.3.5 or that permitted by Table 1604.3.

**1604.3.2 Reinforced concrete.** The deflection of reinforced concrete structural members shall not exceed that permitted by ACI 318.

**1604.3.3 Steel.** The deflection of steel structural members shall not exceed that permitted by AISC 360, AISI S100, ASCE 8, SJI 100 or SJI 200, as applicable.



**TABLE 1604.3**  
**DEFLECTION LIMITS<sup>a, b, c, h, i</sup>**

CONSTRUCTION	$L$ or $L_r$	$S$ or $W^i$	$D + L^{d, g}$
Roof members: <sup>c</sup>			
Supporting plaster or stucco ceiling	$l/360$	$l/360$	$l/240$
Supporting nonplaster ceiling	$l/240$	$l/240$	$l/180$
Not supporting ceiling	$l/180$	$l/180$	$l/120$
Floor members	$l/360$	—	$l/240$
Exterior walls:			
With plaster or stucco finishes	—	$l/360$	—
With other brittle finishes	—	$l/240$	—
With flexible finishes	—	$l/120$	—
Interior partitions: <sup>b</sup>			
With plaster or stucco finishes	$l/360$	—	—
With other brittle finishes	$l/240$	—	—
With flexible finishes	$l/120$	—	—
Farm buildings	—	—	$l/180$
Greenhouses	—	—	$l/120$

For SI: 1 foot = 304.8 mm.

- For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed  $l/60$ . For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed  $l/150$ . For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed  $l/90$ . For roofs, this exception only applies when the metal sheets have no roof covering.
- Flexible, folding and portable partitions are not governed by the provisions of this section. The deflection criterion for interior partitions is based on the horizontal load defined in Section 1607.16.
- See Section 2403 for glass supports.
- The deflection limit for the  $D + (L + L_r)$  load combination only applies to the deflection due to the creep component of long-term dead load deflection plus the short-term live load deflection. For lumber, structural glued laminated timber, prefabricated wood I-joists and structural composite lumber members that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection shall be permitted to be estimated as the immediate dead load deflection resulting from  $0.5D$ . For lumber and glued laminated timber members installed or used at all other moisture conditions or cross laminated timber and wood structural panels that are dry at time of installation and used under dry conditions in accordance with the ANSI/AWC NDS, the creep component of the long-term deflection is permitted to be estimated as the immediate dead load deflection resulting from  $D$ . The value of  $0.5D$  shall not be used in combination with ANSI/AWC NDS provisions for long-term loading.
- The preceding deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to ensure adequate drainage shall be investigated for ponding. See Chapter 8 of ASCE 7.
- The wind load shall be permitted to be taken as 0.42 times the “component and cladding” loads or directly calculated using the 10-year mean return interval wind speed for the purpose of determining deflection limits in Table 1604.3. Where framing members support glass, the deflection limit therein shall not exceed that specified in Section 1604.3.7.
- For steel structural members, the deflection due to creep component of long-term dead load shall be permitted to be taken as zero.
- For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed  $l/60$ . For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed  $l/175$  for each glass lite or  $l/60$  for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed  $l/120$ .
- $l$  = Length of the member between supports. For cantilever members,  $l$  shall be taken as twice the length of the cantilever.

**1604.3.4 Masonry.** The deflection of masonry structural members shall not exceed that permitted by TMS 402.

**1604.3.5 Aluminum.** The deflection of aluminum structural members shall not exceed that permitted by AA ADM.

**1604.3.6 Limits.** The deflection limits of Section 1604.3.1 shall be used unless more restrictive deflection limits are required by a referenced standard for the element or finish material.

**1604.3.7 Framing supporting glass.** The deflection of framing members supporting glass subjected to 0.6 times the “component and cladding” wind loads shall not exceed either of the following:

- $1/175$  of the length of span of the framing member, for framing members having a length not more than 13 feet 6 inches (4115 mm).
- $1/240$  of the length of span of the framing member +  $1/4$  inch (6.4 mm), for framing members having a length greater than 13 feet 6 inches (4115 mm).

**1604.4 Analysis.** Load effects on structural members and their connections shall be determined by methods of structural analysis that take into account equilibrium, general stability, geometric compatibility and both short- and long-term material properties.

Members that tend to accumulate residual deformations under repeated service loads shall have included in their analysis the effects of added deformations expected to occur during their service life.

Any system or method of construction to be used shall be based on a rational analysis in accordance with well-established principles of mechanics. Such analysis shall result in a system that provides a complete load path capable of transferring loads from their point of origin to the load-resisting elements.

The total lateral force shall be distributed to the various vertical elements of the lateral force-resisting system in proportion to their rigidities, considering the rigidity of the horizontal bracing system or *diaphragm*. Rigid elements

## STRUCTURAL DESIGN

assumed not to be a part of the lateral force-resisting system are permitted to be incorporated into buildings provided that their effect on the action of the system is considered and provided for in the design. A *diaphragm* is rigid for the purpose of distribution of *story* shear and torsional moment when the lateral deformation of the *diaphragm* is less than or equal to two times the average *story* drift. Where required by ASCE 7, provisions shall be made for the increased forces induced on resisting elements of the structural system resulting from torsion due to eccentricity between the center of application of the lateral forces and the center of rigidity of the lateral force-resisting system.

Every structure shall be designed to resist the effects caused by the forces specified in this chapter, including overturning, uplift and sliding. Where sliding is used to isolate the elements, the effects of friction between sliding elements shall be included as a force.

**1604.5 Risk category.** Each building and structure shall be assigned a *risk category* in accordance with Table 1604.5. Where a referenced standard specifies an occupancy category, the *risk category* shall not be taken as lower than the occupancy category specified therein. Where a referenced standard specifies that the assignment of a *risk category* be in accordance with ASCE 7, Table 1.5-1, Table 1604.5 shall be used in lieu of ASCE 7, Table 1.5-1.

**Exception:** The assignment of buildings and structures to Tsunami *Risk Categories* III and IV is permitted to be in accordance with Section 6.4 of ASCE 7.

**1604.5.1 Multiple occupancies.** Where a building or structure is occupied by two or more occupancies not included in the same *risk category*, it shall be assigned the classification of the highest *risk category* corresponding to the various occupancies. Where buildings or structures have two or more portions that are structurally separated, each portion shall be separately classified. Where a separated portion of a building or structure provides required access to, required egress from or shares life safety components with another portion having a higher *risk category*, both portions shall be assigned to the higher *risk category*.

**Exception:** Where a *storm shelter* designed and constructed in accordance with ICC 500 is provided in a building, structure or portion thereof normally occupied for other purposes, the *risk category* for the normal occupancy of the building shall apply unless the *storm shelter* is a designated emergency shelter in accordance with Table 1604.5.

**1604.6 In-situ load tests.** The *building official* is authorized to require an engineering analysis or a load test, or both, of any construction whenever there is reason to question the safety of the construction for the intended occupancy. Engineering analysis and load tests shall be conducted in accordance with Section 1708.

**1604.7 Preconstruction load tests.** Materials and methods of construction that are not capable of being designed by *approved* engineering analysis or that do not comply with

the applicable referenced standards, or alternative test procedures in accordance with Section 1707, shall be load tested in accordance with Section 1709.

**1604.8 Anchorage.** Buildings and *other structures*, and portions thereof, shall be provided with anchorage in accordance with Sections 1604.8.1 through 1604.8.3, as applicable.

**1604.8.1 General.** Anchorage of the roof to walls and columns, and of walls and columns to foundations, shall be provided to resist the uplift and sliding forces that result from the application of the prescribed *loads*.

**1604.8.2 Structural walls.** Walls that provide vertical load-bearing resistance or lateral shear resistance for a portion of the structure shall be anchored to the roof and to all floors and members that provide lateral support for the wall or that are supported by the wall. The connections shall be capable of resisting the horizontal forces specified in Section 1.4.4 of ASCE 7 for walls of structures assigned to *Seismic Design Category A* and to Section 12.11 of ASCE 7 for walls of structures assigned to all other *seismic design categories*. Required anchors in masonry walls of hollow units or *cavity walls* shall be embedded in a reinforced grouted structural element of the wall. See Sections 1609 for wind design requirements and 1613 for earthquake design requirements.

**1604.8.3 Decks.** Where supported by attachment to an *exterior wall*, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads as applicable. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. Where positive connection to the primary building structure cannot be verified during inspection, decks shall be self-supporting. Connections of decks with cantilevered framing members to *exterior walls* or other framing members shall be designed for both of the following:

1. The reactions resulting from the *dead load* and *live load* specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on all portions of the deck.
2. The reactions resulting from the *dead load* and *live load* specified in Table 1607.1, or the snow load specified in Section 1608, in accordance with Section 1605, acting on the cantilevered portion of the deck, and no *live load* or snow load on the remaining portion of the deck.

**1604.9 Wind and seismic detailing.** Lateral force-resisting systems shall meet seismic detailing requirements and limitations prescribed in this code and ASCE 7 Chapters 11, 12, 13, 15, 17 and 18 as applicable, even where wind *load effects* are greater than seismic *load effects*.

**Exception:** References within ASCE 7 to Chapter 14 shall not apply, except as specifically required herein.

**1604.10 Loads on storm shelters.** *Loads* and load combinations on storm shelters shall be determined in accordance with ICC 500.

**TABLE 1604.5**  
**RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES**

<b>RISK CATEGORY</b>	<b>NATURE OF OCCUPANCY</b>
<b>I</b>	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> <li>• Agricultural facilities.</li> <li>• Certain temporary facilities.</li> <li>• Minor storage facilities.</li> </ul>
<b>II</b>	Buildings and other structures except those listed in Risk Categories I, III and IV.
<b>III</b>	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: <ul style="list-style-type: none"> <li>• Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300.</li> <li>• Buildings and other structures containing one or more public assembly spaces, each having an occupant load greater than 300 and a cumulative occupant load of these public assembly spaces of greater than 2,500.</li> <li>• Buildings and other structures containing Group E or Group I-4 occupancies or combination thereof, with an occupant load greater than 250.</li> <li>• Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500.</li> <li>• Group I-2, Condition 1 occupancies with 50 or more care recipients.</li> <li>• Group I-2, Condition 2 occupancies not having emergency surgery or emergency treatment facilities.</li> <li>• Group I-3 occupancies.</li> <li>• Any other occupancy with an occupant load greater than 5,000.<sup>a</sup></li> <li>• Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public utility facilities not included in Risk Category IV.</li> <li>• Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: <ul style="list-style-type: none"> <li>• Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the <i>International Fire Code</i>; and</li> <li>• Are sufficient to pose a threat to the public if released.<sup>b</sup></li> </ul> </li> </ul>
<b>IV</b>	Buildings and other structures designated as essential facilities, including but not limited to: <ul style="list-style-type: none"> <li>• Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities.</li> <li>• Ambulatory care facilities having emergency surgery or emergency treatment facilities.</li> <li>• Fire, rescue, ambulance and police stations and emergency vehicle garages</li> <li>• Designated earthquake, hurricane or other emergency shelters.</li> <li>• Designated emergency preparedness, communications and operations centers and other facilities required for emergency response.</li> <li>• Power-generating stations and other public utility facilities required as emergency backup facilities for Risk Category IV structures.</li> <li>• Buildings and other structures containing quantities of highly toxic materials that: <ul style="list-style-type: none"> <li>• Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the <i>International Fire Code</i>; and</li> <li>• Are sufficient to pose a threat to the public if released.<sup>b</sup></li> </ul> </li> <li>• Aviation control towers, air traffic control centers and emergency aircraft hangars.</li> <li>• Buildings and other structures having critical national defense functions.</li> <li>• Water storage facilities and pump structures required to maintain water pressure for fire suppression.</li> </ul>

a. For purposes of occupant load calculation, occupancies required by Table 1004.5 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.

b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided that it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

## SECTION 1605 LOAD COMBINATIONS

**1605.1 General.** Buildings and *other structures* and portions thereof shall be designed to resist the strength load combinations specified in ASCE 7, Section 2.3, the *allowable stress design* load combinations specified in ASCE 7, Section 2.4, or the alternative *allowable stress design* load combinations of Section 1605.2.

### Exceptions:

1. The modifications to load combinations of ASCE 7 Section 2.3, ASCE 7 Section 2.4, and Section 1605.2 specified in ASCE 7 Chapters 18 and 19 shall apply.
2. Where the allowable stress design load combinations of ASCE 7 Section 2.4 are used, flat roof snow loads of 30 pounds per square foot (1.44 kN/m<sup>2</sup>) and roof live loads of 30 pounds per square foot (1.44 kN/m<sup>2</sup>) or less need not be combined with seismic load. Where flat roof snow loads exceed 30 pounds per square foot (1.44 kN/m<sup>2</sup>), 20 percent shall be combined with seismic loads.
3. Where the allowable stress design load combinations of ASCE 7 Section 2.4 are used, crane hook loads need not be combined with *roof live loads* or with more than three-fourths of the snow load or one-half of the wind loads.

**1605.1.1 Stability.** Regardless of which load combinations are used to design for strength, where overall structure stability (such as stability against overturning, sliding, or buoyancy) is being verified, use of the load combinations specified in Section 2.3 or 2.4 of ASCE 7, and in Section 1605.2 shall be permitted. Where the load combinations specified in ASCE 7, Section 2.3 are used, strength reduction factors applicable to soil resistance shall be provided by a registered design professional. The stability of retaining walls shall be verified in accordance with Section 1807.2.3.

**1605.2 Alternative allowable stress design load combinations.** In lieu of the load combinations in ASCE 7, Section 2.4, structures and portions thereof shall be permitted to be designed for the most critical effects resulting from the following combinations. Where using these alternative allowable stress load combinations that include wind or seismic loads, allowable stresses are permitted to be increased or load combinations reduced where permitted by the material chapter of this code or the referenced standards. For load combinations that include the counteracting effects of dead and wind loads, only two-thirds of the minimum *dead load* likely to be in place during a design wind event shall be used. Where using these alternative load combinations to evaluate sliding, overturning and soil bearing at the soil-structure interface, the reduction of foundation overturning from Section 12.13.4 in ASCE 7 shall not be used. Where using these alternative basic load combinations for proportioning foundations for loadings, which include seismic loads, the vertical seismic load effect,  $E_v$ , in Equation 12.4-4 of ASCE 7 is permitted to be taken equal to zero. Where

required by ASCE 7, Chapters 12, 13 and 15, the load combinations including overstrength of ASCE 7, Section 2.3.6 shall be used.

$$D + L + (L_r \text{ or } S \text{ or } R) \quad (\text{Equation 16-1})$$

$$D + L + 0.6W \quad (\text{Equation 16-2})$$

$$D + L + 0.6W + S/2 \quad (\text{Equation 16-3})$$

$$D + L + S + 0.6W/2 \quad (\text{Equation 16-4})$$

$$D + L + S + E/1.4 \quad (\text{Equation 16-5})$$

$$0.9D + E/1.4 \quad (\text{Equation 16-6})$$

### Exceptions:

1. Crane hook loads need not be combined with *roof live loads* or with more than three-fourths of the snow load or one-half of the wind load.
2. Flat roof snow loads of 30 pounds per square foot (1.44 kN/m<sup>2</sup>) or less and *roof live loads* of 30 pounds per square foot (1.44 kN/m<sup>2</sup>) or less need not be combined with seismic loads. Where flat roof snow loads exceed 30 pounds per square foot (1.44 kN/m<sup>2</sup>), 20 percent shall be combined with seismic loads.

## SECTION 1606 DEAD LOADS

**1606.1 General.** *Dead loads* are those loads defined in Chapter 2 of this code. *Dead loads* shall be considered to be permanent loads.

**1606.2 Weights of materials of construction.** For purposes of design, the actual weights of materials of construction shall be used. In the absence of definite information, values used shall be subject to the approval of the *building official*.

**1606.3 Weight of fixed service equipment.** In determining dead loads for purposes of design, the weight of fixed service equipment, including the maximum weight of the contents of fixed service equipment, shall be included. The components of fixed service equipment that are variable, such as liquid contents and movable trays, shall not be used to counteract forces causing overturning, sliding, and uplift conditions in accordance with Section 1.3.6 of ASCE 7.

### Exceptions:

1. Where force effects are the result of the presence of the variable components, the components are permitted to be used to counter those load effects. In such cases, the structure shall be designed for force effects with the variable components present and with them absent.
2. For the calculation of seismic force effects, the components of fixed service equipment that are variable, such as liquid contents and movable trays, need not exceed those expected during normal operation.

**1606.4 Photovoltaic panel systems.** The weight of *photovoltaic panel systems*, their support system, and ballast shall be considered as *dead load*.



**1606.5 Vegetative and landscaped roofs.** The weight of all landscaping and hardscaping materials for vegetative and landscaped roofs shall be considered as *dead load*. The weight shall be computed considering both fully saturated soil and drainage layer materials and fully dry soil and drainage layer materials to determine the most severe *load effects* on the structure.

## SECTION 1607 LIVE LOADS

**1607.1 General.** *Live loads* are those loads defined in Chapter 2 of this code.

**1607.2 Loads not specified.** For occupancies or uses not designated in Section 1607, the *live load* shall be determined in accordance with a method *approved* by the *building official*.

**1607.3 Uniform live loads.** The *live loads* used in the design of buildings and *other structures* shall be the maximum loads expected by the intended use or occupancy but shall not be less than the minimum uniformly distributed *live loads* given in Table 1607.1.

**1607.4 Concentrated live loads.** Floors, roofs and other similar surfaces shall be designed to support the uniformly distributed *live loads* prescribed in Section 1607.3 or the concentrated *live loads*, given in Table 1607.1, whichever produces the greater *load effects*. Unless otherwise specified, the indicated concentration shall be assumed to be uniformly distributed over an area of  $2\frac{1}{2}$  feet by  $2\frac{1}{2}$  feet (762 mm by 762 mm) and shall be located so as to produce the maximum *load effects* in the structural members.

**1607.5 Partition loads.** In office buildings and in other buildings where partition locations are subject to change, provisions for partition weight shall be made, whether or not partitions are shown on the construction documents, unless the specified *live load* is 80 psf (3.83 kN/m<sup>2</sup>) or greater. The partition *load* shall be not less than a uniformly distributed *live load* of 15 psf (0.72 kN/m<sup>2</sup>).

**1607.6 Helipads.** Helipads shall be designed for the following *live loads*:

1. A uniform *live load*, *L*, as specified in Items 1.1 and 1.2. This *load* shall not be reduced.
  - 1.1. 40 psf (1.92 kN/m<sup>2</sup>) where the design basis helicopter has a maximum take-off weight of 3,000 pounds (13.35 kN) or less.
  - 1.2. 60 psf (2.87 kN/m<sup>2</sup>) where the design basis helicopter has a maximum take-off weight greater than 3,000 pounds (13.35 kN).
2. A single concentrated *live load*, *L*, of 3,000 pounds (13.35 kN) applied over an area of 4.5 inches by 4.5 inches (114 mm by 114 mm) and located so as to produce the maximum *load effects* on the structural elements under consideration. The concentrated *load* is not required to act concurrently with other uniform or concentrated *live loads*.

3. Two single concentrated *live loads*, *L*, 8 feet (2438 mm) apart applied on the landing pad (representing the helicopter's two main landing gear, whether skid type or wheeled type), each having a magnitude of 0.75 times the maximum take-off weight of the helicopter, and located so as to produce the maximum *load effects* on the structural elements under consideration. The concentrated loads shall be applied over an area of 8 inches by 8 inches (203 mm by 203 mm) and are not required to act concurrently with other uniform or concentrated *live loads*.

Landing areas designed for a design basis helicopter with maximum take-off weight of 3,000 pounds (13.35 kN) shall be identified with a 3,000-pound (13.34 kN) weight limitation. The landing area weight limitation shall be indicated by the numeral "3" (kips) located in the bottom right corner of the landing area as viewed from the primary approach path. The indication for the landing area weight limitation shall be a minimum 5 feet (1524 mm) in height.

**1607.7 Passenger vehicle garages.** Floors in garages or portions of a building used for the storage of motor vehicles shall be designed for the uniformly distributed *live loads* indicated in Table 1607.1 or the following concentrated *load*:

1. For garages restricted to passenger vehicles accommodating not more than nine passengers, 3,000 pounds (13.35 kN) acting on an area of 4.5 inches by 4.5 inches (114 mm by 114 mm).
2. For mechanical parking structures without slab or deck that are used for storing passenger vehicles only, 2,250 pounds (10 kN) per wheel.

**1607.8 Heavy vehicle loads.** Floors and other surfaces that are intended to support vehicle *loads* greater than a 10,000-pound (4536 kg) gross vehicle weight rating shall comply with Sections 1607.8.1 through 1607.8.5.

**1607.8.1 Loads.** Where any structure does not restrict access for vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, those portions of the structure subject to such *loads* shall be designed using the vehicular *live loads*, including consideration of impact and fatigue, in accordance with the codes and specifications required by the jurisdiction having authority for the design and construction of the roadways and bridges in the same location of the structure.

**1607.8.2 Fire truck and emergency vehicles.** Where a structure or portions of a structure are accessed and loaded by fire department access vehicles and other similar emergency vehicles, the structure shall be designed for the greater of the following *loads*:

1. The actual operational *loads*, including outrigger reactions and contact areas of the vehicles as stipulated and *approved* by the *building official*.
2. The live loading specified in Section 1607.8.1.

## STRUCTURAL DESIGN

**TABLE 1607.1**  
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_o$ , AND MINIMUM CONCENTRATED LIVE LOADS**

OCCUPANCY OR USE			UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
1.	Apartments (see residential)		—	—	—
2.	Access floor systems	Office use	50	2,000	—
		Computer use	100	2,000	—
3.	Armories and drill rooms		150 <sup>b</sup>	—	—
4.	Assembly areas	Fixed seats (fastened to floor)	60 <sup>a</sup>	—	—
		Follow spot, projections and control rooms	50		
		Lobbies	100 <sup>a</sup>		
		Movable seats	100 <sup>a</sup>		
		Stage floors	150 <sup>b</sup>		
		Platforms (assembly)	100 <sup>a</sup>		
		Bleachers, folding and telescopic seating and grandstands	100 <sup>a</sup> (See Section 1607.19)		
		Stadiums and arenas with fixed seats (fastened to the floor)	60 <sup>a</sup> (See Section 1607.19)		
		Other assembly areas	100 <sup>a</sup>		
5.	Balconies and decks		1.5 times the live load for the area served, not required to exceed 100	—	—
6.	Catwalks for maintenance and service access		40	300	—
7.	Cornices		60	—	—
8.	Corridors	First floor	100	—	—
		Other floors	Same as occupancy served except as indicated		
9.	Dining rooms and restaurants		100 <sup>a</sup>	—	—
10.	Dwellings (see residential)		—	—	—
11.	Elevator machine room and control room grating (on area of 2 inches by 2 inches)		—	300	—
12.	Finish light floor plate construction (on area of 1 inch by 1 inch)		—	200	—
13.	Fire escapes		100	—	—
		On single-family dwellings only	40		
14.	Fixed ladders		See Section 1607.17		—
15.	Garages	Passenger vehicles only	40 <sup>c</sup>	See Section 1607.7	—
		Trucks and buses	See Section 1607.8		
16.	Handrails, guards and grab bars		See Section 1607.9		—
17.	Helipads		See Section 1607.6		—
18.	Hospitals	Corridors above first floor	80	1,000	—
		Operating rooms, laboratories	60	1,000	
		Patient rooms	40	1,000	
19.	Hotels (see residential)		—	—	—

(continued)

**TABLE 1607.1—continued**  
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_o$**   
**AND MINIMUM CONCENTRATED LIVE LOADS**

OCCUPANCY OR USE			UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
20.	Libraries	Corridors above first floor	80	1,000	—
		Reading rooms	60	1,000	—
		Stack rooms	150 <sup>b</sup>	1,000	Section 1607.18
21.	Manufacturing	Heavy	250 <sup>b</sup>	3,000	—
		Light	125 <sup>b</sup>	2,000	
22.	Marquees, except one- and two-family dwellings		75	—	—
23.	Office buildings	Corridors above first floor	80	2,000	—
		File and computer rooms shall be designed for heavier loads based on anticipated occupancy	—	—	
		Lobbies and first-floor corridors	100	2,000	
		Offices	50	2,000	
24.	Penal institutions	Cell blocks	40	—	—
		Corridors	100		
25.	Recreational uses	Bowling alleys, poolrooms and similar uses	75 <sup>a</sup>	—	—
		Dance halls and ballrooms	100 <sup>a</sup>		
		Gymnasiums	100 <sup>a</sup>		
		Ice skating rinks	250 <sup>b</sup>		
		Roller skating rinks	100 <sup>a</sup>		
26.	Residential	One- and two-family dwellings:		—	Section 1607.22
		Uninhabitable attics without storage	10		
		Uninhabitable attics with storage	20		
		Habitable attics and sleeping areas	30		
		Canopies, including marquees	20		
		All other areas	40		
		Hotels and multifamily dwellings:			
		Private rooms and corridors serving them	40		
		Public rooms <sup>a</sup> and corridors serving them	100		

*(continued)*

## STRUCTURAL DESIGN

**TABLE 1607.1—continued**  
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS,  $L_o$ , AND MINIMUM CONCENTRATED LIVE LOADS**

OCCUPANCY OR USE			UNIFORM (psf)	CONCENTRATED (pounds)	ALSO SEE SECTION
27.	Roofs	Ordinary flat, pitched, and curved roofs (that are not occupiable)	20	—	Section 1607.14.2
		Roof areas used for assembly purposes	100 <sup>a</sup>	—	
		Roof areas used for occupancies other than assembly	Same as occupancy served	—	
		Vegetative and landscaped roofs:		—	
		Roof areas not intended for occupancy	20	—	
		Roof areas used for assembly purposes	100 <sup>a</sup>	—	
		Roof areas used for other occupancies	Same as occupancy served	—	
		Awnings and canopies:		—	
		Fabric construction supported by a skeleton structure	5 <sup>a</sup>	—	
		All other construction, except one- and two-family dwellings	20	—	
		Primary roof members exposed to a work floor:		—	Section 1607.15.2
		Single panel point of lower chord of roof trusses or any point along primary structural members supporting roofs over manu- facturing, storage warehouses, and repair garages	—	2,000	
		All other primary roof members	—	300	
		All roof surfaces subject to maintenance workers	—	300	
28.	Schools	Classrooms	40	1,000	—
		Corridors above first floor	80	1,000	
		First-floor corridors	100	1,000	
29.	Scuttles, skylight ribs and accessible ceilings		—	200	—
30.	Sidewalks, vehicular driveways and yards, subject to trucking		250 <sup>b</sup>	8,000	Section 1607.20
31.	Stairs and exits	One- and two-family dwellings	40	300	Section 1607.21
		All other	100	300	Section 1607.21
32.	Storage areas above ceilings		20	—	—
33.	Storage ware- houses (shall be designed for heavier loads if required for antici- pated storage)	Heavy	250 <sup>b</sup>	—	—
		Light	125 <sup>b</sup>		
34.	Stores	Retail:			—
		First floor	100	1,000	
		Upper floors	75	1,000	
		Wholesale, all floors	125 <sup>b</sup>	1,000	
35.	Vehicle barriers		See Section 1607.10		—
36.	Walkways and elevated platforms (other than exitways)		60	—	—
37.	Yards and terraces, pedestrian		100 <sup>a</sup>	—	—

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>, 1 pound = 0.004448 kN,  
 1 pound per cubic foot = 16 kg/m<sup>3</sup>.

a. Live load reduction is not permitted.

b. Live load reduction is only permitted in accordance with Section 1607.12.1.2 or Item 1 of Section 1607.12.2.

c. Live load reduction is only permitted in accordance with Section 1607.12.1.3 or Item 2 of Section 1607.12.2.



**1607.8.3 Heavy vehicle garages.** Garages designed to accommodate vehicles that exceed a 10,000-pound (4536 kg) gross vehicle weight rating, shall be designed using the live loading specified by Section 1607.8.1. For garages the design for impact and fatigue is not required.

**Exception:** The vehicular *live loads* and *load* placement are allowed to be determined using the actual vehicle weights for the vehicles allowed onto the garage floors, provided that such *loads* and placement are based on rational engineering principles and are approved by the building official, but shall be not less than 50 psf (2.9 kN/m<sup>2</sup>). This *live load* shall not be reduced.

**1607.8.4 Forklifts and movable equipment.** Where a structure is intended to have forklifts or other movable equipment present, the structure shall be designed for the total vehicle or equipment *load* and the individual wheel *loads* for the anticipated vehicles as specified by the owner of the facility. These *loads* shall be posted in accordance with Section 1607.8.5.

**1607.8.4.1 Impact and fatigue.** *Impact loads* and fatigue loading shall be considered in the design of the supporting structure. For the purposes of design, the vehicle and wheel *loads* shall be increased by 30 percent to account for impact.

**1607.8.5 Posting.** The maximum weight of vehicles allowed into or on a garage or other structure shall be posted by the owner or the owner's authorized agent in accordance with Section 106.1.

**1607.9 Loads on handrails, guards, grab bars and seats.** *Handrails* and *guards* shall be designed and constructed for the structural loading conditions set forth in Section 1607.9.1. Grab bars, shower seats and accessible benches shall be designed and constructed for the structural loading conditions set forth in Section 1607.9.2.

**1607.9.1 Handrails and guards.** *Handrails* and *guards* shall be designed to resist a linear *load* of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section 4.5.1.1 of ASCE 7. Glass *handrail* assemblies and *guards* shall comply with Section 2407.

**Exceptions:**

1. For one- and two-family dwellings, only the single concentrated *load* required by Section 1607.9.1.1 shall be applied.
2. In Group I-3, F, H and S occupancies, for areas that are not accessible to the general public and that have an *occupant load* less than 50, the minimum *load* shall be 20 pounds per foot (0.29 kN/m).

**1607.9.1.1 Concentrated load.** *Handrails* and *guards* shall be designed to resist a concentrated *load* of 200 pounds (0.89 kN) in accordance with Section 4.5.1 of ASCE 7.

**1607.9.1.2 Guard component loads.** Balusters, panel fillers and guard infill components, including all rails except the handrail and the top rail, shall be designed

to resist a concentrated load of 50 pounds (0.22 kN) in accordance with Section 4.5.1.2 of ASCE 7.

**1607.9.2 Grab bars, shower seats and accessible benches.** Grab bars, shower seats and accessible benches shall be designed to resist a single concentrated *load* of 250 pounds (1.11 kN) applied in any direction at any point on the grab bar, shower seat, or seat of the accessible bench so as to produce the maximum *load effects*.

**1607.10 Vehicle barriers.** *Vehicle barriers* for passenger vehicles shall be designed to resist a concentrated *load* of 6,000 pounds (26.70 kN) in accordance with Section 4.5.3 of ASCE 7. Garages accommodating trucks and buses shall be designed in accordance with an *approved* method that contains provisions for traffic railings.

**1607.11 Impact loads.** The *live loads* specified in Sections 1607.3 through 1607.10 shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made in the structural design for uses and loads that involve unusual vibration and impact forces.

**1607.11.1 Elevators.** Members, elements and components subject to dynamic *loads* from elevators shall be designed for *impact loads* and deflection limits prescribed by ASME A17.1/CSA B44.

**1607.11.2 Machinery.** For the purpose of design, the weight of machinery and moving *loads* shall be increased as follows to allow for impact:

1. Light machinery, shaft- or motor-driven, 20 percent.
2. Reciprocating machinery or power-driven units, 50 percent.

Percentages shall be increased where specified by the manufacturer.

**1607.11.3 Elements supporting hoists for façade access and building maintenance equipment.** In addition to any other applicable *live loads*, structural elements that support hoists for façade access and building maintenance equipment shall be designed for a *live load* of 2.5 times the rated *load* of the hoist or the stall *load* of the hoist, whichever is larger.

**1607.11.4 Fall arrest, lifeline, and rope descent system anchorages.** In addition to any other applicable *live loads*, fall arrest, lifeline, and rope descent system anchorages and structural elements that support these anchorages shall be designed for a *live load* of not less than 3,100 pounds (13.8 kN) for each attached line, in any direction that the *load* can be applied.

Anchorage of horizontal lifelines and the structural elements that support these anchorages shall be designed for the maximum tension that develops in the horizontal lifeline from these *live loads*.

**1607.12 Reduction in uniform live loads.** Except for uniform *live loads* at roofs, all other minimum uniformly distributed *live loads*,  $L_o$ , in Table 1607.1 are permitted to be reduced in accordance with Section 1607.12.1 or 1607.12.2. Uniform *live loads* at roofs are permitted to be reduced in accordance with Section 1607.14.2.

## STRUCTURAL DESIGN

**1607.12.1 Basic uniform live load reduction.** Subject to the limitations of Sections 1607.12.1.1 through 1607.12.1.3 and Table 1607.1, members for which a value of  $K_{LL}A_T$  is 400 square feet (37.16 m<sup>2</sup>) or more are permitted to be designed for a reduced uniformly distributed *live load*,  $L$ , in accordance with the following equation:

$$L = L_o \left( 0.25 + \frac{15}{\sqrt{K_{LL}A_T}} \right) \quad (\text{Equation 16-7})$$

$$\text{For SI: } L = L_o \left( 0.25 + \frac{4.57}{\sqrt{K_{LL}A_T}} \right)$$

where:

$L$  = Reduced design *live load* per square foot (m<sup>2</sup>) of area supported by the member.

$L_o$  = Unreduced design *live load* per square foot (m<sup>2</sup>) of area supported by the member (see Table 1607.1).

$K_{LL}$  = *Live load* element factor (see Table 1607.12.1).

$A_T$  = Tributary area, in square feet (m<sup>2</sup>).

$L$  shall be not less than  $0.50L_o$  for members supporting one floor and  $L$  shall be not less than  $0.40L_o$  for members supporting two or more floors.

**TABLE 1607.12.1**  
**LIVE LOAD ELEMENT FACTOR,  $K_{LL}$**

ELEMENT	$K_{LL}$
Interior columns	4
Exterior columns without cantilever slabs	4
Edge columns with cantilever slabs	3
Corner columns with cantilever slabs	2
Edge beams without cantilever slabs	2
Interior beams	2
Members not previously identified including:	1
Edge beams with cantilever slabs	
Cantilever beams	
One-way slabs	
Two-way slabs	
Members without provisions for continuous shear transfer normal to their span	

**1607.12.1.1 One-way slabs.** The tributary area,  $A_T$ , for use in Equation 16-7 for one-way slabs shall not exceed an area defined by the slab span times a width normal to the span of 1.5 times the slab span.

**1607.12.1.2 Heavy live loads.** *Live loads* that exceed 100 psf (4.79 kN/m<sup>2</sup>) shall not be reduced.

**Exceptions:**

1. The *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent, but the *live load* shall be not less than  $L$  as calculated in Section 1607.12.1.

2. For uses other than storage, where *approved*, additional *live load* reductions shall be permitted where shown by the *registered design professional* that a rational approach has been used and that such reductions are warranted.

**1607.12.1.3 Passenger vehicle garages.** The *live loads* shall not be reduced in passenger vehicle garages.

**Exception:** The *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent, but the *live load* shall be not less than  $L$  as calculated in Section 1607.12.1.

**1607.12.2 Alternative uniform live load reduction.** As an alternative to Section 1607.12.1 and subject to the limitations of Table 1607.1, uniformly distributed *live loads* are permitted to be reduced in accordance with the following provisions. Such reductions shall apply to slab systems, beams, girders, columns, piers, walls and foundations.

1. A reduction shall not be permitted where the *live load* exceeds 100 psf (4.79 kN/m<sup>2</sup>) except that the design *live load* for members supporting two or more floors is permitted to be reduced by not greater than 20 percent.

**Exception:** For uses other than storage, where *approved*, additional *live load* reductions shall be permitted where shown by the *registered design professional* that a rational approach has been used and that such reductions are warranted.

2. A reduction shall not be permitted in passenger vehicle parking garages except that the *live loads* for members supporting two or more floors are permitted to be reduced by not greater than 20 percent.
3. For *live loads* not exceeding 100 psf (4.79 kN/m<sup>2</sup>), the design *live load* for any structural member supporting 150 square feet (13.94 m<sup>2</sup>) or more is permitted to be reduced in accordance with Equation 16-8
4. For one-way slabs, the area,  $A$ , for use in Equation 16-8 shall not exceed the product of the slab span and a width normal to the span of 0.5 times the slab span.

$$R = 0.08(A - 150) \quad (\text{Equation 16-8})$$

$$\text{For SI: } R = 0.861(A - 13.94)$$

Such reduction shall not exceed the smallest of:

1. 40 percent for members supporting one floor.
2. 60 percent for members supporting two or more floors.
3.  $R$  as determined by the following equation:

$$R = 23.1(1 + D/L_o) \quad (\text{Equation 16-9})$$

where:

$A$  = Area of floor supported by the member, square feet ( $\text{m}^2$ ).

$D$  = *Dead load* per square foot ( $\text{m}^2$ ) of area supported.

$L_o$  = Unreduced *live load* per square foot ( $\text{m}^2$ ) of area supported.

$R$  = Reduction in percent.

**1607.13 Distribution of floor loads.** Where uniform floor *live loads* are involved in the design of structural members arranged so as to create continuity, the minimum applied loads shall be the full *dead loads* on all spans in combination with the floor *live loads* on spans selected to produce the greatest *load effect* at each location under consideration. Floor *live loads* are permitted to be reduced in accordance with Section 1607.12.

**1607.14 Roof loads.** The structural supports of roofs and *marquees* shall be designed to resist wind and, where applicable, snow and earthquake *loads*, in addition to the *dead load* of construction and the appropriate *live loads* as prescribed in this section, or as set forth in Table 1607.1. The *live loads* acting on a sloping surface shall be assumed to act vertically on the horizontal projection of that surface.

**1607.14.1 Distribution of roof loads.** Where uniform roof *live loads* are reduced to less than 20 psf (0.96  $\text{kN/m}^2$ ) in accordance with Section 1607.14.2.1 and are applied to the design of structural members arranged so as to create continuity, the reduced roof *live load* shall be applied to adjacent spans or to alternate spans, whichever produces the most unfavorable *load effect*. See Section 1607.14.2 for reductions in minimum roof *live loads* and Section 7.5 of ASCE 7 for partial snow loading.

**1607.14.2 Reduction in uniform roof live loads.** The minimum uniformly distributed *live loads* of roofs and *marquees*,  $L_o$ , in Table 1607.1 are permitted to be reduced in accordance with Section 1607.14.2.1.

**1607.14.2.1 Ordinary roofs, awnings and canopies.**

Ordinary flat, pitched and curved roofs, and *awnings* and canopies other than of fabric construction supported by a skeleton structure, are permitted to be designed for a reduced uniformly distributed *roof live load*,  $L_r$ , as specified in the following equations or other controlling combinations of *loads* as specified in Section 1605, whichever produces the greater *load effect*.

In structures such as *greenhouses*, where special scaffolding is used as a work surface for workers and materials during maintenance and repair operations, a lower roof *load* than specified in the following equations shall not be used unless *approved* by the *building official*. Such structures shall be designed for a minimum roof *live load* of 12 psf (0.58  $\text{kN/m}^2$ ).

$$L_r = L_o R_1 R_2 \quad (\text{Equation 16-10})$$

where:  $12 \leq L_r \leq 20$

For SI:  $L_r = L_o R_1 R_2$

where:  $0.58 \leq L_r \leq 0.96$

$L_o$  = Unreduced *roof live load* per square foot ( $\text{m}^2$ ) of horizontal projection supported by the member (see Table 1607.1).

$L_r$  = Reduced *roof live load* per square foot ( $\text{m}^2$ ) of horizontal projection supported by the member.

The reduction factors  $R_1$  and  $R_2$  shall be determined as follows:

$$R_1 = 1 \text{ for } A_i \leq 200 \text{ square feet (18.58 m}^2\text{)} \quad (\text{Equation 16-11})$$

$$R_1 = 1.2 - 0.001A_i \text{ for } 200 \text{ square feet} < A_i < 600 \text{ square feet} \quad (\text{Equation 16-12})$$

For SI:  $1.2 - 0.011A_i$  for  $18.58 \text{ square meters} < A_i < 55.74 \text{ square meters}$

$$R_1 = 0.6 \text{ for } A_i \geq 600 \text{ square feet (55.74 m}^2\text{)} \quad (\text{Equation 16-13})$$

where:

$A_i$  = Tributary area (span length multiplied by effective width) in square feet ( $\text{m}^2$ ) supported by the member, and

$$R_2 = 1 \text{ for } F \leq 4 \quad (\text{Equation 16-14})$$

$$R_2 = 1.2 - 0.05 F \text{ for } 4 < F < 12 \quad (\text{Equation 16-15})$$

$$R_2 = 0.6 \text{ for } F \geq 12 \quad (\text{Equation 16-16})$$

where:

$F$  = For a sloped roof, the number of inches of rise per foot (for SI:  $F = 0.12 \times \text{slope}$ , with slope expressed as a percentage), or for an arch or dome, the rise-to-span ratio multiplied by 32.

**1607.14.2.2 Occupiable roofs.** Areas of roofs that are occupiable, such as *vegetative roofs*, landscaped roofs or for assembly or other similar purposes, and *marquees* are permitted to have their uniformly distributed *live loads* reduced in accordance with Section 1607.12.

**1607.14.3 Awnings and canopies.** *Awnings* and canopies shall be designed for uniform *live loads* as required in Table 1607.1 as well as for snow *loads* and wind *loads* as specified in Sections 1608 and 1609.

**1607.14.4 Photovoltaic panel systems.** Roof structures that provide support for *photovoltaic panel systems* shall be designed in accordance with Sections 1607.14.4.1 through 1607.14.4.5, as applicable.

**1607.14.4.1 Roof live load.** Roof structures that support *photovoltaic panel systems* shall be designed to resist each of the following conditions:

1. Applicable uniform and concentrated roof *loads* with the *photovoltaic panel system dead loads*.

**Exception:** *Roof live loads* need not be applied to the area covered by *photovoltaic panels* where the clear space between the panels and



STRUCTURAL DESIGN

the roof surface is 24 inches (610 mm) or less.

- 2. Applicable uniform and concentrated roof loads without the *photovoltaic panel system* present.

**1607.14.4.2 Photovoltaic panels or modules.** The structure of a roof that supports solar *photovoltaic panels* or modules shall be designed to accommodate the full solar *photovoltaic panels* or modules and ballast *dead load*, including concentrated *loads* from support frames in combination with the *loads* from Section 1607.14.4.1 and other applicable *loads*. Where applicable, snow drift *loads* created by the *photovoltaic panels* or modules shall be included.

**1607.14.4.3 Photovoltaic panels installed on open grid roof structures.** Structures with open grid framing and without a *roof deck* or sheathing supporting *photovoltaic panel systems* shall be designed to support the uniform and concentrated *roof live loads* specified in Section 1607.14.4.1, except that the uniform *roof live load* shall be permitted to be reduced to 12 psf (0.57 kN/m<sup>2</sup>).

**1607.14.4.4 Ground-mounted photovoltaic (PV) panel systems.** Ground-mounted photovoltaic (PV) panel systems that are independent structures and do not have accessible/occupied space underneath are not required to accommodate a roof photovoltaic *live load*. Other *loads* and combinations in accordance with Section 1605 shall be accommodated.

**1607.14.4.5 Ballasted photovoltaic panel systems.** Roof structures that provide support for ballasted *photovoltaic panel systems* shall be designed, or analyzed, in accordance with Section 1604.4; checked in accordance with Section 1604.3.6 for deflections; and checked in accordance with Section 1611 for ponding.

**1607.15 Crane loads.** The crane *live load* shall be the rated capacity of the crane. Design *loads* for the runway beams, including connections and support brackets, of moving bridge cranes and monorail cranes shall include the maximum wheel *loads* of the crane and the vertical impact, lateral and longitudinal forces induced by the moving crane.

**1607.15.1 Maximum wheel load.** The maximum wheel *loads* shall be the wheel *loads* produced by the weight of the bridge, as applicable, plus the sum of the rated capacity and the weight of the trolley with the trolley positioned on its runway at the location where the resulting *load effect* is maximum.

**1607.15.2 Vertical impact force.** The maximum wheel *loads* of the crane shall be increased by the following percentages to account for the effects of vertical impact or vibration:

Monorail cranes (powered)	25 percent
Cab-operated or remotely operated bridge cranes (powered)	25 percent
Pendant-operated bridge cranes (powered)	10 percent
Bridge cranes or monorail cranes with hand-gearred bridge, trolley and hoist	0 percent

**1607.15.3 Lateral force.** The lateral force on crane runway beams with electrically powered trolleys shall be calculated as 20 percent of the sum of the rated capacity of the crane and the weight of the hoist and trolley. The lateral force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction perpendicular to the beam, and shall be distributed with due regard to the lateral stiffness of the runway beam and supporting structure.

**1607.15.4 Longitudinal force.** The longitudinal force on crane runway beams, except for bridge cranes with hand-gearred bridges, shall be calculated as 10 percent of the maximum wheel *loads* of the crane. The longitudinal force shall be assumed to act horizontally at the traction surface of a runway beam, in either direction parallel to the beam.

**1607.16 Interior walls and partitions.** Interior walls and partitions that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength and stiffness to resist the *loads* to which they are subjected but not less than a horizontal *load* of 5 psf (0.240 kN/m<sup>2</sup>).

**1607.16.1 Fabric partitions.** *Fabric partitions* that exceed 6 feet (1829 mm) in height, including their finish materials, shall have adequate strength and stiffness to resist the following *load* conditions:

- 1. The horizontal distributed *load* need only be applied to the partition framing. The total area used to determine the distributed *load* shall be the area of the fabric face between the framing members to which the fabric is attached. The total distributed *load* shall be uniformly applied to such framing members in proportion to the length of each member.
- 2. A concentrated *load* of 40 pounds (0.176 kN) applied to an 8-inch-diameter (203 mm) area [50.3 square inches (32 452 mm<sup>2</sup>)] of the fabric face at a height of 54 inches (1372 mm) above the floor.

**1607.16.2 Fire walls.** In order to meet the structural stability requirements of Section 706.2 where the structure on either side of the wall has collapsed, *fire walls* and their supports shall be designed to withstand a minimum horizontal allowable stress *load* of 5 psf (0.240 kN/m<sup>2</sup>).

**1607.17 Fixed ladders.** Fixed ladders with rungs shall be designed to resist a single concentrated *load* of 300 pounds (1.33 kN) in accordance with Section 4.5.4 of ASCE 7. Where rails of fixed ladders extend above a floor or platform at the top of the ladder, each side rail extension shall be designed to resist a single concentrated *load* of 100 pounds (0.445 kN) in accordance with Section 4.5.4 of ASCE 7. Ship's ladders shall be designed to resist the *stair loads* given in Table 1607.1.

**1607.18 Library stack rooms.** The live loading indicated in Table 1607.1 for library stack rooms applies to stack room floors that support nonmobile, double-faced library book stacks, subject to the following limitations:

- 1. The nominal book stack unit height shall not exceed 90 inches (2290 mm).



2. The nominal shelf depth shall not exceed 12 inches (305 mm) for each face.
3. Parallel rows of double-faced book stacks shall be separated by aisles not less than 36 inches (914 mm) in width.

**1607.19 Seating for assembly uses.** *Bleachers, folding and telescopic seating and grandstands* shall be designed for the loads specified in ICC 300. Stadiums and arenas with fixed seats shall be designed for the horizontal sway loads in Section 1607.19.1.

**1607.19.1 Horizontal sway loads.** The design of stadiums and arenas with fixed seats shall include horizontal swaying forces applied to each row of seats as follows:

1. 24 pounds per linear foot (0.35 kN/m) of seat applied in a direction parallel to each row of seats.
2. 10 pounds per linear foot (0.15 kN/m) of seat applied in a direction perpendicular to each row of seats.

The parallel and perpendicular horizontal swaying forces are not required to be applied simultaneously.

**1607.20 Sidewalks, vehicular driveways, and yards subject to trucking.** The live loading indicated in Table 1607.1 for sidewalks, vehicular driveways, and yards subject to trucking shall comply with the requirements of this section.

**1607.20.1 Uniform loads.** In addition to the loads indicated in Table 1607.1, other uniform loads in accordance with an approved method that contains provisions for truck loading shall be considered where appropriate.

**1607.20.2 Concentrated loads.** The concentrated wheel load indicated in Table 1607.1 shall be applied on an area of  $4\frac{1}{2}$  inches by  $4\frac{1}{2}$  inches (114 mm by 114 mm).

**1607.21 Stair treads.** The concentrated load indicated in Table 1607.1 for stair treads shall be applied on an area of 2 inches by 2 inches (51 mm by 51 mm). This load need not be assumed to act concurrently with the uniform load.

**1607.22 Residential attics.** The live loads indicated in Table 1607.1 for attics in residential occupancies shall comply with the requirements of this section.

**1607.22.1 Uninhabitable attics without storage.** In residential occupancies, uninhabitable attic areas without storage are those where the maximum clear height between the joists and rafters is less than 42 inches (1067 mm), or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches (1067 mm) in height by 24 inches (610 mm) in width, or greater, within the plane of the trusses. The live load in Table 1607.1 need not be assumed to act concurrently with any other live load requirement.

**1607.22.2 Uninhabitable attics with storage.** In residential occupancies, uninhabitable attic areas with storage are those where the maximum clear height between the joist and rafter is 42 inches (1067 mm) or greater, or where

there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches (1067 mm) in height by 24 inches (610 mm) in width, or greater, within the plane of the trusses. The live load in Table 1607.1 need only be applied to those portions of the joists or truss bottom chords where both of the following conditions are met:

1. The attic area is accessed from an opening not less than 20 inches (508 mm) in width by 30 inches (762 mm) in length that is located where the clear height in the attic is not less than 30 inches (762 mm).
2. The slope of the joists or truss bottom chords is not greater than 2 units vertical in 12 units horizontal.

The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 pounds per square foot (0.48 kN/m<sup>2</sup>).

**1607.22.3 Attics served by stairs.** Attic spaces served by stairways other than the pull-down type shall be designed to support the minimum live load specified for habitable attics and sleeping rooms.

## SECTION 1608 SNOW LOADS

**1608.1 General.** Design snow loads shall be determined in accordance with Chapter 7 of ASCE 7, but the design roof load shall be not less than that determined by Section 1607.

**1608.2 Ground snow loads.** The ground snow loads to be used in determining the design snow loads for roofs shall be determined in accordance with ASCE 7 or Figures 1608.2(1) and 1608.2(2) for the contiguous United States and Table 1608.2 for Alaska. Site-specific case studies shall be made in areas designated "CS" in Figures 1608.2(1) and 1608.2(2). Ground snow loads for sites at elevations above the limits indicated in Figures 1608.2(1) and 1608.2(2) and for all sites within the CS areas shall be approved. Ground snow load determination for such sites shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2-percent annual probability of being exceeded (50-year mean recurrence interval). Snow loads are zero for Hawaii, except in mountainous regions as approved by the building official.

**1608.3 Ponding instability.** Susceptible bays of roofs shall be evaluated for ponding instability in accordance with Chapters 7 and 8 of ASCE 7.

## SECTION 1609 WIND LOADS

**1609.1 Applications.** Buildings, structures and parts thereof shall be designed to withstand the minimum wind loads prescribed herein. Decreases in wind loads shall not be made for the effect of shielding by other structures.

## STRUCTURAL DESIGN

**TABLE 1608.2**  
**GROUND SNOW LOADS,  $p_g$ , FOR ALASKAN LOCATIONS**

LOCATION	POUNDS PER SQUARE FOOT
Adak	30
Anchorage	50
Angoon	70
Barrow	25
Barter Island	35
Bethel	40
Big Delta	50
Cold Bay	25
Cordova	100
Fairbanks	60
Fort Yukon	60
Galena	60
Gulkana	70
Homer	40
Juneau	60
Kenai	70
Kodiak	30
Kotzebue	60
McGrath	70
Nenana	80
Nome	70
Palmer	50
Petersburg	150
St. Paul Islands	40
Seward	50
Shemya	25
Sitka	50
Talkeetna	120
Unalakleet	50
Valdez	160
Whittier	300
Wrangell	60
Yakutat	150

For SI: 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

**1609.1.1 Determination of wind loads.** Wind loads on every building or structure shall be determined in accordance with Chapters 26 to 30 of ASCE 7. The type of opening protection required, the basic design wind speed,  $V$ , and the exposure category for a site is permitted to be determined in accordance with Section 1609 or ASCE 7. Wind shall be assumed to come from any horizontal direction and wind pressures shall be assumed to act normal to the surface considered.

**Exceptions:**

1. Subject to the limitations of Section 1609.1.1.1, the provisions of ICC 600 shall be permitted for applicable Group R-2 and R-3 buildings.

2. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AWC WFCM.
3. Subject to the limitations of Section 1609.1.1.1, residential structures using the provisions of AISI S230.
4. Designs using NAAMM FP 1001.
5. Designs using TIA-222 for antenna-supporting structures and antennas, provided that the horizontal extent of Topographic Category 2 escarpments in Section 2.6.6.2 of TIA-222 shall be 16 times the height of the escarpment.
6. Wind tunnel tests in accordance with ASCE 49 and Sections 31.4 and 31.5 of ASCE 7.

The wind speeds in Figures 1609.3(1) through 1609.3(12) are basic design wind speeds,  $V$ , and shall be converted in accordance with Section 1609.3.1 to allowable stress design wind speeds,  $V_{asd}$ , when the provisions of the standards referenced in Exceptions 4 and 5 are used.

**1609.1.1.1 Applicability.** The provisions of ICC 600 are applicable only to buildings located within Exposure B or C as defined in Section 1609.4. The provisions of ICC 600, AWC WFCM and AISI S230 shall not apply to buildings sited on the upper half of an isolated hill, ridge or escarpment meeting all of the following conditions:

1. The hill, ridge or escarpment is 60 feet (18 288 mm) or higher if located in Exposure B or 30 feet (9144 mm) or higher if located in Exposure C.
2. The maximum average slope of the hill exceeds 10 percent.
3. The hill, ridge or escarpment is unobstructed upwind by other such topographic features for a distance from the high point of 50 times the height of the hill or 2 miles (3.22 km), whichever is greater.

**1609.2 Protection of openings.** In windborne debris regions, glazing in buildings shall be impact resistant or protected with an impact-resistant covering meeting the requirements of an approved impact-resistant standard or ASTM E1996 referenced herein as follows:

1. Glazed openings located within 30 feet (9144 mm) of grade shall meet the requirements of the large missile test of ASTM E1996.
2. Glazed openings located more than 30 feet (9144 mm) above grade shall meet the provisions of the small missile test of ASTM E1996.

**Exceptions:**

1. Wood structural panels with a minimum thickness of  $\frac{7}{16}$  inch (11.1 mm) and maximum panel span of 8 feet (2438 mm) shall be permitted for opening protection in buildings with a mean roof height of 33 feet (10 058 mm) or less that are classified as a Group R-3 or R-4 occupancy. Panels shall be

precut so that they shall be attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the components and cladding loads determined in accordance with the provisions of ASCE 7, with corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table 1609.2 with corrosion-resistant attachment hardware provided and anchors permanently installed on the building is permitted for buildings with a mean roof height of 45 feet (13 716 mm) or less where  $V_{asd}$  determined in accordance with Section 1609.3.1 does not exceed 140 mph (63 m/s).

2. Glazing in *Risk Category* I buildings, including greenhouses that are occupied for growing plants on a production or research basis, without public access shall be permitted to be unprotected.
3. Glazing in *Risk Category* II, III or IV buildings located over 60 feet (18 288 mm) above the ground and over 30 feet (9144 mm) above aggregate surface roofs located within 1,500 feet (458 m) of the building shall be permitted to be unprotected.

**1609.2.1 Louvers.** Louvers protecting intake and exhaust ventilation ducts not assumed to be open that are located within 30 feet (9144 mm) of grade shall meet the requirements of AMCA 540.

**1609.2.2 Application of ASTM E1996.** The text of Section 6.2.2 of ASTM E1996 shall be substituted as follows:

6.2.2 Unless otherwise specified, select the wind zone based on the basic design wind speed,  $V$ , as follows:

6.2.2.1 *Wind Zone 1*—130 mph  $\leq$  basic design wind speed,  $V < 140$  mph.

6.2.2.2 *Wind Zone 2*—140 mph  $\leq$  basic design wind speed,  $V < 150$  mph at greater than one mile (1.6 km) from the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.3 *Wind Zone 3*—150 mph (67 m/s)  $\leq$  basic design wind speed,  $V \leq 160$  mph (72 m/s), or 140 mph (63 m/s)  $\leq$  basic design wind speed,  $V \leq 160$  mph (72 m/s) and within one mile (1.6 km) of the coastline. The coastline shall be measured from the mean high water mark.

6.2.2.4 *Wind Zone 4*—basic design wind speed,  $V > 160$  mph (72 m/s).

**1609.2.3 Garage doors.** Garage door glazed opening protection for windborne debris shall meet the requirements of an *approved* impact-resisting standard or ANSI/DASMA 115.

**1609.3 Basic design wind speed.** The basic design wind speed,  $V$ , in mph, for the determination of the wind loads shall be determined by Figures 1609.3(1) through 1609.3(12). The basic design wind speed,  $V$ , for use in the design of *Risk Category* II buildings and structures shall be obtained from Figures 1609.3(1), 1609.3(5) and 1609.3(6). The basic design wind speed,  $V$ , for use in the design of *Risk Category* III buildings and structures shall be obtained from Figures 1609.3(2), 1609.3(7) and 1609.3(8). The basic design wind speed,  $V$ , for use in the design of *Risk Category* IV buildings and structures shall be obtained from Figures 1609.3(3), 1609.3(9) and 1609.3(10). The basic design wind speed,  $V$ , for use in the design of *Risk Category* I buildings and structures shall be obtained from Figures 1609.3(4), 1609.3(11) and 1609.3(12). The basic design wind speed,  $V$ , for the special wind regions indicated near mountainous terrain and near gorges shall be in accordance with local jurisdiction requirements. The basic design wind speeds,  $V$ , determined by the local jurisdiction shall be in accordance with Chapter 26 of ASCE 7.

In nonhurricane-prone regions, when the basic design wind speed,  $V$ , is estimated from regional climatic data, the basic design wind speed,  $V$ , shall be determined in accordance with Chapter 26 of ASCE 7.

**TABLE 1609.2**  
**WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS<sup>a, b, c, d</sup>**

FASTENER TYPE	FASTENER SPACING (inches)		
	Panel Span $\leq$ 4 feet	4 feet < Panel Span $\leq$ 6 feet	6 feet < Panel Span $\leq$ 8 feet
No. 8 wood-screw-based anchor with 2-inch embedment length	16	10	8
No. 10 wood-screw-based anchor with 2-inch embedment length	16	12	9
$\frac{1}{4}$ -inch diameter lag-screw-based anchor with 2-inch embedment length	16	16	16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N, 1 mile per hour = 0.447 m/s.

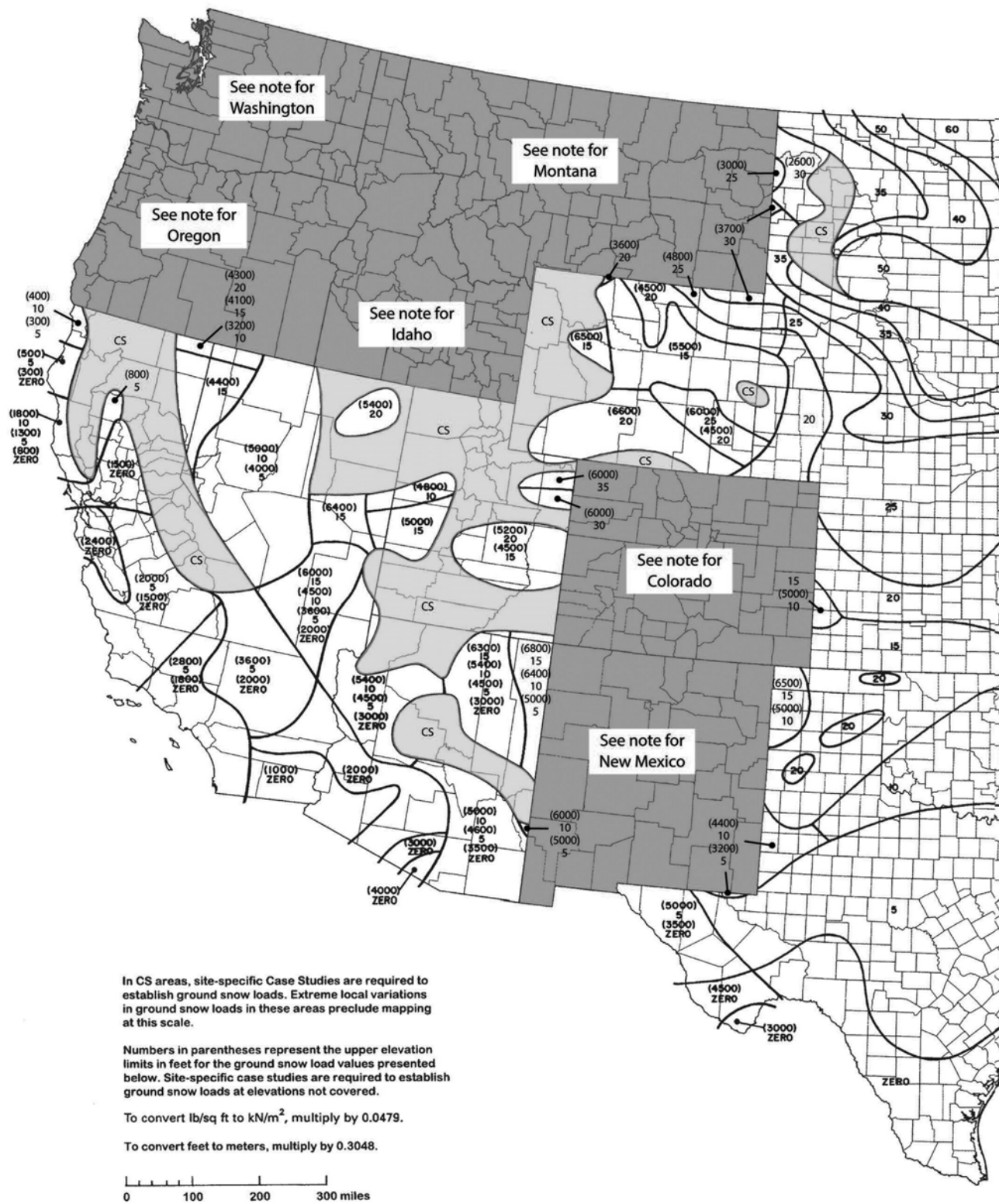
a. This table is based on 140 mph wind speeds and a 45-foot mean roof height.

b. Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located not less than 1 inch from the edge of the panel.

c. Anchors shall penetrate through the exterior wall covering with an embedment length of 2 inches minimum into the building frame. Fasteners shall be located not less than  $2\frac{1}{2}$  inches from the edge of concrete block or concrete.

d. Where panels are attached to masonry or masonry/stucco, they shall be attached using vibration-resistant anchors having a minimum ultimate withdrawal capacity of 1,500 pounds.

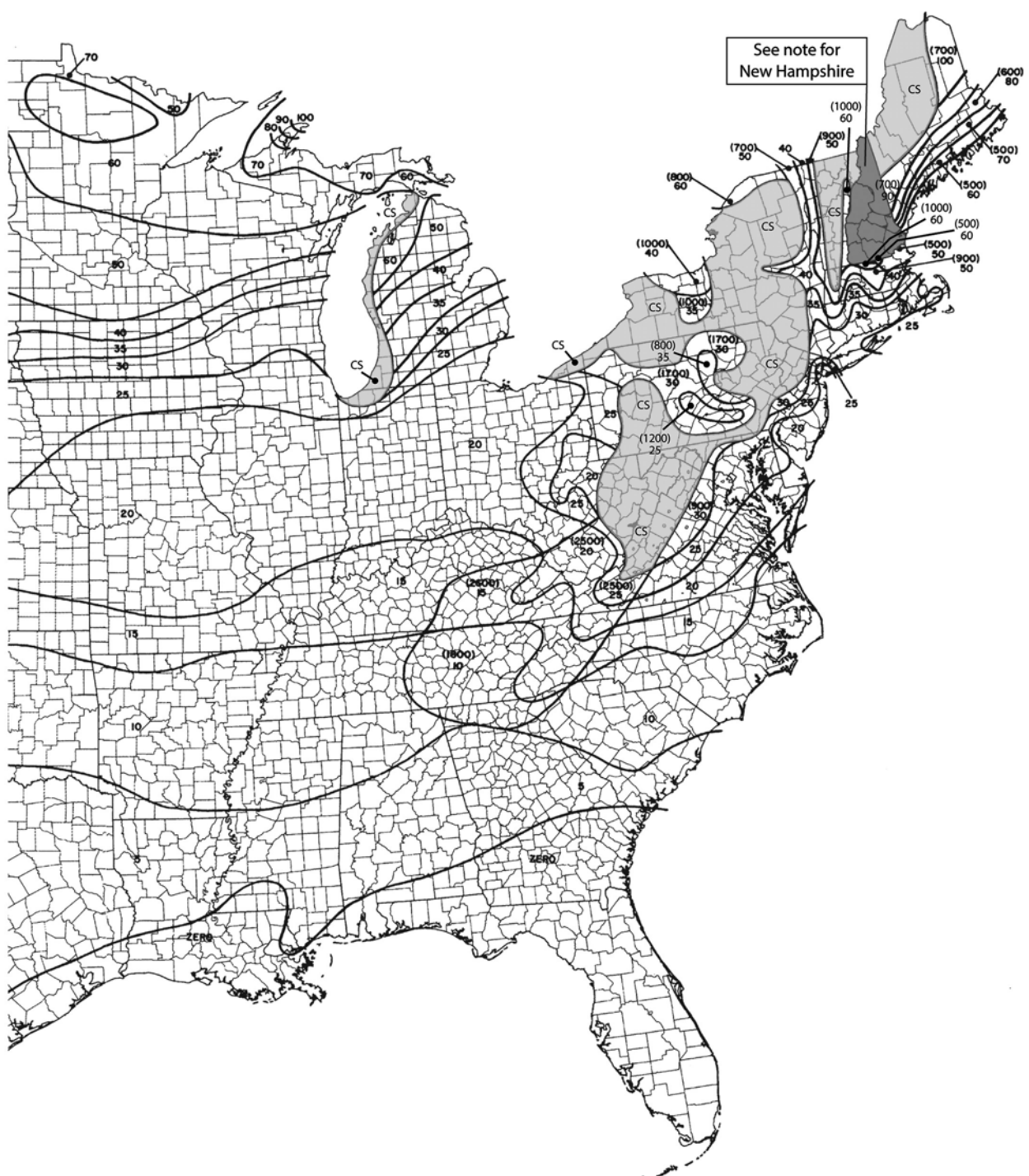




**NOTE:** See ASCE 7 Table 7.2-2 for Colorado, Table 7.2-3 for Idaho, Table 7.2-4 for Montana, Table 7.2-5 for Washington, Table 7.2-6 for New Mexico and Table 7.2-7 for Oregon.

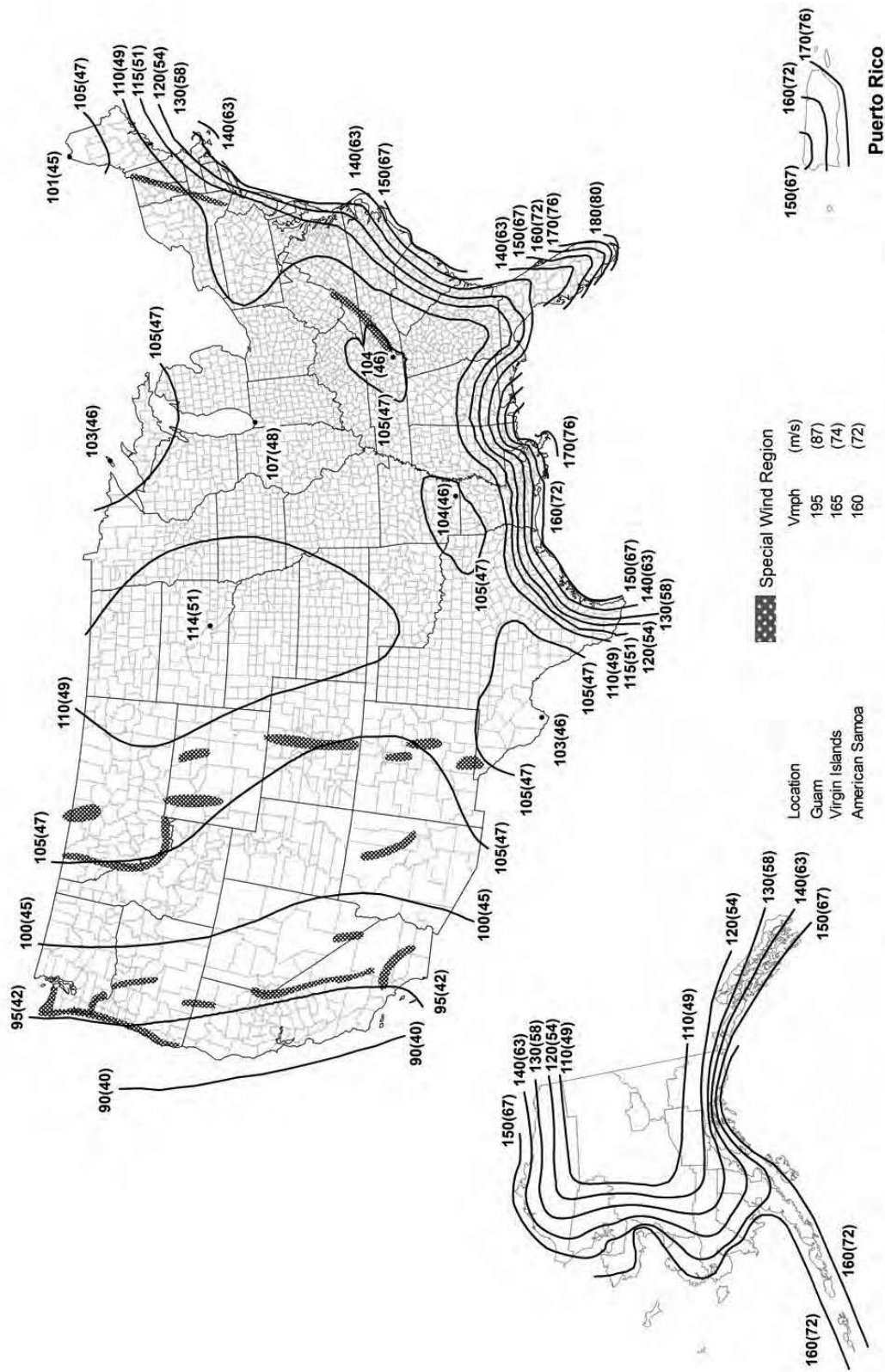
**FIGURE 1608.2(1)**  
**GROUND SNOW LOADS,  $p_g$ , FOR THE UNITED STATES (psf)**





NOTE: See ASCE 7 Table 7.2-8 for New Hampshire.

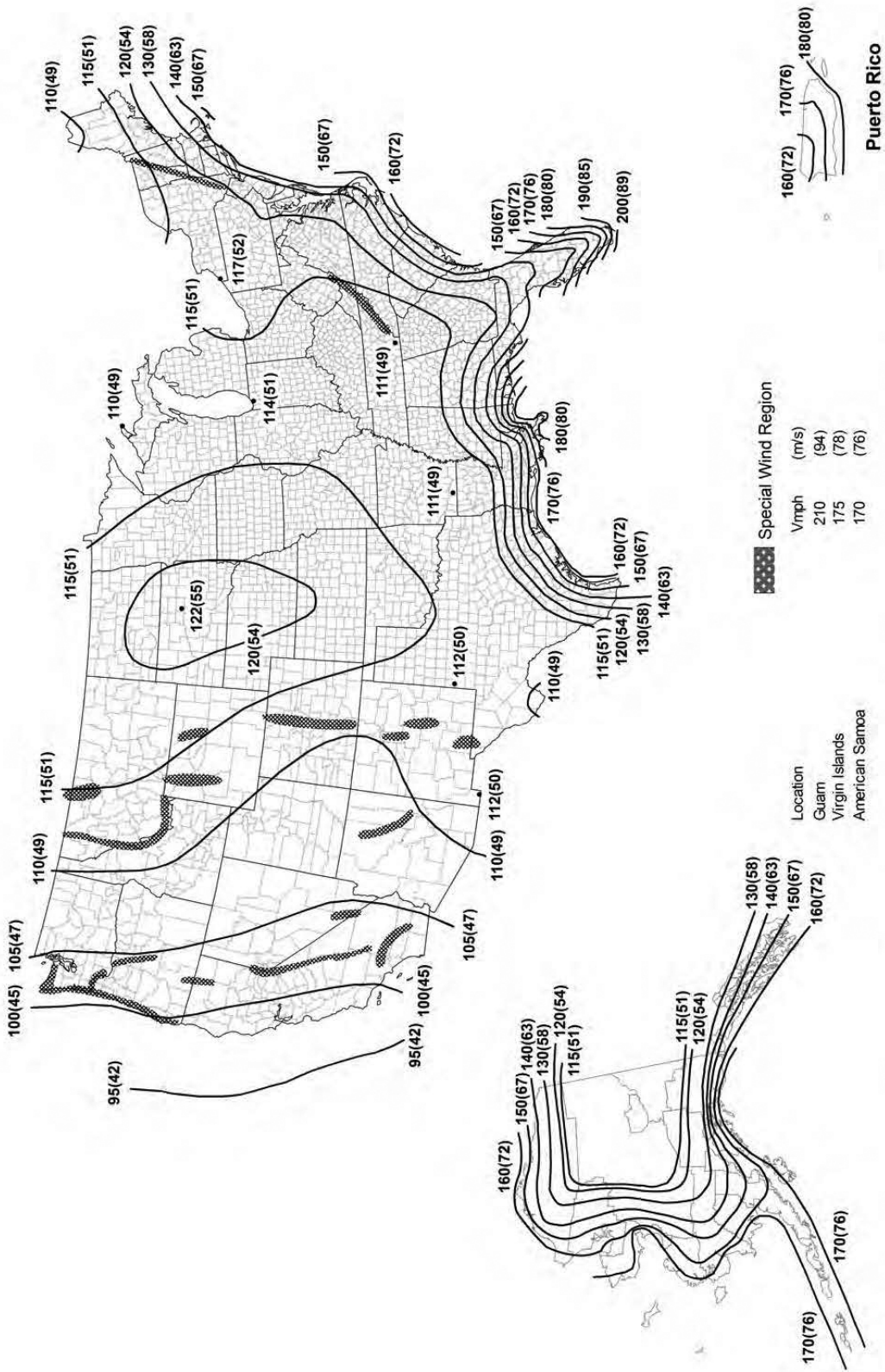
FIGURE 1608.2(2)  
GROUND SNOW LOADS,  $p_g$ , FOR THE UNITED STATES (psf)



- Notes:**
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 feet (10 m) above ground for Exposure C Category.
  2. Linear interpolation between contours. Point values are provided to aid with interpolation.
  3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
  4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
  5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).
  6. Location-specific basic wind speeds shall be determined using [www.atcouncil.org/windspeed](http://www.atcouncil.org/windspeed)

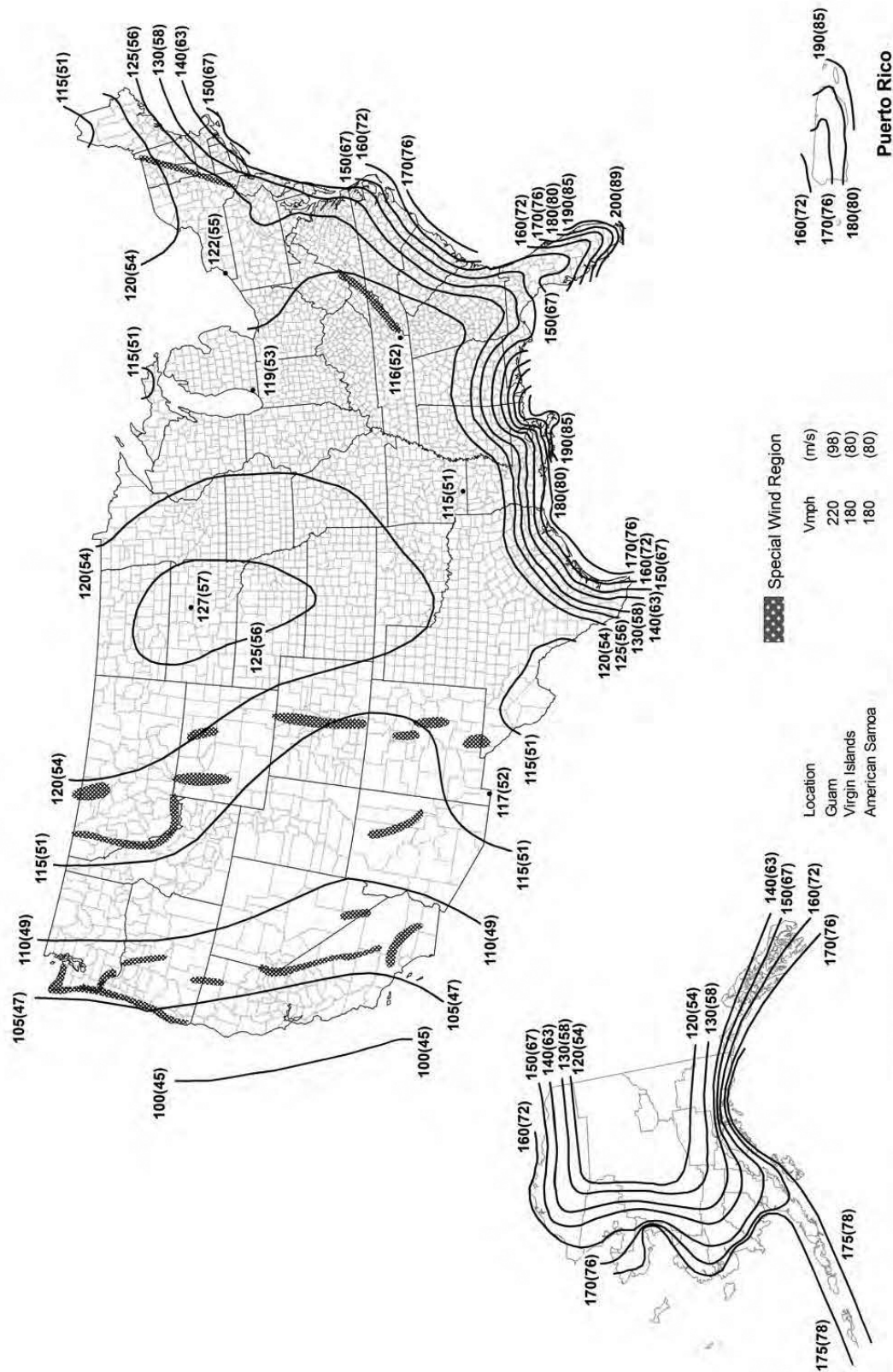
**FIGURE 1609.3(1)**  
**BASIC DESIGN WIND SPEEDS, V, FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES**





- Notes:**
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 feet (10 m) above ground for Exposure C Category.
  2. Linear interpolation between contours. Point values are provided to aid with interpolation.
  3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
  4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
  5. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).
  6. Location-specific basic wind speeds shall be determined using [www.atcouncil.org/windspeed](http://www.atcouncil.org/windspeed)

**FIGURE 1609.3(2)**  
**BASIC DESIGN WIND SPEEDS, V, FOR RISK CATEGORY III BUILDINGS AND OTHER STRUCTURES**

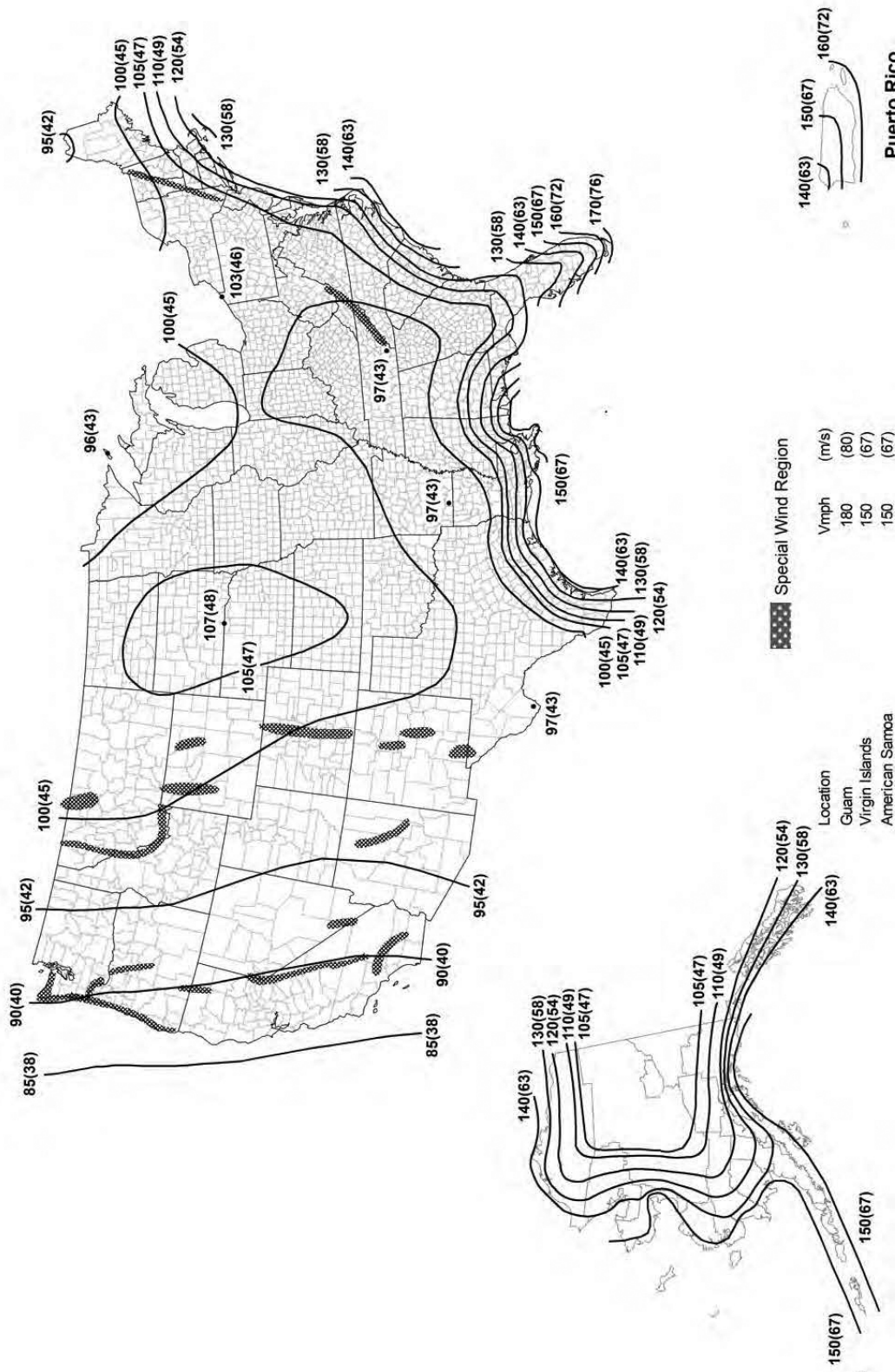


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours. Point values are provided to aid with interpolation.
3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 1.6% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00033,  $MRI = 3000$  Years).
6. Location-specific basic wind speeds shall be permitted to be determined using [www.atcouncil.org/windspeed](http://www.atcouncil.org/windspeed)

**FIGURE 1609.3(3)  
BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY IV BUILDINGS AND OTHER STRUCTURES**



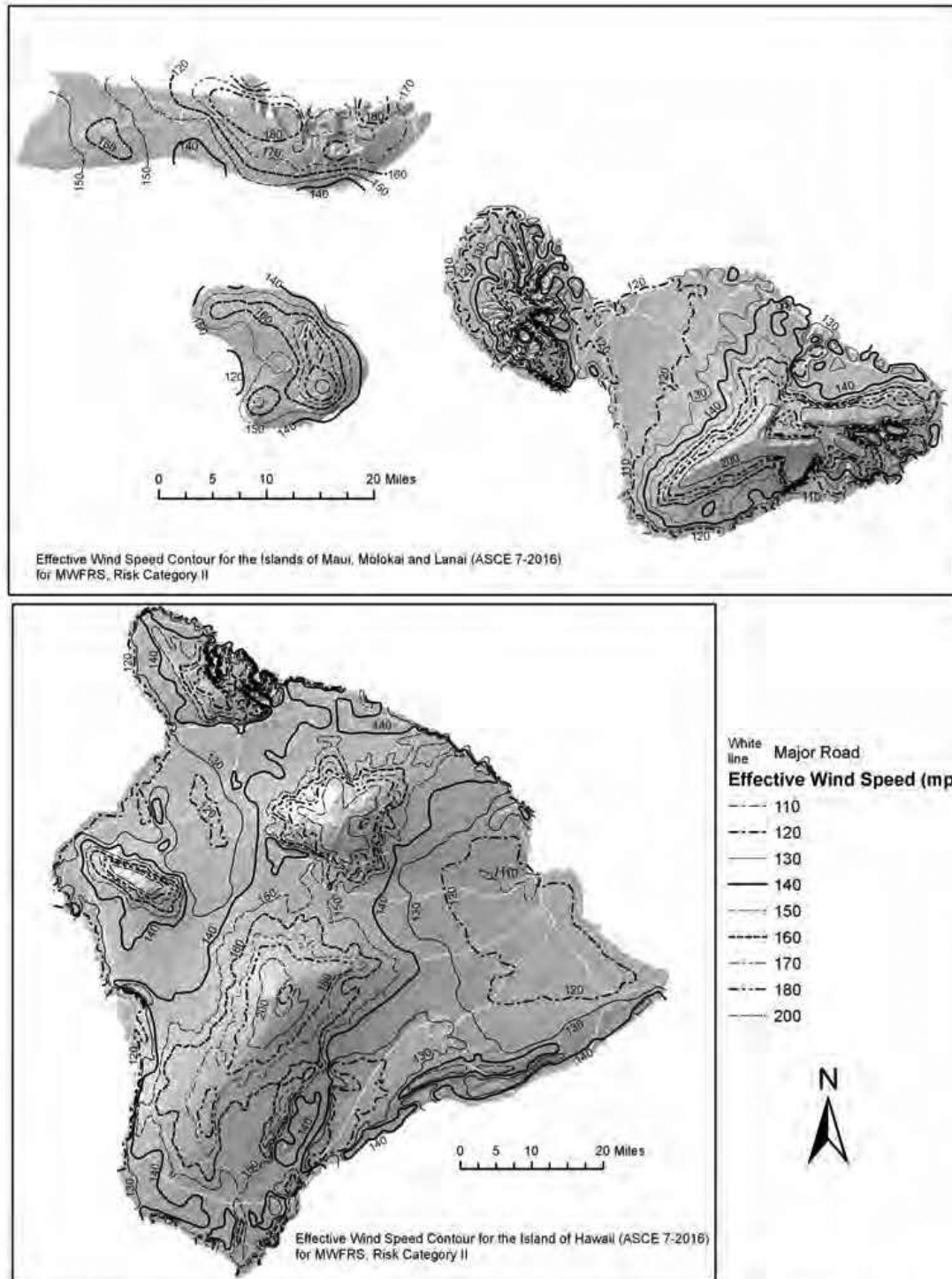


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours. Point values are provided to aid with interpolation.
3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00333, MRI = 300 Years).
6. Location-specific basic wind speeds shall be determined using [www.atcouncil.org/windspeed](http://www.atcouncil.org/windspeed).

**FIGURE 1609.3(4)**  
**BASIC DESIGN WIND SPEEDS, V, FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES**

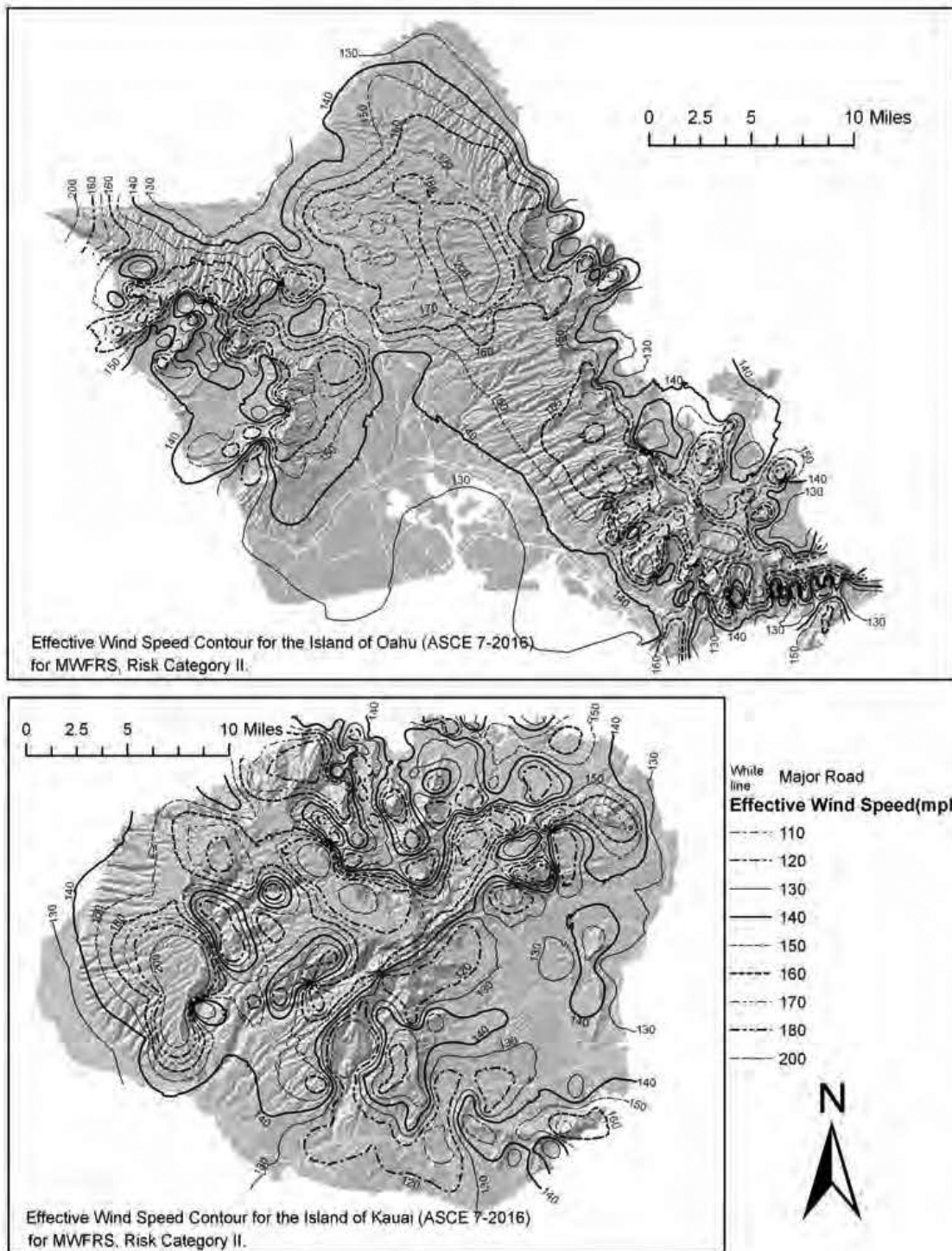
## STRUCTURAL DESIGN

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(5)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES IN HAWAII**

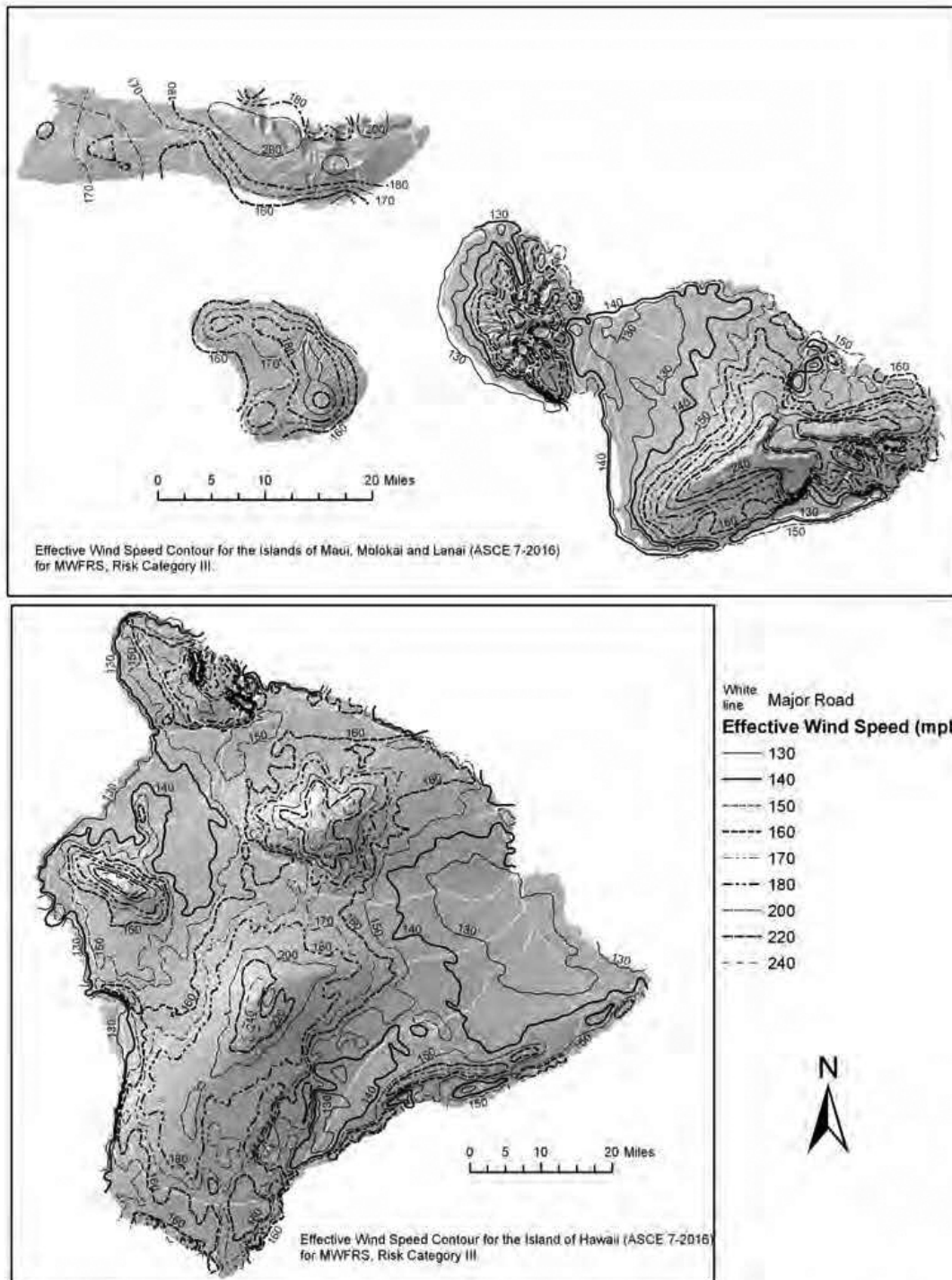


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(6)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY II BUILDINGS AND OTHER STRUCTURES IN HAWAII (OAHU, KAUAI)**

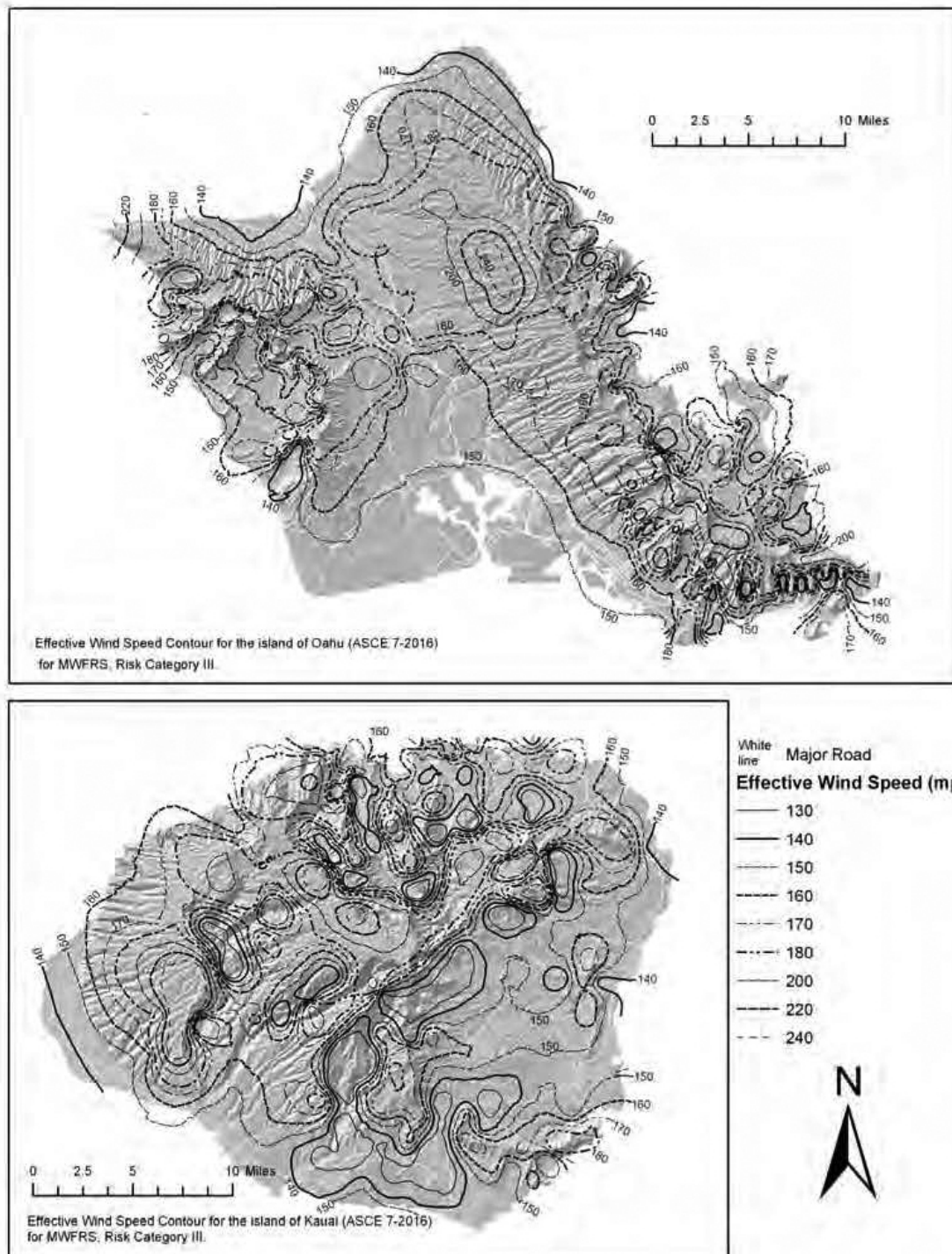
## STRUCTURAL DESIGN

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(7)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY III BUILDINGS AND OTHER STRUCTURES IN HAWAII**



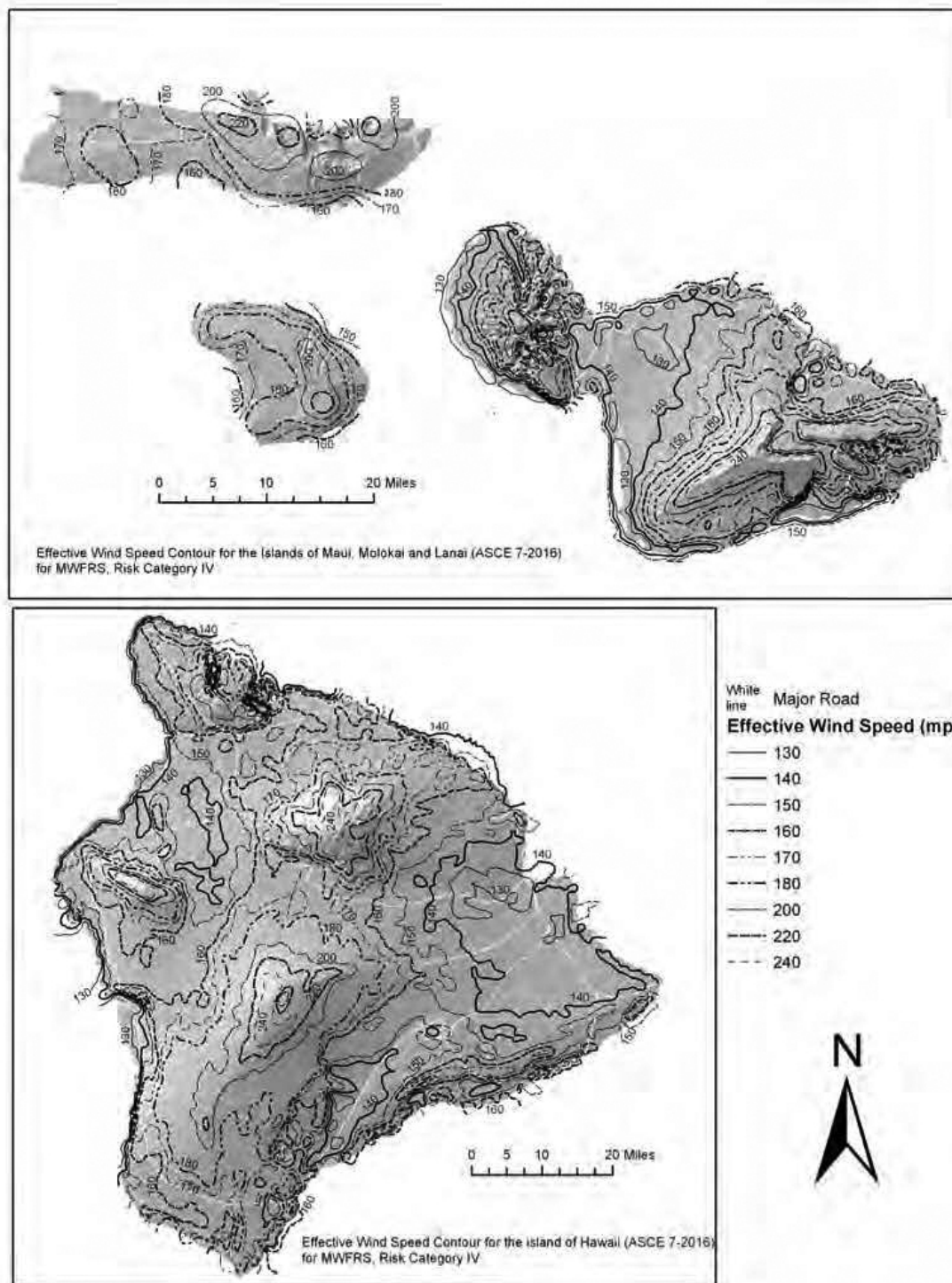


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C Category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(8)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY III BUILDINGS AND OTHER STRUCTURES IN HAWAII (OAHU, KAUAI)**

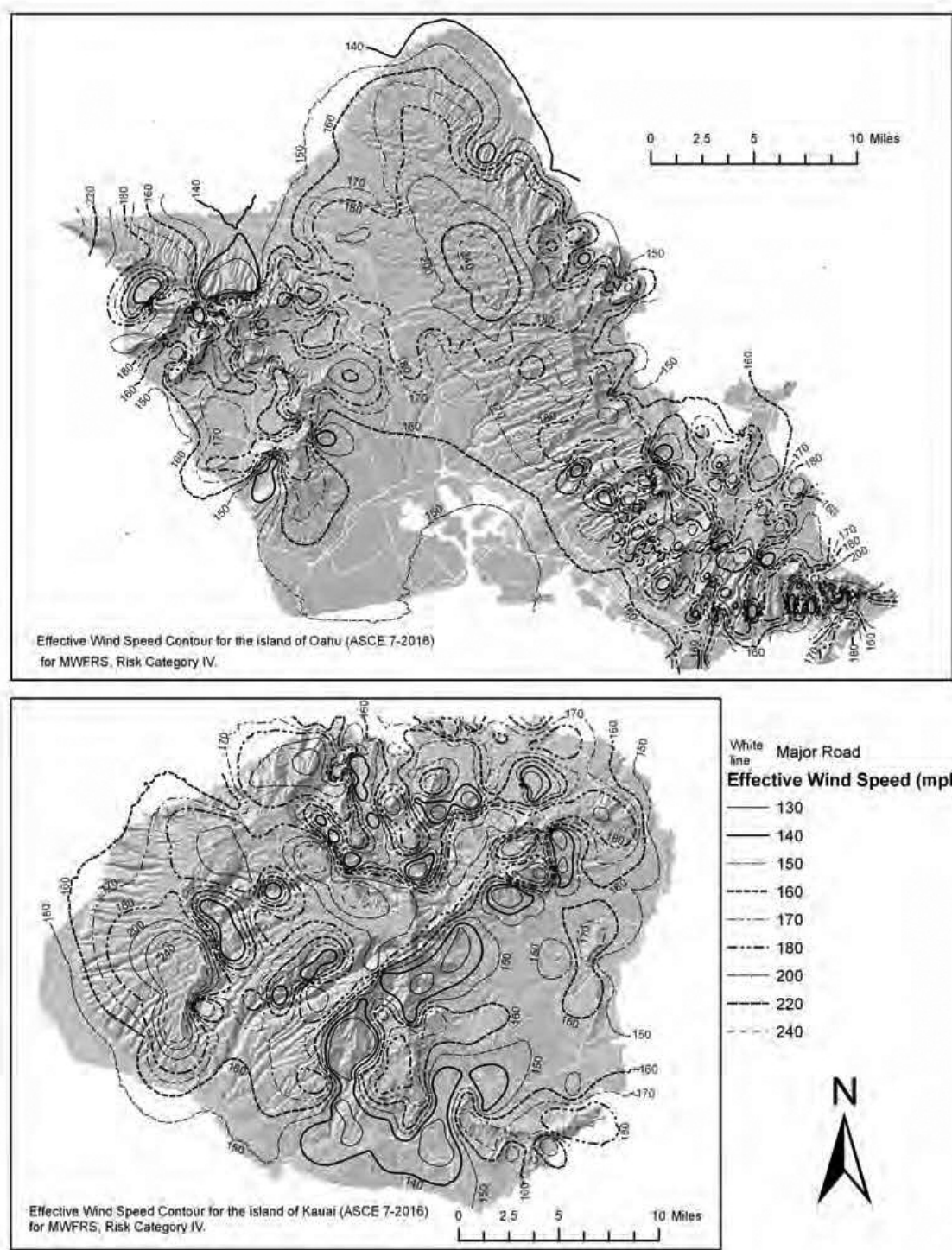
## STRUCTURAL DESIGN

**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_z$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 1.7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(9)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY IV BUILDINGS AND OTHER STRUCTURES IN HAWAII**



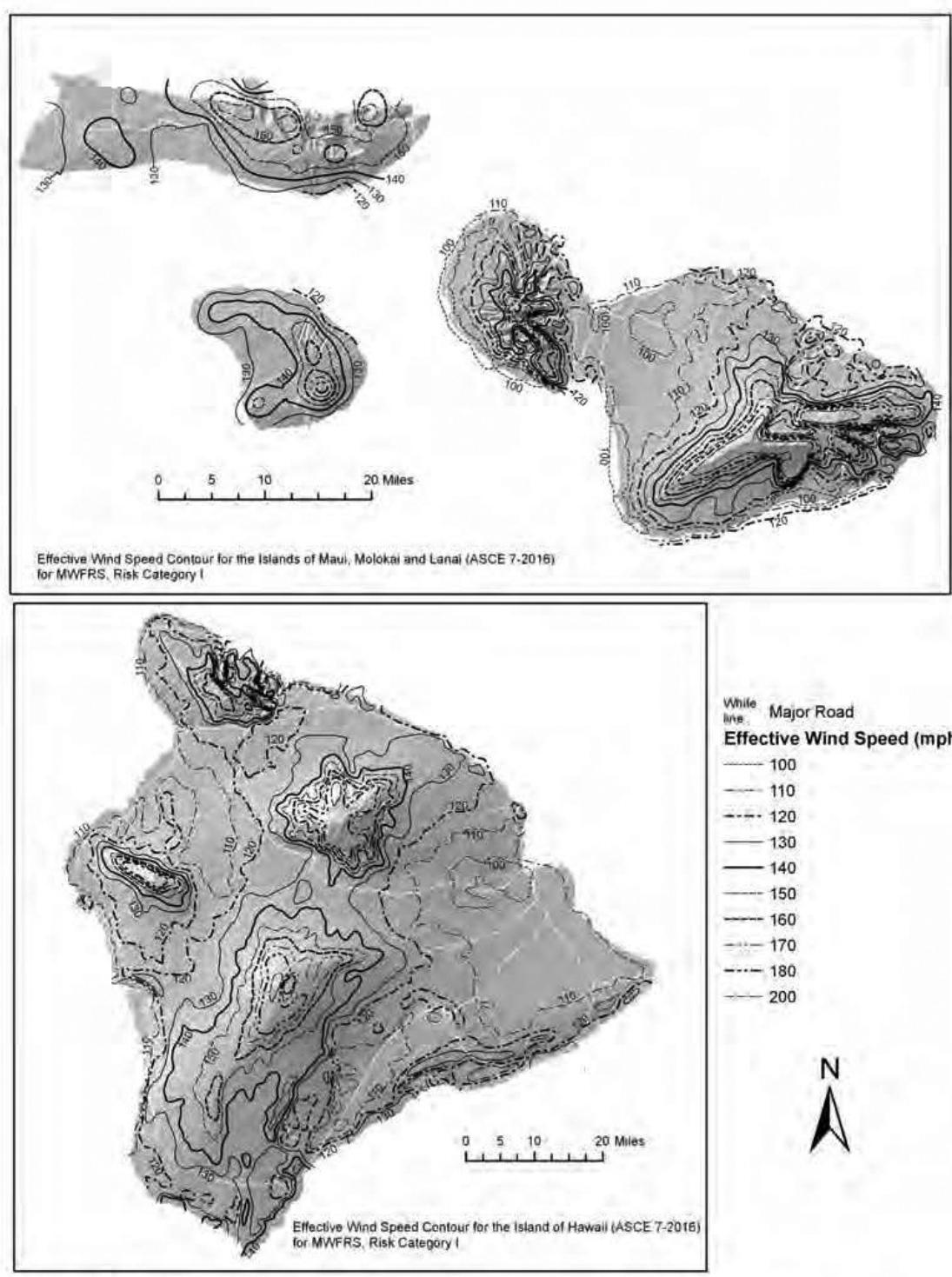


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 1.7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(10)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY IV BUILDINGS AND OTHER STRUCTURES IN HAWAII (OAHU, KAUAI)**

# STRUCTURAL DESIGN

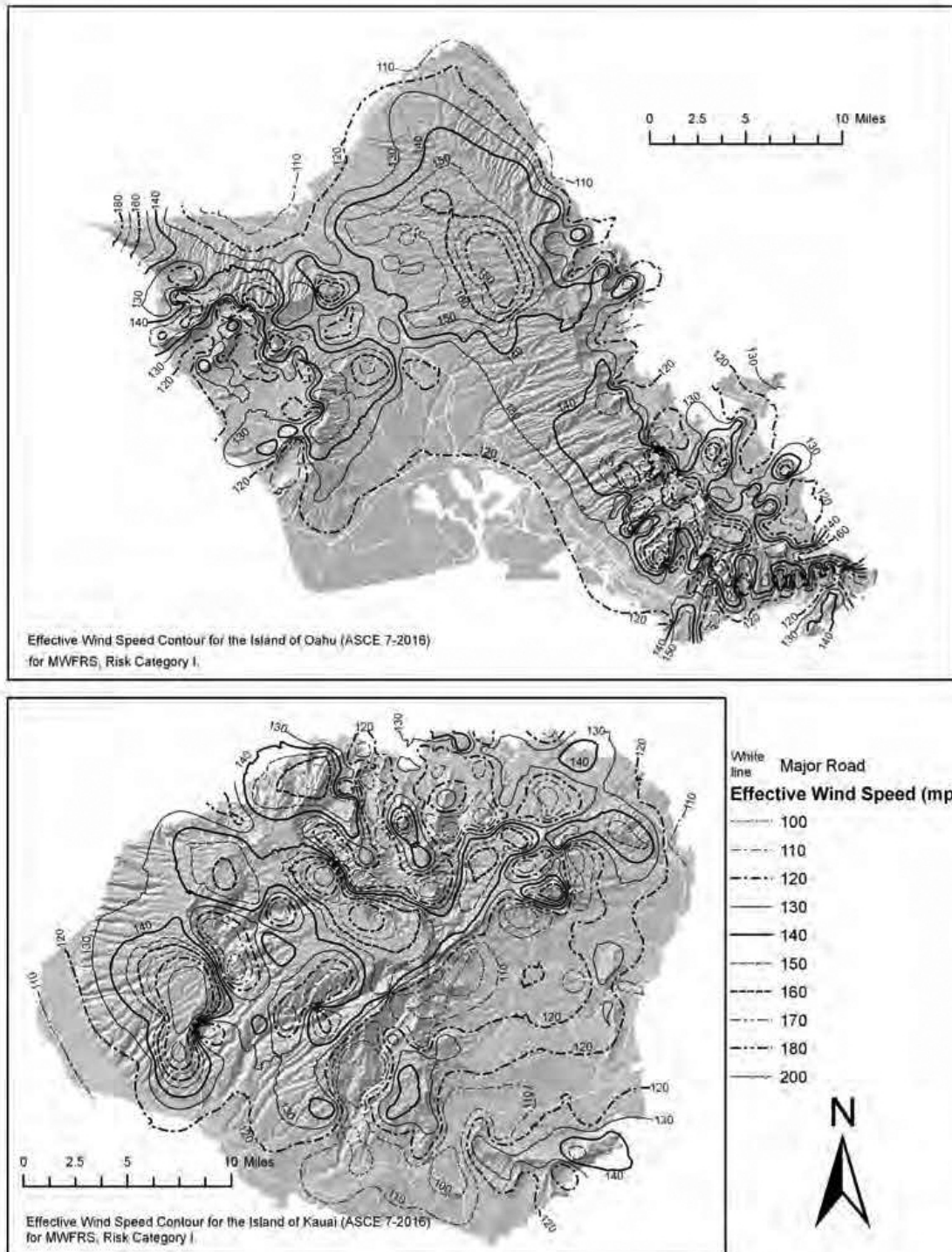


## Notes:

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(11)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES IN HAWAII**



**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour at 33 feet (10 m) above ground for Exposure C category.
2. Linear interpolation between contours is permitted.
3. Islands and coastal areas outside the last contour shall use the last wind speed contour of the coastal area.
4. It is permitted to use the standard values of  $K_{zt}$  of 1.0 and  $K_d$  as given in Table 26.6-1 of ASCE 7.
5. Ocean promontories and local escarpments shall be examined for unusual wind conditions.
6. Wind speeds correspond to approximately a 15% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).

**FIGURE 1609.3(12)**  
**BASIC DESIGN WIND SPEEDS,  $V$ , FOR RISK CATEGORY I BUILDINGS AND OTHER STRUCTURES IN HAWAII (OAHU, KAUAI)**

## STRUCTURAL DESIGN

**1609.3.1 Wind speed conversion.** Where required, the basic design wind speeds of Figures 1609.3(1) through 1609.3(12) shall be converted to *allowable stress design* wind speeds,  $V_{asd}$ , using Table 1609.3.1 or Equation 16-17.

$$V_{asd} = V\sqrt{0.6} \quad (\text{Equation 16-17})$$

where:

$V_{asd}$  = *Allowable stress design* wind speed applicable to methods specified in Exceptions 4 and 5 of Section 1609.1.1.

$V$  = Basic design wind speeds determined from Figures 1609.3(1) through 1609.3(12).

**1609.4 Exposure category.** For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features.

**1609.4.1 Wind directions and sectors.** For each selected wind direction at which the wind *loads* are to be evaluated, the exposure of the building or structure shall be determined for the two upwind sectors extending 45 degrees (0.79 rad) either side of the selected wind direction. The exposures in these two sectors shall be determined in accordance with Sections 1609.4.2 and 1609.4.3 and the exposure resulting in the highest wind *loads* shall be used to represent winds from that direction.

**1609.4.2 Surface roughness categories.** A ground surface roughness within each 45-degree (0.79 rad) sector shall be determined for a distance upwind of the site as defined in Section 1609.4.3 from the following categories, for the purpose of assigning an exposure category as defined in Section 1609.4.3.

**Surface Roughness B.** Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

**Surface Roughness C.** Open terrain with scattered obstructions having heights generally less than 30 feet (9144 mm). This category includes flat open country, and grasslands.

**Surface Roughness D.** Flat, unobstructed areas and water surfaces. This category includes smooth mud flats, salt flats and unbroken ice.

**1609.4.3 Exposure categories.** An exposure category shall be determined in accordance with the following:

**Exposure B.** For buildings with a mean roof height of less than or equal to 30 feet (9144 mm), Exposure B shall apply where the ground surface roughness, as defined by Surface Roughness B, prevails in the upwind direction for a distance of not less than 1,500 feet (457 m). For buildings with a mean roof height greater than 30 feet (9144 mm), Exposure B shall apply where Surface Roughness B prevails in the upwind direction for a distance of not less than 2,600 feet (792 m) or 20 times the height of the building, whichever is greater.

**Exposure C.** Exposure C shall apply for all cases where Exposure B or D does not apply.

**Exposure D.** Exposure D shall apply where the ground surface roughness, as defined by Surface Roughness D, prevails in the upwind direction for a distance of not less than 5,000 feet (1524 m) or 20 times the height of the building, whichever is greater. Exposure D shall apply where the ground surface roughness immediately upwind of the site is B or C, and the site is within a distance of 600 feet (183 m) or 20 times the *building height*, whichever is greater, from an Exposure D condition as defined in the previous sentence.

**1609.5 Roof systems.** Roof systems shall be designed and constructed in accordance with Sections 1609.5.1 through 1609.5.3, as applicable.

**1609.5.1 Roof deck.** The *roof deck* shall be designed to withstand the wind pressures determined in accordance with ASCE 7.

**1609.5.2 Roof coverings.** *Roof coverings* shall comply with Section 1609.5.1.

**Exception:** Rigid tile *roof coverings* that are air permeable and installed over a *roof deck* complying with Section 1609.5.1 are permitted to be designed in accordance with Section 1609.5.3.

Asphalt shingles installed over a *roof deck* complying with Section 1609.5.1 shall comply with the wind-resistance requirements of Section 1504.2.

**TABLE 1609.3.1**  
**WIND SPEED CONVERSIONS<sup>a, b, c</sup>**

$V$	100	110	120	130	140	150	160	170	180	190	200
$V_{asd}$	78	85	93	101	108	116	124	132	139	147	155

For SI: 1 mile per hour = 0.44 m/s.

a. Linear interpolation is permitted.

b.  $V_{asd}$  = allowable stress design wind speed applicable to methods specified in Exceptions 1 through 5 of Section 1609.1.1.

c.  $V$  = basic design wind speeds determined from Figures 1609.3(1) through 1609.3(12).

**1609.5.3 Rigid tile.** Wind *loads* on rigid tile *roof coverings* shall be determined in accordance with the following equation:

$$M_a = q_h C_L b L L_a [1.0 - G C_p] \quad (\text{Equation 16-18})$$

For SI:

$$M_a = \frac{q_h C_L b L L_a [1.0 - G C_p]}{1,000}$$

where:

$b$  = Exposed width, feet (mm) of the roof tile.

$C_L$  = Lift coefficient. The lift coefficient for concrete and clay tile shall be 0.2 or shall be determined by test in accordance with Section 1504.3.1.

$G C_p$  = Roof pressure coefficient for each applicable roof zone determined from Chapter 30 of ASCE 7. Roof coefficients shall not be adjusted for internal pressure.

$L$  = Length, feet (mm) of the roof tile.

$L_a$  = Moment arm, feet (mm) from the axis of rotation to the point of uplift on the roof tile. The point of uplift shall be taken at 0.76L from the head of the tile and the middle of the exposed width. For roof tiles with nails or screws (with or without a tail clip), the axis of rotation shall be taken as the head of the tile for direct deck application or as the top edge of the batten for battened applications. For roof tiles fastened only by a nail or screw along the side of the tile, the axis of rotation shall be determined by testing. For roof tiles installed with battens and fastened only by a clip near the tail of the tile, the moment arm shall be determined about the top edge of the batten with consideration given for the point of rotation of the tiles based on straight bond or broken bond and the tile profile.

$M_a$  = Aerodynamic uplift moment, feet-pounds (N-mm) acting to raise the tail of the tile.

$q_h$  = Wind velocity pressure, psf (kN/m<sup>2</sup>) determined from Section 26.10.2 of ASCE 7.

Concrete and clay roof tiles complying with the following limitations shall be designed to withstand the aerodynamic uplift moment as determined by this section.

1. The roof tiles shall be either loose laid on battens, mechanically fastened, *mortar* set or adhesive set.
2. The roof tiles shall be installed on solid sheathing that has been designed as components and cladding.
3. An *underlayment* shall be installed in accordance with Chapter 15.
4. The tile shall be single lapped interlocking with a minimum head lap of not less than 2 inches (51 mm).
5. The length of the tile shall be between 1.0 and 1.75 feet (305 mm and 533 mm).
6. The exposed width of the tile shall be between 0.67 and 1.25 feet (204 mm and 381 mm).

7. The maximum thickness of the tail of the tile shall not exceed 1.3 inches (33 mm).

8. Roof tiles using *mortar* set or adhesive set systems shall have not less than two-thirds of the tile's area free of *mortar* or adhesive contact.

## SECTION 1610

### SOIL LOADS AND HYDROSTATIC PRESSURE

**1610.1 Lateral pressures.** Foundation walls and retaining walls shall be designed to resist lateral soil *loads* from adjacent soil. Soil *loads* specified in Table 1610.1 shall be used as the minimum design lateral soil *loads* unless determined otherwise by a geotechnical investigation in accordance with Section 1803. Foundation walls and other walls in which horizontal movement is restricted at the top shall be designed for at-rest pressure. Retaining walls free to move and rotate at the top shall be permitted to be designed for active pressure. Lateral pressure from surcharge *loads* shall be added to the lateral soil *load*. Lateral pressure shall be increased if expansive soils are present at the site. Foundation walls shall be designed to support the weight of the full hydrostatic pressure of undrained backfill unless a drainage system is installed in accordance with Sections 1805.4.2 and 1805.4.3.

**Exception:** Foundation walls extending not more than 8 feet (2438 mm) below grade and laterally supported at the top by flexible *diaphragms* shall be permitted to be designed for active pressure.

**1610.2 Uplift loads on floor and foundations.** Basement floors, slabs on ground, foundations, and similar approximately horizontal elements below grade shall be designed to resist uplift *loads* where applicable. The upward pressure of water shall be taken as the full hydrostatic pressure applied over the entire area. The hydrostatic *load* shall be measured from the underside of the element being evaluated. The design for upward *loads* caused by expansive soils shall comply with Section 1808.6.

## SECTION 1611

### RAIN LOADS

**1611.1 Design rain loads.** Each portion of a roof shall be designed to sustain the *load* of rainwater as per the requirements of Chapter 8 of ASCE 7. The design rainfall shall be based on the 100-year 15-minute duration event, or on other rainfall rates determined from approved local weather data. Alternatively, a design rainfall of twice the 100-year hourly rainfall rate indicated in Figures 1611.1(1) through 1611.1(5) shall be permitted.

$$R = 5.2(d_s + d_h) \quad (\text{Equation 16-19})$$

For SI:  $R = 0.0098(d_s + d_h)$

where:

$d_h$  = Additional depth of water on the undeflected roof above the inlet of secondary drainage system at its design flow (in other words, the hydraulic head), in inches (mm).



## STRUCTURAL DESIGN

$d_s$  = Depth of water on the undeflected roof up to the inlet of secondary drainage system when the primary drainage system is blocked (in other words, the static head), in inches (mm).

$R$  = Rain load on the undeflected roof, in psf (kN/m<sup>2</sup>). Where the phrase “undeflected roof” is used, deflections from *loads* (including *dead loads*) shall not be considered when determining the amount of rain on the roof.

**1611.2 Ponding instability.** *Susceptible bays* of roofs shall be evaluated for ponding instability in accordance with Chapters 7 and 8 of ASCE 7.

**1611.3 Controlled drainage.** Roofs equipped with hardware to control the rate of drainage shall be equipped with a secondary drainage system at a higher elevation that limits accumulation of water on the roof above that elevation. Such roofs shall be designed to sustain the *load* of rainwater that will accumulate on them to the elevation of the secondary drainage system plus the uniform *load* caused by water that rises above the inlet of the secondary drainage system at its design flow determined from Section 1611.1. Such roofs shall be checked for ponding instability in accordance with Section 1611.2.

## SECTION 1612 FLOOD LOADS

**1612.1 General.** Within *flood hazard areas* as established in Section 1612.3, all new construction of buildings, structures

and portions of buildings and structures, including *substantial improvement* and restoration of *substantial damage* to buildings and structures, shall be designed and constructed to resist the effects of flood hazards and *flood loads*. For buildings that are located in more than one *flood hazard area*, the provisions associated with the most restrictive *flood hazard area* shall apply.

**1612.2 Design and construction.** The design and construction of buildings and structures located in *flood hazard areas*, including *coastal high hazard areas* and *coastal A zones*, shall be in accordance with Chapter 5 of ASCE 7 and ASCE 24.

**1612.3 Establishment of flood hazard areas.** To establish *flood hazard areas*, the applicable governing authority shall adopt a flood hazard map and supporting data. The flood hazard map shall include, at a minimum, areas of special flood hazard as identified by the Federal Emergency Management Agency in an engineering report entitled “The *Flood Insurance Study* for [INSERT NAME OF JURISDICTION],” dated [INSERT DATE OF ISSUANCE], as amended or revised with the accompanying *Flood Insurance Rate Map* (FIRM) and Flood Boundary and *Floodway Map* (FBFM) and related supporting data along with any revisions thereto. The adopted flood hazard map and supporting data are hereby adopted by reference and declared to be part of this section.

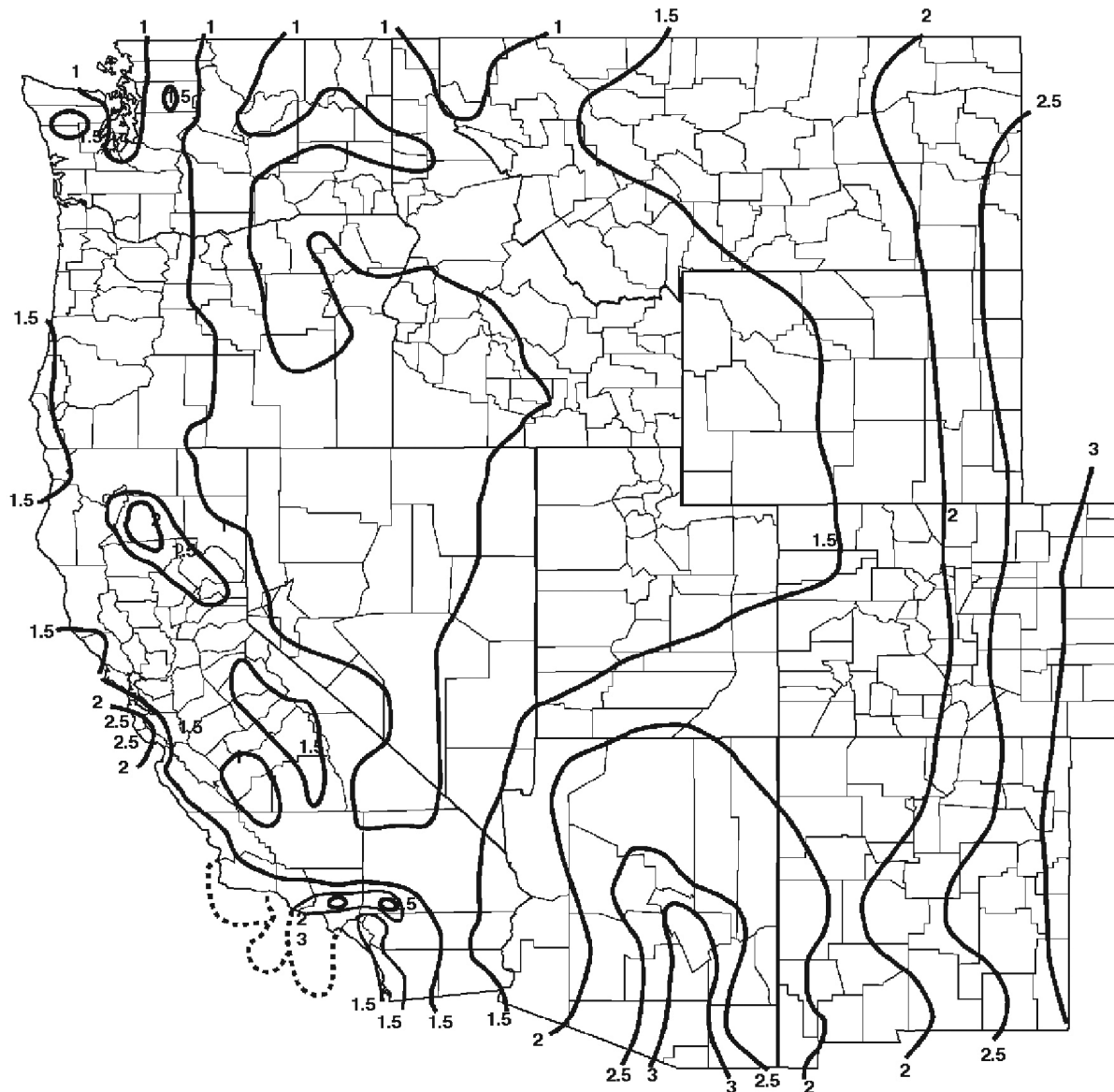
**TABLE 1610.1  
LATERAL SOIL LOAD**

DESCRIPTION OF BACKFILL MATERIAL <sup>c</sup>	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD <sup>a</sup> (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravelly sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

- Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.
- Unsuitable as backfill material.
- The definition and classification of soil materials shall be in accordance with ASTM D2487.



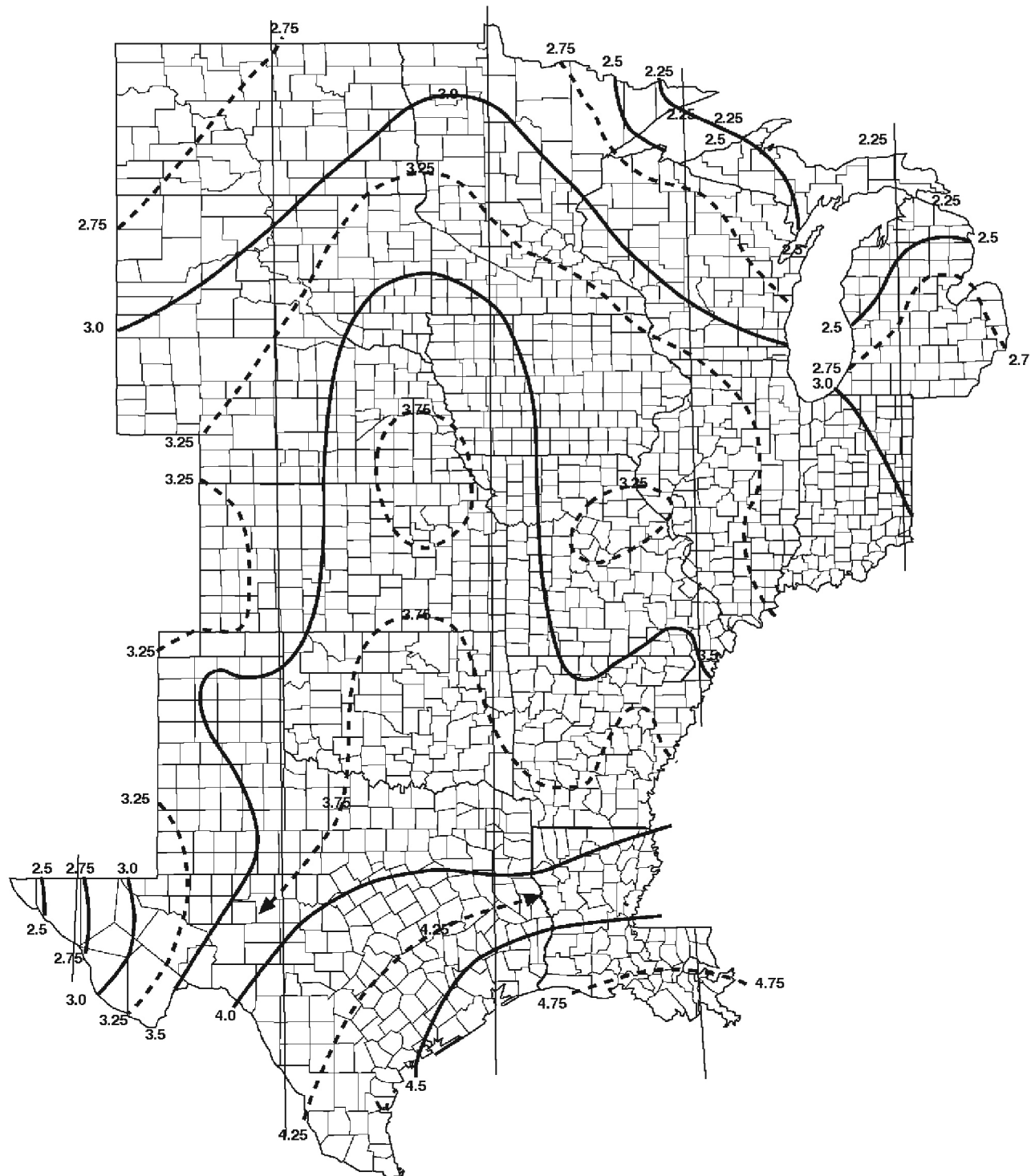


For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

**FIGURE 1611.1(1)**  
**100-YEAR, 1-HOUR RAINFALL (INCHES) WESTERN UNITED STATES**

## STRUCTURAL DESIGN



For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

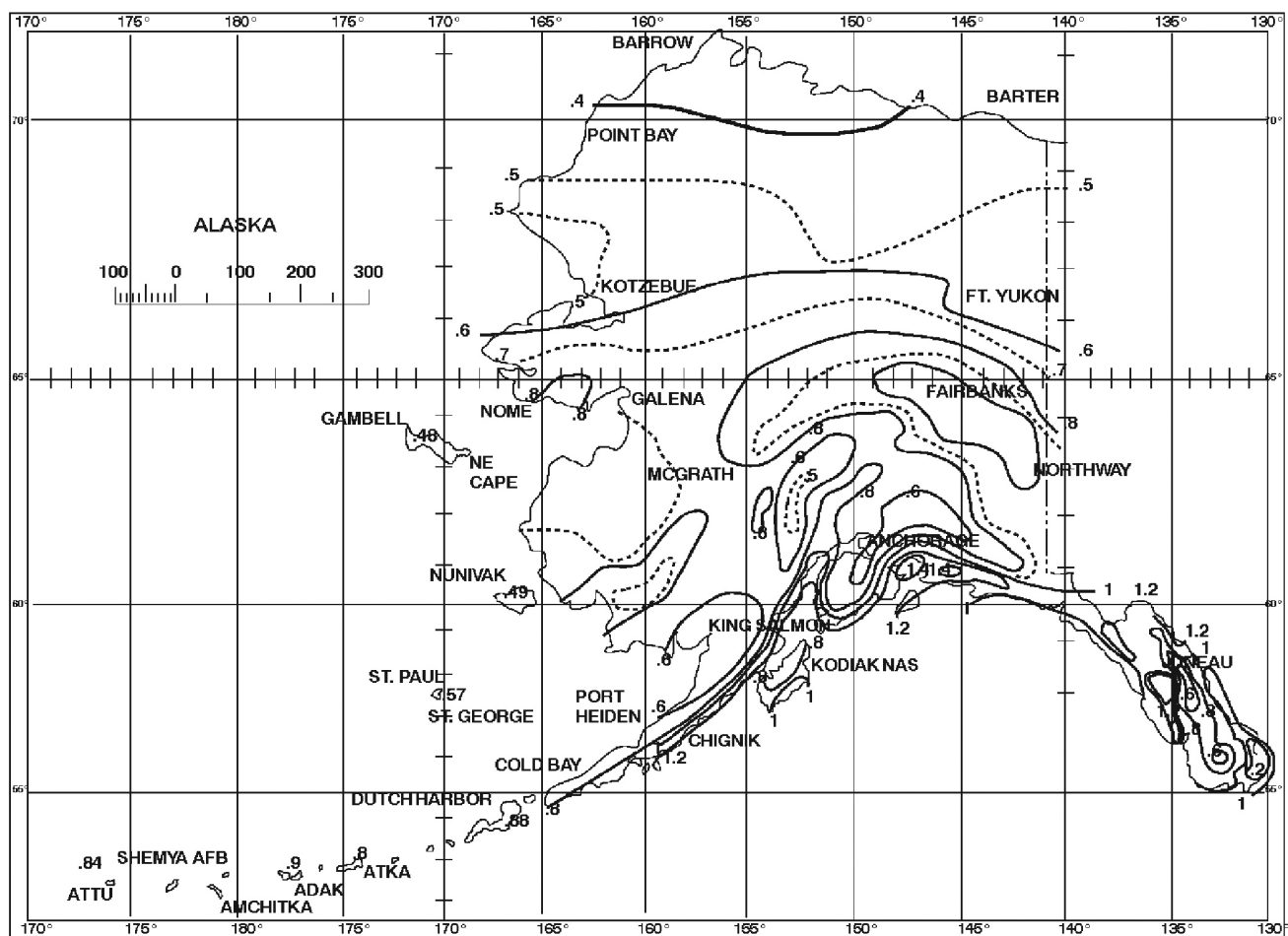
**FIGURE 1611.1(2)**  
**100-YEAR, 1-HOUR RAINFALL (INCHES) CENTRAL UNITED STATES**



For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

**FIGURE 1611.1(3)**  
**100-YEAR, 1-HOUR RAINFALL (INCHES) EASTERN UNITED STATES**

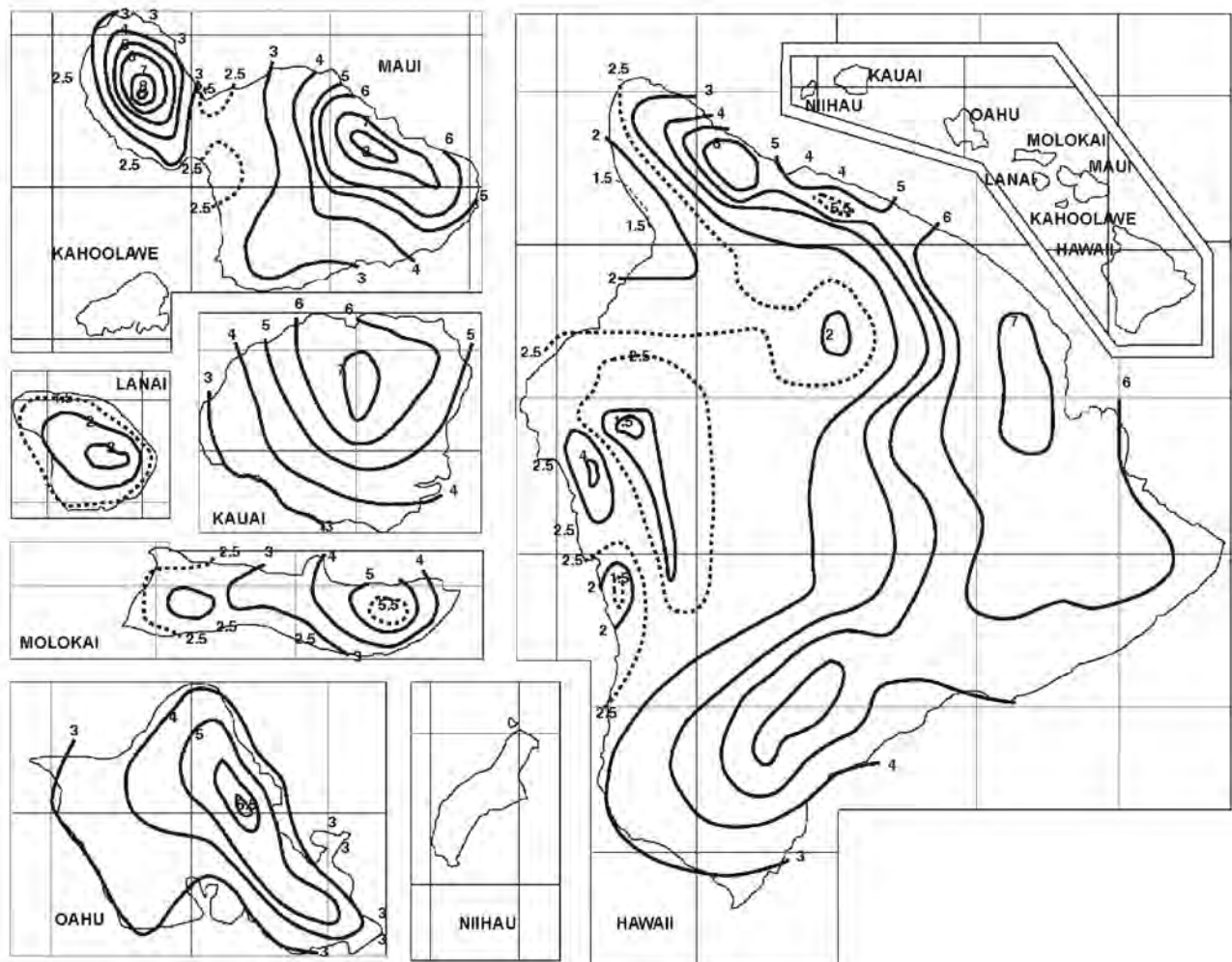


For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

**FIGURE 1611.1(4)**  
**100-YEAR, 1-HOUR RAINFALL (INCHES) ALASKA**





For SI: 1 inch = 25.4 mm.

Source: National Weather Service, National Oceanic and Atmospheric Administration, Washington, DC.

**FIGURE 1611.1(5)**  
**100-YEAR, 1-HOUR RAINFALL (INCHES) HAWAII**

## STRUCTURAL DESIGN

**1612.3.1 Design flood elevations.** Where *design flood elevations* are not included in the *flood hazard areas* established in Section 1612.3, or where *floodways* are not designated, the *building official* is authorized to require the applicant to do one of the following:

1. Obtain and reasonably utilize any *design flood elevation* and *floodway* data available from a federal, state or other source.
2. Determine the *design flood elevation* or *floodway* in accordance with accepted hydrologic and hydraulic engineering practices used to define special *flood hazard areas*. Determinations shall be undertaken by a *registered design professional* who shall document that the technical methods used reflect currently accepted engineering practice.

**1612.3.2 Determination of impacts.** In riverine *flood hazard areas* where *design flood elevations* are specified but *floodways* have not been designated, the applicant shall provide a *floodway* analysis that demonstrates that the proposed work will not increase the *design flood elevation* more than 1 foot (305 mm) at any point within the jurisdiction of the applicable governing authority.

**1612.4 Flood hazard documentation.** The following documentation shall be prepared and sealed by a *registered design professional* and submitted to the *building official*:

1. For construction in *flood hazard areas* other than *coastal high hazard areas* or *coastal A zones*:
  - 1.1. The elevation of the *lowest floor*, including the basement, as required by the lowest floor elevation inspection in Section 110.3.3 and for the final inspection in Section 110.3.12.1.
  - 1.2. For fully enclosed areas below the *design flood elevation* where provisions to allow for the automatic entry and exit of floodwaters do not meet the minimum requirements in Section 2.7.2.1 of ASCE 24, *construction documents* shall include a statement that the design will provide for equalization of hydrostatic flood forces in accordance with Section 2.7.2.2 of ASCE 24.
  - 1.3. For *dry floodproofed* nonresidential buildings, *construction documents* shall include a statement that the *dry floodproofing* is designed in accordance with ASCE 24 and shall include the flood emergency plan specified in Chapter 6 of ASCE 24.
2. For construction in *coastal high hazard areas* and *coastal A zones*:
  - 2.1. The elevation of the bottom of the lowest horizontal structural member as required by the *lowest floor* elevation inspection in Section 110.3.3 and for the final inspection in Section 110.3.12.1.
  - 2.2. *Construction documents* shall include a statement that the building is designed in accordance with ASCE 24, including that

the pile or column foundation and building or structure to be attached thereto is designed to be anchored to resist flotation, collapse and lateral movement due to the effects of wind and *flood loads* acting simultaneously on all building components, and other *load* requirements of Chapter 16.

- 2.3. For breakaway walls designed to have a resistance of more than 20 psf (0.96 kN/m<sup>2</sup>) determined using *allowable stress design*, *construction documents* shall include a statement that the breakaway wall is designed in accordance with ASCE 24.
- 2.4. For breakaway walls where provisions to allow for the automatic entry and exit of floodwaters do not meet the minimum requirements in Section 2.7.2.1 of ASCE 24, *construction documents* shall include a statement that the design will provide for equalization of hydrostatic flood forces in accordance with Section 2.7.2.2 of ASCE 24.

## SECTION 1613 EARTHQUAKE LOADS

**1613.1 Scope.** Every structure, and portion thereof, including nonstructural components that are permanently attached to structures and their supports and attachments, shall be designed and constructed to resist the effects of earthquake motions in accordance with Chapters 11, 12, 13, 15, 17 and 18 of ASCE 7, as applicable. The *seismic design category* for a structure is permitted to be determined in accordance with Section 1613 or ASCE 7.

### Exceptions:

1. Detached one- and two-family dwellings, assigned to *Seismic Design Category* A, B or C, or located where the mapped short-period spectral response acceleration,  $S_s$ , is less than 0.4 g.
2. The *seismic force-resisting system* of wood-frame buildings that conform to the provisions of Section 2308 are not required to be analyzed as specified in this section.
3. Agricultural storage structures intended only for incidental human occupancy.
4. Structures that require special consideration of their response characteristics and environment that are not addressed by this code or ASCE 7 and for which other regulations provide seismic criteria, such as vehicular bridges, electrical transmission towers, hydraulic structures, buried utility lines and their appurtenances and nuclear reactors.
5. References within ASCE 7 to Chapter 14 shall not apply, except as specifically required herein.
6. Buildings and structures complying with Arkansas Code Annotated 12-80-104 (a) (2).

**1613.2 Seismic ground motion values.** Seismic ground motion values shall be determined in accordance with this section.

**1613.2.1 Mapped acceleration parameters.** The parameters  $S_s$  and  $S_1$  shall be determined from the 0.2 and 1-second spectral response accelerations shown on Figures 1613.2.1(1) through 1613.2.1(10). Where  $S_1$  is less than or equal to 0.04 and  $S_s$  is less than or equal to 0.15, the structure is permitted to be assigned *Seismic Design Category A*.

**1613.2.2 Site class definitions.** Based on the site soil properties, the site shall be classified as *Site Class A, B, C, D, E or F* in accordance with Chapter 20 of ASCE 7.

Where the soil properties are not known in sufficient detail to determine the site class, *Site Class D*, subjected to the requirements of Section 1613.2.3, shall be used unless the *building official* or geotechnical data determines that *Site Class E or F* soils are present at the site.

Where site investigations that are performed in accordance with Chapter 20 of ASCE 7 reveal rock conditions consistent with *Site Class B*, but site-specific velocity measurements are not made, the *site coefficients*  $F_a$  and  $F_v$  shall be taken at unity (1.0).

**1613.2.3 Site coefficients and adjusted maximum considered earthquake spectral response acceleration parameters.** The maximum considered earthquake spectral response acceleration for short periods,  $S_{MS}$ , and at 1-second period,  $S_{M1}$ , adjusted for site class effects shall be determined by Equations 16-20 and 16-21, respectively:

$$S_{MS} = F_a S_s \quad (\text{Equation 16-20})$$

$$S_{M1} = F_v S_1 \quad (\text{Equation 16-21})$$

but  $S_{MS}$  shall not be taken less than  $S_{M1}$  except when determining the seismic design category in accordance with Section 1613.2.5.

where:

$F_a$  = Site coefficient defined in Table 1613.2.3(1).

$F_v$  = Site coefficient defined in Table 1613.2.3(2).

$S_s$  = The mapped spectral accelerations for short periods as determined in Section 1613.2.1.

$S_1$  = The mapped spectral accelerations for a 1-second period as determined in Section 1613.2.1.

Where *Site Class D* is selected as the default site class per Section 1613.2.2, the value of  $F_a$  shall be not less than 1.2. Where the simplified design procedure of ASCE 7 Section 12.14 is used, the value of  $F_a$  shall be determined in accordance with ASCE 7 Section 12.14.8.1, and the values of  $F_v$ ,  $S_{MS}$  and  $S_{M1}$  need not be determined.

**1613.2.4 Design spectral response acceleration parameters.** Five-percent damped design spectral response acceleration at short periods,  $S_{DS}$ , and at 1-second period,  $S_{D1}$ , shall be determined from Equations 16-22 and Equation 16-23, respectively:

$$S_{DS} = \frac{2}{3} S_{MS} \quad (\text{Equation 16-22})$$

$$S_{D1} = \frac{2}{3} S_{M1} \quad (\text{Equation 16-23})$$

where:

$S_{MS}$  = The maximum considered earthquake spectral response accelerations for short period as determined in Section 1613.2.3.

$S_{M1}$  = The maximum considered earthquake spectral response accelerations for 1-second period as determined in Section 1613.2.3.

**1613.2.5 Determination of seismic design category.** Structures classified as *Risk Category I, II or III* that are located where the mapped spectral response acceleration parameter at 1-second period,  $S_1$ , is greater than or equal to 0.75 shall be assigned to *Seismic Design Category E*. Structures classified as *Risk Category IV* that are located where the mapped spectral response acceleration parameter at 1-second period,  $S_1$ , is greater than or equal to 0.75 shall be assigned to *Seismic Design Category F*. Other structures shall be assigned to a *seismic design category* based on their *risk category* and the design spectral response acceleration parameters,  $S_{DS}$  and  $S_{D1}$ , determined in accordance with Section 1613.2.4 or the site-specific procedures of ASCE 7. Each building and structure shall be assigned to the more severe *seismic design category* in accordance with Table 1613.2.5(1) or 1613.2.5(2), irrespective of the fundamental period of vibration of the structure,  $T$ .

**1613.2.5.1 Alternative seismic design category determination.** Where  $S_1$  is less than 0.75, the *seismic design category* is permitted to be determined from Table 1613.2.5(1) alone where all of the following apply:

1. In each of the two *orthogonal* directions, the approximate fundamental period of the structure,  $T_a$ , in each of the two *orthogonal* directions determined in accordance with Section 12.8.2.1 of ASCE 7, is less than  $0.8 T_s$  determined in accordance with Section 11.8.6 of ASCE 7.
2. In each of the two *orthogonal* directions, the fundamental period of the structure used to calculate the *story drift* is less than  $T_s$ .
3. Equation 12.8-2 of ASCE 7 is used to determine the seismic response coefficient,  $C_s$ .
4. The *diaphragms* are rigid or are permitted to be idealized as rigid in accordance with Section 12.3.1 of ASCE 7 or, for *diaphragms* permitted to be idealized as flexible in accordance with Section 12.3.1 of ASCE 7, the distances between vertical elements of the *seismic force-resisting system* do not exceed 40 feet (12 192 mm).

**1613.2.5.2 Simplified design procedure.** Where the alternate simplified design procedure of ASCE 7 is used, the *seismic design category* shall be determined in accordance with ASCE 7.

## STRUCTURAL DESIGN

**TABLE 1613.2.3(1)**  
**VALUES OF SITE COEFFICIENT  $F_a^a$**

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE <sub>E</sub> ) SPECTRAL RESPONSE ACCELERATION PARAMETER AT SHORT PERIOD					
	$S_s \leq 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s = 1.25$	$S_s \geq 1.5$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.9	0.9	0.9	0.9	0.9	0.9
C	1.3	1.3	1.2	1.2	1.2	1.2
D	1.6	1.4	1.2	1.1	1.0	1.0
E	2.4	1.7	1.3	Note b	Note b	Note b
F	Note b	Note b	Note b	Note b	Note b	Note b

- a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at short period,  $S_s$ .  
b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.

**TABLE 1613.2.3(2)**  
**VALUES OF SITE COEFFICIENT  $F_v^a$**

SITE CLASS	MAPPED RISK TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE <sub>E</sub> ) SPECTRAL RESPONSE ACCELERATION PARAMETER AT 1-SECOND PERIOD					
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 = 0.5$	$S_1 \geq 0.6$
A	0.8	0.8	0.8	0.8	0.8	0.8
B	0.8	0.8	0.8	0.8	0.8	0.8
C	1.5	1.5	1.5	1.5	1.5	1.4
D	2.4	2.2 <sup>c</sup>	2.0 <sup>c</sup>	1.9 <sup>c</sup>	1.8 <sup>c</sup>	1.7 <sup>c</sup>
E	4.2	3.3 <sup>c</sup>	2.8 <sup>c</sup>	2.4 <sup>c</sup>	2.2 <sup>c</sup>	2.0 <sup>c</sup>
F	Note b	Note b	Note b	Note b	Note b	Note b

- a. Use straight-line interpolation for intermediate values of mapped spectral response acceleration at 1-second period,  $S_1$ .  
b. Values shall be determined in accordance with Section 11.4.8 of ASCE 7.  
c. See requirements for site-specific ground motions in Section 11.4.8 of ASCE 7.

**TABLE 1613.2.5(1)**  
**SEISMIC DESIGN CATEGORY BASED ON SHORT-PERIOD (0.2 second) RESPONSE ACCELERATION**

VALUE OF $S_{DS}$	RISK CATEGORY		
	I or II	III	IV
$S_{DS} < 0.167g$	A	A	A
$0.167g \leq S_{DS} < 0.33g$	B	B	C
$0.33g \leq S_{DS} < 0.50g$	C	C	D
$0.50g \leq S_{DS}$	D	D	D

**TABLE 1613.2.5(2)**  
**SEISMIC DESIGN CATEGORY BASED ON 1-SECOND PERIOD RESPONSE ACCELERATION**

VALUE OF $S_{D1}$	RISK CATEGORY		
	I or II	III	IV
$S_{D1} < 0.067g$	A	A	A
$0.067g \leq S_{D1} < 0.133g$	B	B	C
$0.133g \leq S_{D1} < 0.20g$	C	C	D
$0.20g \leq S_{D1}$	D	D	D



**1613.3 Ballasted photovoltaic panel systems.** Ballasted, roof-mounted *photovoltaic panel systems* need not be rigidly attached to the roof or supporting structure. Ballasted nonpenetrating systems shall be designed and installed only on roofs with slopes not more than one unit vertical in 12 units horizontal. Ballasted nonpenetrating systems shall be designed to resist sliding and uplift resulting from lateral and vertical forces as required by Section 1605, using a coefficient of friction determined by acceptable engineering principles. In structures assigned to *Seismic Design Category C, D, E or F*, ballasted nonpenetrating systems shall be designed to accommodate seismic displacement determined by nonlinear response-history or other *approved* analysis or shake-table testing, using input motions consistent with ASCE 7 lateral and vertical seismic forces for nonstructural components on roofs.

## SECTION 1614 ATMOSPHERIC ICE LOADS

**1614.1 General.** *Ice-sensitive structures* shall be designed for atmospheric ice loads in accordance with Chapter 10 of ASCE 7.

## SECTION 1615 TSUNAMI LOADS

**1615.1 General.** The design and construction of *Risk Category III and IV buildings and structures* located in the *Tsunami Design Zones* defined in the *Tsunami Design Geodatabase* shall be in accordance with Chapter 6 of ASCE 7, except as modified by this code.

## SECTION 1616 STRUCTURAL INTEGRITY

**1616.1 General.** *High-rise buildings* that are assigned to *Risk Category III or IV* shall comply with the requirements of Section 1616.2 if they are frame structures, or Section 1616.3 if they are *bearing wall structures*.

**1616.2 Frame structures.** *Frame structures* shall comply with the requirements of this section.

**1616.2.1 Concrete frame structures.** *Frame structures* constructed primarily of reinforced or prestressed concrete, either cast-in-place or precast, or a combination of these, shall conform to the requirements of Section 4.10 of ACI 318. Where ACI 318 requires that nonprestressed reinforcing or prestressing steel pass through the region bounded by the longitudinal column reinforcement, that reinforcing or prestressing steel shall have a minimum nominal tensile strength equal to two-thirds of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

**Exception:** Where concrete slabs with continuous reinforcement having an area not less than 0.0015 times the concrete area in each of two *orthogonal*

directions are present and are either monolithic with or equivalently bonded to beams, girders or columns, the longitudinal reinforcing or prestressing steel passing through the column reinforcement shall have a nominal tensile strength of one-third of the required one-way vertical strength of the connection of the floor or roof system to the column in each direction of beam or slab reinforcement passing through the column.

**1616.2.2 Structural steel, open web steel joist or joist girder, or composite steel and concrete frame structures.** *Frame structures* constructed with a structural steel frame or a frame composed of open web *steel joists*, joist girders with or without other *structural steel elements* or a frame composed of composite steel or composite *steel joists* and reinforced concrete elements shall conform to the requirements of this section.

**1616.2.2.1 Columns.** Each column splice shall have the minimum *design strength* in tension to transfer the design dead and *live load* tributary to the column between the splice and the splice or base immediately below.

**1616.2.2.2 Beams.** End connections of all beams and girders shall have a minimum nominal axial tensile strength equal to the required vertical shear strength for *allowable stress design* (ASD) or two-thirds of the required shear strength for *load and resistance factor design* (LRFD) but not less than 10 kips (45 kN). For the purpose of this section, the shear force and the axial tensile force need not be considered to act simultaneously.

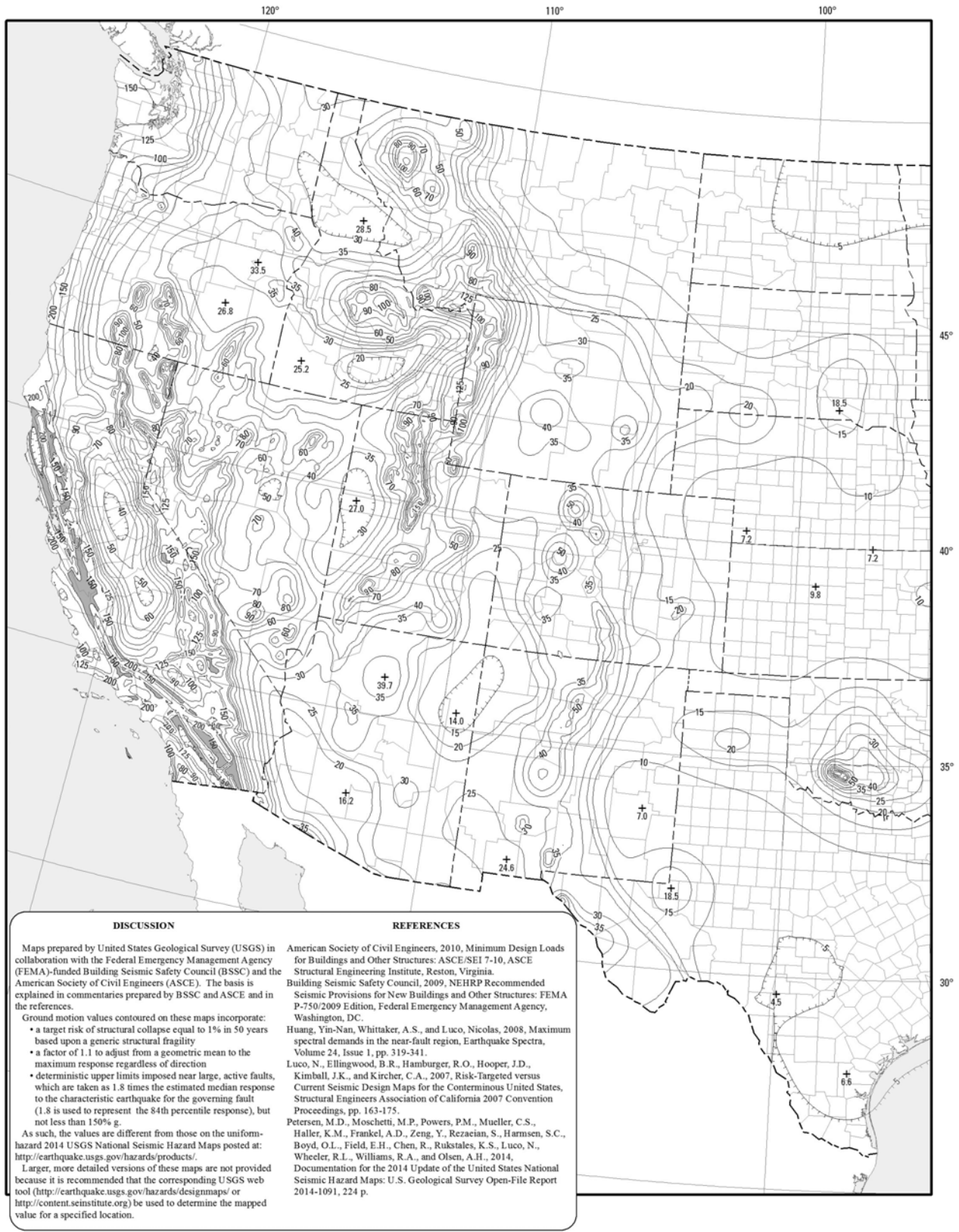
**Exception:** Where beams, girders, open web joist and joist girders support a concrete slab or concrete slab on metal deck that is attached to the beam or girder with not less than 3/8-inch-diameter (9.5 mm) headed shear studs, at a spacing of not more than 12 inches (305 mm) on center, averaged over the length of the member, or other attachment having equivalent shear strength, and the slab contains continuous distributed reinforcement in each of two *orthogonal* directions with an area not less than 0.0015 times the concrete area, the nominal axial tension strength of the end connection shall be permitted to be taken as half the required vertical shear strength for ASD or one-third of the required shear strength for LRFD, but not less than 10 kips (45 kN).

**1616.3 Bearing wall structures.** *Bearing wall structures* shall have vertical ties in all *load-bearing walls* and longitudinal ties, transverse ties and perimeter ties at each floor level in accordance with this section and as shown in Figure 1616.3.

**1616.3.1 Concrete wall structures.** Precast *bearing wall structures* constructed solely of reinforced or prestressed concrete, or combinations of these shall conform to the requirements of Sections 16.2.4 and 16.2.5 of ACI 318.

**1616.3.2 Other bearing wall structures.** Ties in *bearing wall structures* other than those covered in Section 1616.3.1 shall conform to this section.

STRUCTURAL DESIGN



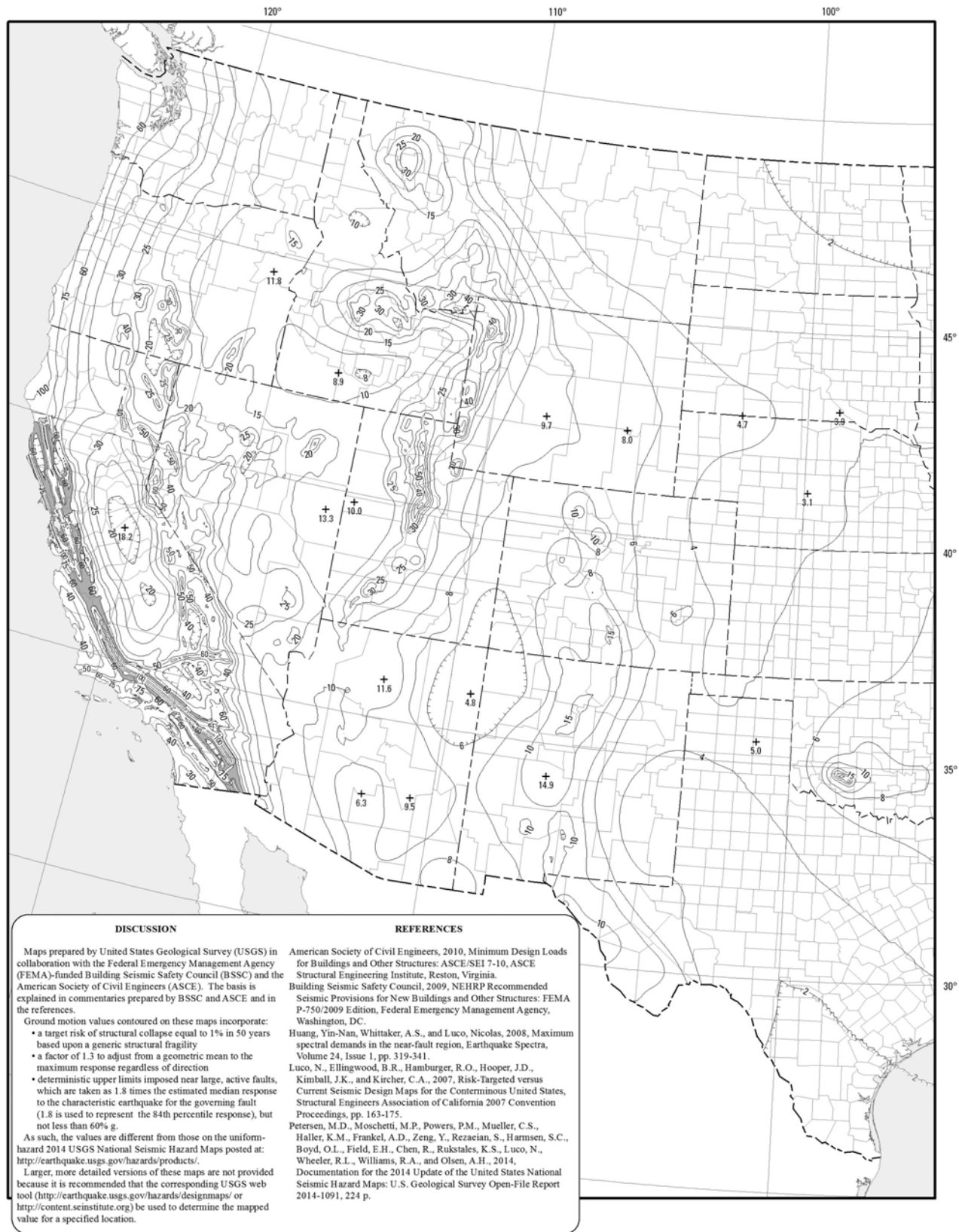
**FIGURE 1613.2.1(1)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS FOR THE**  
**CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)**





**FIGURE 1613.2.1(2)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS FOR THE**  
**CONTERMINOUS UNITED STATES OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)**

## STRUCTURAL DESIGN



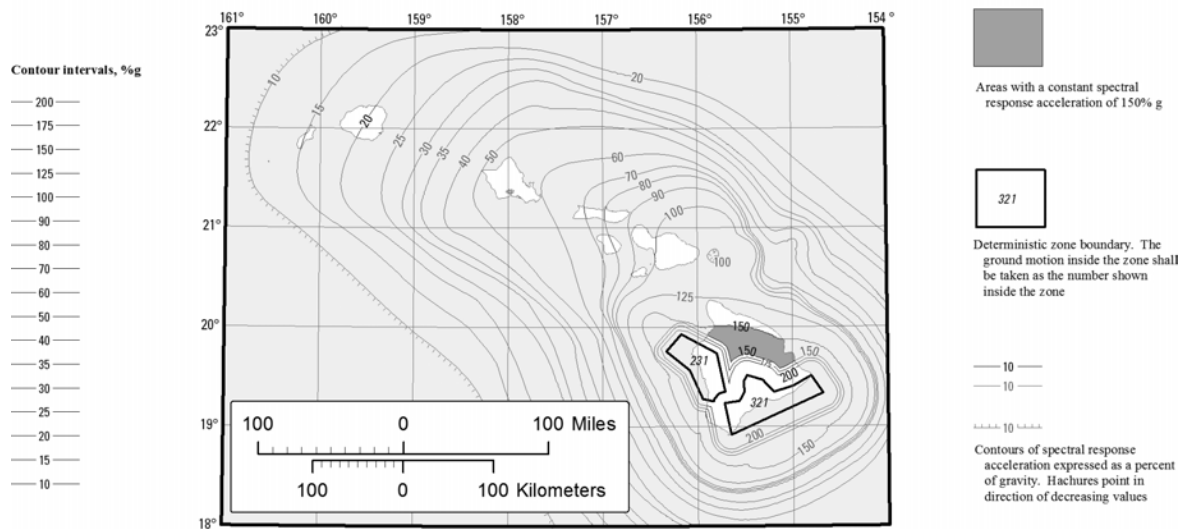
**FIGURE 1613.2.1(3)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS FOR THE CONTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)**



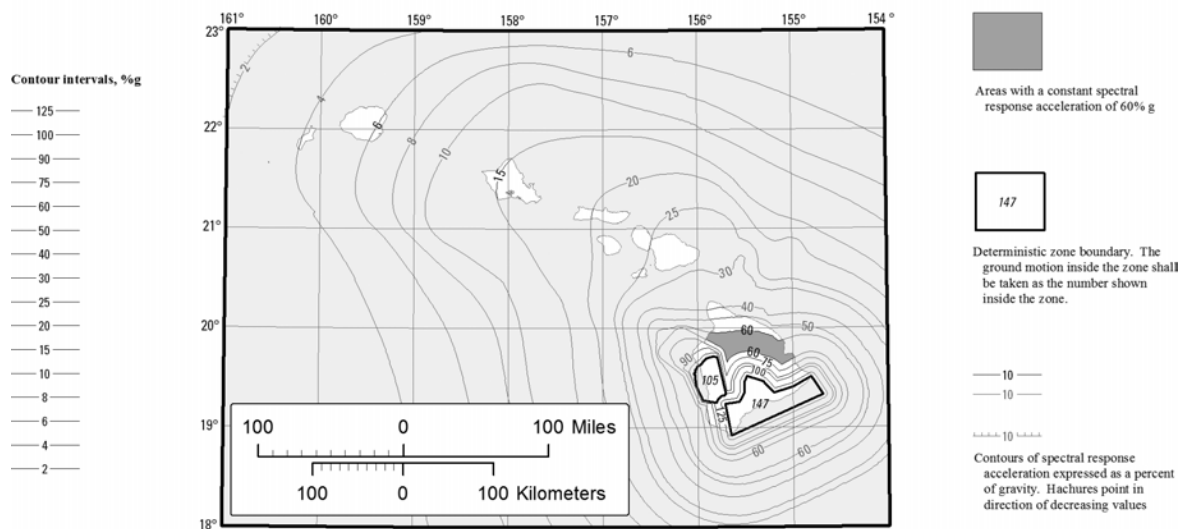


**FIGURE 1613.2.1(4)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS FOR THE**  
**COTERMINOUS UNITED STATES OF 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)**

## STRUCTURAL DESIGN



0.2 Second Spectral Response Acceleration (5% of Critical Damping)



1.0 Second Spectral Response Acceleration (5% of Critical Damping)

## DISCUSSION

Maps prepared by United States Geological Survey (USGS) in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council (BSSC) and the American Society of Civil Engineers (ASCE). The basis is explained in commentaries prepared by BSSC and ASCE and in the references.

Ground motion values contoured on these maps incorporate:

- a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility
- deterministic upper limits imposed near large, active faults, which are taken as 1.8 times the estimated median response to the characteristic earthquake for the fault (1.8 is used to represent the 84th percentile response), but not less than 150% and 60% g for 0.2 and 1.0 sec, respectively.

As such, the values are different from those on the uniform-hazard 1998 USGS National Seismic Hazard Maps for Hawaii posted at <http://earthquake.usgs.gov/hazmaps>.

Larger, more detailed versions of these maps are not provided because it is recommended that the corresponding USGS web tool (<http://earthquake.usgs.gov/designmaps> or <http://content.seisintstitute.org>) be used to determine the mapped value for a specified location.

## REFERENCES

- Building Seismic Safety Council, 2009, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures: FEMA P-750/2009 Edition, Federal Emergency Management Agency, Washington, DC.
- Huang, Yin-Nan, Whittaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, *Earthquake Spectra*, Volume 24, Issue 1, pp. 319-341.
- Klein, F., Frankel, A.D., Mueller, C.S., Wesson, R.L., and Okubo, P., 2001, Seismic hazard in Hawaii: high rate of large earthquakes and probabilistic ground-motion maps, *Bulletin of the Seismological Society of America*, Volume 91, pp. 479-498.
- Luco, Nicolas, Ellingwood, B.R., Hamburger, R.O., Hooper, J.D., Kimball, J.K., and Kircher, C.A., 2007, Risk-Targeted versus Current Seismic Design Maps for the Conterminous United States, *Structural Engineers Association of California 2007 Convention Proceedings*, pp. 163-175.

FIGURE 1613.2.1(5)  
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_E$ ) GROUND MOTION RESPONSE ACCELERATIONS  
FOR HAWAII OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)

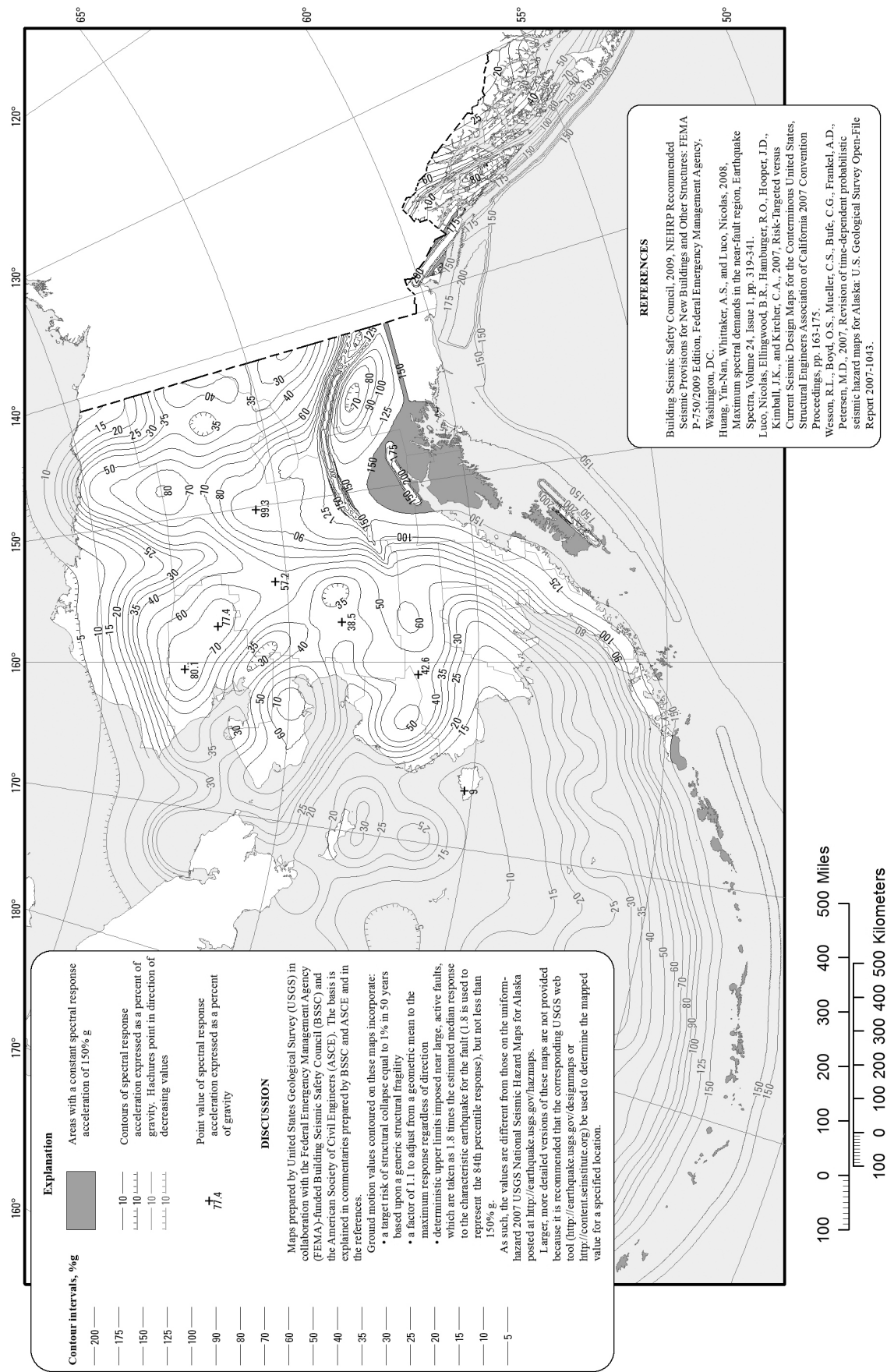


FIGURE 1613.2.1(6)  
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE (MCE<sub>r</sub>) GROUND MOTION RESPONSE ACCELERATIONS  
FOR ALASKA OF 0.2-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)



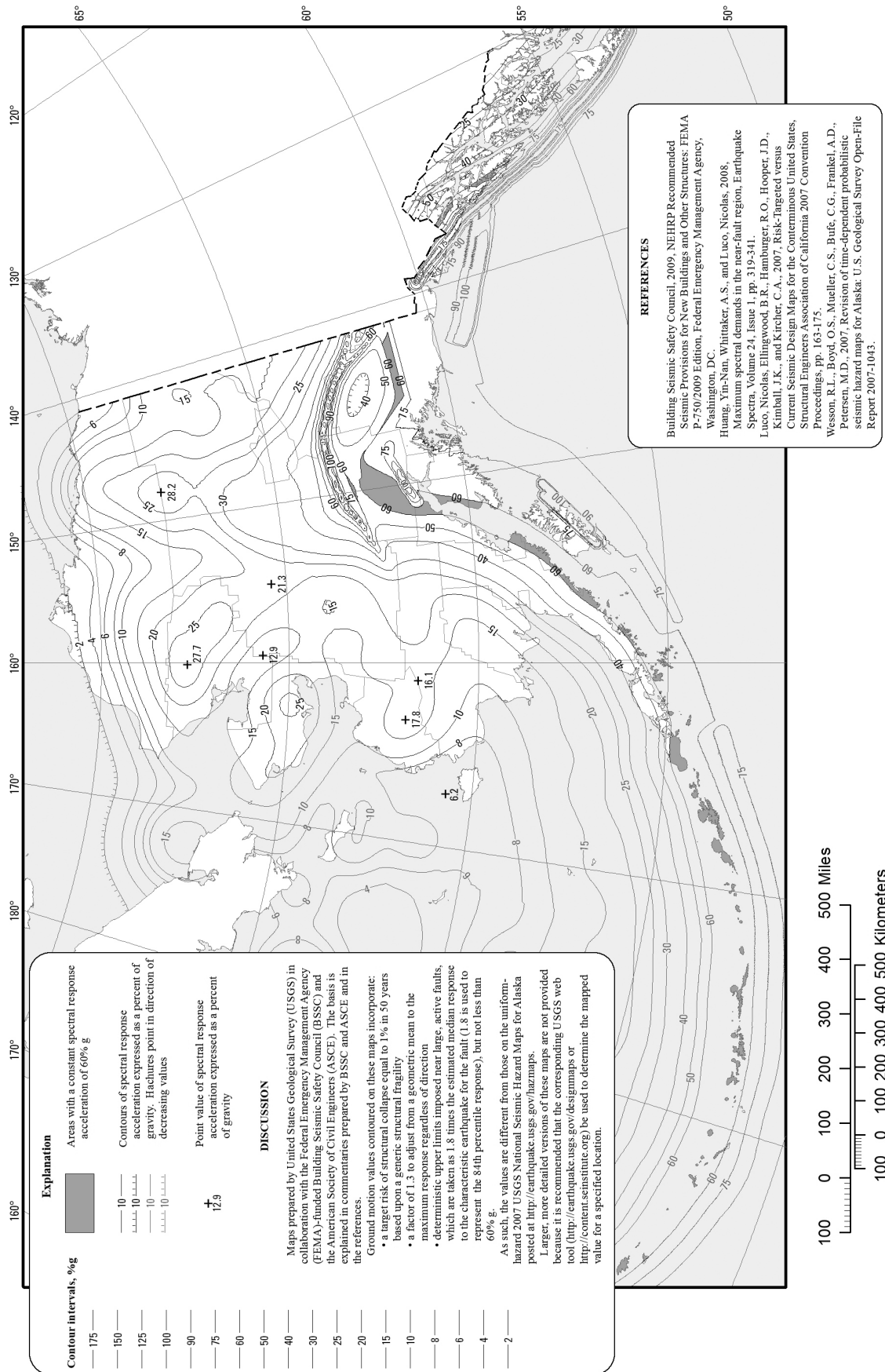
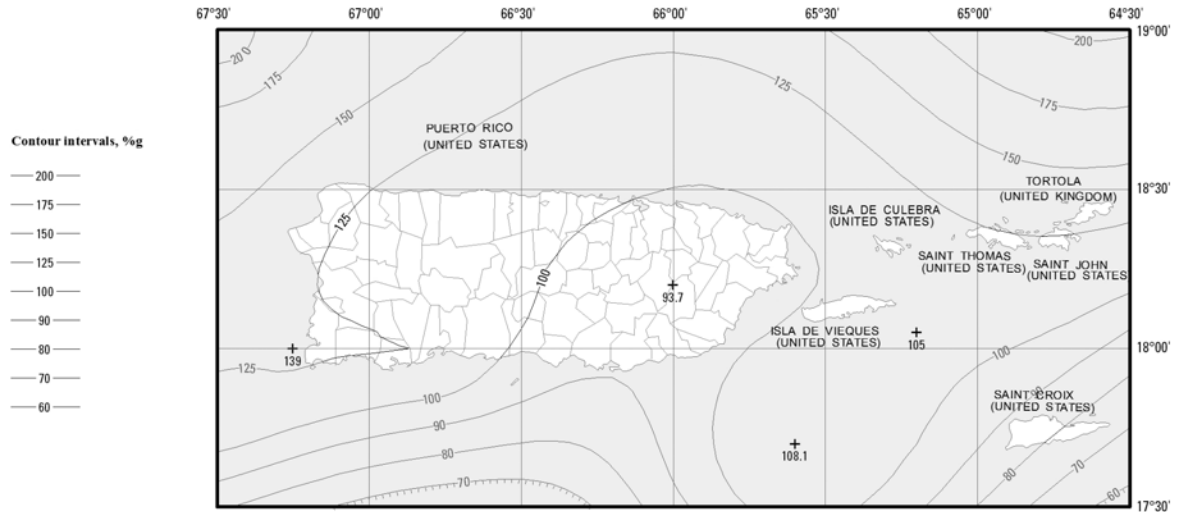
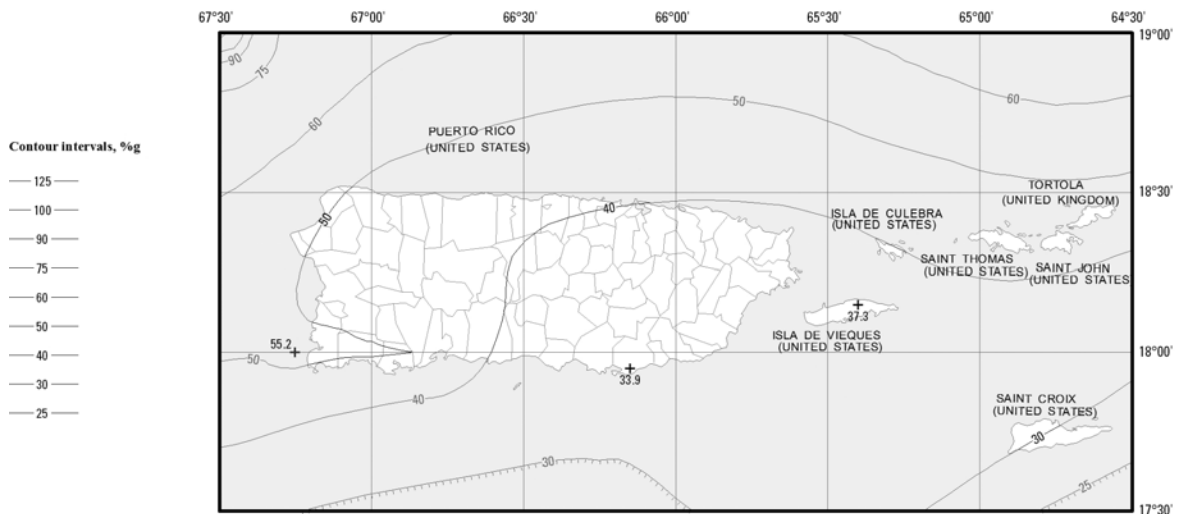


FIGURE 1613.2.1(7)  
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_E$ ) GROUND MOTION RESPONSE ACCELERATIONS  
FOR ALASKA OF 1.0-SECOND SPECTRAL RESPONSE ACCELERATION (5% OF CRITICAL DAMPING)

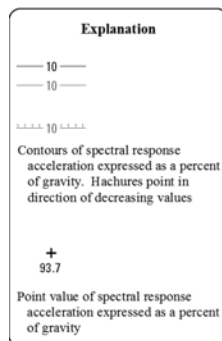




0.2 Second Spectral Response Acceleration (5% of Critical Damping)



1.0 Second Spectral Response Acceleration (5% of Critical Damping)



**DISCUSSION**

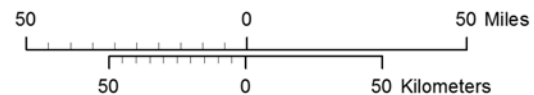
Maps prepared by United States Geological Survey (USGS) in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council (BSSC) and the American Society of Civil Engineers (ASCE). The basis is explained in commentaries prepared by BSSC and ASCE and in the references.

Ground motion values contoured on these maps incorporate:

- a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility
- a factor of 1.1 and 1.3 for 0.2 and 1.0 sec, respectively, to adjust from a geometric mean to the maximum response regardless of direction
- deterministic upper limits imposed near large, active faults, which are taken as 1.8 times the estimated median response to the characteristic earthquake for the fault (1.8 is used to represent the 84th percentile response), but not less than 150% and 60% g for 0.2 and 1.0 sec, respectively.

As such, the values are different from those on the uniform-hazard 2003 USGS National Seismic Hazard Maps for Puerto Rico and the U.S. Virgin Islands posted at <http://earthquake.usgs.gov/hazmaps>.

Larger, more detailed versions of these maps are not provided because it is recommended that the corresponding USGS web tool (<http://earthquake.usgs.gov/designmaps>) or <http://content.seisintstitute.org> be used to determine the mapped value for a specified location.



**REFERENCES**

Building Seismic Safety Council, 2009, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures: FEMA P-750/2009 Edition, Federal Emergency Management Agency, Washington, DC.

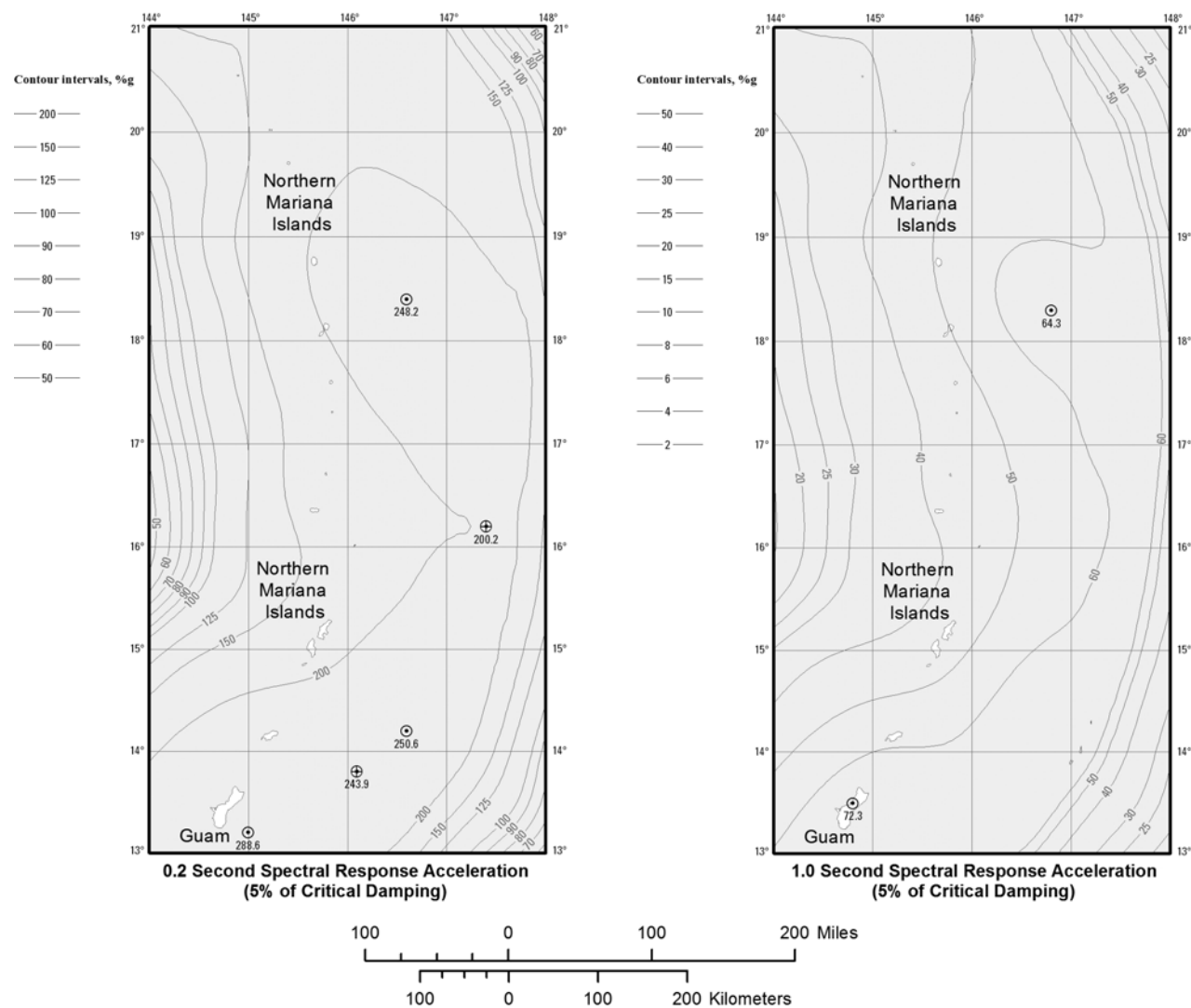
Huang, Yin-Nan, Whittaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, Earthquake Spectra, Volume 24, Issue 1, pp. 319-341.

Luco, Nicolas, Ellingwood, B.R., Hamburger, R.O., Hooper, J.D., Kimball, J.K., and Kircher, C.A., 2007, Risk-Targeted versus Current Seismic Design Maps for the Conterminous United States, Structural Engineers Association of California 2007 Convention Proceedings, pp. 163-175.

Mueller, C.S., Frankel, A.D., Petersen, M.D., and Leyendecker, E.V., 2003, Documentation for the 2003 USGS Seismic Hazard Maps for Puerto Rico and the U.S. Virgin Islands: U.S. Geological Survey Open-File Report 03-379.

**FIGURE 1613.2.1(8)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_r$ ) GROUND MOTION RESPONSE ACCELERATIONS**  
**FOR PUERTO RICO AND THE UNITED STATES VIRGIN ISLANDS OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION**  
**(5% OF CRITICAL DAMPING)**

STRUCTURAL DESIGN



**Explanation**

Contours of spectral response acceleration expressed as a percent of gravity.

— 10 —  
— 10 —

Point values of spectral response acceleration expressed as a percent of gravity.

⊕ Local minimum  
200.2  
⊙ Local maximum  
250.6  
⊕ Saddle point  
243.9

**DISCUSSION**

Maps prepared by United States Geological Survey (USGS) in collaboration with the Federal Emergency Management Agency (FEMA)-funded Building Seismic Safety Council (BSSC). The basis is explained in commentary prepared by BSSC and in the references.

Ground motion values contoured on these maps incorporate:

- a target risk of structural collapse equal to 1% in 50 years based upon a generic structural fragility
- a factor of 1.1 and 1.3 for 0.2 and 1.0 sec, respectively, to adjust from a geometric mean to the maximum response regardless of direction
- deterministic upper limits imposed near large, active faults, which are taken as 1.8 times the estimated median response to the characteristic earthquake for the fault (1.8 is used to represent the 84th percentile response), but not less than 150% and 60% g for 0.2 and 1.0 sec, respectively.

As such, the values are different from those on the uniform-hazard 2012 USGS National Seismic Hazard Maps for Guam and the Northern Mariana Islands posted at <http://earthquake.usgs.gov/hazmaps>.

Larger, more detailed versions of these maps are not provided because it is recommended that the corresponding USGS web tool (<http://earthquake.usgs.gov/designmaps>) be used to determine the mapped value for a specified location.

**REFERENCES**

Building Seismic Safety Council, 2009, NEHRP Recommended Seismic Provisions for New Buildings and Other Structures: FEMA P-750/2009 Edition, Federal Emergency Management Agency, Washington, DC.

Huang, Yin-Nan, Whittaker, A.S., and Luco, Nicolas, 2008, Maximum spectral demands in the near-fault region, Earthquake Spectra, Volume 24, Issue 1, pp. 319-341.

Luco, Nicolas, Ellingwood, B.R., Hamburger, R.O., Hooper, J.D., Kimball, J.K., and Kircher, C.A., 2007, Risk-Targeted versus Current Seismic Design Maps for the Conterminous United States, Structural Engineers Association of California 2007 Convention Proceedings, pp. 163-175.

Mueller, C.S., Haller, K.M., Luco, Nicolas, Petersen, M.D., and Frankel, A.D., 2012, Seismic Hazard Assessment for Guam and the Northern Mariana Islands: U.S. Geological Survey Open-File Report 2012-1015.

**FIGURE 1613.2.1(9)**  
**RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS**  
**FOR GUAM AND THE NORTHERN MARIANA ISLANDS OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION**  
**(5% OF CRITICAL DAMPING)**

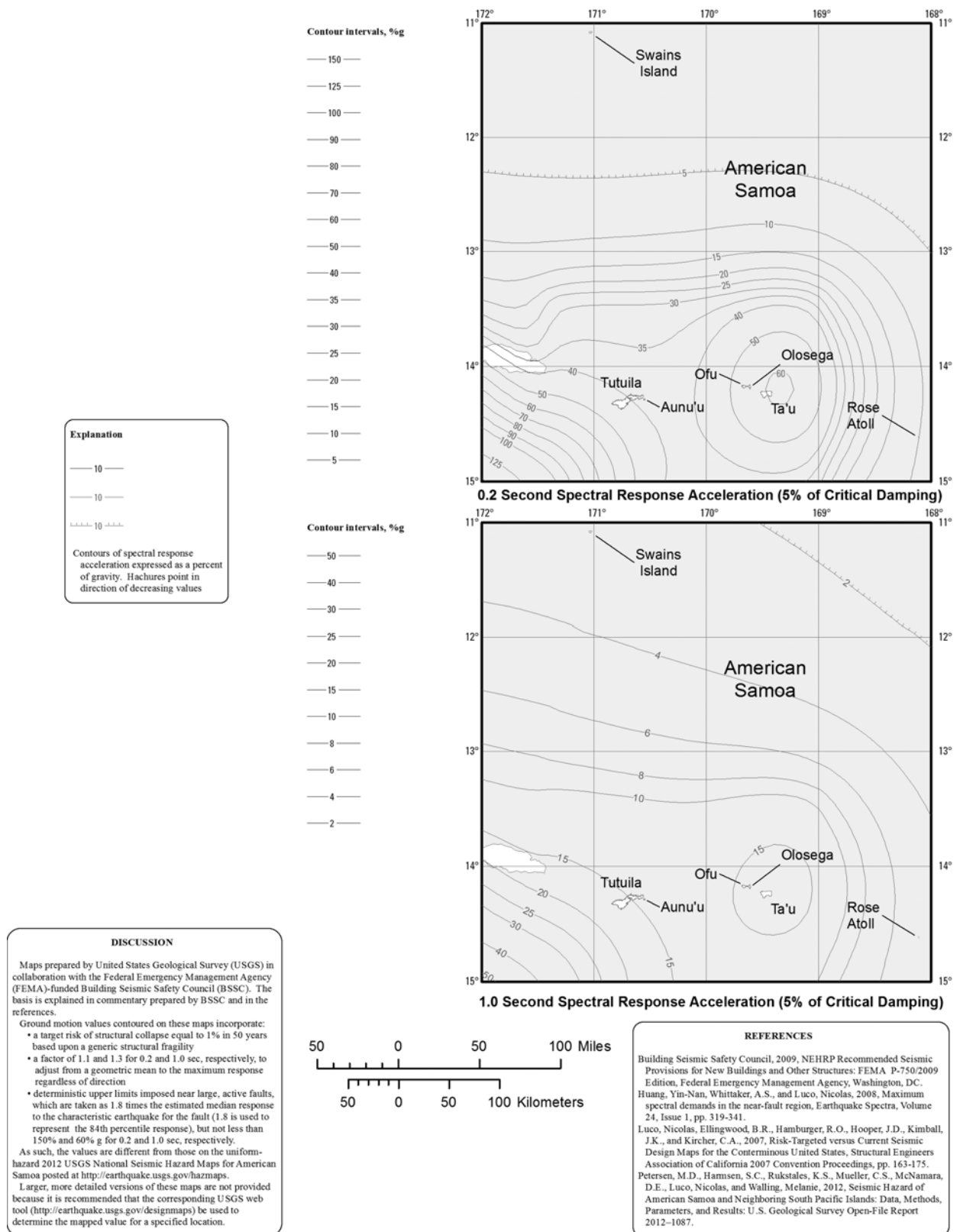
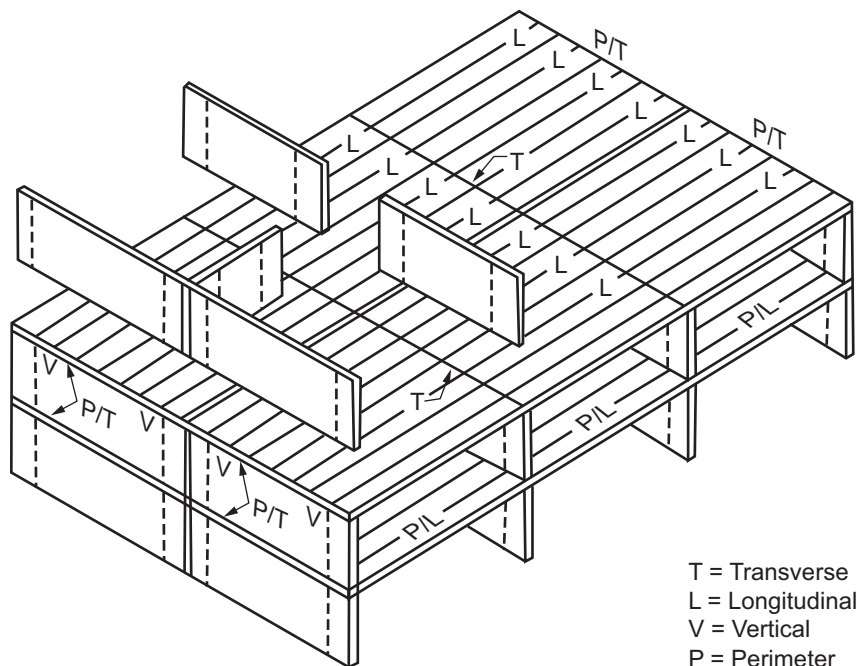


FIGURE 1613.2.1(10)  
RISK-TARGETED MAXIMUM CONSIDERED EARTHQUAKE ( $MCE_R$ ) GROUND MOTION RESPONSE ACCELERATIONS  
FOR AMERICAN SAMOA OF 0.2- AND 1-SECOND SPECTRAL RESPONSE ACCELERATION  
(5% OF CRITICAL DAMPING)



T = Transverse  
L = Longitudinal  
V = Vertical  
P = Perimeter

**FIGURE 1616.3**  
**LONGITUDINAL, PERIMETER, TRANSVERSE AND VERTICAL TIES**

**1616.3.2.1 Longitudinal ties.** Longitudinal ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Longitudinal ties shall extend across interior load-bearing walls and shall connect to exterior *load-bearing walls* and shall be spaced at not greater than 10 feet (3038 mm) on center. Ties shall have a minimum nominal tensile strength,  $T_r$ , given by Equation 16-24. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_r = wLS \leq \alpha_r S \quad (\text{Equation 16-24})$$

where:

$L$  = The span of the horizontal element in the direction of the tie, between bearing walls, feet (m).

$w$  = The weight per unit area of the floor or roof in the span being tied to or across the wall, psf ( $\text{N/m}^2$ ).

$S$  = The spacing between ties, feet (m).

$\alpha_r$  = A coefficient with a value of 1,500 pounds per foot (2.25 kN/m) for masonry *bearing wall structures* and a value of 375 pounds per foot (0.6 kN/m) for structures with bearing walls of cold-formed steel *light-frame construction*.

**1616.3.2.2 Transverse ties.** Transverse ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or

spliced members framing to, within or across walls; or connections of continuous framing members to walls. Transverse ties shall be placed not farther apart than the spacing of *load-bearing walls*. Transverse ties shall have minimum nominal tensile strength  $T_r$ , given by Equation 16-24. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

**1616.3.2.3 Perimeter ties.** Perimeter ties shall consist of continuous reinforcement in slabs; continuous or spliced decks or sheathing; continuous or spliced members framing to, within or across walls; or connections of continuous framing members to walls. Ties around the perimeter of each floor and roof shall be located within 4 feet (1219 mm) of the edge and shall provide a nominal strength in tension not less than  $T_p$ , given by Equation 16-25. For ASD the minimum nominal tensile strength shall be permitted to be taken as 1.5 times the allowable tensile stress times the area of the tie.

$$T_p = 200w \leq \beta_T \quad (\text{Equation 16-25})$$

$$\text{For SI: } T_p = 90.7w \leq \beta_T$$

where:

$w$  = As defined in Section 1616.3.2.1.

$\beta_T$  = A coefficient with a value of 16,000 pounds (7200 kN) for structures with masonry bearing walls and a value of 4,000 pounds (1300 kN) for structures with bearing walls of cold-formed steel *light-frame construction*.



**1616.3.2.4 Vertical ties.** Vertical ties shall consist of continuous or spliced reinforcing, continuous or spliced members, wall sheathing or other engineered systems. Vertical tension ties shall be provided in bearing walls and shall be continuous over the height of the building. The minimum nominal tensile strength for vertical ties within a bearing wall shall be equal to the weight of the wall within that *story* plus the weight of the *diaphragm* tributary to the wall in the *story* below. Not fewer than two ties shall be provided for each wall. The strength of each tie need not exceed 3,000 pounds per foot (450 kN/m) of wall tributary to the tie for walls of masonry construction or 750 pounds per foot (140 kN/m) of wall tributary to the tie for walls of cold-formed steel *light-frame construction*.



## CHAPTER 17

# SPECIAL INSPECTIONS AND TESTS

### User notes:

**About this chapter:** Chapter 17 provides a variety of procedures and criteria for testing materials and assemblies, and labeling materials and assemblies. Its key purposes are to establish where additional inspections/observations and testing must be provided, and the submittals and verifications that must be provided to the building official. This chapter expands on the inspections of Chapter 1 by requiring special inspection by a qualified individual where indicated and, in some cases, structural observation by a registered design professional. Quality assurance measures that verify proper assembly of structural components and the suitability of the installed materials are intended to provide a building that, once constructed, complies with the minimum structural and fire-resistance code requirements as well as the approved design. To determine this compliance often requires frequent inspections and testing at specific stages of construction.

**Code development reminder:** Code change proposals to sections preceded by the designation [BF] will be considered by the IBC—Fire Safety Code Development Committee during the 2021 (Group A) Code Development Cycle. Sections preceded by the designation [F] will be considered by the International Fire Code Development Committee during the 2021 (Group A) Code Development Cycle. All other code change proposals will be considered by the IBC—Structural Code Development Committee during the Group B cycle.

### SECTION 1701 GENERAL

**1701.1 Scope.** The provisions of this chapter shall govern the quality, workmanship and requirements for materials covered. Materials of construction and tests shall conform to the applicable standards listed in this code.

### SECTION 1702 NEW MATERIALS

**1702.1 General.** New building materials, equipment, appliances, systems or methods of construction not provided for in this code, and any material of questioned suitability proposed for use in the construction of a building or structure, shall be subjected to the tests prescribed in this chapter and in the approved rules to determine character, quality and limitations of use.

### SECTION 1703 APPROVALS

**1703.1 Approved agency.** An approved agency shall provide all information as necessary for the *building official* to determine that the agency meets the applicable requirements specified in Sections 1703.1.1 through 1703.1.3.

**1703.1.1 Independence.** An *approved agency* shall be objective, competent and independent from the contractor responsible for the work being inspected. The agency shall disclose to the *building official* and the *registered design professional in responsible charge* possible conflicts of interest so that objectivity can be confirmed.

**1703.1.2 Equipment.** An *approved agency* shall have adequate equipment to perform required tests. The equipment shall be periodically calibrated.

**1703.1.3 Personnel.** An *approved agency* shall employ experienced personnel educated in conducting, supervising and evaluating tests and *special inspections*.

**1703.2 Written approval.** Any material, appliance, equipment, system or method of construction meeting the requirements of this code shall be *approved* in writing after satisfactory completion of the required tests and submission of required test reports.

**1703.3 Record of approval.** For any material, appliance, equipment, system or method of construction that has been *approved*, a record of such approval, including the conditions and limitations of the approval, shall be kept on file in the *building official's* office and shall be available for public review at appropriate times.

**1703.4 Performance.** Specific information consisting of test reports conducted by an *approved agency* in accordance with the appropriate referenced standards, or other such information as necessary, shall be provided for the *building official* to determine that the product, material or assembly meets the applicable code requirements.

**1703.4.1 Research and investigation.** Sufficient technical data shall be submitted to the *building official* to substantiate the proposed use of any product, material or assembly. If it is determined that the evidence submitted is satisfactory proof of performance for the use intended, the *building official* shall approve the use of the product, material or assembly subject to the requirements of this code. The costs, reports and investigations required under these provisions shall be paid by the owner or the owner's authorized agent.

**1703.4.2 Research reports.** Supporting data, where necessary to assist in the approval of products, materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved* sources.

**1703.5 Labeling.** Products, materials or assemblies required to be *labeled* shall be *labeled* in accordance with the procedures set forth in Sections 1703.5.1 through 1703.5.4.

**1703.5.1 Testing.** An *approved agency* shall test a representative sample of the product, material or assembly being *labeled* to the relevant standard or standards. The *approved agency* shall maintain a record of the tests

## SPECIAL INSPECTIONS AND TESTS

performed. The record shall provide sufficient detail to verify compliance with the test standard.

**1703.5.2 Inspection and identification.** The *approved agency* shall periodically perform an inspection, which shall be in-plant if necessary, of the product or material that is to be *labeled*. The inspection shall verify that the labeled product, material or assembly is representative of the product, material or assembly tested.

**1703.5.3 Label information.** The *label* shall contain the manufacturer's identification, model number, serial number or definitive information describing the performance characteristics of the product, material or assembly and the *approved agency's* identification.

**1703.5.4 Method of labeling.** Information required to be permanently identified on the product, material or assembly shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

**1703.6 Evaluation and follow-up inspection services.** Where structural components or other items regulated by this code are not visible for inspection after completion of a prefabricated assembly, the owner or the owner's authorized agent shall submit a report of each prefabricated assembly. The report shall indicate the complete details of the assembly, including a description of the assembly and its components, the basis upon which the assembly is being evaluated, test results and similar information and other data as necessary for the *building official* to determine conformance to this code. Such a report shall be *approved* by the *building official*.

**1703.6.1 Follow-up inspection.** The owner or the owner's authorized agent shall provide for *special inspections* of *fabricated items* in accordance with Section 1704.2.5.

**1703.6.2 Test and inspection records.** Copies of necessary test and *special inspection* records shall be filed with the *building official*.

### SECTION 1704 SPECIAL INSPECTIONS AND TESTS, CONTRACTOR RESPONSIBILITY AND STRUCTURAL OBSERVATION

**1704.1 General.** *Special inspections* and tests, statements of *special inspections*, responsibilities of contractors, submittals to the *building official* and *structural observations* shall meet the applicable requirements of this section.

**1704.2 Special inspections and tests.** Where application is made to the *building official* for construction as specified in Section 105, the owner or the owner's authorized agent, other than the contractor, shall employ one or more *approved agencies* to provide *special inspections* and tests during construction on the types of work specified in Section 1705 and identify the *approved agencies* to the *building official*. These *special inspections* and tests are in addition to the inspections by the *building official* that are identified in Section 110. The Structural Engineers Association of Arkansas has issued "Special Inspection Guidelines" as a reference

document for meeting the special inspection requirements. It is available at the SEAoAR website: [www.seaoar.org](http://www.seaoar.org). It is not listed as a reference document and is not officially adopted by the State of Arkansas as part of the Arkansas Fire Prevention Code.

#### Exceptions:

1. *Special inspections* and tests are not required for construction of a minor nature or as warranted by conditions in the jurisdiction as *approved* by the *building official*.
2. Unless otherwise required by the *building official*, *special inspections* and tests are not required for Group U occupancies that are accessory to a residential occupancy including, but not limited to, those listed in Section 312.1.
3. *Special inspections* and tests are not required for portions of structures designed and constructed in accordance with the cold-formed steel *light-frame construction* provisions of Section 2211.1.2 or the *conventional light-frame construction* provisions of Section 2308.
4. The contractor is permitted to employ the *approved agencies* where the contractor is also the owner.

**1704.2.1 Special inspector qualifications.** Prior to the start of the construction, the *approved agencies* shall provide written documentation to the *building official* demonstrating the competence and relevant experience or training of the *special inspectors* who will perform the *special inspections* and tests during construction. Experience or training shall be considered to be relevant where the documented experience or training is related in complexity to the same type of *special inspection* or testing activities for projects of similar complexity and material qualities. These qualifications are in addition to qualifications specified in other sections of this code.

The *registered design professional in responsible charge* and engineers of record involved in the design of the project are permitted to act as an *approved agency* and their personnel are permitted to act as *special inspectors* for the work designed by them, provided they qualify as *special inspectors*.

**1704.2.2 Access for special inspection.** The construction or work for which *special inspection* or testing is required shall remain accessible and exposed for *special inspection* or testing purposes until completion of the required *special inspections* or tests.

**1704.2.3 Statement of special inspections.** The applicant shall submit a statement of *special inspections* in accordance with Section 107.1 as a condition for permit issuance. This statement shall be in accordance with Section 1704.3.

**Exception:** A statement of *special inspections* is not required for portions of structures designed and constructed in accordance with the cold-formed steel *light-frame construction* provisions of Section 2211.1.2 or the *conventional light-frame construction* provisions of Section 2308.



**1704.2.4 Report requirement.** *Approved agencies* shall keep records of *special inspections* and tests. The *approved agency* shall submit reports of *special inspections* and tests to the *building official* and to the *registered design professional in responsible charge*. Reports shall indicate that work inspected or tested was or was not completed in conformance to *approved construction documents*. Discrepancies shall be brought to the immediate attention of the contractor for correction. If they are not corrected, the discrepancies shall be brought to the attention of the *building official* and to the *registered design professional in responsible charge* prior to the completion of that phase of the work. A final report documenting required *special inspections* and tests, and correction of any discrepancies noted in the inspections or tests, shall be submitted at a point in time agreed upon prior to the start of work by the owner or the owner's authorized agent to the *building official*.

**1704.2.5 Special inspection of fabricated items.** Where fabrication of structural, load-bearing or lateral load-resisting members or assemblies is being conducted on the premises of a fabricator's shop, *special inspections* of the *fabricated items* shall be performed during fabrication, except where the fabricator has been *approved* to perform work without *special inspections* in accordance with Section 1704.2.5.1.

**1704.2.5.1 Fabricator approval.** *Special inspections* during fabrication are not required where the work is done on the premises of a fabricator *approved* to perform such work without *special inspection*. Approval shall be based on review of the fabricator's written fabrication procedures and quality control manuals that provide a basis for control of materials and workmanship, with periodic auditing of fabrication and quality control practices by an *approved agency* or the *building official*. At completion of fabrication, the *approved fabricator* shall submit a *certificate of compliance* to the owner or the owner's authorized agent for submittal to the *building official* as specified in Section 1704.5 stating that the work was performed in accordance with the *approved construction documents*.

**1704.3 Statement of special inspections.** Where *special inspections* or tests are required by Section 1705, the *registered design professional in responsible charge* shall prepare a statement of *special inspections* in accordance with Section 1704.3.1 for submittal by the applicant in accordance with Section 1704.2.3.

**Exception:** The statement of *special inspections* is permitted to be prepared by a qualified person *approved* by the *building official* for construction not designed by a *registered design professional*.

**1704.3.1 Content of statement of special inspections.** The statement of *special inspections* shall identify the following:

1. The materials, systems, components and work required to have *special inspections* or tests by the

*building official* or by the *registered design professional* responsible for each portion of the work.

2. The type and extent of each *special inspection*.
3. The type and extent of each test.
4. Additional requirements for *special inspections* or tests for seismic or wind resistance as specified in Sections 1705.12, 1705.13 and 1705.14.
5. For each type of *special inspection*, identification as to whether it will be continuous *special inspection*, periodic *special inspection* or performed in accordance with the notation used in the referenced standard where the inspections are defined.

**1704.3.2 Seismic requirements in the statement of special inspections.** Where Section 1705.13 or 1705.14 specifies *special inspections* or tests for seismic resistance, the statement of *special inspections* shall identify the *designated seismic systems* and *seismic force-resisting systems* that are subject to the *special inspections* or tests.

**1704.3.3 Wind requirements in the statement of special inspections.** Where Section 1705.12 specifies *special inspection* for wind resistance, the statement of *special inspections* shall identify the *main windforce-resisting systems* and wind-resisting components that are subject to *special inspections*.

**1704.4 Contractor responsibility.** Each contractor responsible for the construction of a main wind- or *seismic force-resisting system*, *designated seismic system* or a wind- or seismic force-resisting component listed in the statement of *special inspections* shall submit a written statement of responsibility to the *building official* and the owner or the owner's authorized agent prior to the commencement of work on the system or component. The contractor's statement of responsibility shall contain acknowledgement of awareness of the special requirements contained in the statement of *special inspections*.

**1704.5 Submittals to the building official.** In addition to the submittal of reports of *special inspections* and tests in accordance with Section 1704.2.4, reports and certificates shall be submitted by the owner or the owner's authorized agent to the *building official* for each of the following:

1. *Certificates of compliance* for the fabrication of structural, load-bearing or lateral load-resisting members or assemblies on the premises of an *approved fabricator* in accordance with Section 1704.2.5.1.
2. *Certificates of compliance* for the seismic qualification of nonstructural components, supports and attachments in accordance with Section 1705.14.2.
3. *Certificates of compliance* for *designated seismic systems* in accordance with Section 1705.14.3.
4. Reports of preconstruction tests for shotcrete in accordance with ACI 318.
5. *Certificates of compliance* for open web *steel joists* and joist girders in accordance with Section 2207.5.

## SPECIAL INSPECTIONS AND TESTS

6. Reports of material properties verifying compliance with the requirements of AWS D1.4 for weldability as specified in Section 26.6.4 of ACI 318 for reinforcing bars in concrete complying with a standard other than ASTM A706 that are to be welded.
7. Reports of mill tests in accordance with Section 20.2.2.5 of ACI 318 for reinforcing bars complying with ASTM A615 and used to resist earthquake-induced flexural or axial forces in the special moment frames, special structural walls or coupling beams connecting special structural walls of *seismic force-resisting systems* in structures assigned to *Seismic Design Category* B, C, D, E or F.

**1704.6 Structural observations.** Where required by the provisions of Section 1704.6.1, the owner or the owner's authorized agent shall employ a *registered design professional* to perform *structural observations*. The structural observer shall visually observe representative locations of structural systems, details and load paths for general conformance to the approved construction documents. *Structural observation* does not include or waive the responsibility for the inspections in Section 110 or the *special inspections* in Section 1705 or other sections of this code. Prior to the commencement of observations, the structural observer shall submit to the *building official* a written statement identifying the frequency and extent of *structural observations*. At the conclusion of the work included in the permit, the structural observer shall submit to the *building official* a written statement that the site visits have been made and identify any reported deficiencies that, to the best of the structural observer's knowledge, have not been resolved.

**1704.6.1 Structural observations for structures.** *Structural observations* shall be provided for those structures where one or more of the following conditions exist:

1. The structure is classified as *Risk Category III or IV*.
2. The structure is a *high-rise building*.
3. The structure is assigned to *Seismic Design Category E*, and is greater than two stories above the grade plane.
4. Such observation is required by the *registered design professional* responsible for the structural design.
5. Such observation is specifically required by the *building official*.

## SECTION 1705

### REQUIRED SPECIAL INSPECTIONS AND TESTS

**1705.1 General.** *Special inspections* and tests of elements and nonstructural components of buildings and structures shall meet the applicable requirements of this section.

**1705.1.1 Special cases.** *Special inspections* and tests shall be required for proposed work that is, in the opinion of

the *building official*, unusual in its nature, such as, but not limited to, the following examples:

1. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
2. Unusual design applications of materials described in this code.
3. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.

**1705.2 Steel construction.** The *special inspections* and nondestructive testing of steel construction in buildings, structures, and portions thereof shall be in accordance with this section.

**Exception:** *Special inspections* of the steel fabrication process shall not be required where the fabrication process for the entire building or structure does not include any welding, thermal cutting or heating operation of any kind. In such cases, the fabricator shall be required to submit a detailed procedure for material control that demonstrates the fabricator's ability to maintain suitable records and procedures such that, at any time during the fabrication process, the material specification and grade for the main stress-carrying elements are capable of being determined. Mill test reports shall be identifiable to the main stress-carrying elements where required by the *approved construction documents*.

**1705.2.1 Structural steel.** *Special inspections* and nondestructive testing of *structural steel elements* in buildings, structures and portions thereof shall be in accordance with the quality assurance inspection requirements of AISC 360.

**Exception:** *Special inspection* of railing systems composed of *structural steel elements* shall be limited to welding inspection of welds at the base of cantilevered rail posts.

**1705.2.2 Cold-formed steel deck.** *Special inspections* and qualification of welding *special inspectors* for cold-formed steel floor and *roof deck* shall be in accordance with the quality assurance inspection requirements of SDI QA/QC.

**1705.2.3 Open-web steel joists and joist girders.** *Special inspections* of open-web *steel joists* and joist girders in buildings, structures and portions thereof shall be in accordance with Table 1705.2.3.

**1705.2.4 Cold-formed steel trusses spanning 60 feet or greater.** Where a cold-formed steel truss clear span is 60 feet (18 288 mm) or greater, the *special inspector* shall verify that the temporary installation restraint/bracing and the permanent *individual truss member* restraint/bracing are installed in accordance with the *approved* truss submittal package.

**TABLE 1705.2.3  
REQUIRED SPECIAL INSPECTIONS OF OPEN-WEB STEEL JOISTS AND JOIST GIRDERS**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD <sup>a</sup>
1. Installation of open-web steel joists and joist girders.			
a. End connections – welding or bolted.	—	X	SJI specifications listed in Section 2207.1.
b. Bridging – horizontal or diagonal.	—	—	—
1. Standard bridging.	—	X	SJI specifications listed in Section 2207.1.
2. Bridging that differs from the SJI specifications listed in Section 2207.1.	—	X	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see Section 1705.13.

**1705.3 Concrete construction.** *Special inspections* and tests of concrete construction shall be performed in accordance with this section and Table 1705.3.

**Exceptions:** *Special inspections* and tests shall not be required for:

1. Isolated spread concrete footings of buildings three stories or less above *grade plane* that are fully supported on earth or rock.
2. Continuous concrete footings supporting walls of buildings three stories or less above *grade plane* that are fully supported on earth or rock where:
  - 2.1. The footings support walls of *light-frame construction*.
  - 2.2. The footings are designed in accordance with Table 1809.7.
  - 2.3. The structural design of the footing is based on a specified compressive strength,  $f'_c$ , not more than 2,500 pounds per square inch (psi) (17.2 MPa), regardless of the compressive strength specified in the *approved construction documents* or used in the footing construction.
3. *Nonstructural concrete* slabs supported directly on the ground, including prestressed slabs on grade, where the effective prestress in the concrete is less than 150 psi (1.03 MPa).
4. Concrete foundation walls constructed in accordance with Table 1807.1.6.2.
5. Concrete patios, driveways and sidewalks, on grade.

**1705.3.1 Welding of reinforcing bars.** *Special inspections* of welding and qualifications of *special inspectors* for reinforcing bars shall be in accordance with the requirements of AWS D1.4 for *special inspection* and of AWS D1.4 for *special inspector* qualification.

**1705.3.2 Material tests.** In the absence of sufficient data or documentation providing evidence of conformance to quality standards for materials in Chapters 19 and 20 of ACI 318, the *building official* shall require testing of materials in accordance with the appropriate standards and criteria for the material in Chapters 19 and 20 of ACI 318.

**1705.4 Masonry construction.** *Special inspections* and tests of masonry construction shall be performed in accordance with the quality assurance program requirements of TMS 402 and TMS 602.

**Exception:** *Special inspections* and tests shall not be required for:

1. Empirically designed masonry, *glass unit masonry* or masonry *veneer* designed in accordance with Section 2109, Section 2110 or Chapter 14, respectively, where they are part of a structure classified as *Risk Category I, II or III*.
2. Masonry foundation walls constructed in accordance with Table 1807.1.6.3(1), 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4).
3. Masonry fireplaces, masonry heaters or masonry chimneys installed or constructed in accordance with Section 2111, 2112 or 2113, respectively.

**1705.4.1 Glass unit masonry and masonry veneer in Risk Category IV.** *Special inspections* and tests for glass unit masonry or masonry *veneer* designed in accordance with Section 2110 or Chapter 14, respectively, where they are part of a structure classified as *Risk Category IV* shall be performed in accordance with TMS 602 Level 2.

**1705.4.2 Vertical masonry foundation elements.** *Special inspections* and tests of vertical masonry foundation elements shall be performed in accordance with Section 1705.4.

**1705.5 Wood construction.** *Special inspections* of prefabricated wood structural elements and assemblies shall be in accordance with Section 1704.2.5. *Special inspections* of site-built assemblies shall be in accordance with this section.

**1705.5.1 High-load diaphragms.** High-load *diaphragms* designed in accordance with Section 2306.2 shall be installed with *special inspections* as indicated in Section 1704.2. The *special inspector* shall inspect the *wood structural panel* sheathing to ascertain whether it is of the grade and thickness shown on the *approved construction documents*. Additionally, the *special inspector* must verify the *nominal size* of framing members at adjoining panel edges, the nail or staple diameter and length, the number of fastener lines and that the spacing between fasteners in each line and at edge margins agrees with the *approved construction documents*.

## SPECIAL INSPECTIONS AND TESTS

**TABLE 1705.3**  
**REQUIRED SPECIAL INSPECTIONS AND TESTS OF CONCRETE CONSTRUCTION**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION	REFERENCED STANDARD <sup>a</sup>	IBC REFERENCE
1. Inspect reinforcement, including prestressing tendons, and verify placement.	—	X	ACI 318: Ch. 20, 25.2, 25.3, 26.6.1-26.6.3	—
2. Reinforcing bar welding:				
a. Verify weldability of reinforcing bars other than ASTM A706;	—	X	AWS D1.4	—
b. Inspect single-pass fillet welds, maximum $\frac{5}{16}$ " ; and	—	X	ACI 318: 26.6.4	—
c. Inspect all other welds.	X	—		
3. Inspect anchors cast in concrete.	—	X	ACI 318: 17.8.2	—
4. Inspect anchors post-installed in hardened concrete members. <sup>b</sup>				
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension loads.	X	—	ACI 318: 17.8.2.4	—
b. Mechanical anchors and adhesive anchors not defined in 4.a.	—	X	ACI 318: 17.8.2	
5. Verify use of required design mix.	—	X	ACI 318: Ch. 19, 26.4.3, 26.4.4	1904.1, 1904.2
6. Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	X	—	ASTM C31 ASTM C172 ACI 318: 26.5, 26.12	—
7. Inspect concrete and shotcrete placement for proper application techniques.	X	—	ACI 318: 26.5	—
8. Verify maintenance of specified curing temperature and techniques.	—	X	ACI 318: 26.5.3-26.5.5	—
9. Inspect prestressed concrete for:				
a. Application of prestressing forces; and	X	—	ACI 318: 26.10	—
b. Grouting of bonded prestressing tendons.	X	—		
10. Inspect erection of precast concrete members.	—	X	ACI 318: 26.9	—
11. For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deformability elements (MDE or HDE) in structures assigned to Seismic Design Category C, D, E or F, inspect such connections and reinforcement in the field for:				
a. Installation of the embedded parts	X	—	ACI 318: 26.13.1.3	—
b. Completion of the continuity of reinforcement across joints.	X	—	ACI 550.5	
c. Completion of connections in the field.	X	—		
12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5.	—	X	ACI 318: 26.13.1.3	—
13. Verify in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	—	X	ACI 318: 26.11.2	—
14. Inspect formwork for shape, location and dimensions of the concrete member being formed.	—	X	ACI 318: 26.11.1.2(b)	—

For SI: 1 inch = 25.4 mm.

a. Where applicable, see Section 1705.13.

b. Specific requirements for special inspection shall be included in the research report for the anchor issued by an approved source in accordance with 17.8.2 in ACI 318, or other qualification procedures. Where specific requirements are not provided, special inspection requirements shall be specified by the registered design professional and shall be approved by the building official prior to the commencement of the work.



**1705.5.2 Metal-plate-connected wood trusses spanning 60 feet or greater.** Where a truss clear span is 60 feet (18 288 mm) or greater, the *special inspector* shall verify that the temporary installation restraint/bracing and the permanent individual truss member restraint/bracing are installed in accordance with the approved truss submittal package.

**1705.5.3 Mass timber construction.** *Special inspections* of mass timber elements in Types IV-A, IV-B and IV-C construction shall be in accordance with Table 1705.5.3.

**1705.6 Soils.** *Special inspections* and tests of existing site soil conditions, fill placement and load-bearing requirements shall be performed in accordance with this section and Table 1705.6. The *approved* geotechnical report and the *construction documents* prepared by the *registered design professionals* shall be used to determine compliance.

**Exception:** Where Section 1803 does not require reporting of materials and procedures for fill placement, the special inspector shall verify that the in-place dry density of the compacted fill is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D1557.

**1705.7 Driven deep foundations.** *Special inspections* and tests shall be performed during installation of driven *deep*

*foundation* elements as specified in Table 1705.7. The approved geotechnical report and the construction documents prepared by the *registered design professionals* shall be used to determine compliance.

**1705.8 Cast-in-place deep foundations.** *Special inspections* and tests shall be performed during installation of cast-in-place *deep foundation* elements as specified in Table 1705.8. The *approved* geotechnical report and the *construction documents* prepared by the *registered design professionals* shall be used to determine compliance.

**1705.9 Helical pile foundations.** *Continuous special inspections* shall be performed during installation of *helical pile* foundations. The information recorded shall include installation equipment used, pile dimensions, tip elevations, final depth, final installation torque and other pertinent installation data as required by the *registered design professional* in responsible charge. The *approved* geotechnical report and the *construction documents* prepared by the *registered design professional* shall be used to determine compliance.

**1705.10 Structural integrity of deep foundation elements.** Whenever there is a reasonable doubt as to the structural integrity of a *deep foundation* element, an engineering assessment shall be required. The engineering assessment shall include tests for defects performed in accordance with

**TABLE 1705.5.3  
REQUIRED SPECIAL INSPECTIONS OF MASS TIMBER CONSTRUCTION**

TYPE		CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1.	Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.	—	X
2.	Inspect erection of mass timber construction.	—	X
3.	Inspection of connections where installation methods are required to meet design loads.		
	Threaded fasteners	Verify use of proper installation equipment.	X
		Verify use of pre-drilled holes where required.	X
		Inspect screws, including diameter, length, head type, spacing, installation angle and depth.	X
	Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads.		X
	Adhesive anchors not defined in preceding cell.		—
	Bolted connections.		X
	Concealed connections.		X

**TABLE 1705.6  
REQUIRED SPECIAL INSPECTIONS AND TESTS OF SOILS**

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify materials below <i>shallow foundations</i> are adequate to achieve the design bearing capacity.	—	X
2. Verify excavations are extended to proper depth and have reached proper material.	—	X
3. Perform classification and testing of compacted fill materials.	—	X
4. During fill placement, verify use of proper materials and procedures in accordance with the provisions of the approved geotechnical report. Verify densities and lift thicknesses during placement and compaction of compacted fill.	X	—
5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.	—	X

## SPECIAL INSPECTIONS AND TESTS

ASTM D4945, ASTM D5882, ASTM D6760 or ASTM D7949, or other *approved method*.

**1705.11 Fabricated items.** *Special inspections* of fabricated items shall be performed in accordance with Section 1704.2.5.

**1705.12 Special inspections for wind resistance.** *Special inspections* for wind resistance specified in Sections 1705.12.1 through 1705.12.3, unless exempted by the exceptions to Section 1704.2, are required for buildings and structures constructed in the following areas:

1. In wind Exposure Category B, where  $V$  is 150 miles per hour (67 m/sec) or greater.
2. In wind Exposure Category C or D, where  $V$  is 140 mph (62.6 m/sec) or greater.

**1705.12.1 Structural wood.** *Continuous special inspection* is required during field gluing operations of elements of the *main windforce-resisting system*. *Periodic special inspection* is required for nailing, bolting, anchoring and other fastening of elements of the *main windforce-resisting system*, including wood *shear walls*, wood *diaphragms*, *drag struts*, braces and *hold-downs*.

**Exception:** *Special inspections* are not required for wood *shear walls*, shear panels and *diaphragms*, including nailing, bolting, anchoring and other fastening to other elements of the *main windforce-resisting system*, where the lateral resistance is provided by structural sheathing and the specified fastener spacing at panel edges is more than 4 inches (102 mm) on center.

### 1705.12.2 Cold-formed steel light-frame construction.

*Periodic special inspection* is required for welding operations of elements of the *main windforce-resisting system*. *Periodic special inspection* is required for screw attachment, bolting, anchoring and other fastening of elements of the *main windforce-resisting system*, including shear walls, braces, *diaphragms*, *collectors (drag struts)* and *hold-downs*.

**Exception:** *Special inspections* are not required for cold-formed steel light-frame shear walls and *diaphragms*, including screwing, bolting, anchoring and other fastening to components of the windforce-resisting system, where either of the following applies:

1. The sheathing is *gypsum board* or *fiberboard*.
2. The sheathing is *wood structural panel* or steel sheets on only one side of the *shear wall*, shear panel or *diaphragm* assembly and the specified fastener spacing at the panel or sheet edges is more than 4 inches (102 mm) on center (o.c.).

**1705.12.3 Wind-resisting components.** *Periodic special inspection* is required for fastening of the following systems and components:

1. *Roof covering*, *roof deck* and roof framing connections.
2. Exterior wall covering and wall connections to roof and floor *diaphragms* and framing.

**1705.13 Special inspections for seismic resistance.** *Special inspections* for seismic resistance shall be required as speci-

TABLE 1705.7  
REQUIRED SPECIAL INSPECTIONS AND TESTS OF DRIVEN DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Verify element materials, sizes and lengths comply with the requirements.	X	—
2. Determine capacities of test elements and conduct additional load tests, as required.	X	—
3. Inspect driving operations and maintain complete and accurate records for each element.	X	—
4. Verify placement locations and plumbness, confirm type and size of hammer, record number of blows per foot of penetration, determine required penetrations to achieve design capacity, record tip and butt elevations and document any damage to foundation element.	X	—
5. For steel elements, perform additional special inspections in accordance with Section 1705.2.	In accordance with Section 1705.2	
6. For concrete elements and concrete-filled elements, perform tests and additional special inspections in accordance with Section 1705.3.	In accordance with Section 1705.3	
7. For specialty elements, perform additional inspections as determined by the registered design professional in responsible charge.	In accordance with Statement of Special Inspections	

TABLE 1705.8  
REQUIRED SPECIAL INSPECTIONS AND TESTS OF CAST-IN-PLACE DEEP FOUNDATION ELEMENTS

TYPE	CONTINUOUS SPECIAL INSPECTION	PERIODIC SPECIAL INSPECTION
1. Inspect drilling operations and maintain complete and accurate records for each element.	X	—
2. Verify placement locations and plumbness, confirm element diameters, bell diameters (if applicable), lengths, embedment into bedrock (if applicable) and adequate end-bearing strata capacity. Record concrete or grout volumes.	X	—
3. For concrete elements, perform tests and additional <i>special inspections</i> in accordance with Section 1705.3.	In accordance with Section 1705.3	

fied in Sections 1705.13.1 through 1705.13.9, unless exempted by the exceptions of Section 1704.2.

**Exception:** The *special inspections* specified in Sections 1705.13.1 through 1705.13.9 are not required for structures designed and constructed in accordance with one of the following:

1. The structure consists of *light-frame construction*; the design spectral response acceleration at short periods,  $S_{DS}$ , as determined in Section 1613.2.4, does not exceed 0.5; and the *building height* of the structure does not exceed 35 feet (10 668 mm).
2. The *seismic force-resisting system* of the structure consists of *reinforced masonry* or reinforced concrete; the design spectral response acceleration at short periods,  $S_{DS}$ , as determined in Section 1613.2.4, does not exceed 0.5; and the *building height* of the structure does not exceed 25 feet (7620 mm).
3. The structure is a detached one- or two-family dwelling not exceeding two *stories above grade plane* and does not have any of the following horizontal or vertical irregularities in accordance with Section 12.3 of ASCE 7:
  - 3.1. Torsional or extreme torsional irregularity.
  - 3.2. Nonparallel systems irregularity.
  - 3.3. Stiffness-soft story or stiffness-extreme soft story irregularity.
  - 3.4. Discontinuity in lateral strength-weak story irregularity.

**1705.13.1 Structural steel.** *Special inspections* for seismic resistance shall be in accordance with Section 1705.13.1.1 or 1705.13.1.2, as applicable.

**1705.13.1.1 Seismic force-resisting systems.** *Special inspections* of structural steel in the *seismic force-resisting systems* in buildings and structures assigned to *Seismic Design Category B, C, D, E or F* shall be performed in accordance with the quality assurance requirements of AISC 341.

**Exceptions:**

1. In buildings and structures assigned to *Seismic Design Category B or C*, *special inspections* are not required for structural steel *seismic force-resisting systems* where the response modification coefficient,  $R$ , designated for “Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems” in ASCE 7, Table 12.2-1, has been used for design and detailing.
2. In structures assigned to *Seismic Design Category D, E, or F*, *special inspections* are not required for structural steel *seismic force-resisting systems* where design and detailing in accordance with AISC 360 is permitted by ASCE 7, Table 15.4-1.

**1705.13.1.2 Structural steel elements.** *Special inspections* of structural steel elements in the *seismic force-resisting systems* of buildings and structures assigned to *Seismic Design Category B, C, D, E or F* other than those covered in Section 1705.13.1.1, including struts, *collectors*, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

**Exceptions:**

1. In buildings and structures assigned to *Seismic Design Category B or C*, *special inspections* of structural steel elements are not required for *seismic force-resisting systems* with a response modification coefficient,  $R$ , of 3 or less.
2. In structures assigned to *Seismic Design Category D, E, or F*, *special inspections* of structural steel elements are not required for *seismic force-resisting systems* where design and detailing other than AISC 341 is permitted by ASCE 7, Table 15.4-1. *Special inspection* shall be in accordance with the applicable referenced standard listed in ASCE 7, Table 15.4-1.

**1705.13.2 Structural wood.** For the *seismic force-resisting systems* of structures assigned to *Seismic Design Category C, D, E or F*:

1. *Continuous special inspection* shall be required during field gluing operations of elements of the *seismic force-resisting system*.
2. *Periodic special inspection* shall be required for nailing, bolting, anchoring and other fastening of elements of the *seismic force-resisting system*, including wood *shear walls*, wood *diaphragms*, *drag struts*, braces, shear panels and *hold-downs*.

**Exception:** *Special inspections* are not required for wood *shear walls*, shear panels and *diaphragms*, including nailing, bolting, anchoring and other fastening to other elements of the *seismic force-resisting system*, where the lateral resistance is provided by structural sheathing, and the specified fastener spacing at the panel edges is more than 4 inches (102 mm) on center.

**1705.13.3 Cold-formed steel light-frame construction.** For the *seismic force-resisting systems* of structures assigned to *Seismic Design Category C, D, E or F*, *periodic special inspection* shall be required for both:

1. Welding operations of elements of the *seismic force-resisting system*.
2. Screw attachment, bolting, anchoring and other fastening of elements of the *seismic force-resisting system*, including shear walls, braces, *diaphragms*, *collectors* (*drag struts*) and *hold-downs*.

**Exception:** *Special inspections* are not required for cold-formed steel light-frame shear walls and

## SPECIAL INSPECTIONS AND TESTS

*diaphragms*, including screw installation, bolting, anchoring and other fastening to components of the *seismic force-resisting system*, where either of the following applies:

1. The sheathing is gypsum board or *fiberboard*.
2. The sheathing is *wood structural panel* or steel sheets on only one side of the *shear wall*, shear panel or *diaphragm* assembly and the specified fastener spacing at the panel or sheet edge is more than 4 inches (102 mm) on center.

**1705.13.4 Designated seismic systems.** For structures assigned to *Seismic Design Category C, D, E or F*, the *special inspector* shall examine *designated seismic systems* requiring seismic qualification in accordance with Section 13.2.2 of ASCE 7 and verify that the label, anchorage and mounting conform to the *certificate of compliance*.

**1705.13.5 Architectural components.** *Periodic special inspection* is required for the erection and fastening of exterior cladding, interior and exterior nonbearing walls and interior and exterior *veneer* in structures assigned to *Seismic Design Category D, E or F*.

**Exception:** *Periodic special inspection* is not required for the following:

1. Exterior cladding, interior and exterior nonbearing walls and interior and exterior *veneer* 30 feet (9144 mm) or less in height above grade or walking surface.
2. Exterior cladding and interior and exterior *veneer* weighing 5 psf (0.24 kN/m<sup>2</sup>) or less.
3. Interior nonbearing walls weighing 15 psf (0.72 kN/m<sup>2</sup>) or less.

**1705.13.5.1 Access floors.** *Periodic special inspection* is required for the anchorage of access floors in structures assigned to *Seismic Design Category D, E or F*.

**1705.13.6 Plumbing, mechanical and electrical components.** *Periodic special inspection* of plumbing, mechanical and electrical components shall be required for the following:

1. Anchorage of electrical equipment for emergency and standby power systems in structures assigned to *Seismic Design Category C, D, E or F*.

2. Anchorage of other electrical equipment in structures assigned to *Seismic Design Category E or F*.
3. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to *Seismic Design Category C, D, E or F*.
4. Installation and anchorage of ductwork designed to carry hazardous materials in structures assigned to *Seismic Design Category C, D, E or F*.
5. Installation and anchorage of vibration isolation systems in structures assigned to *Seismic Design Category C, D, E or F* where the *approved construction documents* require a nominal clearance of  $\frac{1}{4}$  inch (6.4 mm) or less between the equipment support frame and restraint.
6. Installation of mechanical and electrical equipment, including duct work, piping systems and their structural supports, where automatic sprinkler systems are installed in structures assigned to *Seismic Design Category C, D, E or F* to verify one of the following:

- 6.1. Minimum clearances have been provided as required by Section 13.2.3 ASCE/SEI 7.
- 6.2. A nominal clearance of not less than 3 inches (76 mm) has been provided between automatic sprinkler system drops and sprigs and: structural members not used collectively or independently to support the sprinklers; equipment attached to the building structure; and other systems' piping.

Where flexible sprinkler hose fittings are used, *special inspection* of minimum clearances is not required.

**1705.13.7 Storage racks.** Steel storage racks and steel cantilevered storage racks that are 8 feet (2438 mm) in height or greater and assigned to *Seismic Design Category D, E or F* shall be provided with periodic special inspection as required by Table 1705.13.7.

**1705.13.8 Seismic isolation systems.** *Periodic special inspection* shall be provided for seismic isolation systems in seismically isolated structures assigned to *Seismic Design Category B, C, D, E or F* during the fabrication and installation of isolator units and energy dissipation devices.

**TABLE 1705.13.7  
REQUIRED INSPECTIONS OF STORAGE RACK SYSTEMS**

TYPE	CONTINUOUS INSPECTION	PERIODIC INSPECTION	REFERENCED STANDARD	IBC REFERENCE
1. Materials used, to verify compliance with one or more of the material test reports in accordance with the approved construction documents.	—	X	—	—
2. Fabricated storage rack elements.	—	X	—	Section 1704.2.5
3. Storage rack anchorage installation.	—	X	ANSI/MH16.1 Section 7.3.2	—
4. Completed storage rack system, to indicate compliance with the approved construction documents.	—	X	—	—



**1705.13.9 Cold-formed steel special bolted moment frames.** *Periodic special inspection* shall be provided for the installation of cold-formed steel special bolted moment frames in the *seismic force-resisting systems* of structures assigned to *Seismic Design Category* D, E or F.

**1705.14 Testing for seismic resistance.** Testing for seismic resistance shall be required as specified in Sections 1705.14.1 through 1705.14.4, unless exempted from *special inspections* by the exceptions of Section 1704.2.

**1705.14.1 Structural steel.** Nondestructive testing for seismic resistance shall be in accordance with Section 1705.14.1.1 or 1705.14.1.2, as applicable.

**1705.14.1.1 Seismic force-resisting systems.** Nondestructive testing of structural steel in the *seismic force-resisting systems* in buildings and structures assigned to *Seismic Design Category* B, C, D, E or F shall be performed in accordance with the quality assurance requirements of AISC 341.

**Exceptions:**

1. In buildings and structures assigned to *Seismic Design Category* B or C, nondestructive testing is not required for structural steel *seismic force-resisting systems* where the response modification coefficient,  $R$ , designated for “Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems” in ASCE 7, Table 12.2-1, has been used for design and detailing.
2. In structures assigned to *Seismic Design Category* D, E, or F, nondestructive testing is not required for structural steel *seismic force-resisting systems* where design and detailing in accordance with AISC 360 is permitted by ASCE 7, Table 15.4-1.

**1705.14.1.2 Structural steel elements.** Nondestructive testing of *structural steel elements* in the *seismic force-resisting systems* of buildings and structures assigned to *Seismic Design Category* B, C, D, E or F other than those covered in Section 1705.14.1.1, including struts, *collectors*, chords and foundation elements, shall be performed in accordance with the quality assurance requirements of AISC 341.

**Exceptions:**

1. In buildings and structures assigned to *Seismic Design Category* B or C, nondestructive testing of *structural steel elements* is not required for *seismic force-resisting systems* with a response modification coefficient,  $R$ , of 3 or less.
2. In structures assigned to *Seismic Design Category* D, E or F, nondestructive testing of *structural steel elements* is not required for *seismic force-resisting systems* where design and detailing other than AISC 341 is permitted by ASCE 7, Table 15.4-1. Nondestructive testing of *structural steel*

*elements* shall be in accordance with the applicable referenced standard listed in ASCE 7, Table 15.4-1.

**1705.14.2 Nonstructural components.** For structures assigned to *Seismic Design Category* B, C, D, E or F, where the requirements of Section 13.2.1 of ASCE 7 for nonstructural components, supports or attachments are met by seismic qualification as specified in Item 2 therein, the *registered design professional* shall specify on the *approved construction documents* the requirements for seismic qualification by analysis, testing or experience data. *Certificates of compliance* for the seismic qualification shall be submitted to the *building official* as specified in Section 1704.5.

**1705.14.3 Designated seismic systems.** For structures assigned to *Seismic Design Category* C, D, E or F and with *designated seismic systems* that are subject to the requirements of Section 13.2.2 of ASCE 7 for certification, the *registered design professional* shall specify on the *approved construction documents* the requirements to be met by analysis, testing or experience data as specified therein. *Certificates of compliance* documenting that the requirements are met shall be submitted to the *building official* as specified in Section 1704.5.

**1705.14.4 Seismic isolation systems.** Seismic isolation systems in seismically isolated structures assigned to *Seismic Design Category* B, C, D, E or F shall be tested in accordance with Section 17.8 of ASCE 7.

**[BF] 1705.15 Sprayed fire-resistant materials.** *Special inspections* and tests of sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be performed in accordance with Sections 1705.15.1 through 1705.15.6. *Special inspections* shall be based on the fire-resistance design as designated in the *approved construction documents*. The tests set forth in this section shall be based on samplings from specific floor, roof and wall assemblies and structural members. *Special inspections* and tests shall be performed during construction with an additional visual inspection after the rough installation of electrical, automatic sprinkler, mechanical and plumbing systems and suspension systems for ceilings, and before concealment where applicable. The required sample size shall not exceed 110 percent of that specified by the referenced standards in Sections 1705.15.4.1 through 1705.15.4.9.

**[BF] 1705.15.1 Physical and visual tests.** The *special inspections* and tests shall include the following to demonstrate compliance with the listing and the *fire-resistance rating*:

1. Condition of substrates.
2. Thickness of application.
3. Density in pounds per cubic foot ( $\text{kg/m}^3$ ).
4. Bond strength adhesion/cohesion.
5. Condition of finished application.

**[BF] 1705.15.2 Structural member surface conditions.** The surfaces shall be prepared in accordance with the *approved fire-resistance design* and the written instruc-

## SPECIAL INSPECTIONS AND TESTS

tions of *approved* manufacturers. The prepared surface of structural members to be sprayed shall be inspected by the *special inspector* before the application of the sprayed fire-resistant material.

**[BF] 1705.15.3 Application.** The substrate shall have a minimum ambient temperature before and after application as specified in the written instructions of *approved* manufacturers. The area for application shall be ventilated during and after application as required by the written instructions of *approved* manufacturers.

**[BF] 1705.15.4 Thickness.** Not more than 10 percent of the thickness measurements of the sprayed fire-resistant materials applied to floor, roof and wall assemblies and structural members shall be less than the thickness required by the *approved* fire-resistance design, and none shall be less than the minimum allowable thickness required by Section 1705.15.4.1.

**[BF] 1705.15.4.1 Minimum allowable thickness.** For design thicknesses 1 inch (25 mm) or greater, the minimum allowable individual thickness shall be the design thickness minus 1/4 inch (6.4 mm). For design thicknesses less than 1 inch (25 mm), the minimum allowable individual thickness shall be the design thickness minus 25 percent. Thickness shall be determined in accordance with ASTM E605. Samples of the sprayed fire-resistant materials shall be selected in accordance with Sections 1705.15.4.2 and 1705.15.4.3.

**[BF] 1705.15.4.2 Floor, roof and wall assemblies.** The thickness of the sprayed fire-resistant material applied to floor, roof and wall assemblies shall be determined in accordance with ASTM E605, making not less than four measurements for each 1,000 square feet (93 m<sup>2</sup>) of the sprayed area, or portion thereof, in each story.

**[BF] 1705.15.4.3 Cellular decks.** Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. Not fewer than four measurements shall be made, located symmetrically within the square area.

**[BF] 1705.15.4.4 Fluted decks.** Thickness measurements shall be selected from a square area, 12 inches by 12 inches (305 mm by 305 mm) in size. Not fewer than four measurements shall be made, located symmetrically within the square area, including one each of the following: valley, crest and sides. The average of the measurements shall be reported.

**[BF] 1705.15.4.5 Structural members.** The thickness of the sprayed fire-resistant material applied to structural members shall be determined in accordance with ASTM E605. Thickness testing shall be performed on not less than 25 percent of the structural members on each floor.

**[BF] 1705.15.4.6 Beams and girders.** At beams and girders thickness measurements shall be made at nine locations around the beam or girder at each end of a 12-inch (305 mm) length.

**[BF] 1705.15.4.7 Joists and trusses.** At joists and trusses, thickness measurements shall be made at seven locations around the joist or truss at each end of a 12-inch (305 mm) length.

**[BF] 1705.15.4.8 Wide-flanged columns.** At wide-flanged columns, thickness measurements shall be made at 12 locations around the column at each end of a 12-inch (305 mm) length.

**[BF] 1705.15.4.9 Hollow structural section and pipe columns.** At hollow structural section and pipe columns, thickness measurements shall be made at not fewer than four locations around the column at each end of a 12-inch (305 mm) length.

**[BF] 1705.15.5 Density.** The density of the sprayed fire-resistant material shall be not less than the density specified in the *approved* fire-resistance design. Density of the sprayed fire-resistant material shall be determined in accordance with ASTM E605. The test samples for determining the density of the sprayed fire-resistant materials shall be selected as follows:

1. From each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m<sup>2</sup>) or portion thereof of the sprayed area in each story.
2. From beams, girders, trusses and columns at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m<sup>2</sup>) of floor area or portion thereof in each story.

**[BF] 1705.15.6 Bond strength.** The cohesive/adhesive bond strength of the cured sprayed fire-resistant material applied to floor, roof and wall assemblies and structural members shall be not less than 150 pounds per square foot (psf) (7.18 kN/m<sup>2</sup>). The cohesive/adhesive bond strength shall be determined in accordance with the field test specified in ASTM E736 by testing in-place samples of the sprayed fire-resistant material selected in accordance with Sections 1705.15.6.1 through 1705.15.6.3.

**[BF] 1705.15.6.1 Floor, roof and wall assemblies.** The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from each floor, roof and wall assembly at the rate of not less than one sample for every 2,500 square feet (232 m<sup>2</sup>) of the sprayed area, or portion thereof, in each story.

**[BF] 1705.15.6.2 Structural members.** The test samples for determining the cohesive/adhesive bond strength of the sprayed fire-resistant materials shall be selected from beams, girders, trusses, columns and other structural members at the rate of not less than one sample for each type of structural member for each 2,500 square feet (232 m<sup>2</sup>) of floor area or portion thereof in each story.

**[BF] 1705.15.6.3 Primer, paint and encapsulant bond tests.** Bond tests to qualify a primer, paint or encapsulant shall be conducted where the sprayed fire-resistant material is applied to a primed, painted or

encapsulated surface for which acceptable bond-strength performance between these coatings and the fire-resistant material has not been determined. A bonding agent *approved* by the SFRM manufacturer shall be applied to a primed, painted or encapsulated surface where the bond strengths are found to be less than required values.

**[BF] 1705.16 Mastic and intumescent fire-resistant coatings.** *Special inspections* and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWCI 12-B. *Special inspections* and tests shall be based on the fire-resistance design as designated in the *approved construction documents*. *Special inspections* and tests shall be performed during construction. Additional visual inspection shall be performed after the rough installation and, where applicable, prior to the concealment of electrical, automatic sprinkler, mechanical and plumbing systems.

**1705.17 Exterior insulation and finish systems (EIFS).** *Special inspections* shall be required for all EIFS applications.

**Exceptions:**

1. *Special inspections* shall not be required for EIFS applications installed over a *water-resistive barrier* with a means of draining moisture to the exterior.
2. *Special inspections* shall not be required for EIFS applications installed over masonry or concrete walls.

**1705.17.1 Water-resistive barrier coating.** A *water-resistive barrier* coating complying with ASTM E2570 requires *special inspection* of the *water-resistive barrier* coating where installed over a sheathing substrate.

**[BF] 1705.18 Fire-resistant penetrations and joints.** In high-rise buildings, in buildings assigned to *Risk Category III* or *IV*, or in *fire areas* containing Group R occupancies with an *occupant load* greater than 250, *special inspections* for *through-penetrations*, *membrane penetration* firestops, *fire-resistant joint systems* and perimeter fire containment systems that are tested and *listed* in accordance with Sections 714.4.1.2, 714.5.1.2, 715.3.1 and 715.4 shall be in accordance with Section 1705.18.1 or 1705.18.2.

**[BF] 1705.18.1 Penetration firestops.** Inspections of *penetration firestop* systems that are tested and *listed* in accordance with Sections 714.4.1.2 and 714.5.1.2 shall be conducted by an *approved agency* in accordance with ASTM E2174.

**[BF] 1705.18.2 Fire-resistant joint systems.** Inspection of *fire-resistant joint systems* that are tested and *listed* in accordance with Sections 715.3.1 and 715.4 shall be conducted by an *approved agency* in accordance with ASTM E2393.

**[F] 1705.19 Testing for smoke control.** Smoke control systems shall be tested by a *special inspector*.

**[F] 1705.19.1 Testing scope.** The test scope shall be as follows:

1. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording of device location.
2. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements and detection and control verification.

**[F] 1705.19.2 Qualifications.** *Approved agencies* for smoke control testing shall have expertise in fire protection engineering, mechanical engineering and certification as air balancers.

**1705.20 Sealing of mass timber.** Periodic *special inspections* of sealants or adhesives shall be conducted where sealant or adhesive required by Section 703.7 is applied to *mass timber building elements* as designated in the *approved construction documents*.

## SECTION 1706 DESIGN STRENGTHS OF MATERIALS

**1706.1 Conformance to standards.** The *design strengths* and permissible stresses of any structural material that are identified by a manufacturer's designation as to manufacture and grade by mill tests, or the strength and stress grade is otherwise confirmed to the satisfaction of the *building official*, shall conform to the specifications and methods of design of accepted engineering practice or the *approved* rules in the absence of applicable standards.

**1706.2 New materials.** For materials that are not specifically provided for in this code, the *design strengths* and permissible stresses shall be established by tests as provided for in Section 1707.

## SECTION 1707 ALTERNATIVE TEST PROCEDURE

**1707.1 General.** In the absence of *approved* rules or other *approved* standards, the *building official* shall make, or cause to be made, the necessary tests and investigations; or the *building official* shall accept duly authenticated reports from *approved agencies* in respect to the quality and manner of use of new materials or assemblies as provided for in Section 104.11. The cost of all tests and other investigations required under the provisions of this code shall be borne by the owner or the owner's authorized agent.

## SECTION 1708 IN-SITU LOAD TESTS

**1708.1 General.** Whenever there is a reasonable doubt as to the stability or load-bearing capacity of a completed building, structure or portion thereof for the expected *loads*, an engineering assessment shall be required. The engineering



## SPECIAL INSPECTIONS AND TESTS

assessment shall involve either a structural analysis or an in-situ load test, or both. The structural analysis shall be based on actual material properties and other as-built conditions that affect stability or load-bearing capacity, and shall be conducted in accordance with the applicable design standard. The in-situ load tests shall be conducted in accordance with Section 1708.2. If the building, structure or portion thereof is found to have inadequate stability or load-bearing capacity for the expected *loads*, modifications to ensure structural adequacy or the removal of the inadequate construction shall be required.

**1708.2 In-situ load tests.** In-situ load tests shall be conducted in accordance with Section 1708.2.1 or 1708.2.2 and shall be supervised by a *registered design professional*. The test shall simulate the applicable loading conditions specified in Chapter 16 as necessary to address the concerns regarding structural stability of the building, structure or portion thereof.

**1708.2.1 Load test procedure specified.** Where a referenced material standard contains an applicable load test procedure and acceptance criteria, the test procedure and acceptance criteria in the standard shall apply. In the absence of specific *load factors* or acceptance criteria, the *load factors* and acceptance criteria in Section 1708.2.2 shall apply.

**1708.2.2 Load test procedure not specified.** In the absence of applicable load test procedures contained within a material standard referenced by this code or acceptance criteria for a specific material or method of construction, such *existing structure* shall be subjected to an approved test procedure developed by a *registered design professional* that simulates applicable loading and deformation conditions. For components that are not a part of the *seismic force-resisting system*, at a minimum the test load shall be equal to the specified factored design *loads*. For materials such as wood that have strengths that are dependent on load duration, the test load shall be adjusted to account for the difference in load duration of the test compared to the expected duration of the design *loads* being considered. For statically loaded components, the test load shall be left in place for a period of 24 hours. For components that carry dynamic *loads* (for example, machine supports or fall arrest anchors), the load shall be left in place for a period consistent with the component's actual function. The structure shall be considered to have successfully met the test requirements where the following criteria are satisfied:

1. Under the design *load*, the deflection shall not exceed the limitations specified in Section 1604.3.
2. Within 24 hours after removal of the test load, the structure shall have recovered not less than 75 percent of the maximum deflection.
3. During and immediately after the test, the structure shall not show evidence of failure.

## SECTION 1709 PRECONSTRUCTION LOAD TESTS

**1709.1 General.** Where proposed construction is not capable of being designed by *approved* engineering analysis, or where proposed construction design method does not comply with the applicable material design standard, the system of construction or the structural unit and the connections shall be subjected to the tests prescribed in Section 1709. The *building official* shall accept certified reports of such tests conducted by an *approved* testing agency, provided that such tests meet the requirements of this code and *approved* procedures.

**1709.2 Load test procedures specified.** Where specific load test procedures, *load factors* and acceptance criteria are included in the applicable referenced standards, such test procedures, *load factors* and acceptance criteria shall apply. In the absence of specific test procedures, *load factors* or acceptance criteria, the corresponding provisions in Section 1709.3 shall apply.

**1709.3 Load test procedures not specified.** Where load test procedures are not specified in the applicable referenced standards, the load-bearing and deformation capacity of structural components and assemblies shall be determined on the basis of a test procedure developed by a *registered design professional* that simulates applicable loading and deformation conditions. For components and assemblies that are not a part of the *seismic force-resisting system*, the test shall be as specified in Section 1709.3.1. Load tests shall simulate the applicable loading conditions specified in Chapter 16.

**1709.3.1 Test procedure.** The test assembly shall be subjected to an increasing superimposed load equal to not less than two times the superimposed design load. The test load shall be left in place for a period of 24 hours. The tested assembly shall be considered to have successfully met the test requirements if the assembly recovers not less than 75 percent of the maximum deflection within 24 hours after the removal of the test load. The test assembly shall then be reloaded and subjected to an increasing superimposed load until either structural failure occurs or the superimposed load is equal to two and one-half times the load at which the deflection limitations specified in Section 1709.3.2 were reached, or the load is equal to two and one-half times the superimposed design load. In the case of structural components and assemblies for which deflection limitations are not specified in Section 1709.3.2, the test specimen shall be subjected to an increasing superimposed load until structural failure occurs or the load is equal to two and one-half times the desired superimposed design load. The allowable superimposed design load shall be taken as the least of:

1. The load at the deflection limitation given in Section 1709.3.2.
2. The failure load divided by 2.5.
3. The maximum load applied divided by 2.5.



**1709.3.2 Deflection.** The deflection of structural members under the design *load* shall not exceed the limitations in Section 1604.3.

**1709.4 Wall and partition assemblies.** *Load-bearing wall* and partition assemblies shall sustain the test load both with and without window framing. The test load shall include all design load components. Wall and partition assemblies shall be tested both with and without door and window framing.

**1709.5 Exterior window and door assemblies.** The design pressure rating of exterior windows and doors in buildings shall be determined in accordance with Section 1709.5.1 or 1709.5.2. For exterior windows and doors tested in accordance with Section 1709.5.1 or 1709.5.2, required design wind pressures determined from ASCE 7 shall be permitted to be converted to allowable stress design by multiplying by 0.6.

**Exception:** Structural wind load design pressures for window or door assemblies other than the size tested in accordance with Section 1709.5.1 or 1709.5.2 shall be permitted to be different than the design value of the tested assembly, provided that such pressures are determined by accepted engineering analysis or validated by an additional test of the window or door assembly to the alternative allowable design pressure in accordance with Section 1709.5.2. Components of the alternate size assembly shall be the same as the tested or labeled assembly. Where engineering analysis is used, it shall be performed in accordance with the analysis procedures of AAMA 2502.

**1709.5.1 Exterior windows and doors.** Exterior windows and sliding doors shall be tested and *labeled* as conforming to AAMA/WDMA/CSA101/I.S.2/A440. The *label* shall state the name of the manufacturer, the *approved* labeling agency and the product designation as specified in AAMA/WDMA/CSA101/I.S.2/A440. Exterior side-hinged doors shall be tested and *labeled* as conforming to AAMA/WDMA/CSA101/I.S.2/A440 or comply with Section 1709.5.2. Products tested and *labeled* as conforming to AAMA/WDMA/CSA 101/I.S.2/A440 shall not be subject to the requirements of Sections 2403.2 and 2403.3.

**1709.5.2 Exterior windows and door assemblies not provided for in Section 1709.5.1.** Exterior window and door assemblies shall be tested in accordance with ASTM E330. Exterior window and door assemblies containing glass shall comply with Section 2403. The design pressure for testing shall be calculated in accordance with Chapter 16. Each assembly shall be tested for 10 seconds at a load equal to 1.5 times the design pressure.

**1709.5.2.1 Garage doors and rolling doors.** Garage doors and rolling doors shall be tested in accordance with either ASTM E330 or ANSI/DASMA 108, and shall meet the pass/fail criteria of ANSI/DASMA 108. Garage doors and rolling doors shall be labeled with a permanent label identifying the door manufacturer, the door model/series number, the positive and negative

design wind pressure rating, the installation instruction drawing reference number, and the applicable test standard.

**1709.5.3 Windborne debris protection.** Protection of exterior glazed openings in buildings located in *windborne debris regions* shall be in accordance with Section 1609.2.

**1709.5.3.1 Impact protective systems testing and labeling.** *Impact protective systems* shall be tested for impact resistance by an approved independent laboratory for compliance with ASTM E1886 and ASTM E1996 and for design wind pressure for compliance with ASTM E330. Required design wind pressures shall be determined in accordance with ASCE 7, and for the purposes of this section, multiplied by 0.6 to convert to *allowable stress design*.

*Impact protective systems* shall have a permanent label applied in accordance with Section 1703.5.4, identifying the manufacturer, product designation, performance characteristics, and approved inspection agency.

**1709.6 Skylights and sloped glazing.** *Skylights and sloped glazing* shall comply with the requirements of Chapter 24.

**1709.7 Test specimens.** Test specimens and construction shall be representative of the materials, workmanship and details normally used in practice. The properties of the materials used to construct the test assembly shall be determined on the basis of tests on samples taken from the load assembly or on representative samples of the materials used to construct the load test assembly. Required tests shall be conducted or witnessed by an *approved agency*.



## CHAPTER 18

# SOILS AND FOUNDATIONS

### User notes:

**About this chapter:** Chapter 18 provides criteria for geotechnical and structural considerations in the selection, design and installation of foundation systems to support the loads imposed by the structure above. This chapter includes requirements for soils investigation and site preparation for receiving a foundation, including the load-bearing values for soils and protection for the foundation from frost and water intrusion. Section 1808 addresses the basic requirements for all foundation types while subsequent sections address foundation requirements that are specific to shallow foundations and deep foundations.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC–Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 1801 GENERAL

**1801.1 Scope.** The provisions of this chapter shall apply to building and foundation systems.

### SECTION 1802 DESIGN BASIS

**1802.1 General.** Allowable bearing pressures, allowable stresses and design formulas provided in this chapter shall be used with the *allowable stress design* load combinations specified in ASCE 7, Section 2.4 or the alternative allowable stress design load combinations of Section 1605.2. The quality and design of materials used structurally in excavations and foundations shall comply with the requirements specified in Chapters 16, 19, 21, 22 and 23. Excavations and fills shall comply with Chapter 33.

### SECTION 1803 GEOTECHNICAL INVESTIGATIONS

**1803.1 General.** Geotechnical investigations shall be conducted in accordance with Section 1803.2 and reported in accordance with Section 1803.6. Where required by the *building official* or where geotechnical investigations involve in-situ testing, laboratory testing or engineering calculations, such investigations shall be conducted by a *registered design professional*.

**1803.2 Investigations required.** Geotechnical investigations shall be conducted in accordance with Sections 1803.3 through 1803.5.

**Exception:** The *building official* shall be permitted to waive the requirement for a geotechnical investigation where satisfactory data from adjacent areas is available that demonstrates an investigation is not necessary for any of the conditions in Sections 1803.5.1 through 1803.5.6 and Sections 1803.5.10 and 1803.5.11.

**1803.3 Basis of investigation.** Soil classification shall be based on observation and any necessary tests of the materials disclosed by borings, test pits or other subsurface exploration made in appropriate locations. Additional studies shall

be made as necessary to evaluate slope stability, soil strength, position and adequacy of load-bearing soils, the effect of moisture variation on soil-bearing capacity, compressibility, liquefaction and expansiveness.

**1803.3.1 Scope of investigation.** The scope of the geotechnical investigation including the number and types of borings or soundings, the equipment used to drill or sample, the in-situ testing equipment and the laboratory testing program shall be determined by a *registered design professional*.

**1803.4 Qualified representative.** The investigation procedure and apparatus shall be in accordance with generally accepted engineering practice. The *registered design professional* shall have a fully qualified representative on site during all boring or sampling operations.

**1803.5 Investigated conditions.** Geotechnical investigations shall be conducted as indicated in Sections 1803.5.1 through 1803.5.12.

**1803.5.1 Classification.** Soil materials shall be classified in accordance with ASTM D2487.

**1803.5.2 Questionable soil.** Where the classification, strength or compressibility of the soil is in doubt or where a load-bearing value superior to that specified in this code is claimed, the *building official* shall be permitted to require that a geotechnical investigation be conducted.

**1803.5.3 Expansive soil.** In areas likely to have expansive soil, the *building official* shall require soil tests to determine where such soils do exist.

Soils meeting all four of the following provisions shall be considered to be expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

1. Plasticity index (PI) of 15 or greater, determined in accordance with ASTM D4318.
2. More than 10 percent of the soil particles pass a No.200 sieve (75  $\mu$ m), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.

## SOILS AND FOUNDATIONS

4. Expansion index greater than 20, determined in accordance with ASTM D4829.

**1803.5.4 Ground-water table.** A subsurface soil investigation shall be performed to determine whether the existing ground-water table is above or within 5 feet (1524 mm) below the elevation of the *lowest floor* level where such floor is located below the finished ground level adjacent to the foundation.

**Exception:** A subsurface soil investigation to determine the location of the ground-water table shall not be required where waterproofing is provided in accordance with Section 1805.

**1803.5.5 Deep foundations.** Where *deep foundations* will be used, a geotechnical investigation shall be conducted and shall include all of the following, unless sufficient data on which to base the design and installation is otherwise available:

1. Recommended *deep foundation* types and installed capacities.
2. Recommended center-to-center spacing of *deep foundation* elements.
3. Driving criteria.
4. Installation procedures.
5. Field inspection and reporting procedures (to include procedures for verification of the installed bearing capacity where required).
6. Load test requirements.
7. Suitability of *deep foundation* materials for the intended environment.
8. Designation of bearing stratum or strata.
9. Reductions for group action, where necessary.

**1803.5.6 Rock strata.** Where subsurface explorations at the project site indicate variations in the structure of rock on which foundations are to be constructed, a sufficient number of borings shall be drilled to sufficient depths to assess the competency of the rock and its load-bearing capacity.

**1803.5.7 Excavation near foundations.** Where excavation will reduce support from any foundation, a *registered design professional* shall prepare an assessment of the structure as determined from examination of the structure, available design documents, available subsurface data, and, if necessary, excavation of test pits. The *registered design professional* shall determine the requirements for support and protection of any existing foundation and prepare site-specific plans, details and sequence of work for submission. Such support shall be provided by underpinning, bracing, excavation retention systems, or by other means acceptable to the *building official*.

**1803.5.8 Compacted fill material.** Where *shallow foundations* will bear on compacted fill material more than 12 inches (305 mm) in depth, a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of compacted fill material.

2. Specifications for material to be used as compacted fill.
3. Test methods to be used to determine the maximum dry density and optimum moisture content of the material to be used as compacted fill.
4. Maximum allowable thickness of each lift of compacted fill material.
5. Field test method for determining the in-place dry density of the compacted fill.
6. Minimum acceptable in-place dry density expressed as a percentage of the maximum dry density determined in accordance with Item 3.
7. Number and frequency of field tests required to determine compliance with Item 6.

**1803.5.9 Controlled low-strength material (CLSM).** Where *shallow foundations* will bear on *controlled low-strength material (CLSM)*, a geotechnical investigation shall be conducted and shall include all of the following:

1. Specifications for the preparation of the site prior to placement of the *CLSM*.
2. Specifications for the *CLSM*.
3. Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the *CLSM*.
4. Test methods for determining the acceptance of the *CLSM* in the field.
5. Number and frequency of field tests required to determine compliance with Item 4.

**1803.5.10 Alternate setback and clearance.** Where setbacks or clearances other than those required in Section 1808.7 are desired, the *building official* shall be permitted to require a geotechnical investigation by a *registered design professional* to demonstrate that the intent of Section 1808.7 would be satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, *load* intensity and erosion characteristics of slope material.

**1803.5.11 Seismic Design Categories C through F.** For structures assigned to *Seismic Design Category C, D, E or F*, a geotechnical investigation shall be conducted, and shall include an evaluation of all of the following potential geologic and seismic hazards:

1. Slope instability.
2. Liquefaction.
3. Total and differential settlement.
4. Surface displacement due to faulting or seismically induced lateral spreading or lateral flow.

**1803.5.12 Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category D, E or F*, the geotechnical investigation required by Section 1803.5.11 shall include all of the following as applicable:

1. The determination of dynamic seismic lateral earth pressures on foundation walls and retaining walls supporting more than 6 feet (1.83 m) of



backfill height due to *design earthquake ground motions*.

2. The potential for liquefaction and soil strength loss evaluated for site peak ground acceleration, earthquake magnitude and source characteristics consistent with the maximum considered earthquake ground motions. Peak ground acceleration shall be determined based on one of the following:
  - 2.1. A site-specific study in accordance with Chapter 21 of ASCE 7.
  - 2.2. In accordance with Section 11.8.3 of ASCE 7.
3. An assessment of potential consequences of liquefaction and soil strength loss including, but not limited to, the following:
  - 3.1. Estimation of total and differential settlement.
  - 3.2. Lateral soil movement.
  - 3.3. Lateral soil *loads* on foundations.
  - 3.4. Reduction in foundation soil-bearing capacity and lateral soil reaction.
  - 3.5. Soil downdrag and reduction in axial and lateral soil reaction for pile foundations.
  - 3.6. Increases in soil lateral pressures on retaining walls.
  - 3.7. Flotation of buried structures.
4. Discussion of mitigation measures such as, but not limited to, the following:
  - 4.1. Selection of appropriate foundation type and depths.
  - 4.2. Selection of appropriate structural systems to accommodate anticipated displacements and forces.
  - 4.3. Ground stabilization.
  - 4.4. Any combination of these measures and how they shall be considered in the design of the structure.

**1803.6 Reporting.** Where geotechnical investigations are required, a written report of the investigations shall be submitted to the *building official* by the permit applicant at the time of permit application. This geotechnical report shall include, but need not be limited to, the following information:

1. A plot showing the location of the soil investigations.
2. A complete record of the soil boring and penetration test logs and soil samples.
3. A record of the soil profile.
4. Elevation of the water table, if encountered.
5. Recommendations for foundation type and design criteria, including but not limited to: bearing capacity of natural or compacted soil; provisions to mitigate the effects of expansive soils; mitigation of the effects of liquefaction, differential settlement and

varying soil strength; and the effects of adjacent loads.

6. Expected total and differential settlement.
7. *Deep foundation* information in accordance with Section 1803.5.5.
8. Special design and construction provisions for foundations of structures founded on expansive soils, as necessary.
9. Compacted fill material properties and testing in accordance with Section 1803.5.8.
10. *Controlled low-strength material* properties and testing in accordance with Section 1803.5.9.

## SECTION 1804 EXCAVATION, GRADING AND FILL

**1804.1 Excavation near foundations.** Excavation for any purpose shall not reduce vertical or lateral support for any foundation or adjacent foundation without first *underpinning* or protecting the foundation against detrimental lateral or vertical movement, or both, in accordance with Section 1803.5.7.

**1804.2 Underpinning.** Where *underpinning* is chosen to provide the protection or support of adjacent structures, the *underpinning* system shall be designed and installed in accordance with provisions of this chapter and Chapter 33.

**1804.2.1 Underpinning sequencing.** *Underpinning* shall be installed in a sequential manner that protects the neighboring structure and the working construction site. The sequence of installation shall be identified in the *approved construction documents*.

**1804.3 Placement of backfill.** The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or with a *controlled low-strength material (CLSM)*. The backfill shall be placed in lifts and compacted in a manner that does not damage the foundation or the waterproofing or dampproofing material.

**Exception:** *CLSM* need not be compacted.

**1804.4 Site grading.** The ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than 1 unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. If physical obstructions or lot lines prohibit 10 feet (3048 mm) of horizontal distance, a 5-percent slope shall be provided to an *approved* alternative method of diverting water away from the foundation. Swales used for this purpose shall be sloped not less than 2 percent where located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped not less than 2 percent away from the building.

### Exceptions:

1. Where climatic or soil conditions warrant, the slope of the ground away from the building foun-

## SOILS AND FOUNDATIONS

dation shall be permitted to be reduced to not less than 1 unit vertical in 48 units horizontal (2-percent slope).

2. Impervious surfaces shall be permitted to be sloped less than 2 percent where the surface is a door landing or *ramp* that is required to comply with Section 1010.1.4, 1012.3 or 1012.6.1.

The procedure used to establish the final ground level adjacent to the foundation shall account for additional settlement of the backfill.

**1804.5 Grading and fill in flood hazard areas.** In *flood hazard areas* established in Section 1612.3, grading, fill, or both, shall not be *approved*:

1. Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of *flood* water and, as applicable, wave action.
2. In *floodways*, unless it has been demonstrated through hydrologic and hydraulic analyses performed by a *registered design professional* in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in *flood* levels during the occurrence of the *design flood*.
3. In *coastal high hazard areas*, unless such fill is conducted or placed to avoid diversion of water and waves toward any building or structure.
4. Where *design flood elevations* are specified but *floodways* have not been designated, unless it has been demonstrated that the cumulative effect of the proposed *flood hazard area* encroachment, when combined with all other existing and anticipated *flood hazard area* encroachment, will not increase the *design flood elevation* more than 1 foot (305 mm) at any point.

**1804.6 Compacted fill material.** Where *shallow foundations* will bear on compacted fill material, the compacted fill shall comply with the provisions of an *approved* geotechnical report, as set forth in Section 1803.

**Exception:** Compacted fill material 12 inches (305 mm) in depth or less need not comply with an *approved* report, provided that the in-place dry density is not less than 90 percent of the maximum dry density at optimum moisture content determined in accordance with ASTM D1557. The compaction shall be verified by *special inspection* in accordance with Section 1705.6.

**1804.7 Controlled low-strength material (CLSM).** Where *shallow foundations* will bear on *controlled low-strength material (CLSM)*, the *CLSM* shall comply with the provisions of an *approved* geotechnical report, as set forth in Section 1803.

## SECTION 1805 DAMPPOOFING AND WATERPROOFING

**1805.1 General.** Walls or portions thereof that retain earth and enclose interior spaces and floors below grade shall be

waterproofed and dampproofed in accordance with this section, with the exception of those spaces containing groups other than residential and institutional where such omission is not detrimental to the building or occupancy.

Ventilation for crawl spaces shall comply with Section 1202.4.

**1805.1.1 Story above grade plane.** Where a *basement* is considered a *story above grade plane* and the finished ground level adjacent to the basement wall is below the basement floor elevation for 25 percent or more of the perimeter, the floor and walls shall be dampproofed in accordance with Section 1805.2 and a foundation drain shall be installed in accordance with Section 1805.4.2. The foundation drain shall be installed around the portion of the perimeter where the basement floor is below ground level. The provisions of Sections 1803.5.4, 1805.3 and 1805.4.1 shall not apply in this case.

**1805.1.2 Under-floor space.** The finished ground level of an under-floor space such as a crawl space shall not be located below the bottom of the footings. Where there is evidence that the ground-water table rises to within 6 inches (152 mm) of the ground level at the outside building perimeter, or that the surface water does not readily drain from the building site, the ground level of the under-floor space shall be as high as the outside finished ground level, unless an *approved* drainage system is provided. The provisions of Sections 1803.5.4, 1805.2, 1805.3 and 1805.4 shall not apply in this case.

**1805.1.2.1 Flood hazard areas.** For buildings and structures in *flood hazard areas* as established in Section 1612.3, the finished ground level of an under-floor space such as a crawl space shall be equal to or higher than the outside finished ground level on one side or more.

**Exception:** Under-floor spaces of Group R-3 buildings that meet the requirements of FEMA TB 11.

**1805.1.3 Ground-water control.** Where the ground-water table is lowered and maintained at an elevation not less than 6 inches (152 mm) below the bottom of the *lowest floor*, the floor and walls shall be dampproofed in accordance with Section 1805.2. The design of the system to lower the ground-water table shall be based on accepted principles of engineering that shall consider, but not necessarily be limited to, permeability of the soil, rate at which water enters the drainage system, rated capacity of pumps, head against which pumps are to operate and the rated capacity of the disposal area of the system.

**1805.2 Dampproofing.** Where hydrostatic pressure will not occur as determined by Section 1803.5.4, floors and walls for other than wood foundation systems shall be dampproofed in accordance with this section. Wood foundation systems shall be constructed in accordance with AWC PWF.

**1805.2.1 Floors.** Dampproofing materials for floors shall be installed between the floor and the base course required by Section 1805.4.1, except where a separate floor is provided above a concrete slab.

Where installed beneath the slab, dampproofing shall consist of not less than 6-mil (0.006 inch; 0.152 mm) polyethylene with joints lapped not less than 6 inches (152 mm), or other *approved* methods or materials. Where permitted to be installed on top of the slab, dampproofing shall consist of mopped-on bitumen, not less than 4-mil (0.004 inch; 0.102 mm) polyethylene, or other *approved* methods or materials. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

**1805.2.2 Walls.** Dampproofing materials for walls shall be installed on the exterior surface of the wall, and shall extend from the top of the footing to above ground level.

Dampproofing shall consist of a bituminous material, 3 pounds per square yard (16 N/m<sup>2</sup>) of acrylic modified cement,  $\frac{1}{8}$  inch (3.2 mm) coat of *surface-bonding mortar* complying with ASTM C887, any of the materials permitted for waterproofing by Section 1805.3.2 or other *approved* methods or materials.

**1805.2.2.1 Surface preparation of walls.** Prior to application of dampproofing materials on concrete walls, holes and recesses resulting from the removal of form ties shall be sealed with a bituminous material or other *approved* methods or materials. Unit masonry walls shall be parged on the exterior surface below ground level with not less than  $\frac{3}{8}$  inch (9.5 mm) of Portland cement *mortar*. The parging shall be coved at the footing.

**Exception:** Parging of unit masonry walls is not required where a material is *approved* for direct application to the masonry.

**1805.3 Waterproofing.** Where the ground-water investigation required by Section 1803.5.4 indicates that a hydrostatic pressure condition exists, and the design does not include a ground-water control system as described in Section 1805.1.3, walls and floors shall be waterproofed in accordance with this section.

**1805.3.1 Floors.** Floors required to be waterproofed shall be of concrete and designed and constructed to withstand the hydrostatic pressures to which the floors will be subjected.

Waterproofing shall be accomplished by placing a membrane of rubberized asphalt, butyl rubber, fully adhered/fully bonded HDPE or polyolefin composite membrane or not less than 6-mil [0.006 inch (0.152 mm)] polyvinyl chloride with joints lapped not less than 6 inches (152 mm) or other *approved* materials under the slab. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

**1805.3.2 Walls.** Walls required to be waterproofed shall be of concrete or masonry and shall be designed and constructed to withstand the hydrostatic pressures and other lateral *loads* to which the walls will be subjected.

Waterproofing shall be applied from the bottom of the wall to not less than 12 inches (305 mm) above the maximum elevation of the ground-water table. The remainder of the wall shall be dampproofed in accordance with Section 1805.2.2. Waterproofing shall consist of two-ply hot-mopped felts, not less than 6-mil (0.006 inch; 0.152 mm) polyvinyl chloride, 40-mil (0.040 inch; 1.02 mm) polymer-modified asphalt, 6-mil (0.006 inch; 0.152 mm) polyethylene or other *approved* methods or materials capable of bridging nonstructural cracks. Joints in the membrane shall be lapped and sealed in accordance with the manufacturer's installation instructions.

**1805.3.2.1 Surface preparation of walls.** Prior to the application of waterproofing materials on concrete or masonry walls, the walls shall be prepared in accordance with Section 1805.2.2.1.

**1805.3.3 Joints and penetrations.** *Joints* in walls and floors, *joints* between the wall and floor and penetrations of the wall and floor shall be made watertight utilizing *approved* methods and materials.

**1805.4 Subsoil drainage system.** Where a hydrostatic pressure condition does not exist, dampproofing shall be provided and a base shall be installed under the floor and a drain installed around the foundation perimeter. A subsoil drainage system designed and constructed in accordance with Section 1805.1.3 shall be deemed adequate for lowering the ground-water table.

**1805.4.1 Floor base course.** Floors of basements, except as provided for in Section 1805.1.1, shall be placed over a floor base course not less than 4 inches (102 mm) in thickness that consists of gravel or crushed stone containing not more than 10 percent of material that passes through a No. 4 (4.75 mm) sieve.

**Exception:** Where a site is located in well-drained gravel or sand/gravel mixture soils, a floor base course is not required.

**1805.4.2 Foundation drain.** A drain shall be placed around the perimeter of a foundation that consists of gravel or crushed stone containing not more than 10-percent material that passes through a No. 4 (4.75 mm) sieve. The drain shall extend not less than 12 inches (305 mm) beyond the outside edge of the footing. The thickness shall be such that the bottom of the drain is not higher than the bottom of the base under the floor, and that the top of the drain is not less than 6 inches (152 mm) above the top of the footing. The top of the drain shall be covered with an *approved* filter membrane material. Where a drain tile or perforated pipe is used, the invert of the pipe or tile shall not be higher than the floor elevation. The top of joints or the top of perforations shall be protected with an *approved* filter membrane material. The pipe or tile shall be placed on not less than 2 inches (51 mm) of gravel or crushed stone complying with Section 1805.4.1, and shall be covered with not less than 6 inches (152 mm) of the same material.

## SOILS AND FOUNDATIONS

**1805.4.3 Drainage discharge.** The floor base and foundation perimeter drain shall discharge by gravity or mechanical means into an *approved* drainage system that complies with the *International Plumbing Code*.

**Exception:** Where a site is located in well-drained gravel or sand/gravel mixture soils, a dedicated drainage system is not required.

### SECTION 1806 PRESUMPTIVE LOAD-BEARING VALUES OF SOILS

**1806.1 Load combinations.** The presumptive load-bearing values provided in Table 1806.2 shall be used with the *allowable stress design* load combinations specified in ASCE 7, Section 2.4 or the alternative allowable stress design load combinations of Section 1605.2. The values of vertical foundation pressure and lateral bearing pressure given in Table 1806.2 shall be permitted to be increased by one-third where used with the alternative allowable stress design load combinations of Section 1605.2 that include wind or earthquake *loads*.

**1806.2 Presumptive load-bearing values.** The load-bearing values used in design for supporting soils near the surface shall not exceed the values specified in Table 1806.2 unless data to substantiate the use of higher values are submitted and *approved*. Where the *building official* has reason to doubt the classification, strength or compressibility of the soil, the requirements of Section 1803.5.2 shall be satisfied.

Presumptive load-bearing values shall apply to materials with similar physical characteristics and dispositions. Mud, organic silt, organic clays, peat or unprepared fill shall not be assumed to have a presumptive load-bearing capacity unless data to substantiate the use of such a value are submitted.

**Exception:** A presumptive load-bearing capacity shall be permitted to be used where the *building official* deems the load-bearing capacity of mud, organic silt or unprepared fill is adequate for the support of lightweight or temporary structures.

**1806.3 Lateral load resistance.** Where the presumptive values of Table 1806.2 are used to determine resistance to lateral *loads*, the calculations shall be in accordance with Sections 1806.3.1 through 1806.3.4.

**1806.3.1 Combined resistance.** The total resistance to lateral *loads* shall be permitted to be determined by combining the values derived from the lateral bearing pressure and the lateral sliding resistance specified in Table 1806.2.

**1806.3.2 Lateral sliding resistance limit.** For clay, sandy clay, silty clay, clayey silt, silt and sandy silt, the lateral sliding resistance shall not exceed one-half the *dead load*.

**1806.3.3 Increase for depth.** The lateral bearing pressures specified in Table 1806.2 shall be permitted to be increased by the tabular value for each additional foot (305 mm) of depth to a value that is not greater than 15 times the tabular value.

**1806.3.4 Increase for poles.** Isolated poles for uses such as flagpoles or signs and poles used to support buildings that are not adversely affected by a  $\frac{1}{2}$ -inch (12.7 mm) motion at the ground surface due to short-term lateral *loads* shall be permitted to be designed using lateral bearing pressures equal to two times the tabular values.

### SECTION 1807 FOUNDATION WALLS, RETAINING WALLS AND EMBEDDED POSTS AND POLES

**1807.1 Foundation walls.** Foundation walls shall be designed and constructed in accordance with Sections 1807.1.1 through 1807.1.6. Foundation walls shall be supported by foundations designed in accordance with Section 1808.

**1807.1.1 Design lateral soil loads.** Foundation walls shall be designed for the lateral soil *loads* set forth in Section 1610.

**1807.1.2 Unbalanced backfill height.** Unbalanced backfill height is the difference in height between the exterior

TABLE 1806.2  
PRESUMPTIVE LOAD-BEARING VALUES

CLASS OF MATERIALS	VERTICAL FOUNDATION PRESSURE (psf)	LATERAL BEARING PRESSURE (psf/ft below natural grade)	LATERAL SLIDING RESISTANCE	
			Coefficient of friction <sup>a</sup>	Cohesion (psf) <sup>b</sup>
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500	100	—	130

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Cohesion value to be multiplied by the contact area, as limited by Section 1806.3.2.



finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the *interior finish* ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill height shall be permitted to be measured from the exterior finish ground level to the top of the interior concrete slab.

**1807.1.3 Rubble stone foundation walls.** Foundation walls of rough or random rubble stone shall be not less than 16 inches (406 mm) thick. Rubble stone shall not be used for foundation walls of structures assigned to *Seismic Design Category C, D, E or F*.

**1807.1.4 Permanent wood foundation systems.** Permanent wood foundation systems shall be designed and installed in accordance with AWC PWF. Lumber and plywood shall be preservative treated in accordance with AWWA U1 (Commodity Specification A, Special Requirement 4.2) and shall be identified in accordance with Section 2303.1.9.1.

**1807.1.5 Concrete and masonry foundation walls.** Concrete and masonry foundation walls shall be designed in accordance with Chapter 19 or 21, as applicable.

**Exception:** Concrete and masonry foundation walls shall be permitted to be designed and constructed in accordance with Section 1807.1.6.

**1807.1.6 Prescriptive design of concrete and masonry foundation walls.** Concrete and masonry foundation walls that are laterally supported at the top and bottom shall be permitted to be designed and constructed in accordance with this section.

**1807.1.6.1 Foundation wall thickness.** The thickness of prescriptively designed foundation walls shall be not less than the thickness of the wall supported, except that foundation walls of not less than 8-inch (203 mm) nominal width shall be permitted to support brick-veneered frame walls and 10-inch-wide (254 mm) *cavity walls* provided that the requirements of Section 1807.1.6.2 or 1807.1.6.3 are met.

**1807.1.6.2 Concrete foundation walls.** Concrete foundation walls shall comply with the following:

1. The thickness shall comply with the requirements of Table 1807.1.6.2.
2. The size and spacing of vertical reinforcement shown in Table 1807.1.6.2 are based on the use of reinforcement with a minimum yield strength of 60,000 pounds per square inch (psi) (414 MPa). Vertical reinforcement with a minimum yield strength of 40,000 psi (276 MPa) or 50,000 psi (345 MPa) shall be permitted, provided that the same size bar is used and the spacing shown in the table is reduced by multiplying the spacing by 0.67 or 0.83, respectively.
3. Vertical reinforcement, where required, shall be placed nearest the inside face of the wall a distance,  $d$ , from the outside face (soil face) of

the wall. The distance,  $d$ , is equal to the wall thickness,  $t$ , minus 1.25 inches (32 mm) plus one-half the bar diameter,  $d_b$ , [ $d = t - (1.25 + d_b / 2)$ ]. The reinforcement shall be placed within a tolerance of  $\pm 3/8$  inch (9.5 mm) where  $d$  is less than or equal to 8 inches (203 mm) or  $\pm 1/2$  inch (12.7 mm) where  $d$  is greater than 8 inches (203 mm).

4. In lieu of the reinforcement shown in Table 1807.1.6.2, smaller reinforcing bar sizes with closer spacings that provide an equivalent cross-sectional area of reinforcement per unit length shall be permitted.
5. Concrete cover for reinforcement measured from the inside face of the wall shall be not less than  $3/4$  inch (19.1 mm). Concrete cover for reinforcement measured from the outside face of the wall shall be not less than  $1\frac{1}{2}$  inches (38 mm) for No. 5 bars and smaller, and not less than 2 inches (51 mm) for larger bars.
6. Concrete shall have a specified compressive strength,  $f'_c$ , of not less than 2,500 psi (17.2 MPa).
7. The unfactored axial load per linear foot of wall shall not exceed  $1.2 t f'_c$  where  $t$  is the specified wall thickness in inches.

**1807.1.6.2.1 Seismic requirements.** Based on the *seismic design category* assigned to the structure in accordance with Section 1613, concrete foundation walls designed using Table 1807.1.6.2 shall be subject to the following limitations:

1. *Seismic Design Categories A and B.* Not less than one No. 5 bar shall be provided around window, door and similar sized openings. The bar shall be anchored to develop  $f_y$  in tension at the corners of openings.
2. *Seismic Design Categories C, D, E and F.* Tables shall not be used except as allowed for plain concrete members in Section 1905.1.7.

**1807.1.6.3 Masonry foundation walls.** Masonry foundation walls shall comply with the following:

1. The thickness shall comply with the requirements of Table 1807.1.6.3(1) for *plain masonry* walls or Table 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4) for masonry walls with reinforcement.
2. Vertical reinforcement shall have a minimum yield strength of 60,000 psi (414 MPa).
3. The specified location of the reinforcement shall equal or exceed the effective depth distance,  $d$ , noted in Tables 1807.1.6.3(2), 1807.1.6.3(3) and 1807.1.6.3(4) and shall be measured from the face of the exterior (soil) side of the wall to the center of the vertical reinforcement. The reinforcement shall be placed within the tolerances specified in TMS 602, Article 3.4.B.11, of the specified location.
4. Grout shall comply with Section 2103.3.

## SOILS AND FOUNDATIONS

5. Concrete *masonry units* shall comply with ASTM C90.
6. Clay *masonry units* shall comply with ASTM C652 for hollow brick, except compliance with ASTM C62 or ASTM C216 shall be permitted where solid *masonry units* are installed in accordance with Table 1807.1.6.3(1) for *plain masonry*.
7. *Masonry units* shall be laid in *running bond* and installed with Type M or S *mortar* in accordance with Section 2103.2.1.
8. The unfactored axial *load* per linear foot of wall shall not exceed  $1.2 t f'_m$  where  $t$  is the specified wall thickness in inches and  $f'_m$  is the *specified compressive strength of masonry* in pounds per square inch.
9. Not less than 4 inches (102 mm) of *solid masonry* shall be provided at girder supports at the top of hollow *masonry unit* foundation walls.
10. Corbeling of masonry shall be in accordance with Section 2104.1. Where an 8-inch (203 mm) wall is corbeled, the top corbel shall not extend higher than the bottom of the floor framing and shall be a full course of headers not less than 6 inches (152 mm) in length or the top course *bed joint* shall be tied to the vertical wall projection. The tie shall be W2.8 (4.8 mm) and spaced at a maximum horizontal distance of 36 inches (914 mm). The hollow space behind the corbelled masonry shall be filled with *mortar* or grout.

**TABLE 1807.1.6.2**  
**CONCRETE FOUNDATION WALLS<sup>b, c</sup>**

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>a</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)								
		Design lateral soil load <sup>a</sup> (psf per foot of depth)								
		30 <sup>d</sup>			45 <sup>d</sup>			60		
		Minimum wall thickness (inches)								
		7.5	9.5	11.5	7.5	9.5	11.5	7.5	9.5	11.5
5	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
6	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	PC	PC	PC
7	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 48	PC	PC
	7	PC	PC	PC	#5 at 46	PC	PC	#6 at 48	PC	PC
8	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 43	PC	PC
	7	PC	PC	PC	#5 at 41	PC	PC	#6 at 43	PC	PC
	8	#5 at 47	PC	PC	#6 at 43	PC	PC	#6 at 32	#6 at 44	PC
9	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 39	PC	PC
	7	PC	PC	PC	#5 at 37	PC	PC	#6 at 38	#5 at 37	PC
	8	#5 at 41	PC	PC	#6 at 38	#5 at 37	PC	#7 at 39	#6 at 39	#4 at 48
	9 <sup>d</sup>	#6 at 46	PC	PC	#7 at 41	#6 at 41	PC	#7 at 31	#7 at 41	#6 at 39
10	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 37	PC	PC
	7	PC	PC	PC	#6 at 48	PC	PC	#6 at 35	#6 at 48	PC
	8	#5 at 38	PC	PC	#7 at 47	#6 at 47	PC	#7 at 35	#7 at 47	#6 at 45
	9 <sup>d</sup>	#6 at 41	#4 at 48	PC	#7 at 37	#7 at 48	#4 at 48	#6 at 22	#7 at 37	#7 at 47
	10 <sup>d</sup>	#7 at 45	#6 at 45	PC	#7 at 31	#7 at 40	#6 at 38	#6 at 22	#7 at 30	#7 at 38

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.2.

c. PC = Plain Concrete.

d. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable (see Section 1610).

e. For height of unbalanced backfill, see Section 1807.1.2.

**1807.1.6.3.1 Alternative foundation wall reinforcement.** In lieu of the reinforcement provisions for masonry foundation walls in Table 1807.1.6.3(2), 1807.1.6.3(3) or 1807.1.6.3(4), alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per linear foot (mm) of wall shall be permitted to be used, provided that the spacing of reinforcement does not exceed 72 inches (1829 mm) and reinforcing bar sizes do not exceed No. 11.

**1807.1.6.3.2 Seismic requirements.** Based on the *seismic design category* assigned to the structure in accordance with Section 1613, masonry foundation walls designed using Tables 1807.1.6.3(1) through 1807.1.6.3(4) shall be subject to the following limitations:

1. *Seismic Design Categories A and B.* No additional seismic requirements.
2. *Seismic Design Category C.* A design using Tables 1807.1.6.3(1) through 1807.1.6.3(4) is subject to the seismic requirements of Section 7.4.3 of TMS 402.
3. *Seismic Design Category D.* A design using Tables 1807.1.6.3(2) through 1807.1.6.3(4) is subject to the seismic requirements of Section 7.4.4 of TMS 402.
4. *Seismic Design Categories E and F.* A design using Tables 1807.1.6.3(2) through 1807.1.6.3(4) is subject to the seismic requirements of Section 7.4.5 of TMS 402.

**1807.2 Retaining walls.** Retaining walls shall be designed in accordance with Sections 1807.2.1 through 1807.2.4.

**1807.2.1 General.** Retaining walls shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift.

**1807.2.2 Design lateral soil loads.** Retaining walls shall be designed for the lateral soil *loads* set forth in Section 1610. For structures assigned to *Seismic Design Category D, E, or F*, the design of retaining walls supporting more than 6 feet (1829 mm) of backfill height shall incorporate the additional seismic lateral earth pressure in accordance with the geotechnical investigation where required in Section 1803.2.

**1807.2.3 Safety factor.** Retaining walls shall be designed to resist the lateral action of soil to produce sliding and overturning with a minimum safety factor of 1.5 in each case. The load combinations of Section 1605 shall not apply to this requirement. Instead, design shall be based on 0.7 times nominal earthquake *loads*, 1.0 times other *nominal loads*, and investigation with one or more of the variable *loads* set to zero. The safety factor against lateral sliding shall be taken as the available soil resistance at the base of the retaining wall foundation divided by the net lateral force applied to the retaining wall.

**Exception:** Where earthquake loads are included, the minimum safety factor for retaining wall sliding and overturning shall be 1.1.

**1807.2.4 Segmental retaining walls.** Dry-cast concrete units used in the construction of segmental retaining walls shall comply with ASTM C1372.

**TABLE 1807.1.6.3(1)**  
**PLAIN MASONRY FOUNDATION WALLS<sup>a, b, c</sup>**

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>e</sup> (feet)	MINIMUM NOMINAL WALL THICKNESS (inches)		
		Design lateral soil loads (psf per foot of depth)		
		30'	45'	60
7	4 (or less)	8	8	8
	5	8	10	10
	6	10	12	10 (solid <sup>c</sup> )
	7	12	10 (solid <sup>c</sup> )	10 (solid <sup>c</sup> )
8	4 (or less)	8	8	8
	5	8	10	12
	6	10	12	12 (solid <sup>c</sup> )
	7	12	12 (solid <sup>c</sup> )	Note d
9	8	10 (solid <sup>c</sup> )	12 (solid <sup>c</sup> )	Note d
	4 (or less)	8	8	8
	5	8	10	12
	6	12	12	12 (solid <sup>c</sup> )
	7	12 (solid <sup>c</sup> )	12 (solid <sup>c</sup> )	Note d
	8	12 (solid <sup>c</sup> )	Note d	Note d
	9 <sup>f</sup>	Note d	Note d	Note d

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. Solid grouted hollow units or solid masonry units.

d. A design in compliance with Chapter 21 or reinforcement in accordance with Table 1807.1.6.3(2) is required.

e. For height of unbalanced backfill, see Section 1807.1.2.

f. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable (see Section 1610).

## SOILS AND FOUNDATIONS

**1807.3 Embedded posts and poles.** Designs to resist both axial and lateral *loads* employing posts or poles as columns embedded in earth or in concrete footings in earth shall be in accordance with Sections 1807.3.1 through 1807.3.3.

**1807.3.1 Limitations.** The design procedures outlined in this section are subject to the following limitations:

1. The frictional resistance for structural walls and slabs on silts and clays shall be limited to one-half of the normal force imposed on the soil by the weight of the footing or slab.
2. Posts embedded in earth shall not be used to provide lateral support for structural or nonstructural materials such as plaster, masonry or concrete unless bracing is provided that develops the limited deflection required.

Wood poles shall be treated in accordance with AWWA U1 for sawn timber posts (Commodity Specification A,

Use Category 4B) and for round timber posts (Commodity Specification B, Use Category 4B).

**1807.3.2 Design criteria.** The depth to resist lateral *loads* shall be determined using the design criteria established in Sections 1807.3.2.1 through 1807.3.2.3, or by other methods *approved* by the *building official*.

**1807.3.2.1 Nonconstrained.** The following formula shall be used in determining the depth of embedment required to resist lateral *loads* where lateral constraint is not provided at the ground surface, such as by a rigid floor or rigid ground surface pavement, and where lateral constraint is not provided above the ground surface, such as by a structural *diaphragm*.

$$d = 0.5A \{ 1 + [1 + (4.36h/A)]^{1/2} \} \quad \text{(Equation 18-1)}$$

where:

$$A = 2.34P/(S_1 b).$$

**TABLE 1807.1.6.3(2)**  
**8-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE  $d \geq 5$  INCHES<sup>a, b, c</sup>**

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>a</sup> (feet-inches)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Design lateral soil load <sup>a</sup> (psf per foot of depth)		
		30°	45°	60
7-4	4-0 (or less)	#4 at 48	#4 at 48	#4 at 48
	5-0	#4 at 48	#4 at 48	#4 at 48
	6-0	#4 at 48	#5 at 48	#5 at 48
	7-4	#5 at 48	#6 at 48	#7 at 48
8-0	4-0 (or less)	#4 at 48	#4 at 48	#4 at 48
	5-0	#4 at 48	#4 at 48	#4 at 48
	6-0	#4 at 48	#5 at 48	#5 at 48
	7-0	#5 at 48	#6 at 48	#7 at 48
	8-0	#5 at 48	#6 at 48	#7 at 48
8-8	4-0 (or less)	#4 at 48	#4 at 48	#4 at 48
	5-0	#4 at 48	#4 at 48	#5 at 48
	6-0	#4 at 48	#5 at 48	#6 at 48
	7-0	#5 at 48	#6 at 48	#7 at 48
	8-8 <sup>e</sup>	#6 at 48	#7 at 48	#8 at 48
9-4	4-0 (or less)	#4 at 48	#4 at 48	#4 at 48
	5-0	#4 at 48	#4 at 48	#5 at 48
	6-0	#4 at 48	#5 at 48	#6 at 48
	7-0	#5 at 48	#6 at 48	#7 at 48
	8-0	#6 at 48	#7 at 48	#8 at 48
	9-4 <sup>e</sup>	#7 at 48	#8 at 48	#9 at 48
10-0	4-0 (or less)	#4 at 48	#4 at 48	#4 at 48
	5-0	#4 at 48	#4 at 48	#5 at 48
	6-0	#4 at 48	#5 at 48	#6 at 48
	7-0	#5 at 48	#6 at 48	#7 at 48
	8-0	#6 at 48	#7 at 48	#8 at 48
	9-0 <sup>e</sup>	#7 at 48	#8 at 48	#9 at 48
	10-10 <sup>e</sup>	#7 at 48	#9 at 48	#9 at 48

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. For alternative reinforcement, see Section 1807.1.6.3.1.

d. For height of unbalanced backfill, see Section 1807.1.2.

e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.



$b$  = Diameter of round post or footing or diagonal dimension of square post or footing, feet (m).

$d$  = Depth of embedment in earth in feet (m) but not over 12 feet (3658 mm) for purpose of computing lateral pressure.

$h$  = Distance in feet (m) from ground surface to point of application of “ $P$ .”

$P$  = Applied lateral force in pounds (kN).

$S_1$  = Allowable lateral soil-bearing pressure as set forth in Section 1806.2 based on a depth of one-third the depth of embedment in pounds per square foot (psf) (kPa).

**1807.3.2.2 Constrained.** The following formula shall be used to determine the depth of embedment required to resist lateral loads where lateral constraint is provided at the ground surface, such as by a rigid floor or pavement.

$$d = \sqrt{\frac{4.25Ph}{S_3b}} \quad (\text{Equation 18-2})$$

or alternatively

$$d = \sqrt{\frac{4.25M_g}{S_3b}} \quad (\text{Equation 18-3})$$

where:

$M_g$  = Moment in the post at grade, in foot-pounds (kN-m).

$S_3$  = Allowable lateral soil-bearing pressure as set forth in Section 1806.2 based on a depth equal to the depth of embedment in pounds per square foot (kPa).

**1807.3.2.3 Vertical load.** The resistance to vertical loads shall be determined using the vertical foundation pressure set forth in Table 1806.2.

**TABLE 1807.1.6.3(3)**  
**10-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE  $d \geq 6.75$  INCHES<sup>a, b, c</sup>**

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>d</sup> (feet-inches)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Design lateral soil load <sup>e</sup> (psf per foot of depth)		
		30°	45°	60
7-4	4-0 (or less)	#4 at 56	#4 at 56	#4 at 56
	5-0	#4 at 56	#4 at 56	#4 at 56
	6-0	#4 at 56	#4 at 56	#5 at 56
	7-4	#4 at 56	#5 at 56	#6 at 56
8-0	4-0 (or less)	#4 at 56	#4 at 56	#4 at 56
	5-0	#4 at 56	#4 at 56	#4 at 56
	6-0	#4 at 56	#4 at 56	#5 at 56
	7-0	#4 at 56	#5 at 56	#6 at 56
	8-0	#5 at 56	#6 at 56	#7 at 56
8-8	4-0 (or less)	#4 at 56	#4 at 56	#4 at 56
	5-0	#4 at 56	#4 at 56	#4 at 56
	6-0	#4 at 56	#4 at 56	#5 at 56
	7-0	#4 at 56	#5 at 56	#6 at 56
	8-8 <sup>e</sup>	#5 at 56	#7 at 56	#8 at 56
9-4	4-0 (or less)	#4 at 56	#4 at 56	#4 at 56
	5-0	#4 at 56	#4 at 56	#4 at 56
	6-0	#4 at 56	#5 at 56	#5 at 56
	7-0	#4 at 56	#5 at 56	#6 at 56
	8-0	#5 at 56	#6 at 56	#7 at 56
	9-4 <sup>e</sup>	#6 at 56	#7 at 56	#7 at 56
10-0	4-0 (or less)	#4 at 56	#4 at 56	#4 at 56
	5-0	#4 at 56	#4 at 56	#4 at 56
	6-0	#4 at 56	#5 at 56	#5 at 56
	7-0	#5 at 56	#6 at 56	#7 at 56
	8-0	#5 at 56	#7 at 56	#8 at 56
	9-0 <sup>e</sup>	#6 at 56	#7 at 56	#9 at 56
	10-0 <sup>e</sup>	#7 at 56	#8 at 56	#9 at 56

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 1.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. For alternative reinforcement, see Section 1807.1.6.3.1.

d. For height of unbalanced backfill, see Section 1807.1.2.

e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

## SOILS AND FOUNDATIONS

**1807.3.3 Backfill.** The backfill in the *annular space* around columns not embedded in poured footings shall be by one of the following methods:

1. Backfill shall be of concrete with a specified compressive strength of not less than 2,000 psi (13.8 MPa). The hole shall be not less than 4 inches (102 mm) larger than the diameter of the column at its bottom or 4 inches (102 mm) larger than the diagonal dimension of a square or rectangular column.
2. Backfill shall be of clean sand. The sand shall be thoroughly compacted by tamping in layers not more than 8 inches (203 mm) in depth.
3. Backfill shall be of *controlled low-strength material (CLSM)*.

SECTION 1808  
FOUNDATIONS

**1808.1 General.** Foundations shall be designed and constructed in accordance with Sections 1808.2 through 1808.9. *Shallow foundations* shall satisfy the requirements of Section 1809. *Deep foundations* shall satisfy the requirements of Section 1810.

**1808.2 Design for capacity and settlement.** Foundations shall be so designed that the allowable bearing capacity of the soil is not exceeded, and that differential settlement is minimized. Foundations in areas with expansive soils shall be designed in accordance with the provisions of Section 1808.6.

**1808.3 Design loads.** Foundations shall be designed for the most unfavorable effects due to the combinations of *loads* specified in Section 2.3 or 2.4 of ASCE 7 or the alternative

**TABLE 1807.1.6.3(4)**  
**12-INCH MASONRY FOUNDATION WALLS WITH REINFORCEMENT WHERE  $d \geq 8.75$  INCHES<sup>a, b, c</sup>**

MAXIMUM WALL HEIGHT (feet-inches)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>d</sup> (feet-inches)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Design lateral soil load <sup>e</sup> (psf per foot of depth)		
		30°	45°	60°
7-4	4 (or less)	#4 at 72	#4 at 72	#4 at 72
	5-0	#4 at 72	#4 at 72	#4 at 72
	6-0	#4 at 72	#4 at 72	#5 at 72
	7-4	#4 at 72	#5 at 72	#6 at 72
8-0	4 (or less)	#4 at 72	#4 at 72	#4 at 72
	5-0	#4 at 72	#4 at 72	#4 at 72
	6-0	#4 at 72	#4 at 72	#5 at 72
	7-0	#4 at 72	#5 at 72	#6 at 72
8-8	8-0	#5 at 72	#6 at 72	#8 at 72
	4 (or less)	#4 at 72	#4 at 72	#4 at 72
	5-0	#4 at 72	#4 at 72	#4 at 72
	6-0	#4 at 72	#4 at 72	#5 at 72
9-4	7-0	#4 at 72	#5 at 72	#6 at 72
	8-0	#5 at 72	#6 at 72	#7 at 72
	9-4°	#6 at 72	#7 at 72	#8 at 72
10-0	4 (or less)	#4 at 72	#4 at 72	#4 at 72
	5-0	#4 at 72	#4 at 72	#4 at 72
	6-0	#4 at 72	#5 at 72	#5 at 72
	7-0	#4 at 72	#6 at 72	#6 at 72
	8-0	#5 at 72	#6 at 72	#7 at 72
	9-0°	#6 at 72	#7 at 72	#8 at 72
	10-0°	#7 at 72	#8 at 72	#9 at 72

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/m.

a. For design lateral soil loads, see Section 1610.

b. Provisions for this table are based on design and construction requirements specified in Section 1807.1.6.3.

c. For alternative reinforcement, see Section 1807.1.6.3.1.

d. For height of unbalanced backfill, see Section 1807.1.2.

e. Where unbalanced backfill height exceeds 8 feet and design lateral soil loads from Table 1610.1 are used, the requirements for 30 and 45 psf per foot of depth are not applicable. See Section 1610.

allowable stress design load combinations of Section 1605.2. The *dead load* is permitted to include the weight of foundations and overlying fill. Reduced *live loads*, as specified in Sections 1607.12 and 1607.14, shall be permitted to be used in the design of foundations.

**1808.3.1 Seismic overturning.** Where foundations are proportioned using the load combinations of Section 2.3 or 2.4 of ASCE 7 and the computation of seismic overturning effects is by equivalent lateral force analysis or modal analysis, the proportioning shall be in accordance with Section 12.13.4 of ASCE 7.

**1808.3.2 Surcharge.** Fill or other surcharge *loads* shall not be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional *loads* caused by the fill or the surcharge. Existing footings or foundations that will be affected by any excavation shall be underpinned or otherwise protected against settlement and shall be protected against detrimental lateral or vertical movement or both.

**Exception:** Minor grading for landscaping purposes shall be permitted where done with walk-behind equipment, where the grade is not increased more than 1 foot (305 mm) from original design grade or where approved by the *building official*.

**1808.4 Vibratory loads.** Where machinery operations or other vibrations are transmitted through the foundation, consideration shall be given in the foundation design to prevent detrimental disturbances of the soil.

**1808.5 Shifting or moving soils.** Where it is known that the shallow subsoils are of a shifting or moving character, foundations shall be carried to a sufficient depth to ensure stability.

**1808.6 Design for expansive soils.** Foundations for buildings and structures founded on expansive soils shall be designed in accordance with Section 1808.6.1 or 1808.6.2.

**Exceptions:** Foundation design need not comply with Section 1808.6.1 or 1808.6.2 where one of the following conditions is satisfied:

1. The soil is removed in accordance with Section 1808.6.3.
2. The *building official* approves stabilization of the soil in accordance with Section 1808.6.4.

**1808.6.1 Foundations.** Foundations placed on or within the active zone of expansive soils shall be designed to resist differential volume changes and to prevent structural damage to the supported structure. Deflection and racking of the supported structure shall be limited to that which will not interfere with the usability and serviceability of the structure.

Foundations placed below where volume change occurs or below expansive soil shall comply with the following provisions:

1. Foundations extending into or penetrating expansive soils shall be designed to prevent uplift of the supported structure.

2. Foundations penetrating expansive soils shall be designed to resist forces exerted on the foundation due to soil volume changes or shall be isolated from the expansive soil.

**1808.6.2 Slab-on-ground foundations.** Moments, shears and deflections for use in designing slab-on-ground, mat or raft foundations on expansive soils shall be determined in accordance with WRI/CRSI *Design of Slab-on-Ground Foundations* or PTI DC 10.5. Using the moments, shears and deflections determined above, nonprestressed slabs-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with WRI/CRSI *Design of Slab-on-Ground Foundations* and post-tensioned slab-on-ground, mat or raft foundations on expansive soils shall be designed in accordance with PTI DC 10.5. It shall be permitted to analyze and design such slabs by other methods that account for soil-structure interaction, the deformed shape of the soil support, the plate or stiffened plate action of the slab as well as both center lift and edge lift conditions. Such alternative methods shall be rational and the basis for all aspects and parameters of the method shall be available for peer review.

**1808.6.3 Removal of expansive soil.** Where expansive soil is removed in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be removed to a depth sufficient to ensure a constant moisture content in the remaining soil. Fill material shall not contain expansive soils and shall comply with Section 1804.5 or 1804.6.

**Exception:** Expansive soil need not be removed to the depth of constant moisture, provided that the confining pressure in the expansive soil created by the fill and supported structure exceeds the swell pressure.

**1808.6.4 Stabilization.** Where the active zone of expansive soils is stabilized in lieu of designing foundations in accordance with Section 1808.6.1 or 1808.6.2, the soil shall be stabilized by chemical, dewatering, presaturation or equivalent techniques.

**1808.7 Foundations on or adjacent to slopes.** The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall comply with Sections 1808.7.1 through 1808.7.5.

**1808.7.1 Building clearance from ascending slopes.** In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section 1808.7.5 and Figure 1808.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

## SOILS AND FOUNDATIONS

**1808.7.2 Foundation setback from descending slope surface.** Foundations on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the foundation without detrimental settlement. Except as provided for in Section 1808.7.5 and Figure 1808.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

**1808.7.3 Pools.** The setback between pools regulated by this code and slopes shall be equal to one-half the building footing setback distance required by this section. That portion of the pool wall within a horizontal distance of 7 feet (2134 mm) from the top of the slope shall be capable of supporting the water in the pool without soil support.

**1808.7.4 Foundation elevation.** On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an *approved* drainage device not less than 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the *building official*, provided

that it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

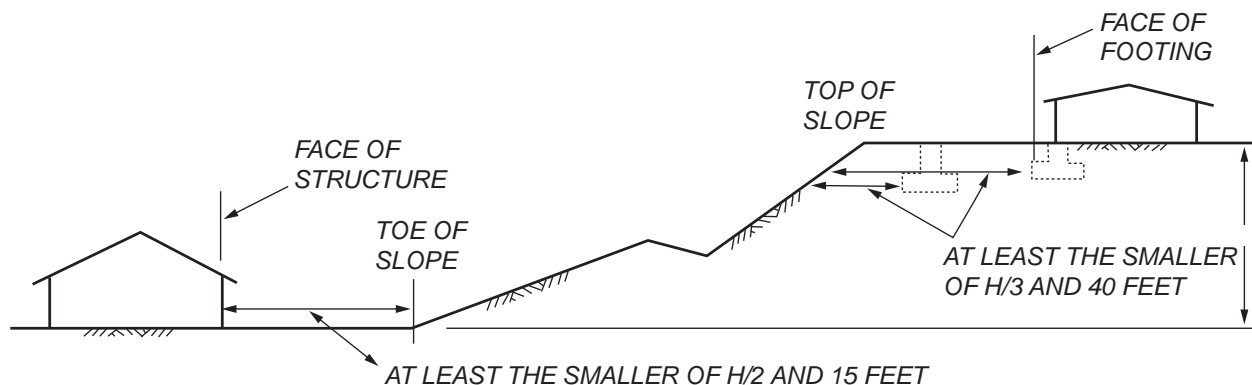
**1808.7.5 Alternate setback and clearance.** Alternate setbacks and clearances are permitted, subject to the approval of the *building official*. The *building official* shall be permitted to require a geotechnical investigation as set forth in Section 1803.5.10.

**1808.8 Concrete foundations.** The design, materials and construction of concrete foundations shall comply with Sections 1808.8.1 through 1808.8.6 and the provisions of Chapter 19.

**Exception:** Where concrete footings supporting walls of *light-frame construction* are designed in accordance with Table 1809.7, a specific design in accordance with Chapter 19 is not required.

**1808.8.1 Concrete or grout strength and mix proportioning.** Concrete or grout in foundations shall have a specified compressive strength ( $f'_c$ ) not less than the largest applicable value indicated in Table 1808.8.1.

Where concrete or grout is to be pumped, the mix design including slump shall be adjusted to produce a pumpable mixture.



For SI: 1 foot = 304.8 mm.

**FIGURE 1808.7.1**  
**FOUNDATION CLEARANCES FROM SLOPES**

**TABLE 1808.8.1**  
**MINIMUM SPECIFIED COMPRESSIVE STRENGTH  $f'_c$  OF CONCRETE OR GROUT**

FOUNDATION ELEMENT OR CONDITION	SPECIFIED COMPRESSIVE STRENGTH, $f'_c$
1. Foundations for structures assigned to Seismic Design Category A, B or C	2,500 psi
2a. Foundations for Group R or U occupancies of light-frame construction, two stories or less in height, assigned to Seismic Design Category D, E or F	2,500 psi
2b. Foundations for other structures assigned to Seismic Design Category D, E or F	3,000 psi
3. Precast nonprestressed driven piles	4,000 psi
4. Socketed drilled shafts	4,000 psi
5. Micropiles	4,000 psi
6. Precast prestressed driven piles	5,000 psi

For SI: 1 pound per square inch = 0.00689 MPa.



**1808.8.2 Concrete cover.** The concrete cover provided for prestressed and nonprestressed reinforcement in foundations shall be not less than the largest applicable value specified in Table 1808.8.2. Longitudinal bars spaced less than  $1\frac{1}{2}$  inches (38 mm) clear distance apart shall be considered to be bundled bars for which the concrete cover provided shall be not less than that required by Section 20.5.1.3.5 of ACI 318. Concrete cover shall be measured from the concrete surface to the outermost surface of the steel to which the cover requirement applies. Where concrete is placed in a temporary or permanent casing or a mandrel, the inside face of the casing or mandrel shall be considered to be the concrete surface.

**1808.8.3 Placement of concrete.** Concrete shall be placed in such a manner as to ensure the exclusion of any foreign matter and to secure a full-size foundation. Concrete shall not be placed through water unless a tremie or other method *approved* by the *building official* is used. Where placed under or in the presence of water, the concrete shall be deposited by *approved* means to ensure minimum segregation of the mix and negligible turbulence of the water. Where depositing concrete from the top of a *deep foundation* element, the concrete shall be chuted directly into smooth-sided pipes or tubes or placed in a rapid and continuous operation through a funnel hopper centered at the top of the element.

**1808.8.4 Protection of concrete.** Concrete foundations shall be protected from freezing during depositing and for a period of not less than 5 days thereafter. Water shall not be allowed to flow through the deposited concrete.

**1808.8.5 Forming of concrete.** Concrete foundations are permitted to be cast against the earth where, in the opinion of the *building official*, soil conditions do not require formwork. Where formwork is required, it shall be in accordance with Section 26.11 of ACI 318.

**1808.8.6 Seismic requirements.** See Section 1905 for additional requirements for foundations of structures assigned to *Seismic Design Category* C, D, E or F.

For structures assigned to *Seismic Design Category* D, E or F, provisions of Section 18.13 of ACI 318 shall apply where not in conflict with the provisions of Sections 1808 through 1810.

**Exceptions:**

1. Detached one- and two-family dwellings of *light-frame construction* and two stories or less above *grade plane* are not required to comply with the provisions of Section 18.13 of ACI 318.
2. Section 18.13.4.3(a) of ACI 318 shall not apply.

**1808.9 Vertical masonry foundation elements.** Vertical masonry foundation elements that are not *foundation piers* as defined in Section 202 shall be designed as piers, walls or columns, as applicable, in accordance with TMS 402.

## SECTION 1809 SHALLOW FOUNDATIONS

**1809.1 General.** *Shallow foundations* shall be designed and constructed in accordance with Sections 1809.2 through 1809.13.

**1809.2 Supporting soils.** *Shallow foundations* shall be built on undisturbed soil, compacted fill material or *controlled low-strength material (CLSM)*. Compacted fill material shall be placed in accordance with Section 1804.5. *CLSM* shall be placed in accordance with Section 1804.6.

**1809.3 Stepped footings.** The top surface of footings shall be level. The bottom surface of footings shall be permitted to have a slope not exceeding 1 unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footing or where the surface of the ground slopes more than 1 unit vertical in 10 units horizontal (10-percent slope).

**1809.4 Depth and width of footings.** The minimum depth of footings below the undisturbed ground surface shall be 12 inches (305 mm). Where applicable, the requirements of

TABLE 1808.8.2  
MINIMUM CONCRETE COVER

FOUNDATION ELEMENT OR CONDITION	MINIMUM COVER
1. Shallow foundations	In accordance with Section 20.5 of ACI 318
2. Precast nonprestressed deep foundation elements	
Exposed to seawater	3 inches
Not manufactured under plant conditions	2 inches
Manufactured under plant control conditions	In accordance with Section 20.5.1.3.3 of ACI 318
3. Precast prestressed deep foundation elements	
Exposed to seawater	2.5 inches
Other	In accordance with Section 20.5.1.3.3 of ACI 318
4. Cast-in-place deep foundation elements not enclosed by a steel pipe, tube or permanent casing	2.5 inches
5. Cast-in-place deep foundation elements enclosed by a steel pipe, tube or permanent casing	1 inch
6. Structural steel core within a steel pipe, tube or permanent casing	2 inches
7. Cast-in-place drilled shafts enclosed by a stable rock socket	1.5 inches

For SI: 1 inch = 25.4 mm.

## SOILS AND FOUNDATIONS

Section 1809.5 shall be satisfied. The minimum width of footings shall be 12 inches (305 mm).

**1809.5 Frost protection.** Except where otherwise protected from frost, foundations and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extending below the frost line of the locality.
2. Constructing in accordance with ASCE 32.
3. Erecting on solid rock.

**Exception:** Free-standing buildings meeting all of the following conditions shall not be required to be protected:

1. Assigned to *Risk Category I*.
2. Area of 600 square feet (56 m<sup>2</sup>) or less for *light-frame construction* or 400 square feet (37 m<sup>2</sup>) or less for other than *light-frame construction*.
3. Eave height of 10 feet (3048 mm) or less.

*Shallow foundations* shall not bear on frozen soil unless such frozen condition is of a permanent character.

**1809.5.1 Frost protection at required exits.** Frost protection shall be provided at exterior landings for all required exits with outward-swinging doors. Frost protection shall only be required to the extent necessary to ensure the unobstructed opening of the required *exit* doors.

**1809.6 Location of footings.** Footings on granular soil shall be so located that the line drawn between the lower edges of adjoining footings shall not have a slope steeper than 30 degrees (0.52 rad) with the horizontal, unless the material supporting the higher footing is braced or retained or otherwise laterally supported in an *approved* manner or a greater slope has been properly established by engineering analysis.

**1809.7 Prescriptive footings for light-frame construction.** Where a specific design is not provided, concrete or masonry-unit footings supporting walls of *light-frame construction* shall be permitted to be designed in accordance with Table 1809.7.

**1809.8 Plain concrete footings.** The edge thickness of plain concrete footings supporting walls of other than *light-frame construction* shall be not less than 8 inches (203 mm) where placed on soil or rock.

**Exception:** For plain concrete footings supporting Group R-3 occupancies, the edge thickness is permitted to be 6 inches (152 mm), provided that the footing does not extend beyond a distance greater than the thickness of the footing on either side of the supported wall.

**1809.9 Masonry-unit footings.** The design, materials and construction of masonry-unit footings shall comply with Sections 1809.9.1 and 1809.9.2, and the provisions of Chapter 21.

**Exception:** Where a specific design is not provided, masonry-unit footings supporting walls of *light-frame construction* shall be permitted to be designed in accordance with Table 1809.7.

**1809.9.1 Dimensions.** Masonry-unit footings shall be laid in Type M or S *mortar* complying with Section 2103.2.1 and the depth shall be not less than twice the projection beyond the wall, pier or column. The width shall be not less than 8 inches (203 mm) wider than the wall supported thereon.

**1809.9.2 Offsets.** The maximum offset of each course in brick foundation walls stepped up from the footings shall be 1½ inches (38 mm) where laid in single courses, and 3 inches (76 mm) where laid in double courses.

**1809.10 Pier and curtain wall foundations.** Except in *Seismic Design Categories D, E and F*, pier and curtain wall foundations shall be permitted to be used to support *light-frame construction* not more than two *stories above grade plane*, provided that the following requirements are met:

1. All *load-bearing walls* shall be placed on continuous concrete footings bonded integrally with the *exterior wall* footings.
2. The minimum actual thickness of a load-bearing masonry wall shall be not less than 4 inches (102 mm) nominal or 3⅝ inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced 6 feet (1829 mm) on center (o.c.).
3. Piers shall be constructed in accordance with Chapter 21 and the following:
  - 3.1. The unsupported height of the masonry piers shall not exceed 10 times their least dimension.
  - 3.2. Where *structural clay tile* or hollow concrete *masonry units* are used for piers supporting beams and girders, the cellular

**TABLE 1809.7**  
**PRESCRIPTIVE FOOTINGS SUPPORTING**  
**WALLS OF LIGHT-FRAME CONSTRUCTION<sup>a, b, c, d, e</sup>**

NUMBER OF FLOORS SUPPORTED BY THE FOOTING <sup>f</sup>	WIDTH OF FOOTING (inches)	THICKNESS OF FOOTING (inches)
1	12	6
2	15	6
3	18	8 <sup>g</sup>

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Depth of footings shall be in accordance with Section 1809.4.
- b. The ground under the floor shall be permitted to be excavated to the elevation of the top of the footing.
- c. Interior stud-bearing walls shall be permitted to be supported by isolated footings. The footing width and length shall be twice the width shown in this table, and footings shall be spaced not more than 6 feet on center.
- d. See Section 1905 for additional requirements for concrete footings of structures assigned to Seismic Design Category C, D, E or F.
- e. For thickness of foundation walls, see Section 1807.1.6.
- f. Footings shall be permitted to support a roof in addition to the stipulated number of floors. Footings supporting roof only shall be as required for supporting one floor.
- g. Plain concrete footings for Group R-3 occupancies shall be permitted to be 6 inches thick.

spaces shall be filled solidly with concrete or Type M or S mortar.

**Exception:** Unfilled hollow piers shall be permitted where the unsupported height of the pier is not more than four times its least dimension.

- 3.3. Hollow piers shall be capped with 4 inches (102 mm) of *solid masonry* or concrete or the cavities of the top course shall be filled with concrete or grout.
4. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood frame walls and floors shall not be more than 4 feet (1219 mm) in height.
5. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for *solid masonry*, nor 12 inches (305 mm) for hollow masonry.

**1809.11 Steel grillage footings.** Grillage footings of *structural steel elements* shall be separated with *approved* steel spacers and be entirely encased in concrete with not less than 6 inches (152 mm) on the bottom and not less than 4 inches (102 mm) at all other points. The spaces between the shapes shall be completely filled with concrete or cement grout.

**1809.12 Timber footings.** Timber footings shall be permitted for buildings of Type V construction and as otherwise *approved* by the *building official*. Such footings shall be treated in accordance with AWP A U1 (Commodity Specification A, Use Category 4B). Treated timbers are not required where placed entirely below permanent water level, or where used as capping for wood piles that project above the water level over submerged or marsh lands. The compressive stresses perpendicular to grain in untreated timber footings supported on treated piles shall not exceed 70 percent of the allowable stresses for the species and grade of timber as specified in the ANSI/AWC NDS.

**1809.13 Footing seismic ties.** Where a structure is assigned to *Seismic Design Category* D, E or F, individual spread footings founded on soil defined in Chapter 20 of ASCE 7 as *Site Class* E or F shall be interconnected by ties. Unless it is demonstrated that equivalent restraint is provided by reinforced concrete beams within slabs on grade or reinforced concrete slabs on grade, ties shall be capable of carrying, in tension or compression, a force equal to the lesser of the product of the larger footing design gravity load times the seismic coefficient,  $S_{DS}$ , divided by 10 and 25 percent of the smaller footing design gravity load.

## SECTION 1810 DEEP FOUNDATIONS

**1810.1 General.** *Deep foundations* shall be analyzed, designed, detailed and installed in accordance with Sections 1810.1 through 1810.4.

**1810.1.1 Geotechnical investigation.** *Deep foundations* shall be designed and installed on the basis of a geotechnical investigation as set forth in Section 1803.

**1810.1.2 Use of existing deep foundation elements.** *Deep foundation* elements left in place where a structure has been demolished shall not be used for the support of new construction unless satisfactory evidence is submitted to the *building official*, which indicates that the elements are sound and meet the requirements of this code. Such elements shall be load tested or redriven to verify their capacities. The design *load* applied to such elements shall be the lowest allowable *load* as determined by tests or redriving data.

**1810.1.3 Deep foundation elements classified as columns.** *Deep foundation* elements standing unbraced in air, water or fluid soils shall be classified as columns and designed as such in accordance with the provisions of this code from their top down to the point where adequate lateral support is provided in accordance with Section 1810.2.1.

**Exception:** Where the unsupported height to least horizontal dimension of a cast-in-place *deep foundation* element does not exceed three, it shall be permitted to design and construct such an element as a pedestal in accordance with ACI 318.

**1810.1.4 Special types of deep foundations.** The use of types of *deep foundation* elements not specifically mentioned herein is permitted, subject to the approval of the *building official*, upon the submission of acceptable test data, calculations and other information relating to the structural properties and load capacity of such elements. The allowable stresses for materials shall not in any case exceed the limitations specified herein.

**1810.2 Analysis.** The analysis of *deep foundations* for design shall be in accordance with Sections 1810.2.1 through 1810.2.5.

**1810.2.1 Lateral support.** Any soil other than fluid soil shall be deemed to afford sufficient lateral support to prevent buckling of *deep foundation* elements and to permit the design of the elements in accordance with accepted engineering practice and the applicable provisions of this code.

Where *deep foundation* elements stand unbraced in air, water or fluid soils, it shall be permitted to consider them laterally supported at a point 5 feet (1524 mm) into stiff soil or 10 feet (3048 mm) into soft soil unless otherwise *approved* by the *building official* on the basis of a geotechnical investigation by a *registered design professional*.

**1810.2.2 Stability.** *Deep foundation* elements shall be braced to provide lateral stability in all directions. Three or more elements connected by a rigid cap shall be considered to be braced, provided that the elements are located in radial directions from the centroid of the group not less than 60 degrees (1 rad) apart. A two-element group in a rigid cap shall be considered to be braced along the axis connecting the two elements. Methods used to brace *deep foundation* elements shall be subject to the approval of the *building official*.



## SOILS AND FOUNDATIONS

*Deep foundation* elements supporting walls shall be placed alternately in lines spaced not less than 1 foot (305 mm) apart and located symmetrically under the center of gravity of the wall load carried, unless effective measures are taken to provide for eccentricity and lateral forces, or the foundation elements are adequately braced to provide for lateral stability.

### Exceptions:

1. Isolated cast-in-place *deep foundation* elements without lateral bracing shall be permitted where the least horizontal dimension is not less than 2 feet (610 mm), adequate lateral support in accordance with Section 1810.2.1 is provided for the entire height and the height does not exceed 12 times the least horizontal dimension.
2. A single row of *deep foundation* elements without lateral bracing is permitted for one- and two-family dwellings and lightweight construction not exceeding two *stories above grade plane* or 35 feet (10 668 mm) in *building height*, provided that the centers of the elements are located within the width of the supported wall.

**1810.2.3 Settlement.** The settlement of a single *deep foundation* element or group thereof shall be estimated based on *approved* methods of analysis. The predicted settlement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

**1810.2.4 Lateral loads.** The moments, shears and lateral deflections used for design of *deep foundation* elements shall be established considering the nonlinear interaction of the shaft and soil, as determined by a *registered design professional*. Where the ratio of the depth of embedment of the element to its least horizontal dimension is less than or equal to six, it shall be permitted to assume the element is rigid.

### 1810.2.4.1 Seismic Design Categories D through F.

For structures assigned to *Seismic Design Category* D, E or F, *deep foundation* elements on *Site Class* E or F sites, as determined in Section 1613.2.2, shall be designed and constructed to withstand maximum imposed curvatures from earthquake ground motions and structure response. Curvatures shall include free-field soil strains modified for soil-foundation-structure interaction coupled with foundation element deformations associated with earthquake *loads* imparted to the foundation by the structure.

**Exception:** *Deep foundation* elements that satisfy the following additional detailing requirements shall be deemed to comply with the curvature capacity requirements of this section.

1. Precast prestressed concrete piles detailed in accordance with Section 1810.3.8.
2. Cast-in-place *deep foundation* elements with a minimum longitudinal reinforce-

ment ratio of 0.005 extending the full length of the element and detailed in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 as required by Section 1810.3.9.4.2.2.

**1810.2.5 Group effects.** The analysis shall include group effects on lateral behavior where the center-to-center spacing of *deep foundation* elements in the direction of lateral force is less than eight times the least horizontal dimension of an element. The analysis shall include group effects on axial behavior where the center-to-center spacing of *deep foundation* elements is less than three times the least horizontal dimension of an element. Group effects shall be evaluated using a generally accepted method of analysis; the analysis for uplift of grouped elements with center-to-center spacing less than three times the least horizontal dimension of an element shall be evaluated in accordance with Section 1810.3.3.1.6.

**1810.3 Design and detailing.** *Deep foundations* shall be designed and detailed in accordance with Sections 1810.3.1 through 1810.3.13.

**1810.3.1 Design conditions.** Design of *deep foundations* shall include the design conditions specified in Sections 1810.3.1.1 through 1810.3.1.6, as applicable.

### 1810.3.1.1 Design methods for concrete elements.

Where concrete *deep foundations* are laterally supported in accordance with Section 1810.2.1 for the entire height and applied forces cause bending moments not greater than those resulting from accidental eccentricities, structural design of the element using the allowable stress design load combinations specified in ASCE 7, Section 2.4 or the alternative allowable stress design load combinations of Section 1605.2 and the allowable stresses specified in this chapter shall be permitted. Otherwise, the structural design of concrete *deep foundation* elements shall use the strength load combinations specified in ASCE 7, Section 2.3 and *approved* strength design methods.

**1810.3.1.2 Composite elements.** Where a single *deep foundation* element comprises two or more sections of different materials or different types spliced together, each section of the composite assembly shall satisfy the applicable requirements of this code, and the maximum allowable *load* in each section shall be limited by the structural capacity of that section.

**1810.3.1.3 Mislocation.** The foundation or superstructure shall be designed to resist the effects of the mislocation of any *deep foundation* element by not less than 3 inches (76 mm). To resist the effects of mislocation, compressive overload of *deep foundation* elements to 110 percent of the allowable design load shall be permitted.

**1810.3.1.4 Driven piles.** Driven piles shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by handling, driving and service loads.



**1810.3.1.5 Helical piles.** *Helical piles* shall be designed and manufactured in accordance with accepted engineering practice to resist all stresses induced by installation into the ground and service loads.

**1810.3.1.6 Casings.** Temporary and permanent casings shall be of steel and shall be sufficiently strong to resist collapse and sufficiently watertight to exclude any foreign materials during the placing of concrete. Where a permanent casing is considered reinforcing steel, the steel shall be protected under the conditions specified in Section 1810.3.2.5. Horizontal joints in the casing shall be spliced in accordance with Section 1810.3.6.

**1810.3.2 Materials.** The materials used in *deep foundation* elements shall satisfy the requirements of Sections 1810.3.2.1 through 1810.3.2.8, as applicable.

**1810.3.2.1 Concrete.** Where concrete is cast in a steel pipe or where an enlarged base is formed by compacting concrete, the maximum size for coarse aggregate shall be  $\frac{3}{4}$  inch (19.1 mm). Concrete to be compacted shall have a zero slump.

**1810.3.2.1.1 Seismic hooks.** For structures assigned to *Seismic Design Category* C, D, E or F, the ends of hoops, spirals and ties used in concrete *deep foundation* elements shall be terminated with seismic hooks, as defined in ACI 318, and shall be turned into the confined concrete core.

**1810.3.2.1.2 ACI 318 Equation (25.7.3.3).** Where this chapter requires detailing of concrete *deep foundation* elements in accordance with Section 18.7.5.4 of ACI 318, compliance with Equation (25.7.3.3) of ACI 318 shall not be required.

**1810.3.2.2 Prestressing steel.** Prestressing steel shall conform to ASTM A416.

**1810.3.2.3 Steel.** Structural steel H-piles and structural steel sheet piling shall conform to the material requirements in ASTM A6. Steel pipe piles shall conform to the material requirements in ASTM A252. Fully welded steel piles shall be fabricated from plates that conform to the material requirements in ASTM A36, ASTM A283, ASTM A572, ASTM A588 or ASTM A690.

**1810.3.2.4 Timber.** Timber *deep foundation* elements shall be designed as piles or poles in accordance with ANSI/AWC NDS. Round timber elements shall conform to ASTM D25. Sawn timber elements shall conform to DOC PS-20.

**1810.3.2.4.1 Preservative treatment.** Timber *deep foundation* elements used to support permanent structures shall be treated in accordance with this section unless it is established that the tops of the untreated timber elements will be below the lowest ground-water level assumed to exist during the life of the structure. Preservative and minimum final retention shall be in accordance with AWP A U1

(Commodity Specification E, Use Category 4C) for round timber elements and AWP A U1 (Commodity Specification A, Use Category 4B) for sawn timber elements. Preservative-treated timber elements shall be subject to a quality control program administered by an *approved* agency. Element cutoffs shall be treated in accordance with AWP A M4.

**1810.3.2.5 Protection of materials.** Where boring records or site conditions indicate possible deleterious action on the materials used in deep foundation elements because of soil constituents, changing water levels or other factors, the elements shall be adequately protected by materials, methods or processes *approved* by the *building official*. Protective materials shall be applied to the elements so as not to be rendered ineffective by installation. The effectiveness of such protective measures for the particular purpose shall have been thoroughly established by satisfactory service records or other evidence.

**1810.3.2.6 Allowable stresses.** The allowable stresses for materials used in deep foundation elements shall not exceed those specified in Table 1810.3.2.6.

**1810.3.2.7 Increased allowable compressive stress for cased mandrel-driven cast-in-place elements.** The allowable compressive stress in the concrete shall be permitted to be increased as specified in Table 1810.3.2.6 for those portions of permanently cased cast-in-place elements that satisfy all of the following conditions:

1. The design shall not use the casing to resist any portion of the axial load imposed.
2. The casing shall have a sealed tip and be mandrel driven.
3. The thickness of the casing shall be not less than manufacturer's standard gage No.14 (0.068 inch) (1.75 mm).
4. The casing shall be seamless or provided with seams of strength equal to the basic material and be of a configuration that will provide confinement to the cast-in-place concrete.
5. The ratio of steel yield strength ( $F_y$ ) to specified compressive strength ( $f'_c$ ) shall be not less than six.
6. The nominal diameter of the element shall not be greater than 16 inches (406 mm).

**1810.3.2.8 Justification of higher allowable stresses.** Use of allowable stresses greater than those specified in Section 1810.3.2.6 shall be permitted where supporting data justifying such higher stresses is filed with the *building official*. Such substantiating data shall include the following:

1. A geotechnical investigation in accordance with Section 1803.
2. Load tests in accordance with Section 1810.3.3.1.2, regardless of the load supported by the element.

## SOILS AND FOUNDATIONS

The design and installation of the deep foundation elements shall be under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations who shall submit a report to the *building official* stating that the elements as installed satisfy the design criteria.

**1810.3.3 Determination of allowable loads.** The allowable axial and lateral loads on deep foundation elements shall be determined by an *approved* formula, load tests or method of analysis.

**1810.3.3.1 Allowable axial load.** The allowable axial load on a deep foundation element shall be determined in accordance with Sections 1810.3.3.1.1 through 1810.3.3.1.9.

**Exception:** Where approved by the *building official*, load testing is not required.

**1810.3.3.1.1 Driving criteria.** The allowable compressive load on any driven deep foundation element where determined by the application of an *approved* driving formula shall not exceed 40 tons (356 kN). For allowable loads above 40 tons (356 kN), the wave equation method of analysis shall be used to estimate driveability for both driving stresses and net displacement per blow at the ultimate load.

mate load. Allowable loads shall be verified by load tests in accordance with Section 1810.3.3.1.2. The formula or wave equation load shall be determined for gravity-drop or power-actuated hammers and the hammer energy used shall be the maximum consistent with the size, strength and weight of the driven elements. The use of a follower is permitted only with the approval of the *building official*. The introduction of fresh hammer cushion or pile cushion material just prior to final penetration is not permitted.

**1810.3.3.1.2 Load tests.** Where design compressive loads are greater than those determined using the allowable stresses specified in Section 1810.3.2.6, where the design load for any deep foundation element is in doubt, or where cast-in-place deep foundation elements have an enlarged base formed either by compacting concrete or by driving a precast base, control test elements shall be tested in accordance with ASTM D1143 or ASTM D4945. One element or more shall be load tested in each area of uniform subsoil conditions. Where required by the *building official*, additional elements shall be load tested where necessary to establish the safe design capacity. The resulting allowable loads shall

**TABLE 1810.3.2.6**  
**ALLOWABLE STRESSES FOR MATERIALS USED IN DEEP FOUNDATION ELEMENTS**

MATERIAL TYPE AND CONDITION	MAXIMUM ALLOWABLE STRESS <sup>a</sup>
1. Concrete or grout in compression <sup>b</sup> Cast-in-place with a permanent casing in accordance with Section 1810.3.2.7 or Section 1810.3.5.3.4 Cast-in-place in other permanent casing or rock Cast-in-place without a permanent casing Precast nonprestressed Precast prestressed	$0.4 f'_c$ $0.33 f'_c$ $0.3 f'_c$ $0.33 f'_c$ $0.33 f'_c - 0.27 f_{pc}$
2. Nonprestressed reinforcement in compression	$0.4 f_y \leq 30,000$ psi
3. Steel in compression Cores within concrete-filled pipes or tubes Pipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8 Pipes or tubes for micropiles Other pipes, tubes or H-piles Helical piles	$0.5 F_y \leq 32,000$ psi $0.5 F_y \leq 32,000$ psi $0.4 F_y \leq 32,000$ psi $0.35 F_y \leq 24,000$ psi $0.6 F_y \leq 0.5 F_u$
4. Nonprestressed reinforcement in tension Within micropiles Other conditions For load combinations that do not include wind or seismic loads For load combinations that include wind or seismic loads	$0.6 f_y$ $0.5 f_y \leq 30,000$ psi $0.5 f_y \leq 40,000$ psi
5. Steel in tension Pipes, tubes or H-piles, where justified in accordance with Section 1810.3.2.8 Other pipes, tubes or H-piles Helical piles	$0.5 F_y \leq 32,000$ psi $0.35 F_y \leq 24,000$ psi $0.6 F_y \leq 0.5 F_u$
6. Timber	In accordance with the ANSI/AWC NDS

a.  $f'_c$  is the specified compressive strength of the concrete or grout;  $f_{pc}$  is the compressive stress on the gross concrete section due to effective prestress forces only;  $f_y$  is the specified yield strength of reinforcement;  $F_y$  is the specified minimum yield stress of steel;  $F_u$  is the specified minimum tensile stress of structural steel.

b. The stresses specified apply to the gross cross-sectional area of the concrete for precast prestressed piles and to the net cross-sectional area for all other piles. Where a temporary or permanent casing is used, the inside face of the casing shall be considered the outer edge of the concrete cross-section.

not be more than one-half of the ultimate axial load capacity of the test element as assessed by one of the published methods listed in Section 1810.3.3.1.3 with consideration for the test type, duration and subsoil. The ultimate axial load capacity shall be determined by a *registered design professional* with consideration given to tolerable total and differential settlements at design *load* in accordance with Section 1810.2.3. In subsequent installation of the balance of deep foundation elements, all elements shall be deemed to have a supporting capacity equal to that of the control element where such elements are of the same type, size and relative length as the test element; are installed using the same or comparable methods and equipment as the test element; are installed in similar subsoil conditions as the test element; and, for driven elements, where the rate of penetration (for example, net displacement per blow) of such elements is equal to or less than that of the test element driven with the same hammer through a comparable driving distance.

**1810.3.3.1.3 Load test evaluation methods.** It shall be permitted to evaluate load tests of *deep foundation* elements using any of the following methods:

1. Davisson Offset Limit.
2. Brinch-Hansen 90-percent Criterion.
3. Butler-Hoy Criterion.
4. Other methods *approved* by the *building official*.

**1810.3.3.1.4 Allowable shaft resistance.** The assumed shaft resistance developed by any uncased cast-in-place *deep foundation* element shall not exceed one-sixth of the bearing value of the soil material at minimum depth as set forth in Table 1806.2, up to 500 psf (24 kPa), unless a greater value is allowed by the *building official* on the basis of a geotechnical investigation as specified in Section 1803 or a greater value is substantiated by a load test in accordance with Section 1810.3.3.1.2. Shaft resistance and end-bearing resistance shall not be assumed to act simultaneously unless determined by a geotechnical investigation in accordance with Section 1803.

**1810.3.3.1.5 Uplift capacity of a single *deep foundation* element.** Where required by the design, the uplift capacity of a single deep foundation element shall be determined by an *approved* method of analysis based on a minimum factor of safety of three or by load tests conducted in accordance with ASTM D3689. The maximum allowable uplift *load* shall not exceed the ultimate load capacity as determined in Section 1810.3.3.1.2, using the results of load tests conducted in accordance with ASTM D3689, divided by a factor of safety of two.

**Exception:** Where uplift is due to wind or seismic loading, the minimum factor of safety shall be two where capacity is determined by an analysis

and one and one-half where capacity is determined by load tests.

**1810.3.3.1.6 Allowable uplift load of grouped *deep foundation* elements.** For grouped *deep foundation* elements subjected to uplift, the allowable uplift *load* for the group shall be calculated by a generally accepted method of analysis. Where the *deep foundation* elements in the group are placed at a center-to-center spacing less than three times the least horizontal dimension of the largest single element, the allowable uplift *load* for the group is permitted to be calculated as the lesser of:

1. The proposed individual allowable uplift *load* times the number of elements in the group.
2. Two-thirds of the effective weight of the group and the soil contained within a block defined by the perimeter of the group and the length of the element, plus two-thirds of the ultimate shear resistance along the soil block.

**1810.3.3.1.7 Load-bearing capacity.** *Deep foundation* elements shall develop ultimate load capacities of not less than twice the design working *loads* in the designated load-bearing layers. Analysis shall show that soil layers underlying the designated load-bearing layers do not cause the load-bearing capacity safety factor to be less than two.

**1810.3.3.1.8 Bent deep foundation elements.** The load-bearing capacity of *deep foundation* elements discovered to have a sharp or sweeping bend shall be determined by an *approved* method of analysis or by load testing a representative element.

**1810.3.3.1.9 Helical piles.** The allowable axial design *load*,  $P_a$ , of *helical piles* shall be determined as follows:

$$P_a = 0.5 P_u \quad \text{(Equation 18-4)}$$

where  $P_u$  is the least value of:

1. Base capacity plus shaft resistance of the *helical pile*. The base capacity is equal to the sum of the areas of the helical bearing plates times the ultimate bearing capacity of the soil or rock comprising the bearing stratum. The shaft resistance is equal to the area of the shaft above the uppermost helical bearing plate times the ultimate skin resistance.
2. Ultimate capacity determined from well-documented correlations with installation torque.
3. Ultimate capacity determined from load tests where required by Section 1810.3.3.1.2.
4. Ultimate axial capacity of pile shaft.

## SOILS AND FOUNDATIONS

5. Ultimate axial capacity of pile shaft couplings.
6. Sum of the ultimate axial capacity of helical bearing plates affixed to pile.

**1810.3.3.2 Allowable lateral load.** Where required by the design, the lateral load capacity of a single *deep foundation* element or a group thereof shall be determined by an *approved* method of analysis or by lateral load tests to not less than twice the proposed design working *load*. The resulting allowable *load* shall not be more than one-half of the *load* that produces a gross lateral movement of 1 inch (25 mm) at the lower of the top of foundation element and the ground surface, unless it can be shown that the predicted lateral movement shall cause neither harmful distortion of, nor instability in, the structure, nor cause any element to be loaded beyond its capacity.

**1810.3.4 Subsiding soils or strata.** Where *deep foundation* elements are installed through subsiding soils or other subsiding strata and derive support from underlying firmer materials, consideration shall be given to the downward frictional forces potentially imposed on the elements by the subsiding upper strata.

Where the influence of subsiding soils or strata is considered as imposing *loads* on the element, the allowable stresses specified in this chapter shall be permitted to be increased where satisfactory substantiating data are submitted.

**1810.3.5 Dimensions of deep foundation elements.** The dimensions of *deep foundation* elements shall be in accordance with Sections 1810.3.5.1 through 1810.3.5.3, as applicable.

**1810.3.5.1 Precast.** The minimum lateral dimension of precast concrete *deep foundation* elements shall be 8 inches (203 mm). Corners of square elements shall be chamfered.

**1810.3.5.2 Cast-in-place or grouted-in-place.** Cast-in-place and grouted-in-place *deep foundation* elements shall satisfy the requirements of this section.

**1810.3.5.2.1 Cased.** Cast-in-place or grouted-in-place *deep foundation* elements with a permanent casing shall have a nominal outside diameter of not less than 8 inches (203 mm).

**1810.3.5.2.2 Uncased.** Cast-in-place or grouted-in-place *deep foundation* elements without a permanent casing shall have a specified diameter of not less than 12 inches (305 mm). The element length shall not exceed 30 times the specified diameter.

**Exception:** The length of the element is permitted to exceed 30 times the specified diameter, provided that the design and installation of the deep foundations are under the direct supervision of a *registered design professional* knowledgeable in the field of soil mechanics and deep foundations. The *registered design professional* shall submit a report to the *building official* stating that the elements were installed in

compliance with the *approved construction documents*.

**1810.3.5.2.3 Micropiles.** Micropiles shall have a nominal diameter of 12 inches (305 mm) or less. The minimum diameter set forth elsewhere in Section 1810.3.5 shall not apply to micropiles.

**1810.3.5.3 Steel.** Steel *deep foundation* elements shall satisfy the requirements of this section.

**1810.3.5.3.1 Structural steel H-piles.** Sections of structural steel H-piles shall comply with the requirements for HP shapes in ASTM A6, or the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall be not less than 80 percent of the depth of the section.
2. The nominal depth in the direction of the web shall be not less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of  $\frac{3}{8}$  inch (9.5 mm).

For structures assigned to *Seismic Design Category* D, E or F, design and detailing of H-piles shall also conform to the requirements of AISC 341.

**1810.3.5.3.2 Fully welded steel piles fabricated from plates.** Sections of fully welded steel piles fabricated from plates shall comply with the following:

1. The flange projections shall not exceed 14 times the minimum thickness of metal in either the flange or the web and the flange widths shall be not less than 80 percent of the depth of the section.
2. The nominal depth in the direction of the web shall be not less than 8 inches (203 mm).
3. Flanges and web shall have a minimum nominal thickness of  $\frac{3}{8}$  inch (9.5 mm).

**1810.3.5.3.3 Structural steel sheet piling.** Individual sections of structural steel sheet piling shall conform to the profile indicated by the manufacturer, and shall conform to the general requirements specified by ASTM A6.

**1810.3.5.3.4 Steel pipes and tubes.** Steel pipes and tubes used as *deep foundation* elements shall have a nominal outside diameter of not less than 8 inches (203 mm). Where steel pipes or tubes are driven open ended, they shall have not less than 0.34 square inch (219 mm<sup>2</sup>) of steel in cross section to resist each 1,000 foot-pounds (1356 Nm) of pile hammer energy, or shall have the equivalent strength for steels having a yield strength greater than 35,000 psi (241 MPa) or the wave equation analysis shall be permitted to be used to assess compression stresses induced by driving to evaluate if the pile section is appropriate for the selected hammer. Where a pipe



or tube with wall thickness less than 0.179 inch (4.6 mm) is driven open ended, a suitable cutting shoe shall be provided. Concrete-filled steel pipes or tubes in structures assigned to *Seismic Design Category C, D, E or F* shall have a wall thickness of not less than  $\frac{3}{16}$  inch (5 mm). The pipe or tube casing for socketed *drilled shafts* shall have a nominal outside diameter of not less than 18 inches (457 mm), a wall thickness of not less than  $\frac{3}{8}$  inch (9.5 mm) and a suitable steel driving shoe welded to the bottom; the diameter of the rock socket shall be approximately equal to the inside diameter of the casing.

#### Exceptions:

1. There is no minimum diameter for steel pipes or tubes used in micropiles.
2. For mandrel-driven pipes or tubes, the minimum wall thickness shall be  $\frac{1}{10}$  inch (2.5 mm).

**1810.3.5.3.5 Helical piles.** Dimensions of the central shaft and the number, size and thickness of helical bearing plates shall be sufficient to support the design loads.

**1810.3.6 Splices.** Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the *deep foundation* element during installation and subsequent thereto and shall be designed to resist the axial and shear forces and moments occurring at the location of the splice during driving and for design load combinations. Where *deep foundation* elements of the same type are being spliced, splices shall develop not less than 50 percent of the bending strength of the weaker section. Where *deep foundation* elements of different materials or different types are being spliced, splices shall develop the full compressive strength and not less than 50 percent of the tension and bending strength of the weaker section. Where structural steel cores are to be spliced, the ends shall be milled or ground to provide full contact and shall be full-depth welded.

**Exception:** For buildings assigned to *Seismic Design Category A or B*, splices need not comply with the 50-percent tension and bending strength requirements where justified by supporting data.

Splices occurring in the upper 10 feet (3048 mm) of the embedded portion of an element shall be designed to resist at allowable stresses the moment and shear that would result from an assumed eccentricity of the axial load of 3 inches (76 mm), or the element shall be braced in accordance with Section 1810.2.2 to other deep foundation elements that do not have splices in the upper 10 feet (3048 mm) of embedment.

**1810.3.6.1 Seismic Design Categories C through F.** For structures assigned to *Seismic Design Category C, D, E or F* splices of *deep foundation* elements shall develop the lesser of the following:

1. The nominal strength of the *deep foundation* element.

2. The axial and shear forces and moments from the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

**1810.3.7 Top of element detailing at cutoffs.** Where a minimum length for reinforcement or the extent of closely spaced confinement reinforcement is specified at the top of a *deep foundation* element, provisions shall be made so that those specified lengths or extents are maintained after cutoff.

**1810.3.8 Precast concrete piles.** Precast concrete piles shall be designed and detailed in accordance with ACI 318.

#### Exceptions:

1. For precast prestressed piles in *Seismic Design Category C*, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.4 of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor,  $\Omega_0$ . In such cases, minimum transverse reinforcement index shall be as specified in Section 13.4.5.6 of ACI 318.
2. For precast prestressed piles in *Seismic Design Categories D through F*, the minimum volumetric ratio of spirals or circular hoops required by Section 18.13.5.10.5(c) of ACI 318 shall not apply in cases where the design includes full consideration of load combinations specified in ASCE 7, Section 2.3.6 or Section 2.4.5 and the applicable overstrength factor,  $\Omega_0$ . In such cases, minimum transverse reinforcement shall be as specified in Section 13.4.5.6 of ACI 318.

**1810.3.9 Cast-in-place deep foundations.** Cast-in-place *deep foundation* elements shall be designed and detailed in accordance with Sections 1810.3.9.1 through 1810.3.9.6.

**1810.3.9.1 Design cracking moment.** The design cracking moment ( $\phi M_n$ ) for a cast-in-place *deep foundation* element not enclosed by a structural steel pipe or tube shall be determined using the following equation:

$$\phi M_n = 3\sqrt{f'_c} S_m \quad (\text{Equation 18-5})$$

$$\text{For SI: } \phi M_n = 0.25\sqrt{f'_c} S_m$$

where:

$f'_c$  = Specified compressive strength of concrete or grout, psi (MPa).

$S_m$  = Elastic section modulus, neglecting reinforcement and casing, cubic inches ( $\text{mm}^3$ ).

**1810.3.9.2 Required reinforcement.** Where subject to uplift or where the required moment strength determined using the load combinations of ASCE 7, Section 2.3 exceeds the design cracking moment deter-

## SOILS AND FOUNDATIONS

mined in accordance with Section 1810.3.9.1, cast-in-place deep foundations not enclosed by a structural steel pipe or tube shall be reinforced.

**1810.3.9.3 Placement of reinforcement.** Reinforcement where required shall be assembled and tied together and shall be placed in the *deep foundation* element as a unit before the reinforced portion of the element is filled with concrete.

### Exceptions:

1. Steel dowels embedded 5 feet (1524 mm) or less shall be permitted to be placed after concreting, while the concrete is still in a semifluid state.
2. For *deep foundation* elements installed with a hollow-stem auger, tied reinforcement shall be placed after elements are concreted, while the concrete is still in a semifluid state. Longitudinal reinforcement without lateral ties shall be placed either through the hollow stem of the auger prior to concreting or after concreting, while the concrete is still in a semifluid state.
3. For Group R-3 and U occupancies not exceeding two stories of *light-frame construction*, reinforcement is permitted to be placed after concreting, while the concrete is still in a semifluid state, and the concrete cover requirement is permitted to be reduced to 2 inches (51 mm), provided that the construction method can be demonstrated to the satisfaction of the *building official*.

**1810.3.9.4 Seismic reinforcement.** Where a structure is assigned to *Seismic Design Category C*, reinforcement shall be provided in accordance with Section 1810.3.9.4.1. Where a structure is assigned to *Seismic Design Category D, E or F*, reinforcement shall be provided in accordance with Section 1810.3.9.4.2.

### Exceptions:

1. Isolated *deep foundation* elements supporting posts of Group R-3 and U occupancies not exceeding two stories of *light-frame construction* shall be permitted to be reinforced as required by rational analysis but with not less than one No. 4 bar, without ties or spirals, where detailed so the element is not subject to lateral loads and the soil provides adequate lateral support in accordance with Section 1810.2.1.
2. Isolated *deep foundation* elements supporting posts and bracing from decks and patios appurtenant to Group R-3 and U occupancies not exceeding two stories of *light-frame construction* shall be permitted to be reinforced as required by

rational analysis but with not less than one No. 4 bar, without ties or spirals, where the lateral *load*, *E*, to the top of the element does not exceed 200 pounds (890 N) and the soil provides adequate lateral support in accordance with Section 1810.2.1.

3. *Deep foundation* elements supporting the concrete foundation wall of Group R-3 and U occupancies not exceeding two stories of light-frame construction shall be permitted to be reinforced as required by rational analysis but with not less than two No. 4 bars, without ties or spirals, where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations with overstrength factor in Section 2.3.6 or 2.4.5 of ASCE 7 and the soil provides adequate lateral support in accordance with Section 1810.2.1.
4. Closed ties or spirals where required by Section 1810.3.9.4.2 shall be permitted to be limited to the top 3 feet (914 mm) of *deep foundation* elements 10 feet (3048 mm) or less in depth supporting Group R-3 and U occupancies of *Seismic Design Category D*, not exceeding two stories of *light-frame construction*.

**1810.3.9.4.1 Seismic reinforcement in Seismic Design Category C.** For structures assigned to *Seismic Design Category C*, cast-in-place *deep foundation* elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.

Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.0025, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-third of the element length.
2. A distance of 10 feet (3048 mm).
3. Three times the least element dimension.
4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of ASCE 7, Section 2.3.

Transverse reinforcement shall consist of closed ties or spirals with a minimum  $\frac{3}{8}$  inch (9.5 mm) diameter. Spacing of transverse reinforcement shall not exceed the smaller of 6 inches (152 mm) or 8-longitudinal-bar diameters, within a distance of three times the least element dimension from the

bottom of the pile cap. Spacing of transverse reinforcement shall not exceed 16 longitudinal bar diameters throughout the remainder of the reinforced length.

**Exceptions:**

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than the manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

**1810.3.9.4.2 Seismic reinforcement in Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category D, E or F*, cast-in-place *deep foundation* elements shall be reinforced as specified in this section. Reinforcement shall be provided where required by analysis.

Not fewer than four longitudinal bars, with a minimum longitudinal reinforcement ratio of 0.005, shall be provided throughout the minimum reinforced length of the element as defined in this section starting at the top of the element. The minimum reinforced length of the element shall be taken as the greatest of the following:

1. One-half of the element length.
2. A distance of 10 feet (3048 mm).
3. Three times the least element dimension.
4. The distance from the top of the element to the point where the design cracking moment determined in accordance with Section 1810.3.9.1 exceeds the required moment strength determined using the load combinations of ASCE 7, Section 2.3.

Transverse reinforcement shall consist of closed ties or spirals not smaller than No. 3 bars for elements with a least dimension up to 20 inches (508 mm), and No. 4 bars for larger elements. Throughout the remainder of the reinforced length outside the regions with transverse confinement reinforcement, as specified in Section 1810.3.9.4.2.1 or 1810.3.9.4.2.2, the spacing of transverse reinforcement shall not exceed the least of the following:

1. 12 longitudinal bar diameters.
2. One-half the least dimension of the element.

3. 12 inches (305 mm).

**Exceptions:**

1. The requirements of this section shall not apply to concrete cast in structural steel pipes or tubes.
2. A spiral-welded metal casing of a thickness not less than manufacturer's standard No. 14 gage (0.068 inch) is permitted to provide concrete confinement in lieu of the closed ties or spirals. Where used as such, the metal casing shall be protected against possible deleterious action due to soil constituents, changing water levels or other factors indicated by boring records of site conditions.

**1810.3.9.4.2.1 Site Classes A through D.** For *Site Class A, B, C or D* sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within three times the least element dimension of the bottom of the pile cap. A transverse spiral reinforcement ratio of not less than one-half of that required in Table 18.10.6.4(g) of ACI 318 shall be permitted.

**1810.3.9.4.2.2 Site Classes E and F.** For *Site Class E or F* sites, transverse confinement reinforcement shall be provided in the element in accordance with Sections 18.7.5.2, 18.7.5.3 and 18.7.5.4 of ACI 318 within seven times the least element dimension of the pile cap and within seven times the least element dimension of the interfaces of strata that are hard or stiff and strata that are liquefiable or are composed of soft- to medium-stiff clay.

**1810.3.9.5 Belled drilled shafts.** Where *drilled shafts* are belled at the bottom, the edge thickness of the bell shall be not less than that required for the edge of footings. Where the sides of the bell slope at an angle less than 60 degrees (1 rad) from the horizontal, the effects of vertical shear shall be considered.

**1810.3.9.6 Socketed drilled shafts.** Socketed *drilled shafts* shall have a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock, both filled with concrete. Socketed *drilled shafts* shall have reinforcement or a structural steel core for the length as indicated by an *approved* method of analysis.

The depth of the rock socket shall be sufficient to develop the full load-bearing capacity of the element with a minimum safety factor of two, but the depth shall be not less than the outside diameter of the pipe or tube casing. The design of the rock socket is permitted to be predicated on the sum of the allowable load-

## SOILS AND FOUNDATIONS

bearing pressure on the bottom of the socket plus bond along the sides of the socket.

Where a structural steel core is used, the gross cross-sectional area of the core shall not exceed 25 percent of the gross area of the *drilled shaft*.

**1810.3.10 Micropiles.** Micropiles shall be designed and detailed in accordance with Sections 1810.3.10.1 through 1810.3.10.4.

**1810.3.10.1 Construction.** Micropiles shall develop their load-carrying capacity by means of a bond zone in soil, bedrock or a combination of soil and bedrock. Micropiles shall be grouted and have either a steel pipe or tube or steel reinforcement at every section along the length. It shall be permitted to transition from deformed reinforcing bars to steel pipe or tube reinforcement by extending the bars into the pipe or tube section by not less than their development length in tension in accordance with ACI 318.

**1810.3.10.2 Materials.** Reinforcement shall consist of deformed reinforcing bars in accordance with ASTM A615 Grade 60 or 75 or ASTM A722 Grade 150.

The steel pipe or tube shall have a minimum wall thickness of  $\frac{3}{16}$  inch (4.8 mm). Splices shall comply with Section 1810.3.6. The steel pipe or tube shall have a minimum yield strength of 45,000 psi (310 MPa) and a minimum elongation of 15 percent as shown by mill certifications or two coupon test samples per 40,000 pounds (18 160 kg) of pipe or tube.

**1810.3.10.3 Reinforcement.** For micropiles or portions thereof grouted inside a temporary or permanent casing or inside a hole drilled into bedrock or a hole drilled with grout, the steel pipe or tube or steel reinforcement shall be designed to carry not less than 40 percent of the design compression load. Micropiles or portions thereof grouted in an open hole in soil without temporary or permanent casing and without suitable means of verifying the hole diameter during grouting shall be designed to carry the entire compression *load* in the reinforcing steel. Where a steel pipe or tube is used for reinforcement, the portion of the grout enclosed within the pipe is permitted to be included in the determination of the allowable stress in the grout.

**1810.3.10.4 Seismic reinforcement.** For structures assigned to *Seismic Design Category C*, a permanent steel casing shall be provided from the top of the *micropile* down to the point of zero curvature. For structures assigned to *Seismic Design Category D*, *E* or *F*, the *micropile* shall be considered as an alternative system in accordance with Section 104.11. The alternative system design, supporting documentation and test data shall be submitted to the *building official* for review and approval.

**1810.3.11 Pile caps.** Pile caps shall conform with ACI 318 and this section. Pile caps shall be of reinforced concrete, and shall include all elements to which vertical

*deep foundation* elements are connected, including grade beams and mats. The soil immediately below the pile cap shall not be considered as carrying any vertical *load*, with the exception of a *combined pile raft*. The tops of vertical *deep foundation* elements shall be embedded not less than 3 inches (76 mm) into pile caps and the caps shall extend not less than 4 inches (102 mm) beyond the edges of the elements. The tops of elements shall be cut or chipped back to sound material before capping.

**1810.3.11.1 Seismic Design Categories C through F.** For structures assigned to *Seismic Design Category C*, *D*, *E* or *F*, concrete *deep foundation* elements shall be connected to the pile cap in accordance with ACI 318.

For resistance to uplift forces, anchorage of steel pipes, tubes or H-piles to the pile cap shall be made by means other than concrete bond to the bare steel section. Concrete-filled steel pipes or tubes shall have reinforcement of not less than 0.01 times the cross-sectional area of the concrete fill developed into the cap and extending into the fill a length equal to two times the required cap embedment, but not less than the development length in tension of the reinforcement.

**1810.3.11.2 Seismic Design Categories D through F.** For structures assigned to *Seismic Design Category D*, *E* or *F*, *deep foundation* element resistance to uplift forces or rotational restraint shall be provided by anchorage into the pile cap, designed considering the combined effect of axial forces due to uplift and bending moments due to fixity to the pile cap. Anchorage shall develop not less than 25 percent of the strength of the element in tension. Anchorage into the pile cap shall comply with the following:

1. In the case of uplift, the anchorage shall be capable of developing the least of the following:
  - 1.1. The nominal tensile strength of the longitudinal reinforcement in a concrete element.
  - 1.2. The nominal tensile strength of a steel element.
  - 1.3. The frictional force developed between the element and the soil multiplied by 1.3.

**Exception:** The anchorage is permitted to be designed to resist the axial tension force resulting from the seismic *load effects* including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

2. In the case of rotational restraint, the anchorage shall be designed to resist the axial and shear forces, and moments resulting from the seismic *load effects* including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7 or the anchorage shall be capable of



developing the full axial, bending and shear nominal strength of the element.

3. The connection between the pile cap and the steel H-piles or unfilled steel pipe piles in structures assigned to *Seismic Design Category* D, E or F shall be designed for a tensile force of not less than 10 percent of the pile compression capacity.

**Exceptions:**

1. Connection tensile capacity need not exceed the strength required to resist seismic load effects including overstrength of ASCE 7 Section 12.4.3 or 12.14.3.2.
2. Connections need not be provided where the foundation or supported structure does not rely on the tensile capacity of the piles for stability under the design seismic force.

Where the vertical lateral-force-resisting elements are columns, the pile cap flexural strengths shall exceed the column flexural strength. The connection between batter piles and pile caps shall be designed to resist the nominal strength of the pile acting as a short column. Batter piles and their connection shall be designed to resist forces and moments that result from the application of seismic *load effects* including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

**1810.3.12 Grade beams.** Grade beams shall comply with the provisions of ACI 318.

**Exception:** Grade beams designed to resist the seismic load effects including overstrength factor in accordance with Section 2.3.6 or 2.4.5 of ASCE 7.

**1810.3.13 Seismic ties.** Seismic ties shall comply with the provisions of ACI 318.

**Exception:** In Group R-3 and U occupancies of *light-frame construction*, *deep foundation* elements supporting foundation walls, isolated interior posts detailed so the element is not subject to lateral *loads* or exterior decks and patios are not subject to interconnection where the soils are of adequate stiffness, subject to the approval of the *building official*.

**1810.4 Installation.** Deep foundations shall be installed in accordance with Section 1810.4. Where a single *deep foundation* element comprises two or more sections of different materials or different types spliced together, each section shall satisfy the applicable conditions of installation.

**1810.4.1 Structural integrity.** *Deep foundation* elements shall be installed in such a manner and sequence as to prevent distortion or damage that would adversely affect the structural integrity of adjacent structures or of foundation elements being installed or already in place and as to avoid compacting the surrounding soil to the extent that other foundation elements cannot be installed properly.

**1810.4.1.1 Compressive strength of precast concrete piles.** A precast concrete pile shall not be driven before the concrete has attained a compressive strength of not less than 75 percent of the specified compressive strength ( $f'_c$ ), but not less than the strength sufficient to withstand handling and driving forces.

**1810.4.1.2 Shafts in unstable soils.** Where cast-in-place *deep foundation* elements are formed through unstable soils, the open hole shall be stabilized by a casing, slurry, or other approved method prior to placing the concrete. Where the casing is withdrawn during concreting, the level of concrete shall be maintained above the bottom of the casing at a sufficient height to offset any hydrostatic or lateral soil pressure. Driven casings shall be mandrel driven their full length in contact with the surrounding soil.

**1810.4.1.3 Driving near uncased concrete.** Deep foundation elements shall not be driven within six element diameters center to center in granular soils or within one-half the element length in cohesive soils of an uncased element filled with concrete less than 48 hours old unless *approved* by the *building official*. If driving near uncased concrete elements causes the concrete surface in any completed element to rise or drop significantly or bleed additional water, the completed element shall be replaced.

**1810.4.1.4 Driving near cased concrete.** *Deep foundation* elements shall not be driven within four and one-half average diameters of a cased element filled with concrete less than 24 hours old unless *approved* by the *building official*. Concrete shall not be placed in casings within heave range of driving.

**1810.4.1.5 Defective timber piles.** Any substantial sudden change in rate of penetration of a timber pile shall be investigated for possible damage. If the sudden change in rate of penetration cannot be correlated to soil strata, the pile shall be removed for inspection or rejected.

**1810.4.2 Identification.** *Deep foundation* materials shall be identified for conformity to the specified grade with this identity maintained continuously from the point of manufacture to the point of installation or shall be tested by an *approved agency* to determine conformity to the specified grade. The *approved agency* shall furnish an affidavit of compliance to the *building official*.

**1810.4.3 Location plan.** A plan showing the location and designation of *deep foundation* elements by an identification system shall be filed with the *building official* prior to installation of such elements. Detailed records for elements shall bear an identification corresponding to that shown on the plan.

**1810.4.4 Preexcavation.** The use of jetting, augering or other methods of preexcavation shall be subject to the approval of the *building official*. Where permitted, preexcavation shall be carried out in the same manner as used for *deep foundation* elements subject to load tests and in such a manner that will not impair the carrying capacity

## SOILS AND FOUNDATIONS

of the elements already in place or damage adjacent structures. Element tips shall be advanced below the preexcavated depth until the required resistance or penetration is obtained.

**1810.4.5 Vibratory driving.** Vibratory drivers shall only be used to install *deep foundation* elements where the element load capacity is verified by load tests in accordance with Section 1810.3.3.1.2. The installation of production elements shall be controlled according to power consumption, rate of penetration or other *approved* means that ensure element capacities equal or exceed those of the test elements.

### Exceptions:

1. The pile installation is completed by driving with an impact hammer in accordance with Section 1810.3.3.1.1.
2. The pile is to be used only for lateral resistance.

**1810.4.6 Heaved elements.** *Deep foundation* elements that have heaved during the driving of adjacent elements shall be redriven as necessary to develop the required capacity and penetration, or the capacity of the element shall be verified by load tests in accordance with Section 1810.3.3.1.2.

**1810.4.7 Enlarged base cast-in-place elements.** Enlarged bases for cast-in-place *deep foundation* elements formed by compacting concrete or by driving a precast base shall be formed in or driven into granular soils. Such elements shall be constructed in the same manner as successful prototype test elements driven for the project. Shafts extending through peat or other organic soil shall be encased in a permanent steel casing. Where a cased shaft is used, the shaft shall be adequately reinforced to resist column action or the *annular space* around the shaft shall be filled sufficiently to reestablish lateral support by the soil. Where heave occurs, the element shall be replaced unless it is demonstrated that the element is undamaged and capable of carrying twice its design *load*.

**1810.4.8 Hollow-stem augered, cast-in-place elements.** Where concrete or grout is placed by pumping through a hollow-stem auger, the auger shall be permitted to rotate in a clockwise direction during withdrawal. As the auger is withdrawn at a steady rate or in increments not to exceed 1 foot (305 mm), concreting or grouting pumping pressures shall be measured and maintained high enough at all times to offset hydrostatic and lateral earth pressures. Concrete or grout volumes shall be measured to ensure that the volume of concrete or grout placed in each element is equal to or greater than the theoretical volume of the hole created by the auger. Where the installation process of any element is interrupted or a loss of concreting or grouting pressure occurs, the element shall be redrilled to 5 feet (1524 mm) below the elevation of the tip of the auger when the installation was interrupted or concrete or grout pressure was lost and reformed. Augered cast-in-place elements shall not be installed within six diameters center to center of an element filled

with concrete or grout less than 12 hours old, unless *approved* by the *building official*. If the concrete or grout level in any completed element drops due to installation of an adjacent element, the element shall be replaced.

**1810.4.9 Socketed drilled shafts.** The rock socket and pipe or tube casing of socketed *drilled shafts* shall be thoroughly cleaned of foreign materials before filling with concrete. Steel cores shall be bedded in cement grout at the base of the rock socket.

**1810.4.10 Micropiles.** *Micropile deep foundation* elements shall be permitted to be formed in holes advanced by rotary or percussive drilling methods, with or without casing. The elements shall be grouted with a fluid cement grout. The grout shall be pumped through a tremie pipe extending to the bottom of the element until grout of suitable quality returns at the top of the element. The following requirements apply to specific installation methods:

1. For micropiles grouted inside a temporary casing, the reinforcing bars shall be inserted prior to withdrawal of the casing. The casing shall be withdrawn in a controlled manner with the grout level maintained at the top of the element to ensure that the grout completely fills the drill hole. During withdrawal of the casing, the grout level inside the casing shall be monitored to verify that the flow of grout inside the casing is not obstructed.
2. For a *micropile* or portion thereof grouted in an open drill hole in soil without temporary casing, the minimum design diameter of the drill hole shall be verified by a suitable device during grouting.
3. For micropiles designed for end bearing, a suitable means shall be employed to verify that the bearing surface is properly cleaned prior to grouting.
4. Subsequent micropiles shall not be drilled near elements that have been grouted until the grout has had sufficient time to harden.
5. Micropiles shall be grouted as soon as possible after drilling is completed.
6. For micropiles designed with a full-length casing, the casing shall be pulled back to the top of the bond zone and reinserted or some other suitable means employed to ensure grout coverage outside the casing.

**1810.4.11 Helical piles.** *Helical piles* shall be installed to specified embedment depth and torsional resistance criteria as determined by a *registered design professional*. The torque applied during installation shall not exceed the manufacturer's rated maximum installation torque resistance of the *helical pile*.

**1810.4.12 Special inspection.** *Special inspections* in accordance with Sections 1705.7 and 1705.8 shall be provided for driven and cast-in-place *deep foundation* elements, respectively. *Special inspections* in accordance with Section 1705.9 shall be provided for *helical piles*.

## CHAPTER 19

# CONCRETE

*Italics are used for text within Sections 1903 through 1905 of this code to indicate provisions that differ from ACI 318.*

### User notes:

**About this chapter:** Chapter 19 provides minimum accepted practices for the design and construction of buildings and structural components using concrete—both plain and reinforced. Chapter 19 relies primarily on the reference to American Concrete Institute (ACI) 318, *Building Code Requirements for Structural Concrete*. Structural concrete must be designed and constructed to comply with this code and all listed standards. There are also specific provisions addressing concrete slabs and shotcrete.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 1901

#### GENERAL

**1901.1 Scope.** The provisions of this chapter shall govern the materials, quality control, design and construction of concrete used in structures.

**1901.2 Plain and reinforced concrete.** Structural concrete shall be designed and constructed in accordance with the requirements of this chapter and ACI 318 as amended in Section 1905 of this code. Except for the provisions of Sections 1904 and 1907, the design and construction of slabs on grade shall not be governed by this chapter unless they transmit vertical *loads* or lateral forces from other parts of the structure to the soil.

**1901.3 Anchoring to concrete.** Anchoring to concrete shall be in accordance with ACI 318 as amended in Section 1905, and applies to cast-in (headed bolts, headed studs and hooked J- or L-bolts), post-installed expansion (torque-controlled and displacement-controlled), undercut, screw, and adhesive anchors.

**1901.4 Composite structural steel and concrete structures.** Systems of structural steel acting compositely with reinforced concrete shall be designed in accordance with Section 2206 of this code.

**1901.5 Construction documents.** The *construction documents* for structural concrete construction shall include:

1. The specified compressive strength of concrete at the stated ages or stages of construction for which each concrete element is designed.
2. The specified strength or grade of reinforcement.
3. The size and location of structural elements, reinforcement and anchors.
4. Provision for dimensional changes resulting from creep, shrinkage and temperature.
5. The magnitude and location of prestressing forces.
6. Anchorage length of reinforcement and location and length of lap splices.
7. Type and location of mechanical and welded splices of reinforcement.

8. Details and location of contraction or isolation *joints* specified for plain concrete.
9. Minimum concrete compressive strength at time of posttensioning.
10. Stressing sequence for posttensioning tendons.
11. For structures assigned to *Seismic Design Category* D, E or F, a statement if slab on grade is designed as a structural *diaphragm*.

**1901.6 Special inspections and tests.** *Special inspections* and tests of concrete elements of buildings and structures and concreting operations shall be as required by Chapter 17.

**1901.7 Tolerances for structural concrete.** Where not indicated in *construction documents*, structural tolerances for concrete structural elements shall be in accordance with this section.

**1901.7.1 Cast-in-place concrete tolerances.** Structural tolerances for cast-in-place concrete structural elements shall be in accordance with ACI 117.

#### Exceptions:

1. Group R-3 detached one- or two-family dwellings are not required to comply with this section.
2. Shotcrete is not required to comply with this section.

**1901.7.2 Precast concrete tolerances.** Structural tolerances for precast concrete structural elements shall be in accordance with ACI ITG-7.

**Exception:** Group R-3 detached one- or two-family dwellings are not required to comply with this section.

### SECTION 1902

#### COORDINATION OF TERMINOLOGY

**1902.1 General.** Coordination of terminology used in ACI 318 and ASCE 7 shall be in accordance with Sections 1902.1.1 and 1902.1.2.

**1902.1.1 Design displacement.** Design displacement at each level shall be the total lateral deflection at the level

## CONCRETE

calculated for the design earthquake using the procedures defined in Section 12.8.6 of ASCE 7.

**1902.1.2 Special structural wall.** Special structural walls made of cast-in-place or precast concrete shall comply with the requirements of Sections 18.2.4 through 18.2.8, 18.10 and 18.11 of ACI 318, as applicable, in addition to the requirements for *ordinary reinforced concrete structural walls* or *ordinary precast structural walls*, as applicable. Where ASCE 7 refers to a "special reinforced concrete shear wall," it shall be deemed to mean a "special structural wall."

### SECTION 1903

#### SPECIFICATIONS FOR TESTS AND MATERIALS

**1903.1 General.** Materials used to produce concrete, concrete itself and testing thereof shall comply with the applicable standards listed in ACI 318.

**1903.2 Special inspections.** *Where required, special inspections and tests shall be in accordance with Chapter 17.*

**1903.3 Glass fiber-reinforced concrete.** *Glass fiber-reinforced concrete (GFRC) and the materials used in such concrete shall be in accordance with the PCI MNL 128 standard.*

**1903.4 Flat wall insulating concrete form (ICF) systems.** *Insulating concrete form material used for forming flat concrete walls shall conform to ASTM E2634.*

### SECTION 1904

#### DURABILITY REQUIREMENTS

**1904.1 Structural concrete.** Structural concrete shall conform to the durability requirements of ACI 318.

**Exception:** *For Group R-2 and R-3 occupancies not more than three stories above grade plane, the specified compressive strength,  $f'_c$ , for concrete in basement walls, foundation walls, exterior walls and other vertical surfaces exposed to the weather shall be not less than 3,000 psi (20.7 MPa).*

**1904.2 Nonstructural concrete.** *The registered design professional shall assign nonstructural concrete a freeze-thaw exposure class, as defined in ACI 318, based on the anticipated exposure of nonstructural concrete. Nonstructural concrete shall have a minimum specified compressive strength,  $f'_c$ , of 2,500 psi (17.2 MPa) for Class F0; 3,000 psi (20.7 MPa) for Class F1; and 3,500 psi (24.1 MPa) for Classes F2 and F3. Nonstructural concrete shall be air entrained in accordance with ACI 318.*

### SECTION 1905

#### MODIFICATIONS TO ACI 318

**1905.1 General.** The text of ACI 318 shall be modified as indicated in Sections 1905.1.1 through 1905.1.8.

**1905.1.1 ACI 318, Section 2.3.** Modify existing definitions and add the following definitions to ACI 318, Section 2.3.

**DETAILED PLAIN CONCRETE STRUCTURAL WALL.** A wall complying with the requirements of Chapter 14, including 14.6.2.

**ORDINARY PRECAST STRUCTURAL WALL.** A precast wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.

**ORDINARY REINFORCED CONCRETE STRUCTURAL WALL.** A *cast-in-place* wall complying with the requirements of Chapters 1 through 13, 15, 16 and 19 through 26.

**ORDINARY STRUCTURAL PLAIN CONCRETE WALL.** A wall complying with the requirements of Chapter 14, *excluding* 14.6.2.

**1905.1.2 ACI 318, Section 18.2.1.** Modify ACI 318 Sections 18.2.1.2 and 18.2.1.6 to read as follows:

- 18.2.1.2 – *Structures assigned to Seismic Design Category A shall satisfy requirements of Chapters 1 through 17 and 19 through 26; Chapter 18 does not apply. Structures assigned to Seismic Design Category B, C, D, E or F shall satisfy 18.2.1.3 through 18.2.1.7, as applicable. Except for structural elements of plain concrete complying with Section 1905.1.7 of the International Building Code, structural elements of plain concrete are prohibited in structures assigned to Seismic Design Category C, D, E or F.*
- 18.2.1.6 – *Structural systems designated as part of the seismic force-resisting system shall be restricted to those permitted by ASCE 7. Except for Seismic Design Category A, for which Chapter 18 does not apply, the following provisions shall be satisfied for each structural system designated as part of the seismic force-resisting system, regardless of the seismic design category:*
  - (a) Ordinary moment frames shall satisfy 18.3.
  - (b) Ordinary reinforced concrete structural walls and ordinary precast structural walls need not satisfy any provisions in Chapter 18.
  - (c) Intermediate moment frames shall satisfy 18.4.
  - (d) Intermediate precast structural walls shall satisfy 18.5.
  - (e) Special moment frames shall satisfy 18.6 through 18.9.
  - (f) Special structural walls shall satisfy 18.10.
  - (g) Special structural walls constructed using precast concrete shall satisfy 18.11.

Special moment frames and special structural walls shall also satisfy 18.2.4 through 18.2.8.

**1905.1.3 ACI 318, Section 18.5.** Modify ACI 318, Section 18.5 by adding new Section 18.5.2.2 and renum-



bering existing Sections 18.5.2.2 and 18.5.2.3 to become 18.5.2.3 and 18.5.2.4, respectively.

*18.5.2.2 – Connections that are designed to yield shall be capable of maintaining 80 percent of their design strength at the deformation induced by the design displacement or shall use Type 2 mechanical splices.*

*18.5.2.3 – Elements of the connection that are not designed to yield shall develop at least  $1.5 S_y$ .*

*18.5.2.4 – In structures assigned to SDC D, E or F, wall piers shall be designed in accordance with 18.10.8 or 18.14 in ACI 318.*

**1905.1.4 ACI 318, Section 18.11.** Modify ACI 318, Section 18.11.2.1 to read as follows:

*18.11.2.1 – Special structural walls constructed using precast concrete shall satisfy all the requirements of 18.10 for cast-in-place special structural walls in addition to 18.5.2.*

**1905.1.5 ACI 318, Section 18.13.1.1.** Modify ACI 318, Section 18.13.1.1 to read as follows:

*18.13.1.1 – Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 unless modified by Chapter 18 of the International Building Code.*

**1905.1.6 ACI 318, Section 14.6.** Modify ACI 318, Section 14.6 by adding new Section 14.6.2 to read as follows:

*14.6.2 – Detailed plain concrete structural walls.*

*14.6.2.1 – Detailed plain concrete structural walls are walls conforming to the requirements of ordinary structural plain concrete walls and 14.6.2.2.*

*14.6.2.2 – Reinforcement shall be provided as follows:*

- Vertical reinforcement of at least 0.20 square inch (129 mm<sup>2</sup>) in cross-sectional area shall be provided continuously from support to support at each corner, at each side of each opening and at the ends of walls. The continuous vertical bar required beside an opening is permitted to substitute for one of the two No. 5 bars required by 14.6.1.
- Horizontal reinforcement at least 0.20 square inch (129 mm<sup>2</sup>) in cross-sectional area shall be provided:
  1. Continuously at structurally connected roof and floor levels and at the top of walls.
  2. At the bottom of load-bearing walls or in the top of foundations where doveled to the wall.
  3. At a maximum spacing of 120 inches (3048 mm).

*Reinforcement at the top and bottom of openings, where used in determining the maximum spacing specified in Item 3 above, shall be continuous in the wall.*

**1905.1.7 ACI 318, Section 14.1.4.** Delete ACI 318, Section 14.1.4 and replace with the following:

*14.1.4 – Plain concrete in structures assigned to Seismic Design Category C, D, E or F.*

*14.1.4.1 – Structures assigned to Seismic Design Category C, D, E or F shall not have elements of structural plain concrete, except as follows:*

- Structural plain concrete basement, foundation or other walls below the base as defined in ASCE 7 are permitted in detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls. In dwellings assigned to Seismic Design Category D or E, the height of the wall shall not exceed 8 feet (2438 mm), the thickness shall be not less than 7½ inches (190 mm), and the wall shall retain no more than 4 feet (1219 mm) of unbalanced fill. Walls shall have reinforcement in accordance with 14.6.1.
- Isolated footings of plain concrete supporting pedestals or columns are permitted, provided the projection of the footing beyond the face of the supported member does not exceed the footing thickness.

**Exception:** In detached one- and two-family dwellings three stories or less in height, the projection of the footing beyond the face of the supported member is permitted to exceed the footing thickness.

- Plain concrete footings supporting walls are permitted, provided the footings have at least two continuous longitudinal reinforcing bars. Bars shall not be smaller than No. 4 and shall have a total area of not less than 0.002 times the gross cross-sectional area of the footing. For footings that exceed 8 inches (203 mm) in thickness, a minimum of one bar shall be provided at the top and bottom of the footing. Continuity of reinforcement shall be provided at corners and intersections.

**Exceptions:**

1. In Seismic Design Categories A, B and C, detached one- and two-family dwellings three stories or less in height constructed with stud-bearing walls are permitted to have plain concrete footings without longitudinal reinforcement.
2. For foundation systems consisting of a plain concrete footing and a

## CONCRETE

*plain concrete stemwall, a minimum of one bar shall be provided at the top of the stemwall and at the bottom of the footing.*

3. *Where a slab on ground is cast monolithically with the footing, one No. 5 bar is permitted to be located at either the top of the slab or bottom of the footing.*

**1905.1.8 ACI 318, Section 17.2.3.** Modify ACI 318 Sections 17.10.5.2, 17.10.5.3(d) and 17.10.6.2 to read as follows:

- 17.10.5.2 – *Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.10.5.3. The anchor design tensile strength shall be determined in accordance with 17.10.5.4.*

**Exception:** *Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section 17.10.5.3(d).*

- 17.10.5.3(d) – *The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include  $E$ , with  $E$  increased by  $\Omega_c$ . The anchor design tensile strength shall be calculated from 17.10.5.4.*
- 17.10.6.2 – *Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.10.6.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.7.*

**Exceptions:**

1. *For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.7.2 and 17.7.3 need not be computed and 17.10.6.3 shall be deemed to be satisfied provided all of the following are met:*

- 1.1. *The allowable in-plane shear strength of the anchor is determined in accordance with ANSI/AWC NDS Table*

*12E for lateral design values parallel to grain.*

- 1.2. *The maximum anchor nominal diameter is  $\frac{5}{8}$  inch (16 mm).*
- 1.3. *Anchor bolts are embedded into concrete a minimum of 7 inches (178 mm).*
- 1.4. *Anchor bolts are located a minimum of  $1\frac{3}{4}$  inches (45 mm) from the edge of the concrete parallel to the length of the wood sill plate.*
- 1.5. *Anchor bolts are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the wood sill plate.*
- 1.6. *The sill plate is 2-inch (51 mm) or 3-inch (76 mm) nominal thickness.*

2. *For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.7.2 and 17.7.3 need not be computed and 17.10.6.3 shall be deemed to be satisfied provided all of the following are met:*

- 2.1. *The maximum anchor nominal diameter is  $\frac{5}{8}$  inch (16 mm).*
- 2.2. *Anchors are embedded into concrete a minimum of 7 inches (178 mm).*
- 2.3. *Anchors are located a minimum of  $1\frac{3}{4}$  inches (45 mm) from the edge of the concrete parallel to the length of the track.*
- 2.4. *Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.*
- 2.5. *The track is 33 to 68 mil (0.84 mm to 1.73 mm) designation thickness.*

*Allowable in-plane shear strength of exempt anchors, parallel to the edge of concrete, shall be permitted to be determined in accordance with AISI S100 Section J3.3.1.*

3. *In light-frame construction bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching sill plate or track to foundation or foundation stem wall need not satisfy 17.10.6.3(a) through (c) when the design strength of the anchors is determined in accordance with 17.7.2.1(c).*

## SECTION 1906

### FOOTINGS FOR LIGHT-FRAME CONSTRUCTION

**1906.1 Plain concrete footings.** For Group R-3 occupancies and buildings of other occupancies less than two stories above grade plane of *light-frame construction*, the required thickness of plain concrete footings is permitted to be 6 inches (152 mm), provided that the footing does not extend more than 4 inches (102 mm) on either side of the supported wall.

## SECTION 1907

### MINIMUM SLAB PROVISIONS

**1907.1 General.** The thickness of concrete floor slabs supported directly on the ground shall be not less than 3½ inches (89 mm). A 6-mil (0.006 inch; 0.15 mm) polyethylene vapor retarder with joints lapped not less than 6 inches (152 mm) shall be placed between the base course or subgrade and the concrete floor slab, or other *approved* equivalent methods or materials shall be used to retard vapor transmission through the floor slab.

**Exception:** A vapor retarder is not required:

1. For detached structures accessory to occupancies in Group R-3, such as garages, utility buildings or other unheated facilities.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m²) and carports attached to occupancies in Group R-3.
3. For buildings of other occupancies where migration of moisture through the slab from below will not be detrimental to the intended occupancy of the building.
4. For driveways, walks, patios and other flatwork that will not be enclosed at a later date.
5. Where *approved* based on local site conditions.

## SECTION 1908

### SHOTCRETE

**1908.1 General.** Shotcrete shall be in accordance with the requirements of ACI 318.





## CHAPTER 20

# ALUMINUM

---

### User notes:

**About this chapter:** Chapter 20 contains standards for the use of aluminum in building construction. Only the structural applications of aluminum are addressed so it would not apply to the use of aluminum in specialty products such as storefront or window framing or architectural hardware. The use of aluminum in heating, ventilating or air-conditioning systems is addressed in the International Mechanical Code®. This chapter references national standards from the Aluminum Association for use of aluminum in building construction, AA ASM 35, Aluminum Sheet Metal Work in Building Construction, and AA ADM, Aluminum Design Manual.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

---

### SECTION 2001

#### GENERAL

**2001.1 Scope.** This chapter shall govern the quality, design, fabrication and erection of aluminum.

### SECTION 2002

#### MATERIALS

**2002.1 General.** Aluminum used for structural purposes in buildings and structures shall comply with AA ASM 35 and AA ADM. The *nominal loads* shall be the minimum design loads required by Chapter 16.



## CHAPTER 21

# MASONRY

### User notes:

**About this chapter:** Chapter 21 establishes minimum requirements for masonry construction. The provisions address: material specifications and test methods; types of wall construction; criteria for engineered and empirical designs; and required details of construction, including the execution of construction. The provisions provide a framework for applying applicable standards to the design and construction of masonry structures. Masonry design methodologies including allowable stress design, strength design and empirical design are covered by the provisions of this chapter. Also addressed are masonry fireplaces and chimneys, masonry heaters and glass unit masonry.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 2101

#### GENERAL

**2101.1 Scope.** This chapter shall govern the materials, design, construction and quality of masonry.

**2101.2 Design methods.** Masonry shall comply with the provisions of TMS 402, TMS 403 or TMS 404 as well as applicable requirements of this chapter.

**2101.2.1 Masonry veneer.** Masonry *veneer* shall comply with the provisions of Chapter 14.

**2101.3 Special inspection.** The *special inspection* of masonry shall be as defined in Chapter 17, or an itemized testing and inspection program shall be provided that meets or exceeds the requirements of Chapter 17.

### SECTION 2102

#### NOTATIONS

**2102.1 General.** The following notations are used in the chapter:

#### NOTATIONS.

$d_b$	= Diameter of reinforcement, inches (mm).
$F_s$	= Allowable tensile or compressive stress in reinforcement, psi (MPa).
$f_r$	= Modulus of rupture, psi (MPa).
$f'_{AAC}$	= Specified compressive strength of AAC masonry, the minimum compressive strength for a class of AAC masonry as specified in TMS 602, psi (MPa).
$f'_m$	= Specified compressive strength of masonry at age of 28 days, psi (MPa).
$f'_{mi}$	= Specified compressive strength of masonry at the time of prestress transfer, psi (MPa).
$K$	= The lesser of the masonry cover, clear spacing between adjacent reinforcement, or five times $d_b$ , inches (mm).
$L_s$	= Distance between supports, inches (mm).
$l_d$	= Required development length or lap length of reinforcement, inches (mm).

$P$	= The applied load at failure, pounds (N).
$S_t$	= Thickness of the test specimen measured parallel to the direction of load, inches (mm).
$S_w$	= Width of the test specimen measured parallel to the loading cylinder, inches (mm).

### SECTION 2103

#### MASONRY CONSTRUCTION MATERIALS

**2103.1 Masonry units.** Concrete *masonry units*, clay or shale *masonry units*, stone *masonry units*, glass unit masonry and AAC *masonry units* shall comply with Article 2.3 of TMS 602. Architectural *cast stone* shall conform to ASTM C1364 and TMS 504. Adhered manufactured stone masonry *veneer units* shall conform to ASTM C1670.

**Exception:** *Structural clay tile* for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The *fire-resistance rating* shall be determined in accordance with ASTM E119 or UL 263 and shall comply with the requirements of Table 705.5.

**2103.1.1 Second-hand units.** Second-hand *masonry units* shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old *mortar* shall be cleaned from the unit before reuse.

**2103.2 Mortar.** *Mortar* for masonry construction shall comply with Section 2103.2.1, 2103.2.2, 2103.2.3 or 2103.2.4.

**2103.2.1 Masonry mortar.** *Mortar* for use in masonry construction shall conform to Articles 2.1 and 2.6 A of TMS 602.

**2103.2.2 Surface-bonding mortar.** *Surface-bonding mortar* shall comply with ASTM C887. Surface bonding of concrete *masonry units* shall comply with ASTM C946.

**2103.2.3 Mortars for ceramic wall and floor tile.** Portland cement *mortars* for installing ceramic wall and floor tile shall comply with ANSI A108.1A and ANSI A108.1B and be of the compositions indicated in Table 2103.2.3.

## MASONRY

**TABLE 2103.2.3  
CERAMIC TILE MORTAR COMPOSITIONS**

LOCATION	MORTAR	COMPOSITION
Walls	Scratchcoat	1 cement; $\frac{1}{5}$ hydrated lime; 4 dry or 5 damp sand
	Setting bed and leveling coat	1 cement; $\frac{1}{2}$ hydrated lime; 5 damp sand to 1 cement; 1 hydrated lime, 7 damp sand
Floors	Setting bed	1 cement; $\frac{1}{10}$ hydrated lime; 5 dry or 6 damp sand; or 1 cement; 5 dry or 6 damp sand
Ceilings	Scratchcoat and sand bed	1 cement; $\frac{1}{2}$ hydrated lime; $2\frac{1}{2}$ dry sand or 3 damp sand

**2103.2.3.1 Dry-set Portland cement mortars.** Premixed prepared Portland cement *mortars*, which require only the addition of water and are used in the installation of ceramic tile, shall comply with ANSI A118.1. The shear bond strength for tile set in such *mortar* shall be as required in accordance with ANSI A118.1. Tile set in dry-set Portland cement *mortar* shall be installed in accordance with ANSI A108.5.

**2103.2.3.2 Latex-modified Portland cement mortar.** Latex-modified Portland cement thin-set *mortars* in which latex is added to dry-set *mortar* as a replacement for all or part of the gauging water that are used for the installation of ceramic tile shall comply with ANSI A118.4. Tile set in latex-modified Portland cement shall be installed in accordance with ANSI A108.5.

**2103.2.3.3 Epoxy mortar.** Ceramic tile set and grouted with chemical-resistant epoxy shall comply with ANSI A118.3. Tile set and grouted with epoxy shall be installed in accordance with ANSI A108.6.

**2103.2.3.4 Furan mortar and grout.** Chemical-resistant furan *mortar* and grout that are used to install ceramic tile shall comply with ANSI A118.5. Tile set and grouted with furan shall be installed in accordance with ANSI A108.8.

**2103.2.3.5 Modified epoxy-emulsion mortar and grout.** Modified epoxy-emulsion *mortar* and grout that are used to install ceramic tile shall comply with ANSI A118.8. Tile set and grouted with modified epoxy-emulsion *mortar* and grout shall be installed in accordance with ANSI A108.9.

**2103.2.3.6 Organic adhesives.** Water-resistant organic adhesives used for the installation of ceramic tile shall comply with ANSI A136.1. The shear bond strength after water immersion shall be not less than 40 psi (275 kPa) for Type I adhesive and not less than 20 psi (138 kPa) for Type II adhesive when tested in accordance with ANSI A136.1. Tile set in organic adhesives shall be installed in accordance with ANSI A108.4.

**2103.2.3.7 Portland cement grouts.** Portland cement grouts used for the installation of ceramic tile shall comply with ANSI A118.6. Portland cement grouts for

tile work shall be installed in accordance with ANSI A108.10.

**2103.2.4 Mortar for adhered masonry veneer.** *Mortar* for use with *adhered masonry veneer* shall conform to ASTM C270 for Type N or S, or shall comply with ANSI A118.4 for latex-modified Portland cement *mortar*.

**2103.3 Grout.** Grout shall comply with Article 2.2 of TMS 602.

**2103.4 Metal reinforcement and accessories.** Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602. Where unidentified reinforcement is *approved* for use, not less than three tension and three bending tests shall be made on representative specimens of the reinforcement from each shipment and grade of reinforcing steel proposed for use in the work.

## SECTION 2104 CONSTRUCTION

**2104.1 Masonry construction.** Masonry construction shall comply with the requirements of Sections 2104.1.1 and 2104.1.2 and with the requirements of either TMS 602 or TMS 604.

**2104.1.1 Support on wood.** Masonry shall not be supported on wood girders or other forms of wood construction except as permitted in Section 2304.12.

**2104.1.2 Molded cornices.** Unless structural support and anchorage are provided to resist the overturning moment, the center of gravity of projecting masonry or molded *cornices* shall lie within the middle one-third of the supporting wall. Terra cotta and metal *cornices* shall be provided with a structural frame of *approved* noncombustible material anchored in an *approved* manner.

## SECTION 2105 QUALITY ASSURANCE

**2105.1 General.** A quality assurance program shall be used to ensure that the constructed masonry is in compliance with the *approved construction documents*.

The quality assurance program shall comply with the inspection and testing requirements of Chapter 17 and TMS 602.

## SECTION 2106 SEISMIC DESIGN

**2106.1 Seismic design requirements for masonry.** Masonry structures and components shall comply with the requirements in Chapter 7 of TMS 402 depending on the structure's *seismic design category*.

## SECTION 2107 ALLOWABLE STRESS DESIGN

**2107.1 General.** The design of masonry structures using *allowable stress design* shall comply with Section 2106 and



the requirements of Chapters 1 through 8 of TMS 402 except as modified by Sections 2107.2 through 2107.3.

**2107.2 TMS 402, Section 6.1.6.1.1, lap splices.** As an alternative to Section 6.1.6.1.1, it shall be permitted to design lap splices in accordance with Section 2107.2.1.

**2107.2.1 Lap splices.** The minimum length of lap splices for reinforcing bars in tension or compression,  $l_d$ , shall be:

$$l_d = 0.002d_b f_s \quad (\text{Equation 21-1})$$

For SI:  $l_d = 0.29d_b f_s$

but not less than 12 inches (305 mm). The length of the lapped splice shall be not less than 40 bar diameters, where:

$d_b$  = Diameter of reinforcement, inches (mm)

$f_s$  = Computed stress in reinforcement due to design loads, psi (MPa).

In regions of moment where the design tensile stresses in the reinforcement are greater than 80 percent of the allowable steel tension stress,  $F_s$ , the lap length of splices shall be increased not less than 50 percent of the minimum required length, but need not be greater than  $72 d_b$ . Other equivalent means of stress transfer to accomplish the same 50 percent increase shall be permitted. Where epoxy coated bars are used, lap length shall be increased by 50 percent.

**2107.3 TMS 402, Section 6.1.6.1, splices of reinforcement.** Modify Section 6.1.6.1 as follows:

6.1.6.1 – Splices of reinforcement. Lap splices, welded splices or mechanical splices are permitted in accordance with the provisions of this section. Welding shall conform to AWS D1.4. Welded splices shall be of ASTM A706 steel reinforcement. Reinforcement larger than No. 9 (M #29) shall be spliced using mechanical connections in accordance with Section 6.1.6.1.3.

## SECTION 2108 STRENGTH DESIGN OF MASONRY

**2108.1 General.** The design of masonry structures using strength design shall comply with Section 2106 and the requirements of Chapters 1 through 7 and Chapter 9 of TMS 402, except as modified by Sections 2108.2 through 2108.3.

**Exception:** AAC masonry shall comply with the requirements of Chapters 1 through 7 and Chapter 11 of TMS 402.

**2108.2 TMS 402, Section 6.1.5.1.1, development.** Modify the second paragraph of Section 6.1.5.1.1 as follows:

The required development length of reinforcement shall be determined by Equation (6-1), but shall be not less than 12 inches (305 mm) and need not be greater than  $72 d_b$ .

**2108.3 TMS 402, Section 6.1.6.1.1, splices.** Modify Sections 6.1.6.1.2 and 6.1.6.1.3 as follows:

6.1.6.1.2 – A welded splice shall have the bars butted and welded to develop not less than 125 percent of the yield

strength,  $f_y$ , of the bar in tension or compression, as required. Welded splices shall be of ASTM A706 steel reinforcement. Welded splices shall not be permitted in plastic hinge zones of intermediate or special reinforced walls.

6.1.6.1.3 – Mechanical splices shall be classified as Type 1 or 2 in accordance with Section 18.2.7.1 of ACI 318. Type 1 mechanical splices shall not be used within a plastic hinge zone or within a beam-column joint of intermediate or special reinforced masonry shear walls. Type 2 mechanical splices are permitted in any location within a member.

## SECTION 2109 EMPIRICAL DESIGN OF ADOBE MASONRY

**2109.1 General.** Empirically designed adobe masonry shall conform to the requirements of Appendix A of TMS 402, except where otherwise noted in this section.

**2109.1.1 Limitations.** The use of empirical design of adobe masonry shall be limited as noted in Section A.1.2 of TMS 402. In buildings that exceed one or more of the limitations of Section A.1.2 of TMS 402, masonry shall be designed in accordance with the engineered design provisions of Section 2101.2 or the foundation wall provisions of Section 1807.1.5.

Section A.1.2.2 of TMS 402 shall be modified as follows:

A.1.2.2 – *Wind.* Empirical requirements shall not apply to the design or construction of masonry for buildings, parts of buildings, or other structures to be located in areas where  $V_{asd}$  as determined in accordance with Section 1609.3.1 of the *International Building Code* exceeds 110 mph.

**2109.2 Adobe construction.** Adobe construction shall comply with this section and shall be subject to the requirements of this code for Type V construction, Appendix A of TMS 402, and this section.

**2109.2.1 Unstabilized adobe.** Unstabilized adobe shall comply with Sections 2109.2.1.1 through 2109.2.1.4.

**2109.2.1.1 Compressive strength.** Adobe units shall have an average compressive strength of 300 psi (2068 kPa) when tested in accordance with ASTM C67. Five samples shall be tested and individual units are not permitted to have a compressive strength of less than 250 psi (1724 kPa).

**2109.2.1.2 Modulus of rupture.** Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and individual units shall not have a modulus of rupture of less than 35 psi (241 kPa).

**2109.2.1.2.1 Support conditions.** A cured unit shall be simply supported by 2-inch-diameter (51 mm) cylindrical supports located 2 inches (51 mm) in from each end and extending the full width of the unit.

## MASONRY

**2109.2.1.2.2 Loading conditions.** A 2-inch-diameter (51 mm) cylinder shall be placed at midspan parallel to the supports.

**2109.2.1.2.3 Testing procedure.** A vertical *load* shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.

**2109.2.1.2.4 Modulus of rupture determination.** The modulus of rupture shall be determined by the equation:

$$f_r = 3 PL_s / [2 S_w (S_t^2)] \quad (\text{Equation 21-2})$$

where, for the purposes of this section only:

$S_w$  = Width of the test specimen measured parallel to the loading cylinder, inches (mm).

$f_r$  = Modulus of rupture, psi (MPa).

$L_s$  = Distance between supports, inches (mm).

$S_t$  = Thickness of the test specimen measured parallel to the direction of load, inches (mm).

$P$  = The applied *load* at failure, pounds (N).

**2109.2.1.3 Moisture content requirements.** Adobe units shall have a moisture content not exceeding 4 percent by weight.

**2109.2.1.4 Shrinkage cracks.** Adobe units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76 mm) in length or  $1/8$  inch (3.2 mm) in width.

**2109.2.2 Stabilized adobe.** *Stabilized adobe* shall comply with Section 2109.2.1 for *unstabilized adobe* in addition to Sections 2109.2.2.1 and 2109.2.2.2.

**2109.2.2.1 Soil requirements.** Soil used for *stabilized adobe* units shall be chemically compatible with the stabilizing material.

**2109.2.2.2 Absorption requirements.** A 4-inch (102 mm) cube, cut from a *stabilized adobe* unit dried to a constant weight in a ventilated oven at 212°F to 239°F (100°C to 115°C), shall not absorb more than  $2\frac{1}{2}$  percent moisture by weight when placed on a constantly water-saturated, porous surface for seven days. Not fewer than five specimens shall be tested and each specimen shall be cut from a separate unit.

**2109.2.3 Allowable stress.** The allowable compressive stress based on gross cross-sectional area of adobe shall not exceed 30 psi (207 kPa).

**2109.2.3.1 Bolts.** Bolt values shall not exceed those set forth in Table 2109.2.3.1.

**2109.2.4 Detailed requirements.** *Adobe construction* shall comply with Sections 2109.2.4.1 through 2109.2.4.9.

**2109.2.4.1 Number of stories.** *Adobe construction* shall be limited to buildings not exceeding one *story*, except that two-*story* construction is allowed where designed by a *registered design professional*.

**2109.2.4.2 Mortar.** *Mortar* for *adobe construction* shall comply with Sections 2109.2.4.2.1 and 2109.2.4.2.2.

**2109.2.4.2.1 General.** *Mortar* for adobe units shall be in accordance with Section 2103.2.1, or be composed of adobe soil of the same composition and stabilization as the adobe brick units. *Unstabilized adobe soil mortar* is permitted in conjunction with *unstabilized adobe* brick units.

**2109.2.4.2.2 Mortar joints.** Adobe units shall be laid with full head and *bed joints* and in full *running bond*.

**2109.2.4.3 Parapet walls.** *Parapet walls* constructed of adobe units shall be waterproofed.

**2109.2.4.4 Wall thickness.** The minimum thickness of *exterior walls* in one-*story* buildings shall be 10 inches (254 mm). The walls shall be laterally supported at intervals not exceeding 24 feet (7315 mm). The minimum thickness of interior *load-bearing walls* shall be 8 inches (203 mm). The unsupported height of any wall constructed of adobe units shall not exceed 10 times the thickness of such wall.

**2109.2.4.5 Foundations.** Foundations for *adobe construction* shall be in accordance with Sections 2109.2.4.5.1 and 2109.2.4.5.2.

**2109.2.4.5.1 Foundation support.** Walls and partitions constructed of adobe units shall be supported by foundations or footings that extend not less than 6 inches (152 mm) above adjacent ground surfaces and are constructed of *solid masonry* (excluding adobe) or concrete. Footings and foundations shall comply with Chapter 18.

**2109.2.4.5.2 Lower course requirements.** *Stabilized adobe* units shall be used in adobe walls for the first 4 inches (102 mm) above the finished first-floor elevation.

**2109.2.4.6 Isolated piers or columns.** Adobe units shall not be used for isolated piers or columns in a load-bearing capacity. Walls less than 24 inches (610 mm) in length shall be considered to be isolated piers or columns.

**2109.2.4.7 Tie beams.** *Exterior walls* and interior *load-bearing walls* constructed of adobe units shall have a continuous tie beam at the level of the floor or roof bearing and meeting the following requirements.

**TABLE 2109.2.3.1**  
**ALLOWABLE SHEAR ON BOLTS IN ADOBE MASONRY**

DIAMETER OF BOLTS (inches)	MINIMUM EMBEDMENT (inches)	SHEAR (pounds)
$1/2$	—	—
$5/8$	12	200
$3/4$	15	300
$7/8$	18	400
1	21	500
$1\frac{1}{8}$	24	600

For SI: 1 inch = 25.4 mm, 1 pound = 4.448 N.

**2109.2.4.7.1 Concrete tie beams.** Concrete tie beams shall be 6 inches (152 mm) or more in depth and 10 inches (254 mm) or more in width. Concrete tie beams shall be continuously reinforced with not fewer than two No. 4 reinforcing bars. The specified compressive strength of concrete shall be not less than 2,500 psi (17.2 MPa).

**2109.2.4.7.2 Wood tie beams.** Wood tie beams shall be solid or built up of lumber having a nominal thickness of not less than 1 inch (25 mm), and shall have a depth of not less than 6 inches (152 mm) and a width of not less than 10 inches (254 mm). Joints in wood tie beams shall be spliced not less than 6 inches (152 mm). Splices shall not be allowed within 12 inches (305 mm) of an opening. Wood used in tie beams shall be *approved* naturally decay-resistant or *preservative-treated wood*.

**2109.2.4.8 Exterior finish.** Exterior finishes applied to adobe masonry walls shall be of any type permitted by this section or Chapter 14, except where stated otherwise in this section.

**2109.2.4.8.1 Where required.** *Unstabilized adobe* masonry walls shall receive a weather protective exterior finish in accordance with Section 2109.2.4.8.

**2109.2.4.8.2 Vapor permeance.** Plaster and finish assemblies shall have a vapor permeance of not less than 5 perms.

**Exception:** Insulation products applied to the exterior of *stabilized adobe* masonry walls in Climate Zones 2B, 3B, 4B and 5B shall not have a vapor permeance requirement.

**2109.2.4.8.3 Plaster thickness and coats.** Plaster applied to adobe masonry shall be not less than  $\frac{7}{8}$  inch (22 mm) and not greater than 2 inches (51 mm) thick. Plaster shall be applied in not less than two coats.

**2109.2.4.8.4 Plaster application.** Where plaster is applied directly to adobe masonry walls, no intermediate membrane shall be used.

**2109.2.4.8.5 Lath for plaster.** Lath shall be provided for all plasters, except where not required elsewhere in Section 2109.2.4.8. Fasteners shall be corrosion resistant and spaced at a maximum of 16 inches (406 mm) on center with a minimum  $1\frac{1}{2}$ -inch (38 mm) penetration into the adobe wall. Metal lath shall comply with ASTM C1063, as modified by this section, and shall be corrosion resistant. Plastic lath shall comply with ASTM C1788, as modified by this section. Wood substrates shall be protected with No. 15 asphalt felt, an approved wood preservative or other protective coating prior to lath application.

**2109.2.4.8.6 Cement plaster.** *Cement plaster* shall conform to ASTM C926 and shall comply with Chapter 25, except that the proportion of lime in plaster coats shall be not less than 1 part lime to 4

parts cement. The combined thickness of *cement plaster* coats shall not exceed 1 inch (25 mm).

**2109.2.4.8.7 Lime plaster.** Lime plaster is any plaster with a binder composed of calcium hydroxide, including Type N or S hydrated lime, hydraulic lime, natural hydraulic lime, or slaked quicklime. Hydrated lime shall comply with ASTM C206. Hydraulic lime shall comply with ASTM C1707. Natural hydraulic lime shall comply with ASTM C141 and EN 459. Quicklime shall comply with ASTM C5.

**2109.2.4.8.8 Cement-lime plaster.** Cement-lime plaster shall be any plaster mix type CL, F or FL, as described in ASTM C926.

**2109.2.4.8.9 Clay plaster.** Clay plaster shall comply with this section.

**2109.2.4.8.9.1 General.** Clay plaster shall be any plaster having a clay or clay subsoil binder. Such plaster shall contain sufficient clay to fully bind the aggregate and shall be permitted to contain reinforcing fibers. Acceptable reinforcing fibers include chopped straw, sisal, and animal hair.

**2109.2.4.8.9.2 Clay subsoil requirements.** The suitability of clay subsoil shall be determined in accordance with the Figure 2 Ribbon Test and the Figure 3 Ball Test in the appendix of ASTM E2392/E2392M.

**2109.2.4.8.9.3 Weather-exposed locations.** Clay plaster exposed to water from direct or wind-driven rain or snow shall be finished with an approved erosion-resistant finish. The use of clay plasters shall not be permitted on weather-exposed parapets.

**2109.2.4.8.9.4 Prohibited finish coat.** Plaster containing Portland cement shall not be permitted as a finish over clay plaster.

**2109.2.4.8.9.5 Conditions where lathing is not required.** For *unstabilized adobe* walls finished with unstabilized clay plaster, lathing shall not be required.

**2109.2.4.9 Lintels.** Lintels shall be considered to be structural members and shall be designed in accordance with the applicable provisions of Chapter 16.

## SECTION 2110 GLASS UNIT MASONRY

**2110.1 General.** *Glass unit masonry* construction shall comply with Chapter 13 of TMS 402 and this section.

**2110.1.1 Limitations.** Solid or hollow *approved* glass block shall not be used in *fire walls*, party walls, fire barriers, *fire partitions* or *smoke barriers*, or for load-bearing construction. Such blocks shall be erected with *mortar* and reinforcement in metal channel-type frames, structural frames, masonry or concrete recesses, embed-



## MASONRY

ded panel anchors as provided for both exterior and interior walls or other *approved* joint materials. Wood strip framing shall not be used in walls required to have a *fire-resistance rating* by other provisions of this code.

### Exceptions:

1. Glass-block assemblies having a *fire protection rating* of not less than  $\frac{3}{4}$  hour shall be permitted as opening protectives in accordance with Section 716 in *fire barriers*, *fire partitions* and *smoke barriers* that have a required *fire-resistance rating* of 1 hour or less and do not enclose exit *stairways* and *ramps* or exit passageways.
2. Glass-block assemblies as permitted in Section 404.6, Exception 2.

## SECTION 2111 MASONRY FIREPLACES

**2111.1 General.** The construction of masonry fireplaces, consisting of concrete or masonry, shall be in accordance with this section.

**2111.2 Fireplace drawings.** The *construction documents* shall describe in sufficient detail the location, size and construction of masonry fireplaces. The thickness and characteristics of materials and the clearances from walls, partitions and ceilings shall be indicated.

**2111.3 Footings and foundations.** Footings for masonry fireplaces and their chimneys shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not less than 6 inches (153 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished grade.

**2111.3.1 Ash dump cleanout.** Cleanout openings, located within foundation walls below fireboxes, where provided, shall be equipped with ferrous metal or masonry doors and frames constructed to remain tightly closed, except when in use. Cleanouts shall be accessible and located so that ash removal will not create a hazard to combustible materials.

**2111.4 Seismic reinforcement.** In structures assigned to *Seismic Design Category A* or *B*, seismic reinforcement is not required. In structures assigned to *Seismic Design Category C* or *D*, masonry fireplaces shall be reinforced and anchored in accordance with Sections 2111.4.1, 2111.4.2 and 2111.5. In structures assigned to *Seismic Design Category E* or *F*, masonry fireplaces shall be reinforced in accordance with the requirements of Sections 2101 through 2108.

**2111.4.1 Vertical reinforcing.** For fireplaces with chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete between *wythes* of *solid masonry* or within the *cells* of hollow unit masonry and

grouted in accordance with Section 2103.3. For fireplaces with chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

**2111.4.2 Horizontal reinforcing.** Vertical reinforcement shall be placed enclosed within  $\frac{1}{4}$ -inch (6.4 mm) ties or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete; or placed in the *bed joints* of unit masonry at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

**2111.5 Seismic anchorage.** Masonry fireplaces and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two  $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25 mm) straps embedded not less than 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not fewer than four floor joists with two  $\frac{1}{2}$ -inch (12.7 mm) bolts.

**Exception:** Seismic anchorage is not required for the following:

1. In structures assigned to *Seismic Design Category A* or *B*.
2. Where the masonry fireplace is constructed completely within the *exterior walls*.

**2111.6 Firebox walls.** Masonry fireboxes shall be constructed of solid *masonry units*, hollow *masonry units* grouted solid, stone or concrete. Where a lining of firebrick not less than 2 inches (51 mm) in thickness or other *approved* lining is provided, the minimum thickness of back and sidewalls shall each be 8 inches (203 mm) of *solid masonry*, including the lining. The width of joints between firebricks shall be not greater than  $\frac{1}{4}$  inch (6.4 mm). Where a lining is not provided, the total minimum thickness of back and sidewalls shall be 10 inches (254 mm) of *solid masonry*. Firebrick shall conform to ASTM C27 or ASTM C1261 and shall be laid with medium-duty refractory *mortar* conforming to ASTM C199.

**2111.6.1 Steel fireplace units.** Steel fireplace units are permitted to be installed with *solid masonry* to form a masonry fireplace provided that they are installed according to either the requirements of their listing or the requirements of this section. Steel fireplace units incorporating a steel firebox lining shall be constructed with steel not less than  $\frac{1}{4}$  inch (6.4 mm) in thickness, and an air-circulating chamber that is ducted to the interior of the building. The firebox lining shall be encased with *solid masonry* to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of *solid masonry* or concrete. Circulating air ducts employed with steel fireplace units shall be constructed of metal or masonry.

**2111.7 Firebox dimensions.** The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 inches (508 mm). The throat shall be not less than 8 inches (203



mm) above the fireplace opening. The throat opening shall be not less than 4 inches (102 mm) in depth. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall be not less than the cross-sectional area of the flue.

**Exception:** Rumford fireplaces shall be permitted provided that the depth of the fireplace is not less than 12 inches (305 mm) and not less than one-third of the width of the fireplace opening, and the throat is not less than 12 inches (305 mm) above the lintel, and not less than  $\frac{1}{20}$  the cross-sectional area of the fireplace opening.

**2111.8 Lintel and throat.** Masonry over a fireplace opening shall be supported by a lintel of noncombustible material. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm). The *fireplace throat* or damper shall be located not less than 8 inches (203 mm) above the top of the fireplace opening.

**2111.8.1 Damper.** Masonry fireplaces shall be equipped with a ferrous metal damper located not less than 8 inches (203 mm) above the top of the fireplace opening. Dampers shall be installed in the fireplace or at the top of the flue venting the fireplace, and shall be operable from the room containing the fireplace. Damper controls shall be permitted to be located in the fireplace.

**2111.9 Smoke chamber walls.** Smoke chamber walls shall be constructed of solid *masonry units*, hollow *masonry units* grouted solid, stone or concrete. The total minimum thickness of front, back and sidewalls shall be 8 inches (203 mm) of *solid masonry*. The inside surface shall be parged smooth with refractory mortar conforming to ASTM C199. Where a lining of firebrick not less than 2 inches (51 mm) thick, or a lining of vitrified clay not less than  $\frac{5}{8}$  inch (15.9 mm) thick, is provided, the total minimum thickness of front, back and sidewalls shall be 6 inches (152 mm) of *solid masonry*, including the lining. Firebrick shall conform to ASTM C1261 and shall be laid with refractory *mortar* conforming to ASTM C199. Vitrified clay linings shall conform to ASTM C315.

**2111.9.1 Smoke chamber dimensions.** The inside height of the smoke chamber from the *fireplace throat* to the beginning of the flue shall be not greater than the inside width of the fireplace opening. The inside surface of the smoke chamber shall not be inclined more than 45 degrees (0.76 rad) from vertical where prefabricated smoke chamber linings are used or where the smoke chamber walls are rolled or sloped rather than corbeled. Where the inside surface of the smoke chamber is formed by corbeled masonry, the walls shall not be corbeled more than 30 degrees (0.52 rad) from vertical.

**2111.10 Hearth and hearth extension.** Masonry fireplace hearths and hearth extensions shall be constructed of concrete or masonry, supported by noncombustible materials, and reinforced to carry their own weight and all imposed *loads*. Combustible material shall not remain against the underside of hearths or hearth extensions after construction.

**2111.10.1 Hearth thickness.** The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

**2111.10.2 Hearth extension thickness.** The minimum thickness of hearth extensions shall be 2 inches (51 mm).

**Exception:** Where the bottom of the firebox opening is raised not less than 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than  $\frac{3}{8}$ -inch-thick (9.5 mm) brick, concrete, stone, tile or other *approved* noncombustible material is permitted.

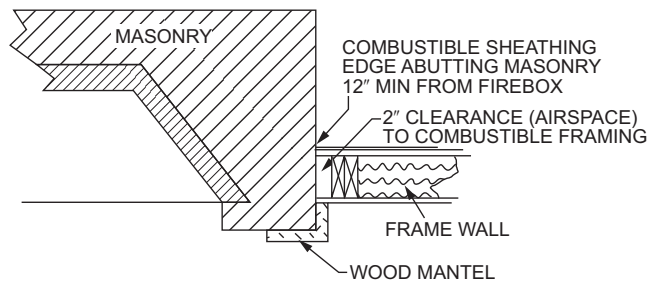
**2111.11 Hearth extension dimensions.** Hearth extensions shall extend not less than 16 inches (406 mm) in front of, and not less than 8 inches (203 mm) beyond, each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.557 m<sup>2</sup>) or larger, the hearth extension shall extend not less than 20 inches (508 mm) in front of, and not less than 12 inches (305 mm) beyond, each side of the fireplace opening.

**2111.12 Fireplace clearance.** Any portion of a masonry fireplace located in the interior of a building or within the *exterior wall* of a building shall have a clearance to combustibles of not less than 2 inches (51 mm) from the front faces and sides of masonry fireplaces and not less than 4 inches (102 mm) from the back faces of masonry fireplaces. The airspace shall not be filled, except to provide *fireblocking* in accordance with Section 2111.13.

#### Exceptions:

1. Masonry fireplaces *listed* and *labeled* for use in contact with combustibles in accordance with UL 127 and installed in accordance with the manufacturer's instructions are permitted to have combustible material in contact with their exterior surfaces.
2. Where masonry fireplaces are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete walls less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.
3. Exposed combustible *trim* and the edges of sheathing materials, such as wood siding, flooring and drywall, are permitted to abut the masonry fireplace sidewalls and hearth extension, in accordance with Figure 2111.12, provided that such combustible *trim* or sheathing is not less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.
4. Exposed combustible mantels or *trim* is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening, provided that such combustible materials shall not be placed within 6 inches (153 mm) of a fireplace opening. Combustible material directly above and within 12 inches (305 mm) of the fireplace opening shall not project more than  $\frac{1}{8}$  inch (3.2 mm) for each 1-inch (25 mm) distance from such opening. Combustible materials located along the sides of the fireplace opening that project more than  $1\frac{1}{2}$  inches (38 mm) from the face of the fireplace shall have an additional clearance equal to the projection.

## MASONRY



Note: 1 inch = 25.4 mm

**FIGURE 2111.12**  
**ILLUSTRATION OF EXCEPTION TO**  
**FIREPLACE CLEARANCE PROVISION**

**2111.13 Fireplace fireblocking.** All spaces between fireplaces and floors and ceilings through which fireplaces pass shall be fireblocked with noncombustible material securely fastened in place. The *fireblocking* of spaces between wood joists, beams or headers shall be to a depth of 1 inch (25 mm) and shall only be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

**2111.14 Exterior air.** Factory-built or masonry fireplaces covered in this section shall be equipped with an exterior air supply to ensure proper fuel combustion unless the room is mechanically ventilated and controlled so that the indoor pressure is neutral or positive.

**2111.14.1 Factory-built fireplaces.** Exterior combustion air ducts for factory-built fireplaces shall be *listed* components of the fireplace, and installed according to the fireplace manufacturer's instructions.

**2111.14.2 Masonry fireplaces.** *Listed* combustion air ducts for masonry fireplaces shall be installed according to the terms of their listing and manufacturer's instructions.

**2111.14.3 Exterior air intake.** The exterior air intake shall be capable of providing all combustion air from the exterior of the *dwelling*. The exterior air intake shall not be located within a garage, *attic*, *basement* or crawl space of the *dwelling* nor shall the air intake be located at an elevation higher than the firebox. The exterior air intake shall be covered with a corrosion-resistant screen of  $\frac{1}{4}$ -inch (6.4 mm) mesh.

**2111.14.4 Clearance.** Unlisted combustion air ducts shall be installed with a minimum 1-inch (25 mm) clearance to combustibles for all parts of the duct within 5 feet (1524 mm) of the duct outlet.

**2111.14.5 Passageway.** The combustion air passageway shall be not less than 6 square inches (3870 mm<sup>2</sup>) and not more than 55 square inches (0.035 m<sup>2</sup>), except that combustion air systems for *listed* fireplaces or for fireplaces tested for emissions shall be constructed according to the fireplace manufacturer's instructions.

**2111.14.6 Outlet.** The exterior air outlet is permitted to be located in the back or sides of the firebox chamber or within 24 inches (610 mm) of the firebox opening on or near the floor. The outlet shall be closable and designed to prevent burning material from dropping into concealed combustible spaces.

## SECTION 2112 MASONRY HEATERS

**2112.1 Definition.** A masonry heater is a heating appliance constructed of concrete or *solid masonry*, hereinafter referred to as "masonry," which is designed to absorb and store heat from a solid fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox includes flow in either a horizontal or downward direction before entering the chimney and which delivers heat by radiation from the masonry surface of the heater.

**2112.2 Installation.** Masonry heaters shall be installed in accordance with this section and comply with one of the following:

1. Masonry heaters shall comply with the requirements of ASTM E1602.
2. Masonry heaters shall be *listed* and *labeled* in accordance with UL 1482 or EN 15250 and installed in accordance with the manufacturer's instructions.

**2112.3 Footings and foundation.** The firebox floor of a masonry heater shall be a minimum thickness of 4 inches (102 mm) of noncombustible material and be supported on a noncombustible footing and foundation in accordance with Section 2113.2.

**2112.4 Seismic reinforcing.** In structures assigned to *Seismic Design Category D, E or F*, masonry heaters shall be anchored to the masonry foundation in accordance with Section 2113.3. Seismic reinforcing shall not be required within the body of a masonry heater with a height that is equal to or less than 3.5 times its body width and where the masonry chimney serving the heater is not supported by the body of the heater. Where the masonry chimney shares a common wall with the facing of the masonry heater, the chimney portion of the structure shall be reinforced in accordance with Section 2113.

**2112.5 Masonry heater clearance.** Combustible materials shall not be placed within 36 inches (914 mm) or the distance of the allowed reduction method from the outside surface of a masonry heater in accordance with NFPA 211, Section 12.6, and the required space between the heater and combustible material shall be fully vented to permit the free flow of air around all heater surfaces.

### Exceptions:

1. Where the masonry heater wall thickness is not less than 8 inches (203 mm) of *solid masonry* and the wall thickness of the heat exchange channels is not less than 5 inches (127 mm) of *solid masonry*,

combustible materials shall not be placed within 4 inches (102 mm) of the outside surface of a masonry heater. A clearance of not less than 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.

2. Masonry heaters *listed* and *labeled* in accordance with UL 1482 or EN 15250 and installed in accordance with the manufacturer's instructions.

## SECTION 2113 MASONRY CHIMNEYS

**2113.1 General.** The construction of masonry chimneys consisting of solid *masonry units*, hollow *masonry units* grouted solid, stone or concrete shall be in accordance with this section.

**2113.2 Footings and foundations.** Footings for masonry chimneys shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not less than 6 inches (152 mm) beyond the face of the foundation or support wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished grade.

**2113.3 Seismic reinforcement.** In structures assigned to *Seismic Design Category A* or *B*, seismic reinforcement is not required. In structures assigned to *Seismic Design Category C* or *D*, masonry chimneys shall be reinforced and anchored in accordance with Sections 2113.3.1, 2113.3.2 and 2113.4. In structures assigned to *Seismic Design Category E* or *F*, masonry chimneys shall be reinforced in accordance with the requirements of Sections 2101 through 2108 and anchored in accordance with Section 2113.4.

**2113.3.1 Vertical reinforcement.** For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars anchored in the foundation shall be placed in the concrete between *wythes* of *solid masonry* or within the *cells* of hollow unit masonry and grouted in accordance with Section 2103.3. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys greater than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 inches (1016 mm) in width or fraction thereof.

**2113.3.2 Horizontal reinforcement.** Vertical reinforcement shall be placed enclosed within  $\frac{1}{4}$ -inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete, or placed in the *bed joints* of unit masonry, at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be provided at each bend in the vertical bars.

**2113.4 Seismic anchorage.** Masonry chimneys and foundations shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above grade with two  $\frac{3}{16}$ -inch by 1-inch (4.8 mm by 25 mm) straps embedded not less than

12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not less than four floor joists with two  $\frac{1}{2}$ -inch (12.7 mm) bolts.

**Exception:** Seismic anchorage is not required for the following:

1. In structures assigned to *Seismic Design Category A* or *B*.
2. Where the masonry fireplace is constructed completely within the *exterior walls*.

**2113.5 Corbeling.** Masonry chimneys shall not be corbeled more than half of the chimney's wall thickness from a wall or foundation, nor shall a chimney be corbeled from a wall or foundation that is less than 12 inches (305 mm) in thickness unless it projects equally on each side of the wall, except that on the second *story* of a two-story *dwelling*, corbeling of chimneys on the exterior of the enclosing walls is permitted to equal the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

**2113.6 Changes in dimension.** The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

**2113.7 Offsets.** Where a masonry chimney is constructed with a fireclay flue liner surrounded by one *wythe* of masonry, the maximum offset shall be such that the centerline of the flue above the offset does not extend beyond the center of the chimney wall below the offset. Where the chimney offset is supported by masonry below the offset in an *approved* manner, the maximum offset limitations shall not apply. Each individual corbeled masonry course of the offset shall not exceed the projection limitations specified in Section 2113.5.

**2113.8 Additional load.** Chimneys shall not support *loads* other than their own weight unless they are designed and constructed to support the additional *load*. Masonry chimneys are permitted to be constructed as part of the masonry walls or concrete walls of the building.

**2113.9 Termination.** Chimneys shall extend not less than 2 feet (610 mm) higher than any portion of the building within 10 feet (3048 mm), but shall be not less than 3 feet (914 mm) above the highest point where the chimney passes through the roof.

**2113.9.1 Chimney caps.** Masonry chimneys shall have a concrete, metal or stone cap, sloped to shed water, a drip edge and a caulked bond break around any flue liners in accordance with ASTM C1283.

**2113.9.2 Spark arrestors.** Where a spark arrestor is installed on a masonry chimney, the spark arrestor shall meet all of the following requirements:

1. The net free area of the arrestor shall be not less than four times the net free area of the outlet of the chimney flue it serves.



## MASONRY

2. The arrestor screen shall have heat and *corrosion resistance* equivalent to 19-gage galvanized steel or 24-gage stainless steel.
3. Openings shall not permit the passage of spheres having a diameter greater than  $\frac{1}{2}$  inch (12.7 mm) nor block the passage of spheres having a diameter less than  $\frac{3}{8}$  inch (9.5 mm).
4. The spark arrestor shall be accessible for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.

**2113.9.3 Rain caps.** Where a masonry or metal rain cap is installed on a masonry chimney, the net free area under the cap shall be not less than four times the net free area of the outlet of the chimney flue it serves.

**2113.10 Wall thickness.** Masonry chimney walls shall be constructed of concrete, solid *masonry units* or hollow *masonry units* grouted solid with not less than 4 inches (102 mm) nominal thickness.

**2113.10.1 Masonry veneer chimneys.** Where masonry is used as *veneer* for a framed chimney, through flashing and weep holes shall be provided as required by Chapter 14.

**2113.11 Flue lining (material).** Masonry chimneys shall be lined. The lining material shall be appropriate for the type of appliance connected, according to the terms of the appliance listing and the manufacturer's instructions.

**2113.11.1 Residential-type appliances (general).** Flue lining systems shall comply with one of the following:

1. Clay flue lining complying with the requirements of ASTM C315.
2. *Listed* chimney lining systems complying with UL 1777.
3. Factory-built chimneys or chimney units *listed* for installation within masonry chimneys.
4. Other *approved* materials that will resist corrosion, erosion, softening or cracking from flue gases and condensate at temperatures up to 1,800°F (982°C).

**2113.11.1.1 Flue linings for specific appliances.** Flue linings other than those covered in Section 2113.11.1 intended for use with specific appliances shall comply with Sections 2113.11.1.2 through 2113.11.1.4, 2113.11.2 and 2113.11.3.

**2113.11.1.2 Gas appliances.** Flue lining systems for gas appliances shall be in accordance with the *International Fuel Gas Code*.

**2113.11.1.3 Pellet fuel-burning appliances.** Flue lining and vent systems for use in masonry chimneys with pellet fuel-burning appliances shall be limited to flue lining systems complying with Section 2113.11.1 and pellet vents *listed* for installation within masonry chimneys (see Section 2113.11.1.5 for marking).

**2113.11.1.4 Oil-fired appliances approved for use with L-vent.** Flue lining and vent systems for use in masonry chimneys with oil-fired appliances *approved* for use with Type L vent shall be limited to flue lining systems complying with Section 2113.11.1 and *listed* chimney liners complying with UL 641 (see Section 2113.11.1.5 for marking).

**2113.11.1.5 Notice of usage.** When a flue is relined with a material not complying with Section 2113.11.1, the chimney shall be plainly and permanently identified by a *label* attached to a wall, ceiling or other conspicuous location adjacent to where the connector enters the chimney. The *label* shall include the following message or equivalent language: "This chimney is for use only with (type or category of appliance) that burns (type of fuel). Do not connect other types of appliances."

**2113.11.2 Concrete and masonry chimneys for medium-heat appliances.** Concrete and masonry chimneys for medium-heat appliances shall comply with Sections 2113.11.2.1 through 2113.11.2.5.

**2113.11.2.1 Construction.** Chimneys for medium-heat appliances shall be constructed of solid *masonry units* or of concrete with walls not less than 8 inches (203 mm) thick, or with stone masonry not less than 12 inches (305 mm) thick.

**2113.11.2.2 Lining.** Concrete and masonry chimneys shall be lined with an *approved* medium-duty refractory brick not less than  $4\frac{1}{2}$  inches (114 mm) thick laid on the  $4\frac{1}{2}$ -inch bed (114 mm) in an *approved* medium-duty refractory *mortar*. The lining shall start 2 feet (610 mm) or more below the lowest chimney connector entrance. Chimneys terminating 25 feet (7620 mm) or less above a chimney connector entrance shall be lined to the top.

**2113.11.2.3 Multiple passageway.** Concrete and masonry chimneys containing more than one passageway shall have the liners separated by a minimum 4-inch-thick (102 mm) concrete or *solid masonry* wall.

**2113.11.2.4 Termination height.** Concrete and masonry chimneys for medium-heat appliances shall extend not less than 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm).

**2113.11.2.5 Clearance.** A minimum clearance of 4 inches (102 mm) shall be provided between the exterior surfaces of a concrete or masonry chimney for medium-heat appliances and combustible material.

**2113.11.3 Concrete and masonry chimneys for high-heat appliances.** Concrete and masonry chimneys for high-heat appliances shall comply with 2113.11.3.1 through 2113.11.3.4.

**2113.11.3.1 Construction.** Chimneys for high-heat appliances shall be constructed with double walls of



solid *masonry units* or of concrete, each wall to be not less than 8 inches (203 mm) thick with a minimum airspace of 2 inches (51 mm) between the walls.

**2113.11.3.2 Lining.** The inside of the interior wall shall be lined with an *approved* high-duty refractory brick, not less than 4 $\frac{1}{2}$  inches (114 mm) thick laid on the 4 $\frac{1}{2}$ -inch bed (114 mm) in an *approved* high-duty refractory *mortar*. The lining shall start at the base of the chimney and extend continuously to the top.

**2113.11.3.3 Termination height.** Concrete and masonry chimneys for high-heat appliances shall extend not less than 20 feet (6096 mm) higher than any portion of any building within 50 feet (15 240 mm).

**2113.11.3.4 Clearance.** Concrete and masonry chimneys for high-heat appliances shall have *approved* clearance from buildings and structures to prevent overheating combustible materials, permit inspection and maintenance operations on the chimney and prevent danger of burns to persons.

**2113.12 Clay flue lining (installation).** Clay flue liners shall be installed in accordance with ASTM C1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a maximum slope not greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty nonwater-soluble refractory *mortar* conforming to ASTM C199 with tight *mortar* joints left smooth on the inside and installed to maintain an airspace or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue lining shall be supported on all sides. Only enough *mortar* shall be placed to make the joint and hold the liners in position.

### 2113.13 Additional requirements.

**2113.13.1 Listed materials.** *Listed* materials used as flue linings shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

**2113.13.2 Space around lining.** The space surrounding a chimney lining system or vent installed within a masonry chimney shall not be used to vent any other appliance.

**Exception:** This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's instructions.

**2113.14 Multiple flues.** Where two or more flues are located in the same chimney, masonry *wythes* shall be built between adjacent flue linings. The masonry *wythes* shall be not less than 4 inches (102 mm) thick and bonded into the walls of the chimney.

**Exception:** Where venting only one appliance, two flues are permitted to adjoin each other in the same chimney

with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered not less than 4 inches (102 mm).

**2113.15 Flue area (appliance).** Chimney flues shall not be smaller in area than the area of the connector from the appliance. Chimney flues connected to more than one appliance shall be not less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

### Exceptions:

1. Chimney flues serving oil-fired appliances sized in accordance with NFPA 31.
2. Chimney flues serving gas-fired appliances sized in accordance with the *International Fuel Gas Code*.

**2113.16 Flue area (masonry fireplace).** Flue sizing for chimneys serving fireplaces shall be in accordance with Section 2113.16.1 or 2113.16.2.

**2113.16.1 Minimum area.** Round chimney flues shall have a minimum net cross-sectional area of not less than  $\frac{1}{12}$  of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of not less than  $\frac{1}{10}$  of the fireplace opening. Rectangular chimney flues with an aspect ratio less than 2 to 1 shall have a minimum net cross-sectional area of not less than  $\frac{1}{10}$  of the fireplace opening. Rectangular chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of not less than  $\frac{1}{8}$  of the fireplace opening.

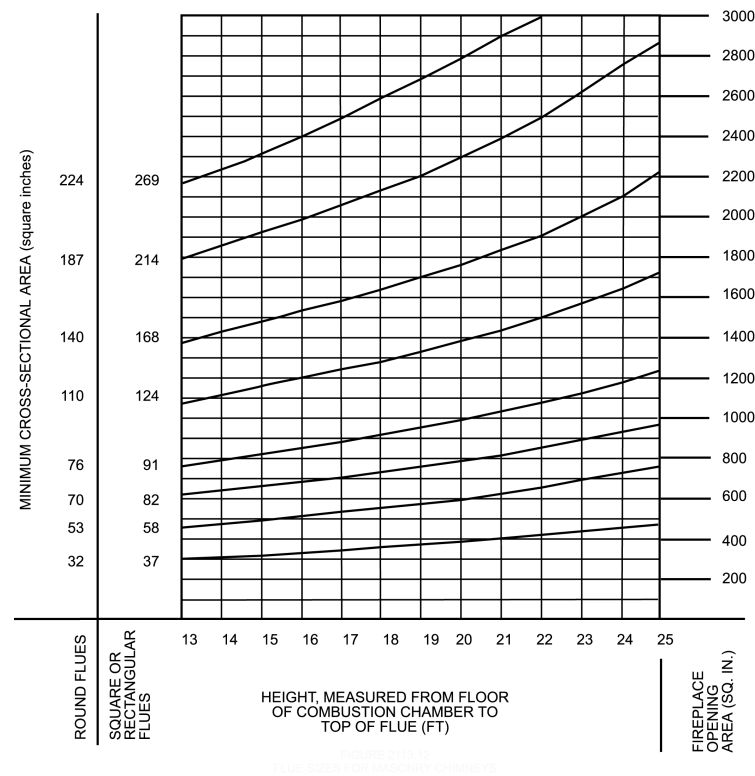
**2113.16.2 Determination of minimum area.** The minimum net cross-sectional area of the flue shall be determined in accordance with Figure 2113.16. A flue size providing not less than the equivalent net cross-sectional area shall be used. Cross-sectional areas of clay flue linings are as provided in Tables 2113.16(1) and 2113.16(2) or as provided by the manufacturer or as measured in the field. The height of the chimney shall be measured from the firebox floor to the top of the chimney flue.

**2113.17 Inlet.** Inlets to masonry chimneys shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

**2113.18 Masonry chimney cleanout openings.** Cleanout openings shall be provided within 6 inches (152 mm) of the base of each flue within every masonry chimney. The upper edge of the cleanout shall be located not less than 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be not less than 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

**Exception:** Chimney flues serving masonry fireplaces, where cleaning is possible through the fireplace opening.

MASONRY



Note: 1 inch = 25.4 mm, 1 square inch = 645 mm<sup>2</sup>.

FIGURE 2113.16  
FLUE SIZES FOR MASONRY CHIMNEYS

TABLE 2113.16(1) NET CROSS-SECTIONAL AREA OF ROUND FLUE SIZES <sup>a</sup>	
FLUE SIZE, INSIDE DIAMETER (inches)	CROSS-SECTIONAL AREA (square inches)
6	28
7	38
8	50
10	78
10 <sup>3</sup> / <sub>4</sub>	90
12	113
15	176
18	254

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.  
a. Flue sizes are based on ASTM C315.

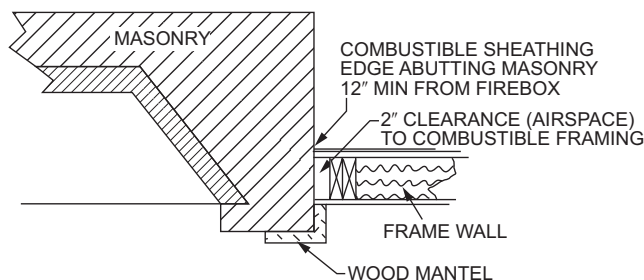
TABLE 2113.16(2) NET CROSS-SECTIONAL AREA OF SQUARE AND RECTANGULAR FLUE SIZES	
FLUE SIZE, OUTSIDE NOMINAL DIMENSIONS (inches)	CROSS-SECTIONAL AREA (square inches)
4.5 × 8.5	23
4.5 × 13	34
8 × 8	42
8.5 × 8.5	49
8 × 12	67
8.5 × 13	76
12 × 12	102
8.5 × 18	101
13 × 13	127
12 × 16	131
13 × 18	173
16 × 16	181
16 × 20	222
18 × 18	233
20 × 20	298
20 × 24	335
24 × 24	431

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.

**2113.19 Chimney clearances.** Any portion of a masonry chimney located in the interior of the building or within the *exterior wall* of the building shall have a minimum airspace clearance to combustibles of 2 inches (51 mm). Chimneys located entirely outside the *exterior walls* of the building, including chimneys that pass through the soffit or *cornice*, shall have a minimum airspace clearance of 1 inch (25 mm). The airspace shall not be filled, except to provide *fireblocking* in accordance with Section 2113.20.

**Exceptions:**

1. Masonry chimneys equipped with a chimney lining system *listed* and *labeled* for use in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, are permitted to have combustible material in contact with their exterior surfaces.
2. Where masonry chimneys are constructed as part of masonry or concrete walls, combustible materials shall not be in contact with the masonry or concrete wall less than 12 inches (305 mm) from the inside surface of the nearest flue lining.
3. Exposed combustible *trim* and the edges of sheathing materials, such as wood siding, are permitted to abut the masonry chimney sidewalls, in accordance with Figure 2113.19, provided that such combustible *trim* or sheathing is not less than 12 inches (305 mm) from the inside surface of the nearest flue lining. Combustible material and *trim* shall not overlap the corners of the chimney by more than 1 inch (25 mm).



**FIGURE 2113.19**  
**ILLUSTRATION OF EXCEPTION THREE**  
**CHIMNEY CLEARANCE PROVISION**

**2113.20 Chimney fireblocking.** All spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with noncombustible material securely fastened in place. The *fireblocking* of spaces between wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between combustible material and the chimney.

## SECTION 2114 DRY-STACK MASONRY

**2114.1 General.** The design of dry-stack masonry structures shall comply with the requirements of Chapters 1 through 8 of TMS 402 except as modified by Sections 2114.2 through 2114.5.

**2114.2 Limitations.** Dry-stack masonry shall be prohibited in *Risk Category IV* structures.

**2114.3 Materials.** Concrete *masonry units* complying with ASTM C90 shall be used.

**2114.4 Strength.** Dry-stack masonry shall be of adequate strength and proportions to support all superimposed *loads* without exceeding the allowable stresses listed in Table 2114.4. Allowable stresses not specified in Table 2114.4 shall comply with the requirements of Chapter 8 of TMS 402.

**TABLE 2114.4**  
**GROSS CROSS-SECTIONAL AREA**  
**ALLOWABLE STRESS FOR DRY-STACK MASONRY**

DESCRIPTION	MAXIMUM ALLOWABLE STRESS (psi)
Compression	45
Flexural tension	
Horizontal span	30
Vertical span	18
Shear	10

For SI: 1 pound per square inch = 0.006895 MPa.

**2114.5 Construction.** Construction of dry-stack masonry shall comply with ASTM C946.





## CHAPTER 22

# STEEL

### User notes:

**About this chapter:** Chapter 22 provides the minimum requirements for the design and construction of structural steel (including composite construction), cold-formed steel, steel joists, steel cable structures and steel storage racks. This chapter specifies appropriate design and construction standards for these types of structures. It also provides a road map of the applicable technical requirements for steel structures. Chapter 22 requires that the design and use of steel structures and components be in accordance with the applicable specifications and standards of the American Institute of Steel Construction, the American Iron and Steel Institute, the Steel Joist Institute and the American Society of Civil Engineers.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 2201 GENERAL

**2201.1 Scope.** The provisions of this chapter govern the quality, design, fabrication and erection of steel construction.

### SECTION 2202 IDENTIFICATION OF STEEL FOR STRUCTURAL PURPOSES

**2202.1 General.** Identification of *structural steel elements* shall be in accordance with AISC 360. Identification of cold-formed steel members shall be in accordance with AISI S100. Identification of cold-formed steel *light-frame construction* shall also comply with the requirements contained in AISI S240 or AISI S220, as applicable. Other steel furnished for structural load-carrying purposes shall be properly identified for conformity to the ordered grade in accordance with the specified ASTM standard or other specification and the provisions of this chapter. Where the steel grade is not readily identifiable from marking and test records, the steel shall be tested to verify conformity to such standards.

### SECTION 2203 PROTECTION OF STEEL FOR STRUCTURAL PURPOSES

**2203.1 General.** Painting of *structural steel elements* shall be in accordance with AISC 360. Painting of open-web steel joists and joist girders shall be in accordance with SJI 100 and SJI 200. Individual structural members and assembled panels of *cold-formed steel construction* shall be protected against corrosion in accordance with the requirements contained in AISI S100. Protection of cold-formed steel *light-frame construction* shall be in accordance with AISI S240 or AISI S220, as applicable.

### SECTION 2204 CONNECTIONS

**2204.1 Welding.** The details of design, workmanship and technique for welding and qualification of welding personnel shall be in accordance with the specifications listed in Sections 2205, 2206, 2207, 2208, 2210 and 2211. For *special inspection* of welding, see Section 1705.2.

**2204.2 Bolting.** The design, installation and inspection of bolts shall be in accordance with the requirements of Sections 2205, 2206, 2207, 2210 and 2211. For *special inspection* of the installation of high-strength bolts, see Section 1705.2.

**2204.3 Anchor rods.** Anchor rods shall be set in accordance with the *approved construction documents*. The protrusion of the threaded ends through the connected material shall fully engage the threads of the nuts but shall not be greater than the length of the threads on the bolts.

### SECTION 2205 STRUCTURAL STEEL

**2205.1 General.** The design, fabrication and erection of *structural steel elements* in buildings, structures and portions thereof shall be in accordance with AISC 360.

**2205.2 Seismic design.** Where required, the seismic design, fabrication and erection of buildings, structures and portions thereof shall be in accordance with Section 2205.2.1 or 2205.2.2, as applicable.

**2205.2.1 Structural steel seismic force-resisting systems.** The design, detailing, fabrication and erection of structural steel *seismic force-resisting systems* shall be in accordance with the provisions of Section 2205.2.1.1 or 2205.2.1.2, as applicable.

**2205.2.1.1 Seismic Design Category B or C.** Structures assigned to *Seismic Design Category B* or *C* shall be of any construction permitted in Section 2205.

## STEEL

Where a response modification coefficient,  $R$ , in accordance with ASCE 7, Table 12.2-1, is used for the design of structures assigned to *Seismic Design Category B* or *C*, the structures shall be designed and detailed in accordance with the requirements of AISC 341. Beam-to-column moment connections in special moment frames and intermediate moment frames shall be prequalified in accordance with AISC 341, Section K1, qualified by testing in accordance with AISC 341, Section K2, or shall be prequalified in accordance with AISC 358.

**Exception:** The response modification coefficient,  $R$ , designated for “Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems” in ASCE 7, Table 12.2-1, shall be permitted for systems designed and detailed in accordance with AISC 360, and need not be designed and detailed in accordance with AISC 341.

**2205.2.1.2 Seismic Design Category D, E or F.** Structures assigned to *Seismic Design Category D*, *E* or *F* shall be designed and detailed in accordance with AISC 341, except as permitted in ASCE 7, Table 15.4-1. Beam-to-column moment connections in special moment frames and intermediate moment frames shall be prequalified in accordance with AISC 341, Section K1, qualified by testing in accordance with AISC 341, Section K2, or shall be prequalified in accordance with AISC 358.

**2205.2.2 Structural steel elements.** The design, detailing, fabrication and erection of *structural steel elements* in *seismic force-resisting systems* other than those covered in Section 2205.2.1, including struts, *collectors*, chords and foundation elements, shall be in accordance with AISC 341 where either of the following applies:

1. The structure is assigned to *Seismic Design Category D*, *E* or *F*, except as permitted in ASCE 7, Table 15.4-1.
2. A response modification coefficient,  $R$ , greater than 3 in accordance with ASCE 7, Table 12.2-1, is used for the design of the structure assigned to *Seismic Design Category B* or *C*.

## SECTION 2206 COMPOSITE STRUCTURAL STEEL AND CONCRETE STRUCTURES

**2206.1 General.** Systems of *structural steel elements* acting compositely with reinforced concrete shall be designed in accordance with AISC 360 and ACI 318, excluding ACI 318 Chapter 14.

**2206.2 Seismic design.** Where required, the seismic design, fabrication and erection of composite steel and concrete systems shall be in accordance with Section 2206.2.1.

**2206.2.1 Seismic requirements for composite structural steel and concrete construction.** Where a response modification coefficient,  $R$ , in accordance with ASCE 7,

Table 12.2-1, is used for the design of systems of structural steel acting compositely with reinforced concrete, the structures shall be designed and detailed in accordance with the requirements of AISC 341.

## SECTION 2207 STEEL JOISTS

**2207.1 General.** The design, manufacture and use of open-web *steel joists* and joist girders shall be in accordance with either SJI 100 or SJI 200, as applicable.

**2207.1.1 Seismic design.** Where required, the seismic design of buildings shall be in accordance with the additional provisions of Section 2205.2 or 2211.1.1.

**2207.2 Design.** The *registered design professional* shall indicate on the *construction documents* the *steel joist* and *steel joist* girder designations from the specifications listed in Section 2207.1; and shall indicate the requirements for joist and joist girder design, layout, end supports, anchorage, bridging design that differs from the SJI specifications listed in Section 2207.1, bridging termination connections and bearing connection design to resist uplift and lateral loads. These documents shall indicate special requirements as follows:

1. Special loads including:
  - 1.1. Concentrated loads.
  - 1.2. Nonuniform loads.
  - 1.3. Net uplift loads.
  - 1.4. Axial loads.
  - 1.5. End moments.
  - 1.6. Connection forces.
2. Special considerations including:
  - 2.1. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.
  - 2.2. Oversized or other nonstandard web openings.
  - 2.3. Extended ends.
3. Live and total load deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.

**2207.3 Calculations.** The *steel joist* and joist girder manufacturer shall design the *steel joists* and *steel joist* girders in accordance with the SJI specifications listed in Section 2207.1 to support the load requirements of Section 2207.2. The *registered design professional* shall be permitted to require submission of the *steel joist* and joist girder calculations as prepared by a *registered design professional* responsible for the product design. Where requested by the *registered design professional*, the *steel joist* manufacturer shall submit design calculations with a cover letter bearing the seal and signature of the joist manufacturer's *registered design professional*. In addition to the design calculations

submitted under seal and signature, the following shall be included:

1. Bridging design that differs from the SJI specifications listed in Section 2207.1, such as cantilevered conditions and net uplift.
2. Connection design for:
  - 2.1. Connections that differ from the SJI specifications listed in Section 2207.1, such as flush-framed or framed connections.
  - 2.2. Field splices.
  - 2.3. Joist headers.

**2207.4 Steel joist drawings.** *Steel joist* placement plans shall be provided to show the *steel joist* products as specified on the *approved construction documents* and are to be utilized for field installation in accordance with specific project requirements as stated in Section 2207.2. *Steel joist* placement plans shall include, at a minimum, the following:

1. Listing of applicable *loads* as stated in Section 2207.2 and used in the design of the *steel joists* and joist girders as specified in the *approved construction documents*.
2. Profiles for joist and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.
3. Connection requirements for:
  - 3.1. Joist supports.
  - 3.2. Joist girder supports.
  - 3.3. Field splices.
  - 3.4. Bridging attachments.
4. Live and total *load* deflection criteria for joists and joist girder configurations that differ from those defined by the SJI specifications listed in Section 2207.1.
5. Size, location and connections for bridging.
6. Joist headers.

*Steel joist* placement plans do not require the seal and signature of the joist manufacturer's *registered design professional*.

**2207.5 Certification.** At completion of manufacture, the *steel joist* manufacturer shall submit a *certificate of compliance* to the owner or the owner's authorized agent for submittal to the *building official* as specified in Section 1704.5 stating that work was performed in accordance with *approved construction documents* and with SJI specifications listed in Section 2207.1.

## SECTION 2208 STEEL CABLE STRUCTURES

**2208.1 General.** The design, fabrication and erection including related connections, and protective coatings of steel cables for buildings shall be in accordance with ASCE 19.

## SECTION 2209 STEEL STORAGE RACKS

**2209.1 Steel storage racks.** The design, testing and utilization of steel *storage racks* made of cold-formed or hot-rolled steel structural members shall be in accordance with RMI ANSI/MH 16.1. Where required by ASCE 7, the seismic design of steel *storage racks* shall be in accordance with Section 15.5.3 of ASCE 7.

**2209.2 Steel cantilevered storage racks.** The design, testing and utilization of steel cantilevered *storage racks* made of cold-formed or hot-rolled steel structural members shall be in accordance with RMI ANSI/MH 16.3. Where required by ASCE 7, the seismic design of steel cantilevered *storage racks* shall be in accordance with Section 15.5.3 of ASCE 7.

**2209.3 Certification.** For rack storage structures that are 8 feet (2438 mm) in height or greater to the top *load* level and assigned to *Seismic Design Category* D, E, or F at completion of the *storage rack* installation, a *certificate of compliance* shall be submitted to the owner or the owner's authorized agent stating that the work was performed in accordance with approved construction documents.

## SECTION 2210 COLD-FORMED STEEL

**2210.1 General.** The design of cold-formed carbon and low-alloy steel structural members shall be in accordance with AISI S100. The design of cold-formed stainless-steel structural members shall be in accordance with ASCE 8. Cold-formed steel *light-frame construction* shall comply with Section 2211. Where required, the seismic design of cold-formed steel structures shall be in accordance with the additional provisions of Section 2210.2.

**2210.1.1 Steel decks.** The design and construction of cold-formed steel decks shall be in accordance with this section.

**2210.1.1.1 Noncomposite steel floor decks.** Noncomposite steel floor decks shall be permitted to be designed and constructed in accordance with ANSI/SDI-NC1.0.

**2210.1.1.2 Steel roof deck.** Steel *roof decks* shall be permitted to be designed and constructed in accordance with ANSI/SDI-RD1.0.

**2210.1.1.3 Composite slabs on steel decks.** Composite slabs of concrete and steel deck shall be permitted to be designed and constructed in accordance with SDI-C.

**2210.2 Seismic requirements for cold-formed steel structures.** Where a response modification coefficient, *R*, in accordance with ASCE 7, Table 12.2-1, is used for the design of cold-formed steel structures, the structures shall be designed and detailed in accordance with the requirements of AISI S100, ASCE 8, or, for cold-formed steel special-bolted moment frames, AISI S400.

## STEEL

## SECTION 2211 COLD-FORMED STEEL LIGHT-FRAME CONSTRUCTION

**2211.1 Structural framing.** For cold-formed steel *light-frame construction*, the design and installation of the following structural framing systems, including their members and connections, shall be in accordance with AISI S240, and Sections 2211.1.1 through 2211.1.3, as applicable:

1. Floor and roof systems.
2. Structural walls.
3. Shear walls, strap-braced walls and diaphragms that resist in-plane lateral loads.
4. Trusses.

**2211.1.1 Seismic requirements for cold-formed steel structural systems.** The design of cold-formed steel *light-frame construction* to resist seismic forces shall be in accordance with the provisions of Section 2211.1.1.1 or 2211.1.1.2, as applicable.

**2211.1.1.1 Seismic Design Categories B and C.** Where a response modification coefficient,  $R$ , in accordance with ASCE 7, Table 12.2-1 is used for the design of cold-formed steel *light-frame construction* assigned to *Seismic Design Category B* or *C*, the *seismic force-resisting system* shall be designed and detailed in accordance with the requirements of AISI S400.

**Exception:** The response modification coefficient,  $R$ , designated for “Steel systems not specifically detailed for seismic resistance, excluding cantilever column systems” in ASCE 7, Table 12.2-1, shall be permitted for systems designed and detailed in accordance with AISI S240 and need not be designed and detailed in accordance with AISI S400.

**2211.1.1.2 Seismic Design Categories D through F.** In cold-formed steel *light-frame construction* assigned to *Seismic Design Category D*, *E* or *F*, the *seismic force-resisting system* shall be designed and detailed in accordance with AISI S400.

**2211.1.2 Prescriptive framing.** Detached one- and two-family *dwelling*s and *townhouse*s, less than or equal to three *stories above grade plane*, shall be permitted to be constructed in accordance with AISI S230 subject to the limitations therein.

**2211.1.3 Truss design.** Cold-formed steel trusses shall comply with the additional provisions of Sections 2211.1.3.1. through 2211.1.3.3.

**2211.1.3.1 Truss design drawings.** The truss design drawings shall conform to the requirements of Section I1 of AISI S202 and shall be provided with the shipment of trusses delivered to the job site. The truss design drawings shall include the details of permanent *individual truss member* restraint/bracing in accordance with Section I1.6 of AISI S202 where these methods are utilized to provide restraint/bracing.

**2211.1.3.2 Trusses spanning 60 feet or greater.** The owner or the owner’s authorized agent shall contract with a *registered design professional* for the design of the temporary installation restraint/bracing and the permanent *individual truss member* restraint/bracing for trusses with clear spans 60 feet (18 288 mm) or greater. *Special inspection* of trusses over 60 feet (18 288 mm) in length shall be in accordance with Section 1705.2.

**2211.1.3.3 Truss quality assurance.** Trusses not part of a manufacturing process that provides requirements for quality control done under the supervision of a third-party quality control agency in accordance with AISI S240 Chapter D shall be fabricated in compliance with Sections 1704.2.5 and 1705.2, as applicable.

**2211.2 Nonstructural members.** For cold-formed steel *light-frame construction*, the design and installation of nonstructural members and connections shall be in accordance with AISI S220.



## CHAPTER 23

# WOOD

### User notes:

**About this chapter:** Chapter 23 provides minimum requirements for the design of buildings and structures that use wood and wood-based products. The chapter is organized around three design methodologies: allowable stress design (ASD), load and resistance factor design (LRFD) and conventional light-frame construction. In addition it allows the use of the American Wood Council Wood Frame Construction Manual for a limited range of structures. Included in the chapter are references to design and manufacturing standards for various wood and wood-based products; general construction requirements; design criteria for lateral force-resisting systems and specific requirements for the application of the three design methods.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 2301 GENERAL

**2301.1 Scope.** The provisions of this chapter shall govern the materials, design, construction and quality of wood members and their fasteners.

**2301.2 Nominal sizes.** For the purposes of this chapter, where dimensions of lumber are specified, they shall be deemed to be nominal dimensions unless specifically designated as actual dimensions (see Section 2304.2).

### SECTION 2302 DESIGN REQUIREMENTS

**2302.1 General.** The design of structural elements or systems, constructed partially or wholly of wood or wood-based products, shall be in accordance with one of the following methods:

1. *Allowable stress design* in accordance with Sections 2304, 2305 and 2306.
2. *Load and resistance factor design* in accordance with Sections 2304, 2305 and 2307.
3. *Conventional light-frame construction* in accordance with Sections 2304 and 2308.
4. AWC WFCM in accordance with Section 2309.
5. The design and construction of log structures in accordance with the provisions of ICC 400.

### SECTION 2303 MINIMUM STANDARDS AND QUALITY

**2303.1 General.** Structural sawn lumber; end-jointed lumber; *prefabricated wood I-joists*; *structural glued-laminated timber*; *wood structural panels*; fiberboard sheathing (where used structurally); *hardboard siding* (where used structurally); *particleboard*; *preservative-treated wood*; structural log members; *structural composite lumber*; round timber poles and piles; *fire-retardant-treated wood*; hard-wood plywood; wood trusses; joist hangers; nails; and staples shall conform to the applicable provisions of this section.

**2303.1.1 Sawn lumber.** Sawn lumber used for load-supporting purposes, including end-jointed or edge-glued lumber, machine stress-rated or machine-evaluated lumber, shall be identified by the grade *mark* of a lumber grading or inspection agency that has been approved by an *accreditation body* that complies with DOC PS 20 or equivalent. Grading practices and identification shall comply with rules published by an agency approved in accordance with the procedures of DOC PS 20 or equivalent procedures.

**2303.1.1.1 Certificate of inspection.** In lieu of a grade *mark* on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section is permitted to be accepted for precut, remanufactured or rough-sawn lumber and for sizes larger than 3 inches (76 mm) nominal thickness.

**2303.1.1.2 End-jointed lumber.** *Approved* end-jointed lumber is permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required to have a *fire-resistance rating* shall have the designation “Heat Resistant Adhesive” or “HRA” included in its grade *mark*.

**2303.1.2 Prefabricated wood I-joists.** Structural capacities and design provisions for *prefabricated wood I-joists* shall be established and monitored in accordance with ASTM D5055.

**2303.1.3 Structural glued-laminated timber.** Glued-laminated timbers shall be manufactured and identified as required in ANSI/APA 190.1 and ASTM D3737.

**2303.1.4 Structural glued cross-laminated timber.** Cross-laminated timbers shall be manufactured and identified in accordance with ANSI/APA PRG 320.

**2303.1.5 Wood structural panels.** *Wood structural panels*, where used structurally (including those used for siding, roof and wall sheathing, subflooring, *diaphragms* and built-up members), shall conform to the requirements for their type in DOC PS 1, DOC PS 2 or ANSI/APA PRP 210. Each panel or member shall be identified for

## WOOD

grade, bond classification, and *Performance Category* by the trademarks of an *approved* testing and grading agency. The *Performance Category* value shall be used as the “nominal panel thickness” or “panel thickness” whenever referenced in this code. *Wood structural panel* components shall be designed and fabricated in accordance with the applicable standards listed in Section 2306.1 and identified by the trademarks of an *approved* testing and inspection agency indicating conformance to the applicable standard. In addition, *wood structural panels* where permanently exposed in outdoor applications shall be of exterior type, except that *wood structural panel* roof sheathing exposed to the outdoors on the underside is permitted to be Exposure 1 type.

**2303.1.6 Fiberboard.** *Fiberboard* for its various uses shall conform to ASTM C208. *Fiberboard* sheathing, where used structurally, shall be identified by an *approved* agency as conforming to ASTM C208.

**2303.1.6.1 Jointing.** To ensure tight-fitting assemblies, edges shall be manufactured with square, shiplapped, beveled, tongue-and-groove or U-shaped joints.

**2303.1.6.2 Roof insulation.** Where used as roof insulation in all types of construction, *fiberboard* shall be protected with an *approved* roof covering.

**2303.1.6.3 Wall insulation.** Where installed and fire-blocked to comply with Chapter 7, *fiberboards* are permitted as wall insulation in all types of construction. In *fire walls* and *fire barriers*, unless treated to comply with Section 803.1 for Class A materials, the boards shall be cemented directly to the concrete, masonry or other noncombustible base and shall be protected with an *approved* noncombustible *veneer* anchored to the base without intervening airspace.

**2303.1.6.3.1 Protection.** *Fiberboard* wall insulation applied on the exterior of foundation walls shall be protected below ground level with a bituminous coating.

**2303.1.7 Hardboard.** *Hardboard* siding shall conform to the requirements of ANSI A135.6 and, where used structurally, shall be identified by the *label* of an *approved* agency. *Hardboard* underlayment shall meet the strength requirements of  $\frac{7}{32}$ -inch (5.6 mm) or  $\frac{1}{4}$ -inch (6.4 mm) service class *hardboard* planed or sanded on one side to a uniform thickness of not less than 0.200 inch (5.1 mm). Prefinished *hardboard* paneling shall meet the requirements of ANSI A135.5. Other basic *hardboard* products shall meet the requirements of ANSI A135.4. *Hardboard* products shall be installed in accordance with manufacturer's recommendations.

**2303.1.8 Particleboard.** *Particleboard* shall conform to ANSI A208.1. *Particleboard* shall be identified by the grade *mark* or certificate of inspection issued by an *approved* agency. *Particleboard* shall not be utilized for applications other than indicated in this section unless the *particleboard* complies with the provisions of Section 2306.3.

**2303.1.8.1 Floor underlayment.** *Particleboard* floor underlayment shall conform to Type PBU of ANSI A208.1. Type PBU underlayment shall be not less than  $\frac{1}{4}$ -inch (6.4 mm) thick and shall be installed in accordance with the instructions of the Composite Panel Association.

**2303.1.9 Preservative-treated wood.** Lumber, timber, plywood, piles and poles supporting permanent structures required by Section 2304.12 to be preservative treated shall conform to AWPA U1 and M4. Lumber and plywood used in permanent wood foundation systems shall conform to Chapter 18.

**2303.1.9.1 Identification.** Wood required by Section 2304.12 to be preservative treated shall bear the quality *mark* of an inspection agency that maintains continuing supervision, testing and inspection over the quality of the *preservative-treated wood*. Inspection agencies for *preservative-treated wood* shall be *listed* by an *accreditation body* that complies with the requirements of the American Lumber Standards Treated Wood Program, or equivalent. The quality *mark* shall be on a stamp or *label* affixed to the *preservative-treated wood*, and shall include the following information:

1. Identification of treating manufacturer.
2. Type of preservative used.
3. Minimum preservative retention (pcf).
4. End use for which the product is treated.
5. AWPA standard to which the product was treated.
6. Identity of the accredited inspection agency.

**2303.1.9.2 Moisture content.** Where *preservative-treated wood* is used in enclosed locations where drying in service cannot readily occur, such wood shall be at a moisture content of 19 percent or less before being covered with insulation, interior wall finish, floor covering or other materials.

**2303.1.10 Structural composite lumber.** Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

**2303.1.11 Structural log members.** Stress grading of structural log members of nonrectangular shape, as typically used in log buildings, shall be in accordance with ASTM D3957. Such structural log members shall be identified by the grade *mark* of an *approved* lumber grading or inspection agency. In lieu of a grade *mark* on the material, a certificate of inspection as to species and grade issued by a lumber grading or inspection agency meeting the requirements of this section shall be permitted.

**2303.1.12 Round timber poles and piles.** Round timber poles and piles shall comply with ASTM D3200 and ASTM D25, respectively.

**2303.1.13 Engineered wood rim board.** *Engineered wood rim boards* shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672.

Structural capacities shall be in accordance with ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

**2303.2 Fire-retardant-treated wood.** *Fire-retardant-treated wood* is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a *listed flame spread index* of 25 or less. Additionally, the ASTM E84 or UL 723 test shall be continued for a 20-minute period and the flame front shall not progress more than  $10^{1/2}$  feet (3200 mm) beyond the centerline of the burners at any time during the test.

**2303.2.1 Pressure process.** For wood products impregnated with chemicals by a pressure process, the process shall be performed in closed vessels under pressures not less than 50 pounds per square inch gauge (psig) (345 kPa).

**2303.2.2 Other means during manufacture.** For wood products impregnated with chemicals by other means during manufacture, the treatment shall be an integral part of the manufacturing process of the wood product. The treatment shall provide permanent protection to all surfaces of the wood product. The use of paints, coating, stains or other surface treatments is not an approved method of protection as required in this section.

**2303.2.3 Fire testing of wood structural panels.** Wood structural panels shall be tested with a ripped or cut longitudinal gap of  $1/8$  inch (3.2 mm).

**2303.2.4 Labeling.** In addition to the labels required in Section 2303.1.1 for sawn lumber and Section 2303.1.5 for *wood structural panels*, each piece of fire-retardant-treated lumber and *wood structural panels* shall be labeled. The *label* shall contain the following items:

1. The identification *mark* of an *approved agency* in accordance with Section 1703.5.
2. Identification of the treating manufacturer.
3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. *Flame spread* and *smoke-developed index*.
6. Method of drying after treatment.
7. Conformance with appropriate standards in accordance with Sections 2303.2.5 through 2303.2.8.
8. For *fire-retardant-treated wood* exposed to weather, damp or wet locations, include the words “No increase in the *listed* classification when subjected to the Standard Rain Test” (ASTM D2898).

**2303.2.5 Strength adjustments.** Design values for untreated lumber and *wood structural panels*, as specified in Section 2303.1, shall be adjusted for *fire-retardant-treated wood*. Adjustments to design values shall be based on an *approved* method of investigation that takes into consideration the effects of the anticipated tempera-

ture and humidity to which the *fire-retardant-treated wood* will be subjected, the type of treatment and redrying procedures.

**2303.2.5.1 Wood structural panels.** The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D5516. The test data developed by ASTM D5516 shall be used to develop adjustment factors, maximum *loads* and spans, or both, for untreated plywood design values in accordance with ASTM D6305. Each manufacturer shall publish the allowable maximum *loads* and spans for service as floor and roof sheathing for its treatment.

**2303.2.5.2 Lumber.** For each species of wood that is treated, the effects of the treatment, the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D5664. The test data developed by ASTM D5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

**2303.2.6 Exposure to weather, damp or wet locations.** Where *fire-retardant-treated wood* is exposed to weather, or damp or wet locations, it shall be identified as “Exterior” to indicate there is no increase in the *listed flame spread index* as defined in Section 2303.2 when subjected to ASTM D2898.

**2303.2.7 Interior applications.** Interior *fire-retardant-treated wood* shall have moisture content of not over 28 percent when tested in accordance with ASTM D3201 procedures at 92-percent relative humidity. Interior *fire-retardant-treated wood* shall be tested in accordance with Section 2303.2.5.1 or 2303.2.5.2. Interior *fire-retardant-treated wood* designated as Type A shall be tested in accordance with the provisions of this section.

**2303.2.8 Moisture content.** *Fire-retardant-treated wood* shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for *wood structural panels* before use. For wood kiln-dried after treatment (KDAT), the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in Section 2303.2.5.1 for plywood and 2303.2.5.2 for lumber.

**2303.2.9 Types I and II construction applications.** See Section 603.1 for limitations on the use of *fire-retardant-treated wood* in buildings of Type I or II construction.

**2303.3 Hardwood and plywood.** Hardwood and decorative plywood shall be manufactured and identified as required in HPVA HP-1.



## WOOD

**2303.4 Trusses.** Wood trusses shall comply with Sections 2303.4.1 through 2303.4.7.

**2303.4.1 Design.** Wood trusses shall be designed in accordance with the provisions of this code and accepted engineering practice. Members are permitted to be joined by nails, glue, bolts, timber connectors, metal connector plates or other *approved* framing devices.

**2303.4.1.1 Truss design drawings.** The written, graphic and pictorial depiction of each individual truss shall be provided to the *building official* for approval prior to installation. Truss design drawings shall be provided with the shipment of trusses delivered to the job site. Truss design drawings shall include, at a minimum, the following information:

1. Slope or depth, span and spacing.
2. Location of all joints and support locations.
3. Number of plies if greater than one.
4. Required bearing widths.
5. Design *loads* as applicable, including:
  - 5.1. Top chord *live load*.
  - 5.2. Top chord *dead load*.
  - 5.3. Bottom chord *live load*.
  - 5.4. Bottom chord *dead load*.
  - 5.5. Additional *loads* and locations.
  - 5.6. Environmental design criteria and *loads* (such as wind, rain, snow, seismic).
6. Other lateral *loads*, including *drag strut loads*.
7. Adjustments to wood member and metal connector plate design value for conditions of use.
8. Maximum reaction force and direction, including maximum uplift reaction forces where applicable.
9. Joint connection type and description, such as size and thickness or gage, and the dimensioned location of each joint connector except where symmetrically located relative to the joint interface.
10. Size, species and grade for each wood member.
11. Truss-to-truss connections and truss field assembly requirements.
12. Calculated span-to-deflection ratio and maximum vertical and horizontal deflection for live and total *load* as applicable.
13. Maximum axial tension and compression forces in the truss members.
14. Required permanent *individual truss member* restraint location and the method and details of restraint and diagonal bracing to be used in accordance with Section 2303.4.1.2.

**2303.4.1.2 Permanent individual truss member restraint (PITMR) and permanent individual truss member diagonal bracing (PITMDB).** Where the

truss design drawings designate the need for *permanent individual truss member restraint*, it shall be accomplished by one of the following methods:

1. *PITMR* and *PITMDB* installed using standard industry lateral restraint and diagonal bracing details in accordance with TPI 1, Section 2.3.3.1.1, accepted engineering practice, or Figures 2303.4.1.2(1), (3), and (5).
2. *Individual truss member* reinforcement in place of the specified lateral restraints (i.e., buckling reinforcement such as T-reinforcement, L-reinforcement, proprietary reinforcement, etc.) such that the buckling of any individual truss member is resisted internally by the individual truss. The buckling reinforcement of individual truss members shall be installed as shown on the truss design drawing, on supplemental truss member buckling reinforcement details provided by the truss designer or in accordance with Figures 2303.4.1.2 (2) and (4).
3. A project-specific *PITMR* and *PITMDB* design provided by any *registered design professional*.

**2303.4.1.2.1 Trusses installed without a diaphragm.** Trusses installed without a *diaphragm* on the top or bottom chord shall require a project specific *PITMR* and *PITMDB* design prepared by a *registered design professional*.

**Exception:** Group U occupancies.

**2303.4.1.3 Trusses spanning 60 feet or greater.** The owner or the owner's authorized agent shall contract with any qualified *registered design professional* for the design of the temporary installation restraint and diagonal bracing and the *PITMR* and *PITMDB* for all trusses with clear spans 60 feet (18 288 mm) or greater.

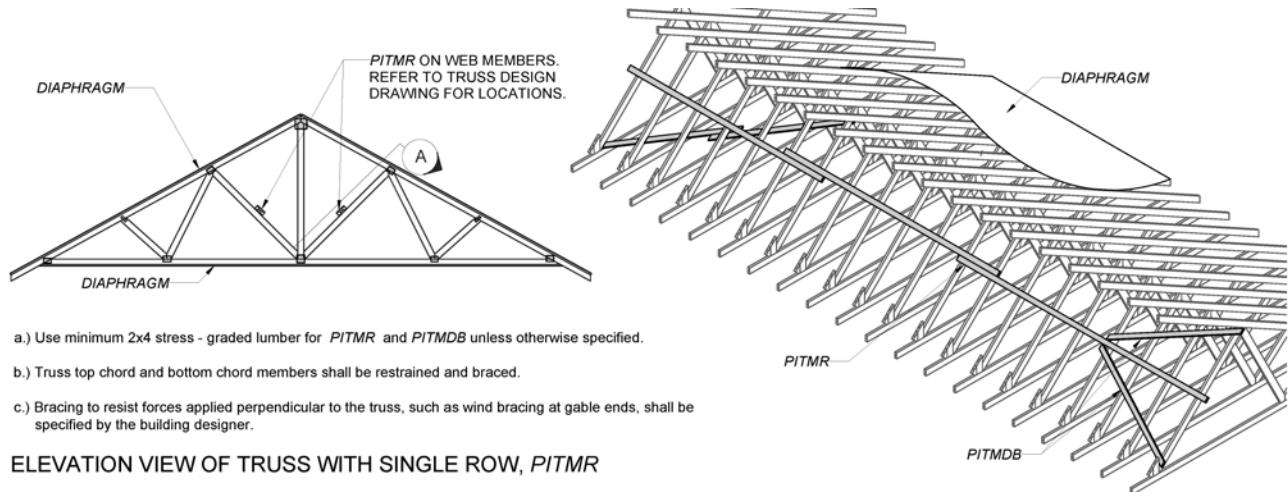
**2303.4.1.4 Truss designer.** The individual or organization responsible for the design of trusses.

**2303.4.1.4.1 Truss design drawings.** Where required by the *registered design professional*, the *building official* or the statutes of the jurisdiction in which the project is to be constructed, each individual truss design drawing shall bear the seal and signature of the truss designer.

**Exceptions:**

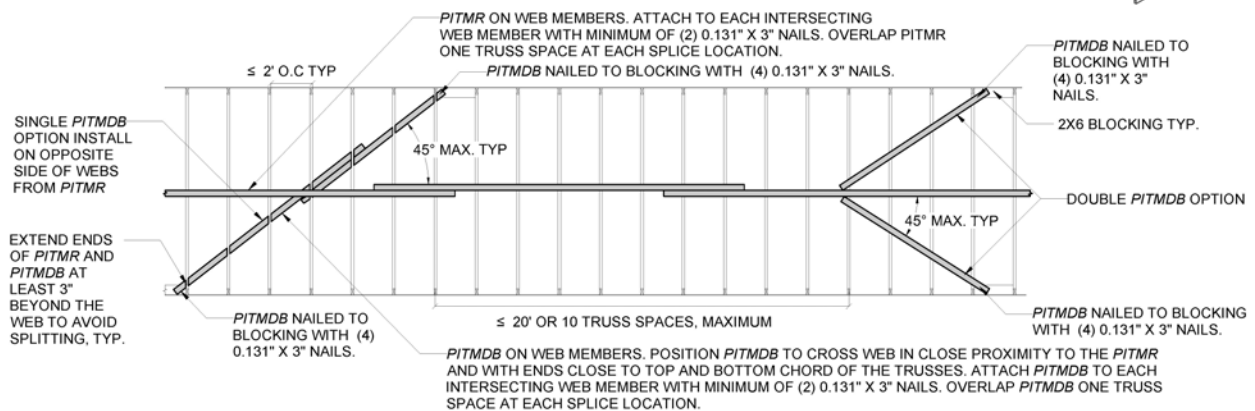
1. Where a cover sheet and truss index sheet are combined into a single sheet and attached to the set of truss design drawings, the single cover/truss index sheet is the only document required to be signed and sealed by the truss designer.
2. Where a cover sheet and a truss index sheet are separately provided and attached to the set of truss design drawings, the cover sheet and the truss index sheet are the only documents required to be signed and sealed by the truss designer.





- a.) Use minimum 2x4 stress - graded lumber for *PITMR* and *PITMDB* unless otherwise specified.
- b.) Truss top chord and bottom chord members shall be restrained and braced.
- c.) Bracing to resist forces applied perpendicular to the truss, such as wind bracing at gable ends, shall be specified by the building designer.

#### ELEVATION VIEW OF TRUSS WITH SINGLE ROW, *PITMR*

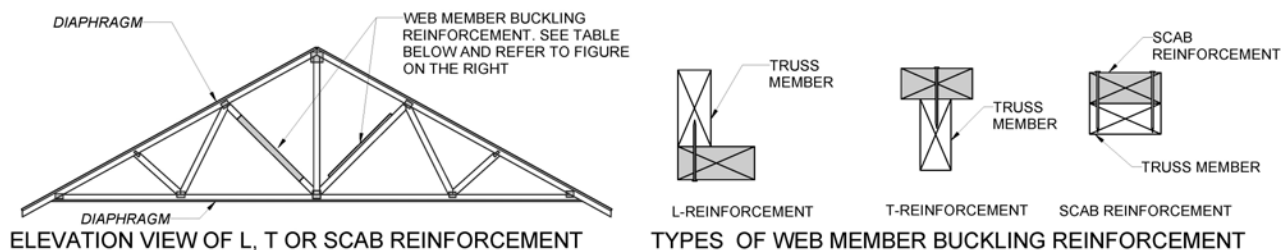


#### A SECTION (EXAMPLE OF SINGLE ROW OF *PITMR* WITH *PITMDB* ON WEB MEMBERS)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2303.4.1.2 (1)**  
**PITMR AND PITMDB FOR TRUSS WEB MEMBERS REQUIRING ONE ROW OF PITMR**

WOOD



- a.) Truss top chord and bottom chord members shall be restrained and braced.
- b.) Bracing to resist forces applied perpendicular to the truss, such as wind bracing at gable ends, shall be specified by the building designer.
- c.) Use the table below unless project specific web member reinforcement is provided on the truss design drawing or supplemental truss buckling reinforcement details are provided by the truss designer.

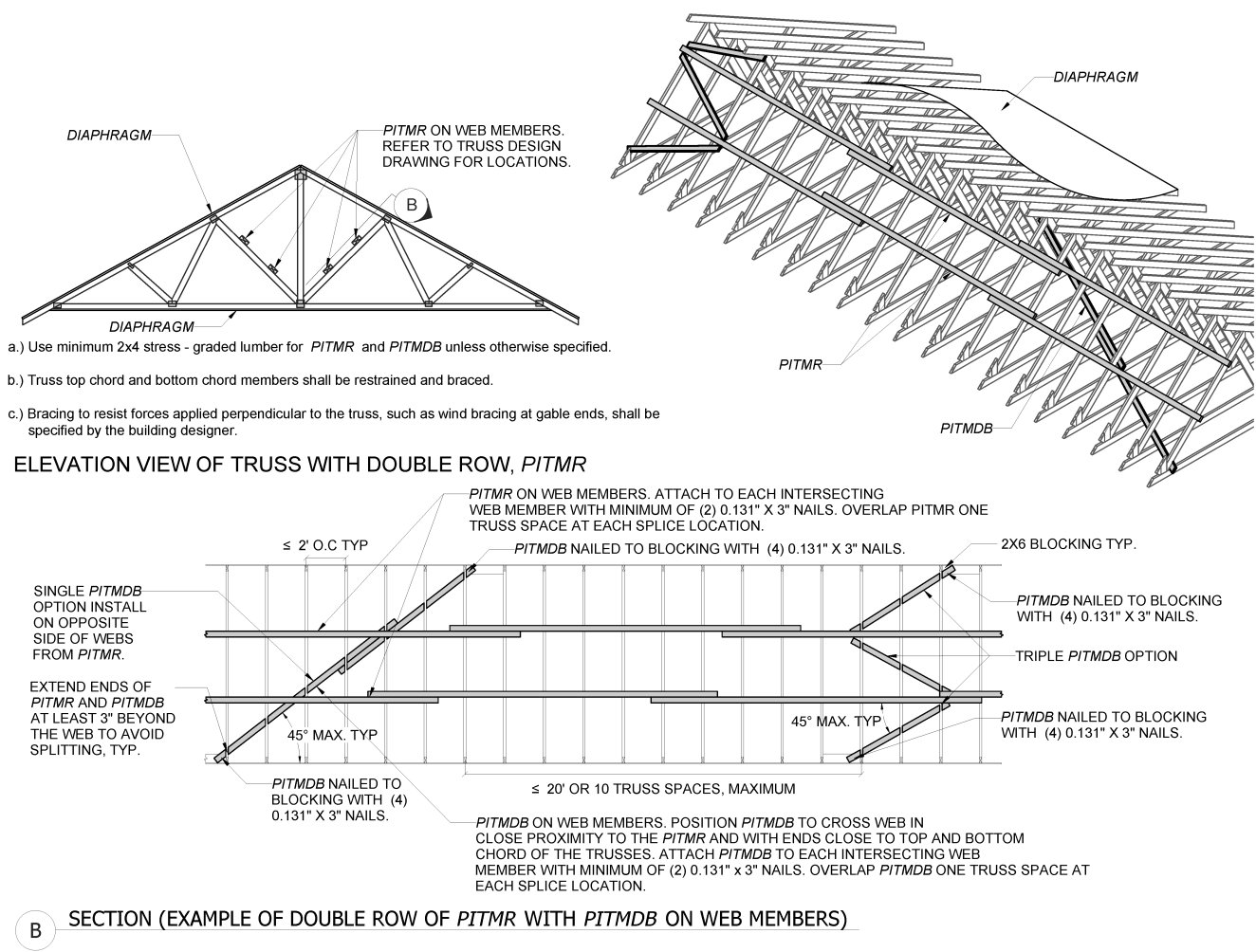
NUMBER OF ROWS OF PITMR SPECIFIED ON WEB MEMBER	SIZE OF TRUSS WEB	TYPE AND SIZE OF WEB REINFORCEMENT <sup>1</sup> FOR T, L OR SCAB <sup>2</sup>	GRADE OF WEB REINFORCEMENT	MINIMUM LENGTH OF WEB REINFORCEMENT	MINIMUM CONNECTION OF WEB REINFORCEMENT TO WEB
ONE	2x4	2x4	Same species and grade or better than web member	90% of web or extend to within 6" of end of web member, whichever is greater	(0.131" x 3") nails at 6" on-center <sup>2</sup>
	2x6	2x6			
	2x8	2x8			

<sup>1</sup>Maximum allowable web length is 14'

<sup>2</sup>Attach Scab reinforcement to web with two rows of minimum 0.131" x 3" nails at 6" on-center

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

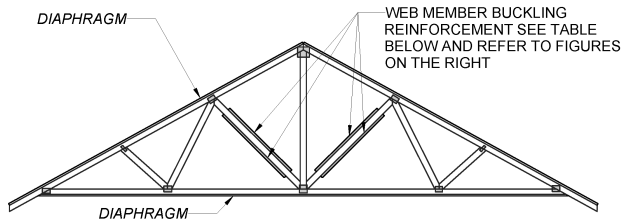
**FIGURE 2303.4.1.2(2)**  
**ALTERNATIVE INSTALLATION USING BUCKLING REINFORCEMENT FOR TRUSS WEB MEMBERS IN LIEU OF ONE ROW OF PITMR**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2303.4.1.2(3)**  
**PITMR AND PITMDB FOR TRUSS WEB MEMBERS REQUIRING TWO ROWS OF PITMR**

## WOOD



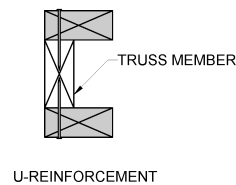
## ELEVATION VIEW OF I OR U REINFORCEMENT

- a.) Truss top chord and bottom chord members shall be restrained and braced.
- b.) Bracing to resist forces applied perpendicular to the truss, such as wind bracing at gable ends, shall be specified by the building designer.
- c.) Use the table below unless project specific web member reinforcement is provided on the truss design drawing or supplemental truss buckling reinforcement details are provided by the truss designer.

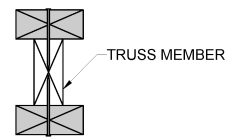
NUMBER OF ROWS OF PITMR SPECIFIED ON WEB MEMBER	SIZE OF TRUSS WEB	TYPE AND SIZE OF WEB FOR I OR U REINFORCEMENT <sup>1</sup>	GRADE OF WEB REINFORCEMENT	MINIMUM LENGTH OF WEB REINFORCEMENT	MINIMUM CONNECTION OF WEB REINFORCEMENT TO WEB
TWO	2x4	(2) -2x4	Same species and grade or better than web member	90% of web or extend to within 6" of end of web member, whichever is greater	(0.131" x 3") nails at 6" on-center
	2x6	(2) -2x6			
	2x8	(2) -2x8			

<sup>1</sup>Maximum allowable web length is 14'

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.



U-REINFORCEMENT



I-REINFORCEMENT

## TYPES OF WEB MEMBER BUCKLING REINFORCEMENT

**FIGURE 2303.4.1.2(4)**  
**ALTERNATIVE INSTALLATION USING BUCKLING REINFORCEMENT FOR TRUSS WEB MEMBERS IN LIEU OF TWO ROWS OF PITMR**



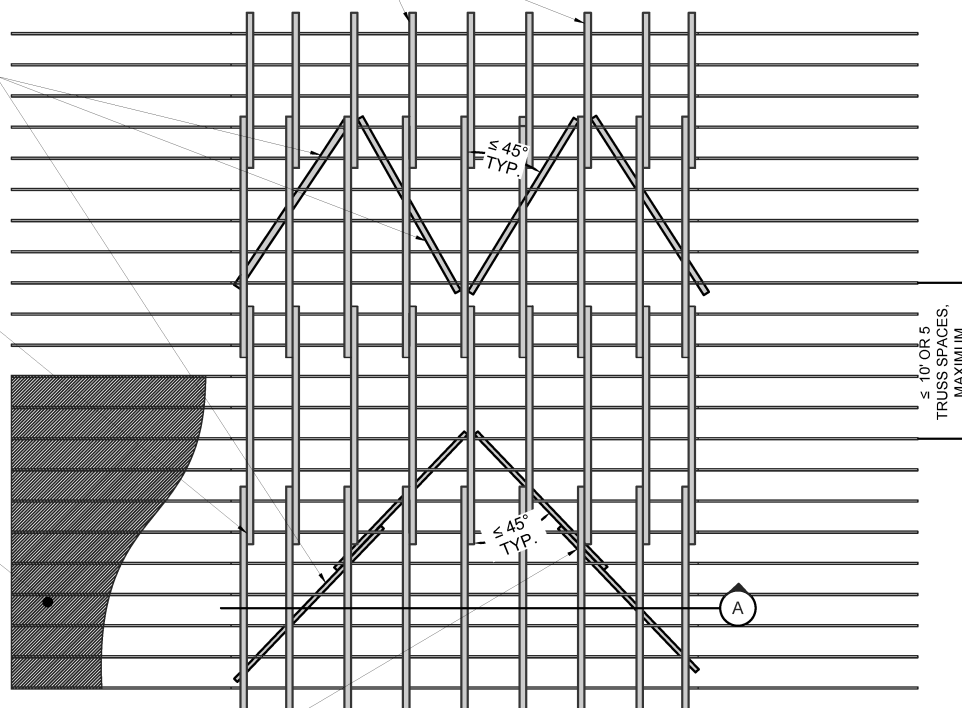
*PITMR* INSTALLED ON TOP CHORD OF SUPPORTING TRUSSES. REFER TO TRUSS DESIGN DRAWINGS FOR SPACING AND LOCATION. ATTACH TO EACH TOP CHORD WITH MINIMUM (2) 0.131" X 3" NAILS. LAP *PITMR* AT LEAST ONE TRUSS SPACE AT EACH SPLICE LOCATION.

*PITMDB* INSTALLED ON BOTTOM EDGE OF TOP CHORD OF THE SUPPORTING TRUSSES. ATTACH TO EACH TOP CHORD WITH MINIMUM (2) 0.131" X 3" NAILS. REPEAT *PITMDB* AT  $\leq 10'$  OR 5 TRUSS SPACES MAXIMUM.

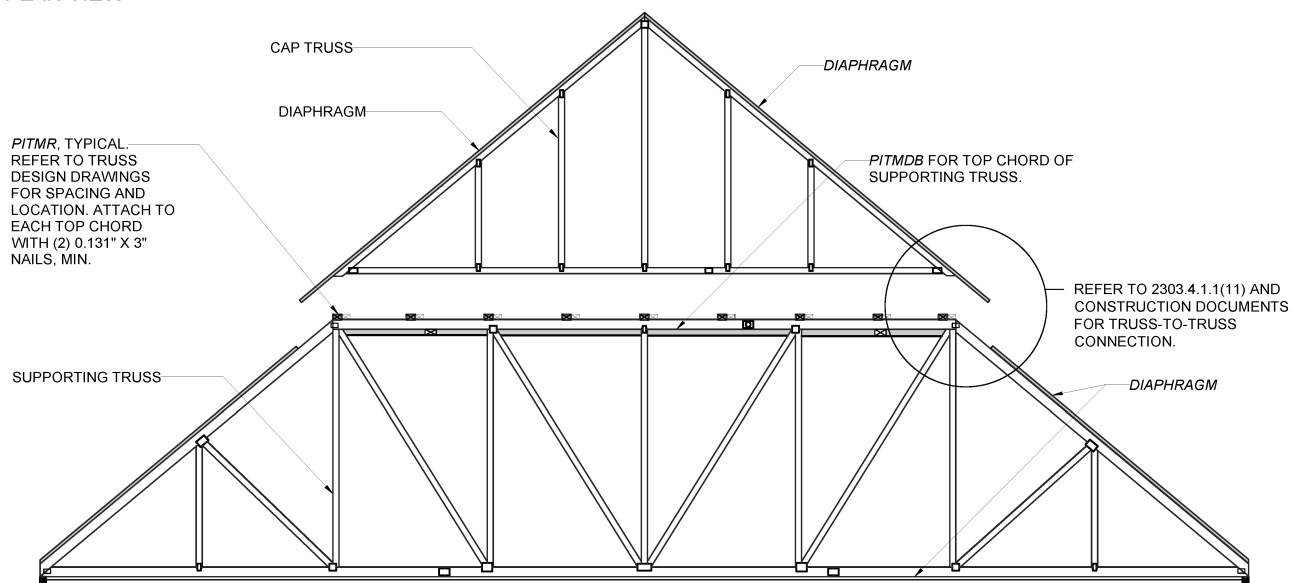
EXTEND ENDS OF *PITMR* AND *PITMDB* AT LEAST 3" BEYOND THE TOP CHORD TO AVOID SPLITTING, TYP.

DIAPHRAGM

LAP *PITMDB* AT LEAST ONE TRUSS SPACE AT EACH SPLICE LOCATION.



## PLAN VIEW



- Use minimum 2x4 stress - graded lumber for *PITMR* and *PITMDB* unless otherwise specified.
- Web *PITMR* and *PITMDB* not shown for clarity.
- Truss top chord and bottom chord members shall be restrained and braced.
- Bracing to resist forces applied perpendicular to the truss, such as wind bracing at gable ends, shall be specified by the building designer.

## SECTION AT A

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2303.4.1.2(5)**  
**PITMR AND PITMDB FOR FLAT PORTION OF TOP CHORD IN A PIGGYBACK ASSEMBLY**

## WOOD

**2303.4.2 Truss placement diagram.** The truss manufacturer shall provide a truss placement diagram that identifies the proposed location for each individually designated truss and references the corresponding truss design drawing. The truss placement diagram shall be provided as part of the truss submittal package, and with the shipment of trusses delivered to the job site. Truss placement diagrams that serve only as a guide for installation and do not deviate from the *permit* submittal drawings shall not be required to bear the seal or signature of the truss designer.

**2303.4.3 Truss submittal package.** The truss submittal package provided by the truss manufacturer shall consist of each individual truss design drawing, the truss placement diagram, the permanent *individual truss member* restraint/bracing method and details and any other structural details germane to the trusses; and, as applicable, the cover/truss index sheet.

**2303.4.4 Anchorage.** The design for the transfer of *loads* and anchorage of each truss to the supporting structure is the responsibility of the *registered design professional*.

**2303.4.5 Alterations to trusses.** Truss members and components shall not be cut, notched, drilled, spliced or otherwise altered in any way without written concurrence and approval of a *registered design professional*. Alterations resulting in the addition of *loads* to any member (for example, HVAC equipment, piping, additional roofing or insulation) shall not be permitted without verification that the truss is capable of supporting such additional loading.

**2303.4.6 TPI 1 specifications.** In addition to Sections 2303.4.1 through 2303.4.5, the design, manufacture and quality assurance of metal-plate-connected wood trusses shall be in accordance with TPI 1. Job-site inspections shall be in compliance with Section 110.4, as applicable.

**2303.4.7 Truss quality assurance.** Trusses not part of a manufacturing process in accordance with either Section 2303.4.6 or a referenced standard, which provides requirements for quality control done under the supervision of a third-party quality control agency, shall be manufactured in compliance with Sections 1704.2.5 and 1705.5, as applicable.

**2303.5 Test standard for joist hangers.** Joist hangers shall be in accordance with ASTM D7147.

**2303.6 Nails and staples.** Nails and staples shall conform to requirements of ASTM F1667, including Supplement 1. Nails used for framing and sheathing connections shall have minimum average bending yield strengths as follows: 80 kips per square inch (ksi) (551 MPa) for shank diameters larger than 0.177 inch (4.50 mm) but not larger than 0.254 inch (6.45 mm), 90 ksi (620 MPa) for shank diameters larger than 0.142 inch (3.61 mm) but not larger than 0.177 inch (4.50 mm) and 100 ksi (689 MPa) for shank diameters of not less than 0.099 inch (2.51 mm) but not larger than 0.142 inch (3.61 mm). Staples used for framing and sheathing connections shall have minimum average bending moments as follows: 3.6 in.-lbs (0.41 N-m) for No. 16 gage staples, 4.0

in.-lbs (0.45 N-m) for No. 15 gage staples, and 4.3 in.-lbs (0.49 N-m) for No. 14 gage staples.

**2303.7 Shrinkage.** Consideration shall be given in design for the effects of wood cross-grain dimensional changes that occur as a result of changes in the wood moisture content after installation.

## SECTION 2304 GENERAL CONSTRUCTION REQUIREMENTS

**2304.1 General.** The provisions of this section apply to design methods specified in Section 2302.1.

**2304.2 Size of structural members.** Computations to determine the required sizes of members shall be based on the net dimensions (actual sizes) and not nominal sizes.

**2304.3 Wall framing.** The framing of exterior and interior walls shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

**2304.3.1 Bottom plates.** Studs shall have full bearing on a 2-inch-thick (actual 1½-inch, 38 mm) or larger plate or sill having a width not less than equal to the width of the studs.

**2304.3.2 Framing over openings.** Headers, double joists, trusses or other *approved* assemblies that are of adequate size to transfer *loads* to the vertical members shall be provided over window and door openings in *load-bearing walls* and partitions.

**2304.3.3 Shrinkage.** Wood walls and bearing partitions shall not support more than two floors and a roof unless an analysis satisfactory to the *building official* shows that shrinkage of the wood framing will not have adverse effects on the structure or any plumbing, electrical or mechanical systems or other equipment installed therein due to excessive shrinkage or differential movements caused by shrinkage. The analysis shall show that the roof drainage system and the foregoing systems or equipment will not be adversely affected or, as an alternate, such systems shall be designed to accommodate the differential shrinkage or movements.

**2304.4 Floor and roof framing.** The framing of wood-joisted floors and wood-framed roofs shall be in accordance with the provisions specified in Section 2308 unless a specific design is furnished.

**2304.5 Framing around flues and chimneys.** Combustible framing shall be not less than 2 inches (51 mm), but shall be not less than the distance specified in Sections 2111 and 2113 and the *International Mechanical Code*, from flues, chimneys and fireplaces, and 6 inches (152 mm) away from flue openings.

**2304.6 Exterior wall sheathing.** Wall sheathing on the outside of *exterior walls*, including *gables*, and the connection of the sheathing to framing shall be designed in accordance with the general provisions of this code and shall be capable of resisting wind pressures in accordance with Section 1609.

**2304.6.1 Wood structural panel sheathing.** Where *wood structural panel* sheathing is used as the exposed finish on the outside of *exterior walls*, it shall have an exterior exposure durability classification. Where *wood structural panel* sheathing is used elsewhere, but not as the exposed finish, it shall be of a type manufactured with exterior glue (Exposure 1 or Exterior). *Wood structural panel* sheathing, connections and framing spacing shall be in accordance with Table 2304.6.1 for the applicable wind speed and exposure category where used in enclosed buildings with a mean roof height not greater than 30 feet (9144 mm) and a topographic factor ( $K_{zt}$ ) of 1.0.

**2304.7 Interior paneling.** Softwood *wood structural panels* used for interior paneling shall conform to the provisions of Chapter 8 and shall be installed in accordance with Table 2304.10.2. Panels shall comply with DOC PS 1, DOC PS 2 or ANSI/APA PRP 210. Prefinished *hardboard* paneling shall meet the requirements of ANSI A135.5. Hardwood plywood shall conform to HPVA HP-1.

**2304.8 Floor and roof sheathing.** Structural floor sheathing and structural roof sheathing shall comply with Sections 2304.8.1 and 2304.8.2, respectively.

**2304.8.1 Structural floor sheathing.** Structural floor sheathing shall be designed in accordance with the general provisions of this code.

Floor sheathing conforming to the provisions of Table 2304.8(1), 2304.8(2), 2304.8(3) or 2304.8(4) shall be deemed to meet the requirements of this section.

**2304.8.2 Structural roof sheathing.** Structural roof sheathing shall be designed in accordance with the general provisions of this code and the special provisions in this section.

Roof sheathing conforming to the provisions of Table 2304.8(1), 2304.8(2), 2304.8(3) or 2304.8(5) shall be deemed to meet the requirements of this section. *Wood structural panel* roof sheathing shall be of a type manufactured with exterior glue (Exposure 1 or Exterior).

**TABLE 2304.6.1**  
**MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED,  $V_{asd}$  PERMITTED FOR**  
**WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES<sup>a, b, c</sup>**

MINIMUM NAIL		MINIMUM WOOD STRUCTURAL PANEL SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inches)	MAXIMUM WALL STUD SPACING (inches)	PANEL NAIL SPACING		MAXIMUM ALLOWABLE STRESS DESIGN WIND SPEED, $V_{asd}$ <sup>d</sup> (MPH)		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	Wind exposure category		
							B	C	D
6d common (2.0" × 0.113")	1.5	24/0	3/8	16	6	12	110	90	85
		24/16	7/16	16	6	12	110	100	90
						6	150	125	110
8d common (2.5" × 0.131")	1.75	24/16	7/16	16	6	12	130	110	105
				24	6	6	150	125	110
						12	110	90	85
						6	110	90	85

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- Panel strength axis shall be parallel or perpendicular to supports. Three-ply plywood sheathing with studs spaced more than 16 inches on center shall be applied with panel strength axis perpendicular to supports.
- The table is based on wind pressures acting toward and away from building surfaces in accordance with Section 30.7 of ASCE 7. Lateral requirements shall be in accordance with Section 2305 or 2308.
- Wood structural panels with span ratings of wall-16 or wall-24 shall be permitted as an alternative to panels with a 24/0 span rating. Plywood siding rated 16 on center or 24 on center shall be permitted as an alternative to panels with a 24/16 span rating. Wall-16 and plywood siding 16 on center shall be used with studs spaced not more than 16 inches on center.
- $V_{asd}$  shall be determined in accordance with Section 1609.3.1.

**TABLE 2304.8(1)**  
**ALLOWABLE SPANS FOR LUMBER FLOOR AND ROOF SHEATHING**

SPAN (inches)	MINIMUM NET THICKNESS (inches) OF LUMBER PLACED			
	Perpendicular to supports		Diagonally to supports	
	Surfaced dry <sup>a</sup>	Surfaced unseasoned	Surfaced dry <sup>a</sup>	Surfaced unseasoned
<b>Floors</b>				
24	3/4	25/32	3/4	25/32
16	5/8	11/16	5/8	11/16
<b>Roofs</b>				
24	5/8	11/16	3/4	25/32

For SI: 1 inch = 25.4 mm.

- Maximum 19-percent moisture content.

## WOOD

**TABLE 2304.8(2)**  
**SHEATHING LUMBER, MINIMUM GRADE REQUIREMENTS: BOARD GRADE**

SOLID FLOOR OR ROOF SHEATHING	SPACED ROOF SHEATHING	GRADING RULES
Utility	Standard	NLGA, WCLIB, WWPA
4 common or utility	3 common or standard	NLGA, WCLIB, WWPA, NSLB or NELMA
No. 3	No. 2	SPIB
Merchantable	Construction common	RIS

**TABLE 2304.8(3)**  
**ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANEL SHEATHING AND SINGLE-FLOOR GRADES CONTINUOUS OVER TWO OR MORE SPANS WITH STRENGTH AXIS PERPENDICULAR TO SUPPORTS<sup>a</sup>**

SHEATHING GRADES		ROOF <sup>b</sup>				FLOOR <sup>c</sup>
Panel span rating roof/floor span	Panel thickness (inches)	Maximum span (inches)		Load <sup>d</sup> (psf)		Maximum span (inches)
		With edge support <sup>e</sup>	Without edge support	Total load	Live load	
16/0	$\frac{3}{8}$	16	16	40	30	0
20/0	$\frac{3}{8}$	20	20	40	30	0
24/0	$\frac{3}{8}, \frac{7}{16}, \frac{1}{2}$	24	20 <sup>f</sup>	40	30	0
24/16	$\frac{7}{16}, \frac{1}{2}$	24	24	50	40	16
32/16	$\frac{15}{32}, \frac{1}{2}, \frac{5}{8}$	32	28	40	30	16 <sup>g</sup>
40/20	$\frac{19}{32}, \frac{5}{8}, \frac{3}{4}, \frac{7}{8}$	40	32	40	30	20 <sup>g,h</sup>
48/24	$\frac{23}{32}, \frac{3}{4}, \frac{7}{8}$	48	36	45	35	24
54/32	$\frac{7}{8}, 1$	54	40	45	35	32
60/32	$\frac{7}{8}, 1\frac{1}{8}$	60	48	45	35	32
SINGLE FLOOR GRADES		ROOF <sup>b</sup>				FLOOR <sup>c</sup>
Panel span rating	Panel thickness (inches)	Maximum span (inches)		Load <sup>e</sup> (psf)		Maximum span (inches)
		With edge support <sup>e</sup>	Without edge support	Total load	Live load	
16 o.c.	$\frac{1}{2}, \frac{19}{32}, \frac{5}{8}$	24	24	50	40	16 <sup>g</sup>
20 o.c.	$\frac{19}{32}, \frac{5}{8}, \frac{3}{4}$	32	32	40	30	20 <sup>g,h</sup>
24 o.c.	$\frac{23}{32}, \frac{3}{4}$	48	36	35	25	24
32 o.c.	$\frac{7}{8}, 1$	48	40	50	40	32
48 o.c.	$1\frac{3}{32}, 1\frac{1}{8}$	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

a. Applies to panels 24 inches or wider.

b. Uniform load deflection limitations  $\frac{1}{180}$  of span under live load plus dead load,  $\frac{1}{240}$  under live load only.

c. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking unless  $\frac{1}{4}$ -inch minimum thickness underlayment or  $1\frac{1}{2}$  inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is  $\frac{3}{4}$ -inch wood strip. Allowable uniform load based on deflection of  $\frac{1}{360}$  of span is 100 pounds per square foot except the span rating of 48 inches on center is based on a total load of 65 pounds per square foot.

d. Allowable load at maximum span.

e. Tongue-and-groove edges, panel edge clips (one midway between each support, except two equally spaced between supports 48 inches on center), lumber blocking or other. Only lumber blocking shall satisfy blocked diaphragm requirements.

f. For  $\frac{1}{2}$ -inch panel, maximum span shall be 24 inches.

g. Span is permitted to be 24 inches on center where  $\frac{3}{4}$ -inch wood strip flooring is installed at right angles to joist.

h. Span is permitted to be 24 inches on center for floors where  $1\frac{1}{2}$  inches of cellular or lightweight concrete is applied over the panels.



**TABLE 2304.8(4)**  
**ALLOWABLE SPAN FOR WOOD STRUCTURAL PANEL COMBINATION SUBFLOOR-UNDERLAYMENT (SINGLE FLOOR)<sup>a</sup>**  
**(Panels Continuous Over Two or More Spans and Strength Axis Perpendicular to Supports)**

IDENTIFICATION	MAXIMUM SPACING OF JOISTS (inches)				
	16	20	24	32	48
Species group <sup>b</sup>	Thickness (inches)				
1	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	—	—
2, 3	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	—	—
4	$\frac{3}{4}$	$\frac{7}{8}$	1	—	—
Single floor span rating <sup>c</sup>	16 o.c.	20 o.c.	24 o.c.	32 o.c.	48 o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

- a. Spans limited to value shown because of possible effects of concentrated loads. Allowable uniform loads based on deflection of  $\frac{1}{360}$  of span is 100 pounds per square foot except allowable total uniform load for  $\frac{1}{8}$ -inch wood structural panels over joists spaced 48 inches on center is 65 pounds per square foot. Panel edges shall have approved tongue-and-groove joints or shall be supported with blocking, unless  $\frac{1}{4}$ -inch minimum thickness underlayment or  $\frac{1}{2}$  inches of approved cellular or lightweight concrete is placed over the subfloor, or finish floor is  $\frac{3}{4}$ -inch wood strip.
- b. Applicable to all grades of sanded exterior-type plywood. See DOC PS 1 for plywood species groups.
- c. Applicable to Underlayment grade, C-C (Plugged) plywood, and Single Floor grade wood structural panels.

**TABLE 2304.8(5)**  
**ALLOWABLE LOAD (PSF) FOR WOOD STRUCTURAL PANEL ROOF SHEATHING CONTINUOUS**  
**OVER TWO OR MORE SPANS AND STRENGTH AXIS PARALLEL TO SUPPORTS**  
**(Plywood structural panels are five-ply, five-layer unless otherwise noted)<sup>a</sup>**

PANEL GRADE	THICKNESS (inch)	MAXIMUM SPAN (inches)	LOAD AT MAXIMUM SPAN (psf)	
			Live	Total
Structural I sheathing	$\frac{7}{16}$	24	20	30
	$\frac{15}{32}$	24	35 <sup>b</sup>	45 <sup>b</sup>
	$\frac{1}{2}$	24	40 <sup>b</sup>	50 <sup>b</sup>
	$\frac{19}{32}$ , $\frac{5}{8}$	24	70	80
	$\frac{23}{32}$ , $\frac{3}{4}$	24	90	100
Sheathing, other grades covered in DOC PS 1 or DOC PS 2	$\frac{7}{16}$	16	40	50
	$\frac{15}{32}$	24	20	25
	$\frac{1}{2}$	24	25	30
	$\frac{19}{32}$	24	40 <sup>b</sup>	50 <sup>b</sup>
	$\frac{5}{8}$	24	45 <sup>b</sup>	55 <sup>b</sup>
	$\frac{23}{32}$ , $\frac{3}{4}$	24	60 <sup>b</sup>	65 <sup>b</sup>

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>.

- a. Uniform load deflection limitations  $\frac{1}{180}$  of span under live load plus dead load,  $\frac{1}{240}$  under live load only. Edges shall be blocked with lumber or other approved type of edge supports.
- b. For composite and four-ply plywood structural panel, load shall be reduced by 15 pounds per square foot.

**2304.9 Lumber decking.** Lumber decking shall be designed and installed in accordance with the general provisions of this code and Sections 2304.9.1 through 2304.9.5.3. Other lumber decking patterns and connection designs shall be substantiated through engineering analysis.

**2304.9.1 General.** Each piece of lumber decking shall be square-end trimmed. Where random lengths are furnished, each piece shall be square end trimmed across the face so that not less than 90 percent of the pieces are within 0.5 degrees (0.00873 rad) of square. The ends of the pieces shall be permitted to be beveled up to 2 degrees (0.0349 rad) from the vertical with the exposed face of the piece slightly longer than the opposite face of the piece. Tongue-and-groove decking shall be installed with the tongues up on sloped or pitched roofs with pattern faces down.

**2304.9.2 Layup patterns.** Lumber decking is permitted to be laid up following one of five standard patterns as defined in Sections 2304.9.2.1 through 2304.9.2.5.

**2304.9.2.1 Simple span pattern.** All pieces shall be supported on their ends (in other words, by two supports).

**2304.9.2.2 Two-span continuous pattern.** All pieces shall be supported by three supports, and all end joints shall occur in line on alternating supports. Supporting members shall be designed to accommodate the *load* redistribution caused by this pattern.

**2304.9.2.3 Combination simple and two-span continuous pattern.** Courses in end spans shall be alternating simple-span pattern and two-span continuous pattern. End joints shall be staggered in adjacent courses and shall bear on supports.

## WOOD

**2304.9.2.4 Cantilevered pieces intermixed pattern.**

The decking shall extend across not fewer than three spans. Pieces in each starter course and every third course shall be simple span pattern. Pieces in other courses shall be cantilevered over the supports with end joints at alternating quarter or third points of the spans. Each piece shall bear on one support or more.

**2304.9.2.5 Controlled random pattern.** The decking shall extend across not fewer than three spans. End joints of pieces within 6 inches (152 mm) of the end joints of the adjacent pieces in either direction shall be separated by not fewer than two intervening courses. In the end bays, each piece shall bear on one support or more. Where an end joint occurs in an end bay, the next piece in the same course shall continue over the first inner support for not less than 24 inches (610 mm). The details of the controlled random pattern shall be as specified for each decking material in Section 2304.9.3.3, 2304.9.4.3 or 2304.9.5.3.

Decking that cantilevers beyond a support for a horizontal distance greater than 18 inches (457 mm), 24 inches (610 mm) or 36 inches (914 mm) for 2-inch (51 mm), 3-inch (76 mm) and 4-inch (102 mm) nominal thickness decking, respectively, shall comply with the following:

1. The maximum cantilevered length shall be 30 percent of the length of the first adjacent interior span.
2. A structural fascia shall be fastened to each decking piece to maintain a continuous, straight line.
3. End joints shall not be in the decking between the cantilevered end of the decking and the centerline of the first adjacent interior span.

**2304.9.3 Mechanically laminated decking.** Mechanically laminated decking shall comply with Sections 2304.9.3.1 through 2304.9.3.3.

**2304.9.3.1 General.** Mechanically laminated decking consists of square-edged dimension lumber laminations set on edge and nailed to the adjacent pieces and to the supports.

**2304.9.3.2 Nailing.** The length of nails connecting laminations shall be not less than two and one-half times the net thickness of each lamination. Where decking supports are 48 inches (1219 mm) on center or less, side nails shall be installed not more than 30 inches (762 mm) on center alternating between top and bottom edges, and staggered one-third of the spacing in adjacent laminations. Where supports are spaced more than 48 inches (1219 mm) on center, side nails shall be installed not more than 18 inches (457 mm) on center alternating between top and bottom edges and staggered one-third of the spacing in adjacent laminations. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, nailing in accordance with Table 2304.9.3.2 shall be permitted. Two side nails shall be installed at each end of butt-jointed pieces.

Laminations shall be toenailed to supports with 20d or larger common nails. Where the supports are 48 inches (1219 mm) on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches (1219 mm) on center, alternate laminations shall be toenailed to every support. For mechanically laminated decking constructed with laminations of 2-inch (51 mm) nominal thickness, toenailing in accordance with Table 2304.9.3.2 shall be permitted.

**TABLE 2304.9.3.2  
FASTENING SCHEDULE FOR MECHANICALLY LAMINATED DECKING USING LAMINATIONS OF 2-INCH NOMINAL THICKNESS**

MINIMUM NAIL SIZE (Length x Diameter) (inches)	MAXIMUM SPACING BETWEEN FACE NAILS <sup>a, b</sup> (inches)		NUMBER OF TOENAILS INTO SUPPORTS <sup>c</sup>
	Decking Supports ≤ 48 inches o.c.	Decking Supports > 48 inches o.c.	
4 × 0.192	30	18	1
4 × 0.162	24	14	2
4 × 0.148	22	13	2
3½ × 0.162	20	12	2
3½ × 0.148	19	11	2
3½ × 0.135	17	10	2
3 × 0.148	11	7	2
3 × 0.128	9	5	2
2¾ × 0.148	10	6	2
2¾ × 0.131	9	6	3
2¾ × 0.120	8	5	3

For SI: 1 inch = 25.4 mm

- a. Nails shall be driven perpendicular to the lamination face, alternating between top and bottom edges.
- b. Where nails penetrate through two laminations and into the third, they shall be staggered one-third of the spacing in adjacent laminations. Otherwise, nails shall be staggered one-half of the spacing in adjacent laminations.
- c. Where supports are 48 inches on center or less, alternate laminations shall be toenailed to alternate supports; where supports are spaced more than 48 inches on center, alternate laminations shall be toenailed to every support.

**2304.9.3.3 Controlled random pattern.** There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on not fewer than two supports with end joints in these two courses occurring on alternate supports. Not more than seven intervening courses shall be permitted before this pattern is repeated.

**2304.9.4 Two-inch sawn tongue-and-groove decking.** Two-inch (51 mm) sawn tongue-and-groove decking shall comply with Sections 2304.9.4.1 through 2304.9.4.3.

**2304.9.4.1 General.** Two-inch (51 mm) decking shall have a maximum moisture content of 15 percent. Decking shall be machined with a single tongue-and-groove pattern. Each decking piece shall be nailed to each support.

**2304.9.4.2 Nailing.** Each piece of decking shall be toenailed at each support with one 16d common nail through the tongue and face-nailed with one 16d common nail.

**2304.9.4.3 Controlled random pattern.** There shall be a minimum distance of 24 inches (610 mm) between end joints in adjacent courses. The pieces in the first and second courses shall bear on not fewer than two supports with end joints in these two courses occurring on alternate supports. Not more than seven intervening courses shall be permitted before this pattern is repeated.

**2304.9.5 Three- and four-inch sawn tongue-and-groove decking.** Three- and four-inch (76 mm and 102 mm) sawn tongue-and-groove decking shall comply with Sections 2304.9.5.1 through 2304.9.5.3.

**2304.9.5.1 General.** Three-inch (76 mm) and four-inch (102 mm) decking shall have a maximum moisture content of 19 percent. Decking shall be machined with a double tongue-and-groove pattern. Decking pieces shall be interconnected and nailed to the supports.

**2304.9.5.2 Nailing.** Each piece shall be toenailed at each support with one 40d common nail and face-nailed with one 60d common nail. Courses shall be spiked to each other with 8-inch (203 mm) spikes at maximum intervals of 30 inches (762 mm) through predrilled edge holes penetrating to a depth of approximately 4 inches (102 mm). One spike shall be installed at a distance not exceeding 10 inches (254 mm) from the end of each piece.

**2304.9.5.3 Controlled random pattern.** There shall be a minimum distance of 48 inches (1219 mm) between end joints in adjacent courses. Pieces not bearing on a support are permitted to be located in

interior bays provided that the adjacent pieces in the same course continue over the support for not less than 24 inches (610 mm). This condition shall not occur more than once in every six courses in each interior bay.

**2304.10 Connectors and fasteners.** Connectors and fasteners shall comply with the applicable provisions of Sections 2304.10.1 through 2304.10.8.

**2304.10.1 Connection fire-resistance rating.** *Fire-resistance* ratings for connections in Type IV-A, IV-B, or IV-C construction shall be determined by one of the following:

1. Testing in accordance with Section 703.2 where the connection is part of the *fire resistance* test.
2. Engineering analysis that demonstrates that the temperature rise at any portion of the connection is limited to an average temperature rise of 250°F (139°C), and a maximum temperature rise of 325°F (181°C), for a time corresponding to the required *fire-resistance* rating of the structural element being connected. For the purposes of this analysis, the connection includes connectors, fasteners, and portions of wood members included in the structural design of the connection.

**2304.10.2 Fastener requirements.** Connections for wood members shall be designed in accordance with the appropriate methodology in Section 2302.1. The number and size of fasteners connecting wood members shall be not less than that set forth in Table 2304.10.2.

**2304.10.3 Sheathing fasteners.** Sheathing nails or other *approved* sheathing connectors shall be driven so that their head or crown is flush with the surface of the sheathing.

**2304.10.4 Joist hangers and framing anchors.** Connections depending on joist hangers or framing anchors, ties and other mechanical fastenings not otherwise covered are permitted where *approved*. The vertical load-bearing capacity, torsional moment capacity and deflection characteristics of joist hangers shall be determined in accordance with ASTM D7147.

**2304.10.5 Other fasteners.** Clips, staples, glues and other *approved* methods of fastening are permitted where *approved*.

**2304.10.6 Fasteners and connectors in contact with preservative-treated and fire-retardant-treated wood.** Fasteners, including nuts and washers, and connectors in contact with *preservative-treated* and *fire-retardant-treated wood* shall be in accordance with Sections 2304.10.6.1 through 2304.10.6.4. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A153. Stainless steel driven fasteners shall be in accordance with the material requirements of ASTM F1667.

## WOOD

**TABLE 2304.10.2  
FASTENING SCHEDULE**

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a</sup>	SPACING AND LOCATION
<b>Roof</b>		
1. Blocking between ceiling joists, rafters or trusses to top plate or other framing below	4-8d box (2½" x 0.113"); or 3-8d common (2½" x 0.131"); or 3-10d box (3" x 0.128"); or 3-3" x 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	Each end, toenail
Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common (2½" x 0.131") 2-3" x 0.131" nails 2-3" 14 gage staples	Each end, toenail
	2-16 d common (3½" x 0.162") 3-3" x 0.131" nails 3-3" 14 gage staples	End nail
Flat blocking to truss and web filler	16d common (3½" x 0.162") @ 6" o.c. 3" x 0.131" nails @ 6" o.c. 3" x 14 gage staples @ 6" o.c.	Face nail
2. Ceiling joists to top plate	4-8d box (2½" x 0.113"); or 3-8d common (2½" x 0.131"); or 3-10d box (3" x 0.128"); or 3-3" x 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	Each joist, toenail
3. Ceiling joist not attached to parallel rafter, laps over partitions (no thrust) (see Section 2308.7.3.1, Table 2308.7.3.1)	3-16d common (3½" x 0.162"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	Face nail
4. Ceiling joist attached to parallel rafter (heel joint) (see Section 2308.7.3.1, Table 2308.7.3.1)	Per Table 2308.7.3.1	Face nail
5. Collar tie to rafter	3-10d common (3" x 0.148"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	Face nail
6. Rafter or roof truss to top plate (See Section 2308.7.5, Table 2308.7.5)	3-10 common (3" x 0.148"); or 3-16d box (3½" x 0.135"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131 nails; or 4-3" 14 gage staples, 7/16" crown	2 toenails on one side and 1 toenail on opposite side of rafter or truss <sup>c</sup>
7. Roof rafters to ridge valley or hip rafters; or roof rafter to 2-inch ridge beam	2-16d common (3½" x 0.162"); or 3-16d box (3½" x 0.135"); or 3-10d box (3" x 0.128"); or 3-3" x 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	End nail
	3-10d common (3½" x 0.148"); or 4-16d box (3½" x 0.135"); or 4-10d box (3" x 0.128"); or 4-3" x 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	Toenail
<b>Wall</b>		
8. Stud to stud (not at braced wall panels)	16d common (3½" x 0.162");	24" o.c. face nail
	10d box (3" x 0.128"); or 3" x 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	16" o.c. face nail

(continued)



**TABLE 2304.10.2—continued  
FASTENING SCHEDULE**

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a</sup>	SPACING AND LOCATION
<b>Wall</b>		
9. Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d common (3½" × 0.162")	16" o.c. face nail
	16d box (3½" × 0.135"); or 3" × 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	12" o.c. face nail
10. Built-up header (2" to 2" header)	16d common (3½" × 0.162")	16" o.c. each edge, face nail
	16d box (3½" × 0.135")	12" o.c. each edge, face nail
11. Continuous header to stud	4-8d common (2½" × 0.131"); or 4-10d box (3" × 0.128"); or 5-8d box (2½" × 0.113")	Toenail
12. Top plate to top plate	16d common (3½" × 0.162")	16" o.c. face nail
	10d box (3" × 0.128"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
13. Top plate to top plate, at end joints	8-16d common (3½" × 0.162"); or 12-16d box (3½" × 0.135"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails; or 12-3" 14 gage staples, 7/16" crown	Each side of end joint, face nail (minimum 24" lap splice length each side of end joint)
14. Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3½" × 0.162")	16" o.c. face nail
	16d box (3½" × 0.135"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	12" o.c. face nail
15. Bottom plate to joist, rim joist, band joist or blocking at braced wall panels	2-16d common (3½" × 0.162"); or 3-16d box (3½" × 0.135"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	16" o.c. face nail
16. Stud to top or bottom plate	3-16d box (3½" × 0.135"); or 4-8d common (2½" × 0.131"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-8d box (2½" × 0.113"); or 4-3" 14 gage staples, 7/16" crown	Toenail
	2-16d common (3½" × 0.162"); or 3-16d box (3½" × 0.135"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	End nail
17. Top plates, laps at corners and intersections	2-16d common (3½" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	Face nail
18. 1" brace to each stud and plate	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 2-10d box (3" × 0.128"); or 2-3" × 0.131" nails; or 2-3" 14 gage staples, 7/16" crown	Face nail
19. 1" × 6" sheathing to each bearing	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 2-10d box (3" × 0.128"); or 2-1¾" 16 gage staples, 1" crown	Face nail

(continued)

## WOOD

**TABLE 2304.10.2—continued  
FASTENING SCHEDULE**

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>9</sup>	SPACING AND LOCATION
Wall		
20. 1" × 8" and wider sheathing to each bearing	3-8d common (2½" × 0.131"); or 3-8d box (2½" x 0.113"); or 3-10d box (3" × 0.128"); or 3-1¾" 16 gage staples, 1" crown	Face nail
	Wider than 1" × 8" 3-8d common (2½" x 0.131"); or 4-8d box (2½" × 0.113"); or 3-10d box (3" × 0.128"); or 4-1¾" 16 gage staples, 1" crown	
Floor		
21. Joist to sill, top plate, or girder	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or floor 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	Toenail
22. Rim joist, band joist, or blocking to top plate, sill or other framing below	8d box (2½" × 0.113")	4" o.c., toenail
	8d common (2½" × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	6" o.c., toenail
23. 1" × 6" subfloor or less to each joist	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 2-1¾" 16 gage staples, 1" crown	Face nail
24. 2 subfloor to joist or girder	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")	Blind and face nail
25. 2" planks (plank & beam – floor & roof)	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")	Each bearing, face nail
26. Built-up girders and beams, 2" lumber layers	20d common (4" × 0.192")	32" o.c., face nail at top and bottom staggered on opposite sides
	10d box (3" × 0.128"); or 3" × 0.131" nails; or 3" 14 gage staples, 7/16" crown	24" o.c. face nail at top and bottom staggered on opposite sides
	And: 2-20d common (4" × 0.192"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails; or 3-3" 14 gage staples, 7/16" crown	Ends and at each splice, face nail
27. Ledger strip supporting joists or rafters	3-16d common (3½" × 0.162"); or 4-16d box (3½" × 0.135"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	Each joist or rafter, face nail
28. Joist to band joist or rim joist	3-16d common (3½" × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" 14 gage staples, 7/16" crown	End nail
29. Bridging or blocking to joist, rafter or truss	2-8d common (2½" × 0.131"); or 2-10d box (3" × 0.128"); or 2-3" × 0.131" nails; or 2-3" 14 gage staples, 7/16" crown	Each end, toenail

(continued)

**TABLE 2304.10.2—continued  
FASTENING SCHEDULE**

DESCRIPTION OF BUILDING ELEMENTS		NUMBER AND TYPE OF FASTENER <sup>a</sup>	SPACING AND LOCATION	
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing <sup>a</sup>				
			Edges (inches)	Intermediate supports (inches)
30. $\frac{3}{8}$ " – $\frac{1}{2}$ "	6d common or deformed (2" × 0.113"); or $2\frac{3}{8}$ " × 0.113" nail (subfloor and wall)		6	12
	8d common or deformed (2½" × 0.131" × 0.281" head) (roof) or RSRS-01 ( $2\frac{3}{8}$ " × 0.113") nail (roof) <sup>d</sup>		6 <sup>e</sup>	6 <sup>e</sup>
	1¾" 16 gage staple, ⅞" crown (subfloor and wall)		4	8
	2⅜" × 0.113" × 0.266" head nail (roof)		3 <sup>f</sup>	3 <sup>f</sup>
	1¾" 16 gage staple, ⅞" crown (roof)		3 <sup>f</sup>	3 <sup>f</sup>
31. $\frac{19}{32}$ " – $\frac{3}{4}$ "	8d common (2½" × 0.131"); or deformed (2" × 0.113") (subfloor and wall)		6	12
	8d common or deformed (2½" × 0.131" × 0.281" head) (roof) or RSRS-01 ( $2\frac{3}{8}$ " × 0.113") nail (roof) <sup>d</sup>		6 <sup>e</sup>	6 <sup>e</sup>
	2⅜" × 0.113" × 0.266" head nail; or 2" 16 gage staple, ⅞" crown		4	8
32. $\frac{7}{8}$ " – 1¼"	10d common (3" × 0.148"); or deformed (2½" × 0.131" × 0.281" head)		6	12
Other exterior wall sheathing				
33. ½" fiberboard sheathing <sup>b</sup>	1½" × 0.120", galvanized roofing nail (⅞" head diameter); or 1¼" 16 gage staple with ⅞" or 1" crown		3	6
34. $\frac{25}{32}$ " fiberboard sheathing <sup>b</sup>	1¾" × 0.120" galvanized roofing nail (⅞" diameter head); or 1½" 16 gage staple with ⅞" or 1" crown		3	6
Wood structural panels, combination subfloor underlayment to framing				
35. ¾" and less	8d common (2½" × 0.131"); or deformed (2" × 0.113"); or deformed (2" × 0.120")		6	12
36. ⅞" – 1"	8d common (2½" × 0.131"); or deformed (2½" × 0.131"); or deformed (2½" × 0.120")		6	12
37. 1⅛" – 1¼"	10d common (3" × 0.148"); or deformed (2½" × 0.131"); or deformed (2½" × 0.120")		6	12
Panel siding to framing				
38. ½" or less	6d corrosion-resistant siding (1⅞" × 0.106"); or 6d corrosion-resistant casing (2" × 0.099")		6	12
39. ⅝"	8d corrosion-resistant siding (2⅜" × 0.128"); or 8d corrosion-resistant casing (2½" × 0.113")		6	12

(continued)

## WOOD

TABLE 2304.10.2—continued  
FASTENING SCHEDULE

DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a</sup>	SPACING AND LOCATION	
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing <sup>a</sup>			
		Edges (inches)	Intermediate supports (inches)
Interior paneling			
40. 1/4"	4d casing (1 1/2" × 0.080"); or 4d finish (1 1/2" × 0.072")	6	12
41. 3/8"	6d casing (2" × 0.099"); or 6d finish (2" × 0.092") (Panel supports at 24 inches)	6	12

For SI: 1 inch = 25.4 mm.

- Nails spaced at 6 inches at intermediate supports where spans are 48 inches or more. For nailing of wood structural panel and particleboard diaphragms and shear walls, refer to Section 2305. Nails for wall sheathing are permitted to be common, box or casing.
- Spacing shall be 6 inches on center on the edges and 12 inches on center at intermediate supports for nonstructural applications. Panel supports at 16 inches (20 inches if strength axis in the long direction of the panel, unless otherwise marked).
- Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule and the ceiling joist is fastened to the top plate in accordance with this schedule, the number of toenails in the rafter shall be permitted to be reduced by one nail.
- RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.
- Tabulated fastener requirements apply where the ultimate design wind speed is less than 140 mph. For wood structural panel roof sheathing attached to gable-end roof framing and to intermediate supports within 48 inches of roof edges and ridges, nails shall be spaced at 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 110 mph in Exposure C. Spacing exceeding 6 inches on center at intermediate supports shall be permitted where the fastening is designed per the AWC NDS.
- Fastening is only permitted where the ultimate design wind speed is less than or equal to 110 mph.
- Nails and staples are carbon steel meeting the specifications of ASTM F1667. Connections using nails and staples of other materials, such as stainless steel, shall be designed by acceptable engineering practice or approved under Section 104.11.

**2304.10.6.1 Fasteners and connectors for preservative-treated wood.** Fasteners, including nuts and washers, in contact with *preservative-treated wood* shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Staples shall be of stainless steel. Fasteners other than nails, staples, timber rivets, wood screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum. Connectors that are used in exterior applications and in contact with *preservative-treated wood* shall have coating types and weights in accordance with the treated wood or connector manufacturer's recommendations. In the absence of manufacturer's recommendations, not less than ASTM A653, Type G185 zinc-coated galvanized steel, or equivalent, shall be used.

**Exception:** Plain carbon steel fasteners, including nuts and washers, in SBX/DOT and zinc borate *preservative-treated wood* in an interior, dry environment shall be permitted.

**2304.10.6.2 Fastenings for wood foundations.** Fastenings, including nuts and washers, for wood foundations shall be as required in AWC PWF.

**2304.10.6.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations.** Fasteners, including nuts and washers, for *fire-retardant-treated wood* used in exterior applications or wet or damp locations shall be of hot-dipped zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Staples shall be of stainless steel. Fasteners other than nails, staples, timber rivets, wood

screws and lag screws shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum.

**2304.10.6.4 Fasteners for fire-retardant-treated wood used in interior applications.** Fasteners, including nuts and washers, for *fire-retardant-treated wood* used in interior locations shall be in accordance with the manufacturer's recommendations. In the absence of manufacturer's recommendations, Section 2304.10.6.3 shall apply.

**2304.10.7 Load path.** Where wall framing members are not continuous from the foundation sill to the roof, the members shall be secured to ensure a continuous *load* path. Where required, sheet metal clamps, ties or clips shall be formed of galvanized steel or other *approved* corrosion-resistant material not less than 0.0329-inch (0.836 mm) base metal thickness.

**2304.10.8 Framing requirements.** Wood columns and posts shall be framed to provide full end bearing. Alternatively, column-and-post end connections shall be designed to resist the full compressive *loads*, neglecting end-bearing capacity. Column-and-post end connections shall be fastened to resist lateral and net induced uplift forces.

**2304.11 Heavy timber construction.** Where a structure, portion thereof or individual structural elements are required by provisions of this code to be of heavy timber, the *building elements* therein shall comply with the applicable provisions of Sections 2304.11.1 through 2304.11.4. Minimum dimensions of heavy timber shall comply with the applicable



requirements in Table 2304.11 based on roofs or floors supported and the configuration of each structural element, or in Sections 2304.11.2 through 2304.11.4. Lumber decking shall be in accordance with Section 2304.9.

#### 2304.11.1 Details of heavy timber structural members.

Heavy timber structural members shall be detailed and constructed in accordance with Sections 2304.11.1 through 2304.11.1.3.

**2304.11.1.1 Columns.** Minimum dimensions of columns shall be in accordance with Table 2304.11. Columns shall be continuous or superimposed throughout all stories and connected in an *approved* manner. Girders and beams at column connections shall be closely fitted around columns and adjoining ends shall be cross tied to each other, or intertied by caps or ties, to transfer horizontal *loads* across joints. Wood bolsters shall not be placed on tops of columns unless the columns support roof *loads* only. Where traditional heavy timber detailing is used, connections shall be by means of reinforced concrete or metal caps with brackets, by properly designed steel or iron caps, with pintles and base plates, by timber splice plates affixed to the columns by metal connectors housed within the contact faces, or by other *approved* methods.

**2304.11.1.2 Floor framing.** Minimum dimensions of floor framing shall be in accordance with Table 2304.11. *Approved* wall plate boxes or hangers shall be provided where wood beams, girders or trusses rest on masonry or concrete walls. Where intermediate beams are used to support a floor, they shall rest on top of girders, or shall be supported by an *approved* metal

hanger into which the ends of the beams shall be closely fitted. Where traditional heavy timber detailing is used, these connections shall be permitted to be supported by ledgers or blocks securely fastened to the sides of the girders.

**2304.11.1.3 Roof framing.** Minimum dimensions of roof framing shall be in accordance with Table 2304.11. Every roof girder and not less than every alternate roof beam shall be anchored to its supporting member to resist forces as required in Chapter 16.

**2304.11.2 Partitions and walls.** Partitions and walls shall comply with Section 2304.11.2.1 or 2304.11.2.2.

**2304.11.2.1 Exterior walls.** *Exterior walls* shall be permitted to be *cross-laminated timber* not less than 4 inches (102 mm) in thickness meeting the requirements of Section 2303.1.4.

**2304.11.2.2 Interior walls and partitions.** Interior walls and partitions shall be of solid wood construction formed by not less than two layers of 1-inch (25 mm) matched boards or laminated construction 4 inches (102 mm) thick, or of 1-hour fire-resistance-rated construction.

**2304.11.3 Floors.** Floors shall be without concealed spaces or with concealed spaces complying with Section 602.4.4.3. Wood floors shall be constructed in accordance with Section 2304.11.3.1 or 2304.11.3.2.

**2304.11.3.1 Cross-laminated timber floors.** *Cross-laminated timber* shall be not less than 4 inches (102 mm) in actual thickness. *Cross-laminated timber* shall be continuous from support to support and mechanically fastened to one another. *Cross-laminated timber*

TABLE 2304.11  
MINIMUM DIMENSIONS OF HEAVY TIMBER STRUCTURAL MEMBERS

SUPPORTING	HEAVY TIMBER STRUCTURAL ELEMENTS	MINIMUM NOMINAL SOLID SAWN SIZE		MINIMUM GLUED- LAMINATED NET SIZE		MINIMUM STRUCTURAL COMPOSITE LUMBER NET SIZE	
		Width, inch	Depth, inch	Width, inch	Depth, inch	Width, inch	Depth, inch
Floor loads only or combined floor and roof loads	Columns; Framed sawn or glued-laminated timber arches that spring from the floor line; Framed timber trusses	8	8	6 <sup>3</sup> / <sub>4</sub>	8 <sup>1</sup> / <sub>4</sub>	7	7 <sup>1</sup> / <sub>2</sub>
	Wood beams and girders	6	10	5	10 <sup>1</sup> / <sub>2</sub>	5 <sup>1</sup> / <sub>4</sub>	9 <sup>1</sup> / <sub>2</sub>
Roof loads only	Columns (roof and ceiling loads); Lower half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	8	5	8 <sup>1</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>4</sub>	7 <sup>1</sup> / <sub>2</sub>
	Upper half of: wood-frame or glued-laminated arches that spring from the floor line or from grade	6	6	5	6	5 <sup>1</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub>
	Framed timber trusses and other roof framing; <sup>a</sup> Framed or glued-laminated arches that spring from the top of walls or wall abutments	4 <sup>b</sup>	6	3 <sup>b</sup>	6 <sup>7</sup> / <sub>8</sub>	3 <sup>1</sup> / <sub>2</sub> <sup>b</sup>	5 <sup>1</sup> / <sub>2</sub>

For SI: 1 inch = 25.4 mm.

- Spaced members shall be permitted to be composed of two or more pieces not less than 3 inches nominal in thickness where blocked solidly throughout their intervening spaces or where spaces are tightly closed by a continuous wood cover plate of not less than 2 inches nominal in thickness secured to the underside of the members. Splice plates shall be not less than 3 inches nominal in thickness.
- Where protected by approved automatic sprinklers under the roof deck, framing members shall be not less than 3 inches nominal in width.

## WOOD

shall be permitted to be connected to walls without a shrinkage gap providing swelling or shrinking is considered in the design. Corbelling of masonry walls under the floor shall be permitted to be used.

**2304.11.3.2 Sawn or glued-laminated plank floors.** Sawn or glued-laminated plank floors shall be one of the following:

1. Sawn or glued-laminated planks, splined or tongue-and-groove, of not less than 3 inches (76 mm) nominal in thickness covered with 1-inch (25 mm) nominal dimension tongue-and-groove flooring, laid crosswise or diagonally,  $15/32$ -inch (12 mm) *wood structural panel* or  $1/2$ -inch (12.7 mm) *particleboard*.
2. Planks not less than 4 inches (102 mm) nominal in width set on edge close together and well spiked and covered with 1-inch (25 mm) nominal dimension flooring or  $15/32$ -inch (12 mm) *wood structural panel* or  $1/2$ -inch (12.7 mm) *particleboard*.

The lumber shall be laid so that continuous lines of joints will occur only at points of support. Floors shall not extend closer than  $1/2$  inch (12.7 mm) to walls. Such  $1/2$ -inch (12.7 mm) space shall be covered by a molding fastened to the wall and so arranged that it will not obstruct the swelling or shrinkage movements of the floor. Corbelling of masonry walls under the floor shall be permitted to be used in place of molding.

**2304.11.4 Roof decks.** Roofs shall be without concealed spaces or with concealed spaces complying with Section 602.4.4.3. Roof decks shall be constructed in accordance with Section 2304.11.4.1 or 2304.11.4.2. Other types of decking shall be an alternative that provides equivalent *fire resistance* and structural properties. Where supported by a wall, *roof decks* shall be anchored to walls to resist forces determined in accordance with Chapter 16. Such anchors shall consist of steel bolts, lags, screws or *approved hardware* of sufficient strength to resist prescribed forces.

**2304.11.4.1 Cross-laminated timber roofs.** *Cross-laminated timber* roofs shall be not less than 3 inches (76 mm) nominal in thickness and shall be continuous from support to support and mechanically fastened to one another.

**2304.11.4.2 Sawn, wood structural panel, or glued-laminated plank roofs.** Sawn, *wood structural panel*, or glued-laminated plank roofs shall be one of the following:

1. Sawn or glued laminated, splined or tongue-and-groove plank, not less than 2 inches (51 mm) nominal in thickness.
2.  $1\frac{1}{8}$ -inch-thick (32 mm) *wood structural panel* (exterior glue).
3. Planks not less than 3 inches (76 mm) nominal in width, set on edge close together and laid as required for floors.

**2304.12 Protection against decay and termites.** Wood shall be protected from decay and termites in accordance with the applicable provisions of Sections 2304.12.1 through 2304.12.4.

**2304.12.1 Locations requiring waterborne preservatives or naturally durable wood.** Wood used above ground in the locations specified in Sections 2304.12.1.1 through 2304.12.1.5 shall be *naturally durable wood* or *preservative-treated wood* using waterborne preservatives, in accordance with AWP A U1 for above-ground use.

**2304.12.1.1 Joists, girders and subfloor.** Wood joists or wood structural floors that are closer than 18 inches (457 mm) or wood girders that are closer than 12 inches (305 mm) to the exposed ground in crawl spaces or unexcavated areas located within the perimeter of the building foundation shall be of naturally durable or *preservative-treated wood*.

**2304.12.1.2 Wood supported by exterior foundation walls.** Wood framing members, including wood sheathing, that are in contact with exterior foundation walls and are less than 8 inches (203 mm) from exposed earth shall be of naturally durable or *preservative-treated wood*.

**2304.12.1.3 Exterior walls below grade.** Wood framing members and furring strips in direct contact with the interior of exterior masonry or concrete walls below grade shall be of naturally durable or *preservative-treated wood*.

**2304.12.1.4 Sleepers and sills.** Sleepers and sills on a concrete or masonry slab that is in direct contact with earth shall be of naturally durable or *preservative-treated wood*.

**2304.12.1.5 Wood siding.** Clearance between wood siding and earth on the exterior of a building shall be not less than 6 inches (152 mm) or less than 2 inches (51 mm) vertical from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather except where siding, sheathing and wall framing are of naturally durable or *preservative-treated wood*.

**2304.12.2 Other locations.** Wood used in the locations specified in Sections 2304.12.2.1 through 2304.12.2.8 shall be *naturally durable wood* or *preservative-treated wood* in accordance with AWP A U1. *Preservative-treated wood* used in interior locations shall be protected with two coats of urethane, shellac, latex epoxy or varnish unless waterborne preservatives are used. Prior to application of the protective finish, the wood shall be dried in accordance with the manufacturer's recommendations.

**2304.12.2.1 Girder ends.** The ends of wood girders entering exterior masonry or concrete walls shall be provided with a  $1/2$ -inch (12.7 mm) airspace on top, sides and end, unless naturally durable or *preservative-treated wood* is used.

**2304.12.2.2 Posts or columns.** Posts or columns supporting permanent structures and supported by a

concrete or masonry slab or footing that is in direct contact with the earth shall be of naturally durable or *preservative-treated wood*.

**Exception:** Posts or columns that meet all of the following:

1. Are not exposed to the weather, or are protected by a roof, eave, overhang, or other covering if exposed to the weather.
2. Are supported by concrete piers or metal pedestals projected not less than 1 inch (25 mm) above the slab or deck and are separated from the concrete pier by an impervious moisture barrier.
3. Are located not less than 8 inches (203 mm) above exposed earth.

**2304.12.2.3 Supporting member for permanent appurtenances.** Naturally durable or *preservative-treated wood* shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering to prevent moisture or water accumulation on the surface or at joints between members.

**Exception:** Sawn lumber in buildings located in a geographical region where experience has demonstrated that climatic conditions preclude the need to use durable materials where the structure is exposed to the weather.

**2304.12.2.4 Supporting members for permeable floors and roofs.** Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or *preservative-treated wood* unless separated from such floors or roofs by an impervious moisture barrier. The impervious moisture barrier system protecting the structure supporting floors shall provide positive drainage of water that infiltrates the moisture-permeable floor topping.

**2304.12.2.5 Ventilation beneath balcony or elevated walking surfaces.** Enclosed framing in exterior balconies and elevated walking surfaces that have *weather-exposed surfaces* shall be provided with openings that provide a net free cross-ventilation area not less than  $\frac{1}{150}$  of the area of each separate space.

**2304.12.2.6 Wood in contact with the ground or fresh water.** Wood used in contact with exposed earth shall be naturally durable for both decay and termite resistance or preservative treated in accordance with AWP A U1 for soil or fresh water use.

**Exception:** Untreated wood is permitted where such wood is continuously and entirely below the ground-water level or submerged in fresh water.

**2304.12.2.6.1 Posts or columns.** Posts and columns that are supporting permanent structures and embed-

ded in concrete that is exposed to the weather or in direct contact with the earth shall be of *preservative-treated wood*.

**2304.12.2.7 Termite protection.** In geographical areas where hazard of termite damage is known to be very heavy, wood floor framing in the locations specified in Section 2304.12.1.1 and exposed framing of exterior decks or balconies shall be of *naturally durable species (termite resistant)* or preservative treated in accordance with AWP A U1 for the species, product preservative and end use or provided with *approved* methods of termite protection.

**2304.12.2.8 Wood used in retaining walls and cribs.** Wood installed in retaining or crib walls shall be preservative treated in accordance with AWP A U1 for soil and fresh water use.

**2304.12.3 Attic ventilation.** For *attic* ventilation, see Section 1202.2.2.

**2304.12.4 Under-floor ventilation (crawl space).** For under-floor ventilation (crawl space), see Section 1202.4.

**2304.13 Long-term loading.** Wood members supporting concrete, masonry or similar materials shall be checked for the effects of long-term loading using the provisions of the ANSI/AWC NDS. The total deflection, including the effects of long-term loading, shall be limited in accordance with Section 1604.3.1 for these supported materials.

**Exception:** Horizontal wood members supporting masonry or concrete nonstructural floor or roof surfacing not more than 4 inches (102 mm) thick need not be checked for long-term loading.

## SECTION 2305

### GENERAL DESIGN REQUIREMENTS FOR LATERAL FORCE-RESISTING SYSTEMS

**2305.1 General.** Structures using wood-frame *shear walls* or wood-frame *diaphragms* to resist wind, seismic or other lateral loads shall be designed and constructed in accordance with AWC SDPWS and the applicable provisions of Sections 2305, 2306 and 2307.

**2305.1.1 Openings in shear panels.** Openings in shear panels that materially affect their strength shall be detailed on the plans and shall have their edges adequately reinforced to transfer all shearing stresses.

**2305.2 Diaphragm deflection.** The deflection of wood-frame *diaphragms* shall be determined in accordance with AWC SDPWS. The deflection ( $\Delta_{dia}$ ) of a blocked *wood structural panel* diaphragm uniformly fastened throughout with staples is permitted to be calculated in accordance with Equation 23-1. If not uniformly fastened, the constant 0.188 (For SI: 1/1627) in the third term shall be modified by an approved method.

$$\Delta_{dia} = 5vL^3/8EAW + vL/4Gt + 0.188Le_n + \Sigma(x\Delta_c)/2W \quad \text{(Equation 23-1)}$$

$$\text{For SI: } \Delta_{dia} = 0.052vL^3/EAW + vL/4Gt + Le_n/1627 + \Sigma(x\Delta_c)/2W$$

## WOOD

where:

$A$  = Area of chord cross section, in square inches ( $\text{mm}^2$ ).

$E$  = Modulus of elasticity of *diaphragm* chords, in pounds per square inch ( $\text{N/mm}^2$ ).

$e_n$  = Staple slip, in inches (mm) [see Table 2305.2(1)].

$Gt$  = Panel rigidity through the thickness, in pounds per inch ( $\text{N/mm}$ ) of panel width or depth [see Table 2305.2(2)].

$L$  = *Diaphragm* length (dimension perpendicular to the direction of the applied *load*), in feet (mm).

$v$  = Induced unit shear in pounds per linear foot (plf) ( $\text{N/mm}$ ).

$W$  = *Diaphragm* width [in the direction of applied force, in feet (mm)].

$x$  = Distance from chord splice to nearest support, in feet (mm).

$\Delta_c$  = *Diaphragm* chord splice slip at the induced unit shear, in inches (mm).

$\Delta_{\text{dia}}$  = Maximum mid-span *diaphragm* deflection determined by elastic analysis, in inches (mm).

**TABLE 2305.2(1)**  
 **$e_n$  VALUES (inches) FOR USE IN CALCULATING DIAPHRAGM AND SHEAR WALL DEFLECTION DUE TO FASTENER SLIP (Structural I)<sup>a, c</sup>**

LOAD PER FASTENER <sup>b</sup> (pounds)	FASTENER DESIGNATIONS
	14-Ga staple x 2 inches long
60	0.011
80	0.018
100	0.028
120	0.04
140	0.053
160	0.068

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N.

a. Increase  $e_n$  values 20 percent for plywood grades other than Structural I.

b. Load per fastener = maximum shear per foot divided by the number of fasteners per foot at interior panel edges.

c. Decrease  $e_n$  values 50 percent for seasoned lumber (moisture content < 19 percent).

**TABLE 2305.2(2)**  
**VALUES OF  $Gt$  FOR USE IN CALCULATING DEFLECTION OF WOOD STRUCTURAL PANEL SHEAR WALLS AND DIAPHRAGMS**

PANEL TYPE	SPAN RATING	VALUES OF $Gt$ (lb/in. panel depth or width)							
		Structural Sheathing				Structural I			
		Plywood			OSB	Plywood			OSB
		3-ply	4-ply	5-ply <sup>a</sup>		3-ply	4-ply	5-ply <sup>a</sup>	
Sheathing	24/0	25,000	32,500	37,500	77,500	32,500	42,500	41,500	77,500
	24/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	32/16	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	40/20	28,500	37,000	43,000	88,500	37,000	48,000	47,500	88,500
	48/24	31,000	40,500	46,500	96,000	40,500	52,500	51,000	96,000
Single Floor	16 o.c.	27,000	35,000	40,500	83,500	35,000	45,500	44,500	83,500
	20 o.c.	28,000	36,500	42,000	87,000	36,500	47,500	46,000	87,000
	24 o.c.	30,000	39,000	45,000	93,000	39,000	50,500	49,500	93,000
	32 o.c.	36,000	47,000	54,000	110,000	47,000	61,000	59,500	110,000
	48 o.c.	50,500	65,500	76,000	155,000	65,500	85,000	83,500	155,000

	Thickness (in.)	Structural Sheathing			Structural I		
		A-A, A-C	Marine	All Other Grades	A-A, A-C	Marine	All Other Grades
Sanded Plywood	1/4	24,000	31,000	24,000	31,000	31,000	31,000
	11/32	25,500	33,000	25,500	33,000	33,000	33,000
	3/8	26,000	34,000	26,000	34,000	34,000	34,000
	15/32	38,000	49,500	38,000	49,500	49,500	49,500
	1/2	38,500	50,000	38,500	50,000	50,000	50,000
	19/32	49,000	63,500	49,000	63,500	63,500	63,500
	5/8	49,500	64,500	49,500	64,500	64,500	64,500
	23/32	50,500	65,500	50,500	65,500	65,500	65,500
	3/4	51,000	66,500	51,000	66,500	66,500	66,500
	7/8	52,500	68,500	52,500	68,500	68,500	68,500
	1	73,500	95,500	73,500	95,500	95,500	95,500
	1 1/8	75,000	97,500	75,000	97,500	97,500	97,500

For SI: 1 inch = 25.4 mm, 1 pound/inch = 0.1751 N/mm.

a. 5-ply applies to plywood with five or more layers. For 5-ply plywood with three layers, use values for 4-ply panels.



**2305.3 Shear wall deflection.** The deflection of wood-frame *shear walls* shall be determined in accordance with AWC SDPWS. The deflection ( $\Delta_{sw}$ ) of a blocked *wood structural panel* shear wall uniformly fastened throughout with staples is permitted to be calculated in accordance with Equation 23-2.

$$\Delta_{sw} = 8vh^3/EAb + vh/4Gt + 0.75he_n + d_a h/b \quad (\text{Equation 23-2})$$

$$\text{For SI: } \Delta_{sw} = vh^3/3EAb + vh/Gt + \frac{he_n}{407.6} + d_a h/b$$

where:

$A$  = Area of end-post cross section in square inches (mm<sup>2</sup>).

$b$  = Shear wall length, in feet (mm).

$d_a$  = Total vertical elongation of wall anchorage system (such as fastener slip, device elongation, rod elongation) in inches (mm), at the induced unit shear in the shear wall ( $v$ ).

$E$  = Modulus of elasticity of end posts, in pounds per square inch (N/mm<sup>2</sup>).

$e_n$  = Staple slip, in inches (mm) [see Table 2305.2(1)].

$Gt$  = Panel rigidity through the thickness, in pounds per inch (N/mm) of panel width or depth [see Table 2305.2(2)].

$h$  = *Shear wall* height, in feet (mm).

$v$  = Induced unit shear, in pounds per linear foot (N/mm).

$\Delta_{sw}$  = Maximum *shear wall* deflection determined by elastic analysis, in inches (mm).

## SECTION 2306 ALLOWABLE STRESS DESIGN

**2306.1 Allowable stress design.** The design and construction of wood elements in structures using *allowable stress design* shall be in accordance with the following applicable standards:

**2306.1.1 Joists and rafters.** The design of rafter spans is permitted to be in accordance with the AWC STJR.

**2306.1.2 Plank and beam flooring.** The design of plank and beam flooring is permitted to be in accordance with the AWC Wood Construction Data No. 4.

**2306.1.3 Treated wood stress adjustments.** The allowable unit stresses for *preservative-treated wood* need not be adjusted for treatment, but are subject to other adjustments.

The allowable unit stresses for *fire-retardant-treated wood*, including fastener values, shall be developed from an *approved* method of investigation that considers the effects of anticipated temperature and humidity to which the *fire-retardant-treated wood* will be subjected, the type of treatment and the redrying process. Other adjustments are applicable except that the *impact load* duration shall not apply.

**2306.1.4 Lumber decking.** The capacity of lumber decking arranged according to the patterns described in Section 2304.9.2 shall be the lesser of the capacities determined for moment and deflection according to the formulas in Table 2306.1.4.

**TABLE 2306.1  
STANDARDS FOR DESIGN AND  
CONSTRUCTION OF WOOD ELEMENTS  
IN STRUCTURES USING ALLOWABLE STRESS DESIGN**

STANDARDS PROMULGATOR	STANDARD	TITLE
<b>American Wood Council</b>		
	ANSI/AWC NDS	National Design Specification for Wood Construction
	SDPWS	Special Design Provisions for Wind and Seismic
<b>American Society of Agricultural and Biological Engineers</b>		
	ASABE EP 484.3	Diaphragm Design of Metal-clad, Wood-Frame Rectangular Buildings
	ASABE EP 486.3	Shallow Post and Pier Foundation Design
	ASABE EP 559.1	Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies
<b>APA—The Engineered Wood Association</b>		
	ANSI 117	Standard Specifications for Structural Glued Laminated Timber of Softwood Species
	ANSI A190.1	Structural Glued Laminated Timber
		Panel Design Specification
		Plywood Design Specification Supplement 1—Design & Fabrication of Plywood Curved Panel
		Plywood Design Specification Supplement 2—Design & Fabrication of Glued Plywood-lumber Beams
		Plywood Design Specification Supplement 3—Design & Fabrication of Plywood Stressed-skin Panels
		Plywood Design Specification Supplement 4—Design & Fabrication of Plywood Sandwich Panels
		Plywood Design Specification Supplement 5—Design & Fabrication of All-plywood Beams
	APA T300	Glulam Connection Details
	APA S560	Field Notching and Drilling of Glued Laminated Timber Beams
	APA S475	Glued Laminated Beam Design Tables
	APA X450	Glulam in Residential Construction
	APA X440	Product and Application Guide: Glulam
	APA R540	Builders Tips: Proper Storage and Handling of Glulam Beams
<b>Truss Plate Institute, Inc.</b>		
	TPI 1	National Design Standard for Metal Plate Connected Wood Truss Construction
<b>West Coast Lumber Inspection Bureau</b>		
	AITC 104	Typical Construction Details
	AITC 110	Standard Appearance Grades for Structural Glued Laminated Timber
	AITC 113	Standard for Dimensions of Structural Glued Laminated Timber
	AITC 119	Standard Specifications for Structural Glued Laminated Timber of Hardwood Species
	AITC 200	Inspection Manual

**TABLE 2306.1.4**  
**ALLOWABLE LOADS FOR LUMBER DECKING**

PATTERN	ALLOWABLE AREA LOAD <sup>a</sup>	
	Moment	Deflection
Simple span	$w_b = \frac{8F_b'd^2}{l^2 6}$	$w_\Delta = \frac{384\Delta E'd^3}{5l^4 12}$
Two-span continuous	$w_b = \frac{8F_b'd^2}{l^2 6}$	$w_\Delta = \frac{185\Delta E'd^3}{l^4 12}$
Combination simple- and two-span continuous	$w_b = \frac{8F_b'd^2}{l^2 6}$	$w_\Delta = \frac{131\Delta E'd^3}{l^4 12}$
Cantilevered pieces intermixed	$w_b = \frac{20F_b'd^2}{3l^2 6}$	$w_\Delta = \frac{105\Delta E'd^3}{l^4 12}$
<b>Controlled random layout</b>		
Mechanically laminated decking	$w_b = \frac{20F_b'd^2}{3l^2 6}$	$w_\Delta = \frac{100\Delta E'd^3}{l^4 12}$
2-inch decking	$w_b = \frac{20F_b'd^2}{3l^2 6}$	$w_\Delta = \frac{100\Delta E'd^3}{l^4 12}$
3-inch and 4-inch decking	$w_b = \frac{8F_b'd^2}{l^2 6}$	$w_\Delta = \frac{116\Delta E'd^3}{l^4 12}$

For SI: 1 inch = 25.4 mm.

a.  $w_b$  = Allowable total uniform load limited by moment.

$w_\Delta$  = Allowable total uniform load limited by deflection.

$d$  = Actual decking thickness.

$l$  = Span of decking.

$F_b'$  = Allowable bending stress adjusted by applicable factors.

$E'$  = Modulus of elasticity adjusted by applicable factors.

**2306.2 Wood-frame diaphragms.** Wood-frame *diaphragms* shall be designed and constructed in accordance with AWC SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AWC SDPWS shall be met and the allowable shear values set forth in Table 2306.2(1) or 2306.2(2) shall be permitted. The allowable shear values in Tables 2306.2(1) and 2306.2(2) are permitted to be increased 40 percent for wind design.

**2306.2.1 Gypsum board diaphragm ceilings.** *Gypsum board diaphragm* ceilings shall be in accordance with Section 2508.6.

**2306.3 Wood-frame shear walls.** Wood-frame *shear walls* shall be designed and constructed in accordance with AWC SDPWS. Where panels are fastened to framing members with staples, requirements and limitations of AWC SDPWS shall be met and the allowable shear values set forth in Table 2306.3(1), 2306.3(2) or 2306.3(3) shall be permitted. The allowable shear values in Tables 2306.3(1) and 2306.3(2) are permitted to be increased 40 percent for wind design. Panels complying with ANSI/APA PRP-210 shall be permitted to use design values for Plywood Siding in the AWC SDPWS.

## SECTION 2307

### LOAD AND RESISTANCE FACTOR DESIGN

**2307.1 Load and resistance factor design.** The design and construction of wood elements and structures using *load and resistance factor design* shall be in accordance with ANSI/AWC NDS and AWC SDPWS.

## SECTION 2308

### CONVENTIONAL LIGHT-FRAME CONSTRUCTION

**2308.1 General.** The requirements of this section are intended for *conventional light-frame construction*. Other construction methods are permitted to be used, provided that a satisfactory design is submitted showing compliance with other provisions of this code. Interior nonload-bearing partitions, ceilings and curtain walls of *conventional light-frame construction* are not subject to the limitations of Section 2308.2. Detached one- and two-family dwellings and townhouses not more than three *stories above grade plane* in height with a separate *means of egress* and their accessory structures shall comply with the *International Residential Code*.

**2308.1.1 Portions exceeding limitations of conventional light-frame construction.** Where portions of a building of otherwise *conventional light-frame construction* exceed the limits of Section 2308.2, those portions and the supporting load path shall be designed in accordance with accepted engineering practice and the provisions of this code. For the purposes of this section, the term “portions” shall mean parts of buildings containing volume and area such as a room or a series of rooms. The extent of such design need only demonstrate compliance of the nonconventional light-framed elements with other applicable provisions of this code and shall be compatible with the performance of the conventional light-framed system.

**2308.1.2 Connections and fasteners.** Connectors and fasteners used in conventional construction shall comply with the requirements of Section 2304.10.

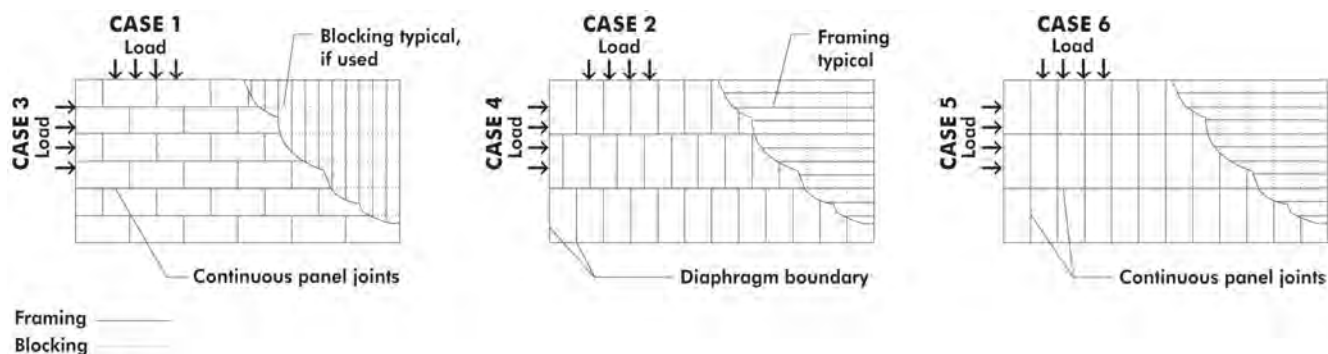
**2308.2 Limitations.** Buildings are permitted to be constructed in accordance with the provisions of *conventional light-frame construction*, subject to the limitations in Sections 2308.2.1 through 2308.2.6.

**TABLE 2306.2(1)**  
**ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL DIAPHRAGMS**  
**UTILIZING STAPLES WITH FRAMING OF DOUGLAS FIR-LARCH, OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>f</sup>**

PANEL GRADE	STAPLE LENGTH AND GAGE <sup>d</sup>	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBERS AT ADJOINING PANEL EDGES AND BOUNDARIES <sup>e</sup> (inches)	BLOCKED DIAPHRAGMS				UNBLOCKED DIAPHRAGMS	
					Fastener spacing (inches) at diaphragm boundaries (all cases) at continuous panel edges parallel to load (Cases 3, 4), and at all panel edges (Cases 5, 6) <sup>b</sup>				Fasteners spaced 6 inches max. at supported edges <sup>b</sup>	
					6	4	2½ <sup>c</sup>	2 <sup>c</sup>	Case 1 (No unblocked edges or continuous joints parallel to load)	All other configurations (Cases 2, 3, 4, 5 and 6) <sup>g</sup>
					Fastener spacing (inches) at other panel edges (Cases 1, 2, 3 and 4) <sup>b</sup>					
					6	6	4	3		
Structural I grades	1½ 16 gage	1	⅜	2	175	235	350	400	155	115
				3	200	265	395	450	175	130
			15/32	2	175	235	350	400	155	120
				3	200	265	395	450	175	130
Sheathing, single floor and other grades covered in DOC PS 1 and PS 2	1½ 16 gage	1	⅜	2	160	210	315	360	140	105
				3	180	235	355	400	160	120
			7/16	2	165	225	335	380	150	110
				3	190	250	375	425	165	125
			15/32	2	160	210	315	360	140	105
				3	180	235	355	405	160	120
			19/32	2	175	235	350	400	155	115
				3	200	265	395	450	175	130

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- a. For framing of other species: (1) Find specific gravity for species of lumber in ANSI/AWC NDS. (2) For staples find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- b. Space fasteners maximum 12 inches on center along intermediate framing members (6 inches on center where supports are spaced 48 inches on center).
- c. Framing at adjoining panel edges shall be 3 inches nominal or wider.
- d. Staples shall have a minimum crown width of 7/16 inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- e. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- f. For shear loads of normal or permanent load duration as defined by the ANSI/AWC NDS, the values in the table shall be multiplied by 0.63 or 0.56, respectively.
- g. For Case 1 through 6 descriptions see Figure 2306.2(1).



**FIGURE 2306.2(1)**  
**CASES 1 THROUGH 6 FOR USE WITH TABLE 2306.2(1)**

## WOOD

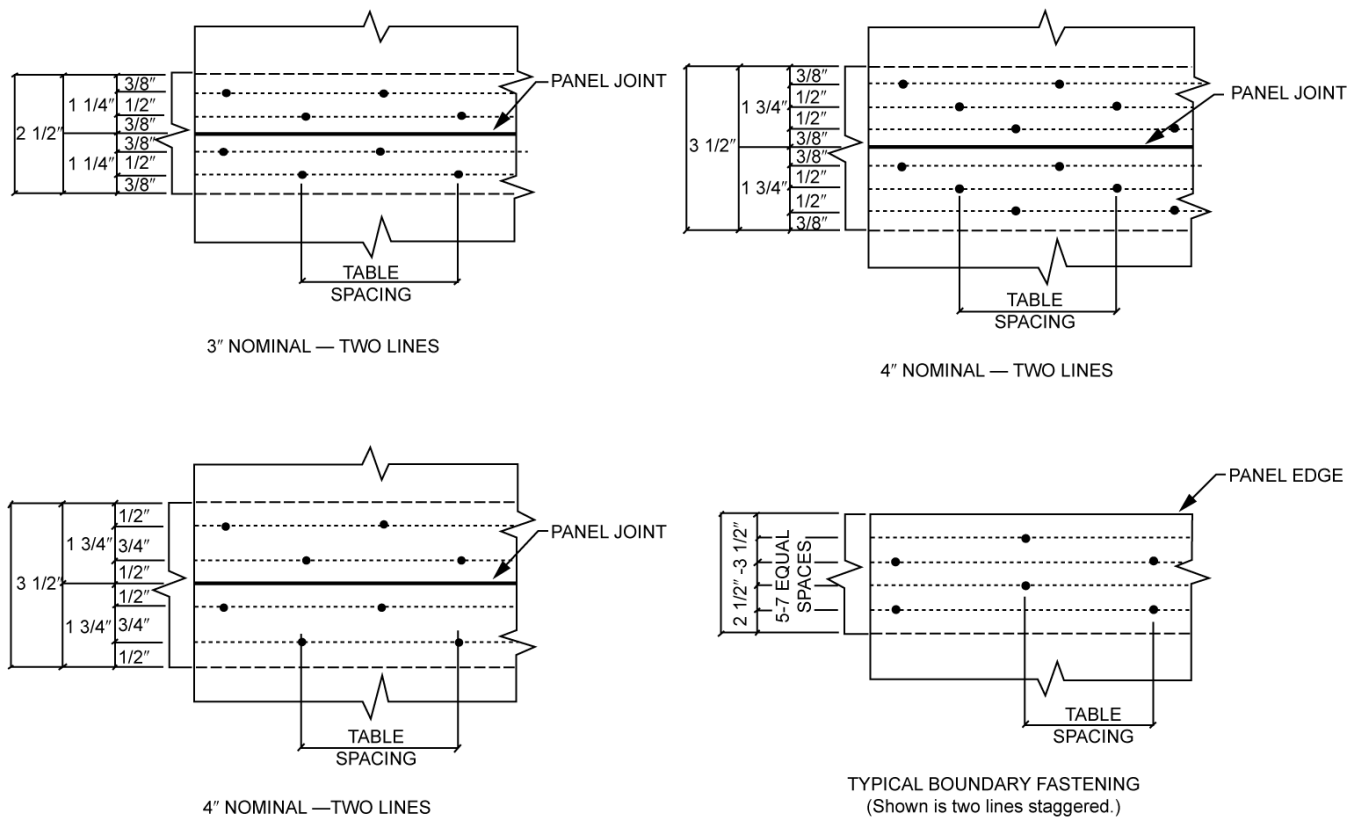
**TABLE 2306.2(2)**  
**ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL BLOCKED DIAPHRAGMS**  
**UTILIZING MULTIPLE ROWS OF STAPLES (HIGH-LOAD DIAPHRAGMS) WITH FRAMING OF**  
**DOUGLAS FIR-LARCH OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>b, g, h</sup>**

PANEL GRADE <sup>c</sup>	STAPLE GAGE <sup>f</sup>	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM NOMINAL WIDTH OF FRAMING MEMBER AT ADJOINING PANEL EDGES AND BOUNDARIES <sup>e</sup>	LINES OF FASTENERS	BLOCKED DIAPHRAGMS					
						Cases 1 and 2 <sup>d</sup>					
						Fastener Spacing Per Line at Boundaries (inches) <sup>i</sup>					
						4	2 1/2	2			
						Fastener Spacing Per Line at Other Panel Edges (inches) <sup>i</sup>					
						6	4	4	3	3	2
Structural I grades	14 gage staples	2	15/32	3	2	600	600	860	960	1,060	1,200
				4	3	860	900	1,160	1,295	1,295	1,400
			19/32	3	2	600	600	875	960	1,075	1,200
				4	3	875	900	1,175	1,440	1,475	1,795
Sheathing single floor and other grades covered in DOC PS 1 and PS 2	14 gage staples	2	15/32	3	2	540	540	735	865	915	1,080
				4	3	735	810	1,005	1,105	1,105	1,195
			19/32	3	2	600	600	865	960	1,065	1,200
				4	3	865	900	1,130	1,430	1,370	1,485
			23/32	4	3	865	900	1,130	1,490	1,430	1,545

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of framing lumber in ANSI/AWC NDS. (2) For staples, find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Fastening along intermediate framing members: Space fasteners not greater than 12 inches on center, except 6 inches on center for spans greater than 32 inches.
- Panels conforming to DOC PS 1 or PS 2.
- This table gives shear values for Cases 1 and 2 as shown in Table 2306.2(1). The values shown are applicable to Cases 3, 4, 5 and 6 as shown in Table 2306.2(1), providing fasteners at all continuous panel edges are spaced in accordance with the boundary fastener spacing.
- The minimum nominal depth of framing members shall be 3 inches nominal. The minimum nominal width of framing members not located at boundaries or adjoining panel edges shall be 2 inches.
- Staples shall have a minimum crown width of 7/16 inch, and shall be installed with their crowns parallel to the long dimension of the framing members.
- High-load diaphragms shall be subject to special inspection in accordance with Section 1705.5.1.
- For shear loads of normal or permanent load duration as defined by the ANSI/AWC NDS, the values in the table shall be multiplied by 0.63 or 0.56, respectively.
- For fastener spacing diagrams see Figure 2306.2(2).





NOTE: SPACE PANEL END AND EDGE JOINT 1/8-INCH. REDUCE SPACING BETWEEN LINES OF NAILS AS NECESSARY TO MAINTAIN MINIMUM 3/8-INCH FASTENER EDGE MARGINS, MINIMUM SPACING BETWEEN LINES IS 3/8-INCH

For SI: 1 inch = 25.4 mm.

FIGURE 2306.2(2)  
FASTENER SPACING DIAGRAMS FOR USE WITH TABLE 2306.2(2)

## WOOD

**TABLE 2306.3(1)**  
**ALLOWABLE SHEAR VALUES (POUNDS PER FOOT) FOR WOOD STRUCTURAL PANEL SHEAR WALLS UTILIZING STAPLES WITH**  
**FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE<sup>a</sup> FOR WIND OR SEISMIC LOADING<sup>b, f, g, i</sup>**

PANEL GRADE	MINIMUM NOMINAL PANEL THICKNESS (inch)	MINIMUM FASTENER PENETRATION IN FRAMING (inches)	PANELS APPLIED DIRECT TO FRAMING					PANELS APPLIED OVER 1/2" OR 5/8" GYPSUM SHEATHING					
				Staple length and gage <sup>h</sup> (inches)	Fastener spacing at panel edges (inches)				Staple length and gage <sup>h</sup> (inches)	Fastener spacing at panel edges (inches)			
					6	4	3	2 <sup>d</sup>		6	4	3	2 <sup>d</sup>
Structural I sheathing	3/8	1	1½ 16 Gage	155	235	315	400	2 16 Gage	155	235	310	400	
	7/16			170	260	345	440		155	235	310	400	
	15/32			185	280	375	475		155	235	300	400	
Sheathing, plywood siding <sup>c</sup> except Group 5 Species, ANSI/APA PRP 210siding <sup>c</sup>	5/16 <sup>c</sup> or 1/4 <sup>c</sup>	1	1½ 16 Gage	145	220	295	375	2 16 Gage	110	165	220	285	
	3/8			140	210	280	360		140	210	280	360	
	7/16			155	230	310	395		140	210	280	360	
	15/32			170	255	335	430		140	210	280	360	
	19/32		1¾ 16 Gage	185	280	375	475	—	—	—	—	—	

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- For framing of other species: (1) Find specific gravity for species of lumber in ANSI/AWC NDS. (2) For staples find shear value from table for Structural I panels (regardless of actual grade) and multiply value by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Panel edges backed with 2-inch nominal or wider framing. Install panels either horizontally or vertically. Space fasteners maximum 6 inches on center along intermediate framing members for 3/8-inch and 7/16-inch panels installed on studs spaced 24 inches on center. For other conditions and panel thickness, space fasteners maximum 12 inches on center on intermediate supports.
- 3/8-inch panel thickness or siding with a span rating of 16 inches on center is the minimum recommended where applied directly to framing as exterior siding. For grooved panel siding, the nominal panel thickness is the thickness of the panel measured at the point of fastening.
- Framing at adjoining panel edges shall be 3 inches nominal or wider.
- Values apply to all-veneer plywood. Thickness at point of fastening on panel edges governs shear values.
- Where panels are applied on both faces of a wall and fastener spacing is less than 6 inches on center on either side, panel joints shall be offset to fall on different framing members, or framing shall be 3 inches nominal or thicker at adjoining panel edges.
- In Seismic Design Category D, E or F, where shear design values exceed 350 pounds per linear foot, all framing members receiving edge fastening from abutting panels shall be not less than a single 3-inch nominal member, or two 2-inch nominal members fastened together in accordance with Section 2306.1 to transfer the design shear value between framing members. Wood structural panel joint and sill plate nailing shall be staggered at all panel edges. See AWC SDPWS for sill plate size and anchorage requirements.
- Staples shall have a minimum crown width of 7/16 inch and shall be installed with their crowns parallel to the long dimension of the framing members.
- For shear loads of normal or permanent load duration as defined by the ANSI/AWC NDS, the values in the table shall be multiplied by 0.63 or 0.56, respectively.

**TABLE 2306.3(2)**  
**ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON SHEAR WALLS OF FIBERBOARD SHEATHING BOARD**  
**CONSTRUCTION UTILIZING STAPLES FOR TYPE V CONSTRUCTION ONLY<sup>a, b, c, d, e</sup>**

THICKNESS AND GRADE (inches)	STAPLE GAGE AND DIMENSIONS	ALLOWABLE SHEAR VALUE (pounds per linear foot) STAPLE SPACING AT PANEL EDGES (inches) <sup>a</sup>		
		4	3	2
1/2 or 25/32 Structural	No. 16 gage galvanized staple, 7/16" crown 1 3/4 inches long	150	200	225
	No. 16 gage galvanized staple, 1" crown 1 3/4 inches long	220	290	325

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.

- Fiberboard sheathing shall not be used to brace concrete or masonry walls.
- Panel edges shall be backed with 2-inch or wider framing of Douglas Fir-larch or Southern pine. For framing of other species: (1) Find specific gravity for species of framing lumber in ANSI/AWC NDS. (2) For staples, multiply the shear value from the table by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species.
- Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.
- Fastener shall be spaced 6 inches on center along intermediate framing members.
- Values are not permitted in Seismic Design Category D, E or F.

**TABLE 2306.3(3)**  
**ALLOWABLE SHEAR VALUES FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND**  
**PLASTER OR GYPSUM BOARD WOOD FRAMED WALL ASSEMBLIES UTILIZING STAPLES**

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	STAPLE SPACING <sup>b</sup> MAXIMUM (inches)	SHEAR VALUE <sup>a, c</sup> (plf)	MINIMUM STAPLE SIZE <sup>f, g</sup>
1. Expanded metal or woven wire lath and Portland cement plaster	$\frac{7}{8}$ "	Unblocked	6	180	No. 16 gage galv. staple, $\frac{7}{8}$ " legs
2. Gypsum lath, plain or perforated	$\frac{3}{8}$ " lath and $\frac{1}{2}$ " plaster	Unblocked	5	100	No. 16 gage galv. staple, $1\frac{1}{8}$ " long
3. Gypsum sheathing	$\frac{1}{2}$ " $\times$ 2' $\times$ 8'	Unblocked	4	75	No. 16 gage galv. staple, $1\frac{3}{4}$ " long
	$\frac{1}{2}$ " $\times$ 4'	Blocked <sup>d</sup>	4	175	
		Unblocked	7	100	
4. Gypsum board, gypsum veneer base or water-resistant gypsum backing board	$\frac{1}{2}$ "	Unblocked <sup>d</sup>	7	75	No. 16 gage galv. staple, $1\frac{1}{2}$ " long
		Unblocked <sup>d</sup>	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked <sup>e</sup>	7	125	
		Blocked <sup>e</sup>	4	150	
	$\frac{5}{8}$ "	Unblocked <sup>d</sup>	7	115	No. 16 gage galv. staple, $1\frac{5}{8}$ " long
			4	145	
		Blocked <sup>e</sup>	7	145	
			4	175	
		Blocked <sup>e</sup> Two-ply	Base ply: 9 Face ply: 7	250	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

- These shear walls shall not be used to resist loads imposed by masonry or concrete walls (see AWC SDPWS). Values shown are for short-term loading due to wind or seismic loading. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of ASCE 7. Values shown shall be reduced 25 percent for normal loading.
- Applies to fastening at studs, top and bottom plates and blocking.
- Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.
- Maximum framing spacing of 24 inches on center.
- All edges are blocked, and edge fastening is provided at all supports and all panel edges.
- Staples shall have a minimum crown width of  $\frac{7}{16}$  inch, measured outside the legs, and shall be installed with their crowns parallel to the long dimension of the framing members.
- Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of  $\frac{3}{4}$  inch, measured outside the legs.

**2308.2.1 Stories.** Structures of *conventional light-frame construction* shall be limited in *story* height in accordance with Table 2308.2.1.

**TABLE 2308.2.1**  
**ALLOWABLE STORY HEIGHT**

SEISMIC DESIGN CATEGORY	ALLOWABLE STORY ABOVE GRADE PLANE
A and B	Three stories
C	Two stories
D and E <sup>a</sup>	One story

For SI: 1 inch = 25.4 mm.

- For the purposes of this section, for buildings assigned to Seismic Design Category D or E, cripple walls shall be considered to be a story unless cripple walls are solid blocked and do not exceed 14 inches in height.

**2308.2.2 Allowable floor-to-floor height.** Maximum floor-to-floor height shall not exceed 11 feet, 7 inches (3531 mm). Exterior bearing wall and interior braced

wall heights shall not exceed a stud height of 10 feet (3048 mm).

**2308.2.3 Allowable loads.** *Loads* shall be in accordance with Chapter 16 and shall not exceed the following:

- Average *dead loads* shall not exceed 15 psf (718 N/m<sup>2</sup>) for combined roof and ceiling, *exterior walls*, floors and partitions.

**Exceptions:**

- Subject to the limitations of Section 2308.6.10, stone or masonry *veneer* up to the less of 5 inches (127 mm) thick or 50 pounds per square foot (2395 N/m<sup>2</sup>) and installed in accordance with Chapter 14 is permitted to a height of 30 feet (9144 mm) above a noncombustible foundation, with an additional 8 feet (2439) permitted for *gable ends*.

## WOOD

2. Concrete or masonry fireplaces, heaters and chimneys shall be permitted in accordance with the provisions of this code.
2. *Live loads* shall not exceed 40 psf (1916 N/m<sup>2</sup>) for floors.

**Exception:** *Live loads* for concrete slab-on-ground floors in *Risk Categories I and II* shall be not more than 125 psf.

3. Ground snow *loads* shall not exceed 50 psf (2395 N/m<sup>2</sup>).

**2308.2.4 Basic wind speed.** *V* shall not exceed 130 miles per hour (57 m/s) (3-second gust).

**Exceptions:**

1. *V* shall not exceed 140 mph (63 m/s) (3-second gust) for buildings in Exposure Category B that are not located in a *hurricane-prone region*.
2. Where *V* exceeds 130 mph (3-second gust), the provisions of either AWC WFCM or ICC 600 are permitted to be used.

**2308.2.5 Allowable roof span.** Ceiling joist and rafter framing constructed in accordance with Section 2308.7 and trusses shall not span more than 40 feet (12 192 mm) between points of vertical support. A ridge board in accordance with Section 2308.7 or 2308.7.3.1 shall not be considered a vertical support.

**2308.2.6 Risk category limitation.** The use of the provisions for *conventional light-frame construction* in this section shall not be permitted for *Risk Category IV* buildings assigned to *Seismic Design Category B, C, D or F*.

**2308.3 Foundations and footings.** Foundations and footings shall be designed and constructed in accordance with Chapter 18. Connections to foundations and footings shall comply with this section.

**2308.3.1 Foundation plates or sills.** Foundation plates or sills resting on concrete or masonry foundations shall comply with Section 2304.3.1. Foundation plates or sills shall be bolted or anchored to the foundation with not less than  $\frac{1}{2}$ -inch-diameter (12.7 mm) steel bolts or *approved* anchors spaced to provide equivalent anchorage as the steel bolts. Bolts shall be embedded not less than 7 inches (178 mm) into concrete or masonry. The bolts shall be located in the middle third of the width of the plate. Bolts shall be spaced not more than 6 feet (1829 mm) on center and there shall be not less than two bolts or anchor straps per piece with one bolt or anchor strap located not more than 12 inches (305 mm) or less than 4 inches (102 mm) from each end of each piece. Bolts in sill plates of *braced wall lines* in structures over two stories above grade shall be spaced not more than 4 feet (1219 mm) on center. A properly sized nut and washer shall be tightened on each bolt to the plate.

**2308.3.1.1 Braced wall line sill plate anchorage in Seismic Design Category D.** Sill plates along *braced wall lines* in buildings assigned to *Seismic Design*

*Category D* shall be anchored with not less than  $\frac{1}{2}$ -inch (12.7 mm) diameter anchor bolts with steel plate washers between the foundation sill plate and the nut, or approved anchor straps load-rated in accordance with Section 2304.10.4 and spaced to provide equivalent anchorage. Plate washers shall be not less than 0.229 inch by 3 inches (5.82 mm by 76 mm by 76 mm) in size. The hole in the plate washer is permitted to be diagonally slotted with a width of up to  $\frac{3}{16}$  inch (4.76 mm) larger than the bolt diameter and a slot length not to exceed  $1\frac{3}{4}$  inches (44 mm), provided that a standard cut washer is placed between the plate washer and the nut.

**2308.3.1.2 Braced wall line sill plate anchorage in Seismic Design Category E.** Sill plates along *braced wall lines* in buildings assigned to *Seismic Design Category E* shall be anchored with not less than  $\frac{5}{8}$ -inch diameter (15.9 mm) anchor bolts with steel plate washers between the foundation sill plate and the nut, or approved anchor straps load-rated in accordance with Section 2304.10.4 and spaced to provide equivalent anchorage. Plate washers shall be not less than 0.229 inch by 3 inches (5.82 mm by 76 mm by 76 mm) in size. The hole in the plate washer is permitted to be diagonally slotted with a width of up to  $\frac{3}{16}$  inch (4.76 mm) larger than the bolt diameter and a slot length not to exceed  $1\frac{3}{4}$  inches (44 mm), provided that a standard cut washer is placed between the plate washer and the nut.

**2308.4 Floor framing.** Floor framing shall comply with this section.

**2308.4.1 Girders.** Girders for single-story construction or girders supporting *loads* from a single floor shall be not less than 4 inches by 6 inches (102 mm by 152 mm) for spans 6 feet (1829 mm) or less, provided that girders are spaced not more than 8 feet (2438 mm) on center. Other girders shall be designed to support the *loads* specified in this code. Girder end joints shall occur over supports.

Where a girder is spliced over a support, an adequate tie shall be provided. The ends of beams or girders supported on masonry or concrete shall not have less than 3 inches (76 mm) of bearing.

**2308.4.1.1 Allowable girder spans.** The allowable spans of girders that are fabricated of dimension lumber shall not exceed the values set forth in Table 2308.4.1.1(1) or 2308.4.1.1(2).

**2308.4.2 Floor joists.** Floor joists shall comply with this section.

**2308.4.2.1 Span.** Spans for floor joists shall be in accordance with Table 2308.4.2.1(1), Table 2308.4.2.1(2) or the AWC STJR.

**2308.4.2.2 Bearing.** The ends of each joist shall have not less than  $1\frac{1}{2}$  inches (38 mm) of bearing on wood or metal, or not less than 3 inches (76 mm) on masonry, except where supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and nailed to the adjoining stud.



## WOOD

**TABLE 2308.4.1.1(1)**  
**HEADER AND GIRDER SPANS<sup>a, b</sup> FOR EXTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf) <sup>a</sup>																	
		30						50						70					
		Building width <sup>c</sup> (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>
Roof and ceiling	1-2 × 6	4-0	1	3-1	2	2-7	2	3-5	1	2-8	2	2-3	2	3-0	2	2-4	2	2-0	2
	1-2 × 8	5-1	2	3-11	2	3-3	2	4-4	2	3-4	2	2-10	2	3-10	2	3-0	2	2-6	3
	1-2 × 10	6-0	2	4-8	2	3-11	2	5-2	2	4-0	2	3-4	3	4-7	2	3-6	3	3-0	3
	1-2 × 12	7-1	2	5-5	2	4-7	3	6-1	2	4-8	3	3-11	3	5-5	2	4-2	3	3-6	3
	2-2 × 4	4-0	1	3-1	1	2-7	1	3-5	1	2-7	1	2-2	1	3-0	1	2-4	1	2-0	1
	2-2 × 6	6-0	1	4-7	1	3-10	1	5-1	1	3-11	1	3-3	2	4-6	1	3-6	2	2-11	2
	2-2 × 8	7-7	1	5-9	1	4-10	2	6-5	1	5-0	2	4-2	2	5-9	1	4-5	2	3-9	2
	2-2 × 10	9-0	1	6-10	2	5-9	2	7-8	2	5-11	2	4-11	2	6-9	2	5-3	2	4-5	2
	2-2 × 12	10-7	2	8-1	2	6-10	2	9-0	2	6-11	2	5-10	2	8-0	2	6-2	2	5-2	3
	3-2 × 8	9-5	1	7-3	1	6-1	1	8-1	1	6-3	1	5-3	2	7-2	1	5-6	2	4-8	2
	3-2 × 10	11-3	1	8-7	1	7-3	2	9-7	1	7-4	2	6-2	2	8-6	1	6-7	2	5-6	2
	3-2 × 12	13-2	1	10-1	2	8-6	2	11-3	2	8-8	2	7-4	2	10-0	2	7-9	2	6-6	2
	4-2 × 8	10-11	1	8-4	1	7-0	1	9-4	1	7-2	1	6-0	1	8-3	1	6-4	1	5-4	2
	4-2 × 10	12-11	1	9-11	1	8-4	1	11-1	1	8-6	1	7-2	2	9-10	1	7-7	2	6-4	2
	4-2 × 12	15-3	1	11-8	1	9-10	2	13-0	1	10-0	2	8-5	2	11-7	1	8-11	2	7-6	2
Roof, ceiling and one center- bearing floor	1-2 × 6	3-3	1	2-7	2	2-2	2	3-0	2	2-4	2	2-0	2	2-9	2	2-2	2	1-10	2
	1-2 × 8	4-1	2	3-3	2	2-9	2	3-9	2	3-0	2	2-6	3	3-6	2	2-9	2	2-4	3
	1-2 × 10	4-11	2	3-10	2	3-3	3	4-6	2	3-6	3	3-0	3	4-1	2	3-3	3	2-9	3
	1-2 × 12	5-9	2	4-6	3	3-10	3	5-3	2	4-2	3	3-6	3	4-10	3	3-10	3	3-3	4
	2-2 × 4	3-3	1	2-6	1	2-2	1	3-0	1	2-4	1	2-0	1	2-8	1	2-2	1	1-10	1
	2-2 × 6	4-10	1	3-9	1	3-3	2	4-5	1	3-6	2	3-0	2	4-1	1	3-3	2	2-9	2
	2-2 × 8	6-1	1	4-10	2	4-1	2	5-7	2	4-5	2	3-9	2	5-2	2	4-1	2	3-6	2
	2-2 × 10	7-3	2	5-8	2	4-10	2	6-8	2	5-3	2	4-5	2	6-1	2	4-10	2	4-1	2
	2-2 × 12	8-6	2	6-8	2	5-8	2	7-10	2	6-2	2	5-3	3	7-2	2	5-8	2	4-10	3
	3-2 × 8	7-8	1	6-0	1	5-1	2	7-0	1	5-6	2	4-8	2	6-5	1	5-1	2	4-4	2
	3-2 × 10	9-1	1	7-2	2	6-1	2	8-4	1	6-7	2	5-7	2	7-8	2	6-1	2	5-2	2
	3-2 × 12	10-8	2	8-5	2	7-2	2	9-10	2	7-8	2	6-7	2	9-0	2	7-1	2	6-1	2
	4-2 × 8	8-10	1	6-11	1	5-11	1	8-1	1	6-4	1	5-5	2	7-5	1	5-11	1	5-0	2
	4-2 × 10	10-6	1	8-3	2	7-0	2	9-8	1	7-7	2	6-5	2	8-10	1	7-0	2	6-0	2
	4-2 × 12	12-4	1	9-8	2	8-3	2	11-4	2	8-11	2	7-7	2	10-4	2	8-3	2	7-0	2
Roof, ceiling and one clear span floor	1-2 × 6	2-11	2	2-3	2	1-11	2	2-9	2	2-1	2	1-9	2	2-7	2	2-0	2	1-8	2
	1-2 × 8	3-9	2	2-10	2	2-5	3	3-6	2	2-8	2	2-3	3	3-3	2	2-6	3	2-2	3
	1-2 × 10	4-5	2	3-5	3	2-10	3	4-2	2	3-2	3	2-8	3	3-11	2	3-0	3	2-6	3
	1-2 × 12	5-2	2	4-0	3	3-4	3	4-10	3	3-9	3	3-2	4	4-7	3	3-6	3	3-0	4
	2-2 × 4	2-11	1	2-3	1	1-10	1	2-9	1	2-1	1	1-9	1	2-7	1	2-0	1	1-8	1
	2-2 × 6	4-4	1	3-4	2	2-10	2	4-1	1	3-2	2	2-8	2	3-10	1	3-0	2	2-6	2
	2-2 × 8	5-6	2	4-3	2	3-7	2	5-2	2	4-0	2	3-4	2	4-10	2	3-9	2	3-2	2
	2-2 × 10	6-7	2	5-0	2	4-2	2	6-1	2	4-9	2	4-0	2	5-9	2	4-5	2	3-9	3
	2-2 × 12	7-9	2	5-11	2	4-11	3	7-2	2	5-7	2	4-8	3	6-9	2	5-3	3	4-5	3
	3-2 × 8	6-11	1	5-3	2	4-5	2	6-5	1	5-0	2	4-2	2	6-1	1	4-8	2	4-0	2
	3-2 × 10	8-3	2	6-3	2	5-3	2	7-8	2	5-11	2	5-0	2	7-3	2	5-7	2	4-8	2
	3-2 × 12	9-8	2	7-5	2	6-2	2	9-0	2	7-0	2	5-10	2	8-6	2	6-7	2	5-6	3
	4-2 × 8	8-0	1	6-1	1	5-1	2	7-5	1	5-9	2	4-10	2	7-0	1	5-5	2	4-7	2
	4-2 × 10	9-6	1	7-3	2	6-1	2	8-10	1	6-10	2	5-9	2	8-4	1	6-5	2	5-5	2
	4-2 × 12	11-2	2	8-6	2	7-2	2	10-5	2	8-0	2	6-9	2	9-10	2	7-7	2	6-5	2

(continued)

## WOOD

**TABLE 2308.4.1.1(1)—continued**  
**HEADER AND GIRDER SPANS<sup>a, b</sup> FOR EXTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf) <sup>a</sup>																	
		30						50						70					
		Building width <sup>c</sup> (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>
Roof, ceiling and two center-bear- ing floors	1-2 × 6	2-8	2	2-1	2	1-10	2	2-7	2	2-0	2	1-9	2	2-5	2	1-11	2	1-8	2
	1-2 × 8	3-5	2	2-8	2	2-4	3	3-3	2	2-7	2	2-2	3	3-1	2	2-5	3	2-1	3
	1-2 × 10	4-0	2	3-2	3	2-9	3	3-10	2	3-1	3	2-7	3	3-8	2	2-11	3	2-5	3
	1-2 × 12	4-9	3	3-9	3	3-2	4	4-6	3	3-7	3	3-1	4	4-3	3	3-5	3	2-11	4
	2-2 × 4	2-8	1	2-1	1	1-9	1	2-6	1	2-0	1	1-8	1	2-5	1	1-11	1	1-7	1
	2-2 × 6	4-0	1	3-2	2	2-8	2	3-9	1	3-0	2	2-7	2	3-7	1	2-10	2	2-5	2
	2-2 × 8	5-0	2	4-0	2	3-5	2	4-10	2	3-10	2	3-3	2	4-7	2	3-7	2	3-1	2
	2-2 × 10	6-0	2	4-9	2	4-0	2	5-8	2	4-6	2	3-10	3	5-5	2	4-3	2	3-8	3
	2-2 × 12	7-0	2	5-7	2	4-9	3	6-8	2	5-4	3	4-6	3	6-4	2	5-0	3	4-3	3
	3-2 × 8	6-4	1	5-0	2	4-3	2	6-0	1	4-9	2	4-1	2	5-8	2	4-6	2	3-10	2
	3-2 × 10	7-6	2	5-11	2	5-1	2	7-1	2	5-8	2	4-10	2	6-9	2	5-4	2	4-7	2
	3-2 × 12	8-10	2	7-0	2	5-11	2	8-5	2	6-8	2	5-8	3	8-0	2	6-4	2	5-4	3
	4-2 × 8	7-3	1	5-9	1	4-11	2	6-11	1	5-6	2	4-8	2	6-7	1	5-2	2	4-5	2
	4-2 × 10	8-8	1	6-10	2	5-10	2	8-3	2	6-6	2	5-7	2	7-10	2	6-2	2	5-3	2
	4-2 × 12	10-2	2	8-1	2	6-10	2	9-8	2	7-8	2	6-7	2	9-2	2	7-3	2	6-2	2
Roof, ceiling and two clear span floors	1-2 × 6	2-3	2	1-9	2	1-5	2	2-3	2	1-9	2	1-5	3	2-2	2	1-8	2	1-5	3
	1-2 × 8	2-10	2	2-2	3	1-10	3	2-10	2	2-2	3	1-10	3	2-9	2	2-1	3	1-10	3
	1-2 × 10	3-4	2	2-7	3	2-2	3	3-4	3	2-7	3	2-2	4	3-3	3	2-6	3	2-2	4
	1-2 × 12	4-0	3	3-0	3	2-7	4	4-0	3	3-0	4	2-7	4	3-10	3	3-0	4	2-6	4
	2-2 × 4	2-3	1	1-8	1	1-4	1	2-3	1	1-8	1	1-4	1	2-2	1	1-8	1	1-4	2
	2-2 × 6	3-4	1	2-6	2	2-2	2	3-4	2	2-6	2	2-2	2	3-3	2	2-6	2	2-1	2
	2-2 × 8	4-3	2	3-3	2	2-8	2	4-3	2	3-3	2	2-8	2	4-1	2	3-2	2	2-8	3
	2-2 × 10	5-0	2	3-10	2	3-2	3	5-0	2	3-10	2	3-2	3	4-10	2	3-9	3	3-2	3
	2-2 × 12	5-11	2	4-6	3	3-9	3	5-11	2	4-6	3	3-9	3	5-8	2	4-5	3	3-9	3
	3-2 × 8	5-3	1	4-0	2	3-5	2	5-3	2	4-0	2	3-5	2	5-1	2	3-11	2	3-4	2
	3-2 × 10	6-3	2	4-9	2	4-0	2	6-3	2	4-9	2	4-0	2	6-1	2	4-8	2	4-0	3
	3-2 × 12	7-5	2	5-8	2	4-9	3	7-5	2	5-8	2	4-9	3	7-2	2	5-6	3	4-8	3
	4-2 × 8	6-1	1	4-8	2	3-11	2	6-1	1	4-8	2	3-11	2	5-11	1	4-7	2	3-10	2
	4-2 × 10	7-3	2	5-6	2	4-8	2	7-3	2	5-6	2	4-8	2	7-0	2	5-5	2	4-7	2
	4-2 × 12	8-6	2	6-6	2	5-6	2	8-6	2	6-6	2	5-6	2	8-3	2	6-4	2	5-4	3

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- Spans are given in feet and inches.
- Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine and spruce-pine fir.
- Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
- NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.
- Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.
- Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (for example, cripple studs bearing on the header), tabulated spans for headers consisting of 2 × 8, 2 × 10, or 2 × 12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

**TABLE 2308.4.1.1(2)**  
**HEADER AND GIRDER SPANS<sup>a, b</sup> FOR INTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir and required number of jack studs)

HEADERS AND GIRDER SUPPORTING	SIZE	BUILDING WIDTH <sup>c</sup> (feet)					
		12		24		36	
		Span <sup>e</sup>	NJ <sup>d</sup>	Span <sup>e</sup>	NJ <sup>d</sup>	Span <sup>e</sup>	NJ <sup>d</sup>
One floor only	2-2 × 4	4-1	1	2-10	1	2-4	1
	2-2 × 6	6-1	1	4-4	1	3-6	1
	2-2 × 8	7-9	1	5-5	1	4-5	2
	2-2 × 10	9-2	1	6-6	2	5-3	2
	2-2 × 12	10-9	1	7-7	2	6-3	2
	3-2 × 8	9-8	1	6-10	1	5-7	1
	3-2 × 10	11-5	1	8-1	1	6-7	2
	3-2 × 12	13-6	1	9-6	2	7-9	2
	4-2 × 8	11-2	1	7-11	1	6-5	1
	4-2 × 10	13-3	1	9-4	1	7-8	1
	4-2 × 12	15-7	1	11-0	1	9-0	2
Two floors	2-2 × 4	2-7	1	1-11	1	1-7	1
	2-2 × 6	3-11	1	2-11	2	2-5	2
	2-2 × 8	5-0	1	3-8	2	3-1	2
	2-2 × 10	5-11	2	4-4	2	3-7	2
	2-2 × 12	6-11	2	5-2	2	4-3	3
	3-2 × 8	6-3	1	4-7	2	3-10	2
	3-2 × 10	7-5	1	5-6	2	4-6	2
	3-2 × 12	8-8	2	6-5	2	5-4	2
	4-2 × 8	7-2	1	5-4	1	4-5	2
	4-2 × 10	8-6	1	6-4	2	5-3	2
	4-2 × 12	10-1	1	7-5	2	6-2	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- Spans are given in feet and inches.
- Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine and spruce-pine fir.
- Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
- NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.
- Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (for example, cripple studs bearing on the header), tabulated spans for headers consisting of 2 × 8, 2 × 10, or 2 × 12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

## WOOD

**TABLE 2308.4.2.1(1)**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES**  
 (Residential sleeping areas, live load = 30 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	12-6	16-6	21-0	25-7	12-6	16-6	21-0	25-7
	Douglas Fir-Larch	#1	12-0	15-10	20-3	24-8	12-0	15-7	19-0	22-0
	Douglas Fir-Larch	#2	11-10	15-7	19-10	23-0	11-6	14-7	17-9	20-7
	Douglas Fir-Larch	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Hem-Fir	SS	11-10	15-7	19-10	24-2	11-10	15-7	19-10	24-2
	Hem-Fir	#1	11-7	15-3	19-5	23-7	11-7	15-2	18-6	21-6
	Hem-Fir	#2	11-0	14-6	18-6	22-6	11-0	14-4	17-6	20-4
	Hem-Fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Southern Pine	SS	12-3	16-2	20-8	25-1	12-3	16-2	20-8	25-1
	Southern Pine	#1	11-10	15-7	19-10	24-2	11-10	15-7	18-7	22-0
	Southern Pine	#2	11-3	14-11	18-1	21-4	10-9	13-8	16-2	19-1
	Southern Pine	#3	9-2	11-6	14-0	16-6	8-2	10-3	12-6	14-9
	Spruce-Pine-Fir	SS	11-7	15-3	19-5	23-7	11-7	15-3	19-5	23-7
	Spruce-Pine-Fir	#1	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-Pine-Fir	#2	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-Pine-Fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
16	Douglas Fir-Larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-0
	Douglas Fir-Larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas Fir-Larch	#2	10-9	14-1	17-2	19-11	9-11	12-7	15-5	17-10
	Douglas Fir-Larch	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Hem-Fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-Fir	#1	10-6	13-10	17-8	20-9	10-4	13-1	16-0	18-7
	Hem-Fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern Pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern Pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern Pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern Pine	#3	7-11	10-10	12-1	14-4	7-1	8-11	10-10	12-10
	Spruce-Pine-Fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-Pine-Fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-Pine-Fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

(continued)



**TABLE 2308.4.2.1(1)—continued**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES**  
**(Residential sleeping areas, live load = 30 psf, L/Δ = 360)**

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	10-8	14-1	18-0	21-10	10-8	14-1	18-0	21-0
	Douglas Fir-Larch	#1	10-4	13-7	16-9	19-6	9-8	12-4	15-0	17-5
	Douglas Fir-Larch	#2	10-1	12-10	15-8	18-3	9-1	11-6	14-1	16-3
	Douglas Fir-Larch	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Hem-Fir	SS	10-1	13-4	17-0	20-8	10-1	13-4	17-0	20-7
	Hem-Fir	#1	9-10	13-0	16-4	19-0	9-6	12-0	14-8	17-0
	Hem-Fir	#2	9-5	12-5	15-6	17-1	8-11	11-4	13-10	16-1
	Hem-Fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Southern Pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern Pine	#1	10-1	13-4	16-5	19-6	9-11	12-7	14-8	17-5
	Southern Pine	#2	9-6	12-1	14-4	16-10	8-6	10-10	12-10	15-1
	Southern Pine	#3	7-3	9-1	11-0	13-1	6-5	8-2	9-10	11-8
	Spruce-Pine-Fir	SS	9-10	13-0	16-7	20-2	9-10	13-0	16-7	19-6
	Spruce-Pine-Fir	#1	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#2	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
24	Douglas Fir-Larch	SS	9-11	13-1	16-8	20-3	9-11	13-1	16-2	18-9
	Douglas Fir-Larch	#1	9-7	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Douglas Fir-Larch	#2	9-1	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Douglas Fir-Larch	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Hem-Fir	SS	9-4	12-4	15-9	19-2	9-4	12-4	15-9	18-5
	Hem-Fir	#1	9-2	12-0	14-8	17-0	8-6	10-9	13-1	15-2
	Hem-Fir	#2	8-9	11-4	13-10	16-1	8-0	10-2	12-5	14-4
	Hem-Fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Southern Pine	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-8
	Southern Pine	#1	9-4	12-4	14-8	17-5	8-10	11-3	13-1	15-7
	Southern Pine	#2	8-6	10-10	12-10	15-1	7-7	9-8	11-5	13-6
	Southern Pine	#3	6-5	8-2	9-10	11-8	5-9	7-3	8-10	10-5
	Spruce-Pine-Fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-0	17-5
	Spruce-Pine-Fir	#1	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-Pine-Fir	#2	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-Pine-Fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

**Note:** Check sources for availability of lumber in lengths greater than 20 feet.

## WOOD

**TABLE 2308.4.2.1(2)**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES**  
 (Residential living areas, live load = 40 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas Fir-Larch	#1	10-11	14-5	18-5	22-0	10-11	14-2	17-4	20-1
	Douglas Fir-Larch	#2	10-9	14-2	17-9	20-7	10-6	13-3	16-3	18-10
	Douglas Fir-Larch	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Hem-Fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-Fir	#1	10-6	13-10	17-8	21-6	10-6	13-10	16-11	19-7
	Hem-Fir	#2	10-0	13-2	16-10	20-4	10-0	13-1	16-0	18-6
	Hem-Fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Southern Pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern Pine	#1	10-9	14-2	18-0	21-11	10-9	14-2	16-11	20-1
	Southern Pine	#2	10-3	13-6	16-2	19-1	9-10	12-6	14-9	17-5
	Southern Pine	#3	8-2	10-3	12-6	14-9	7-5	9-5	11-5	13-6
	Spruce-Pine-Fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Spruce-Pine-Fir	#1	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-Pine-Fir	#2	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-Pine-Fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
16	Douglas Fir-Larch	SS	10-4	13-7	17-4	21-1	10-4	13-7	17-4	21-0
	Douglas Fir-Larch	#1	9-11	13-1	16-5	19-1	9-8	12-4	15-0	17-5
	Douglas Fir-Larch	#2	9-9	12-7	15-5	17-10	9-1	11-6	14-1	16-3
	Douglas Fir-Larch	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Hem-Fir	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Hem-Fir	#1	9-6	12-7	16-0	18-7	9-6	12-0	14-8	17-0
	Hem-Fir	#2	9-1	12-0	15-2	17-7	8-11	11-4	13-10	16-1
	Hem-Fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Southern Pine	SS	10-2	13-4	17-0	20-9	10-2	13-4	17-0	20-9
	Southern Pine	#1	9-9	12-10	16-1	19-1	9-9	12-7	14-8	17-5
	Southern Pine	#2	9-4	11-10	14-0	16-6	8-6	10-10	12-10	15-1
	Southern Pine	#3	7-1	8-11	10-10	12-10	6-5	8-2	9-10	11-8
	Spruce-Pine-Fir	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Spruce-Pine-Fir	#1	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#2	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-Pine-Fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4

(continued)

**TABLE 2308.4.2.1(2)—continued**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES**  
 (Residential living areas, live load = 40 psf, L/Δ = 360)

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	9-8	12-10	16-4	19-10	9-8	12-10	16-4	19-2
	Douglas Fir-Larch	#1	9-4	12-4	15-0	17-5	8-10	11-3	13-8	15-11
	Douglas Fir-Larch	#2	9-1	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Douglas Fir-Larch	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Hem-Fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-5	18-9
	Hem-Fir	#1	9-0	11-10	14-8	17-0	8-8	10-11	13-4	15-6
	Hem-Fir	#2	8-7	11-3	13-10	16-1	8-2	10-4	12-8	14-8
	Hem-Fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Southern Pine	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Southern Pine	#1	9-2	12-1	14-8	17-5	9-0	11-5	13-5	15-11
	Southern Pine	#2	8-6	10-10	12-10	15-1	7-9	9-10	11-8	13-9
	Southern Pine	#3	6-5	8-2	9-10	11-8	5-11	7-5	9-0	10-8
	Spruce-Pine-Fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-Pine-Fir	#	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-Pine-Fir	#2	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-Pine-Fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
24	Douglas Fir-Larch	SS	9-0	11-11	15-2	18-5	9-0	11-11	14-9	17-1
	Douglas Fir-Larch	#1	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Douglas Fir-Larch	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Douglas Fir-Larch	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Hem-Fir	SS	8-6	11-3	14-4	17-5	8-6	11-3	14-4	16-10 <sup>a</sup>
	Hem-Fir	#1	8-4	10-9	13-1	15-2	7-9	9-9	11-11	13-10
	Hem-Fir	#2	7-11	10-2	12-5	14-4	7-4	9-3	11-4	13-1
	Hem-Fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Southern Pine	SS	8-10	11-8	14-11	18-1	8-10	11-8	14-11	18-0
	Southern Pine	#1	8-6	11-3	13-1	15-7	8-1	10-3	12-0	14-3
	Southern Pine	#2	7-7	9-8	11-5	13-6	7-0	8-10	10-5	12-4
	Southern Pine	#3	5-9	7-3	8-10	10-5	5-3	6-8	8-1	9-6
	Spruce-Pine-Fir	SS	8-4	11-0	14-0	17-0	8-4	11-0	13-8	15-11
	Spruce-Pine-Fir	#1	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-Pine-Fir	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-Pine-Fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

**Note:** Check sources for availability of lumber in lengths greater than 20 feet.

a. End bearing length shall be increased to 2 inches.

## WOOD

**2308.4.2.3 Framing details.** Joists shall be supported laterally at the ends and at each support by solid blocking except where the ends of the joists are nailed to a header, band or rim joist or to an adjoining stud or by other means. Solid blocking shall be not less than 2 inches (51 mm) in thickness and the full depth of the joist. Joist framing from opposite sides of a beam, girder or partition shall be lapped not less than 3 inches (76 mm) or the opposing joists shall be tied together in an approved manner. Joists framing into the side of a wood girder shall be supported by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

**2308.4.2.4 Notches and holes.** Notches on the ends of joists shall not exceed one-fourth the joist depth. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span. Holes bored in joists shall not be within 2 inches (51 mm) of the top or bottom of the joist and the diameter of any such hole shall not exceed one-third the depth of the joist.

**2308.4.3 Engineered wood products.** Engineered wood products shall be installed in accordance with manufacturer's recommendations. Cuts, notches and holes bored in trusses, *structural composite lumber*, structural glued-laminated members or I-joists are not permitted except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a *registered design professional*.

**2308.4.4 Framing around openings.** Trimmer and header joists shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header joists more than 6 feet (1829 mm) in length shall be supported by framing anchors or joist hangers unless bearing on a beam, partition or wall. Tail joists over 12 feet (3658 mm) in length shall be supported at the header by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

**2308.4.4.1 Openings in floor diaphragms in Seismic Design Categories B, C, D and E.** Openings in horizontal *diaphragms* in *Seismic Design Categories B, C, D and E* with a dimension that is greater than 4 feet (1219 mm) shall be constructed with metal ties and blocking in accordance with this section and Figure 2308.4.4.1(1). Metal ties shall be not less than 0.058 inch [1.47 mm (16 galvanized gage)] in thickness by 1½ inches (38 mm) in width and shall have a yield stress not less than 33,000 psi (227 Mpa). Blocking shall extend not less than the dimension of the opening in the direction of the tie and blocking. Ties shall be attached to blocking in accordance with the manufacturer's instructions but with not less than eight 16d common nails on each side of the header-joist intersection.

Openings in floor *diaphragms* in *Seismic Design Categories D and E* shall not have any dimension exceeding 50 percent of the distance between *braced*

*wall lines* or an area greater than 25 percent of the area between *orthogonal* pairs of *braced wall lines* [see Figure 2308.4.4.1(2)]; or the portion of the structure containing the opening shall be designed in accordance with accepted engineering practice to resist the forces specified in Chapter 16, to the extent such irregular opening affects the performance of the conventional framing system.

**2308.4.4.2 Vertical offsets in floor diaphragms in Seismic Design Categories D and E.** In *Seismic Design Categories D and E*, portions of a floor level shall not be vertically offset such that the framing members on either side of the offset cannot be lapped or tied together in an *approved* manner in accordance with Figure 2308.4.4.2 unless the portion of the structure containing the irregular offset is designed in accordance with accepted engineering practice.

**Exception:** Framing supported directly by foundations need not be lapped or tied directly together.

**2308.4.5 Joists supporting bearing partitions.** Bearing partitions parallel to joists shall be supported on beams, girders, doubled joists, walls or other bearing partitions. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than the joist depth unless such joists are of sufficient size to carry the additional *load*.

**2308.4.6 Lateral support.** Floor and ceiling framing with a nominal depth-to-thickness ratio not less than 5 to 1 shall have one edge held in line for the entire span. Where the nominal depth-to-thickness ratio of the framing member exceeds 6 to 1, there shall be one line of bridging for each 8 feet (2438 mm) of span, unless both edges of the member are held in line. The bridging shall consist of not less than 1-inch by 3-inch (25 mm by 76 mm) lumber, double nailed at each end, or equivalent metal bracing of equal rigidity, full-depth solid blocking or other *approved* means. A line of bridging shall be required at supports where equivalent lateral support is not otherwise provided.

**2308.4.7 Structural floor sheathing.** Structural floor sheathing shall comply with the provisions of Section 2304.8.1.

**2308.4.8 Under-floor ventilation.** For under-floor ventilation, see Section 1202.4.

**2308.4.9 Floor framing supporting braced wall panels.** Where *braced wall panels* are supported by cantilevered floors or are set back from the floor joist support, the floor framing shall comply with Section 2308.6.7.

**2308.4.10 Anchorage of exterior means of egress components in Seismic Design Categories D and E.** Exterior egress balconies, exterior *stairways* and *ramps* and similar *means of egress* components in structures assigned to *Seismic Design Category D or E* shall be positively anchored to the primary structure at not more than 8 feet (2438 mm) on center or shall be designed for lateral forces. Such attachment shall not be accomplished by use of toenails or nails subject to withdrawal.



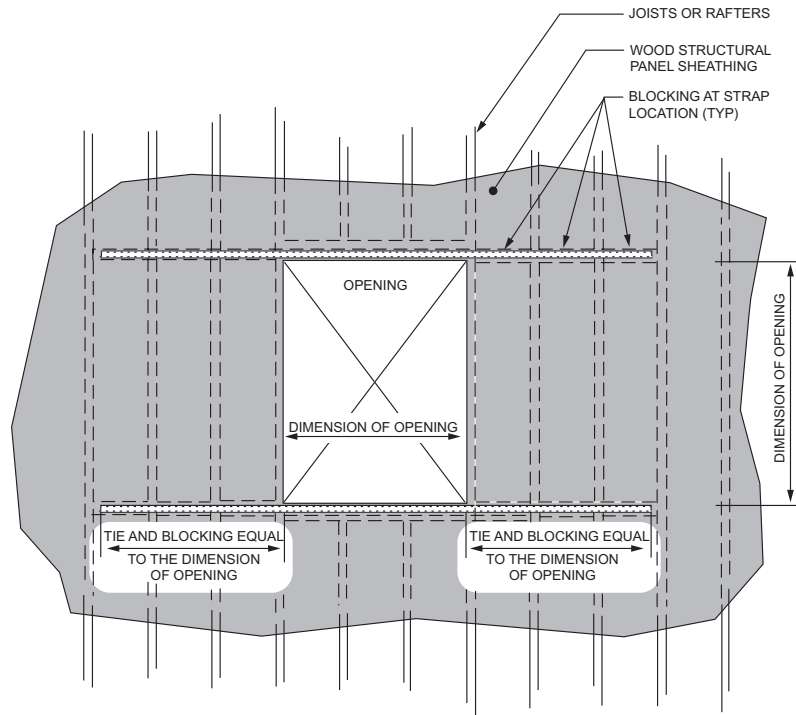


FIGURE 2308.4.4.1(1)  
OPENINGS IN FLOOR AND ROOF DIAPHRAGMS

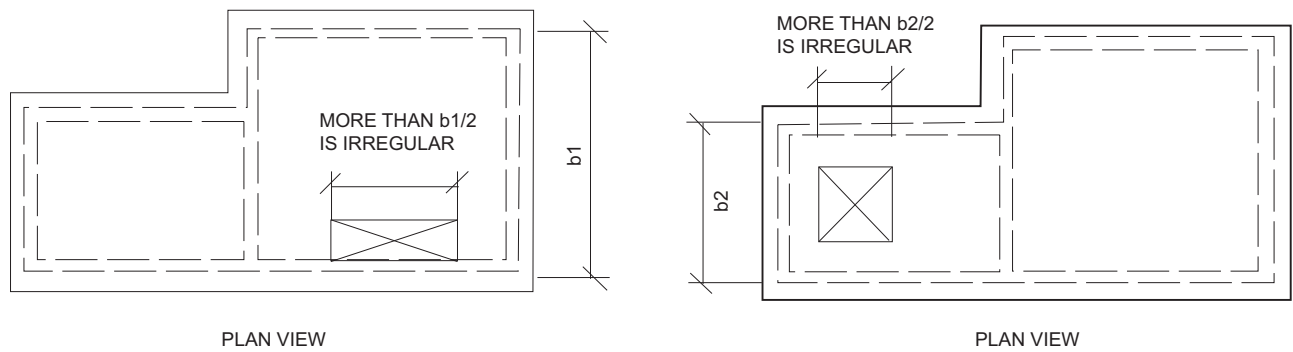


FIGURE 2308.4.4.1(2)  
OPENING LIMITATIONS FOR FLOOR AND ROOF DIAPHRAGMS

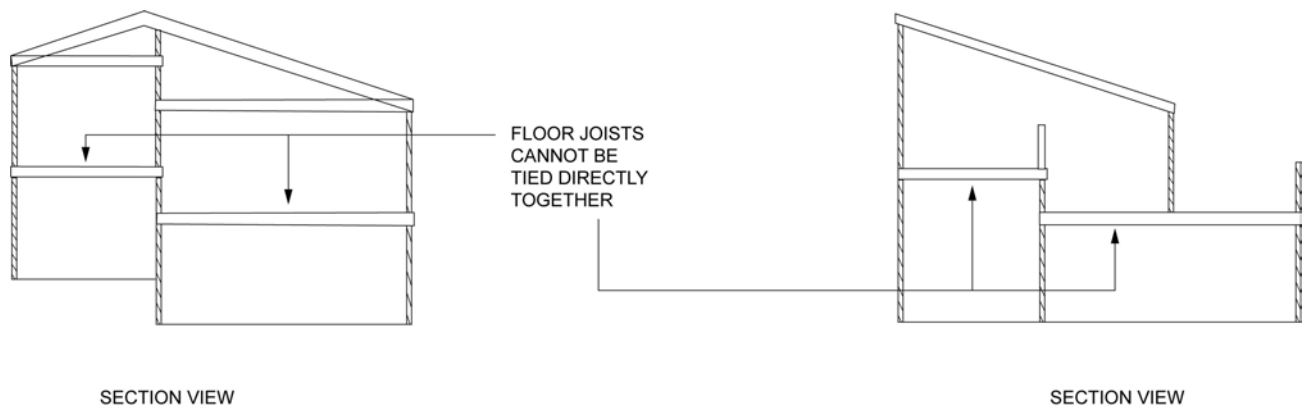


FIGURE 2308.4.4.2  
PORTIONS OF FLOOR LEVEL OFFSET VERTICALLY

## WOOD

**2308.5 Wall construction.** Walls of *conventional light-frame construction* shall be in accordance with this section.

**2308.5.1 Stud size, height and spacing.** The size, height and spacing of studs shall be in accordance with Table 2308.5.1.

Studs shall be continuous from a support at the sole plate to a support at the top plate to resist *loads* perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof *diaphragm* or shall be designed in accordance with accepted engineering practice.

**Exception:** Jack studs, trimmer studs and cripple studs at openings in walls that comply with Table 2308.4.1.1(1) or 2308.4.1.1(2).

**2308.5.2 Framing details.** Studs shall be placed with their wide dimension perpendicular to the wall. Not less than three studs shall be installed at each corner of an *exterior wall*.

**Exceptions:**

1. In interior nonbearing walls and partitions, studs are permitted to be set with the long dimension parallel to the wall.
2. At corners, two studs are permitted, provided that wood spacers or backup cleats of  $\frac{3}{8}$ -inch-thick (9.5 mm) *wood structural panel*,  $\frac{3}{8}$ -inch (9.5 mm) Type M “Exterior Glue” *particle-board*, 1-inch-thick (25 mm) lumber or other approved devices that will serve as an adequate backing for the attachment of facing materials are used. Where *fire-resistance ratings* or shear values are involved, wood spacers, backup cleats or other devices shall not be used unless specifically *approved* for such use.

**2308.5.3 Plates and sills.** Studs shall have plates and sills in accordance with this section.

**2308.5.3.1 Bottom plate or sill.** Studs shall have full bearing on a plate or sill. Plates or sills shall be not less than 2 inches (51 mm) nominal in thickness and have a width not less than the width of the wall studs.

**2308.5.3.2 Top plates.** Bearing and exterior wall studs shall be capped with double top plates installed to provide overlapping at corners and at intersections with other partitions. End joints in double top plates shall be offset not less than 48 inches (1219 mm), and shall be nailed in accordance with Table 2304.10.2. Plates shall be a nominal 2 inches (51 mm) in depth and have a width not less than the width of the studs.

**Exception:** A single top plate is permitted, provided that the plate is adequately tied at corners and intersecting walls by not less than the equivalent of 3-inch by 6-inch (76 mm by 152 mm) by 0.036-inch-thick (0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by six 8d [ $2\frac{1}{2}$ "  $\times$  0.113" (64-mm by 2.87 mm)] box nails or equivalent on each side of the joint. For the butt-joint splice between adjacent single top plates, not less than the equivalent of a 3-inch by 12-inch (76 mm by 304 mm) by 0.036-inch-thick (0.914 mm) galvanized steel plate that is nailed to each wall or segment of wall by 12 8d [ $2\frac{1}{2}$ -inch  $\times$  0.113-inch (64 mm by 2.87 mm)] box nails on each side of the joint shall be required, provided that the rafters, joists or trusses are centered over the studs with a tolerance of not more than 1 inch (25 mm). The top plate shall not be required over headers that are in the same plane and in line with the upper surface of the adjacent top plates and are tied to adjacent wall sections as required for the butt joint splice between adjacent single top plates.

Where bearing studs are spaced at 24-inch (610 mm) intervals, top plates are less than two 2-inch by 6-inch (51 mm by 152 mm) or two 3-inch by 4-inch (76 mm by 102 mm) members and the floor joists, floor trusses or roof trusses that they support are spaced at more than 16-inch (406 mm) intervals, such joists or trusses shall bear within 5 inches (127 mm) of the studs beneath or a third plate shall be installed.

**2308.5.4 Nonload-bearing walls and partitions.** In *nonload-bearing walls* and partitions, that are not part of a *braced wall panel*, studs shall be spaced not more than

**TABLE 2308.5.1**  
**SIZE, HEIGHT AND SPACING OF WOOD STUDS<sup>a</sup>**

STUD SIZE (inches)	BEARING WALLS				NONBEARING WALLS	
	Laterally unsupported stud height <sup>a</sup> (feet)	Supporting roof and ceiling only	Supporting one floor, roof and ceiling	Supporting two floors, roof and ceiling	Laterally unsupported stud height <sup>a</sup> (feet)	Spacing (inches)
		Spacing (inches)				
2 × 3 <sup>b</sup>	—	—	—	—	10	16
2 × 4	10	24	16	—	14	24
3 × 4	10	24	24	16	14	24
2 × 5	10	24	24	—	16	24
2 × 6	10	24	24	16	20	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Increases in unsupported height are permitted where justified by an analysis.
- b. Shall not be used in exterior walls.
- c. Utility-grade studs shall not be spaced more than 16 inches on center or support more than a roof and ceiling, or exceed 8 feet in height for exterior walls and load-bearing walls or 10 feet for interior nonload-bearing walls.

24 inches (610 mm) on center. In interior *nonload-bearing walls* and partitions, studs are permitted to be set with the long dimension parallel to the wall. Where studs are set with the long dimensions parallel to the wall, use of utility *grade lumber* or studs exceeding 10 feet (3048 mm) is not permitted. Interior nonload-bearing partitions shall be capped with not less than a single top plate installed to provide overlapping at corners and at intersections with other walls and partitions. The plate shall be continuously tied at joints by solid blocking not less than 16 inches (406 mm) in length and equal in size to the plate or by  $\frac{1}{2}$ -inch by  $1\frac{1}{2}$ -inch (12.7 mm by 38 mm) metal ties with spliced sections fastened with two 16d nails on each side of the joint.

**2308.5.5 Openings in walls and partitions.** Openings in exterior and interior walls and partitions shall comply with Sections 2308.5.5.1 through 2308.5.5.3.

**2308.5.5.1 Openings in exterior bearing walls.**

Headers shall be provided over each opening in exterior bearing walls. The size and spans in Table 2308.4.1.1(1) are permitted to be used for one- and two-family *dwelling*s. Headers for other buildings shall be designed in accordance with Section 2302.1, Item 1 or 2. Headers of two or more pieces of nominal 2-inch (51 mm) framing lumber set on edge shall be permitted in accordance with Table 2308.4.1.1(1) and nailed together in accordance with Table 2304.10.2 or of solid lumber of equivalent size.

Single-member headers of nominal 2-inch (51 mm) thickness shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures 2308.5.5.1(1) and 2308.5.5.1(2) and face nailed to the top and bottom of the header with 10d box nails [3 inches  $\times$  0.128 inches (76 mm  $\times$  3.3 mm)] spaced 12 inches (305 mm) on center.

Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1). Each end of a lintel or header shall have a bearing length of not less than  $1\frac{1}{2}$  inches (38 mm) for the full width of the lintel.

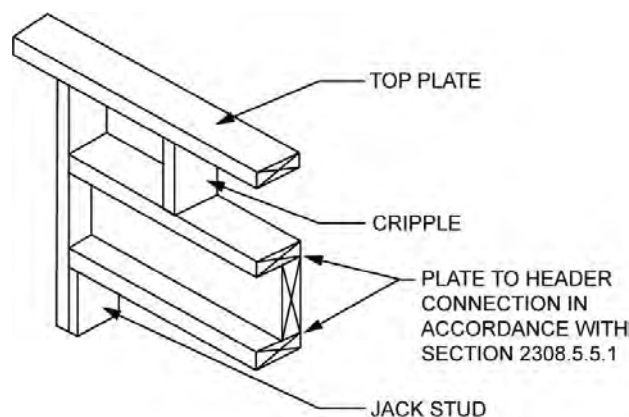


FIGURE 2308.5.5.1(1)  
SINGLE-MEMBER HEADER IN EXTERIOR BEARING WALL

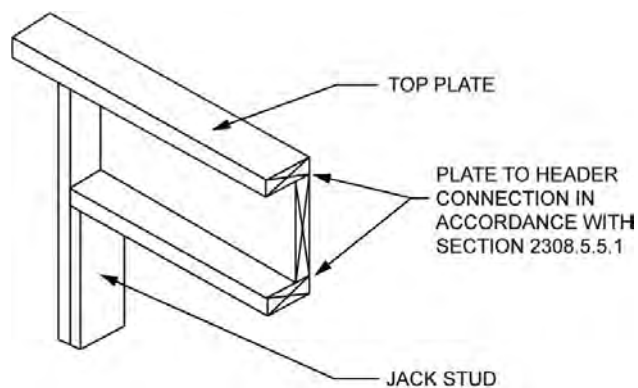


FIGURE 2308.5.5.1(2)  
ALTERNATIVE SINGLE-MEMBER HEADER WITHOUT CRIPPLE

**2308.5.5.2 Openings in interior bearing partitions.**

Headers shall be provided over each opening in interior bearing partitions as required in Section 2308.5.5.1. The spans in Table 2308.4.1.1(2) are permitted to be used. Wall studs shall support the ends of the header in accordance with Table 2308.4.1.1(1) or 2308.4.1.1(2), as applicable.

**2308.5.5.3 Openings in interior nonbearing partitions.**

Openings in nonbearing partitions are permitted to be framed with single studs and headers. Each end of a lintel or header shall have a bearing length of not less than  $1\frac{1}{2}$  inches (38 mm) for the full width of the lintel.

**2308.5.6 Cripple walls.** Foundation *cripple walls* shall be framed of studs that are not less than the size of the stud-*ding* above. Exterior *cripple wall* studs shall be not less than 14 inches (356 mm) in length, or shall be framed of solid blocking. Where exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional *story*. See Section 2308.6.6 for *cripple wall* bracing.

**2308.5.7 Bridging.** Unless covered by interior or *exterior wall coverings* or sheathing meeting the minimum requirements of this code, stud partitions or walls with studs having a height-to-least-thickness ratio exceeding 50 shall have bridging that is not less than 2 inches (51 mm) in thickness and of the same width as the studs fitted snugly and nailed thereto to provide adequate lateral support. Bridging shall be placed in every stud cavity and at a frequency such that studs so braced shall not have a height-to-least-thickness ratio exceeding 50 with the height of the stud measured between horizontal framing and bridging or between bridging, whichever is greater.

**2308.5.8 Pipes in walls.** Stud partitions containing plumbing, heating or other pipes shall be framed and the joists underneath spaced to provide proper clearance for the piping. Where a partition containing piping runs parallel to the floor joists, the joists underneath such partitions shall be doubled and spaced to permit the passage of pipes and shall be bridged. Where plumbing, heating or other pipes are placed in, or partly in, a partition, necessitating the cutting of the soles or plates, a metal tie not less

## WOOD

than 0.058 inch (1.47 mm) (16 galvanized gage) and 1½ inches (38 mm) in width shall be fastened to each plate across and to each side of the opening with not less than six 16d nails.

**2308.5.9 Cutting and notching.** In *exterior walls* and bearing partitions, a wood stud shall not be cut or notched in excess of 25 percent of its depth. In nonbearing partitions that do not support *loads* other than the weight of the partition, a stud shall not be cut or notched in excess of 40 percent of its depth.

**2308.5.10 Bored holes.** The diameter of bored holes in wood studs shall not exceed 40 percent of the stud depth. The diameter of bored holes in wood studs shall not exceed 60 percent of the stud depth in nonbearing partitions. The diameter of bored holes in wood studs shall not exceed 60 percent of the stud depth in any wall where each stud is doubled, provided that not more than two such successive doubled studs are so bored. The edge of the bored hole shall not be closer than ⅝ inch (15.9 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

**2308.5.11 Exterior wall sheathing.** Except where stucco construction that complies with Section 2510 is installed, the outside of *exterior walls*, including *gables*, of enclosed buildings shall be sheathed with one of the materials of the nominal thickness specified in Table 2308.5.11 with fasteners in accordance with the requirements of Section 2304.10 or fasteners designed in accordance with accepted engineering practice. Alternatively, sheathing materials and fasteners complying with Section 2304.6 shall be permitted.

**2308.6 Wall bracing.** Buildings shall be provided with exterior and interior *braced wall lines* as described in Sections 2308.6.1 through 2308.6.10.2.

**2308.6.1 Braced wall lines.** For the purpose of determining the amount and location of bracing required along each story level of a building, *braced wall lines* shall be designated as straight lines through the building plan in both the longitudinal and transverse direction and placed in accordance with Table 2308.6.1 and Figure 2308.6.1. *Braced wall line* spacing shall not exceed the distance specified in Table 2308.6.1. In structures assigned to *Seis-*

*mic Design Category D or E, braced wall lines* shall intersect perpendicularly to each other.

**2308.6.2 Braced wall panels.** *Braced wall panels* shall be placed along *braced wall lines* in accordance with Table 2308.6.1 and Figure 2308.6.1 and as specified in Table 2308.6.3(1). A *braced wall panel* shall be located at each end of the *braced wall line* and at the corners of intersecting *braced wall lines* or shall begin within the maximum distance from the end of the *braced wall line* in accordance with Table 2308.6.1. *Braced wall panels* in a *braced wall line* shall not be offset from each other by more than 4 feet (1219 mm). *Braced wall panels* shall be clearly indicated on the plans.

**2308.6.3 Braced wall panel methods.** Construction of *braced wall panels* shall be by one or a combination of the methods in Table 2308.6.3(1). *Braced wall panel* length shall be in accordance with Section 2308.6.4 or 2308.6.5.

**2308.6.4 Braced wall panel construction.** For Methods DWB, WSP, SFB, PBS, PCP and HPS, each panel must be not less than 48 inches (1219 mm) in length, covering three stud spaces where studs are spaced 16 inches (406 mm) on center and covering two stud spaces where studs are spaced 24 inches (610 mm) on center. *Braced wall panels* less than 48 inches (1219 mm) in length shall not contribute toward the amount of required bracing. *Braced wall panels* that are longer than the required length shall be credited for their actual length. For Method GB, each panel must be not less than 96 inches (2438 mm) in length where applied to one side of the studs or 48 inches (1219 mm) in length where applied to both sides.

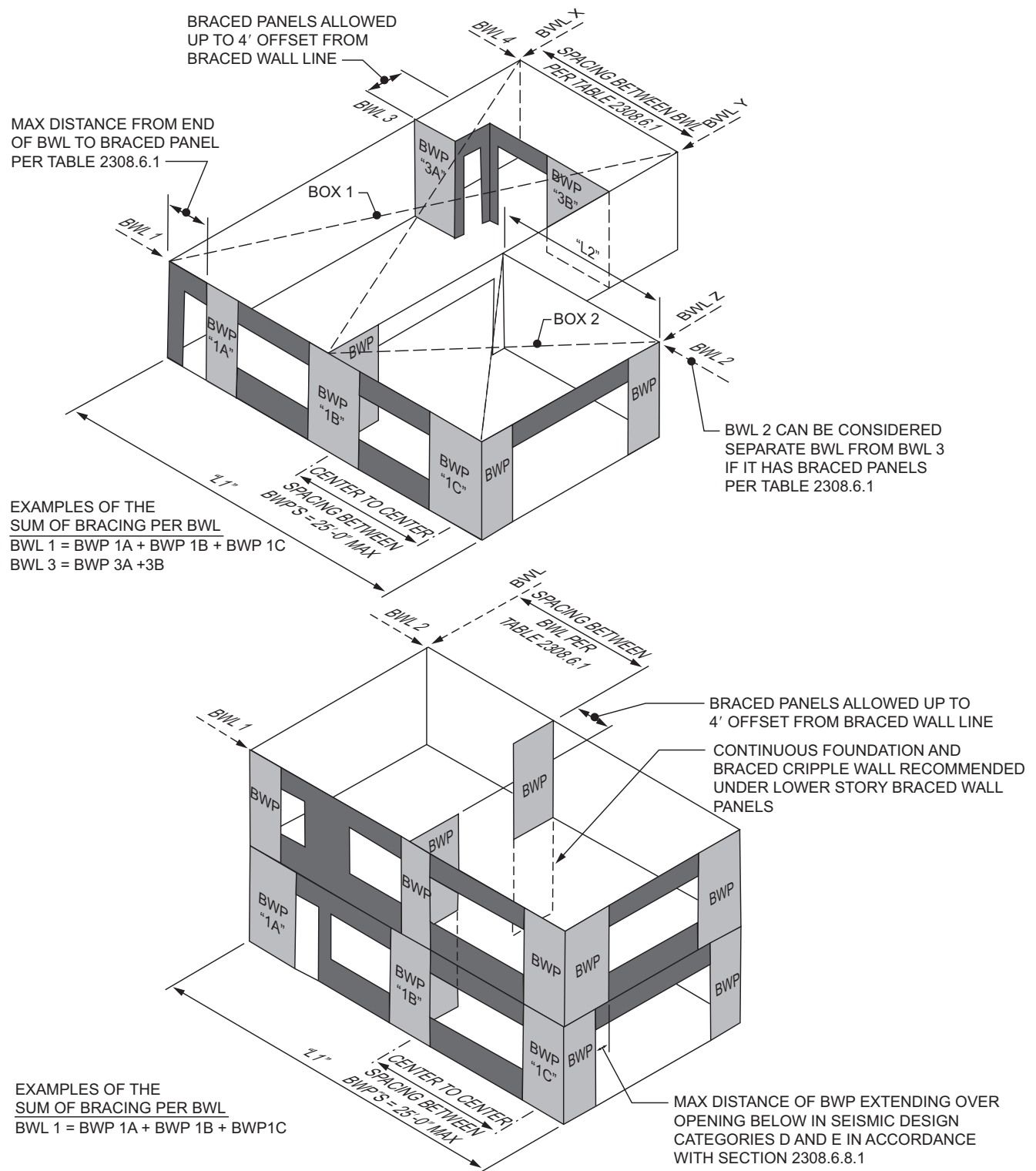
Vertical joints of panel sheathing shall occur over studs and adjacent panel joints shall be nailed to common framing members. Horizontal joints shall occur over blocking or other framing equal in size to the studding except where waived by the installation requirements for the specific sheathing materials. Sole plates shall be nailed to the floor framing in accordance with Section 2308.6.7 and top plates shall be connected to the framing above in accordance with Section 2308.6.7.2. Where joists are perpendicular to *braced wall lines* above, blocking shall be provided under and in line with the *braced wall panels*.

TABLE 2308.5.11  
MINIMUM THICKNESS OF WALL SHEATHING

SHEATHING TYPE	MINIMUM THICKNESS	MAXIMUM WALL STUD SPACING
Diagonal wood boards	⅝ inch	24 inches on center
Structural fiberboard	1½ inch	16 inches on center
Wood structural panel	In accordance with Tables 2308.6.3(2) and 2308.6.3(3)	—
M-S “Exterior Glue” and M-2 “Exterior Glue” particleboard	In accordance with Section 2306.3 and Table 2308.6.3(4)	—
Gypsum sheathing	1½ inch	16 inches on center
Reinforced cement mortar	1 inch	24 inches on center
Hardboard panel siding	In accordance with Table 2308.6.3(5)	—

For SI: 1 inch = 25.4 mm.



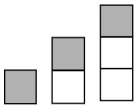







For SI: 1 foot = 304.8 mm.

**FIGURE 2308.6.1**  
**BASIC COMPONENTS OF THE LATERAL BRACING SYSTEM**

## WOOD

**TABLE 2308.6.1**  
**WALL BRACING REQUIREMENTS<sup>a</sup>**

SEISMIC DESIGN CATEGORY	STORY CONDITION (SEE SECTION 2308.2)	MAXIMUM SPACING OF BRACED WALL LINES	BRACED PANEL LOCATION, SPACING (O.C.) AND MINIMUM PERCENTAGE (X)			MAXIMUM DISTANCE OF BRACED WALL PANELS FROM EACH END OF BRACED WALL LINE
			Bracing method <sup>b</sup>			
			LIB	DWB, WSP	SFB, PBS, PCP, HPS, GB <sup>c, d</sup>	
A and B		35'- 0"	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	12'- 6"
		35'- 0"	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	12'- 6"
		35'- 0"	NP	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	12'- 6"
C		35'- 0"	NP	Each end and ≤ 25'- 0" o.c.	Each end and ≤ 25'- 0" o.c.	12'- 6"
		35'- 0"	NP	Each end and ≤ 25'- 0" o.c. (minimum 25% of wall length) <sup>e</sup>	Each end and ≤ 25'- 0" o.c. (minimum 25% of wall length) <sup>e</sup>	12'- 6"
D and E		25'- 0"	NP	$S_{DS} < 0.50$ : Each end and ≤ 25'- 0" o.c. (minimum 21% of wall length) <sup>e</sup>	$S_{DS} < 0.50$ : Each end and ≤ 25'- 0" o.c. (minimum 43% of wall length) <sup>e</sup>	8'- 0"
				$0.5 \leq S_{DS} < 0.75$ : Each end and ≤ 25'- 0" o.c. (minimum 32% of wall length) <sup>e</sup>	$0.5 \leq S_{DS} < 0.75$ : Each end and ≤ 25'- 0" o.c. (minimum 59% of wall length) <sup>e</sup>	
				$0.75 \leq S_{DS} \leq 1.00$ : Each end and ≤ 25'- 0" o.c. (minimum 37% of wall length) <sup>e</sup>	$0.75 \leq S_{DS} \leq 1.00$ : Each end and ≤ 25'- 0" o.c. (minimum 75% of wall length) <sup>e</sup>	
				$S_{DS} > 1.00$ : Each end and ≤ 25'- 0" o.c. (minimum 48% of wall length) <sup>e</sup>	$S_{DS} > 1.00$ : Each end and ≤ 25'- 0" o.c. (minimum 100% of wall length) <sup>e</sup>	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

NP = Not Permitted.

a. This table specifies minimum requirements for braced wall panels along interior or exterior braced wall lines.



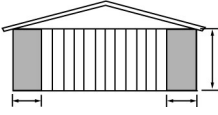
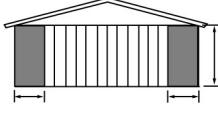
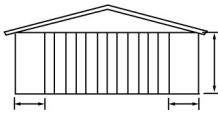
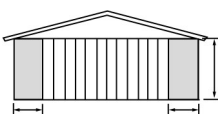
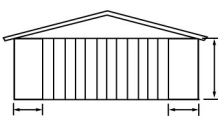
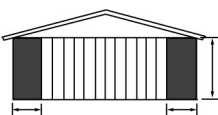
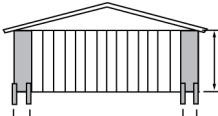
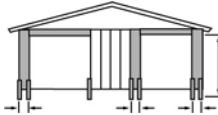
b. See Section 2308.6.3 for full description of bracing methods.

c. For Method GB, gypsum wallboard applied to framing supports that are spaced at 16 inches on center.

d. The required lengths shall be doubled for gypsum board applied to only one face of a braced wall panel.

e. Percentage shown represents the minimum amount of bracing required along the building length (or wall length if the structure has an irregular shape).

**TABLE 2308.6.3(1)  
BRACING METHODS**

METHODS, MATERIAL	MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA <sup>a</sup>	
			Fasteners	Spacing
<b>LIB<sup>a</sup></b> Let-in-bracing	1" × 4" wood or approved metal straps attached at 45° to 60° angles to studs at maximum of 16" o.c.		Table 2304.10.2	Wood: per stud plus top and bottom plates
			Metal strap: installed in accordance with manufacturer's recommendations	Metal strap: installed in accordance with manufacturer's recommendations
<b>DWB</b> Diagonal wood boards	$\frac{3}{4}$ " thick (1" nominal) × 6" minimum width to studs at maximum of 24" o.c.		Table 2304.10.2	Per stud
<b>WSP</b> Wood structural panel	$\frac{3}{8}$ " in accordance with Table 2308.6.3(2) or 2308.6.3(3)		Table 2304.10.2	6" edges 12" field
<b>SFB</b> Structural fiber-board sheathing	$\frac{1}{2}$ " in accordance with Table 2304.10.2 to studs at maximum 16" o.c.		Table 2304.10.2	3" edges 6" field
<b>GB</b> Gypsum board (Double sided)	$\frac{1}{2}$ " or $\frac{5}{8}$ " by not less than 4' wide to studs at maximum of 24" o.c.		Section 2506.2 for exterior and interior sheathing: 5d annual ringed cooler nails ( $1\frac{5}{8}$ " × 0.086") or 1 $\frac{1}{4}$ " screws (Type W or S) for $\frac{1}{2}$ " gypsum board or 1 $\frac{5}{8}$ " screws (Type W or S) for $\frac{5}{8}$ " gypsum board	For all braced wall panel locations: 7" o.c. along panel edges (including top and bottom plates) and 7" o.c. in the field
<b>PBS</b> Particleboard sheathing	$\frac{3}{8}$ " or $\frac{1}{2}$ " in accordance with Table 2308.6.3(4) to studs at maximum of 16" o.c.		6d common (2" long × 0.113" dia.) nails for $\frac{3}{8}$ " thick sheathing or 8d common (2 $\frac{1}{2}$ " long × 0.131" dia.) nails for $\frac{1}{2}$ " thick sheathing	3" edges 6" field
<b>PCP</b> Portland cement plaster	Section 2510 to studs at maximum of 16" o.c.		1 $\frac{1}{2}$ " long, 11 gage, 0.120" dia., $\frac{7}{16}$ " dia. head nails or $\frac{7}{8}$ " long, 16 gage staples	6" o.c. on all framing members
<b>HPS</b> Hardboard panel siding	$\frac{7}{16}$ " in accordance with Table 2308.6.3(5)		Table 2304.10.2	4" edges 8" field
<b>ABW</b> Alternate braced wall	$\frac{3}{8}$ "		Figure 2308.6.5.1 and Section 2308.6.5.1	Figure 2308.6.5.1
<b>PFH</b> Portal frame with hold-downs	$\frac{3}{8}$ "		Figure 2308.6.5.2 and Section 2308.6.5.2	Figure 2308.6.5.2

For SI: 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

a. Method LIB shall have gypsum board fastened to one or more side(s) with nails or screws

## WOOD

**TABLE 2308.6.3(2)**  
**EXPOSED PLYWOOD PANEL SIDING**

MINIMUM THICKNESS <sup>a</sup> (inch)	MINIMUM NUMBER OF PLYS	STUD SPACING (inches) Plywood siding applied directly to studs or over sheathing
$\frac{3}{8}$	3	16 <sup>b</sup>
$\frac{1}{2}$	4	24

For SI: 1 inch = 25.4 mm.

a. Thickness of grooved panels is measured at bottom of grooves.

b. Spans are permitted to be 24 inches if plywood siding applied with face grain perpendicular to studs or over one of the following: 1-inch board sheathing;  $\frac{7}{16}$ -inch wood structural panel sheathing; or  $\frac{3}{8}$ -inch wood structural panel sheathing with strength axis (which is the long direction of the panel unless otherwise marked) of sheathing perpendicular to studs.

**TABLE 2308.6.3(3)**  
**WOOD STRUCTURAL PANEL WALL SHEATHING<sup>b</sup>**  
(Not exposed to the weather, strength axis parallel or perpendicular to studs except as indicated)

MINIMUM THICKNESS (inch)	PANEL SPAN RATING	STUD SPACING (inches)		
		Siding nailed to studs	Nailable sheathing	
			Sheathing parallel to studs	Sheathing perpendicular to studs
$\frac{3}{8}$ , $\frac{15}{32}$ , $\frac{1}{2}$	16/0, 20/0, 24/0, 32/16 Wall—24" o.c.	24	16	24
$\frac{7}{16}$ , $\frac{15}{32}$ , $\frac{1}{2}$	24/0, 24/16, 32/16 Wall—24" o.c.	24	24 <sup>a</sup>	24

For SI: 1 inch = 25.4 mm.

a. Plywood shall consist of four or more plies.

b. Blocking of horizontal joints shall not be required except as specified in Section 2308.6.4.

**TABLE 2308.6.3(4)**  
**ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING**  
(Not exposed to the weather, long dimension of the panel parallel or perpendicular to studs)

GRADE	THICKNESS (inch)	STUD SPACING (inches)	
		Siding nailed to studs	Sheathing under coverings specified in Section 2308.6.3 parallel or perpendicular to studs
M-S "Exterior Glue" and M-2 "Exterior Glue"	$\frac{3}{8}$	16	—
	$\frac{1}{2}$	16	16

For SI: 1 inch = 25.4 mm.



**TABLE 2308.6.3(5)  
HARDBOARD SIDING**

SIDING	MINIMUM NOMINAL THICKNESS (inch)	2 x 4 FRAMING MAXIMUM SPACING	NAIL SIZE <sup>a, b, d</sup>	NAIL SPACING	
				General	Bracing panels <sup>e</sup>
1. Lap siding					
Direct to studs	<sup>3</sup> / <sub>8</sub>	16" o.c.	8d	16" o.c.	Not applicable
Over sheathing	<sup>3</sup> / <sub>8</sub>	16" o.c.	10d	16" o.c.	Not applicable
2. Square edge panel siding					
Direct to studs	<sup>3</sup> / <sub>8</sub>	24" o.c.	6d	6" o.c. edges; 12" o.c. at intermediate supports	4" o.c. edges; 8" o.c. at intermediate supports
Over sheathing	<sup>3</sup> / <sub>8</sub>	24" o.c.	8d	6" o.c. edges; 12" o.c. at intermediate supports	4" o.c. edges; 8" o.c. at intermediate supports
3. Shiplap edge panel siding					
Direct to studs	<sup>3</sup> / <sub>8</sub>	16" o.c.	6d	6" o.c. edges; 12" o.c. at intermediate supports	4" o.c. edges; 8" o.c. at intermediate supports
Over sheathing	<sup>3</sup> / <sub>8</sub>	16" o.c.	8d	6" o.c. edges; 12" o.c. at intermediate supports	4" o.c. edges; 8" o.c. at intermediate supports

For SI: 1 inch = 25.4 mm.

a. Nails shall be corrosion resistant.

b. Minimum acceptable nail dimensions:

	Panel Siding (inch)	Lap Siding (inch)
Shank diameter	0.092	0.099
Head diameter	0.225	0.240

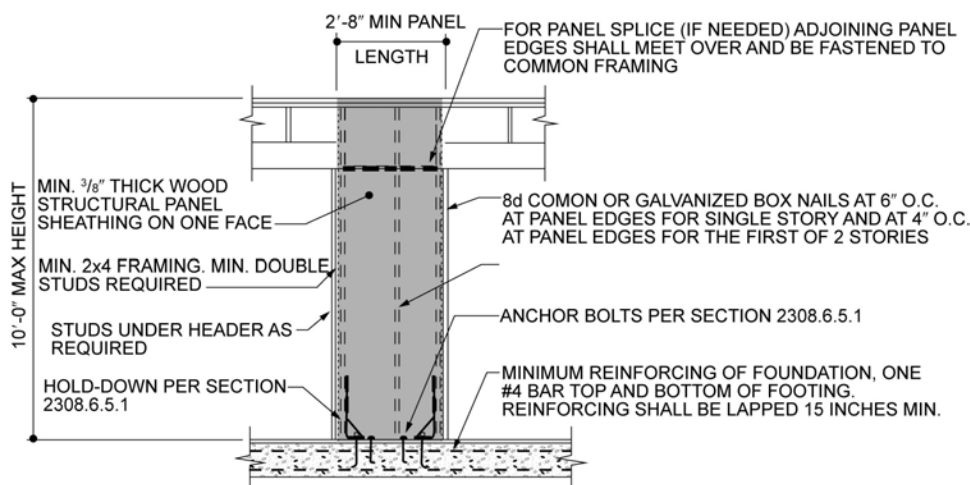
c. Where used to comply with Section 2308.6.

d. Nail length must accommodate the sheathing and penetrate framing  $1\frac{1}{2}$  inches.

**2308.6.5 Alternative bracing.** An alternate braced wall (ABW) or a portal frame with *hold-downs* (PFH) described in this section is permitted to substitute for a 48-inch (1219 mm) *braced wall panel* of Method DWB, WSP, SFB, PBS, PCP or HPS. For Method GB, each 96-inch (2438 mm) section (applied to one face) or 48-inch (1219 mm) section (applied to both faces) or portion thereof required by Table 2308.6.1 is permitted to be

replaced by one panel constructed in accordance with Method ABW or PFH.

**2308.6.5.1 Alternate braced wall (ABW).** An ABW shall be constructed in accordance with this section and Figure 2308.6.5.1. In one-story buildings, each panel shall have a length of not less than 2 feet 8 inches (813 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2308.6.5.1  
ALTERNATE BRACED WALL PANEL (ABW)**

## WOOD

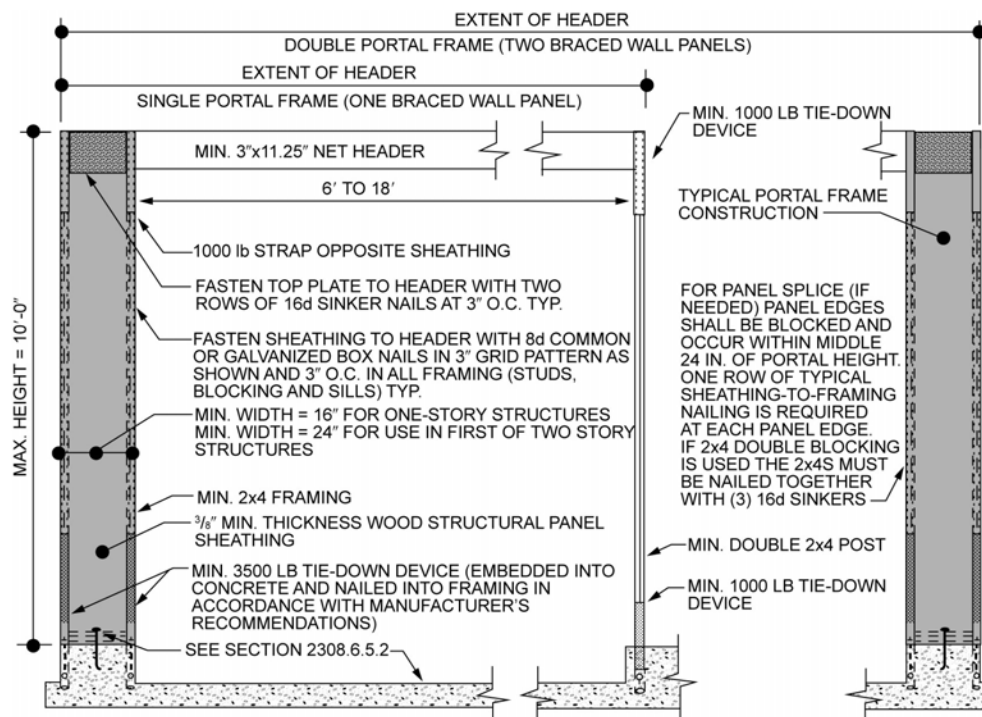
with  $\frac{3}{8}$ -inch (3.2 mm) minimum-thickness *wood structural panel* sheathing nailed with 8d common or galvanized box nails in accordance with Table 2304.10.2 and blocked at *wood structural panel* edges. Two anchor bolts installed in accordance with Section 2308.3.1 shall be provided in each panel. Anchor bolts shall be placed at each panel outside quarter points. Each panel end stud shall have a *hold-down* device fastened to the foundation, capable of providing an *approved* uplift capacity of not less than 1,800 pounds (8006 N). The *hold-down* device shall be installed in accordance with the manufacturer's recommendations. The ABW shall be supported directly on a foundation or on floor framing supported directly on a foundation that is continuous across the entire length of the *braced wall line*. This foundation shall be reinforced with not less than one No. 4 bar top and bottom. Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned-down slab edge is permitted at door openings in the *braced wall line*. This continuous footing or turned-down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the *braced wall line*.

Where the ABW is installed at the first story of two-story buildings, the *wood structural panel* sheath-

ing shall be provided on both faces, three anchor bolts shall be placed at one-quarter points and *tie-down* device uplift capacity shall be not less than 3,000 pounds (13 344 N).

**2308.6.5.2 Portal frame with hold-downs (PFH).** A PFH shall be constructed in accordance with this section and Figure 2308.6.5.2. The adjacent door or window opening shall have a full-length header.

In one-story buildings, each panel shall have a length of not less than 16 inches (406 mm) and a height of not more than 10 feet (3048 mm). Each panel shall be sheathed on one face with a single layer of  $\frac{3}{8}$ -inch (9.5 mm) minimum-thickness *wood structural panel* sheathing nailed with 8d common or galvanized box nails in accordance with Figure 2308.6.5.2. The *wood structural panel* sheathing shall extend up over the solid sawn or glued-laminated header and shall be nailed in accordance with Figure 2308.6.5.2. A built-up header consisting of not fewer than two 2-inch by 12-inch (51 mm by 305 mm) boards, fastened in accordance with Item 24 of Table 2304.10.2 shall be permitted to be used. A spacer, if used, shall be placed on the side of the built-up beam opposite the *wood structural panel* sheathing. The header shall extend between the inside faces of the first full-length outer studs of each panel. The clear span of the header between the inner studs of each panel shall be not less than 6 feet (1829 mm) and not more than 18 feet (5486 mm) in length. A strap with an uplift capacity of not



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N.

**FIGURE 2308.6.5.2**  
**PORTAL FRAME WITH HOLD-DOWNS (PFH)**

less than 1,000 pounds (4,400 N) shall fasten the header to the inner studs opposite the sheathing. One anchor bolt not less than  $\frac{5}{8}$  inch (15.9 mm) diameter and installed in accordance with Section 2308.3.1 shall be provided in the center of each sill plate. The studs at each end of the panel shall have a *hold-down* device fastened to the foundation with an uplift capacity of not less than 3,500 pounds (15 570 N).

Where a panel is located on one side of the opening, the header shall extend between the inside face of the first full-length stud of the panel and the bearing studs at the other end of the opening. A strap with an uplift capacity of not less than 1,000 pounds (4400 N) shall fasten the header to the bearing studs. The bearing studs shall have a *hold-down* device fastened to the foundation with an uplift capacity of not less than 1,000 pounds (4400 N). The *hold-down* devices shall be an embedded strap type, installed in accordance with the manufacturer's recommendations. The PFH panels shall be supported directly on a foundation that is continuous across the entire length of the *braced wall line*. This foundation shall be reinforced with not less than one No. 4 bar top and bottom. Where the continuous foundation is required to have a depth greater than 12 inches (305 mm), a minimum 12-inch by 12-inch (305 mm by 305 mm) continuous footing or turned-down slab edge is permitted at door openings in the *braced wall line*. This continuous footing or turned-down slab edge shall be reinforced with not less than one No. 4 bar top and bottom. This reinforcement shall be lapped not less than 15 inches (381 mm) with the reinforcement required in the continuous foundation located directly under the *braced wall line*.

Where a PFH is installed at the first *story* of two-story buildings, each panel shall have a length of not less than 24 inches (610 mm).

**2308.6.6 Cripple wall bracing.** *Cripple walls* shall be braced in accordance with Section 2308.6.6.1 or 2308.6.6.2.

**2308.6.6.1 Cripple wall bracing in Seismic Design Categories A, B and C.** For the purposes of this section, *cripple walls* in *Seismic Design Categories A, B and C* having a stud height exceeding 14 inches (356 mm) shall be considered to be a *story* and shall be braced in accordance with Table 2308.6.1. Spacing of *edge nailing* for required *cripple wall* bracing shall not exceed 6 inches (152 mm) on center along the foundation plate and the top plate of the *cripple wall*. Nail size, nail spacing for *field nailing* and more restrictive *boundary nailing* requirements shall be as required elsewhere in the code for the specific bracing material used.

**2308.6.6.2 Cripple wall bracing in Seismic Design Categories D and E.** For the purposes of this section, *cripple walls* in *Seismic Design Categories D and E* shall not have a stud height exceeding 14 inches (356 mm), and studs shall be solid blocked in accordance with Section 2308.5.6 for the full dwelling perimeter

and for the full length of interior braced walls lines supported on foundations, excepting ventilation and access openings.

**2308.6.7 Connections of braced wall panels.** *Braced wall panel* joints shall occur over studs or blocking. *Braced wall panels* shall be fastened to studs, top and bottom plates and at panel edges. *Braced wall panels* shall be applied to nominal 2-inch-wide [actual  $1\frac{1}{2}$ -inch (38 mm)] or larger stud framing.

**2308.6.7.1 Bottom plate connection.** *Braced wall line* bottom plates shall be connected to joists or full-depth blocking below in accordance with Table 2304.10.2, or to foundations in accordance with Section 2308.6.7.3.

**2308.6.7.2 Top plate connection.** Where joists or rafters are used, *braced wall line* top plates shall be fastened over the full length of the *braced wall line* to joists, rafters, rim boards or full-depth blocking above in accordance with Table 2304.10.2, as applicable, based on the orientation of the joists or rafters to the *braced wall line*. Blocking shall be not less than 2 inches (51 mm) in nominal thickness and shall be fastened to the *braced wall line* top plate as specified in Table 2304.10.2. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.4.2.4 or 2308.7.4 shall be permitted.

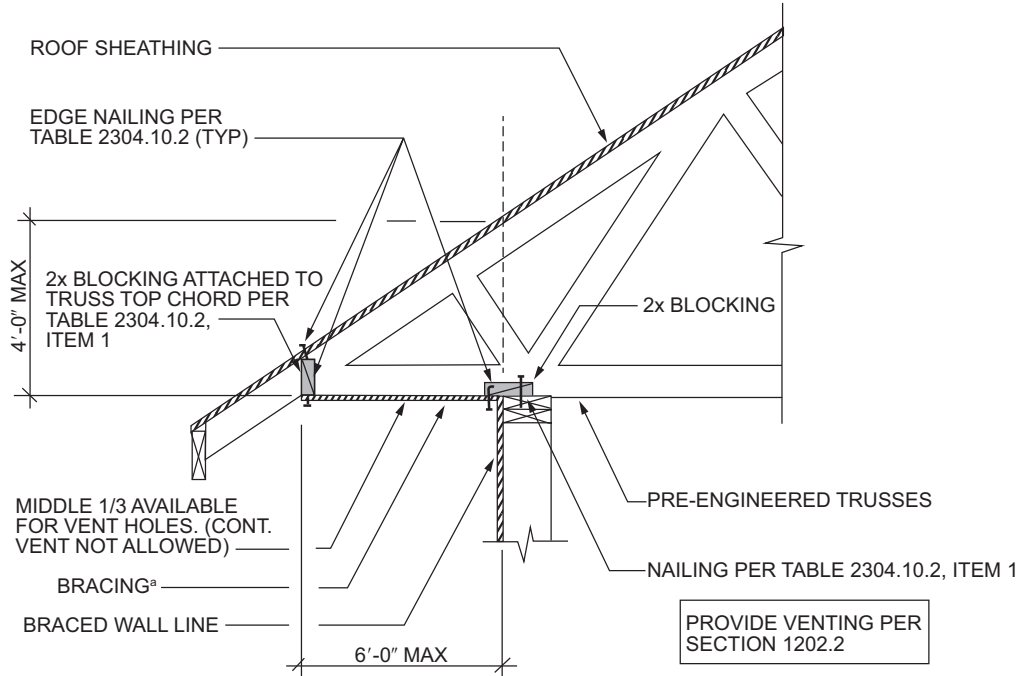
At exterior *gable* end walls, *braced wall panel* sheathing in the top *story* shall be extended and fastened to the roof framing where the spacing between parallel exterior braced wall lines is greater than 50 feet (15 240 mm).

Where roof trusses are used and are installed perpendicular to an exterior *braced wall line*, lateral forces shall be transferred from the roof *diaphragm* to the braced wall over the full length of the *braced wall line* by blocking of the ends of the trusses or by other *approved* methods providing equivalent lateral force transfer. Blocking shall be not less than 2 inches (51 mm) in nominal thickness and equal to the depth of the truss at the wall line and shall be fastened to the *braced wall line* top plate as specified in Table 2304.10.2. Notching or drilling of holes in blocking in accordance with the requirements of Section 2308.4.2.4 or 2308.7.4 shall be permitted.

**Exception:** Where the roof sheathing is greater than  $9\frac{1}{4}$  inches (235 mm) above the top plate, solid blocking is not required where the framing members are connected using one of the following methods:

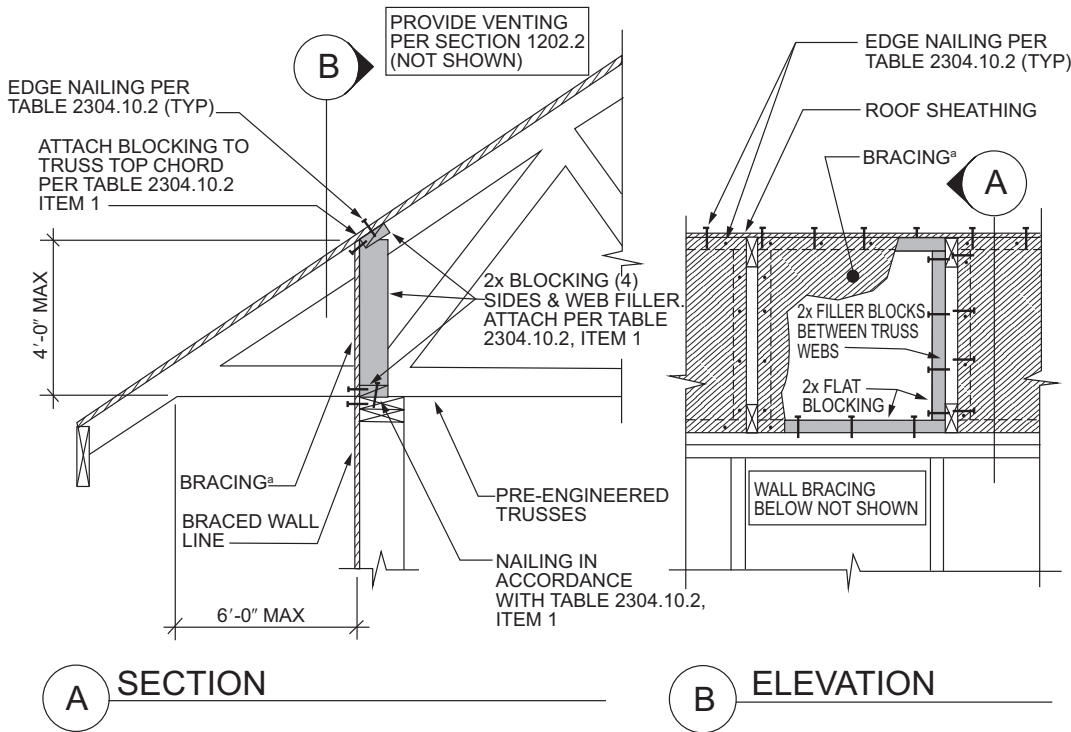
1. In accordance with Figure 2308.6.7.2(1).
2. In accordance with Figure 2308.6.7.2(2).
3. Full-height engineered blocking panels designed for values listed in AWC WFCM.
4. A design in accordance with accepted engineering methods.

WOOD



For SI: 1 foot = 304.8 mm.  
a. Methods of bracing shall be as described in Table 2308.6.3(1) DWB, WSP, SFB, GB, PBS, PCP or HPS.

**FIGURE 2308.6.7.2(1)**  
**BRACED WALL LINE TOP PLATE CONNECTION**



For SI: 1 foot = 304.8 mm.  
a. Methods of bracing shall be as described in Table 2308.6.3(1) DWB, WSP, SFB, GB, PBS, PCP or HPS.

**FIGURE 2308.6.7.2(2)**  
**BRACED WALL PANEL TOP PLATE CONNECTION**



**2308.6.7.3 Sill anchorage.** Where foundations are required by Section 2308.6.8, *braced wall line* sills shall be anchored to concrete or masonry foundations. Such anchorage shall conform to the requirements of Section 2308.3. The anchors shall be distributed along the length of the *braced wall line*. Other anchorage devices having equivalent capacity are permitted.

**2308.6.7.4 Anchorage to all-wood foundations.** Where all-wood foundations are used, the force transfer from the *braced wall lines* shall be determined based on calculation and shall have a capacity that is not less than the connections required by Section 2308.3.

**2308.6.8 Braced wall line and diaphragm support.** *Braced wall lines* and floor and roof *diaphragms* shall be supported in accordance with this section.

**2308.6.8.1 Foundation requirements.** *Braced wall lines* shall be supported by continuous foundations.

**Exception:** For structures with a maximum plan dimension not more than 50 feet (15 240 mm), continuous foundations are required at *exterior walls* only.

For structures in *Seismic Design Categories* D and E, exterior *braced wall panels* shall be in the same plane vertically with the foundation or the portion of the structure containing the offset shall be designed in accordance with accepted engineering practice and Section 2308.1.1.

**Exceptions:**

1. Exterior *braced wall panels* shall be permitted to be located not more than 4 feet (1219 mm) from the foundation below where supported by a floor constructed in accordance with all of the following:
  - 1.1. Cantilevers or setbacks shall not exceed four times the nominal depth of the floor joists.
  - 1.2. Floor joists shall be 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) on center.
  - 1.3. The ratio of the back span to the cantilever shall be not less than 2 to 1.
  - 1.4. Floor joists at ends of *braced wall panels* shall be doubled.
  - 1.5. A continuous rim joist shall be connected to the ends of cantilevered joists. The rim joist is permitted to be spliced using a metal tie not less than 0.058 inch (1.47 mm) (16 galvanized gage) and 1½ inches (38 mm) in width fastened with six 16d common nails on each side. The metal tie

shall have a yield stress not less than 33,000 psi (227 MPa).

- 1.6. Joists at setbacks or the end of cantilevered joists shall not carry gravity *loads* from more than a single *story* having uniform wall and roof *loads* nor carry the reactions from headers having a span of 8 feet (2438 mm) or more.
2. The end of a required *braced wall panel* shall be allowed to extend not more than 1 foot (305 mm) over an opening in the wall below. This requirement is applicable to *braced wall panels* offset in plane and *braced wall panels* offset out of plane as permitted by Exception 1. *Braced wall panels* are permitted to extend over an opening not more than 8 feet (2438 mm) in width where the header is a 4-inch by 12-inch (102 mm by 305 mm) or larger member.

**2308.6.8.2 Floor and roof diaphragm support in Seismic Design Categories D and E.** In structures assigned to *Seismic Design Categories* D or E, floor and roof *diaphragms* shall be laterally supported by *braced wall lines* on all edges and connected in accordance with Section 2308.6.7 [see Figure 2308.6.8.2(1)].

**Exception:** Portions of roofs or floors that do not support *braced wall panels* above are permitted to extend up to 6 feet (1829 mm) beyond a *braced wall line* [see Figure 2308.6.8.2(2)] provided that the framing members are connected to the *braced wall line* below in accordance with Section 2308.6.7.

**2308.6.8.3 Stepped footings in Seismic Design Categories B, C, D and E.** In *Seismic Design Categories* B, C, D and E, where the height of a required *braced wall panel* extending from foundation to floor above varies more than 4 feet (1219 mm), the following construction shall be used:

1. Where the bottom of the footing is stepped and the *lowest floor* framing rests directly on a sill bolted to the footings, the sill shall be anchored as required in Section 2308.3.
2. Where the *lowest floor* framing rests directly on a sill bolted to a footing not less than 8 feet (2438 mm) in length along a line of bracing, the line shall be considered to be braced. The double plate of the cripple stud wall beyond the segment of footing extending to the lowest framed floor shall be spliced to the sill plate with metal ties, one on each side of the sill and plate. The metal ties shall be not less than 0.058 inch [1.47 mm (16 galvanized gage)] by 1½ inches (38 mm) in width by 48 inches (1219 mm) with eight 16d common nails on each side of the splice location (see Figure

## WOOD

2308.6.8.3). The metal tie shall have a yield stress not less than 33,000 pounds per square inch (psi) (227 MPa).

- Where *cripple walls* occur between the top of the footing and the *lowest floor* framing, the bracing requirements for a *story* shall apply.

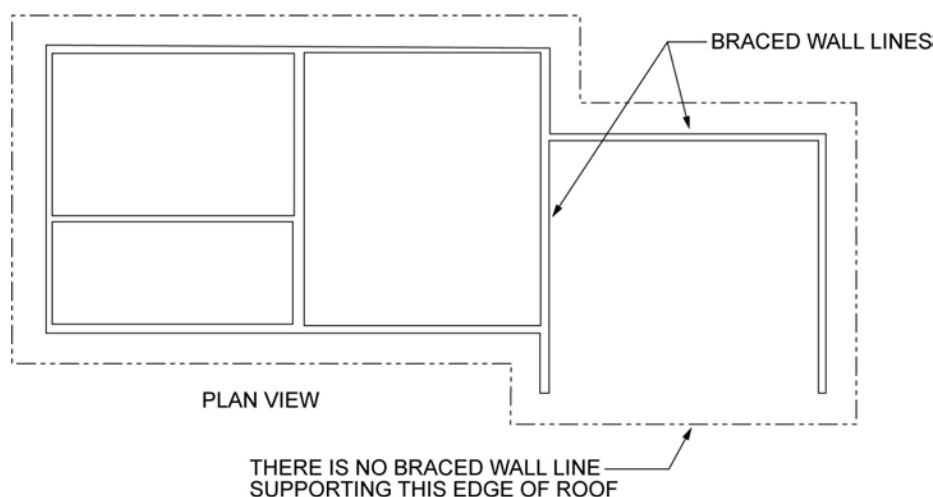
**2308.6.9 Attachment of sheathing.** Fastening of *braced wall panel* sheathing shall be not less than that prescribed in Tables 2308.6.1 and 2304.10.2. Wall sheathing shall not be attached to framing members by adhesives.

**2308.6.10 Limitations of concrete or masonry veneer.** Concrete or masonry *veneer* shall comply with Chapter 14 and this section.

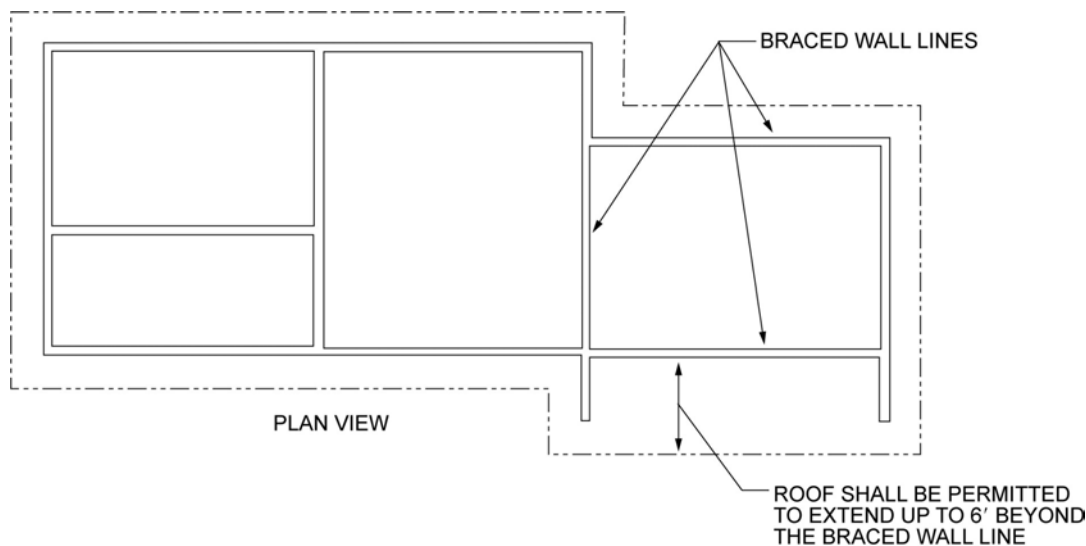
**2308.6.10.1 Limitations of concrete or masonry veneer in Seismic Design Category B or C.** In *Seismic Design Categories B* and *C*, concrete or masonry walls and stone or masonry *veneer* shall not extend above a basement.

**Exceptions:**

- In structures assigned to *Seismic Design Category B*, stone and masonry *veneer* is permitted to be used in the first two *stories above grade plane* or the first three *stories above grade plane* where the lowest *story* has concrete or masonry walls, provided that *wood structural panel wall bracing* is used and the length of bracing provided is



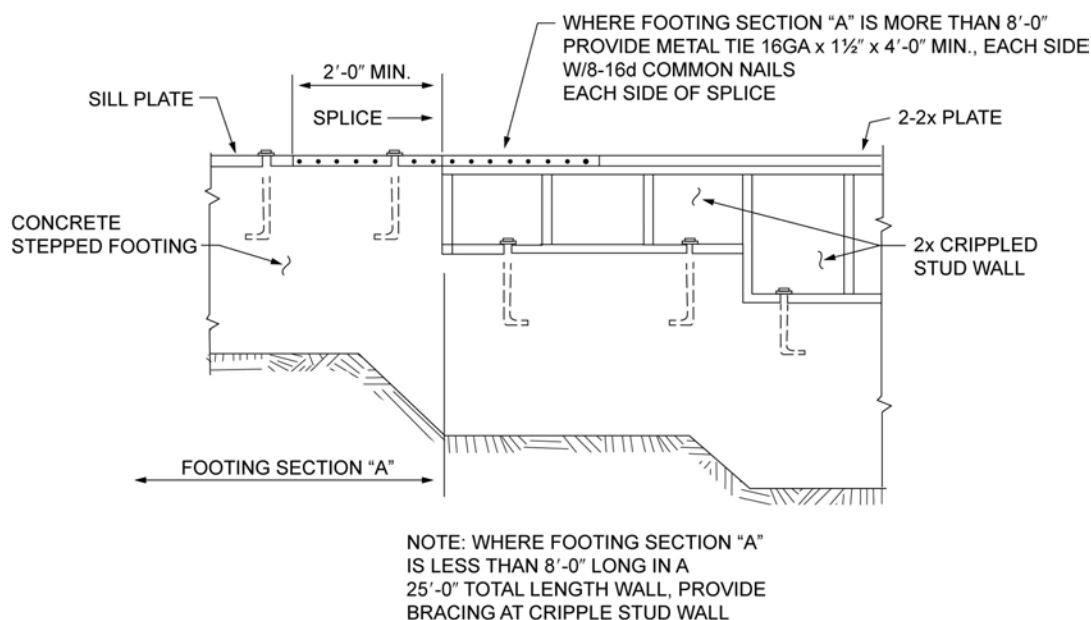
**FIGURE 2308.6.8.2(1)**  
**ROOF IN SDC D OR E NOT SUPPORTED ON ALL EDGES**



**FIGURE 2308.6.8.2(2)**  
**ROOF EXTENSION IN SDC D OR E BEYOND BRACED WALL LINE**

For SI: 1 foot = 304.8 mm.

- one and one-half times the required length specified in Table 2308.6.1.
2. Stone and masonry *veneer* is permitted to be used in the first *story above grade plane* or the first two *stories above grade plane* where the lowest *story* has concrete or masonry walls.
  3. Stone and masonry *veneer* is permitted to be used in both *stories* of buildings with two *stories above grade plane*, provided that the following criteria are met:
    - 3.1. Type of brace in accordance with Section 2308.6.1 shall be WSP and the allowable shear capacity in accordance with Section 2306.3 shall be not less than 350 plf (5108 N/m).
    - 3.2. *Braced wall panels* in the second *story* shall be located in accordance with Section 2308.6.1 and not more than 25 feet (7620 mm) on center, and the total length of *braced wall panels* shall be not less than 25 percent of the *braced wall line* length. *Braced wall panels* in the first *story* shall be located in accordance with Section 2308.6.1 and not more than 25 feet (7620 mm) on center, and the total length of *braced wall panels* shall be not less than 45 percent of the *braced wall line* length.
    - 3.3. *Hold-down* connectors with an allowable capacity of 2,000 pounds (8896 N) shall be provided at the ends of each *braced wall panel* for the second *story* to the first *story* connection. *Hold-down* connectors with an allowable capacity of 3,900 pounds (17 347 N) shall be provided at the ends of each *braced wall panel* for the first *story* to the foundation connection. In all cases, the *hold-down* connector force shall be transferred to the foundation.
    - 3.4. *Cripple walls* shall not be permitted.
- 2308.6.10.2 Limitations of concrete or masonry in Seismic Design Categories D and E.** In *Seismic Design Categories D and E*, concrete or masonry walls and stone or masonry *veneer* shall not extend above a basement.
- Exception:** In structures assigned to *Seismic Design Category D*, stone and masonry *veneer* is permitted to be used in the first *story above grade plane*, provided that the following criteria are met:
1. Type of brace in accordance with Section 2308.6.1 shall be WSP and the allowable shear capacity in accordance with Section 2306.3 shall be not less than 350 plf (5108 N/m).



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 2308.6.8.3**  
**STEPPED FOOTING CONNECTION DETAILS**

## WOOD

2. The *braced wall panels* in the first story shall be located at each end of the *braced wall line* and not more than 25 feet (7620 mm) on center, and the total length of *braced wall panels* shall be not less than 45 percent of the *braced wall line* length.
3. *Hold-down* connectors shall be provided at the ends of braced walls for the first floor to foundation with an allowable capacity of 2,100 pounds (9341 N).
4. *Cripple walls* shall not be permitted.

**2308.7 Roof and ceiling framing.** The framing details required in this section apply to roofs having a slope of not less than three units vertical in 12 units horizontal (25-percent slope). Where the roof slope is less than three units vertical in 12 units horizontal (25-percent slope), members supporting rafters and ceiling joists such as ridge board, hips and valleys shall be designed as beams.

**2308.7.1 Ceiling joist spans.** Spans for ceiling joists shall be in accordance with Table 2308.7.1(1) or 2308.7.1(2). For other grades and species, and other loading conditions, refer to the AWC STJR.

**2308.7.2 Rafter spans.** Spans for rafters shall be in accordance with Table 2308.7.2(1), 2308.7.2(2), 2308.7.2(3), 2308.7.2(4), 2308.7.2(5) or 2308.7.2(6). For other grades and species and other loading conditions, refer to the AWC STJR. The span of each rafter shall be measured along the horizontal projection of the rafter.

**2308.7.3 Ceiling joist and rafter framing.** Rafters shall be framed directly opposite each other at the ridge. There shall be a ridge board not less than 1-inch (25 mm) nominal thickness at ridges and not less in depth than the cut end of the rafter. At valleys and hips, there shall be a single valley or hip rafter not less than 2-inch (51 mm) nominal thickness and not less in depth than the cut end of the rafter.

**2308.7.3.1 Ceiling joist and rafter connections.** Ceiling joists and rafters shall be nailed to each other and the assembly shall be nailed to the top wall plate in accordance with Tables 2304.10.2 and 2308.7.5. Ceiling joists shall be continuous or securely joined where they meet over interior partitions and be fastened to adjacent rafters in accordance with Tables 2304.10.2 and 2308.7.3.1 to provide a continuous rafter tie across the building where such joists are parallel to the rafters. Ceiling joists shall have a bearing surface of not less than 1½ inches (38 mm) on the top plate at each end.

Where ceiling joists are not parallel to rafters, an equivalent rafter tie shall be installed in a manner to provide a continuous tie across the building, at a spacing of not more than 4 feet (1219 mm) on center. The connections shall be in accordance with Tables 2308.7.3.1 and 2304.10.2, or connections of equivalent capacities shall be provided. Where ceiling joists or rafter ties are not provided at the top of the rafter support walls, the ridge formed by these rafters shall

be supported by a girder conforming to Section 2308.8. Rafter ties shall be spaced not more than 4 feet (1219 mm) on center.

Rafter tie connections shall be based on the equivalent rafter spacing in Table 2308.7.3.1. Rafter-to-ceiling joist connections and rafter tie connections shall be of sufficient size and number to prevent splitting from nailing.

Roof framing member connection to *braced wall lines* shall be in accordance with Section 2308.6.7.2.

**2308.7.4 Notches and holes.** Notching at the ends of rafters or ceiling joists shall not exceed one-fourth the depth. Notches in the top or bottom of the rafter or ceiling joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span, except that a notch not more than one-third of the depth is permitted in the top of the rafter or ceiling joist not further from the face of the support than the depth of the member. Holes bored in rafters or ceiling joists shall not be within 2 inches (51 mm) of the top and bottom and their diameter shall not exceed one-third the depth of the member.

**2308.7.5 Wind uplift.** The roof construction shall have rafter and truss ties to the wall below. Resultant uplift loads shall be transferred to the foundation using a continuous *load* path. The rafter or truss to wall connection shall comply with Tables 2304.10.2 and 2308.7.5.

**2308.7.6 Framing around openings.** Trimmer and header rafters shall be doubled, or of lumber of equivalent cross section, where the span of the header exceeds 4 feet (1219 mm). The ends of header rafters that are more than 6 feet (1829 mm) in length shall be supported by framing anchors or rafter hangers unless bearing on a beam, partition or wall.

**2308.7.6.1 Openings in roof diaphragms in Seismic Design Categories B, C, D and E.** In buildings classified as *Seismic Design Category B, C, D or E*, openings in horizontal *diaphragms* with a dimension that is greater than 4 feet (1219 mm) shall be constructed with metal ties and blocking in accordance with this section and Figure 2308.4.4.1(1). Metal ties shall be not less than 0.058 inch [1.47 mm (16 galvanized gage)] in thickness by 1½ inches (38 mm) in width and shall have a yield stress not less than 33,000 psi (227 Mpa). Blocking shall extend not less than the dimension of the opening in the direction of the tie and blocking. Ties shall be attached to blocking in accordance with the manufacturer's instructions but with not less than eight 16d common nails on each side of the header-joist intersection.

**2308.7.7 Purlins.** Purlins to support roof *loads* are permitted to be installed to reduce the span of rafters within allowable limits and shall be supported by struts to bearing walls. The maximum span of 2-inch by 4-inch (51 mm by 102 mm) purlins shall be 4 feet (1219 mm). The maximum span of the 2-inch by 6-inch (51 mm by 152 mm) purlin shall be 6 feet (1829 mm), but the purlin shall not be smaller than the supported rafter. Struts shall be



not less than 2-inch by 4-inch (51 mm by 102 mm) members. The unbraced length of struts shall not exceed 8 feet (2438 mm) and the slope of the struts shall be not less than 45 degrees (0.79 rad) from the horizontal.

**2308.7.8 Blocking.** Roof rafters and ceiling joists shall be supported laterally to prevent rotation and lateral displacement in accordance with Section 2308.4.6 and connected to *braced wall lines* in accordance with Section 2308.6.7.2.

**2308.7.9 Engineered wood products.** *Prefabricated wood I-joists, structural glued-laminated timber and structural composite lumber* shall not be notched or drilled except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a *registered design professional*.

**2308.7.10 Roof sheathing.** Roof sheathing shall be in accordance with Tables 2304.8(3) and 2304.8(5) for *wood structural panels*, and Tables 2304.8(1) and 2304.8(2) for lumber and shall comply with Section 2304.8.2.

**2308.7.11 Joints.** Joints in lumber sheathing shall occur over supports unless *approved* end-matched lumber is used, in which case each piece shall bear on not fewer than two supports.

**2308.7.12 Roof planking.** Planking shall be designed in accordance with the general provisions of this code.

In lieu of such design, 2-inch (51 mm) tongue-and-groove planking is permitted in accordance with Table 2308.7.12. Joints in such planking are permitted to be randomly spaced, provided that the system is applied to not less than three continuous spans, planks are center matched and end matched or splined, each plank bears on one support or more, and joints are separated by not less than 24 inches (610 mm) in adjacent pieces.

**2308.7.13 Wood trusses.** Wood trusses shall be designed in accordance with Section 2303.4. Connection to *braced wall lines* shall be in accordance with Section 2308.6.7.2.

**2308.7.14 Attic ventilation.** For *attic* ventilation, see Section 1202.2.1.

**2308.8 Design of elements.** Combining of engineered elements or systems and conventionally specified elements or systems shall be permitted subject to the limits of Sections 2308.8.1 and 2308.8.2.

**2308.8.1 Elements exceeding limitations of conventional construction.** Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section 2308.2, these elements and the supporting *load* path shall be designed in accordance with accepted engineering practice and the provisions of this code.

**TABLE 2308.7.5**  
**REQUIRED RATING OF APPROVED UPLIFT CONNECTORS (pounds)<sup>a, b, c, e, f, g, h</sup>**

NOMINAL DESIGN WIND SPEED, $V_{asd}$ <sup>i</sup>	ROOF SPAN (feet)							OVERHANGS (pounds/feet) <sup>d</sup>
	12	20	24	28	32	36	40	
85	-72	-120	-145	-169	-193	-217	-241	-38.55
90	-91	-151	-181	-212	-242	-272	-302	-43.22
100	-131	-281	-262	-305	-349	-393	-436	-53.36
110	-175	-292	-351	-409	-467	-526	-584	-64.56

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.61 km/hr, 1 pound = 0.454 Kg, 1 pound/foot = 14.5939 N/m.

a. The uplift connection requirements are based on a 30-foot mean roof height located in Exposure B. For Exposure C or D and for other mean roof heights, multiply the loads by the following adjustment coefficients:

EXPOSURE	Mean Roof Height (feet)									
	15	20	25	30	35	40	45	50	55	60
B	1.00	1.00	1.00	1.00	1.05	1.09	1.12	1.16	1.19	1.22
C	1.21	1.29	1.35	1.40	1.45	1.49	1.53	1.56	1.59	1.62
D	1.47	1.55	1.61	1.66	1.70	1.74	1.78	1.81	1.84	1.87

b. The uplift connection requirements are based on the framing being spaced 24 inches on center. Multiply by 0.67 for framing spaced 16 inches on center and multiply by 0.5 for framing spaced 12 inches on center.

c. The uplift connection requirements include an allowance for 10 pounds of dead load.

d. The uplift connection requirements do not account for the effects of overhangs. The magnitude of the loads shall be increased by adding the overhang loads found in the table. The overhang loads are based on framing spaced 24 inches on center. The overhang loads given shall be multiplied by the overhang projection and added to the roof uplift value in the table.

e. The uplift connection requirements are based on wind loading on end zones as defined in Figure 28.5-1 of ASCE 7. Connection loads for connections located a distance of 20 percent of the least horizontal dimension of the building from the corner of the building are permitted to be reduced by multiplying the table connection value by 0.7 and multiplying the overhang load by 0.8.

f. For wall-to-wall and wall-to-foundation connections, the capacity of the uplift connector is permitted to be reduced by 100 pounds for each full wall above. (For example, if a 500-pound rated connector is used on the roof framing, a 400-pound rated connector is permitted at the next floor level down).

g. Interpolation is permitted for intermediate values of  $V_{asd}$  and roof spans.

h. The rated capacity of approved tie-down devices is permitted to include up to a 60-percent increase for wind effects where allowed by material specifications.

i.  $V_{asd}$  shall be determined in accordance with Section 1609.3.1.

## WOOD

**2308.8.2 Structural elements or systems not described herein.** Where a building of otherwise conventional construction contains structural elements or systems not described in Section 2308, these elements or systems shall be designed in accordance with accepted engineering practice and the provisions of this code. The extent of such design need only demonstrate compliance of the nonconventional elements with other applicable provisions of this code and shall be compatible with the performance of the conventionally framed system.

### SECTION 2309 WOOD FRAME CONSTRUCTION MANUAL

**2309.1 Wood Frame Construction Manual.** Structural design in accordance with the AWC WFCM shall be permitted for buildings assigned to *Risk Category* I or II subject to the limitations of Section 1.1.3 of the AWC WFCM and the *load* assumptions contained therein. Structural elements beyond these limitations shall be designed in accordance with accepted engineering practice.

**TABLE 2308.7.1(1)**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES**  
(Uninhabitable attics without storage, live load = 10 psf,  $L/\Delta = 240$ )

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	13-2	20-8	Note a	Note a
	Douglas Fir-Larch	#1	12-8	19-11	Note a	Note a
	Douglas Fir-Larch	#2	12-5	19-6	25-8	Note a
	Douglas Fir-Larch	#3	10-10	15-10	20-1	24-6
	Hem-Fir	SS	12-5	19-6	25-8	Note a
	Hem-Fir	#1	12-2	19-1	25-2	Note a
	Hem-Fir	#2	11-7	18-2	24-0	Note a
	Hem-Fir	#3	10-10	15-10	20-1	24-6
	Southern Pine	SS	12-11	20-3	Note a	Note a
	Southern Pine	#1	12-5	19-6	25-8	Note a
	Southern Pine	#2	11-10	18-8	24-7	Note a
	Southern Pine	#3	10-1	14-11	18-9	22-9
	Spruce-Pine-Fir	SS	12-2	19-1	25-2	Note a
	Spruce-Pine-Fir	#1	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#2	11-10	18-8	24-7	Note a
	Spruce-Pine-Fir	#3	10-10	15-10	20-1	24-6
16	Douglas Fir-Larch	SS	11-11	18-9	24-8	Note a
	Douglas Fir-Larch	#1	11-6	18-1	23-10	Note a
	Douglas Fir-Larch	#2	11-3	17-8	23-0	Note a
	Douglas Fir-Larch	#3	9-5	13-9	17-5	21-3
	Hem-Fir	SS	11-3	17-8	23-4	Note a
	Hem-Fir	#1	11-0	17-4	22-10	Note a
	Hem-Fir	#2	10-6	16-6	21-9	Note a
	Hem-Fir	#3	9-5	13-9	17-5	21-3
	Southern Pine	SS	11-9	18-5	24-3	Note a
	Southern Pine	#1	11-3	17-8	23-4	Note a
	Southern Pine	#2	10-9	16-11	21-7	25-7
	Southern Pine	#3	8-9	12-11	16-3	19-9
	Spruce-Pine-Fir	SS	11-0	17-4	22-10	Note a
	Spruce-Pine-Fir	#1	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#2	10-9	16-11	22-4	Note a
	Spruce-Pine-Fir	#3	9-5	13-9	17-5	21-3

(continued)

## WOOD

**TABLE 2308.7.1(1)—continued**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES**  
(Uninhabitable attics without storage, live load = 10 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	11-3	17-8	23-3	Note a
	Douglas Fir-Larch	#1	10-10	17-0	22-5	Note a
	Douglas Fir-Larch	#2	10-7	16-7	21-0	25-8
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5
	Hem-Fir	SS	10-7	16-8	21-11	Note a
	Hem-Fir	#1	10-4	16-4	21-6	Note a
	Hem-Fir	#2	9-11	15-7	20-6	25-3
	Hem-Fir	#3	8-7	12-6	15-10	19-5
	Southern Pine	SS	11-0	17-4	22-10	Note a
	Southern Pine	#1	10-7	16-8	22-0	Note a
	Southern Pine	#2	10-2	15-7	19-8	23-5
	Southern Pine	#3	8-0	11-9	14-10	18-0
	Spruce-Pine-Fir	SS	10-4	16-4	21-6	Note a
	Spruce-Pine-Fir	#1	10-2	15-11	21-0	25-8
	Spruce-Pine-Fir	#2	10-2	15-11	21-0	25-8
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5
24	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a
	Douglas Fir-Larch	#1	10-0	15-9	20-1	24-6
	Douglas Fir-Larch	#2	9-10	14-10	18-9	22-11
	Douglas Fir-Larch	#3	7-8	11-2	14-2	17-4
	Hem-Fir	SS	9-10	15-6	20-5	Note a
	Hem-Fir	#1	9-8	15-2	19-7	23-11
	Hem-Fir	#2	9-2	14-5	18-6	22-7
	Hem-Fir	#3	7-8	11-2	14-2	17-4
	Southern Pine	SS	10-3	16-1	21-2	Note a
	Southern Pine	#1	9-10	15-6	20-5	24-0
	Southern Pine	#2	9-3	13-11	17-7	20-11
	Southern Pine	#3	7-2	10-6	13-3	16-1
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5
	Spruce-Pine-Fir	#1	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#2	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#3	7-8	11-2	14-2	17-4

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.



**TABLE 2308.7.1(2)**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES**  
**(Uninhabitable attics with limited storage, live load = 20 psf, L/Δ = 240)**

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note a
	Douglas Fir-Larch	#1	10-0	15-9	20-1	24-6
	Douglas Fir-Larch	#2	9-10	14-10	18-9	22-11
	Douglas Fir-Larch	#3	7-8	11-2	14-2	17-4
	Hem-Fir	SS	9-10	15-6	20-5	Note a
	Hem-Fir	#1	9-8	15-2	19-7	23-11
	Hem-Fir	#2	9-2	14-5	18-6	22-7
	Hem-Fir	#3	7-8	11-2	14-2	17-4
	Southern Pine	SS	10-3	16-1	21-2	Note a
	Southern Pine	#1	9-10	15-6	20-5	24-0
	Southern Pine	#2	9-3	13-11	17-7	20-11
	Southern Pine	#3	7-2	10-6	13-3	16-1
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5
	Spruce-Pine-Fir	#1	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#2	9-5	14-9	18-9	22-11
	Spruce-Pine-Fir	#3	7-8	11-2	14-2	17-4
16	Douglas Fir-Larch	SS	9-6	14-11	19-7	25-0
	Douglas Fir-Larch	#1	9-1	13-9	17-5	21-3
	Douglas Fir-Larch	#2	8-9	12-10	16-3	19-10
	Douglas Fir-Larch	#3	6-8	9-8	12-4	15-0
	Hem-Fir	SS	8-11	14-1	18-6	23-8
	Hem-Fir	#1	8-9	13-5	16-10	20-8
	Hem-Fir	#2	8-4	12-8	16-0	19-7
	Hem-Fir	#3	6-8	9-8	12-4	15-0
	Southern Pine	SS	9-4	14-7	19-3	24-7
	Southern Pine	#1	8-11	14-0	17-9	20-9
	Southern Pine	#2	8-0	12-0	15-3	18-1
	Southern Pine	#3	6-2	9-2	11-6	14-0
	Spruce-Pine-Fir	SS	8-9	13-9	18-1	23-1
	Spruce-Pine-Fir	#1	8-7	12-10	16-3	19-10
	Spruce-Pine-Fir	#2	8-7	12-10	16-3	19-10
	Spruce-Pine-Fir	#3	6-8	9-8	12-4	15-0

(continued)

## WOOD

**TABLE 2308.7.1(2)—continued**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES**  
(Uninhabitable attics with limited storage, live load = 20 psf, L/Δ = 240)

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	8-11	14-0	18-5	23-4
	Douglas Fir-Larch	#1	8-7	12-6	15-10	19-5
	Douglas Fir-Larch	#2	8-0	11-9	14-10	18-2
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8
	Hem-Fir	SS	8-5	13-3	17-5	22-3
	Hem-Fir	#1	8-3	12-3	15-6	18-11
	Hem-Fir	#2	7-10	11-7	14-8	17-10
	Hem-Fir	#3	6-1	8-10	11-3	13-8
	Southern Pine	SS	8-9	13-9	18-2	23-1
	Southern Pine	#1	8-5	12-9	16-2	18-11
	Southern Pine	#2	7-4	11-0	13-11	16-6
	Southern Pine	#3	5-8	8-4	10-6	12-9
	Spruce-Pine-Fir	SS	8-3	12-11	17-1	21-8
	Spruce-Pine-Fir	#1	8-0	11-9	14-10	18-2
	Spruce-Pine-Fir	#2	8-0	11-9	14-10	18-2
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8
24	Douglas Fir-Larch	SS	8-3	13-0	17-1	20-11
	Douglas Fir-Larch	#1	7-8	11-2	14-2	17-4
	Douglas Fir-Larch	#2	7-2	10-6	13-3	16-3
	Douglas Fir-Larch	#3	5-5	7-11	10-0	12-3
	Hem-Fir	SS	7-10	12-3	16-2	20-6
	Hem-Fir	#1	7-6	10-11	13-10	16-11
	Hem-Fir	#2	7-1	10-4	13-1	16-0
	Hem-Fir	#3	5-5	7-11	10-0	12-3
	Southern Pine	SS	8-1	12-9	16-10	21-6
	Southern Pine	#1	7-8	11-5	14-6	16-11
	Southern Pine	#2	6-7	9-10	12-6	14-9
	Southern Pine	#3	5-1	7-5	9-5	11-5
	Spruce-Pine-Fir	SS	7-8	12-0	15-10	19-5
	Spruce-Pine-Fir	#1	7-2	10-6	13-3	16-3
	Spruce-Pine-Fir	#2	7-2	10-6	13-3	16-3
	Spruce-Pine-Fir	#3	5-5	7-11	10-0	12-3

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.

## WOOD

**TABLE 2308.7.2(1)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Roof live load = 20 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	11-6	18-0	23-9	Note b	Note b	11-6	18-0	23-5	Note b	Note b
	Douglas Fir-Larch	#1	11-1	17-4	22-5	Note b	Note b	10-6	15-4	19-5	23-9	Note b
	Douglas Fir-Larch	#2	10-10	16-7	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Hem-Fir	SS	10-10	17-0	22-5	Note b	Note b	10-10	17-0	22-5	Note b	Note b
	Hem-Fir	#1	10 -7	16-8	21-10	Note b	Note b	10-3	14-11	18-11	23-2	Note b
	Hem-Fir	#2	10-1	15-11	20-8	25-3	Note b	9-8	14-2	17-11	21-11	25-5
	Hem-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern Pine	SS	11-3	17-8	23-4	Note b	Note b	11-3	17-8	23-4	Note b	Note b
	Southern Pine	#1	10-10	17-0	22-5	26-0	26-0	10-6	15-8	19-10	23-2	Note b
	Southern Pine	#2	10-4	15-7	19-8	23-5	26-0	9-0	13-6	17-1	20-3	23-10
	Southern Pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-Pine-Fir	SS	10-7	16-8	21-11	Note b	Note b	10-7	16-8	21-9	Note b	Note b
	Spruce-Pine-Fir	#1	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-0	20-3	24-9	Note b
	Douglas Fir-Larch	#1	10-0	15-4	19-5	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas Fir-Larch	#2	9-10	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Douglas Fir-Larch	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-11	24-4	Note b
	Hem-Fir	#1	9-8	14-11	18-11	23-2	Note b	8-10	12-11	16-5	20-0	23-3
	Hem-Fir	#2	9-2	14-2	17-11	21-11	25-5	8-5	12-3	15-6	18-11	22-0
	Hem-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern Pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	25-7	Note b
	Southern Pine	#1	9-10	15-6	19-10	23-2	26-0	9-1	13-7	17-2	20-1	23-10
	Southern Pine	#2	9-0	13-6	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern Pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	14-10	18-10	23-0	Note b
	Spruce-Pine-Fir	#1	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#2	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

## WOOD

**TABLE 2308.7.2(1)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Roof live load = 20 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	9-10	15-5	20-4	25-11	Note b	9-10	14-7	18-6	22-7	Note b
	Douglas Fir-Larch	#1	9-5	14-0	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas Fir-Larch	#2	8-11	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Douglas Fir-Larch	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-4	18-2	22-3	25-9
	Hem-Fir	#1	9-1	13-8	17-4	21-1	24-6	8-1	11-10	15-0	18-4	21-3
	Hem-Fir	#2	8-8	12-11	16-4	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern Pine	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-7	23-4	Note b
	Southern Pine	#1	9-3	14-3	18-1	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern Pine	#2	8-2	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern Pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-Pine-Fir	SS	9-1	14-3	18-9	23-11	Note b	9-1	13-7	17-2	21-0	24-4
	Spruce-Pine-Fir	#1	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#2	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas Fir-Larch	SS	9-1	14-4	18-10	23-4	Note b	8-11	13-1	16-7	20-3	23-5
	Douglas Fir-Larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas Fir-Larch	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	12-10	16-3	19-10	23-0
	Hem-Fir	#1	8-4	12-3	15-6	18-11	21-11	7-3	10-7	13-5	16-4	19-0
	Hem-Fir	#2	7-11	11-7	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern Pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	13-10	17-6	20-10	24-8
	Southern Pine	#1	8-7	12-9	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern Pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern Pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-Pine-Fir	SS	8-5	13-3	17-5	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Spruce-Pine-Fir	#1	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).
- b. Span exceeds 26 feet in length.



## WOOD

**TABLE 2308.7.2(2)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Roof live load = 20 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-4	21-7	Note b	Note b
	Douglas Fir-Larch	#1	10-0	15-9	20-10	Note b	Note b	10-0	15-4	19-5	23-9	Note b
	Douglas Fir-Larch	#2	9-10	15-6	20-5	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Douglas Fir-Larch	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Hem-Fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	Note b	Note b
	Hem-Fir	#1	9-8	15-2	19-11	25-5	Note b	9-8	14-11	18-11	23-2	Note b
	Hem-Fir	#2	9-2	14-5	19-0	24-3	Note b	9-2	14-2	17-11	21-11	25-5
	Hem-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern Pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	Note b	Note b
	Southern Pine	#1	9-10	15-6	20-5	26-0	26-0	9-10	15-6	19-10	23-2	26-0
	Southern Pine	#2	9-5	14-9	19-6	23-5	26-0	9-0	13-6	17-1	20-3	23-10
	Southern Pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-Pine-Fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-11	25-5	Note b
	Spruce-Pine-Fir	#1	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#2	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-Pine-Fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas Fir-Larch	SS	9-6	14-11	19-7	25-0	Note b	9-6	14-11	19-7	24-9	Note b
	Douglas Fir-Larch	#1	9-1	14-4	18-11	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas Fir-Larch	#2	8-11	14-1	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Douglas Fir-Larch	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Hem-Fir	#1	8-9	13-9	18-1	23-1	Note b	8-9	12-11	16-5	20-0	23-3
	Hem-Fir	#2	8-4	13-1	17-3	21-11	25-5	8-4	12-3	15-6	18-11	22-0
	Hem-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern Pine	SS	9-4	14-7	19-3	24-7	Note b	9-4	14-7	19-3	24-7	Note b
	Southern Pine	#1	8-11	14-1	18-6	23-2	26-0	8-11	13-7	17-2	20-1	23-10
	Southern Pine	#2	8-7	13-5	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern Pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-Pine-Fir	SS	8-9	13-9	18-1	23-1	Note b	8-9	13-9	18-1	23-0	Note b
	Spruce-Pine-Fir	#1	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#2	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-Pine-Fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

## WOOD

**TABLE 2308.7.2(2)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Roof live load = 20 psf, ceiling attached to rafters,  $L/\Delta = 240$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	8-11	14-0	18-5	23-7	Note b	8-11	14-0	18-5	22-7	Note b
	Douglas Fir-Larch	#1	8-7	13-6	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas Fir-Larch	#2	8-5	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Douglas Fir-Larch	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	25-9
	Hem-Fir	#1	8-3	12-11	17-1	21-1	24-6	8-1	11-10	15-0	18-4	21-3
	Hem-Fir	#2	7-10	12-4	16-3	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern Pine	SS	8-9	13-9	18-2	23-1	Note b	8-9	13-9	18-2	23-1	Note b
	Southern Pine	#1	8-5	13-3	17-5	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern Pine	#2	8-1	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern Pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-Pine-Fir	SS	8-3	12-11	17-1	21-9	Note b	8-3	12-11	17-1	21-0	24-4
	Spruce-Pine-Fir	#1	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#2	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-Pine-Fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas Fir-Larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	16-7	20-3	23-5
	Douglas Fir-Larch	#1	8-0	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas Fir-Larch	#2	7-10	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Douglas Fir-Larch	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	19-10	23-0
	Hem-Fir	#1	7-8	12-0	15-6	18-11	21-11	7-3	10-7	13-5	16-4	19-0
	Hem-Fir	#2	7-3	11-5	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern Pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	20-10	24-8
	Southern Pine	#1	7-10	12-3	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern Pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern Pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-Pine-Fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-4	18-9	21-9
	Spruce-Pine-Fir	#1	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#2	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-Pine-Fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).
- Span exceeds 26 feet in length.

## WOOD

**TABLE 2308.7.2(3)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 30 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	10-0	15-9	20-9	Note b	Note b	10-0	15-9	20-1	24-6	Note b
	Douglas Fir-Larch	#1	9-8	14-9	18-8	22-9	Note b	9-0	13-2	16-8	20-4	23-7
	Douglas Fir-Larch	#2	9-5	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Douglas Fir-Larch	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Hem-Fir	SS	9-6	14-10	19-7	25-0	Note b	9-6	14-10	19-7	24-1	Note b
	Hem-Fir	#1	9-3	14-4	18-2	22-2	25-9	8-9	12-10	16-3	19-10	23-0
	Hem-Fir	#2	8-10	13-7	17-2	21-0	24-4	8-4	12-2	15-4	18-9	21-9
	Hem-Fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern Pine	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	25-4	Note b
	Southern Pine	#1	9-6	14-10	19-0	22-3	26-0	9-0	13-5	17-0	19-11	23-7
	Southern Pine	#2	8-7	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern Pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-Pine-Fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-7	18-8	22-9	Note b
	Spruce-Pine-Fir	#1	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-Pine-Fir	#2	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-Pine-Fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas Fir-Larch	SS	9-1	14-4	18-10	23-9	Note b	9-1	13-9	17-5	21-3	24-8
	Douglas Fir-Larch	#1	8-9	12-9	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas Fir-Larch	#2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Douglas Fir-Larch	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Hem-Fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-1	20-10	24-2
	Hem-Fir	#1	8-5	12-5	15-9	19-3	22-3	7-7	11-1	14-1	17-2	19-11
	Hem-Fir	#2	8-0	11-9	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-Fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern Pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-5	21-11	25-11
	Southern Pine	#1	8-7	13-0	16-6	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern Pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern Pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-Pine-Fir	SS	8-5	13-3	17-5	22-1	25-7	8-5	12-9	16-2	19-9	22-10
	Spruce-Pine-Fir	#1	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-Pine-Fir	#2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-Pine-Fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6

(continued)

## WOOD

**TABLE 2308.7.2(3)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 30 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	8-7	13-6	17-9	21-8	25-2	8-7	12-6	15-10	19-5	22-6
	Douglas Fir-Larch	#1	7-11	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas Fir-Larch	#2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Douglas Fir-Larch	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Hem-Fir	SS	8-1	12-9	16-9	21-4	24-8	8-1	12-4	15-7	19-1	22-1
	Hem-Fir	#1	7-9	11-4	14-4	17-7	20-4	6-11	10-2	12-10	15-8	18-2
	Hem-Fir	#2	7-4	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-Fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Southern Pine	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	16-10	20-0	23-7
	Southern Pine	#1	8-0	11-10	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern Pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern Pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-Pine-Fir	SS	7-11	12-5	16-5	20-2	23-4	7-11	11-8	14-9	18-0	20-11
	Spruce-Pine-Fir	#1	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-Pine-Fir	#2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-Pine-Fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
24	Douglas Fir-Larch	SS	7-11	12-6	15-10	19-5	22-6	7-8	11-3	14-2	17-4	20-1
	Douglas Fir-Larch	#1	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas Fir-Larch	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Douglas Fir-Larch	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Hem-Fir	SS	7-6	11-10	15-7	19-1	22-1	7-6	11-0	13-11	17-0	19-9
	Hem-Fir	#1	6-11	10-2	12-10	15-8	18-2	6-2	9-1	11-6	14-0	16-3
	Hem-Fir	#2	6-7	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern Pine	SS	7-10	12-3	16-2	20-0	23-7	7-10	11-10	15-0	17-11	21-2
	Southern Pine	#1	7-1	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-Pine-Fir	SS	7-4	11-7	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#1	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-Pine-Fir	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-Pine-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).
- b. Span exceeds 26 feet in length.



## WOOD

**TABLE 2308.7.2(4)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 50 psf, ceiling not attached to rafters, L/Δ = 180)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	8-5	13-3	17-6	22-4	26-0	8-5	13-3	17-0	20-9	24-0
	Douglas Fir-larch	#1	8-2	12-0	15-3	18-7	21-7	7-7	11-2	14-1	17-3	20-0
	Douglas Fir-larch	#2	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Douglas Fir-larch	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Hem-Fir	SS	8-0	12-6	16-6	21-1	25-6	8-0	12-6	16-6	20-4	23-7
	Hem-Fir	#1	7-10	11-9	14-10	18-1	21-0	7-5	10-10	13-9	16-9	19-5
	Hem-Fir	#2	7-5	11-1	14-0	17-2	19-11	7-0	10-3	13-0	15-10	18-5
	Hem-Fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern Pine	SS	8-4	13-1	17-2	21-11	Note b	8-4	13-1	17-2	21-5	25-3
	Southern Pine	#1	8-0	12-3	15-6	18-2	21-7	7-7	11-4	14-5	16-10	20-0
	Southern Pine	#2	7-0	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern Pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-Pine-Fir	SS	7-10	12-3	16-2	20-8	24-1	7-10	12-3	15-9	19-3	22-4
	Spruce-Pine-Fir	#1	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#2	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas Fir-Larch	SS	7-8	12-1	15-10	19-5	22-6	7-8	11-7	14-8	17-11	20-10
	Douglas Fir-Larch	#1	7-1	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas Fir-Larch	#2	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Douglas Fir-Larch	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Hem-Fir	SS	7-3	11-5	15-0	19-1	22-1	7-3	11-5	14-5	17-8	20-5
	Hem-Fir	#1	6-11	10-2	12-10	15-8	18-2	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	#2	6-7	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern Pine	SS	7-6	11-10	15-7	19-11	23-7	7-6	11-10	15-7	18-6	21-10
	Southern Pine	#1	7-1	10-7	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-Pine-Fir	SS	7-1	11-2	14-8	18-0	20-11	7-1	10-9	13-8	15-11	19-4
	Spruce-Pine-Fir	#1	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-Pine-Fir	#2	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-Pine-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3

(continued)

## WOOD

**TABLE 2308.7.2(4)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 50 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	7-3	11-4	14-6	17-8	20-6	7-3	10-7	13-5	16-5	19-0
	Douglas Fir-Larch	#1	6-6	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas Fir-Larch	#2	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Douglas Fir-Larch	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Hem-Fir	SS	6-10	10-9	14-2	17-5	20-2	6-10	10-5	13-2	16-1	18-8
	Hem-Fir	#1	6-4	9-3	11-9	14-4	16-7	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	#2	6-0	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-Fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Southern Pine	SS	7-1	11-2	14-8	18-3	21-7	7-1	11-2	14-2	16-11	20-0
	Southern Pine	#1	6-6	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern Pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern Pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-Pine-Fir	SS	6-8	10-6	13-5	16-5	19-1	6-8	9-10	12-5	15-3	17-8
	Spruce-Pine-Fir	#1	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-Pine-Fir	#2	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-Pine-Fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas Fir-Larch	SS	6-8	10-3	13-0	15-10	18-4	6-6	9-6	12-0	14-8	17-0
	Douglas Fir-Larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas Fir-Larch	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Douglas Fir-Larch	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Hem-Fir	SS	6-4	9-11	12-9	15-7	18-0	6-4	9-4	11-9	14-5	16-8
	Hem-Fir	#1	5-8	8-3	10-6	12-10	14-10	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-Fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern Pine	SS	6-7	10-4	13-8	16-4	19-3	6-7	10-0	12-8	15-2	17-10
	Southern Pine	#1	5-10	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern Pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern Pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-Pine-Fir	SS	6-2	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Spruce-Pine-Fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-Pine-Fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-Pine-Fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).
- b. Span exceeds 26 feet in length.

## WOOD

**TABLE 2308.7.2(5)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 30 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-4	18-10	24-1	Note b
	Douglas Fir-Larch	#1	8-9	13-9	18-2	22-9	Note b	8-9	13-2	16-8	20-4	23-7
	Douglas Fir-Larch	#2	8-7	13-6	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Douglas Fir-Larch	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Hem-Fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-10	22-9	Note b
	Hem-Fir	#1	8-5	13-3	17-5	22-2	25-9	8-5	12-10	16-3	19-10	23-0
	Hem-Fir	#2	8-0	12-7	16-7	21-0	24-4	8-0	12-2	15-4	18-9	21-9
	Hem-Fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern Pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Southern Pine	#1	8-7	13-6	17-10	22-3	Note b	8-7	13-5	17-0	19-11	23-7
	Southern Pine	#2	8-3	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern Pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-Pine-Fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	Note b
	Spruce-Pine-Fir	#1	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-Pine-Fir	#2	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-Pine-Fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas Fir-Larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	17-2	21-3	24-8
	Douglas Fir-Larch	#1	8-0	12-6	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas Fir-Larch	#2	7-10	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Douglas Fir-Larch	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Hem-Fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	20-8	24-2
	Hem-Fir	#1	7-8	12-0	15-9	19-3	22-3	7-7	11-1	14-1	17-2	19-11
	Hem-Fir	#2	7-3	11-5	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-Fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern Pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	21-6	25-11
	Southern Pine	#1	7-10	12-3	16-2	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern Pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern Pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-Pine-Fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	19-9	22-10
	Spruce-Pine-Fir	#1	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-Pine-Fir	#2	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-Pine-Fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6

(continued)

## WOOD

**TABLE 2308.7.2(5)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 30 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	7-9	12-3	16-1	20-7	25-0	7-9	12-3	15-10	19-5	22-6
	Douglas Fir-Larch	#1	7-6	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas Fir-Larch	#2	7-4	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Douglas Fir-Larch	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Hem-Fir	SS	7-4	11-7	15-3	19-5	23-7	7-4	11-7	15-3	19-1	22-1
	Hem-Fir	#1	7-2	11-4	14-4	17-7	20-4	6-11	10-2	12-10	15-8	18-2
	Hem-Fir	#2	6-10	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-Fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Southern Pine	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	20-0	23-7
	Southern Pine	#1	7-4	11-7	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern Pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern Pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-Pine-Fir	SS	7-2	11-4	14-11	19-0	23-1	7-2	11-4	14-9	18-0	20-11
	Spruce-Pine-Fir	#1	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-Pine-Fir	#2	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-Pine-Fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
24	Douglas Fir-Larch	SS	7-3	11-4	15-0	19-1	22-6	7-3	11-3	14-2	17-4	20-1
	Douglas Fir-Larch	#1	7-0	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas Fir-Larch	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Douglas Fir-Larch	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Hem-Fir	SS	6-10	10-9	14-2	18-0	21-11	6-10	10-9	13-11	17-0	19-9
	Hem-Fir	#1	6-8	10-2	12-10	15-8	18-2	6-2	9-1	11-6	14-0	16-3
	Hem-Fir	#2	6-4	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern Pine	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	17-11	21-2
	Southern Pine	#1	6-10	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-Pine-Fir	SS	6-8	10-6	13-10	17-8	20-11	6-8	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#1	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-Pine-Fir	#2	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-Pine-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).
- Span exceeds 26 feet in length.



## WOOD

**TABLE 2308.7.2(6)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 50 psf, ceiling attached to rafters, L/Δ = 240)

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
12	Douglas Fir-Larch	SS	7-8	12-1	15-11	20-3	24-8	7-8	12-1	15-11	20-3	24-0
	Douglas Fir-Larch	#1	7-5	11-7	15-3	18-7	21-7	7-5	11-2	14-1	17-3	20-0
	Douglas Fir-Larch	#2	7-3	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Douglas Fir-Larch	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Hem-Fir	SS	7-3	11-5	15-0	19-2	23-4	7-3	11-5	15-0	19-2	23-4
	Hem-Fir	#1	7-1	11-2	14-8	18-1	21-0	7-1	10-10	13-9	16-9	19-5
	Hem-Fir	#2	6-9	10-8	14-0	17-2	19-11	6-9	10-3	13-0	15-10	18-5
	Hem-Fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern Pine	SS	7-6	11-10	15-7	19-11	24-3	7-6	11-10	15-7	19-11	24-3
	Southern Pine	#1	7-3	11-5	15-0	18-2	21-7	7-3	11-4	14-5	16-10	20-0
	Southern Pine	#2	6-11	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern Pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-Pine-Fir	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	18-9	22-4
	Spruce-Pine-Fir	#1	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#2	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-Pine-Fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas Fir-Larch	SS	7-0	11-0	14-5	18-5	22-5	7-0	11-0	14-5	17-11	20-10
	Douglas Fir-Larch	#1	6-9	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas Fir-Larch	#2	6-7	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Douglas Fir-Larch	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Hem-Fir	SS	6-7	10-4	13-8	17-5	21-2	6-7	10-4	13-8	17-5	20-5
	Hem-Fir	#1	6-5	10-2	12-10	15-8	18-2	6-5	9-5	11-11	14-6	16-10
	Hem-Fir	#2	6-2	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern Pine	SS	6-10	10-9	14-2	18-1	22-0	6-10	10-9	14-2	18-1	21-10
	Southern Pine	#1	6-7	10-4	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern Pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern Pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-Pine-Fir	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-8	19-4
	Spruce-Pine-Fir	#1	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-Pine-Fir	#2	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-Pine-Fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3

(continued)

## WOOD

**TABLE 2308.7.2(6)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES**  
 (Ground snow load = 50 psf, ceiling attached to rafters,  $L/\Delta = 240$ )

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)	(ft. - in.)
19.2	Douglas Fir-Larch	SS	6-7	10-4	13-7	17-4	20-6	6-7	10-4	13-5	16-5	19-0
	Douglas Fir-Larch	#1	6-4	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas Fir-Larch	#2	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Douglas Fir-Larch	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Hem-Fir	SS	6-2	9-9	12-10	16-5	19-11	6-2	9-9	12-10	16-1	18-8
	Hem-Fir	#1	6-1	9-3	11-9	14-4	16-7	5-10	8-7	10-10	13-3	15-5
	Hem-Fir	#2	5-9	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-Fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Southern Pine	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-11	20-0
	Southern Pine	#1	6-2	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern Pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern Pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-Pine-Fir	SS	6-1	9-6	12-7	16-0	19-1	6-1	9-6	12-5	15-3	17-8
	Spruce-Pine-Fir	#1	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-Pine-Fir	#2	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-Pine-Fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas Fir-Larch	SS	6-1	9-7	12-7	15-10	18-4	6-1	9-6	12-0	14-8	17-0
	Douglas Fir-Larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas Fir-Larch	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Douglas Fir-Larch	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Hem-Fir	SS	5-9	9-1	11-11	15-2	18-0	5-9	9-1	11-9	14-5	15-11
	Hem-Fir	#1	5-8	8-3	10-6	12-10	14-10	5-3	7-8	9-9	11-10	13-9
	Hem-Fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-Fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern Pine	SS	6-0	9-5	12-5	15-10	19-3	6-0	9-5	12-5	15-2	17-10
	Southern Pine	#1	5-9	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern Pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern Pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-Pine-Fir	SS	5-8	8-10	11-8	14-8	17-1	5-8	8-10	11-2	13-7	15-9
	Spruce-Pine-Fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-Pine-Fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-Pine-Fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table 2308.7.2(7).

**TABLE 2308.7.2(7)**  
**RAFTER SPAN ADJUSTMENT FACTOR**

$H_C/H_R^a$	RAFTER SPAN ADJUSTMENT FACTOR
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

a.  $H_C$  = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls;

$H_R$  = Height of roof ridge measured vertically above the top of the rafter support walls.

**TABLE 2308.7.3.1  
RAFTER TIE CONNECTIONS<sup>i</sup>**

RAFTER SLOPE	TIE SPACING (inches)	LIVE LOAD ONLY <sup>g</sup>			GROUND SNOW LOAD (pounds per square foot)					
					30 pounds per square foot			50 pounds per square foot		
		Roof span (feet)								
		12	24	36	12	24	36	12	24	36
Required number of 16d common (3½" x 0.162") nails per connection <sup>a, b, c, d, e, f, h</sup>										
3:12	12	3	5	8	3	6	9	5	9	13
	16	4	7	10	4	8	12	6	12	17
	19.2	4	8	12	5	10	14	7	14	21
	24	5	10	15	6	12	18	9	17	26
	32	7	13	20	8	16	24	12	23	34
	48	10	20	29	12	24	35	17	34	51
4:12	12	3	4	6	3	5	7	4	7	10
	16	3	5	8	3	6	9	5	9	13
	19.2	3	6	9	4	7	11	6	11	16
	24	4	8	11	5	9	13	7	13	19
	32	5	10	15	6	12	18	9	17	26
	48	8	15	22	9	18	26	13	26	38
5:12	12	3	3	5	3	4	6	3	6	8
	16	3	4	6	3	5	7	4	7	11
	19.2	3	5	7	3	6	9	5	9	13
	24	3	6	9	4	7	11	6	11	16
	32	4	8	12	5	10	14	7	14	21
	48	6	12	18	7	14	21	11	21	31
7:12	12	3	3	4	3	3	4	3	4	6
	16	3	3	5	3	4	5	3	5	8
	19.2	3	4	5	3	4	6	3	6	9
	24	3	5	7	3	5	8	4	8	11
	32	3	6	9	4	7	10	5	10	15
	48	5	9	13	5	10	15	8	15	22
9:12	12	3	3	3	3	3	3	3	3	5
	16	3	3	4	3	3	4	3	4	6
	19.2	3	3	4	3	4	5	3	5	7
	24	3	4	5	3	4	6	3	6	9
	32	3	5	7	3	6	8	4	8	12
	48	4	7	10	4	8	12	6	12	17
12:12	12	3	3	3	3	3	3	3	3	4
	16	3	3	3	3	3	3	3	3	5
	19.2	3	3	3	3	3	4	3	4	6
	24	3	3	4	3	3	5	3	5	7
	32	3	4	5	3	4	6	3	6	9
	48	3	5	8	3	6	9	5	9	13

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.8 N/m<sup>2</sup>.

- 10d common (3" x 0.148") nails shall be permitted to be substituted for 16d common (3<sup>1</sup>/<sub>2</sub>" x 0.162") nails where the required number of nails is taken as 1.2 times the required number of 16d common nails, rounded up to the next full nail.
- Rafter tie heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.
- Where intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements are permitted to be reduced proportionally to the reduction in span.
- Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.
- Connected members shall be of sufficient size to prevent splitting due to nailing.
- For snow loads less than 30 pounds per square foot, the required number of nails is permitted to be reduced by multiplying by the ratio of actual snow load plus 10 divided by 40, but not less than the number required for no snow load.
- Applies to roof live load of 20 psf or less.
- Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. Where ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the adjustment factors in Table 2308.7.3.1(1).
- Tabulated requirements are based on 10 psf roof dead load in combination with the specified roof snow load and roof live load.

## WOOD

**TABLE 2308.7.3.1(1)**  
**HEEL JOINT CONNECTION ADJUSTMENT FACTORS**

$H_C/H_R^{a,b}$	HEEL JOINT CONNECTION ADJUSTMENT FACTOR
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

a.  $H_C$  = Height of ceiling joists or rafter ties measured vertically from the top of the rafter support walls to the bottom of the ceiling joists or rafter ties;  
 $H_R$  = Height of roof ridge measured vertically from the top of the rafter support walls to the bottom of the roof ridge.

b. Where  $H_C/H_R$  exceeds 1/3, connections shall be designed in accordance with accepted engineering practice.

**TABLE 2308.7.12**  
**ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING**

SPAN <sup>a</sup> (feet)	LIVE LOAD (pounds per square foot)	DEFLECTION LIMIT	BENDING STRESS (f) (pounds per square inch)	MODULUS OF ELASTICITY (E) (pounds per square inch)
<b>Roofs</b>				
4	20	1/240	160	170,000
		1/360		256,000
	30	1/240	210	256,000
		1/360		384,000
	40	1/240	270	340,000
		1/360		512,000
4.5	20	1/240	200	242,000
		1/360		305,000
	30	1/240	270	363,000
		1/360		405,000
	40	1/240	350	484,000
		1/360		725,000
5.0	20	1/240	250	332,000
		1/360		500,000
	30	1/240	330	495,000
		1/360		742,000
	40	1/240	420	660,000
		1/360		1,000,000
5.5	20	1/240	300	442,000
		1/360		660,000
	30	1/240	400	662,000
		1/360		998,000
	40	1/240	500	884,000
		1/360		1,330,000
6.0	20	1/240	360	575,000
		1/360		862,000
	30	1/240	480	862,000
		1/360		1,295,000
	40	1/240	600	1,150,000
		1/360		1,730,000

(continued)



**TABLE 2308.7.12—continued**  
**ALLOWABLE SPANS FOR 2-INCH TONGUE-AND-GROOVE DECKING**

SPAN <sup>a</sup> (feet)	LIVE LOAD (pounds per square foot)	DEFLECTION LIMIT	BENDING STRESS (f) (pounds per square inch)	MODULUS OF ELASTICITY (E) (pounds per square inch)
Roofs				
6.5	20	1/240	420	595,000
		1/360		892,000
	30	1/240	560	892,000
		1/360		1,340,000
	40	1/240	700	1,190,000
		1/360		1,730,000
7.0	20	1/240	490	910,000
		1/360		1,360,000
	30	1/240	650	1,370,000
		1/360		2,000,000
	40	1/240	810	1,820,000
		1/360		2,725,000
7.5	20	1/240	560	1,125,000
		1/360		1,685,000
	30	1/240	750	1,685,000
		1/360		2,530,000
	40	1/240	930	2,250,000
		1/360		3,380,000
8.0	20	1/240	640	1,360,000
		1/360		2,040,000
	30	1/240	850	2,040,000
		1/360		3,060,000
Floors				
4	40	1/360	840	1,000,000
4.5			950	1,300,000
5.0			1,060	1,600,000

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kN/m<sup>2</sup>, 1 pound per square inch = 0.00689 N/mm<sup>2</sup>.

- a. Spans are based on simple beam action with 10 pounds per square foot dead load and provisions for a 300-pound concentrated load on a 12-inch width of decking. Random layup is permitted in accordance with the provisions of Section 2308.7.12. Lumber thickness is 1½ inches nominal.



## CHAPTER 24

# GLASS AND GLAZING

### User notes:

**About this chapter:** Chapter 24 establishes regulations for glass and glazing used in buildings and structures. Engineering and design requirements are included in the chapter for glazing that is subjected to wind and snow loads. Another concern of this chapter is glass and glazing used in areas where it is likely to be impacted by the occupants. Section 2406 identifies hazardous locations where glazing must either be safety glazing or protected to prevent impacts by occupants. Safety glazing must meet stringent standards and be appropriately marked or identified. Additional requirements are provided for glass and glazing in guards, handrails, elevator hoistways and elevator cars, as well as in athletic facilities.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 2401 GENERAL

**2401.1 Scope.** The provisions of this chapter shall govern the materials, design, construction and quality of glass, light-transmitting ceramic and light-transmitting plastic panels for exterior and interior use in both vertical and sloped applications in buildings and structures. Light-transmitting plastic glazing shall also meet the applicable requirements of Chapter 26.

### SECTION 2402 GLAZING REPLACEMENT

**2402.1 General.** The installation of replacement glass shall be as required for new installations.

### SECTION 2403 GENERAL REQUIREMENTS FOR GLASS

**2403.1 Identification.** Each pane shall bear the manufacturer's *mark* designating the type and thickness of the glass or glazing material. The identification shall not be omitted unless *approved* and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with *approved construction documents* that comply with the provisions of this chapter. Safety glazing shall be identified in accordance with Section 2406.3.

Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification *mark* shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

Tempered spandrel glass shall be provided with a removable paper marking by the manufacturer.

**2403.2 Glass supports.** Where one or more sides of any pane of glass are not firmly supported, or are subjected to unusual *load* conditions, detailed *construction documents*, detailed shop drawings and analysis or test data ensuring safe performance for the specific installation shall be prepared by a *registered design professional*.

**2403.3 Glass framing.** To be considered firmly supported, the framing members for each individual pane of glass shall be designed so that the deflection of the edge of the glass perpendicular to the glass pane does not exceed  $1/175$  of the glass edge length where the glass edge length is not more than 13 feet 6 inches (4115 mm), or  $1/240$  of the glass edge length +  $1/4$  inch (6.4 mm) where the glass edge length is greater than 13 feet 6 inches (4115 mm), when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605.

**2403.4 Interior glazed areas.** Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall be not greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface.

**2403.5 Louvered windows or jalousies.** Float, wired and patterned glass in louvered windows and jalousies shall be not thinner than nominal  $3/16$  inch (4.8 mm) and not longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in louvered windows or jalousies.

Where other glass types are used, the design shall be submitted to the *building official* for approval.

### SECTION 2404 WIND, SNOW, SEISMIC AND DEAD LOADS ON GLASS

**2404.1 Vertical glass.** Glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind *loads* due to basic design *wind speed*, *V*, in Section 1609 for components and cladding. Glass in glazed curtain walls, glazed storefronts and glazed partitions shall meet the seismic requirements of ASCE 7, Section 13.5.9. The load resistance of glass under uniform *load* shall be determined in accordance with ASTM E1300.

## GLASS AND GLAZING

The design of vertical glazing shall be based on Equation 24-1.

$$0.6F_{gw} \leq F_{ga} \quad (\text{Equation 24-1})$$

where:

$F_{gw}$  = Wind load on the glass due to basic design wind speed,  $V$ , computed in accordance with Section 1609.

$F_{ga}$  = Short duration load on the glass as determined in accordance with ASTM E1300.

**2404.2 Sloped glass.** Glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, *sunrooms*, sloped roofs and other exterior applications shall be designed to resist the most critical combinations of loads determined by Equations 24-2, 24-3 and 24-4.

$$F_g = 0.6W_o - D \quad (\text{Equation 24-2})$$

$$F_g = 0.6W_i + D + 0.5 S \quad (\text{Equation 24-3})$$

$$F_g = 0.3 W_i + D + S \quad (\text{Equation 24-4})$$

where:

$D$  = Glass dead load psf (kN/m<sup>2</sup>).

For glass sloped 30 degrees (0.52 rad) or less from horizontal,

$$= 13 t_g \text{ (For SI: } 0.0245 t_g \text{)}.$$

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

$$= 13 t_g \cos \theta \text{ (For SI: } 0.0245 t_g \cos \theta \text{)}.$$

$F_g$  = Total load, psf (kN/m<sup>2</sup>) on glass.

$S$  = Snow load, psf (kN/m<sup>2</sup>) as determined in Section 1608.

$t_g$  = Total glass thickness, inches (mm) of glass panes and plies.

$W_i$  = Inward wind force, psf (kN/m<sup>2</sup>) due to basic design wind speed,  $V$ , as calculated in Section 1609.

$W_o$  = Outward wind force, psf (kN/m<sup>2</sup>) due to basic design wind speed,  $V$ , as calculated in Section 1609.

$\theta$  = Angle of slope from horizontal.

**Exception:** The performance grade rating of *unit skylights* and *tubular daylighting devices* shall be determined in accordance with Section 2405.5.

The design of sloped glazing shall be based on Equation 24-5.

$$F_g \leq F_{ga} \quad (\text{Equation 24-5})$$

where:

$F_g$  = Total load on the glass as determined by Equations 24-2, 24-3 and 24-4.

$F_{ga}$  = Short duration load resistance of the glass as determined in accordance with ASTM E1300 for Equations 24-2 and 24-3; or the long duration load resistance of the glass as determined in accordance with ASTM E1300 for Equation 24-4.

### 2404.3 Wired, patterned and sandblasted glass.

**2404.3.1 Vertical wired glass.** Wired glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to the following equation:

$$0.6F_{gw} < 0.5 F_{ge} \quad (\text{Equation 24-6})$$

where:

$F_{gw}$  = Wind load on the glass due to basic design wind speed,  $V$ , computed in accordance with Section 1609.

$F_{ge}$  = Nonfactored load from ASTM E1300 using a thickness designation for monolithic glass that is not greater than the thickness of wired glass.

**2404.3.2 Sloped wired glass.** Wired glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.

For Equations 24-2 and 24-3:

$$F_g < 0.5 F_{ge} \quad (\text{Equation 24-7})$$

For Equation 24-4:

$$F_g < 0.3 F_{ge} \quad (\text{Equation 24-8})$$

where:

$F_g$  = Total load on the glass as determined by Equations 24-2, 24-3 and 24-4.

$F_{ge}$  = Nonfactored load in accordance with ASTM E1300.

**2404.3.3 Vertical patterned glass.** Patterned glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding according to Equation 24-9.

$$F_{gw} < 1.0 F_{ge} \quad (\text{Equation 24-9})$$

where:

$F_{gw}$  = Wind load on the glass due to basic design wind speed,  $V$ , computed in accordance with Section 1609.

$F_{ge}$  = Nonfactored load in accordance with ASTM E1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between nonfactored load charts in ASTM E1300 shall be permitted.

**2404.3.4 Sloped patterned glass.** Patterned glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunspaces, sloped roofs and other exterior applications shall be designed to resist the most critical of the combinations of loads from Section 2404.2.



For Equations 24-2 and 24-3:

$$F_g < 1.0 F_{ge} \quad (\text{Equation 24-10})$$

For Equation 24-4:

$$F_g < 0.6 F_{ge} \quad (\text{Equation 24-11})$$

where:

$F_g$  = Total *load* on the glass as determined by Equations 24-2, 24-3 and 24-4.

$F_{ge}$  = Nonfactored *load* in accordance with ASTM E1300. The value for patterned glass shall be based on the thinnest part of the glass. Interpolation between the nonfactored *load* charts in ASTM E1300 shall be permitted.

**2404.3.5 Vertical sandblasted glass.** Sandblasted glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors, and other exterior applications shall be designed to resist the wind *loads* in Section 1609 for components and cladding according to Equation 24-12.

$$0.6 F_{gw} < 0.5 F_{ge} \quad (\text{Equation 24-12})$$

where:

$F_g$  = Wind *load* on the glass due to basic design *wind speed*,  $V$ , computed in accordance with Section 1609.

$F_{ge}$  = Nonfactored *load* in accordance with ASTM E1300. The value for sandblasted glass is for moderate levels of sandblasting.

**2404.4 Other designs.** For designs outside the scope of this section, an analysis or test data for the specific installation shall be prepared by a *registered design professional*.

## SECTION 2405 SLOPED GLAZING AND SKYLIGHTS

**2405.1 Scope.** This section applies to the installation of glass and other transparent, translucent or opaque glazing material installed at a slope of more than 15 degrees (0.26 rad) from the vertical plane, including glazing materials in skylights, roofs and sloped walls.

**2405.2 Allowable glazing materials and limitations.** Sloped glazing shall be any of the following materials, subject to the listed limitations.

1. For monolithic glazing systems, the glazing material of the single light or layer shall be laminated glass with a minimum 30-mil (0.76 mm) polyvinyl butyral (or equivalent) interlayer, wired glass, light-transmitting plastic materials meeting the requirements of Section 2607, heat-strengthened glass or fully tempered glass.
2. For multiple-layer glazing systems, each light or layer shall consist of any of the glazing materials specified in Item 1.

Annealed glass is permitted to be used as specified in Exceptions 2 and 3 of Section 2405.3.

Laminated glass and plastic materials described in Items 1 and 2 shall not require the screening or height restrictions provided in Section 2405.3.

For additional requirements for plastic skylights, see Section 2610. Glass-block construction shall conform to the requirements of Section 2110.1.

**2405.3 Screening.** Where used in monolithic glazing systems, annealed, heat-strengthened, fully tempered and wired glass shall have broken glass retention screens installed below the glazing material. The screens and their fastenings shall be: capable of supporting twice the weight of the glazing; firmly and substantially fastened to the framing members; and installed within 4 inches (102 mm) of the glass. The screens shall be constructed of a noncombustible material not thinner than No. 12 B&S gage (0.0808 inch) with mesh not larger than 1 inch by 1 inch (25 mm by 25 mm). In a corrosive atmosphere, structurally equivalent noncorrosive screen materials shall be used. Annealed, heat-strengthened, fully tempered and wired glass, where used in multiple-layer glazing systems as the bottom glass layer over the walking surface, shall be equipped with screening that conforms to the requirements for monolithic glazing systems.

**Exception:** In monolithic and multiple-layer sloped glazing systems, the following applies:

1. Fully tempered glass installed without protective screens where glazed between intervening floors at a slope of 30 degrees (0.52 rad) or less from the vertical plane shall have the highest point of the glass 10 feet (3048 mm) or less above the walking surface.
2. Screens are not required below any glazing material, including annealed glass, where the walking surface below the glazing material is permanently protected from the risk of falling glass or the area below the glazing material is not a walking surface.
3. Any glazing material, including annealed glass, is permitted to be installed without screens in the sloped glazing systems of commercial or detached noncombustible *greenhouses* used exclusively for growing plants and not open to the public, provided that the height of the *greenhouse* at the ridge does not exceed 30 feet (9144 mm) above grade.
4. Screens shall not be required in individual *dwelling units* in Groups R-2, R-3 and R-4 where fully tempered glass is used as single glazing or as both panes in an insulating glass unit, and the following conditions are met:
  - 4.1. Each pane of the glass is 16 square feet (1.5 m<sup>2</sup>) or less in area.
  - 4.2. The highest point of the glass is 12 feet (3658 mm) or less above any walking surface or other accessible area.
  - 4.3. The glass thickness is  $\frac{3}{16}$  inch (4.8 mm) or less.

## GLASS AND GLAZING

5. Screens shall not be required for laminated glass with a 15-mil (0.38 mm) polyvinyl butyral (or equivalent) interlayer used in individual *dwelling units* in Groups R-2, R-3 and R-4 within the following limits:

- 5.1. Each pane of glass is 16 square feet (1.5 m<sup>2</sup>) or less in area.
- 5.2. The highest point of the glass is 12 feet (3658 mm) or less above a walking surface or other accessible area.

**2405.4 Framing.** In Types I and II construction, sloped glazing and skylight frames shall be constructed of noncombustible materials. In structures where acid fumes deleterious to metal are incidental to the use of the buildings, *approved* pressure-treated wood or other *approved* noncorrosive materials are permitted to be used for sash and frames. Framing supporting sloped glazing and skylights shall be designed to resist the tributary roof loads in Chapter 16. Skylights set at an angle of less than 45 degrees (0.79 rad) from the horizontal plane shall be mounted not less than 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame. Skylights shall not be installed in the plane of the roof where the roof pitch is less than 45 degrees (0.79 rad) from the horizontal.

**Exception:** Installation of a skylight without a curb shall be permitted on roofs with a minimum slope of 14 degrees (three units vertical in 12 units horizontal) in Group R-3 occupancies. *Unit skylights* installed in a roof with a pitch flatter than 14 degrees (0.25 rad) shall be mounted not less than 4 inches (102 mm) above the plane of the roof on a curb constructed as required for the frame unless otherwise specified in the manufacturer's installation instructions.

**2405.5 Unit skylights and tubular daylighting devices.** *Unit skylights* and *tubular daylighting devices* shall be tested and labeled as complying with AAMA/WDMA/CSA 101/I.S./A440. The *label* shall state the name of the manufacturer, the *approved* labeling agency, the product designation and the performance grade rating as specified in AAMA/WDMA/CSA 101/I.S.2/A440. Where the product manufacturer has chosen to have the performance grade of the skylight rated separately for positive and negative design pressure, then the *label* shall state both performance grade ratings as specified in AAMA/WDMA/CSA 101/I.S.2/A440 and the skylight shall comply with Section 2405.5.2. Where the skylight is not rated separately for positive and negative pressure, then the performance grade rating shown on the *label* shall be the performance grade rating determined in accordance with AAMA/WDMA/CSA 101/I.S.2/A440 for both positive and negative design pressure and the skylight shall conform to Section 2405.5.1.

**2405.5.1 Skylights rated for the same performance grade for both positive and negative design pressure.** The design of skylights shall be based on Equation 24-13.

$$F_g \leq PG \quad (\text{Equation 24-13})$$

where:

$F_g$  = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

$PG$  = Performance grade rating of the skylight.

**2405.5.2 Skylights rated for separate performance grades for positive and negative design pressure.** The design of skylights rated for performance grade for both positive and negative design pressures shall be based on Equations 24-14 and 24-15.

$$F_{gi} \leq PG_{Pos} \quad (\text{Equation 24-14})$$

$$F_{go} \leq PG_{Neg} \quad (\text{Equation 24-15})$$

where:

$PG_{Pos}$  = Performance grade rating of the skylight under positive design pressure;

$PG_{Neg}$  = Performance grade rating of the skylight under negative design pressure; and

$F_{gi}$  and  $F_{go}$  are determined in accordance with the following:

For  $0.6W_o \geq D$ ,

where:

$W_o$  = Outward wind force, psf (kN/m<sup>2</sup>) due to basic design wind speed,  $V$ , as calculated in Section 1609.

$D$  = The dead weight of the glazing, psf (kN/m<sup>2</sup>) as determined in Section 2404.2 for glass, or by the weight of the plastic, psf (kN/m<sup>2</sup>) for plastic glazing.

$F_{gi}$  = Maximum load on the skylight determined from Equations 24-3 and 24-4 in Section 2404.2.

$F_{go}$  = Maximum load on the skylight determined from Equation 24-2.

For  $0.6W_o < D$ ,

where:

$W_o$  = The outward wind force, psf (kN/m<sup>2</sup>) due to basic design wind speed,  $V$ , as calculated in Section 1609.

$D$  = The dead weight of the glazing, psf (kN/m<sup>2</sup>) as determined in Section 2404.2 for glass, or by the weight of the plastic for plastic glazing.

$F_{gi}$  = Maximum load on the skylight determined from Equations 24-2 through 24-4 in Section 2404.2.

$F_{go}$  = 0.

## SECTION 2406 SAFETY GLAZING

**2406.1 Human impact loads.** Individual glazed areas, including glass mirrors, in hazardous locations as defined in Section 2406.4 shall comply with Sections 2406.1.1 through 2406.1.4.

**Exception:** Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.

**2406.1.1 Impact test.** Except as provided in Sections 2406.1.2 through 2406.1.4, all glazing shall pass the impact test requirements of Section 2406.2.

**2406.1.2 Plastic glazing.** Plastic glazing shall meet the weathering requirements of ANSI Z97.1.

**2406.1.3 Glass block.** Glass-block walls shall comply with Section 2110.

**2406.1.4 Louvered windows and жалousies.** Louvered windows and жалousies shall comply with Section 2403.5.

**2406.2 Impact test.** Where required by other sections of this code, glazing shall be tested in accordance with CPSC 16 CFR Part 1201. Glazing shall comply with the test criteria for Category II, unless otherwise indicated in Table 2406.2(1).

**Exception:** Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A, unless otherwise indicated in Table 2406.2(2).

**2406.3 Identification of safety glazing.** Except as indicated in Section 2406.3.1, each pane of safety glazing installed in hazardous locations shall be identified by a manufacturer's designation specifying who applied the designation, the manufacturer or installer and the safety glazing standard with which it complies, as well as the information specified in Section 2403.1. The designation shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that once applied, cannot be removed without being destroyed. A *label* meeting the requirements of this section shall be permitted in lieu of the manufacturer's designation.

**Exceptions:**

1. For other than tempered glass, manufacturer's designations are not required, provided that the *building official* approves the use of a certificate, affidavit or other evidence confirming compliance with this code.

2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation.

**2406.3.1 Multipane assemblies.** Multipane glazed assemblies having individual panes not exceeding 1 square foot (0.09 m<sup>2</sup>) in exposed areas shall have one pane or more in the assembly marked as indicated in Section 2406.3. Other panes in the assembly shall be marked "CPSC 16 CFR Part 1201" or "ANSI Z97.1," as appropriate.

**2406.4 Hazardous locations.** The locations specified in Sections 2406.4.1 through 2406.4.7 shall be considered to be specific hazardous locations requiring safety glazing materials.

**2406.4.1 Glazing in doors.** Glazing in all fixed and operable panels of swinging, sliding and bifold doors shall be considered to be a hazardous location.

**Exceptions:**

1. Glazed openings of a size through which a 3-inch-diameter (76 mm) sphere is unable to pass.
2. Decorative glazing.
3. Glazing materials used as curved glazed panels in revolving doors.
4. Commercial refrigerated cabinet glazed doors.

**2406.4.2 Glazing adjacent to doors.** Glazing in an individual fixed or operable panel adjacent to a door where the nearest vertical edge of the glazing is within a 24-inch (610 mm) arc of either vertical edge of the door in a closed position and where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the walking surface shall be considered to be a hazardous location.

**Exceptions:**

1. Decorative glazing.
2. Where there is an intervening wall or other permanent barrier between the door and glazing.
3. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth.

**TABLE 2406.2(1)**  
**MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR PART 1201**

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category class)	GLAZING IN DOORS (Category class)	GLAZED PANELS REGULATED BY SECTION 2406.4.3 (Category class)	GLAZED PANELS REGULATED BY SECTION 2406.4.2 (Category class)	DOORS AND ENCLOSURES REGULATED BY SECTION 2406.4.5 (Category class)	SLIDING GLASS DOORS PATIO TYPE (Category class)
9 square feet or less	I	I	No requirement	I	II	II
More than 9 square feet	II	II	II	II	II	II

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

**TABLE 2406.2(2)**  
**MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1**

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZED PANELS REGULATED BY SECTION 2406.4.3 (Category class)	GLAZED PANELS REGULATED BY SECTION 2406.4.2 (Category class)	DOORS AND ENCLOSURES REGULATED BY SECTION 2406.4.5 <sup>a</sup> (Category class)
9 square feet or less	No requirement	B	A
More than 9 square feet	A	A	A

For SI: square foot = 0.0929 m<sup>2</sup>.

a. Use is only permitted by the exception to Section 2406.2.

## GLASS AND GLAZING

Glazing in this application shall comply with Section 2406.4.3.

4. Glazing in walls on the latch side of and perpendicular to the plane of the door in a closed position in one- and two-family dwellings or within dwelling units in Group R-2.

**2406.4.3 Glazing in windows.** Glazing in an individual fixed or operable panel that meets all of the following conditions shall be considered to be a hazardous location:

1. The exposed area of an individual pane is greater than 9 square feet (0.84 m<sup>2</sup>).
2. The bottom edge of the glazing is less than 18 inches (457 mm) above the floor.
3. The top edge of the glazing is greater than 36 inches (914 mm) above the floor.
4. One or more walking surface(s) are within 36 inches (914 mm), measured horizontally and in a straight line, of the plane of the glazing.

**Exceptions:**

1. Decorative glazing.
2. Where a horizontal rail is installed on the accessible side(s) of the glazing 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal *load* of 50 pounds per linear foot (730 N/m) without contacting the glass and be not less than 1½ inches (38 mm) in cross-sectional height.
3. Outboard panes in insulating glass units or multiple glazing where the bottom exposed edge of the glass is 25 feet (7620 mm) or more above any grade, roof, walking surface or other horizontal or sloped (within 45 degrees of horizontal) (0.79 rad) surface adjacent to the glass exterior.

**2406.4.4 Glazing in guards and railings.** Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface shall be considered to be a hazardous location.

**2406.4.5 Glazing and wet surfaces.** Glazing in walls, enclosures or fences containing or facing hot tubs, spas, whirlpools, saunas, steam rooms, bathtubs, showers and indoor or outdoor *swimming pools* where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) measured vertically above any standing or walking surface shall be considered to be a hazardous location. This shall apply to single glazing and all panes in multiple glazing.

**Exception:** Glazing that is more than 60 inches (1524 mm), measured horizontally and in a straight line, from the water's edge of a bathtub, hot tub, spa, whirlpool or *swimming pool*.

**2406.4.6 Glazing adjacent to stairways and ramps.** Glazing where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the plane of the

adjacent walking surface of *stairways*, landings between flights of *stairs* and ramps shall be considered to be a hazardous location.

**Exceptions:**

1. The side of a *stairway*, landing or *ramp* that has a *guard* complying with the provisions of Sections 1015 and 1607.9, and the plane of the glass is greater than 18 inches (457 mm) from the railing.
2. Glazing 36 inches (914 mm) or more measured horizontally from the walking surface.

**2406.4.7 Glazing adjacent to the bottom stairway landing.** Glazing adjacent to the landing at the bottom of a *stairway* where the glazing is less than 60 inches (1524 mm) above the landing and within a 60-inch (1524 mm) horizontal arc that is less than 180 degrees (3.14 rad) from the bottom tread *nosings* shall be considered to be a hazardous location.

**Exception:** Glazing that is protected by a *guard* complying with Sections 1015 and 1607.9 where the plane of the glass is greater than 18 inches (457 mm) from the *guard*.

**2406.5 Fire department access panels.** Fire department glass access panels shall be of tempered glass. For insulating glass units, all panes shall be tempered glass.

## SECTION 2407 GLASS IN HANDRAILS AND GUARDS

**2407.1 Materials.** Glass used in a *handrail* or a *guard* shall be laminated glass constructed of fully tempered or heat-strengthened glass and shall comply with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1. Glazing in a *handrail* or a *guard* shall be of an *approved* safety glazing material that conforms to the provisions of Section 2406.1.1. For all glazing types, the minimum nominal thickness shall be ¼ inch (6.4 mm).

**Exception:** Single fully tempered glass complying with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1 shall be permitted to be used in *handrails* and *guards* where there is no walking surface beneath them or the walking surface is permanently protected from the risk of falling glass.

**2407.1.1 Loads.** Glass *handrails* and *guards* and their support systems shall be designed to withstand the *loads* specified in Section 1607.9. Glass *handrails* and *guards* shall be designed using a factor of safety of four.

**2407.1.2 Guards with structural glass balusters.** *Guards* with structural glass balusters, whether vertical posts, columns or panels, shall be installed with an attached top rail or *handrail*. The top rail or *handrail* shall be supported by not fewer than three glass balusters, or shall be otherwise supported to remain in place should one glass baluster fail.

**Exception:** An attached top rail or *handrail* is not required where the glass baluster panels are laminated



glass with two or more glass plies of equal thickness and of the same glass type. The balusters shall be tested to remain in place as a barrier following impact or glass breakage in accordance with ASTM E2353.

**2407.1.3 Parking garages.** Glazing materials shall not be installed in *handrails* or *guards* in parking garages except for pedestrian areas not exposed to impact from vehicles.

**2407.1.4 Glazing in windborne debris regions.** Glazing installed in exterior *handrails* or *guards* in *windborne debris regions* shall be laminated glass complying with Category II of CPSC 16 CFR 1201 or Class A of ANSI Z97.1. Where the top rail is supported by glass, the assembly shall be tested according to the impact requirements of Section 1609.2 and the top rail shall remain in place after impact.

## SECTION 2408 GLAZING IN ATHLETIC FACILITIES

**2408.1 General.** Glazing in athletic facilities and similar uses subject to impact loads, which forms whole or partial wall sections or which is used as a door or part of a door, shall comply with this section.

### 2408.2 Racquetball and squash courts.

**2408.2.1 Testing.** Test methods and loads for individual glazed areas in racquetball and squash courts subject to impact loads shall conform to those of CPSC 16 CFR Part 1201 or ANSI Z97.1 with impacts being applied at a height of 59 inches (1499 mm) above the playing surface to an actual or simulated glass wall installation with fixtures, fittings and methods of assembly identical to those used in practice.

Glass walls shall comply with the following conditions:

1. A glass wall in a racquetball or squash court, or similar use subject to impact loads, shall remain intact following a test impact.
2. The deflection of such walls shall be not greater than  $1\frac{1}{2}$  inches (38 mm) at the point of impact for a drop height of 48 inches (1219 mm).

Glass doors shall comply with the following conditions:

1. Glass doors shall remain intact following a test impact at the prescribed height in the center of the door.
2. The relative deflection between the edge of a glass door and the adjacent wall shall not exceed the thickness of the wall plus  $\frac{1}{2}$  inch (12.7 mm) for a drop height of 48 inches (1219 mm).

**2408.3 Gymnasiums and basketball courts.** Glazing in multipurpose gymnasiums, basketball courts and similar athletic facilities subject to human impact loads shall comply with Category II of CPSC 16 CFR Part 1201 or Class A of ANSI Z97.1.

## SECTION 2409 GLASS IN WALKWAYS, ELEVATOR HOISTWAYS AND ELEVATOR CARS

**2409.1 Glass walkways.** Glass installed as a part of a floor/ceiling assembly as a walking surface and constructed with laminated glass shall comply with ASTM E2751 or with the *load* requirements specified in Chapter 16. Such assemblies shall comply with the *fire-resistance rating* and marking requirements of this code where applicable.

**2409.2 Glass in elevator hoistway enclosures.** Glass in elevator hoistway enclosures and hoistway doors shall be laminated glass conforming to ANSI Z97.1 or CPSC 16 CFR Part 1201.

**2409.2.1 Fire-resistance-rated hoistways.** Glass installed in hoistways and hoistway doors where the hoistway is required to have a *fire-resistance rating* shall comply with Section 716.

**2409.2.2 Glass hoistway doors.** The glass in glass hoistway doors shall be not less than 60 percent of the total visible door panel surface area as seen from the landing side.

**2409.3 Vision panels in elevator hoistway doors.** Glass in vision panels in elevator hoistway doors shall be permitted to be any transparent glazing material not less than  $\frac{1}{4}$  inch (6.4 mm) in thickness conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201. The area of any single vision panel shall be not less than 24 square inches (15 484 mm<sup>2</sup>) and the total area of one or more vision panels in any hoistway door shall be not more than 85 square inches (54 839 mm<sup>2</sup>).

**2409.4 Glass in elevator cars.** Glass in elevator cars shall be in accordance with this section.

**2409.4.1 Glass types.** Glass in elevator car enclosures, glass elevator car doors and glass used for lining walls and ceilings of elevator cars shall be laminated glass conforming to Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

**Exception:** Tempered glass shall be permitted to be used for lining walls and ceilings of elevator cars provided that:

1. The glass is bonded to a nonpolymeric coating, sheeting or film backing having a physical integrity to hold the fragments when the glass breaks.
2. The glass is not subjected to further treatment such as sandblasting; etching; heat treatment or painting that could alter the original properties of the glass.
3. The glass is tested to the acceptance criteria for laminated glass as specified for Class A in accordance with ANSI Z97.1 or Category II in accordance with CPSC 16 CFR Part 1201.

**2409.4.2 Surface area.** The glass in glass elevator car doors shall be not less than 60 percent of the total visible door panel surface area as seen from the car side of the doors.



## CHAPTER 25

## GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

## User notes:

**About this chapter:** Chapter 25 contains the provisions and referenced standards that regulate the design, construction and quality of gypsum board, gypsum panel products and plaster and, in addition, addresses reinforced gypsum concrete. These materials are some of the most commonly used interior and exterior finish materials in the building industry. This chapter primarily addresses quality-control-related issues with regard to material specifications and installation requirements. Most products are manufactured in accordance with industry standards. The building official or inspector needs to verify that the appropriate product is used and properly installed for the intended use and location. Proper design and installation of these materials are necessary to provide weather resistance and required fire protection for both structural and nonstructural building components.

**Code development reminder:** Code change proposals to this chapter will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

SECTION 2501  
GENERAL

**2501.1 Scope.** Provisions of this chapter shall govern the materials, design, construction and quality of *gypsum board, gypsum panel products, lath, gypsum plaster, cement plaster* and reinforced gypsum concrete.

**2501.2 Other materials.** Other *approved* wall or ceiling coverings shall be permitted to be installed in accordance with the recommendations of the manufacturer and the conditions of approval.

SECTION 2502  
PERFORMANCE

**2502.1 General.** Lathing, plastering and *gypsum board* and *gypsum panel product* construction shall be done in the manner and with the materials specified in this chapter and, where required for fire protection, shall comply with the provisions of Chapter 7.

SECTION 2503  
INSPECTION

**2503.1 Inspection.** Lath, *gypsum board* and *gypsum panel products* shall be inspected in accordance with Section 110.3.6.

SECTION 2504  
VERTICAL AND HORIZONTAL ASSEMBLIES

**2504.1 Scope.** The following requirements shall be met where construction involves *gypsum board, gypsum panel products* or lath and plaster in vertical and *horizontal assemblies*.

**2504.1.1 Wood framing.** Wood supports for lath, *gypsum board* or *gypsum panel products*, as well as wood

stripping or furring, shall be not less than 2 inches (51 mm) nominal thickness in the least dimension.

**Exception:** The minimum nominal dimension of wood furring strips installed over solid backing shall be not less than 1 inch by 2 inches (25 mm by 51 mm).

**2504.1.2 Studless partitions.** The minimum thickness of vertically erected studless solid plaster partitions of  $\frac{3}{8}$ -inch (9.5 mm) and  $\frac{3}{4}$ -inch (19.1 mm) rib metal lath,  $\frac{1}{2}$ -inch-thick (12.7 mm) gypsum lath, *gypsum board* or *gypsum panel product* shall be 2 inches (51 mm).

SECTION 2505  
SHEAR WALL CONSTRUCTION

**2505.1 Resistance to shear (wood framing).** Wood-frame *shear walls* sheathed with *gypsum board, gypsum panel products* or lath and plaster shall be designed and constructed in accordance with Section 2306.3 and are permitted to resist wind and seismic *loads*. Walls resisting seismic *loads* shall be subject to the limitations in Section 12.2.1 of ASCE 7.

**2505.2 Resistance to shear (steel framing).** Cold-formed steel-frame shear walls sheathed with *gypsum board* or *gypsum panel products* and constructed in accordance with the materials and provisions of Section 2211.1.1 are permitted to resist wind and seismic *loads*. Walls resisting seismic *loads* shall be subject to the limitations in Section 12.2.1 of ASCE 7.

SECTION 2506  
GYPSUM BOARD AND  
GYPSUM PANEL PRODUCT MATERIALS

**2506.1 General.** *Gypsum board, gypsum panel products* and accessories shall be identified by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored to protect such materials from the weather.

## GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

**2506.2 Standards.** *Gypsum board and gypsum panel products* shall conform to the appropriate standards listed in Table 2506.2 and Chapter 35 and, where required for fire protection, shall conform to the provisions of Chapter 7.

**2506.2.1 Other materials.** Metal suspension systems for acoustical and lay-in panel ceilings shall comply with ASTM C635 listed in Chapter 35 and Section 13.5.6 of ASCE 7 for installation in high seismic areas.

### SECTION 2507 LATHING AND PLASTERING

**2507.1 General.** Lathing and plastering materials and accessories shall be marked by the manufacturer's designation to indicate compliance with the appropriate standards referenced in this section and stored in such a manner to protect them from the weather.

**2507.2 Standards.** Lathing and plastering materials shall conform to the standards listed in Table 2507.2 and Chapter 35 and, where required for fire protection, shall conform to the provisions of Chapter 7.

### SECTION 2508 GYPSUM CONSTRUCTION

**2508.1 General.** *Gypsum board, gypsum panel products and gypsum plaster* construction shall be of the materials listed in Tables 2506.2 and 2507.2. These materials shall be assembled and installed in compliance with the appropriate standards listed in Tables 2508.1 and 2511.1.1 and Chapter 35.

**2508.2 Limitations.** *Gypsum wallboard or gypsum plaster* shall not be used in any exterior surface where such gypsum construction will be exposed directly to the weather. *Gypsum*

*wallboard* shall not be used where there will be direct exposure to water or continuous high humidity conditions. *Gypsum sheathing* shall be installed on exterior surfaces in accordance with ASTM C1280.

**2508.2.1 Weather protection.** *Gypsum wallboard, gypsum lath or gypsum plaster* shall not be installed until weather protection for the installation is provided.

**2508.3 Single-ply application.** Edges and ends of *gypsum board* and *gypsum panel products* shall occur on the framing members, except those edges and ends that are perpendicular to the framing members. Edges and ends of *gypsum board* and *gypsum panel products* shall be in moderate contact except in concealed spaces where fire-resistance-rated construction, shear resistance or *diaphragm* action is not required.

**2508.3.1 Floating angles.** Fasteners at the top and bottom plates of vertical assemblies, or the edges and ends of *horizontal assemblies* perpendicular to supports, and at the wall line are permitted to be omitted except on shear resisting elements or fire-resistance-rated assemblies. Fasteners shall be applied in such a manner as not to fracture the face paper with the fastener head.

TABLE 2508.1  
INSTALLATION OF GYPSUM CONSTRUCTION

MATERIAL	STANDARD
Gypsum board and gypsum panel products	GA-216; ASTM C840
Gypsum sheathing and gypsum panel products	ASTM C1280
Gypsum veneer base	ASTM C844
Interior lathing and furring	ASTM C841
Steel framing for gypsum board and gypsum panel products	ASTM C754; C1007

TABLE 2506.2  
GYPSUM BOARD AND GYPSUM PANEL PRODUCTS MATERIALS AND ACCESSORIES

MATERIAL	STANDARD
Accessories for gypsum board	ASTM C1047
Adhesives for fastening gypsum board	ASTM C557
Cold-formed steel studs and track, structural	AISI S240
Cold-formed steel studs and track, nonstructural	AISI S220
Elastomeric joint sealants	ASTM C920
Expandable foam adhesives for fastening gypsum wallboard	ASTM D6464
Factory-laminated gypsum panel products	ASTM C1766
Fiber-reinforced gypsum panels	ASTM C1278
Glass mat gypsum backing panel	ASTM C1178
Glass mat gypsum panel 5	ASTM C1658
Glass mat gypsum substrate	ASTM C1177
Joint reinforcing tape and compound	ASTM C474; C475
Nails for gypsum boards	ASTM C514, F547, F1667
Steel screws	ASTM C954; C1002
Standard specification for gypsum board	ASTM C1396
Testing gypsum and gypsum products	ASTM C22; C472; C473



## GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

**2508.4 Adhesives.** *Gypsum board* and *gypsum panel products* secured to framing with adhesives in ceiling assemblies shall be attached using an approved fastening schedule. Expandable foam adhesives for fastening *gypsum wallboard* shall conform to ASTM D6464. Other adhesives for the installation of *gypsum wallboard* shall conform to ASTM C557.

**2508.5 Joint treatment.** *Gypsum board* and *gypsum panel product* fire-resistance-rated assemblies shall have joints and fasteners treated.

**Exception:** Joint and fastener treatment need not be provided where any of the following conditions occur:

1. Where the *gypsum board* or the *gypsum panel product* is to receive a decorative finish such as wood paneling, battens, acoustical finishes or any

similar application that would be equivalent to joint treatment.

2. On single-layer systems where joints occur over wood framing members.
3. Square edge or tongue-and-groove edge *gypsum board* (V-edge), *gypsum panel products*, gypsum backing board or *gypsum sheathing*.
4. On multilayer systems where the joints of adjacent layers are offset.
5. Assemblies tested without joint treatment.

**2508.6 Horizontal gypsum board or gypsum panel product diaphragm ceilings.** *Gypsum board* or *gypsum panel products* shall be permitted to be used on wood joists to create a horizontal *diaphragm* ceiling in accordance with Table 2508.6.

**TABLE 2507.2  
LATH, PLASTERING MATERIALS AND ACCESSORIES**

MATERIAL	STANDARD
Accessories for gypsum veneer base	ASTM C1047
Blended cement	ASTM C595
Cold-formed steel studs and track, structural	AISI S240
Cold-formed steel studs and track, nonstructural	AISI S220
Exterior plaster bonding compounds	ASTM C932
Hydraulic cement	ASTM C1157; C1600
Gypsum casting and molding plaster	ASTM C59
Gypsum Keene's cement	ASTM C61
Gypsum plaster	ASTM C28
Gypsum veneer plaster	ASTM C587
Interior bonding compounds, gypsum	ASTM C631
Lime plasters	ASTM C5; C206
Masonry cement	ASTM C91
Metal lath	ASTM C847
Plaster aggregates	
Sand	ASTM C35; C897
Perlite	ASTM C35
Vermiculite	ASTM C35
Plastic cement	ASTM C1328
Portland cement	ASTM C150
Steel screws	ASTM C1002; C954
Welded wire lath	ASTM C933
Woven wire plaster base	ASTM C1032

**TABLE 2508.6  
SHEAR CAPACITY FOR HORIZONTAL WOOD-FRAME GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES**

MATERIAL	THICKNESS OF MATERIAL (MINIMUM) (inches)	SPACING OF FRAMING MEMBERS (inches)	SHEAR VALUE <sup>a, b</sup> (PLF OF CEILING)	MINIMUM FASTENER SIZE
Gypsum board or gypsum panel product	1/2	16 o.c.	90	5d cooler or wallboard nail; 1 <sup>5</sup> / <sub>8</sub> -inch long; 0.086-inch shank; 1 <sup>5</sup> / <sub>64</sub> -inch head <sup>c</sup>
Gypsum board or gypsum panel product	1/2	24 o.c.	70	5d cooler or wallboard nail; 1 <sup>5</sup> / <sub>8</sub> -inch long; 0.086-inch shank; 1 <sup>5</sup> / <sub>64</sub> -inch head <sup>c</sup>

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.59 N/m.

a. Values are not cumulative with other horizontal diaphragm values and are for short-term wind or seismic loading. Values shall be reduced 25 percent for normal loading.

b. Values shall be reduced 50 percent in Seismic Design Categories D, E and F.

c. 1<sup>1</sup>/<sub>4</sub>-inch, No. 6 Type S or W screws are permitted to be substituted for the listed nails.

## GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

**2508.6.1 Diaphragm proportions.** The maximum allowable *diaphragm* proportions shall be 1 $\frac{1}{2}$ :1 between shear resisting elements. Rotation or cantilever conditions shall not be permitted.

**2508.6.2 Installation.** *Gypsum board* or *gypsum panel products* used in a horizontal *diaphragm* ceiling shall be installed perpendicular to ceiling framing members. End joints of adjacent courses of *gypsum board* shall not occur on the same joist.

**2508.6.3 Blocking of perimeter edges.** Perimeter edges shall be blocked using a wood member not less than 2-inch by 6-inch (51 mm by 152 mm) nominal dimension. Blocking material shall be installed flat over the top plate of the wall to provide a nailing surface not less than 2 inches (51 mm) in width for the attachment of the *gypsum board* or *gypsum panel product*.

**2508.6.4 Fasteners.** Fasteners used for the attachment of *gypsum board* or *gypsum panel products* to a horizontal *diaphragm* ceiling shall be as defined in Table 2508.6. Fasteners shall be spaced not more than 7 inches (178 mm) on center at all supports, including perimeter blocking, and not more than  $\frac{3}{8}$  inch (9.5 mm) from the edges and ends of the *gypsum board* or *gypsum panel product*.

**2508.6.5 Lateral force restrictions.** *Gypsum board* or *gypsum panel products* shall not be used in *diaphragm* ceilings to resist lateral forces imposed by masonry or concrete construction.

### SECTION 2509 SHOWERS AND WATER CLOSETS

**2509.1 Wet areas.** Showers and public toilet walls shall conform to Section 1210.2.

**2509.2 Base for tile.** Materials used as a base for wall tile in tub and shower areas and wall and ceiling panels in shower areas shall be of materials listed in Table 2509.2 and installed in accordance with the manufacturer's recommendations. Water-resistant gypsum backing board shall be used as a base for tile in water closet compartment walls when installed in accordance with GA-216 or ASTM C840 and the manufacturer's recommendations. Regular *gypsum wallboard* is permitted under tile or wall panels in other wall and ceiling areas when installed in accordance with GA 216 or ASTM C840.

TABLE 2509.2  
BACKERBOARD MATERIALS

MATERIAL	STANDARD
Glass mat gypsum backing panel	ASTM C1178
Nonasbestos fiber-cement backer board	ASTM C1288 or ISO 8336, Category C
Nonasbestos fiber-mat reinforced cementitious backer unit	ASTM C1325

**2509.3 Limitations.** Water-resistant gypsum backing board shall not be used in the following locations:

- Over a vapor retarder in shower or bathtub compartments.

- Where there will be direct exposure to water or in areas subject to continuous high humidity.

### SECTION 2510 LATHING AND FURRING FOR CEMENT PLASTER (STUCCO)

**2510.1 General.** Exterior and interior *cement plaster* and lathing shall be done with the appropriate materials listed in Table 2507.2 and Chapter 35.

**2510.2 Weather protection.** Materials shall be stored in such a manner as to protect them from the weather.

**2510.3 Installation.** Installation of these materials shall be in compliance with ASTM C926 and ASTM C1063.

**2510.4 Corrosion resistance.** Metal lath and lath attachments shall be of corrosion-resistant material.

**2510.5 Backing.** Backing or a lath shall provide sufficient rigidity to permit plaster applications.

**2510.5.1 Support of lath.** Where lath on vertical surfaces extends between rafters or other similar projecting members, solid backing shall be installed to provide support for lath and attachments.

**2510.5.2 Use of gypsum backing board.** Gypsum backing for cement plaster shall be in accordance with Section 2510.5.2.1 or 2510.5.2.2.

**2510.5.2.1 Gypsum board as a backing board.** Gypsum lath or *gypsum wallboard* shall not be used as a backing for *cement plaster*.

**Exception:** Gypsum lath or *gypsum wallboard* is permitted, with a *water-resistive barrier*, as a backing for self-furred metal lath or self-furred wire fabric lath and *cement plaster* where either of the following conditions occur:

- On horizontal supports of ceilings or roof soffits.
- On interior walls.

**2510.5.2.2 Gypsum sheathing backing.** *Gypsum sheathing* is permitted as a backing for metal or wire fabric lath and *cement plaster* on walls. A *water-resistive barrier* shall be provided in accordance with Section 2510.6.

**2510.5.3 Backing not required.** *Wire backing* is not required under expanded metal lath or paperbacked wire fabric lath.

**2510.6 Water-resistive barriers.** *Water-resistive barriers* shall be installed as required in Section 1403.2 and, where applied over wood-based sheathing, shall comply with Section 2510.6.1 or 2510.6.2.

**2510.6.1 Dry climates.** One of the following shall apply for dry (B) climate zones:

- The water-resistive barrier shall be two layers of 10-minute Grade D paper or have a water resistance equal to or greater than two layers of water-resistive barrier complying with ASTM E2556,

Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane and any flashing, installed in accordance with Section 1404.4 and intended to drain to the water-resistive barrier, is directed between the layers.

2. The water-resistive barrier shall be 60-minute Grade D paper or have a water resistance equal to or greater than one layer of water-resistive barrier complying with ASTM E2556, Type II. The water-resistive barrier shall be separated from the stucco by a layer of foam plastic insulating sheathing or other nonwater absorbing layer, or a drainage space.

**2510.6.2 Moist or marine climates.** In moist (A) or marine (C) climate zones, *water-resistive barrier* shall comply with one of the following:

1. In addition to complying with Item 1 or 2 of Section 2510.6.1, a space or drainage material not less than  $\frac{3}{16}$  inch (4.8 mm) in depth shall be applied to the exterior side of the *water-resistive barrier*.
2. In addition to complying with Item 2 of Section 2510.6.1, drainage on the exterior side of the *water-resistive barrier* shall have a minimum drainage efficiency of 90 percent as measured in accordance with ASTM E2273 or Annex A2 of ASTM E2925.

**2510.7 Preparation of masonry and concrete.** Surfaces shall be clean, free from efflorescence, sufficiently damp and rough for proper bond. If the surface is insufficiently rough, *approved* bonding agents or a Portland cement dash bond coat mixed in proportions of not more than two parts volume of sand to one part volume of Portland cement or plastic cement shall be applied. The dash bond coat shall be left undisturbed and shall be moist cured not less than 24 hours.

## SECTION 2511 INTERIOR PLASTER

**2511.1 General.** Plastering gypsum plaster or *cement plaster* shall be not less than three coats where applied over metal lath or wire fabric lath and not less than two coats where applied over other bases permitted by this chapter.

**Exception:** *Gypsum veneer plaster* and *cement plaster* specifically designed and *approved* for one-coat applications.

**2511.1.1 Installation.** Installation of lathing and plaster materials shall conform to Table 2511.1.1 and Section 2507.

**2511.2 Limitations.** Plaster shall not be applied directly to fiber insulation board. *Cement plaster* shall not be applied directly to gypsum lath or *gypsum plaster* except as specified in Sections 2510.5.1 and 2510.5.2.

**2511.3 Grounds.** Where installed, grounds shall ensure the minimum thickness of plaster as set forth in ASTM C842

and ASTM C926. Plaster thickness shall be measured from the face of lath and other bases.

**2511.4 Interior masonry or concrete.** Condition of surfaces shall be as specified in Section 2510.7. *Approved* specially prepared *gypsum plaster* designed for application to concrete surfaces or *approved* acoustical plaster is permitted. The total thickness of base coat plaster applied to concrete ceilings shall be as set forth in ASTM C842 or ASTM C926. Should ceiling surfaces require more than the maximum thickness permitted in ASTM C842 or ASTM C926, metal lath or wire fabric lath shall be installed on such surfaces before plastering.

**2511.5 Wet areas.** Showers and public toilet walls shall conform to Sections 1210.2 and 1210.3. Where wood frame walls and partitions are covered on the interior with *cement plaster* or tile of similar material and are subject to water splash, the framing shall be protected with an *approved* moisture barrier.

## SECTION 2512 EXTERIOR PLASTER

**2512.1 General.** Plastering with *cement plaster* shall be not less than three coats where applied over metal lath or wire fabric lath or *gypsum board* backing as specified in Section 2510.5 and shall be not less than two coats where applied over masonry or concrete. If the plaster surface is to be completely covered by *veneer* or other facing material, or is completely concealed by another wall, plaster application need only be two coats, provided that the total thickness is as set forth in ASTM C926.

**2512.1.1 On-grade floor slab.** On wood frame or steel stud construction with an on-grade concrete floor slab system, exterior plaster shall be applied in such a manner as to cover, but not to extend below, the lath and paper. The application of lath, paper and flashing or drip screeds shall comply with ASTM C1063.

**2512.1.2 Weep screeds.** A minimum 0.019-inch (0.48 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed with a minimum vertical attachment flange of  $3\frac{1}{2}$  inches (89 mm) shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C926. The weep screed shall be placed not less than 4 inches (102 mm) above the earth or 2 inches

TABLE 2511.1.1  
INSTALLATION OF PLASTER CONSTRUCTION

MATERIAL	STANDARD
Cement plaster	ASTM C926
Gypsum plaster	ASTM C842
Gypsum veneer plaster	ASTM C843
Interior lathing and furring (gypsum plaster)	ASTM C841
Lathing and furring (cement plaster)	ASTM C1063
Steel framing	ASTM C754; C1007

## GYPSUM BOARD, GYPSUM PANEL PRODUCTS AND PLASTER

(51 mm) above paved areas and be of a type that will allow trapped water to drain to the exterior of the building. The *water-resistive barrier* shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.

**2512.2 Plasticity agents.** Only *approved* plasticity agents and *approved* amounts thereof shall be added to Portland cement or blended cements. Where plastic cement or masonry cement is used, additional lime or plasticizers shall not be added. Hydrated lime or the equivalent amount of lime putty used as a plasticizer is permitted to be added to *cement plaster* or cement and lime plaster in an amount not to exceed that set forth in ASTM C926.

**2512.3 Limitations.** *Gypsum plaster* shall not be used on exterior surfaces.

**2512.4 Cement plaster.** Plaster coats shall be protected from freezing for a period of not less than 24 hours after set has occurred. Plaster shall be applied when the ambient temperature is higher than 40°F (4°C), unless provisions are made to keep *cement plaster* work above 40°F (4°C) during application and 48 hours thereafter.

**2512.5 Second-coat application.** The second coat shall be brought out to proper thickness, rodged and floated sufficiently rough to provide adequate bond for the finish coat. The second coat shall not have variations greater than 1/4 inch (6.4 mm) in any direction under a 5-foot (1524 mm) straight edge.

**2512.6 Curing and interval.** First and second coats of *cement plaster* shall be applied and moist cured as set forth in ASTM C926 and Table 2512.6.

**TABLE 2512.6  
CEMENT PLASTERS**

COAT	MINIMUM PERIOD MOIST CURING	MINIMUM INTERVAL BETWEEN COATS
First	48 hours <sup>a</sup>	48 hours <sup>b</sup>
Second	48 hours	7 days <sup>c</sup>
Finish	—	Note c

- The first two coats shall be as required for the first coats of exterior plaster, except that the moist-curing time period between the first and second coats shall be not less than 24 hours. Moist curing shall not be required where job and weather conditions are favorable to the retention of moisture in the cement plaster for the required time period.
- Twenty-four-hour minimum interval between coats of interior cement plaster. For alternative method of application, see Section 2512.8.
- Finish coat plaster is permitted to be applied to interior cement plaster base coats after a 48-hour period.

**2512.7 Application to solid backings.** Where applied over gypsum backing as specified in Section 2510.5 or directly to unit masonry surfaces, the second coat is permitted to be applied as soon as the first coat has attained sufficient hardness.

**2512.8 Alternate method of application.** The second coat is permitted to be applied as soon as the first coat has attained sufficient rigidity to receive the second coat.

**2512.8.1 Admixtures.** Where using this method of application, calcium aluminate cement up to 15 percent of the

weight of the Portland cement is permitted to be added to the mix.

**2512.8.2 Curing.** Curing of the first coat is permitted to be omitted and the second coat shall be cured as set forth in ASTM C926 and Table 2512.6.

**2512.9 Finish coats.** *Cement plaster* finish coats shall be applied over base coats that have been in place for the time periods set forth in ASTM C926. The third or finish coat shall be applied with sufficient material and pressure to bond and to cover the brown coat and shall be of sufficient thickness to conceal the brown coat.

## SECTION 2513 EXPOSED AGGREGATE PLASTER

**2513.1 General.** Exposed natural or integrally colored aggregate is permitted to be partially embedded in a natural or colored bedding coat of *cement plaster* or *gypsum plaster*, subject to the provisions of this section.

**2513.2 Aggregate.** The aggregate shall be applied manually or mechanically and shall consist of marble chips, pebbles or similar durable, moderately hard (three or more on the Mohs hardness scale), nonreactive materials.

**2513.3 Bedding coat proportions.** The bedding coat for interior or exterior surfaces shall be composed of one part Portland cement and one part Type S lime; or one part blended cement and one part Type S lime; or masonry cement; or plastic cement and not more than three parts of graded white or natural sand by volume. The bedding coat for *interior surfaces* shall be composed of 100 pounds (45.4 kg) of neat *gypsum plaster* and not more than 200 pounds (90.8 kg) of graded white sand. A factory-prepared bedding coat for interior or exterior use is permitted. The bedding coat for exterior surfaces shall have a minimum compressive strength of 1,000 pounds per square inch (6895 kPa).

**2513.4 Application.** The bedding coat is permitted to be applied directly over the first (scratch) coat of plaster, provided that the ultimate overall thickness is not less than 7/8 inch (22 mm), including lath. Over concrete or masonry surfaces, the overall thickness shall be not less than 1/2 inch (12.7 mm).

**2513.5 Bases.** Exposed aggregate plaster is permitted to be applied over concrete, masonry, *cement plaster* base coats or *gypsum plaster* base coats installed in accordance with Section 2511 or 2512.

**2513.6 Preparation of masonry and concrete.** Masonry and concrete surfaces shall be prepared in accordance with the provisions of Section 2510.7.

**2513.7 Curing of base coats.** *Cement plaster* base coats shall be cured in accordance with ASTM C926. Cement plaster bedding coats shall retain sufficient moisture for hydration (hardening) for 24 hours minimum or, where necessary, shall be kept damp for 24 hours by light water spraying.



## SECTION 2514 REINFORCED GYPSUM CONCRETE

**2514.1 General.** Reinforced gypsum concrete shall comply with the requirements of ASTM C317 and ASTM C956.

**2514.2 Minimum thickness.** The minimum thickness of reinforced gypsum concrete shall be 2 inches (51 mm) except the minimum required thickness shall be reduced to 1½ inches (38 mm), provided that the following conditions are satisfied:

1. The overall thickness, including the formboard, is not less than 2 inches (51 mm).
2. The clear span of the gypsum concrete between supports does not exceed 33 inches (838 mm).
3. *Diaphragm* action is not required.
4. The design *live load* does not exceed 40 pounds per square foot (psf) (1915 Pa).



## CHAPTER 26

# PLASTIC

### User note:

**About this chapter:** The use of plastics in building construction and components is addressed in Chapter 26. This chapter provides standards addressing foam plastic insulation, foam plastics used as interior finish and trim, and other plastic veneers used on the inside or outside of a building. This chapter addresses the use of light-transmitting plastics in various configurations such as walls, roof panels, skylights, signs and glazing. Requirements for the use of fiber-reinforced polymers, fiberglass-reinforced polymers and reflective plastic core insulation are also contained in this chapter. Additionally, requirements specific to the use of wood-plastic composites and plastic lumber are contained in this chapter.

### SECTION 2601 GENERAL

**2601.1 Scope.** These provisions shall govern the materials, design, application, construction and installation of foam plastic, foam plastic insulation, plastic *veneer*, interior plastic finish and *trim*, light-transmitting plastics and plastic composites, including plastic lumber.

### SECTION 2602 FINISH AND TRIM

**2602.1 Exterior wall covering and architectural trim.** See Chapter 14 for requirements for *exterior wall* covering and architectural trim.

**2602.2 Interior finish and trim.** See Section 2604 for requirements for *interior finish* and *trim*.

### SECTION 2603 FOAM PLASTIC INSULATION

**2603.1 General.** The provisions of this section shall govern the requirements and uses of foam plastic insulation in buildings and structures.

**2603.1.1 Spray-applied foam plastic.** Single- and multi-component spray-applied foam plastic insulation shall comply with the provisions of Section 2603 and ICC 1100-2018.

**2603.2 Labeling and identification.** Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the *label* of an *approved agency* showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

**2603.3 Surface-burning characteristics.** Unless otherwise indicated in this section, foam plastic insulation and foam plastic cores of manufactured assemblies shall have a *flame spread index* of not more than 75 and a *smoke-developed index* of not more than 450 where tested in the maximum thickness intended for use in accordance with ASTM E84 or UL 723. Loose fill-type foam plastic insulation shall be

tested as board stock for the *flame spread* and smoke-developed indices.

### Exceptions:

1. *Smoke-developed index* for interior *trim* as provided for in Section 2604.2.
2. In cold storage buildings, ice plants, food plants, food processing rooms and similar areas, foam plastic insulation where tested in a thickness of 4 inches (102 mm) shall be permitted in a thickness up to 10 inches (254 mm) where the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1. The approved *automatic sprinkler system* shall be provided in both the room and that part of the building in which the room is located.
3. Foam plastic insulation that is a part of a Class A, B or C roof-covering assembly provided that the assembly with the foam plastic insulation satisfactorily passes NFPA 276 or UL 1256. The *smoke-developed index* shall not be limited for roof applications.
4. Foam plastic insulation greater than 4 inches (102 mm) in thickness shall have a maximum *flame spread index* of 75 and a *smoke-developed index* of 450 where tested at a minimum thickness of 4 inches (102 mm), provided that the end use is approved in accordance with Section 2603.9 using the maximum thickness and density intended for use.
5. *Flame spread* and smoke-developed indices for foam plastic interior signs in *covered and open mall buildings* provided that the signs comply with Section 402.6.4.

**2603.4 Thermal barrier.** Except as provided for in Sections 2603.4.1 and 2603.9, foam plastic shall be separated from the interior of a building by an approved thermal barrier of  $\frac{1}{2}$ -inch (12.7 mm) *gypsum wallboard*, heavy timber in accordance with Section 602.4 or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275. Combustible concealed spaces shall comply with Section 718.

## PLASTIC

**2603.4.1 Thermal barrier not required.** The thermal barrier specified in Section 2603.4 is not required under the conditions set forth in Sections 2603.4.1.1 through 2603.4.1.14.

**2603.4.1.1 Masonry or concrete construction.** A thermal barrier is not required for foam plastic installed in a masonry or concrete wall, floor or roof system where the foam plastic insulation is covered on each face by not less than 1-inch (25 mm) thickness of masonry or concrete.

**2603.4.1.2 Cooler and freezer walls.** Foam plastic installed in a maximum thickness of 10 inches (254 mm) in cooler and freezer walls shall:

1. Have a *flame spread index* of 25 or less and a *smoke-developed index* of not more than 450, where tested in a minimum 4-inch (102 mm) thickness.
2. Have flash ignition and self-ignition temperatures of not less than 600°F and 800°F (316°C and 427°C), respectively.
3. Have a covering of not less than 0.032-inch (0.8 mm) aluminum or corrosion-resistant steel having a base metal thickness not less than 0.0160 inch (0.4 mm) at any point.
4. Be protected by an *automatic sprinkler system* in accordance with Section 903.3.1.1. Where the cooler or freezer is within a building, both the cooler or freezer and that part of the building in which it is located shall be sprinklered.

**2603.4.1.3 Walk-in coolers.** In nonsprinklered buildings, foam plastic having a thickness that does not exceed 4 inches (102 mm) and a maximum *flame spread index* of 75 is permitted in walk-in coolers or freezer units where the aggregate floor area does not exceed 400 square feet (37 m<sup>2</sup>) and the foam plastic is covered by a metal facing not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm). A thickness of up to 10 inches (254 mm) is permitted where protected by a thermal barrier.

**2603.4.1.4 Exterior walls, one-story buildings.** For one-story buildings, foam plastic having a *flame spread index* of 25 or less, and a *smoke-developed index* of not more than 450, shall be permitted without thermal barriers in or on *exterior walls* in a thickness not more than 4 inches (102 mm) where the foam plastic is covered by a thickness of not less than 0.032-inch-thick (0.81 mm) aluminum or corrosion-resistant steel having a base metal thickness of 0.0160 inch (0.41 mm) and the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**2603.4.1.5 Roofing.** A thermal barrier is not required for foam plastic insulation that is a part of a Class A, B or C roof-covering assembly that is installed in accordance with the code and the manufacturer's

instructions and is either constructed as described in Item 1 or tested as described in Item 2.

1. The roof assembly is separated from the interior of the building by *wood structural panel* sheathing not less than 0.47 inch (11.9 mm) in thickness bonded with exterior glue, with edges supported by blocking, tongue-and-groove joints, other approved type of edge support or an equivalent material.
2. The assembly with the foam plastic insulation satisfactorily passes NFPA 276 or UL 1256.

**2603.4.1.6 Attics and crawl spaces.** Within an *attic* or *crawl space* where entry is made only for service of utilities, foam plastic insulation shall be protected against ignition by 1½-inch-thick (38 mm) mineral fiber insulation; ¼-inch-thick (6.4 mm) *wood structural panel*, *particleboard* or *hardboard*; ⅜-inch (9.5 mm) *gypsum wallboard*, corrosion-resistant steel having a base metal thickness of 0.016 inch (0.4 mm); 1½-inch-thick (38 mm) self-supported spray-applied cellulose insulation in *attic* spaces only or other approved material installed in such a manner that the foam plastic insulation is not exposed. The protective covering shall be consistent with the requirements for the type of construction.

**2603.4.1.7 Doors not required to have a fire protection rating.** Where pivoted or side-hinged doors are permitted without a *fire protection rating*, foam plastic insulation, having a *flame spread index* of 75 or less and a *smoke-developed index* of not more than 450, shall be permitted as a core material where the door facing is of aluminum not less than 0.032 inch (0.8 mm) in thickness or steel having a base metal thickness of not less than 0.016 inch (0.4 mm) at any point.

**2603.4.1.8 Exterior doors in buildings of Group R-2 or R-3.** In occupancies classified as Group R-2 or R-3, foam-filled exterior entrance doors to individual *dwelling units* that do not require a *fire-resistance rating* shall be faced with aluminum, steel, fiberglass, wood or other approved materials.

**2603.4.1.9 Garage doors.** Where garage doors are permitted without a *fire-resistance rating* and foam plastic is used as a core material, the door facing shall be metal having a minimum thickness of 0.032-inch (0.8 mm) aluminum or 0.010-inch (0.25 mm) steel or the facing shall be minimum 0.125-inch-thick (3.2 mm) wood. Garage doors having facings other than those described in this section shall be tested in accordance with, and meet the acceptance criteria of, DASMA 107.

**Exception:** Garage doors using foam plastic insulation complying with Section 2603.3 in detached and attached garages associated with one- and two-family dwellings need not be provided with a thermal barrier.



**2603.4.1.10 Siding backer board.** Foam plastic insulation of not more than 2,000 British thermal units per square foot (Btu/sq. ft.) (22.7 mJ/m<sup>2</sup>) as determined by NFPA 259 shall be permitted as a siding backer board with a maximum thickness of 1/2 inch (12.7 mm), provided that it is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation or equivalent or where applied as insulation with re-siding over existing wall construction.

**2603.4.1.11 Interior trim.** Foam plastic used as interior *trim* in accordance with Section 2604 shall be permitted without a thermal barrier.

**2603.4.1.12 Interior signs.** Foam plastic used for interior signs in *covered mall buildings* in accordance with Section 402.6.4 shall be permitted without a thermal barrier. Foam plastic signs that are not affixed to interior building surfaces shall comply with Chapter 8 of the *International Fire Code*.

**2603.4.1.13 Type V construction.** Foam plastic spray applied to a sill plate, joist header and rim joist in Type V construction is subject to all of the following:

1. The maximum thickness of the foam plastic shall be 3 1/4 inches (82.6 mm).
2. The density of the foam plastic shall be in the range of 1.5 to 2.0 pcf (24 to 32 kg/m<sup>3</sup>).
3. The foam plastic shall have a *flame spread index* of 25 or less and an accompanying *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723.

**2603.4.1.14 Floors.** The thermal barrier specified in Section 2603.4 is not required to be installed on the walking surface of a structural floor system that contains foam plastic insulation where the foam plastic is covered by a minimum nominal 1/2-inch-thick (12.7 mm) *wood structural panel* or approved equivalent. The thermal barrier specified in Section 2603.4 is required on the underside of the structural floor system that contains foam plastic insulation where the underside of the structural floor system is exposed to the interior of the building.

**Exception:** Foam plastic used as part of an *interior floor finish*.

**2603.5 Exterior walls of buildings of any height.** *Exterior walls* of buildings of Type I, II, III or IV construction of any height shall comply with Sections 2603.5.1 through 2603.5.7. *Exterior walls* of cold storage buildings required to be constructed of noncombustible materials, where the building is more than one *story* in height, shall comply with the provisions of Sections 2603.5.1 through 2603.5.7. *Exterior walls* of buildings of Type V construction shall comply with Sections 2603.2, 2603.3 and 2603.4. *Fireblocking* shall be in accordance with Section 718.2.

**2603.5.1 Fire-resistance-rated walls.** Where the wall is required to have a *fire-resistance rating*, data based on tests conducted in accordance with ASTM E119 or UL

263 shall be provided to substantiate that the *fire-resistance rating* is maintained.

**2603.5.2 Thermal barrier.** Any foam plastic insulation shall be separated from the building interior by a thermal barrier meeting the provisions of Section 2603.4, unless special approval is obtained on the basis of Section 2603.9.

**Exception:** One-story buildings complying with Section 2603.4.1.4.

**2603.5.3 Potential heat.** The potential heat of foam plastic insulation in any portion of the wall or panel shall not exceed the potential heat expressed in Btu per square foot (mJ/m<sup>2</sup>) of the foam plastic insulation contained in the wall assembly tested in accordance with Section 2603.5.5. The potential heat of the foam plastic insulation shall be determined by tests conducted in accordance with NFPA 259 and the results shall be expressed in Btu per square foot (mJ/m<sup>2</sup>).

**Exception:** One-story buildings complying with Section 2603.4.1.4.

**2603.5.4 Flame spread and smoke-developed indices.** Foam plastic insulation, exterior coatings and facings shall be tested separately in the thickness intended for use, but not to exceed 4 inches (102 mm), and shall each have a *flame spread index* of 25 or less and a *smoke-developed index* of 450 or less as determined in accordance with ASTM E84 or UL 723.

**Exception:** Prefabricated or factory-manufactured panels having minimum 0.020-inch (0.51 mm) aluminum facings and a total thickness of 1/4 inch (6.4 mm) or less are permitted to be tested as an assembly where the foam plastic core is not exposed in the course of construction.

**2603.5.5 Vertical and lateral fire propagation.** The *exterior wall* assembly shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

**Exceptions:**

1. One-story buildings complying with Section 2603.4.1.4.
2. Wall assemblies where the foam plastic insulation is covered on each face by not less than 1-inch (25 mm) thickness of masonry or concrete and meeting one of the following:
  - 2.1. There is no airspace between the insulation and the concrete or masonry.
  - 2.2. The insulation has a *flame spread index* of not more than 25 as determined in accordance with ASTM E84 or UL 723 and the maximum airspace between the insulation and the concrete or masonry is not more than 1 inch (25 mm).

**2603.5.6 Label required.** The edge or face of each piece, package or container of foam plastic insulation shall bear the *label* of an *approved agency*. The *label* shall contain the manufacturer's or distributor's identification, model

## PLASTIC

number, serial number or definitive information describing the product or materials' performance characteristics and *approved agency's* identification.

**2603.5.7 Ignition.** *Exterior walls* shall not exhibit sustained flaming where tested in accordance with NFPA 268. Where a material is intended to be installed in more than one thickness, tests of the minimum and maximum thickness intended for use shall be performed.

**Exception:** Assemblies protected on the outside with one of the following:

1. A thermal barrier complying with Section 2603.4.
2. A minimum 1-inch (25 mm) thickness of concrete or masonry.
3. Glass-fiber-reinforced concrete panels of a minimum thickness of  $\frac{3}{8}$  inch (9.5 mm).
4. Metal-faced panels having minimum 0.019-inch-thick (0.48 mm) aluminum or 0.016-inch-thick (0.41 mm) corrosion-resistant steel outer facings.
5. A minimum  $\frac{7}{8}$ -inch (22.2 mm) thickness of stucco complying with Section 2510.
6. A minimum  $\frac{1}{4}$ -inch (6.4 mm) thickness of *fiber-cement* lap, panel or shingle siding complying with Section 1404.16 and Section 1404.16.1 or 1404.16.2.

**2603.6 Roofing.** Foam plastic insulation meeting the requirements of Sections 2603.2, 2603.3 and 2603.4 shall be permitted as part of a roof-covering assembly, provided that the assembly with the foam plastic insulation is a Class A, B or C roofing assembly where tested in accordance with ASTM E108 or UL 790.

**2603.7 Foam plastic in plenums as interior finish or interior trim.** Foam plastic in plenums used as interior wall or ceiling finish, or interior *trim*, shall exhibit a *flame spread index* of 25 or less and a *smoke-developed index* of 50 or less when tested in accordance with ASTM E84 or UL 723 at the maximum thickness and density intended for use, and shall be tested in accordance with NFPA 286 and meet the acceptance criteria of Section 803.1.1. As an alternative to testing to NFPA 286, the foam plastic shall be approved based on tests conducted in accordance with Section 2603.9.

**Exceptions:**

1. Foam plastic in plenums used as interior wall or ceiling finish, or interior *trim*, shall exhibit a *flame spread index* of 75 or less and a *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723 at the maximum thickness and density intended for use, where it is separated from the airflow in the plenum by a thermal barrier complying with Section 2603.4.
2. Foam plastic in plenums used as interior wall or ceiling finish, or interior *trim*, shall exhibit a *flame spread index* of 75 or less and a *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723 at the maximum

thickness and density intended for use, where it is separated from the airflow in the plenum by corrosion-resistant steel having a base metal thickness of not less than 0.0160 inch (0.4 mm).

3. Foam plastic in plenums used as interior wall or ceiling finish, or interior *trim*, shall exhibit a *flame spread index* of 75 or less and a *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723 at the maximum thickness and density intended for use, where it is separated from the airflow in the plenum by not less than a 1-inch (25 mm) thickness of masonry or concrete.

**2603.8 Protection against termites.** In areas where the probability of termite infestation is very heavy in accordance with Figure 2603.8, extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below grade. The clearance between foam plastics installed above grade and exposed earth shall be not less than 6 inches (152 mm).

**Exceptions:**

1. Buildings where the structural members of walls, floors, ceilings and roofs are entirely of noncombustible materials or *preservative-treated wood*.
2. An approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
3. On the interior side of basement walls.

**2603.9 Special approval.** Foam plastic shall not be required to comply with the requirements of Section 2603.4 or those of Section 2603.6 where specifically approved based on large-scale tests such as, but not limited to, NFPA 286 (with the acceptance criteria of Section 803.1.1.1), FM 4880, UL 1040 or UL 1715. Such testing shall be related to the actual end-use configuration and be performed on the finished manufactured foam plastic assembly in the maximum thickness intended for use. Foam plastics that are used as *interior finish* on the basis of special tests shall conform to the *flame spread* and *smoke-developed* requirements of Chapter 8. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

**[BS] 2603.10 Wind resistance.** Foam plastic insulation complying with ASTM C578 and ASTM C1289 and used as *exterior wall* sheathing on framed wall assemblies shall comply with ANSI/FS 100 for wind pressure resistance.

**[BS] 2603.11 Cladding attachment over foam sheathing to masonry or concrete wall construction.** Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's installation instructions or an approved design. Foam sheathing shall be attached to masonry or concrete construction in accordance with the insulation manufacturer's installation instructions or an approved design. Furring and furring attachments through foam sheathing shall be designed to resist design *loads* determined in accordance with Chapter 16, including support of

cladding weight as applicable. Fasteners used to attach cladding or furring through foam sheathing to masonry or concrete substrates shall be approved for application into masonry or concrete material and shall be installed in accordance with the fastener manufacturer's installation instructions.

**Exceptions:**

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing and connection to a masonry or concrete substrate, those requirements shall apply.
2. For *exterior insulation and finish systems*, refer to Section 1407.
3. For anchored masonry or stone *vener* installed over foam sheathing, refer to Section 1404.

**[BS] 2603.12 Cladding attachment over foam sheathing to cold-formed steel framing.** Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's approved installation instructions, including any limitations for use over foam plastic sheathing, or an approved design. Where used, furring and furring attachments shall be designed to resist design *loads* determined in accordance with Chapter 16. In addition, the cladding or furring attachments through foam sheathing to cold-formed steel framing shall meet or exceed the minimum fastening requirements of Sections 2603.12.1 and 2603.12.2, or an approved design for support of cladding weight.

**Exceptions:**

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.

2. For *exterior insulation and finish systems*, refer to Section 1407.
3. For anchored masonry or stone *vener* installed over foam sheathing, refer to Section 1404.

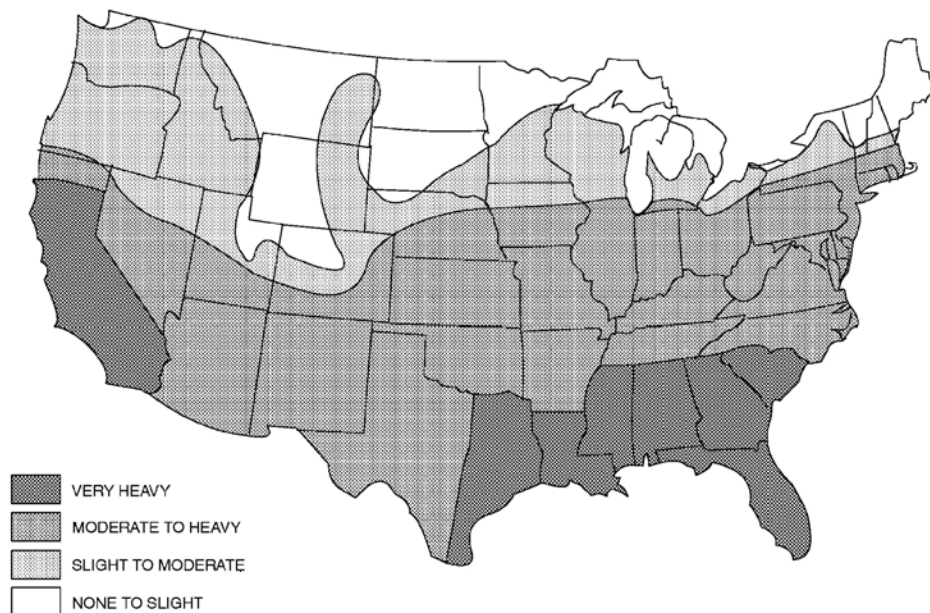
**[BS] 2603.12.1 Direct attachment.** Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.1.

**[BS] 2603.12.2 Furred cladding attachment.** Where steel or wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.12.2. Where placed horizontally, wood furring shall be *preservative-treated wood* in accordance with Section 2303.1.9 or *naturally durable wood* and fasteners shall be corrosion resistant in accordance Section 2304.10.6. Steel furring shall have a minimum G60 galvanized coating.

**[BS] 2603.13 Cladding attachment over foam sheathing to wood framing.** Cladding shall be specified and installed in accordance with Chapter 14 and the cladding manufacturer's installation instructions. Where used, furring and furring attachments shall be designed to resist design *loads* determined in accordance with Chapter 16. In addition, the cladding or furring attachments through foam sheathing to framing shall meet or exceed the minimum fastening requirements of Section 2603.13.1 or 2603.13.2, or an approved design for support of cladding weight.

**Exceptions:**

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.



**FIGURE 2603.8**  
**TERMITE INFESTATION PROBABILITY MAP**



## PLASTIC

**[BS]TABLE 2603.12.1**  
**CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT**  
**ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a</sup>**

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE <sup>b</sup>	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>c</sup> (inches)							
			16" o.c. fastener horizontal spacing				24" o.c. fastener horizontal spacing			
			Cladding weight				Cladding weight			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Cold-formed steel framing (minimum penetration of steel thickness plus 3 threads)	#8 screw into 33 mil steel or thicker	6	3.00	2.95	2.20	1.45	3.00	2.35	1.25	DR
		8	3.00	2.55	1.60	0.60	3.00	1.80	DR	DR
		12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
	#10 screw into 33 mil steel	6	4.00	3.50	2.70	1.95	4.00	2.90	1.70	0.55
		8	4.00	3.10	2.05	1.00	4.00	2.25	0.70	DR
		12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
	#10 screw into 43 mil steel or thicker	6	4.00	4.00	4.00	3.60	4.00	4.00	3.45	2.70
		8	4.00	4.00	3.70	3.00	4.00	3.85	2.80	1.80
		12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.

DR = design required, o.c. = on center.

a. Cold-formed steel framing shall be minimum 33 ksi steel for 33 mil and 43 mil steel and 50 ksi steel for 54 mil steel or thicker.

b. Screws shall comply with the requirements of AISI S240.

c. Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578 or ASTM C1289.

**[BS]TABLE 2603.12.2**  
**FURRING MINIMUM FASTENING REQUIREMENTS FOR**  
**APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a</sup>**

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE <sup>b</sup>	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>d</sup> (inches)							
					16" o.c. furring <sup>e</sup>				24" o.c. furring <sup>e</sup>			
					Cladding weight				Cladding weight			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 33 mil steel furring or minimum 1x wood furring <sup>c</sup>	33 mil cold-formed steel stud	#8 screw	Steel thickness plus 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4.00	2.25	0.70	DR	3.70	1.05	DR	DR
				16	3.85	1.45	DR	DR	3.40	DR	DR	DR
				24	3.40	DR	DR	DR	2.70	DR	DR	DR
	43 mil or thicker cold-formed steel stud	#8 Screw	Steel thickness plus 3 threads	12	3.00	1.80	DR	DR	3.00	0.65	DR	DR
				16	3.00	1.00	DR	DR	2.85	DR	DR	DR
				24	2.85	DR	DR	DR	2.20	DR	DR	DR
		#10 screw	Steel thickness plus 3 threads	12	4.00	3.85	2.80	1.80	4.00	3.05	1.50	DR
				16	4.00	3.30	1.95	0.60	4.00	2.25	DR	DR
				24	4.00	2.25	DR	DR	4.00	0.65	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.

DR = Design Required, o.c. = on center.

a. Wood furring shall be spruce-pine-fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33 ksi steel. Cold-formed steel studs shall be minimum 33 ksi steel for 33 mil and 43 mil thickness and 50 ksi steel for 54 mil steel or thicker.

b. Screws shall comply with the requirements of AISI S240.

c. Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 1 1/2 inches, a minimum 2-inch nominal wood furring or an approved design shall be used.

d. Foam sheathing shall have a minimum compressive strength of 15 pounds per square inch in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.



2. For *exterior insulation and finish systems*, refer to Section 1407.
3. For anchored masonry or stone *veneer* installed over foam sheathing, refer to Section 1404.

**[BS] 2603.13.1 Direct attachment.** Where cladding is installed directly over foam sheathing without the use of furring, minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.13.1.

**[BS] 2603.13.2 Furred cladding attachment.** Where wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table 2603.13.2. Where placed horizontally, wood furring shall be *preservative-treated wood* in accordance with Section 2303.1.9 or *naturally durable wood* and fasteners shall be corrosion resistant in accordance with Section 2304.10.6.

## SECTION 2604 INTERIOR FINISH AND TRIM

**2604.1 General.** Plastic materials installed as *interior finish* or *trim* shall comply with Chapter 8. Foam plastics shall only be installed as *interior finish* where approved in accordance with the special provisions of Section 2603.9. Foam plastics that are used as *interior finish* shall meet the *flame spread* and *smoke-developed index* requirements for *interior finish* in accordance with Chapter 8. Foam plastics installed as *interior trim* shall comply with Section 2604.2.

**2604.1.1 Plenums.** Foam plastics installed in plenums as interior wall or ceiling finish shall comply with Section

2603.7. Foam plastics installed in plenums as interior *trim* shall comply with Sections 2604.2 and 2603.7.

**[F] 2604.2 Interior trim.** Foam plastic used as interior *trim* shall comply with Sections 2604.2.1 through 2604.2.4.

**[F] 2604.2.1 Density.** The minimum density of the interior *trim* shall be 20 pcf (320 kg/m<sup>3</sup>).

**[F] 2604.2.2 Thickness.** The maximum thickness of the interior *trim* shall be 1/2 inch (12.7 mm) and the maximum width shall be 8 inches (204 mm).

**[F] 2604.2.3 Area limitation.** The interior *trim* shall not constitute more than 10 percent of the specific wall or ceiling areas to which it is attached.

**[F] 2604.2.4 Flame spread.** The *flame spread index* shall not exceed 75 where tested in accordance with ASTM E84 or UL 723. The *smoke-developed index* shall not be limited.

**Exception:** Where the interior *trim* material has been tested as an *interior finish* in accordance with NFPA 286 and complies with the acceptance criteria in Section 803.1.1.1, it shall not be required to be tested for *flame spread index* in accordance with ASTM E84 or UL 723.

## SECTION 2605 PLASTIC VENEER

**2605.1 Interior use.** Where used within a building, plastic *veneer* shall comply with the *interior finish* requirements of Chapter 8.

**[BS]TABLE 2603.13.1  
CLADDING MINIMUM FASTENING REQUIREMENTS FOR DIRECT  
ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a</sup>**

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE <sup>b</sup>	CLADDING FASTENER VERTICAL SPACING (INCHES)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>c</sup> (INCHES)							
			16" o.c. fastener horizontal spacing				24" o.c. fastener horizontal spacing			
			Cladding weight:				Cladding weight:			
			3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Wood Framing (minimum 1 1/4-inch penetration)	0.113" diameter nail	6	2.00	1.45	0.75	DR	2.00	0.85	DR	DR
		8	2.00	1.00	DR	DR	2.00	0.55	DR	DR
		12	2.00	0.55	DR	DR	1.85	DR	DR	DR
	0.120" diameter nail	6	3.00	1.70	0.90	0.55	3.00	1.05	0.50	DR
		8	3.00	1.20	0.60	DR	3.00	0.70	DR	DR
		12	3.00	0.70	DR	DR	2.15	DR	DR	DR
	0.131" diameter nail	6	4.00	2.15	1.20	0.75	4.00	1.35	0.70	DR
		8	4.00	1.55	0.80	DR	4.00	0.90	DR	DR
		12	4.00	0.90	DR	DR	2.70	0.50	DR	DR
	0.162" diameter nail	6	4.00	3.55	2.05	1.40	4.00	2.25	1.25	0.80
		8	4.00	2.55	1.45	0.95	4.00	1.60	0.85	0.50
		12	4.00	1.60	0.85	0.50	4.00	0.95	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa.

DR = Design Required, o.c. = on center.

a. Wood framing shall be spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with ANSI/AWC NDS.

b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

## PLASTIC

**[BS]TABLE 2603.13.2**  
**FURRING MINIMUM FASTENING REQUIREMENTS FOR**  
**APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a, b</sup>**

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE	MINIMUM PENETRATION INTO WALL FRAMING (INCHES)	FASTENER SPACING IN FURRING (INCHES)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>d</sup> (INCHES)							
					16" o.c. furring <sup>e</sup>				24" o.c. furring <sup>e</sup>			
					Siding weight:				Siding weight:			
					3 psf	11 psf	18 psf	25 psf	3 psf	11 psf	18 psf	25 psf
Minimum 1x Wood Furring <sup>c</sup>	Minimum 2x Wood Stud	0.131" diameter nail	1 1/4	8	4.00	2.45	1.45	0.95	4.00	1.60	0.85	DR
				12	4.00	1.60	0.85	DR	4.00	0.95	DR	DR
				16	4.00	1.10	DR	DR	3.05	0.60	DR	DR
		0.162" diameter nail	1 1/4	8	4.00	4.00	2.45	1.60	4.00	2.75	1.45	0.85
				12	4.00	2.75	1.45	0.85	4.00	1.65	0.75	DR
				16	4.00	1.90	0.95	DR	4.00	1.05	DR	DR
		No. 10 wood screw	1	12	4.00	2.30	1.20	0.70	4.00	1.40	0.60	DR
				16	4.00	1.65	0.75	DR	4.00	0.90	DR	DR
				24	4.00	0.90	DR	DR	2.85	DR	DR	DR
		1/4" lag screw	1 1/2	12	4.00	2.65	1.50	0.90	4.00	1.65	0.80	DR
				16	4.00	1.95	0.95	0.50	4.00	1.10	DR	DR
				24	4.00	1.10	DR	DR	3.25	0.50	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot (psf) = 0.0479 kPa, 1 pound per square inch = 0.00689 MPa.

DR = Design Required, o.c. = on center.

a. Wood framing and furring shall be spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with ANSI/AWC NDS.

b. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

c. Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 1 1/2 inches, a minimum 2-inch nominal wood furring or an approved design shall be used.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not greater than 24 inches on center in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

**2605.2 Exterior use.** Exterior plastic *veneer*, other than plastic siding, shall be permitted to be installed on the *exterior walls* of buildings of any type of construction in accordance with all of the following requirements:

1. Plastic *veneer* shall comply with Section 2606.4.
2. Plastic *veneer* shall not be attached to any *exterior wall* to a height greater than 50 feet (15 240 mm) above grade.
3. Sections of plastic *veneer* shall not exceed 300 square feet (27.9 m<sup>2</sup>) in area and shall be separated by not less than 4 feet (1219 mm) vertically.

**Exception:** The area and separation requirements and the smoke-density limitation are not applicable to plastic *veneer* applied to buildings constructed of Type VB construction, provided that the walls are not required to have a *fire-resistance rating*.

**2605.3 Plastic siding.** Plastic siding shall comply with the requirements of Sections 1403 and 1404.

## SECTION 2606 LIGHT-TRANSMITTING PLASTICS

**2606.1 General.** The provisions of this section and Sections 2607 through 2611 shall govern the quality and methods of application of light-transmitting plastics for use as light-transmitting materials in buildings and structures. Foam

plastics shall comply with Section 2603. Light-transmitting plastic materials that meet the other code requirements for walls and roofs shall be permitted to be used in accordance with the other applicable chapters of the code.

**2606.2 Approval for use.** Sufficient technical data shall be submitted to substantiate the proposed use of any light-transmitting material, as approved by the *building official* and subject to the requirements of this section.

**2606.3 Identification.** Each unit or package of light-transmitting plastic shall be identified with a *mark* or decal satisfactory to the *building official*, which includes identification as to the material classification.

**2606.4 Specifications.** Light-transmitting plastics, including thermoplastic, thermosetting or reinforced thermosetting plastic material, shall have a self-ignition temperature of 650°F (343°C) or greater where tested in accordance with ASTM D1929; a *smoke-developed index* not greater than 450 where tested in the manner intended for use in accordance with ASTM E84 or UL 723, or a maximum average smoke density rating not greater than 75 where tested in the thickness intended for use in accordance with ASTM D2843 and shall conform to one of the following combustibility classifications:

**Class CC1:** Plastic materials that have a burning extent of 1 inch (25 mm) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D635.

**Class CC2:** Plastic materials that have a burning rate of  $2\frac{1}{2}$  inches per minute (1.06 mm/s) or less where tested at a nominal thickness of 0.060 inch (1.5 mm), or in the thickness intended for use, in accordance with ASTM D635.

**[BS] 2606.5 Structural requirements.** Light-transmitting plastic materials in their assembly shall be of adequate strength and durability to withstand the *loads* indicated in Chapter 16. Technical data shall be submitted to establish stresses, maximum unsupported spans and such other information for the various thicknesses and forms used as deemed necessary by the *building official*.

**[BS] 2606.6 Fastening.** Fastening shall be adequate to withstand the *loads* in Chapter 16. Proper allowance shall be made for expansion and contraction of light-transmitting plastic materials in accordance with accepted data on the coefficient of expansion of the material and other material in conjunction with which it is employed.

**2606.7 Light-diffusing systems.** Unless the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, *light-diffusing systems* shall not be installed in the following occupancies and locations:

1. Group A with an *occupant load* of 1,000 or more.
2. Theaters with a *stage* and proscenium opening and an *occupant load* of 700 or more.
3. Group I-2.
4. Group I-3.
5. *Interior exit stairways* and *ramps* and exit passageways.

**2606.7.1 Support.** Light-transmitting plastic diffusers shall be supported directly or indirectly from ceiling or roof construction by use of noncombustible hangers. Hangers shall be not less than No. 12 steel-wire gage (0.106 inch) galvanized wire or equivalent.

**2606.7.2 Installation.** Light-transmitting plastic diffusers shall comply with Chapter 8 unless the light-transmitting plastic diffusers will fall from the mountings before igniting, at an ambient temperature of not less than 200°F (111°C) below the ignition temperature of the panels. The panels shall remain in place at an ambient room temperature of 175°F (79°C) for a period of not less than 15 minutes.

**2606.7.3 Size limitations.** Individual panels or units shall not exceed 10 feet (3048 mm) in length nor 30 square feet (2.79 m<sup>2</sup>) in area.

**2606.7.4 Automatic sprinkler system.** In buildings that are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, plastic *light-diffusing systems* shall be protected both above and below unless the sprinkler system has been specifically approved for installation only above the *light-diffusing system*, or the *light-diffusing system* is listed and labeled in accordance with UL 723S. Areas of *light-diffusing systems* that are protected in accordance with this section shall not be limited.

**2606.7.5 Electrical luminaires.** Light-transmitting plastic panels and light-diffuser panels that are installed in approved electrical luminaires shall comply with the requirements of Chapter 8 unless the light-transmitting plastic panels conform to the requirements of Section 2606.7.2. The area of approved light-transmitting plastic materials that is used in required *exits* or *corridors* shall not exceed 30 percent of the aggregate area of the ceiling in which such panels are installed, unless the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**2606.8 Partitions.** Light-transmitting plastics used in or as partitions shall comply with the requirements of Chapters 6 and 8.

**2606.9 Bathroom accessories.** Light-transmitting plastics shall be permitted as glazing in shower stalls, shower doors, bathtub enclosures and similar accessory units. Safety glazing shall be provided in accordance with Chapter 24.

**2606.10 Awnings, patio covers and similar structures.** Awnings constructed of light-transmitting plastics shall be constructed in accordance with the provisions specified in Section 3105 and Chapter 32 for projections. Patio covers constructed of light-transmitting plastics shall comply with Section 2606. Light-transmitting plastics used in canopies at motor fuel-dispensing facilities shall comply with Section 2606, except as modified by Section 406.7.2.

**2606.11 Greenhouses.** Light-transmitting plastics shall be permitted in lieu of glass in *greenhouses*.

**2606.12 Solar collectors.** Light-transmitting plastic covers on solar collectors having noncombustible sides and bottoms shall be permitted on buildings not over three *stories above grade plane* or 9,000 square feet (836.1 m<sup>2</sup>) in total floor area, provided that the light-transmitting plastic cover does not exceed 33.33 percent of the roof area for CC1 materials or 25 percent of the roof area for CC2 materials.

**Exception:** Light-transmitting plastic covers having a thickness of 0.010 inch (0.3 mm) or less shall be permitted to be of any plastic material provided that the area of the solar collectors does not exceed 33.33 percent of the roof area.

## SECTION 2607 LIGHT-TRANSMITTING PLASTIC WALL PANELS

**2607.1 General.** Light-transmitting plastics shall not be used as wall panels in *exterior walls* in occupancies in Groups A-1, A-2, H, I-2 and I-3. In other groups, light-transmitting plastics shall be permitted to be used as wall panels in *exterior walls*, provided that the walls are not required to have a *fire-resistance rating* and the installation conforms to the requirements of this section. Such panels shall be erected and anchored on a foundation, waterproofed or otherwise protected from moisture absorption and sealed with a coat of mastic or other approved waterproof coating. Light-transmitting plastic wall panels shall comply with Section 2606.

## PLASTIC

**2607.2 Installation.** *Exterior wall* panels installed as provided for herein shall not alter the type of construction classification of the building.

**2607.3 Height limitation.** Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above *grade plane*.

**2607.4 Area limitation and separation.** The maximum area of a single wall panel and minimum vertical and horizontal separation requirements for exterior light-transmitting plastic wall panels shall be as provided for in Table 2607.4. The maximum percentage of wall area of any *story* in light-transmitting plastic wall panels shall not exceed that indicated in Table 2607.4 or the percentage of unprotected openings permitted by Section 705.8, whichever is smaller.

### Exceptions:

1. In structures provided with approved flame barriers extending 30 inches (760 mm) beyond the *exterior wall* in the plane of the floor, a vertical separation is not required at the floor except that provided by the vertical thickness of the flame barrier projection.
2. *Veneers* of approved weather-resistant light-transmitting plastics used as exterior siding in buildings of Type V construction in compliance with Section 1405.
3. The area of light-transmitting plastic wall panels in *exterior walls* of *greenhouses* shall be exempt from the area limitations of Table 2607.4 but shall be limited as required for unprotected openings in accordance with Section 705.8.

**2607.5 Automatic sprinkler system.** Where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, the maximum percentage area of *exterior wall* in any *story* in light-transmitting plastic wall panels and the maximum square footage of a single area given in Table 2607.4 shall be increased 100 percent, but the area of light-transmitting plastic wall panels shall not exceed 50 percent of the wall area in any *story*, or the area permitted by Section 705.8 for unprotected openings, whichever is smaller. These installations shall not be installed more than 75 feet (22 860 mm) above *grade plane*.

**2607.6 Combinations of glazing and wall panels.** Combinations of light-transmitting plastic glazing and light-transmitting plastic wall panels shall be subject to the area, height and percentage limitations and the separation requirements applicable to the class of light-transmitting plastic as prescribed for light-transmitting plastic wall panel installations.

## SECTION 2608 LIGHT-TRANSMITTING PLASTIC GLAZING

**2608.1 Buildings of Type VB construction.** Openings in the *exterior walls* of buildings of Type VB construction, where not required to be protected by Section 705, shall be permitted to be glazed or equipped with light-transmitting plastic. Light-transmitting plastic glazing shall comply with Section 2606.

**2608.2 Buildings of other types of construction.** Openings in the *exterior walls* of buildings of types of construction other than Type VB, where not required to be protected by Section 705, shall be permitted to be glazed or equipped with light-transmitting plastic in accordance with Section 2606 and all of the following:

1. The aggregate area of light-transmitting plastic glazing shall not exceed 25 percent of the area of any wall face of the *story* in which it is installed. The area of a single pane of glazing installed above the first *story above grade plane* shall not exceed 16 square feet (1.5 m<sup>2</sup>) and the vertical dimension of a single pane shall not exceed 4 feet (1219 mm).

**Exception:** Where an *automatic sprinkler system* is provided throughout in accordance with Section 903.3.1.1, the area of allowable glazing shall be increased to not more than 50 percent of the wall face of the *story* in which it is installed with no limit on the maximum dimension or area of a single pane of glazing.

2. Approved flame barriers extending 30 inches (762 mm) beyond the *exterior wall* in the plane of the floor, or vertical panels not less than 4 feet (1219

TABLE 2607.4  
AREA LIMITATION AND SEPARATION REQUIREMENTS FOR LIGHT-TRANSMITTING PLASTIC WALL PANELS<sup>a</sup>

FIRE SEPARATION DISTANCE (feet)	CLASS OF PLASTIC	MAXIMUM PERCENTAGE AREA OF EXTERIOR WALL IN PLASTIC WALL PANELS	MAXIMUM SINGLE AREA OF PLASTIC WALL PANELS (square feet)	MINIMUM SEPARATION OF PLASTIC WALL PANELS (feet)	
				Vertical	Horizontal
Less than 6	—	Not Permitted	Not Permitted	—	—
6 or more but less than 11	CC1	10	50	8	4
	CC2	Not Permitted	Not Permitted	—	—
11 or more but less than or equal to 30	CC1	25	90	6	4
	CC2	15	70	8	4
Over 30	CC1	50	Not Limited	3 <sup>b</sup>	0
	CC2	50	100	6 <sup>b</sup>	3

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

a. For combinations of plastic glazing and plastic wall panel areas permitted, see Section 2607.6.

b. For reductions in vertical separation allowed, see Section 2607.4.



mm) in height, shall be installed between glazed units located in adjacent stories.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

- 3. Light-transmitting plastics shall not be installed more than 75 feet (22 860 mm) above grade level.

**Exception:** Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.

**SECTION 2609  
LIGHT-TRANSMITTING PLASTIC ROOF PANELS**

**2609.1 General.** Light-transmitting plastic roof panels shall comply with this section and Section 2606. Light-transmitting plastic roof panels shall not be installed in Groups H, I-2 and I-3. In all other groups, light-transmitting plastic roof panels shall comply with any one of the following conditions:

- 1. The building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
- 2. The roof construction is not required to have a *fire-resistance rating* by Table 601.
- 3. The roof panels meet the requirements for roof coverings in accordance with Chapter 15.

**2609.2 Separation.** Individual roof panels shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

**Exceptions:**

- 1. The separation between roof panels is not required in a building equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
- 2. The separation between roof panels is not required in low-hazard occupancy buildings complying with the conditions of Section 2609.4, Exception 2 or 3.

**2609.3 Location.** Where *exterior wall* openings are required to be protected by Section 705.8, a roof panel shall not be installed within 6 feet (1829 mm) of such *exterior wall*.

**2609.4 Area limitations.** Roof panels shall be limited in area and the aggregate area of panels shall be limited by a percentage of the floor area of the room or space sheltered in accordance with Table 2609.4.

**Exceptions:**

- 1. The area limitations of Table 2609.4 shall be permitted to be increased by 100 percent in buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
- 2. Low-hazard occupancy buildings, such as swimming pool shelters, shall be exempt from the area

limitations of Table 2609.4, provided that the buildings do not exceed 5,000 square feet (465 m<sup>2</sup>) in area and have a minimum *fire separation distance* of 10 feet (3048 mm).

- 3. *Greenhouses* that are occupied for growing or maintaining plants, without public access, shall be exempt from the area limitations of Table 2609.4 provided that they have a minimum *fire separation distance* of 4 feet (1220 mm).
- 4. Roof coverings over terraces and patios in occupancies in Group R-3 shall be exempt from the area limitations of Table 2609.4 and shall be permitted with light-transmitting plastics.

**TABLE 2609.4  
AREA LIMITATIONS FOR  
LIGHT-TRANSMITTING PLASTIC ROOF PANELS**

CLASS OF PLASTIC	MAXIMUM AREA OF INDIVIDUAL ROOF PANELS (square feet)	MAXIMUM AGGREGATE AREA OF ROOF PANELS (percent of floor area)
CC1	300	30
CC2	100	25

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

**SECTION 2610  
LIGHT-TRANSMITTING  
PLASTIC SKYLIGHT GLAZING**

**2610.1 Light-transmitting plastic glazing of skylight assemblies.** Skylight assemblies glazed with light-transmitting plastic shall conform to the provisions of this section and Section 2606.

**Exception:** Skylights in which the light-transmitting plastic conforms to the required roof-covering class in accordance with Section 1505.

**2610.1.1 Unit skylights.** *Unit skylights* glazed with light-transmitting plastic shall comply with Section 2405.5.

**2610.2 Mounting.** The light-transmitting plastic shall be mounted above the plane of the roof on a curb constructed in accordance with the requirements for the type of construction classification, but not less than 4 inches (102 mm) above the plane of the roof. Edges of the light-transmitting plastic skylights or domes shall be protected by metal or other approved noncombustible material, or the light transmitting plastic dome or skylight shall be shown to be able to resist ignition where exposed at the edge to a flame from a Class B brand as described in ASTM E108 or UL 790. The Class B brand test shall be conducted on a skylight that is elevated to a height as specified in the manufacturer's installation instructions, but not less than 4 inches (102 mm).

**Exceptions:**

- 1. Curbs shall not be required for skylights used on roofs having a minimum slope of three units vertical in 12 units horizontal (25-percent slope) in occupancies in Group R-3 and on buildings with a nonclassified *roof covering*.

## PLASTIC

- The metal or noncombustible edge material is not required where nonclassified roof coverings are permitted.

**2610.3 Slope.** Flat or corrugated light-transmitting plastic skylights shall slope not less than four units vertical in 12 units horizontal (4:12). Dome-shaped skylights shall rise above the mounting flange a minimum distance equal to 10 percent of the maximum width of the dome but not less than 3 inches (76 mm).

**Exception:** Skylights that pass the Class B Burning Brand Test specified in ASTM E108 or UL 790.

**2610.4 Maximum area of skylights.** Each skylight shall have a maximum area within the curb of 100 square feet (9.3 m<sup>2</sup>).

**Exception:** The area limitation shall not apply where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

**2610.5 Aggregate area of skylights.** The aggregate area of skylights shall not exceed 33<sup>1</sup>/<sub>3</sub> percent of the floor area of the room or space sheltered by the roof in which such skylights are installed where Class CC1 materials are utilized, and 25 percent where Class CC2 materials are utilized.

**Exception:** The aggregate area limitations of light-transmitting plastic skylights shall be increased 100 percent beyond the limitations set forth in this section where the building is equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or the building is equipped with smoke and heat vents in accordance with Section 910.

**2610.6 Separation.** Skylights shall be separated from each other by a distance of not less than 4 feet (1219 mm) measured in a horizontal plane.

**Exceptions:**

- Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
- In Group R-3, multiple skylights located above the same room or space with a combined area not exceeding the limits set forth in Section 2610.4.

**2610.7 Location.** Where *exterior wall* openings are required to be protected in accordance with Section 705, a skylight shall not be installed within 6 feet (1829 mm) of such *exterior wall*.

**2610.8 Combinations of roof panels and skylights.** Combinations of light-transmitting plastic roof panels and skylights shall be subject to the area and percentage limitations and separation requirements applicable to roof panel installations.

## SECTION 2611

## LIGHT-TRANSMITTING PLASTIC INTERIOR SIGNS

**2611.1 General.** Light-transmitting plastic interior signs shall be limited as specified in Sections 2606 and 2611.2 through 2611.4.

**Exception:** Light-transmitting plastic interior wall signs in *covered and open mall buildings* shall comply with Section 402.6.4.

**2611.2 Maximum area.** The aggregate area of all light-transmitting plastics shall not exceed 24 square feet (2.23 m<sup>2</sup>).

**Exception:** In buildings equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1, the aggregate area of light-transmitting plastics shall not exceed 100 square feet (9.29 m<sup>2</sup>), provided that all plastics are Class CC1 in accordance with Section 2606.4.

**2611.3 Separation.** Signs exceeding the aggregate area of Section 2611.2 shall be separated from each other by not less than 4 feet (1219 mm) horizontally and 8 feet (2438 mm) vertically.

**2611.4 Encasement.** Backs of wall-mounted signs and non-illuminated portions of all signs regulated by this section shall be fully encased in metal.

## SECTION 2612

## PLASTIC COMPOSITES

**[BS] 2612.1 General.** Plastic composites shall consist of either wood/plastic composites or plastic lumber. Plastic composites shall comply with the provisions of this code and with the additional requirements of Section 2612.

**[BS] 2612.2 Labeling.** Plastic composite deck boards and *stair* treads, or their packaging, shall bear a *label* that indicates compliance with ASTM D7032 and includes the allowable load and maximum allowable span determined in accordance with ASTM D7032. Plastic composite *handrails* and *guards*, or their packaging, shall bear a label that indicates compliance with ASTM D7032 and includes the maximum allowable span determined in accordance with ASTM D7032.

**2612.3 Flame spread index.** Plastic composite deck boards, *stair* treads, *handrails* and *guards* shall exhibit a *flame spread index* not exceeding 200 when tested in accordance with ASTM E84 or UL 723 with the test specimen remaining in place during the test.

**Exception:** Materials determined to be noncombustible in accordance with Section 703.3.

**[BS] 2612.4 Termite and decay resistance.** Where required by Section 2304.12, plastic composite deck boards, *stair* treads, *handrails* and *guards* containing wood, cellulosic or any other biodegradable materials shall be termite and *decay resistant* as determined in accordance with ASTM D7032.

**[BS] 2612.5 Construction requirements.** Plastic composites meeting the requirements of Section 2612 shall be permitted to be used as exterior deck boards, *stair* treads, *handrails* and *guards* where combustible construction is permitted.

**[BS] 2612.5.1 Span rating.** Plastic composites used as exterior deck boards shall have a span rating determined in accordance with ASTM D7032.

**[BS] 2612.6 Plastic composite deck boards, stair treads, handrails and guards.** Plastic composite deck boards, *stair* treads, *handrails* and *guards* shall be installed in accordance with this code and the manufacturer's instructions.

## SECTION 2613 FIBER-REINFORCED POLYMER

**2613.1 General.** The provisions of this section shall govern the requirements and uses of *fiber-reinforced polymer* in and on buildings and structures.

**2613.2 Labeling and identification.** Packages and containers of *fiber-reinforced polymer* and their components delivered to the job site shall bear the *label* of an *approved agency* showing the manufacturer's name, product listing, product identification and information sufficient to determine that the end use will comply with the code requirements.

**2613.3 Interior finishes.** *Fiber-reinforced polymer* used as *interior finishes*, *decorative materials* or *trim* shall comply with Chapter 8.

**2613.3.1 Foam plastic cores.** *Fiber-reinforced polymer* used as *interior finish* and that contains foam plastic cores shall comply with Chapter 8 and this chapter.

**2613.4 Light-transmitting materials.** *Fiber-reinforced polymer* used as light-transmitting materials shall comply with Sections 2606 through 2611 as required for the specific application.

**2613.5 Exterior use.** *Fiber-reinforced polymer* shall be permitted to be installed on the *exterior walls* of buildings of any type of construction where such polymers meet the requirements of Section 2603.5. *Fireblocking* shall be installed in accordance with Section 718.

### Exceptions:

1. Compliance with Section 2603.5 is not required where all of the following conditions are met:
  - 1.1. The *fiber-reinforced polymer* shall not exceed an aggregate total of 20 percent of the area of the specific wall to which it is attached, and single architectural elements shall not exceed 10 percent of the area of the specific wall to which it is attached, and no contiguous sets of architectural elements shall not exceed 10 percent of the area of the specific wall to which they are attached.
  - 1.2. The *fiber-reinforced polymer* shall have a *flame spread index* of 25 or less. The *flame*

*spread index* requirement shall not be required for coatings or paints having a thickness of less than 0.036 inch (0.9 mm) that are applied directly to the surface of the *fiber-reinforced polymer*.

- 1.3. *Fireblocking* complying with Section 718.2.6 shall be installed.
- 1.4. The *fiber-reinforced polymer* shall be installed directly to a noncombustible substrate or be separated from the *exterior wall* by one of the following materials: corrosion-resistant steel having a minimum base metal thickness of 0.016 inch (0.41 mm) at any point, aluminum having a minimum thickness of 0.019 inch (0.5 mm) or other approved noncombustible material.
2. Compliance with Section 2603.5 is not required where the *fiber-reinforced polymer* is installed on buildings that are 40 feet (12 190 mm) or less above grade and the following conditions are met:
  - 2.1. The *fiber-reinforced polymer* shall meet the requirements of Section 1405.1.
  - 2.2. Where the *fire separation distance* is 5 feet (1524 mm) or less, the area of the fiber-reinforced polymer shall not exceed 10 percent of the wall area. Where the *fire separation distance* is greater than 5 feet (1524 mm), the area of the *exterior wall* coverage using *fiber-reinforced polymer* shall not be limited.
  - 2.3. The *fiber-reinforced polymer* shall have a *flame spread index* of 200 or less. The *flame spread index* requirements do not apply to coatings or paints having a thickness of less than 0.036 inch (0.9 mm) that are applied directly to the surface of the *fiber-reinforced polymer*.
  - 2.4. *Fireblocking* complying with Section 718.2.6 shall be installed.

## SECTION 2614 REFLECTIVE PLASTIC CORE INSULATION

**2614.1 General.** The provisions of this section shall govern the requirements and uses of reflective plastic core insulation in buildings and structures. Reflective plastic core insulation shall comply with the requirements of Section 2614 and of Section 2614.3 or 2614.4.

**2614.2 Identification.** Packages and containers of reflective plastic core insulation delivered to the job site shall show the manufacturer's or supplier's name, product identification and information sufficient to determine that the end use will comply with the code requirements.

**2614.3 Surface-burning characteristics.** Reflective plastic core insulation shall have a *flame spread index* of not more than 25 and a *smoke-developed index* of not more than 450

**PLASTIC**

when tested in accordance with ASTM E84 or UL 723. The reflective plastic core insulation shall be tested at the maximum thickness intended for use. Test specimen preparation and mounting shall be in accordance with ASTM E2599.

**2614.4 Room corner test heat release.** Reflective plastic core insulation shall comply with the acceptance criteria of Section 803.1.1.1 when tested in accordance with NFPA 286 or UL 1715 in the manner intended for use and at the maximum thickness intended for use.



## CHAPTER 27

# ELECTRICAL

*Chapter 27 is deleted in its entirety. Refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★



## CHAPTER 28

# MECHANICAL SYSTEMS

---

### User note:

**About this chapter:** Mechanical systems are a key element of any building. Chapter 28 regulates such systems by linking to the International Mechanical Code® and International Fuel Gas Code®, where details of mechanical system requirements are provided.

---

### SECTION 2801 GENERAL

**[M] 2801.1 Scope.** The provisions of this chapter, the *International Mechanical Code* and the *International Fuel Gas Code* shall govern the design, construction, erection and installation of mechanical appliances, equipment and systems used in buildings and structures covered by this code. Masonry chimneys, fireplaces and barbecues shall comply with the *International Mechanical Code* and Chapter 21 of this code. The *International Fire Code*, the *International Property Maintenance Code*, the *International Mechanical Code* and the *International Fuel Gas Code* shall govern the use and maintenance of mechanical components, appliances, equipment and systems. The *International Existing Building Code*, the *International Mechanical Code* and the *International Fuel Gas Code* shall govern the alteration, repair, relocation, replacement and addition of mechanical components, appliances, equipment and systems.





## CHAPTER 29

# PLUMBING SYSTEMS

*Chapter 29 is deleted in its entirety. Refer to the Arkansas Plumbing Code as adopted by the State of Arkansas.*





## CHAPTER 30

# ELEVATORS AND CONVEYING SYSTEMS

### User note:

**About this chapter:** Chapter 30 contains the provisions that regulate vertical and horizontal transportation and material-handling systems installed in buildings. This chapter also provides several elements that protect occupants and assist emergency responders during fires.

### SECTION 3001 GENERAL

**3001.1 Scope.** This chapter governs the design, construction, installation, *alteration* and repair of elevators and conveying systems and their components.

**3001.2 Emergency elevator communication systems for the deaf, hard of hearing and speech impaired.** An emergency two-way communication system shall be provided. The system shall provide visible text and audible modes that meet all of the following requirements:

1. When operating in each mode, include a live interactive system that allows back and forth conversation between the elevator occupants and emergency personnel.
2. Is operational when the elevator is operational.
3. Allows elevator occupants to select the text-based or audible mode depending on their communication needs to interact with emergency personnel.

**3001.3 Referenced standards.** Except as otherwise provided for in this code, the design, construction, installation, alteration, repair and maintenance of elevators and conveying systems and their components shall conform to the applicable standard specified in Table 3001.3 and ASCE 24 for construction in *flood hazard areas* established in Section 1612.3.

**TABLE 3001.3**  
**ELEVATORS AND CONVEYING SYSTEMS AND COMPONENTS**

TYPE	STANDARD
Automotive lifts	ALI ALCTV
Belt manlifts	ASME A90.1
Conveyors and related equipment	ASME B20.1
Elevators, escalators, dumbwaiters, moving walks, material lifts	ASME A17.1/CSA B44, ASME A17.7/CSA B44.7
Industrial scissor lifts	ANSI MH29.1
Platform lifts, stairway chairlifts, wheelchair lifts	ASME A18.1

**3001.4 Accessibility.** Passenger elevators required to be accessible or to serve as part of an *accessible* means of egress shall comply with Sections 1009 and 1110.8.

**3001.5 Change in use.** A change in use of an elevator from freight to passenger, passenger to freight, or from one freight class to another freight class shall comply with Section 8.7 of ASME A17.1/CSA B44.

### SECTION 3002 HOISTWAY ENCLOSURES

**3002.1 Hoistway enclosure protection.** Elevator, dumbwaiter and other hoistway enclosures shall be *shaft enclosures* complying with Sections 712 and 713.

**3002.1.1 Opening protectives.** Openings in hoistway enclosures shall be protected as required in Chapter 7.

**Exception:** The elevator car doors and the associated hoistway enclosure doors at the floor level designated for recall in accordance with Section 3003.2 shall be permitted to remain open during Phase I Emergency Recall Operation.

**3002.1.2 Hardware.** Hardware on opening protectives shall be of an *approved* type installed as tested, except that *approved* interlocks, mechanical locks and electric contacts, door and gate electric contacts and door-operating mechanisms shall be exempt from the fire test requirements.

**3002.2 Number of elevator cars in a hoistway.** Where four or more elevator cars serve all or the same portion of a building, the elevators shall be located in not fewer than two separate hoistways. Not more than four elevator cars shall be located in any single hoistway enclosure.

**3002.3 Emergency signs.** An *approved* pictorial sign of a standardized design shall be posted adjacent to each elevator call station on all floors instructing occupants to use the exit stairways and not to use the elevators in case of fire. The sign shall read: IN CASE OF FIRE, ELEVATORS ARE OUT OF SERVICE. USE EXIT STAIRS.

#### Exceptions:

1. The emergency sign shall not be required for elevators that are part of an *accessible* means of egress complying with Section 1009.4.
2. The emergency sign shall not be required for elevators that are used for occupant self-evacuation in accordance with Section 3008.

**3002.4 Elevator car to accommodate ambulance stretcher.** Where elevators are provided in buildings four or more *stories* above, or four or more *stories* below, *grade plane*, not fewer than one elevator shall be provided for fire department emergency access to all floors. The elevator car shall be of such a size and arrangement to accommodate an ambulance stretcher 24 inches by 84 inches (610 mm by 2134 mm) with not less than 5-inch (127 mm) radius

## ELEVATORS AND CONVEYING SYSTEMS

corners, in the horizontal, open position and shall be identified by the international symbol for emergency medical services (star of life). The symbol shall be not less than 3 inches (76 mm) in height and shall be placed inside on both sides of the hoistway door frame.

**3002.5 Emergency doors.** Where an elevator is installed in a single blind hoistway or on the outside of a building, there shall be installed in the blind portion of the hoistway or blank face of the building, an emergency door in accordance with ASME A17.1/CSA B44.

**3002.6 Prohibited doors.** Doors, other than hoistway doors and the elevator car door, shall be prohibited at the point of access to an elevator car unless such doors are readily openable from the car side without a key, tool, special knowledge or effort.

**3002.7 Common enclosure with stairway.** Elevators shall not be in a common *shaft enclosure* with a stairway.

**Exception:** Elevators within *open parking garages* need not be separated from stairway enclosures.

**3002.8 Glass in elevator enclosures.** Glass in elevator enclosures shall comply with Section 2409.2.

**3002.9 Plumbing and mechanical systems.** Plumbing and mechanical systems shall not be located in an elevator hoistway enclosure.

**Exception:** Floor drains, sumps and sump pumps shall be permitted at the base of the hoistway enclosure provided that they are indirectly connected to the plumbing system.

### SECTION 3003 EMERGENCY OPERATIONS

**[F] 3003.1 Standby power.** In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 3003.1.1 through 3003.1.4.

**[F] 3003.1.1 Manual transfer.** Standby power shall be manually transferable to all elevators in each bank.

**[F] 3003.1.2 One elevator.** Where only one elevator is installed, the elevator shall automatically transfer to standby power within 60 seconds after failure of normal power.

**[F] 3003.1.3 Two or more elevators.** Where two or more elevators are controlled by a common operating system, all elevators shall automatically transfer to standby power within 60 seconds after failure of normal power where the standby power source is of sufficient capacity to operate all elevators at the same time. Where the standby power source is not of sufficient capacity to operate all elevators at the same time, all elevators shall transfer to standby power in sequence, return to the designated landing and disconnect from the standby power source. After all elevators have been returned to the designated level, not less than one elevator shall remain operable from the standby power source.

**[F] 3003.1.4 Venting.** Where standby power is connected to elevators, the machine room *ventilation* or air conditioning shall be connected to the standby power source.

**[F] 3003.2 Fire fighters' emergency operation.** Elevators shall be provided with Phase I emergency recall operation and Phase II emergency in-car operation in accordance with ASME A17.1/CSA B44.

**[F] 3003.3 Standardized fire service elevator keys.** All elevators shall be equipped to operate with a standardized fire service elevator key in accordance with the *International Fire Code*.

### SECTION 3004 CONVEYING SYSTEMS

**3004.1 General.** Escalators, moving walks, conveyors, personnel hoists and material hoists shall comply with the provisions of Sections 3004.2 through 3004.4.

**3004.2 Escalators and moving walks.** Escalators and moving walks shall be constructed of *approved* noncombustible and fire-retardant materials. This requirement shall not apply to electrical equipment, wiring, wheels, handrails and the use of  $\frac{1}{28}$ -inch (0.9 mm) wood *veneers* on balustrades backed up with noncombustible materials.

**3004.2.1 Enclosure.** Escalator floor openings shall be enclosed with *shaft enclosures* complying with Section 713.

**3004.2.2 Escalators.** Where provided in below-grade transportation stations, escalators shall have a clear width of not less than 32 inches (815 mm).

**3004.3 Conveyors.** Conveyors and conveying systems shall comply with ASME B20.1.

**3004.3.1 Enclosure.** Conveyors and related equipment connecting successive floors or levels shall be enclosed with *shaft enclosures* complying with Section 713.

**3004.3.2 Conveyor safeties.** Power-operated conveyors, belts and other material-moving devices shall be equipped with automatic limit switches that will shut off the power in an emergency and automatically stop all operation of the device.

**3004.4 Personnel and material hoists.** Personnel and material hoists shall be designed utilizing an *approved* method that accounts for the conditions imposed during the intended operation of the hoist device. The design shall include, but is not limited to, anticipated loads, structural stability, impact, vibration, stresses and seismic restraint. The design shall account for the construction, installation, operation and inspection of the hoist tower, car, machinery and control equipment, guide members and hoisting mechanism. Additionally, the design of personnel hoists shall include provisions for field testing and maintenance that will demonstrate that the hoist device functions in accordance with the design. Field tests shall be conducted upon the completion of an installation or following a major *alteration* of a personnel hoist.



## SECTION 3005 MACHINE ROOMS

**3005.1 Access.** An *approved* means of access shall be provided to elevator machine rooms, control rooms, control spaces and machinery spaces.

**3005.2 Venting.** Elevator machine rooms, machinery spaces that contain the driving machine, and control rooms or spaces that contain the operation or motion controller for elevator operation shall be provided with an independent *ventilation* or air-conditioning system to protect against the overheating of the electrical equipment. The system shall be capable of maintaining temperatures within the range established for the elevator equipment.

**3005.3 Pressurization.** The elevator machine room, control rooms or control space with openings into a pressurized elevator hoistway shall be pressurized upon activation of a heat or smoke detector located in the elevator machine room, control room or control space.

**3005.4 Machine rooms, control rooms, machinery spaces, and control spaces.** The following rooms and spaces shall be enclosed with *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both:

1. Machine rooms.
2. Control rooms.
3. Control spaces.
4. Machinery spaces outside of the hoistway enclosure.

The *fire-resistance rating* shall be not less than the required rating of the hoistway enclosure served by the machinery. Openings in the *fire barriers* shall be protected with assemblies having a *fire protection rating* not less than that required for the hoistway enclosure doors.

### Exceptions:

1. For other than fire service access elevators and occupant evacuation elevators, where machine rooms, machinery spaces, control rooms and control spaces do not abut and do not have openings to the hoistway enclosure they serve, the *fire barriers* constructed in accordance with Section 707 or *horizontal assemblies* constructed in accordance with Section 711, or both, shall be permitted to be reduced to a 1-hour *fire-resistance rating*.
2. For other than fire service access elevators and occupant evacuation elevators, in buildings four *stories* or less above *grade plane* where machine room, machinery spaces, control rooms and control spaces do not abut and do not have openings to the hoistway enclosure they serve, the machine room, machinery spaces, control rooms and control spaces are not required to be fire-resistance rated.

**3005.5 Shunt trip.** Where elevator hoistways, elevator machine rooms, control rooms and control spaces containing elevator control equipment are protected with automatic sprinklers, a means installed in accordance with Section 21.4

of NFPA 72 shall be provided to automatically disconnect the main line power supply to the affected elevator prior to the application of water. This means shall not be self-resetting. The activation of automatic sprinklers outside the hoistway, machine room, machinery space, control room or control space shall not disconnect the main line power supply.

**3005.6 Plumbing systems.** Plumbing systems shall not be located in elevator equipment rooms.

## SECTION 3006 ELEVATOR LOBBIES AND HOISTWAY OPENING PROTECTION

**3006.1 General.** Elevator hoistway openings and enclosed elevator lobbies shall be provided in accordance with the following:

1. Where hoistway opening protection is required by Section 3006.2, such protection shall be in accordance with Section 3006.3.
2. Where enclosed elevator lobbies are required for underground buildings, such lobbies shall comply with Section 405.4.3.
3. Where an *area of refuge* is required and an enclosed elevator lobby is provided to serve as an *area of refuge*, the enclosed elevator lobby shall comply with Section 1009.6.
4. Where fire service access elevators are provided, enclosed elevator lobbies shall comply with Section 3007.6.
5. Where occupant evacuation elevators are provided, enclosed elevator lobbies shall comply with Section 3008.6.

**3006.2 Hoistway opening protection required.** Elevator hoistway door openings shall be protected in accordance with Section 3006.3 where an elevator hoistway connects more than three *stories*, is required to be enclosed within a *shaft enclosure* in accordance with Section 712.1.1 and any of the following conditions apply:

1. The building is not protected throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 or 903.3.1.2.
2. The building contains a Group I-1, Condition 2 occupancy.
3. The building contains a Group I-2 occupancy.
4. The building contains a Group I-3 occupancy.
5. The building is a high rise and the elevator hoistway is more than 75 feet (22 860 mm) in height. The height of the hoistway shall be measured from the *lowest floor* to the highest floor of the floors served by the hoistway.

### Exceptions:

1. Protection of elevator hoistway door openings is not required where the elevator serves only *open parking garages* in accordance with Section 406.5.

## ELEVATORS AND CONVEYING SYSTEMS

2. Protection of elevator hoistway door openings is not required at the level(s) of exit discharge, provided that the level(s) of exit discharge is equipped with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
3. Enclosed elevator lobbies and protection of elevator hoistway door openings are not required on levels where the elevator hoistway opens to the exterior.

**3006.2.1 Rated corridors.** Where *corridors* are required to be fire-resistance rated in accordance with Section 1020.2, elevator hoistway openings shall be protected in accordance with Section 3006.3.

**3006.3 Hoistway opening protection.** Where Section 3006.2 requires protection of the elevator hoistway door opening, the protection shall be provided by one of the following:

1. An enclosed elevator lobby shall be provided at each floor to separate the elevator hoistway *shaft enclosure* doors from each floor by *fire partitions* in accordance with Section 708. In addition, doors protecting openings in the elevator lobby enclosure walls shall comply with Section 716.2.2.1 as required for *corridor* walls. Penetrations of the enclosed elevator lobby by ducts and air transfer openings shall be protected as required for *corridors* in accordance with Section 717.5.4.1.
2. An enclosed elevator lobby shall be provided at each floor to separate the elevator hoistway *shaft enclosure* doors from each floor by *smoke partitions* in accordance with Section 710 where the building is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1 or 903.3.1.2. In addition, doors protecting openings in the *smoke partitions* shall comply with Sections 710.5.2.2, 710.5.2.3 and 716.2.6.1. Penetrations of the enclosed elevator lobby by ducts and air transfer openings shall be protected as required for *corridors* in accordance with Section 717.5.4.1.
3. Additional doors shall be provided at each elevator hoistway door opening in accordance with Section 3002.6. Such door shall comply with the smoke and draft control door assembly requirements in Section 716.2.2.1.1 when tested in accordance with UL 1784 without an artificial bottom seal.
4. The elevator hoistway shall be pressurized in accordance with Section 909.21.

**3006.4 Means of egress.** Elevator lobbies shall be provided with not less than one *means of egress* complying with Chapter 10 and other provisions in this code. Egress through an enclosed elevator lobby shall be permitted in accordance with Item 1 of Section 1016.2.

## SECTION 3007 FIRE SERVICE ACCESS ELEVATOR

**3007.1 General.** Where required by Section 403.6.1, every floor above and including the lowest level of fire department vehicle access of the building shall be served by fire service access elevators complying with Sections 3007.1 through 3007.9. Except as modified in this section, fire service access elevators shall be installed in accordance with this chapter and ASME A17.1/CSA B44.

### Exceptions:

1. Elevators that only service an open or enclosed parking garage and the lobby of the building shall not be required to serve as fire service access elevators.
2. The elevator shall not be required to serve the top floor of a building where that floor is utilized only for equipment for building systems.

**3007.2 Automatic sprinkler system.** The building shall be equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, except as otherwise permitted by Section 903.3.1.1.1 and as prohibited by Section 3007.2.1.

**3007.2.1 Prohibited locations.** Automatic sprinklers shall not be installed in machine rooms, elevator machinery spaces, control rooms, control spaces and elevator hoistways of fire service access elevators.

**3007.2.2 Sprinkler system monitoring.** The sprinkler system shall have a sprinkler control valve supervisory switch and water-flow-initiating device provided for each floor that is monitored by the building's *fire alarm system*.

**3007.3 Water protection.** Water from the operation of an automatic sprinkler system outside the enclosed lobby shall be prevented from infiltrating into the hoistway enclosure in accordance with an approved method.

**3007.4 Shunt trip.** Means for elevator shutdown in accordance with Section 3005.5 shall not be installed on elevator systems used for fire service access elevators.

**3007.5 Hoistway enclosures.** The fire service access elevator hoistway shall be located in a *shaft enclosure* complying with Section 713.

**3007.5.1 Structural integrity of hoistway enclosures.** The fire service access elevator hoistway enclosure shall comply with Sections 403.2.2.1 through 403.2.2.4.

**3007.5.2 Hoistway lighting.** When fire-fighters' emergency operation is active, the entire height of the hoistway shall be illuminated at not less than 1 footcandle (11 lux) as measured from the top of the car of each fire service access elevator.

**3007.6 Fire service access elevator lobby.** The fire service access elevator shall open into an enclosed fire service access elevator lobby in accordance with Sections 3007.6.1 through 3007.6.5. Egress is permitted through the enclosed elevator lobby in accordance with Item 1 of Section 1016.2.

**Exception:** Where a fire service access elevator has two entrances onto a floor, the second entrance shall be permitted to be protected in accordance with Section 3006.3.

**3007.6.1 Access to interior exit stairway or ramp.** The enclosed fire service access elevator lobby shall have *direct access* from the enclosed elevator lobby to an enclosure for an *interior exit stairway or ramp*.

**Exception:** Access to an *interior exit stairway or ramp* shall be permitted to be through a protected path of travel that has a level of fire protection not less than the elevator lobby enclosure. The protected path shall be separated from the enclosed elevator lobby through an opening protected by a smoke and draft control assembly in accordance Section 716.2.2.1.

**3007.6.2 Lobby enclosure.** The fire service access elevator lobby shall be enclosed with a *smoke barrier* having a *fire-resistance rating* of not less than 1 hour, except that lobby doorways shall comply with Section 3007.6.3.

**Exception:** Enclosed fire service access elevator lobbies are not required at the *levels of exit discharge*.

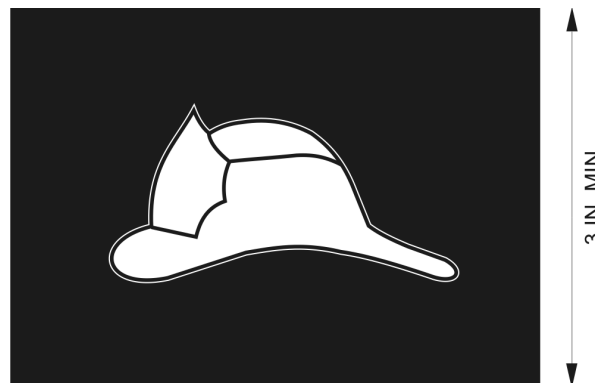
**3007.6.3 Lobby doorways.** Other than doors to the hoistway, elevator control room or elevator control space, each doorway to an enclosed fire service access elevator lobby shall be provided with a  $\frac{3}{4}$ -hour *fire door assembly* complying with Section 716. The *fire door assembly* shall comply with the smoke and draft control door assembly requirements of Section 716.2.2.1.1 and be tested in accordance with UL 1784 without an artificial bottom seal.

**3007.6.4 Lobby size.** Regardless of the number of fire service access elevators served by the same elevator lobby, the enclosed fire service access elevator lobby shall be not less than 150 square feet (14 m<sup>2</sup>) in an area with a dimension of not less than 8 feet (2440 mm).

**3007.6.5 Fire service access elevator symbol.** A pictorial symbol of a standardized design designating which elevators are fire service access elevators shall be installed on each side of the hoistway door frame on the portion of the frame at right angles to the fire service access elevator lobby. The fire service access elevator symbol shall be designed as shown in Figure 3007.6.5 and shall comply with the following:

1. The fire service access elevator symbol shall be not less than 3 inches (76 mm) in height.
2. The helmet shall contrast with the background, with either a light helmet on a dark background or a dark helmet on a light background.
3. The vertical center line of the fire service access elevator symbol shall be centered on the hoistway door frame. Each symbol shall be not less than 78

inches (1981 mm), and not more than 84 inches (2134 mm) above the finished floor at the threshold.



For S.I. 1 inch = 25.4 mm.

**FIGURE 3007.6.5  
FIRE SERVICE ACCESS ELEVATOR SYMBOL**

**3007.7 Elevator system monitoring.** The fire service access elevator shall be continuously monitored at the *fire command center* by a standard emergency service interface system meeting the requirements of NFPA 72.

**3007.8 Electrical power.** The following features serving each fire service access elevator shall be supplied by both normal power and Type 60/Class 2/Level 1 standby power:

1. Elevator equipment.
2. Elevator hoistway lighting.
3. *Ventilation* and cooling equipment for elevator machine rooms, control rooms, machine spaces and control spaces.
4. Elevator car lighting.

**3007.8.1 Protection of wiring or cables.** Wires or cables that are located outside of the elevator hoistway and machine room and that provide normal or standby power, control signals, communication with the car, lighting, heating, air conditioning, *ventilation* and fire-detecting systems to fire service access elevators shall be protected using one of the following methods:

1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 2 hours.
2. *Electrical circuit protective systems* shall have a *fire-resistance rating* of not less than 2 hours. *Electrical circuit protective systems* shall be installed in accordance with their listing requirements.
3. Construction having a *fire-resistance rating* of not less than 2 hours.

**Exception:** Wiring and cables to control signals are not required to be protected provided that wiring and cables do not serve Phase II emergency in-car operations.



## ELEVATORS AND CONVEYING SYSTEMS

**3007.9 Standpipe hose connection.** A Class I standpipe hose connection in accordance with Section 905 shall be provided in the *interior exit stairway* and *ramp* having *direct access* from the enclosed fire service access elevator lobby.

**3007.9.1 Access.** The exit enclosure containing the standpipe shall have access to the floor without passing through the enclosed fire service access elevator lobby.

### SECTION 3008 OCCUPANT EVACUATION ELEVATORS

**3008.1 General.** Elevators used for occupant self-evacuation during fires shall comply with Sections 3008.1 through 3008.10.

**3008.1.1 Number of occupant evacuation elevators.** The number of elevators available for occupant evacuation shall be determined based on an egress analysis that addresses one of the following scenarios:

1. Full-building evacuation where the analysis demonstrates that the number of elevators provided for evacuation results in an evacuation time less than 1 hour.
2. Evacuation of the five consecutive floors with the highest cumulative *occupant load* where the analysis demonstrates that the number of elevators provided for evacuation results in an evacuation time less than 15 minutes.

Not less than one elevator in each bank shall be designated for occupant evacuation. Not less than two shall be provided in each occupant evacuation elevator lobby where more than one elevator opens into the lobby. Signage shall be provided to denote which elevators are available for occupant evacuation.

**3008.1.2 Additional exit stairway.** Where an additional *means of egress* is required in accordance with Section 403.5.2, an additional *exit stairway* shall not be required to be installed in buildings provided with occupant evacuation elevators complying with Section 3008.1.

**3008.1.3 Fire safety and evacuation plan.** The building shall have an *approved* fire safety and evacuation plan in accordance with the applicable requirements of Section 404 of the *International Fire Code*. The fire safety and evacuation plan shall incorporate specific procedures for the occupants using evacuation elevators.

**3008.1.4 Operation.** The occupant evacuation elevators shall be used for occupant self-evacuation in accordance with the occupant evacuation operation requirements in ASME A17.1/CSA B44 and the building's fire safety and evacuation plan.

**3008.2 Automatic sprinkler system.** The building shall be equipped throughout with an *approved*, electrically supervised *automatic sprinkler system* in accordance with Section 903.3.1.1, except as otherwise permitted by Section 903.3.1.1.1 and as prohibited by Section 3008.2.1.

**3008.2.1 Prohibited locations.** Automatic sprinklers shall not be installed in elevator machine rooms, machin-

ery spaces, control rooms, control spaces and elevator hoistways of occupant evacuation elevators.

**3008.2.2 Sprinkler system monitoring.** The *automatic sprinkler system* shall have a sprinkler control valve supervisory switch and water-flow-initiating device provided for each floor that is monitored by the building's *fire alarm system*.

**3008.3 Water protection.** Water from the operation of an *automatic sprinkler system* outside the enclosed lobby shall be prevented from infiltrating into the hoistway enclosure in accordance with an *approved* method.

**3008.4 Shunt trip.** Means for elevator shutdown in accordance with Section 3005.5 shall not be installed on elevator systems used for occupant evacuation elevators.

**3008.5 Hoistway enclosure protection.** Occupant evacuation elevator hoistways shall be located in *shaft enclosures* complying with Section 713.

**3008.5.1 Structural integrity of hoistway enclosures.** Occupant evacuation elevator hoistway enclosures shall comply with Sections 403.2.2.1 through 403.2.2.4.

**3008.6 Occupant evacuation elevator lobby.** Occupant evacuation elevators shall open into an enclosed elevator lobby in accordance with Sections 3008.6.1 through 3008.6.6. Egress is permitted through the elevator lobby in accordance with Item 1 of Section 1016.2.

**3008.6.1 Access to interior exit stairway or ramp.** The occupant evacuation elevator lobby shall have *direct access* from the enclosed elevator lobby to an *interior exit stairway or ramp*.

#### Exceptions:

1. Access to an *interior exit stairway or ramp* shall be permitted to be through a protected path of travel that has a level of fire protection not less than the elevator lobby enclosure. The protected path shall be separated from the enclosed elevator lobby through an opening protected by a smoke and draft control assembly in accordance Section 716.2.2.1.
2. Elevators that only service an *open parking garage* and the lobby of the building shall not be required to provide *direct access*.

**3008.6.2 Lobby enclosure.** The occupant evacuation elevator lobby shall be enclosed with a *smoke barrier* having a *fire-resistance rating* of not less than 1 hour, except that lobby doorways shall comply with Section 3008.6.3.

**Exception:** Enclosed occupant evacuation elevator lobbies are not required at the *levels of exit discharge*.

**3008.6.3 Lobby doorways.** Other than the doors to the hoistway, elevator machine rooms, machinery spaces, control rooms and control spaces within the lobby enclosure *smoke barrier*, each doorway to an occupant evacuation elevator lobby shall be provided with a  $\frac{3}{4}$ -hour *fire door assembly* complying with Section 716. The *fire door assembly* shall comply with the smoke and draft



control assembly requirements of Section 716.2.2.1.1 and be tested in accordance with UL 1784 without an artificial bottom seal.

**3008.6.3.1 Vision panel.** A vision panel shall be installed in each *fire door assembly* protecting the lobby doorway. The vision panel shall consist of fire-protection-rated glazing, shall comply with the requirements of Section 716 and shall be located to furnish clear vision of the occupant evacuation elevator lobby.

**3008.6.3.2 Door closing.** Each *fire door assembly* protecting the lobby doorway shall be automatic-closing upon receipt of any fire alarm signal from the *emergency voice/alarm communication system* serving the building.

**3008.6.4 Lobby size.** Each occupant evacuation elevator lobby shall have minimum floor area as follows:

1. The occupant evacuation elevator lobby floor area shall accommodate, at 3 square feet (0.28 m<sup>2</sup>) per person, not less than 25 percent of the *occupant load* of the floor area served by the lobby.
2. The occupant evacuation elevator lobby floor area shall accommodate one *wheelchair space* of 30 inches by 52 inches (760 mm by 1320 mm) for each 50 persons, or portion thereof, of the *occupant load* of the floor area served by the lobby.

**Exception:** The size of lobbies serving multiple banks of elevators shall have the minimum floor area *approved* on an individual basis and shall be consistent with the building's fire safety and evacuation plan.

**3008.6.5 Signage.** An *approved* sign indicating elevators are suitable for occupant self-evacuation shall be posted on all floors adjacent to each elevator call station serving occupant evacuation elevators.

**3008.6.6 Two-way communication system.** A two-way communication system shall be provided in each occupant evacuation elevator lobby for the purpose of initiating communication with the *fire command center* or an alternate location *approved* by the fire department. The two-way communication system shall be designed and installed in accordance with Sections 1009.8.1 and 1009.8.2.

**3008.7 Elevator system monitoring.** The occupant evacuation elevators shall be continuously monitored at the *fire command center* or a central control point *approved* by the fire department and arranged to display all of the following information:

1. Floor location of each elevator car.
2. Direction of travel of each elevator car.
3. Status of each elevator car with respect to whether it is occupied.
4. Status of normal power to the elevator equipment, elevator machinery and electrical apparatus cooling equipment where provided, elevator machine room, control room and control space *ventilation* and cooling equipment.

5. Status of standby or emergency power system that provides backup power to the elevator equipment, elevator machinery and electrical cooling equipment where provided, elevator machine room, control room and control space *ventilation* and cooling equipment.

6. Activation of any fire alarm initiating device in any elevator lobby, elevator machine room, machine space containing a motor controller or electric driving machine, control space, control room or elevator hoistway.

**3008.7.1 Elevator recall.** The *fire command center* or an alternate location *approved* by the fire department shall be provided with the means to manually initiate a Phase I Emergency Recall of the occupant evacuation elevators in accordance with ASME A17.1/CSA B44.

**3008.8 Electrical power.** The following features serving each occupant evacuation elevator shall be supplied by both normal power and Type 60/Class 2/Level 1 standby power:

1. Elevator equipment.
2. *Ventilation* and cooling equipment for elevator machine rooms, control rooms, machinery spaces and control spaces.
3. Elevator car lighting.

**3008.8.1 Determination of standby power load.** Standby power loads shall be based on the determination of the number of occupant evacuation elevators in Section 3008.1.1.

**3008.8.2 Protection of wiring or cables.** Wires or cables that are located outside of the elevator hoistway, machine room, control room and control space and that provide normal or standby power, control signals, communication with the car, lighting, heating, air conditioning, *ventilation* and fire-detecting systems to occupant evacuation elevators shall be protected using one of the following methods:

1. Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196 and shall have a *fire-resistance rating* of not less than 2 hours.
2. *Electrical circuit protective systems* shall have a *fire-resistance rating* of not less than 2 hours. *Electrical circuit protective systems* shall be installed in accordance with their listing requirements.
3. Construction having a *fire-resistance rating* of not less than 2 hours.

**Exception:** Wiring and cables to control signals are not required to be protected provided that wiring and cables do not serve Phase II emergency in-car operation.

**3008.9 Emergency voice/alarm communication system.** The building shall be provided with an *emergency voice/alarm communication system*. The *emergency voice/alarm communication system* shall be accessible to the

## ELEVATORS AND CONVEYING SYSTEMS

fire department. The system shall be provided in accordance with Section 907.5.2.2.

**3008.9.1 Notification appliances.** Not fewer than one audible and one visible notification appliance shall be installed within each occupant evacuation elevator lobby.

**3008.10 Hazardous material areas.** Building areas shall not contain hazardous materials exceeding the maximum allowable quantities per *control area* as addressed in Section 414.2.

## CHAPTER 31

# SPECIAL CONSTRUCTION

### User notes:

**About this chapter:** Chapter 31 provides regulations for unique buildings and building elements. Those include buildings such as membrane structures, greenhouses and relocatable buildings. Special elements include pedestrian walkways and tunnels, awnings, canopies and marquees, vehicular gates, solar energy systems, public use restrooms in flood hazard areas, and intermodal shipping containers.

**Code development reminder:** Code change proposals to sections preceded by the designation [BS] will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 3101 GENERAL

**3101.1 Scope.** The provisions of this chapter shall govern special building construction including *membrane structures*, temporary structures, *pedestrian walkways* and tunnels, automatic *vehicular gates*, *awnings* and *canopies*, *marquees*, signs, towers, antennas, relocatable buildings, swimming pool enclosures and safety devices, solar energy systems, public use restroom buildings on publicly owned lands in *flood hazard areas* and *intermodal shipping containers*.

### SECTION 3102 MEMBRANE STRUCTURES

**3102.1 General.** The provisions of Sections 3102.1 through 3102.8 shall apply to *air-supported*, *air-inflated*, *membrane-covered cable*, *membrane-covered frame* and *tensile membrane structures*, collectively known as *membrane structures*, erected for a period of 180 days or longer. Those erected for a shorter period of time shall comply with the *International Fire Code*. Membrane structures covering water storage facilities, water clarifiers, water treatment plants, sewage treatment plants, *greenhouses* and similar facilities not used for human occupancy are required to meet only the requirements of Sections 3102.3.1 and 3102.7. Membrane structures erected on a building, balcony, deck or other structure for any period of time shall comply with this section.

**3102.2 Tensile membrane structures and air-supported structures.** *Tensile membrane structures* and *air-supported structures*, including permanent and temporary structures, shall be designed and constructed in accordance with ASCE 55. The provisions in Sections 3102.3 through 3102.6 shall apply.

**3102.3 Type of construction.** *Noncombustible membrane structures* shall be classified as Type IIB construction. Noncombustible frame or cable-supported structures covered by an *approved* membrane in accordance with Section 3102.3.1 shall be classified as Type IIB construction. Heavy timber frame-supported structures covered by an *approved* membrane in accordance with Section 3102.3.1 shall be classified as Type IV-HT construction. Other

membrane structures shall be classified as Type V construction.

**Exception:** Plastic less than 30 feet (9144 mm) above any floor used in *greenhouses*, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701.

**3102.3.1 Membrane and interior liner material.** Membranes and interior liners shall be either noncombustible as set forth in Section 703.3 or meet the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 and the manufacturer's test protocol.

**Exception:** Plastic less than 20 mil (0.5 mm) in thickness used in *greenhouses*, where occupancy by the general public is not authorized, and for aquaculture pond covers is not required to meet the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701.

**3102.4 Allowable floor areas.** The area of a membrane structure shall not exceed the limitations specified in Section 506.

**3102.5 Maximum height.** Membrane structures shall not exceed one *story* nor shall such structures exceed the height limitations in feet specified in Section 504.3.

**Exception:** *Noncombustible membrane structures* serving as roofs only.

**3102.6 Mixed construction.** Membrane structures shall be permitted to be utilized as specified in this section as a portion of buildings of other types of construction. Height and area limits shall be as specified for the type of construction and occupancy of the building.

**3102.6.1 Noncombustible membrane.** A noncombustible membrane shall be permitted for use as the roof or as a skylight of any building or *atrium* of a building of any type of construction provided that the membrane is not less than 20 feet (6096 mm) above any floor, balcony or gallery.

**3102.6.1.1 Membrane.** A membrane meeting the fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701 shall be

## SPECIAL CONSTRUCTION

permitted to be used as the roof or as a skylight on buildings of Type IIB, III, IV-HT and V construction, provided that the membrane is not less than 20 feet (6096 mm) above any floor, balcony or gallery.

**3102.7 Engineering design.** The structure shall be designed and constructed to sustain *dead loads*; *loads* due to tension or inflation; *live loads* including wind, snow or *flood* and seismic loads and in accordance with Chapter 16.

**3102.7.1 Lateral restraint.** For *membrane-covered frame structures*, the membrane shall not be considered to provide lateral restraint in the calculation of the capacities of the frame members.

**3102.8 Inflation systems.** *Air-supported* and *air-inflated structures* shall be provided with primary and auxiliary inflation systems to meet the minimum requirements of Sections 3102.8.1 through 3102.8.3.

**3102.8.1 Equipment requirements.** The inflation system shall consist of one or more blowers and shall include provisions for automatic control to maintain the required inflation pressures. The system shall be so designed as to prevent overpressurization of the system.

**3102.8.1.1 Auxiliary inflation system.** In addition to the primary inflation system, in buildings larger than 1,500 square feet (140 m<sup>2</sup>) in area, an auxiliary inflation system shall be provided with sufficient capacity to maintain the inflation of the structure in case of primary system failure. The auxiliary inflation system shall operate automatically when there is a loss of internal pressure and when the primary blower system becomes inoperative.

**3102.8.1.2 Blower equipment.** Blower equipment shall meet all of the following requirements:

1. Blowers shall be powered by continuous-rated motors at the maximum power required for any flow condition as required by the structural design.
2. Blowers shall be provided with inlet screens, belt guards and other protective devices as required by the *building official* to provide protection from injury.
3. Blowers shall be housed within a weather-protecting structure.
4. Blowers shall be equipped with backdraft check dampers to minimize air loss when inoperative.
5. Blower inlets shall be located to provide protection from air contamination. The location of inlets shall be *approved*.

**3102.8.2 Standby power.** Wherever an auxiliary inflation system is required, an *approved* standby power-generating system shall be provided. The system shall be equipped with a suitable means for automatically starting the generator set upon failure of the normal electrical

service and for automatic transfer and operation of all of the required electrical functions at full power within 60 seconds of such service failure. Standby power shall be capable of operating independently for not less than 4 hours.

**3102.8.3 Support provisions.** A system capable of supporting the membrane in the event of deflation shall be provided for in *air-supported* and *air-inflated structures* having an *occupant load* of 50 or more or where covering a swimming pool regardless of *occupant load*. The support system shall be capable of maintaining membrane structures used as a roof for Type I construction not less than 20 feet (6096 mm) above floor or seating areas. The support system shall be capable of maintaining other membranes not less than 7 feet (2134 mm) above the floor, seating area or surface of the water.

## SECTION 3103 TEMPORARY STRUCTURES

**3103.1 General.** The provisions of Sections 3103.1 through 3103.4 shall apply to structures erected for a period of less than 180 days. *Special event structures*, tents, umbrella structures and other membrane structures erected for a period of less than 180 days shall also comply with the *International Fire Code*. Those erected for a longer period of time shall comply with applicable sections of this code.

**3103.1.1 Conformance.** Temporary structures and uses shall conform to the structural strength, fire safety, *means of egress*, accessibility, light, *ventilation* and sanitary requirements of this code as necessary to ensure public health, safety and general welfare.

**3103.1.2 Permit required.** Temporary structures that cover an area greater than 120 square feet (11.16 m<sup>2</sup>), including connecting areas or spaces with a common *means of egress* or entrance that are used or intended to be used for the gathering together of 10 or more persons, shall not be erected, operated or maintained for any purpose without obtaining a *permit* from the *building official*.

**3103.2 Construction documents.** A *permit* application and *construction documents* shall be submitted for each installation of a temporary structure. The *construction documents*, shall include a site plan indicating the location of the temporary structure and information delineating the *means of egress* and the *occupant load*.

**3103.3 Location.** Temporary structures shall be located in accordance with the requirements of Table 705.5 based on the *fire-resistance rating* of the *exterior walls* for the proposed type of construction.

**3103.4 Means of egress.** Temporary structures shall conform to the *means of egress* requirements of Chapter 10 and shall have an *exit access* travel distance of 100 feet (30 480 mm) or less.



## SECTION 3104 PEDESTRIAN WALKWAYS AND TUNNELS

**3104.1 General.** This section shall apply to connections between buildings such as *pedestrian walkways* or tunnels, located at, above or below grade level, that are used as a means of travel by persons. The *pedestrian walkway* shall not contribute to the *building area* or the number of *stories* or height of connected buildings.

**3104.1.1 Application.** *Pedestrian walkways* shall be designed and constructed in accordance with Sections 3104.2 through 3104.9. Tunnels shall be designed and constructed in accordance with Sections 3104.2 and 3104.10.

**3104.2 Separate structures.** Buildings connected by *pedestrian walkways* or tunnels shall be considered to be separate structures.

### Exceptions:

1. Buildings that are on the same lot and considered as portions of a single building in accordance with Section 503.1.2.
2. For purposes of calculating the number of *Type B units* required by Chapter 11, structurally connected buildings and buildings with multiple wings shall be considered to be one structure.

**3104.3 Construction.** The *pedestrian walkway* shall be of noncombustible construction.

### Exceptions:

1. Combustible construction shall be permitted where connected buildings are of combustible construction.
2. *Fire-retardant-treated wood*, in accordance with Section 603.1, Item 1.3, shall be permitted for the roof construction of the *pedestrian walkway* where connected buildings are not less than Type I or II construction.

**3104.4 Contents.** Only materials and decorations *approved* by the *building official* shall be located in the *pedestrian walkway*.

**3104.5 Connections of pedestrian walkways to buildings.** The connection of a *pedestrian walkway* to a building shall comply with Section 3104.5.1, 3104.5.2, 3104.5.3 or 3104.5.4.

**Exception:** Buildings that are on the same lot and considered as portions of a single building in accordance with Section 503.1.2.

**3104.5.1 Fire barriers.** *Pedestrian walkways* shall be separated from the interior of the building by not less than 2-hour *fire barriers* constructed in accordance with Section 707 and Sections 3104.5.1.1 through 3104.5.1.3.

**3104.5.1.1 Exterior walls.** *Exterior walls* of buildings connected to *pedestrian walkways* shall be 2-hour fire-resistance rated. This protection shall extend not less than 10 feet (3048 mm) in every direction surrounding the perimeter of the *pedestrian walkway*.

**3104.5.1.2 Openings in exterior walls of connected buildings.** Openings in *exterior walls* required to be fire-resistance rated in accordance with Section 3104.5.1.1 shall be equipped with opening protectives providing a not less than  $\frac{3}{4}$ -hour *fire protection rating* in accordance with Section 716.

**3104.5.1.3 Supporting construction.** The *fire barrier* shall be supported by construction as required by Section 707.5.1.

**3104.5.2 Alternative separation.** The wall separating the *pedestrian walkway* and the building shall comply with Section 3104.5.2.1 or 3104.5.2.2 where:

1. The distance between the connected buildings is more than 10 feet (3048 mm).
2. The *pedestrian walkway* and connected buildings are equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, and the roof of the walkway is not more than 55 feet (16 764 mm) above grade connecting to the fifth, or lower, *story above grade plane*, of each building.

**Exception:** *Open parking garages* need not be equipped with an *automatic sprinkler system*.

**3104.5.2.1 Passage of smoke.** The wall shall be capable of resisting the passage of smoke.

**3104.5.2.2 Glass.** The wall shall be constructed of a tempered, wired or laminated glass and doors separating the interior of the building from the *pedestrian walkway*. The glass shall be protected by an *automatic sprinkler system* in accordance with Section 903.3.1.1 that, when actuated, shall completely wet the entire surface of interior sides of the wall or glass. Obstructions shall not be installed between the sprinkler heads and the wall or glass. The glass shall be in a gasketed frame and installed in such a manner that the framing system will deflect without breaking (loading) the glass before the sprinkler operates.

**3104.5.3 Open sides on walkway.** Where the distance between the connected buildings is more than 10 feet (3048 mm), the walls at the intersection of the *pedestrian walkway* and each building need not be fire-resistance rated provided that both sidewalls of the *pedestrian walkway* are not less than 50 percent open with the open area uniformly distributed to prevent the accumulation of smoke and *toxic gases*. The roof of the walkway shall be located not more than 40 feet (12 160 mm) above *grade plane*, and the walkway shall only be permitted to connect to the third or lower *story* of each building.

**Exception:** Where the *pedestrian walkway* is protected with an automatic sprinkler system in accordance with Section 903.3.1.1, the roof of the walkway shall be located not more than 55 feet (16 764 mm) above *grade plane* and the walkway shall only be permitted to connect to the fifth or lower *story* of each building.

## SPECIAL CONSTRUCTION

**3104.5.4 Exterior walls greater than 2 hours.** Where *exterior walls* of connected buildings are required by Section 705 to have a *fire-resistance rating* greater than 2 hours, the walls at the intersection of the *pedestrian walkway* and each building need not be fire-resistance rated provided:

1. The *pedestrian walkway* is equipped throughout with an *automatic sprinkler system* installed in accordance with Section 903.3.1.1.
2. The roof of the walkway is not located more than 55 feet (16 764 mm) above *grade plane* and the walkway connects to the fifth, or lower, *story above grade plane* of each building.

**3104.6 Public way.** *Pedestrian walkways* over a *public way* shall comply with Chapter 32.

**3104.7 Egress.** Access shall be provided at all times to a *pedestrian walkway* that serves as a required *exit*.

**3104.8 Width.** The unobstructed width of *pedestrian walkways* shall be not less than 36 inches (914 mm). The total width shall be not greater than 30 feet (9144 mm).

**3104.9 Exit access travel.** The length of *exit access* travel shall be 200 feet (60 960 mm) or less.

### Exceptions:

1. *Exit access* travel distance on a *pedestrian walkway* equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1 shall be 250 feet (76 200 mm) or less.
2. *Exit access* travel distance on a *pedestrian walkway* constructed with both sides not less than 50 percent open shall be 300 feet (91 440 mm) or less.
3. *Exit access* travel distance on a *pedestrian walkway* constructed with both sides not less than 50 percent open, and equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1, shall be 400 feet (122 m) or less.

**3104.10 Tunneled walkway.** Separation between the tunneled walkway and the building to which it is connected shall be not less than 2-hour fire-resistant construction and openings therein shall be protected in accordance with Section 716.

## SECTION 3105 AWNINGS AND CANOPIES

**3105.1 General.** *Awnings* and *canopies* shall comply with the requirements of Sections 3105.2 and 3105.3 and other applicable sections of this code.

**3105.2 Design and construction.** *Awnings* and *canopies* shall be designed and constructed to withstand wind or other lateral loads and live loads as required by Chapter 16 with due allowance for shape, open construction and similar features that relieve the pressures or loads. Structural members shall be protected to prevent deterioration. *Awnings* shall have frames of noncombustible material, *fire-*

*retardant-treated wood*, heavy timber complying with Section 2304.11, or 1-hour construction with combustible or noncombustible covers and shall be either fixed, retractable, folding or collapsible.

**3105.3 Awnings and canopy materials.** *Awnings* and *canopies* shall be provided with an *approved* covering that complies with one of the following:

1. The fire propagation performance criteria of Test Method 1 or Test Method 2, as appropriate, of NFPA 701.
2. Has a *flame spread index* not greater than 25 when tested in accordance with ASTM E84 or UL 723.
3. Meets all of the following criteria when tested in accordance with NFPA 286:
  - 3.1. During the 40 kW exposure, flames shall not spread to the ceiling.
  - 3.2. Flashover, as defined in NFPA 286, shall not occur.
  - 3.3. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
  - 3.4. The peak heat release rate throughout the test shall not exceed 800 kW.

**Exception:** The fire propagation performance and *flame spread index* requirements shall not apply to awnings installed on detached one- and two-family dwellings.

## SECTION 3106 MARQUEES

**3106.1 General.** *Marquees* shall comply with Sections 3106.2 through 3106.5 and other applicable sections of this code.

**3106.2 Thickness.** The height or thickness of a *marquee* measured vertically from its lowest to its highest point shall be not greater than 3 feet (914 mm) where the *marquee* projects more than two-thirds of the distance from the *lot line* to the curb line, and shall be not greater than 9 feet (2743 mm) where the *marquee* is less than two-thirds of the distance from the *lot line* to the curb line.

**3106.3 Roof construction.** Where the roof or any part thereof is a skylight, the skylight shall comply with the requirements of Chapter 24. Every roof and skylight of a *marquee* shall be sloped to downspouts that shall conduct any drainage from the *marquee* in such a manner so as not to spill over the sidewalk.

**3106.4 Location prohibited.** Every *marquee* shall be so located as not to interfere with the operation of any exterior standpipe, and such that the *marquee* does not obstruct the clear passage of *stairways* or *exit discharge* from the building or the installation or maintenance of street lighting.

**3106.5 Construction.** A *marquee* shall be supported entirely from the building and constructed of noncombustible materials. *Marquees* shall be designed as required in Chapter 16. Structural members shall be protected to prevent deterioration.

## SECTION 3107 SIGNS

**3107.1 General.** Signs shall be designed, constructed and maintained in accordance with this code.

## SECTION 3108 TELECOMMUNICATION AND BROADCAST TOWERS

**[BS] 3108.1 General.** Towers shall be designed and constructed in accordance with the provisions of TIA 222. Towers shall be designed for seismic loads; exceptions related to seismic design listed in Section 2.7.3 of TIA 222 shall not apply. In Section 2.6.6.2 of TIA 222, the horizontal extent of Topographic Category 2, escarpments, shall be 16 times the height of the escarpment.

**Exception:** Single free-standing poles used to support antennas not greater than 75 feet (22 860 mm), measured from the top of the pole to grade, shall not be required to be noncombustible.

**[BS] 3108.2 Location and access.** Towers shall be located such that guy wires and other accessories shall not cross or encroach on any street or other public space, or over above-ground electric utility lines, or encroach on any privately owned property without the written consent of the owner of the encroached-upon property, space or above-ground electric utility lines. Towers shall be equipped with climbing and working facilities in compliance with TIA 222. Access to the tower sites shall be limited as required by applicable OSHA, FCC and EPA regulations.

## SECTION 3109 SWIMMING POOLS, SPAS AND HOT TUBS

**3109.1 General.** The design and construction of swimming pools, spas and hot tubs shall comply with the *International Swimming Pool and Spa Code*.

## SECTION 3110 AUTOMATIC VEHICULAR GATES

**3110.1 General.** *Automatic vehicular gates* shall comply with the requirements of Sections 3110.2 and 3110.3 and other applicable sections of this code.

**3110.2 Vehicular gates intended for automation.** *Vehicular gates* intended for automation shall be designed, constructed and installed to comply with the requirements of ASTM F2200.

**3110.3 Vehicular gate openers.** *Vehicular gate* openers, where provided, shall be *listed* in accordance with UL 325.

## SECTION 3111 SOLAR ENERGY SYSTEMS

**3111.1 General.** Solar energy systems shall comply with the requirements of this section.

**3111.1.1 Wind resistance.** Rooftop-mounted photovoltaic (PV) panel systems and solar thermal collectors shall be designed in accordance with Section 1609.

**3111.1.2 Roof live load.** Roof structures that provide support for solar energy systems shall be designed in accordance with Section 1607.14.4.

**3111.2 Solar thermal systems.** Solar thermal systems shall be designed and installed in accordance with this section, the *International Plumbing Code*, the *International Mechanical Code* and the *International Fire Code*. Where light-transmitting plastic covers are used, solar thermal collectors shall be designed in accordance with Section 2606.12.

**3111.2.1 Equipment.** Solar thermal systems and components shall be *listed* and *labeled* in accordance with ICC 900/SRCC 300 and ICC 901/SRCC 100.

**3111.3 Photovoltaic solar energy systems.** Photovoltaic solar energy systems shall be designed and installed in accordance with this section, the *International Fire Code*, NFPA 70 and the manufacturer's installation instructions.

**3111.3.1 Equipment.** *Photovoltaic panels* and modules shall be *listed* and *labeled* in accordance with UL 1703 or with both UL 61730-1 and UL 61730-2. Inverters shall be *listed* and *labeled* in accordance with UL 1741. Systems connected to the utility grid shall use inverters *listed* for utility interaction.

**3111.3.2 Fire classification.** Rooftop-mounted photovoltaic (PV) panel systems shall have a fire classification in accordance with Section 1505.9. Building-integrated photovoltaic (BIPV) systems installed as roof coverings shall have a fire classification in accordance with Section 1505.8.

**3111.3.3 Building-integrated photovoltaic (BIPV) systems.** BIPV systems installed as roof coverings shall be designed and installed in accordance with Section 1507.

**3111.3.4 Access and pathways.** Roof access, pathways and spacing requirements shall be provided in accordance with Section 1205 of the *International Fire Code*.

**3111.3.5 Ground-mounted photovoltaic systems.** Ground-mounted photovoltaic systems shall be designed and installed in accordance with Chapter 16 and the *International Fire Code*.

**3111.3.5.1 Fire separation distances.** Ground-mounted photovoltaic systems shall be subject to the *fire separation distance* requirements determined by the local jurisdiction.

## SECTION 3112 GREENHOUSES

**3112.1 General.** The provisions of this section shall apply to *greenhouses* that are designed and used for the cultivation, maintenance, or protection of plants.

**3112.2 Accessibility.** *Greenhouses* shall be *accessible* in accordance with Chapter 11.



## SPECIAL CONSTRUCTION

**3112.3 Structural design.** *Greenhouses* shall comply with the structural design requirements for *greenhouses* in Chapter 16.

**3112.4 Glass and glazing.** Glass and glazing used in *greenhouses* shall comply with Section 2405.

**3112.5 Light-transmitting plastics.** Light-transmitting plastics shall be permitted in lieu of plain glass in *greenhouses* and shall comply with Section 2606.

**3112.6 Membrane structures.** *Greenhouses* that are membrane structures shall comply with Section 3102.

**3112.6.1 Plastic film.** Plastic films used in *greenhouses* shall comply with Section 3102.3.

### SECTION 3113 RELOCATABLE BUILDINGS

**3113.1 General.** The provisions of this section shall apply to relocatable buildings. Relocatable buildings manufactured after the effective date of this code shall comply with the applicable provisions of this code.

**Exception:** This section shall not apply to manufactured housing used as dwellings.

**3113.1.1 Compliance.** A newly constructed relocatable building shall comply with the requirements of this code for new construction. An existing relocatable building that is undergoing alteration, addition, change of occupancy or relocation shall comply with Chapter 14 of the *International Existing Building Code*.

**3113.2 Supplemental information.** Supplemental information specific to a relocatable building shall be submitted to the authority having jurisdiction. It shall, as a minimum, include the following in addition to the information required by Section 105:

1. Manufacturer's name and address.
2. Date of manufacture.
3. Serial number of module.
4. Manufacturer's design drawings.
5. Type of construction in accordance with Section 602.
6. Design loads including: *roof live load*, *roof snow load*, *floor live load*, *wind load* and *seismic site class*, use group and design category.
7. Additional building planning and structural design data.
8. Site-built structure or appurtenance attached to the relocatable building.

**3113.3 Manufacturer's data plate.** Each relocatable module shall have a data plate that is permanently attached on or adjacent to the electrical panel, and shall include the following information:

1. Occupancy group.
2. Manufacturer's name and address.
3. Date of manufacture.
4. Serial number of module.

5. Design *roof live load*, design *floor live load*, snow load, wind and seismic design.
6. *Approved* quality assurance agency or *approved* inspection agency.
7. Codes and standards of construction.
8. Envelope thermal resistance values.
9. Electrical service size.
10. Fuel-burning equipment and size.
11. Special limitations if any.

**3113.4 Inspection agencies.** The building official is authorized to accept reports of inspections conducted by *approved* inspection agencies during off-site construction of the relocatable building, and to satisfy the applicable requirements of Sections 110.3 through 110.3.12.1.

### SECTION 3114 PUBLIC USE RESTROOM BUILDINGS IN FLOOD HAZARD AREAS

**3114.1 General.** For the purpose of this section, public restroom buildings are located on publicly owned lands in *flood hazard areas* and intended for public use. Public restroom buildings and portions of other buildings that contain public restrooms are limited to toilet rooms, bathrooms, showers and changing rooms. Public restroom buildings and portions of buildings that contain public restrooms shall comply with the requirements of this section. Public-use restrooms that are not elevated or *dry flood-proofed* in accordance with Section 1612 shall comply with Section 3114.2. Portions of buildings that include uses other than public-use toilet rooms, bathrooms, showers and changing rooms shall comply with Section 1612.

**3114.2 Flood resistance.** Public-use restrooms on publicly owned lands in *flood hazard areas* shall comply with the requirements of ASCE 24, except for elevation requirements, and shall comply with all of the following criteria:

1. The building footprint is not more than 1,500 square feet (139 m<sup>2</sup>).
2. Located, designed and constructed to resist the effects of flood hazards and flood loads to minimize flood damage from a combination of wind and water loads associated with the base flood.
3. Anchored to prevent flotation, collapse or lateral movement resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy during conditions of the base flood.
4. Constructed of flood-damage-resistant materials.
5. Where enclosed by walls, the walls have flood openings.
6. Mechanical and electrical systems are located above the base flood elevation.
7. Plumbing fixtures and plumbing connections are located above the base flood elevation.
8. An emergency plan, approved by the jurisdiction, is submitted to the building official and includes build-



ing design documents specifying implementation of protection measures prior to the onset of flooding conditions.

#### Exceptions:

1. Minimum necessary electric equipment required to address health, life safety and electric code requirements is permitted below the base flood elevation in accordance with ASCE 24 provisions for electric elements installed below the minimum elevations.
2. Plumbing fixtures and connections are permitted below the base flood elevation provided that the fixtures and connections are designed and installed to minimize or eliminate infiltration of floodwaters into the sanitary sewage system and discharges from sanitary sewage systems into floodwaters.

### SECTION 3115

#### INTERMODAL SHIPPING CONTAINERS

**3115.1 General.** The provisions of Section 3115 and other applicable sections of this code shall apply to *intermodal shipping containers* that are repurposed for use as buildings or structures, or as a part of buildings or structures.

#### Exceptions:

1. Intermodal shipping containers previously approved as existing relocatable buildings complying with Chapter 14 of the International Existing Building Code.
2. Stationary storage battery arrays located in intermodal shipping containers complying with Chapter 12 of the International Fire Code.
3. Intermodal shipping containers that are listed as equipment complying with the standard for equipment, such as air chillers, engine generators, modular data centers, and other similar equipment.
4. Intermodal shipping containers housing or supporting experimental equipment are exempt from the requirements of Section 3115, provided that they comply with all of the following:
  - 4.1. Such units shall be single stand-alone units supported at grade level and used only for occupancies as specified under Risk Category I in Table 1604.5.
  - 4.2. Such units are located a minimum of 8 feet (2438 mm) from adjacent structures, and are not connected to a fuel gas system or fuel gas utility.
  - 4.3. In hurricane-prone regions and flood hazard areas, such units are designed in accordance with the applicable provisions of Chapter 16.

**3115.2 Construction documents.** The construction documents shall contain information to verify the dimensions and

establish the physical properties of the steel components and wood floor components of the *intermodal shipping container*, in addition to the information required by Sections 107 and 1603.

**3115.3 Intermodal shipping container information.** Intermodal shipping containers shall bear an existing data plate containing the following information as required by ISO 6346 and verified by an approved agency. A report of the verification process and findings shall be provided to the building owner.

1. Manufacturer's name or identification number.
2. Date manufactured.
3. Safety approval number.
4. Identification number.
5. Maximum operating gross mass or weight (kg) (lbs).
6. Allowable stacking load for 1.8G (kg) (lbs).
7. Transverse racking test force (Newtons).
8. Valid maintenance examination date.

Where approved by the *building official*, the markings and existing data plate are permitted to be removed from the intermodal shipping containers before they are repurposed for use as buildings or structures or as a part of buildings or structures.

**3115.4 Protection against decay and termites.** Wood structural floors of *intermodal shipping containers* shall be protected from decay and termites in accordance with the applicable provisions of Section 2304.12.1.1.

**3115.5 Under-floor ventilation.** The space between the bottom of the floor joists and the earth under any *intermodal shipping container*, except spaces occupied by basements and cellars, shall be provided with ventilation in accordance with Section 1202.4.

**3115.6 Roof assemblies.** *Intermodal shipping container* roof assemblies shall comply with the applicable requirements of Chapter 15.

**Exception:** Single-unit, stand-alone intermodal shipping containers not attached to, or stacked vertically over, other intermodal shipping containers, buildings or structures.

**3115.7 Joints and voids.** Joints and voids that create concealed spaces between connected or stacked *intermodal shipping containers* at fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies shall be protected by an approved *fire-resistant joint system* in accordance with Section 715.

**3115.8 Structural.** Intermodal shipping containers that conform to ISO 1496-1 and are repurposed for use as buildings or structures, or as a part of buildings or structures, shall be designed in accordance with Chapter 16 and this section.

**3115.8.1 Foundations.** *Intermodal shipping containers* repurposed for use as a permanent building or structure shall be supported on foundations or other supporting structures designed and constructed in accordance with Chapters 16 through 23.

**3115.8.1.1 Anchorage.** *Intermodal shipping containers* shall be anchored to foundations or other supporting structures as necessary to provide a continuous load path for all applicable design and environmental loads in accordance with Chapter 16.

**3115.8.2 Welds.** New welds and connections shall be equal to or greater than the original connections.

**3115.8.3 Structural design.** The structural design for the *intermodal shipping containers* repurposed for use as a building or structure, or as part of a building or structure, shall comply with Section 3115.8.4 or 3115.8.5.

**3115.8.4 Detailed design procedure.** A structural analysis meeting the requirements of this section shall be provided to the *building official* to demonstrate the structural adequacy of the *intermodal shipping containers*.

**Exception:** *Intermodal shipping containers* designed in accordance with Section 3115.8.5.

**3115.8.4.1 Material properties.** Structural material properties for existing *intermodal shipping container* steel components shall be established by material testing where the steel grade and composition cannot be identified by the manufacturer's designation as to manufacture and mill test.

**3115.8.4.2 Seismic design parameters.** The seismic force-resisting system shall be designed and detailed in accordance with one of the following:

1. Where all or portions of the corrugated steel container sides are considered to be the seismic force-resisting system, design and detailing shall be in accordance with the ASCE 7, Table 12.2-1 requirements for light-frame bearing-wall systems with shear panels of all other materials.
2. Where portions of the corrugated steel container sides are retained, but are not considered to be the seismic force-resisting system, an independent seismic force-resisting system shall be selected, designed and detailed in accordance with ASCE 7, Table 12.2-1.
3. Where portions of the corrugated steel container sides are retained and integrated into a seismic force-resisting system other than as permitted by Item 1, seismic design parameters shall be developed from testing and analysis in accordance with Section 104.11 and ASCE 7, Section 12.2.1.1 or 12.2.1.2.

**3115.8.4.3 Allowable shear value.** The allowable shear values for the *intermodal shipping container* corrugated steel sheet panel side walls and end walls shall be demonstrated by testing and analysis in accordance with Section 104.11. Where penetrations are made in the side walls or end walls designated as part of the lateral force-resisting system, the penetrations shall be substantiated by rational analysis.

**3115.8.5 Simplified structural design of single-unit containers.** Single-unit *intermodal shipping containers*

conforming to the limitations of Section 3115.8.5.1 shall be permitted to be designed in accordance with the simplified structural design provisions of Section 3115.8.5.2.

**3115.8.5.1 Limitations.** The use of Section 3115.8.5 is subject to the following limitations:

1. The *intermodal shipping container* shall be a single-unit, stand-alone unit supported on a foundation and shall not be in contact with or supporting any other shipping container or other structure.
2. The *intermodal shipping container* top and bottom rails, corner castings, and columns or any portion thereof shall not be notched, cut, or removed in any manner.
3. The *intermodal shipping container* shall be erected in a level and horizontal position with the floor located at the bottom.
4. The *intermodal shipping container* shall be located in Seismic Design Category A, B, C or D.

**3115.8.5.2 Simplified structural design.** Where permitted by Section 3115.8.5.1, single-unit, stand-alone *intermodal shipping containers* shall be designed using the following assumptions for the corrugated steel shear walls:

1. The appropriate detailing requirements contained in Chapters 16 through 23.
2. Response modification coefficient,  $R = 2$ .
3. Overstrength factor,  $\Omega_0 = 2.5$ .
4. Deflection amplification factor,  $C_d = 2$ .
5. Limits on structural height,  $h_n = 9.5$  feet (2900 mm).

**3115.8.5.3 Allowable shear.** The allowable shear for the corrugated steel side walls (longitudinal) and end walls (transverse) for wind design and seismic design using the coefficients of Section 3115.8.5.2 shall be in accordance with Table 3115.8.5.3, provided that all of the following conditions are met:

1. The total linear length of all openings in any individual side wall or end wall shall be limited to not more than 50 percent of the length of that side wall or end wall, as shown in Figure 3115.8.5.3(1).
2. Any full-height wall length, or portion thereof, less than 4 feet (305 mm) shall not be considered as a portion of the lateral force-resisting system, as shown in Figure 3115.8.5.3(2).
3. All side walls or end walls used as part of the lateral force-resisting system shall have an existing or new boundary element on all sides to form a continuous load path, or paths, with adequate strength and stiffness to transfer all forces from the point of application to the final point of resistance, as shown in Figure 3115.8.5.3(3).

4. Where openings are made in container walls, floors or roofs, for doors, windows and other openings:
  - 4.1 The openings shall be framed with steel elements that are designed in accordance with Chapters 16 and 22.
  - 4.2 The cross section and material grade of any new steel element shall be equal to or greater than the steel element removed.
5. A maximum of one penetration not greater than 6 inches (152 mm) in diameter for conduits, pipes, tubes or vents, or not greater than 16 square inches (10 323 mm<sup>2</sup>) for electrical boxes, is permitted for each individual 8-foot (2438 mm) length of lateral force-resisting wall. Penetrations located in walls that are not part of the lateral force-resisting system shall not be limited in size or quantity. Existing intermodal shipping container vents shall not be considered a penetration, as shown in Figure 3115.8.5.3(4).
6. End wall doors designated as part of the lateral force-resisting system shall be welded closed.

**TABLE 3115.8.5.3**  
**ALLOWABLE SHEAR VALUES FOR INTERMODAL**  
**SHIPPING CONTAINER CORRUGATED STEEL WALLS FOR WIND OR SEISMIC LOADING**

SHEAR WALLS FOR CONTAINER CONNECTED STEEL FRAMES FOR WIND ON CLADDING LOADS				
CONTAINER DESIGNATION <sup>b</sup>	CONTAINER DIMENSION (nominal length)	CONTAINER DIMENSION (nominal height)	ALLOWABLE SHEAR VALUES (PLF) <sup>a, c</sup>	
			Side Wall	End Wall
1EEE	45 feet	9.5 feet	75	843
1EE		8.5 feet		
1AAA	40 feet	9.5 feet	84	
1AA		8.5 feet		
1A		8.0 feet		
1AX		< 8.0 feet		
1BBB	30 feet	9.5 feet	112	
1BB		8.5 feet		
1B		8.0 feet		
1BX		< 8.0 feet		
1CC	20 feet	8.5 feet	168	
1C		8.0 feet		
1CX		< 8.0 feet		
1D	10 feet	8.0 feet	337	
1DX		< 8.0 feet		

For SI: 1 foot = 304.8 mm.

a. The allowable strength shear for the side walls and end walls of the intermodal shipping containers are derived from ISO 1496-1 and reduced by a factor of safety of 5.

b. Container designation type is derived from ISO 668.

c. Limitations of Section 3115.8.5.1 shall apply.

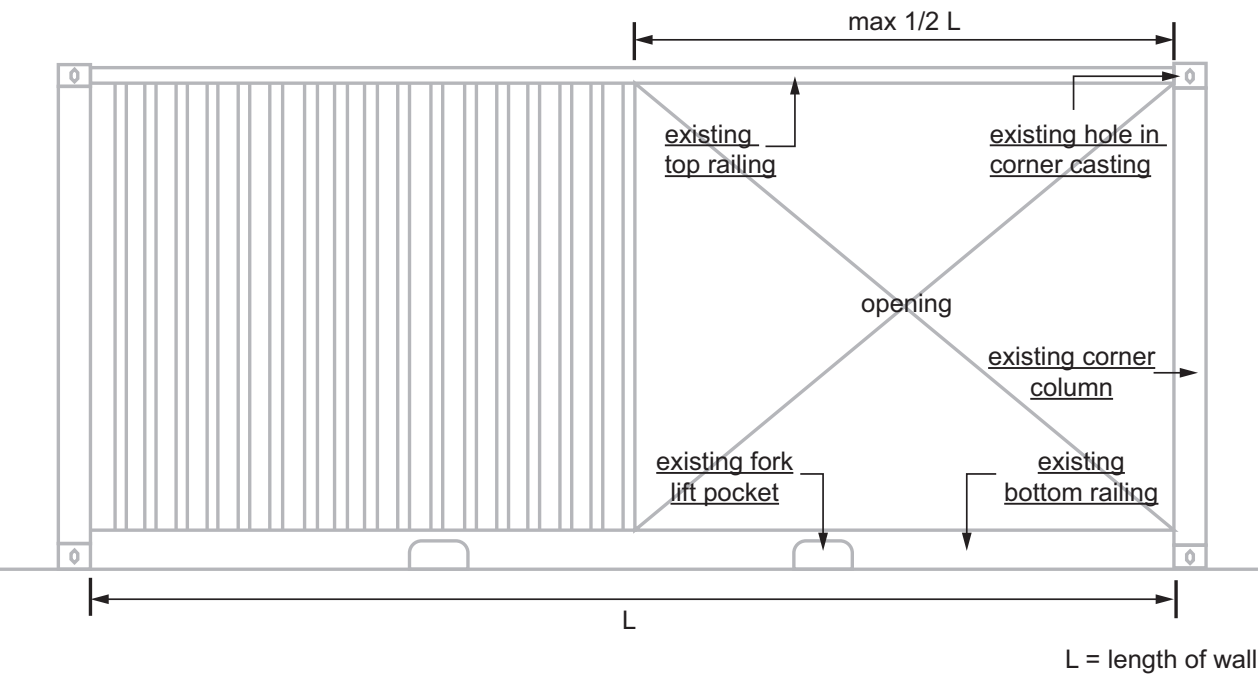


FIGURE 3115.8.5.3(1)  
BRACING UNIT DISTRIBUTION—MAXIMUM LINEAR LENGTH

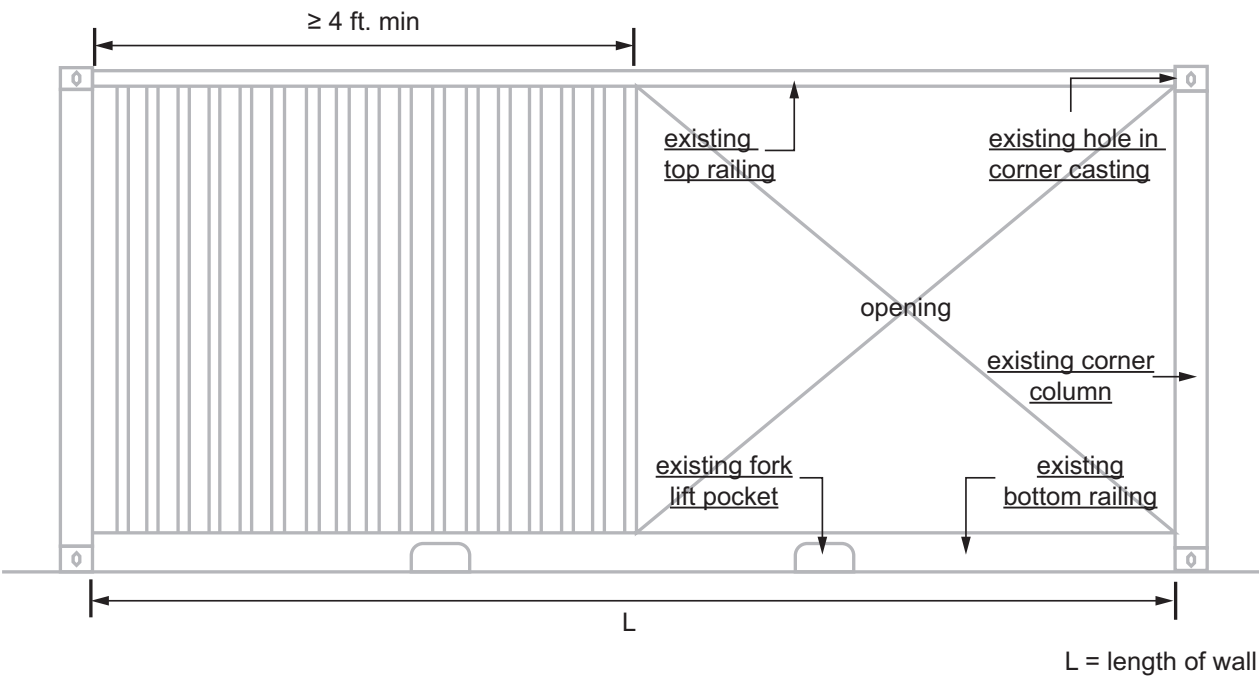


FIGURE 3115.8.5.3(2)  
BRACING UNIT DISTRIBUTION—MINIMUM LINEAR LENGTH

For SI: 1 foot = 304.8 mm.



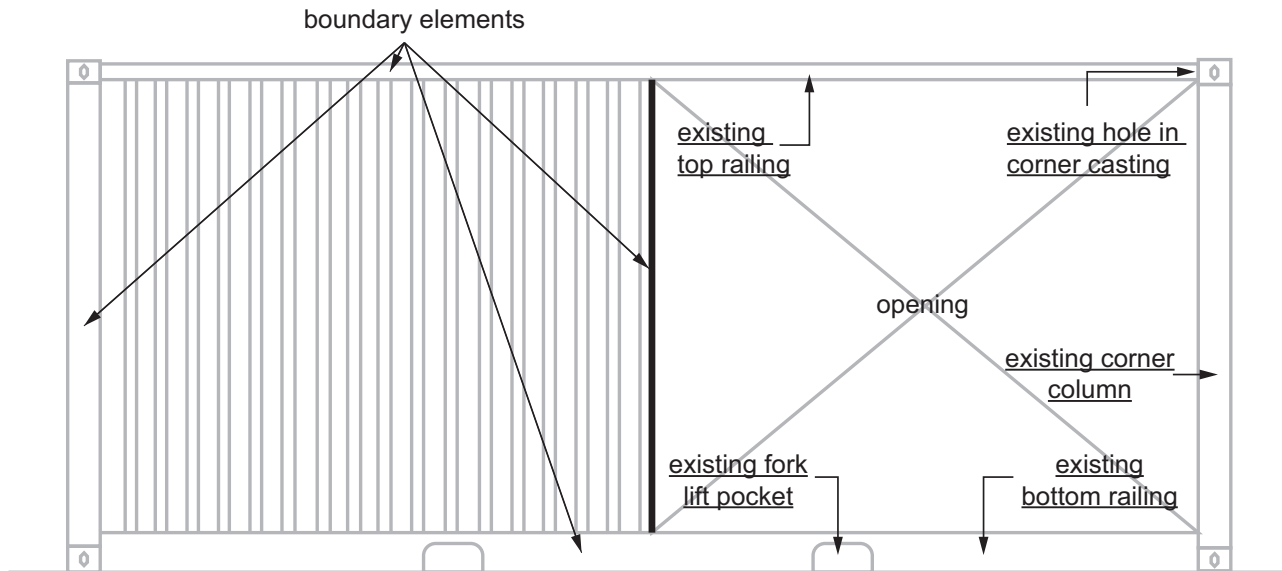
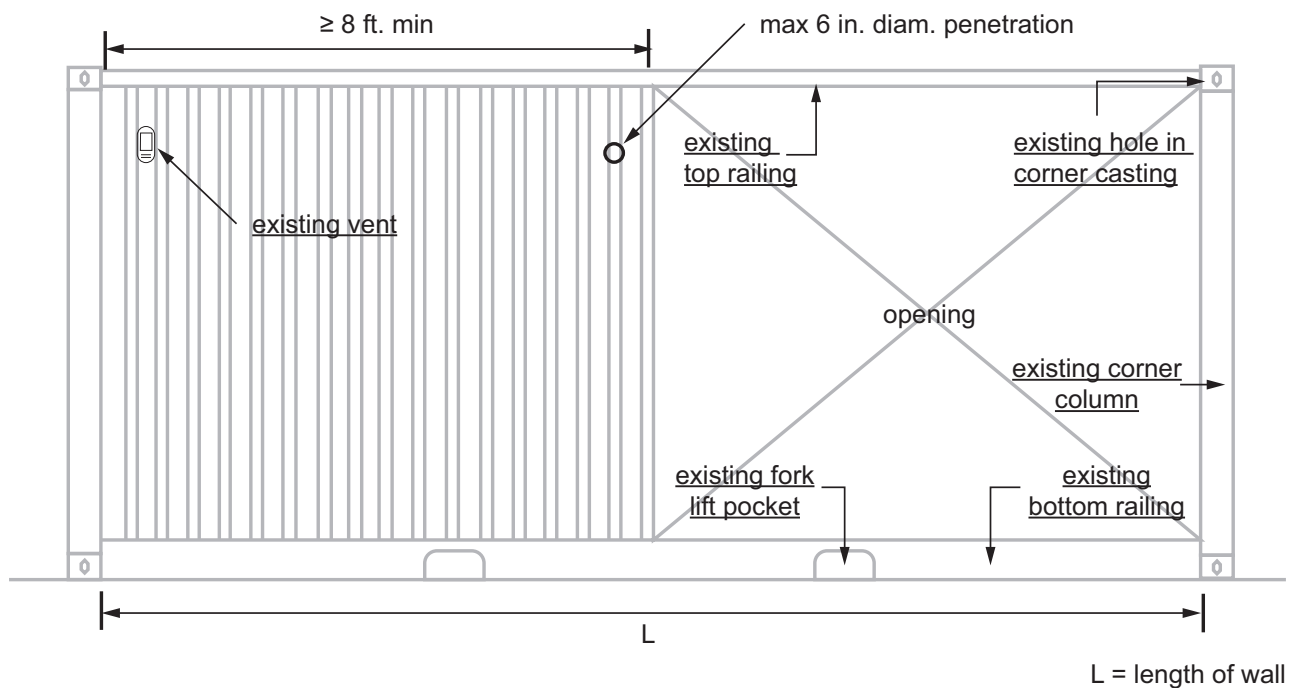


FIGURE 3115.8.5.3(3)  
BRACING UNIT DISTRIBUTION—BOUNDARY ELEMENTS



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 3115.8.5.3(4)  
BRACING UNIT DISTRIBUTION—PENETRATION LIMITATIONS



## CHAPTER 32

## ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY

## User note:

**About this chapter:** From time to time it is necessary or appropriate for a portion of a building to encroach onto an adjoining public right-of-way. Chapter 32 establishes parameters for such encroachments not only at grade but also above and below grade.

SECTION 3201  
GENERAL

**3201.1 Scope.** The provisions of this chapter shall govern the encroachment of structures into the public right-of-way.

**3201.2 Measurement.** The projection of any structure or portion thereof shall be the distance measured horizontally from the *lot line* to the outermost point of the projection.

**3201.3 Other laws.** The provisions of this chapter shall not be construed to permit the violation of other laws or ordinances regulating the use and occupancy of public property.

**3201.4 Drainage.** Drainage water collected from a roof, *awning*, *canopy* or *marquee*, and condensate from mechanical equipment shall not flow over a public walking surface.

SECTION 3202  
ENCROACHMENTS

**3202.1 Encroachments below grade.** Encroachments below grade shall comply with Sections 3202.1.1 through 3202.1.3.

**3202.1.1 Structural support.** A part of a building erected below grade that is necessary for structural support of the building or structure shall not project beyond the *lot lines*, except that the footings of street walls or their supports that are located not less than 8 feet (2438 mm) below grade shall not project more than 12 inches (305 mm) beyond the street *lot line*.

**3202.1.2 Vaults and other enclosed spaces.** The construction and utilization of vaults and other enclosed spaces below grade shall be subject to the terms and conditions of the applicable governing authority.

**3202.1.3 Areaways.** *Areaways* shall be protected by grates, *guards* or other *approved* means.

**3202.2 Encroachments above grade and below 8 feet in height.** Encroachments into the public right-of-way above grade and below 8 feet (2438 mm) in height shall be prohibited except as provided for in Sections 3202.2.1 through 3202.2.3. Doors and windows shall not open or project into the public right-of-way.

**3202.2.1 Steps.** Steps shall not project more than 12 inches (305 mm) and shall be guarded by *approved* devices not less than 3 feet (914 mm) in height, or shall be located between columns or pilasters.

**3202.2.2 Architectural features.** Columns or pilasters, including bases and moldings, shall not project more than

12 inches (305 mm). Belt courses, lintels, sills, architraves, pediments and similar architectural features shall not project more than 4 inches (102 mm).

**3202.2.3 Awnings.** The vertical clearance from the public right-of-way to the lowest part of any *awning*, including valances, shall be not less than 7 feet (2134 mm).

**3202.3 Encroachments 8 feet or more above grade.** Encroachments 8 feet (2438 mm) or more above grade shall comply with Sections 3202.3.1 through 3202.3.4.

**3202.3.1 Awnings, canopies, marquees and signs.** *Awnings*, *canopies*, *marquees* and signs shall be constructed so as to support applicable *loads* as specified in Chapter 16. *Awnings*, *canopies*, *marquees* and signs with less than 15 feet (4572 mm) of clearance above the sidewalk shall not extend into or occupy more than two-thirds the width of the sidewalk measured from the building. Stanchions or columns that support *awnings*, *canopies*, *marquees* and signs shall be located not less than 2 feet (610 mm) in from the curb line.

**3202.3.2 Windows, balconies, architectural features and mechanical equipment.** Where the vertical clearance above grade to projecting windows, balconies, architectural features or mechanical equipment is more than 8 feet (2438 mm), 1 inch (25 mm) of encroachment is permitted for each additional 1 inch (25 mm) of clearance above 8 feet (2438 mm), but the maximum encroachment shall be 4 feet (1219 mm).

**3202.3.3 Encroachments 15 feet or more above grade.** Encroachments 15 feet (4572 mm) or more above grade shall not be limited.

**3202.3.4 Pedestrian walkways.** The installation of a *pedestrian walkway* over a public right-of-way shall be subject to the approval of the applicable governing authority. The vertical clearance from the public right-of-way to the lowest part of a *pedestrian walkway* shall be not less than 15 feet (4572 mm).

**3202.4 Temporary encroachments.** Where allowed by the applicable governing authority, vestibules and storm enclosures shall not be erected for a period of time exceeding 7 months in any 1 year and shall not encroach more than 3 feet (914 mm) nor more than one-fourth of the width of the sidewalk beyond the street *lot line*. Temporary entrance awnings shall be erected with a clearance of not less than 7 feet (2134 mm) to the lowest portion of the hood or awning where supported on removable steel or other *approved* noncombustible support.





## CHAPTER 33

# SAFEGUARDS DURING CONSTRUCTION

### User notes:

**About this chapter:** While the balance of the chapters in this code specify how a building is to be designed and constructed in order to be in compliance with the code, Chapter 33 looks to the actual construction process. Parameters are provided for demolition and for protecting adjacent property during demolition and construction. This chapter also addresses the need for a fire watch during nonworking hours for certain buildings once the construction has progressed significantly. Issues such as how to provide egress while the building is growing, the timing of standpipe and sprinkler installation, and protection of pedestrians are addressed.

**Code development reminder:** Code change proposals to sections preceded by the designation [BS] will be considered by the IBC—Structural Code Development Committee during the 2022 (Group B) Code Development Cycle.

### SECTION 3301 GENERAL

**3301.1 Scope.** The provisions of this chapter shall govern safety during construction and the protection of adjacent public and private properties.

**3301.2 Storage and placement.** Construction equipment and materials shall be stored and placed so as not to endanger the public, the workers or adjoining property for the duration of the construction project.

\*\*

[BS] **3301.2.1 Structural and construction loads.** Structural roof components shall be capable of supporting the roof-covering system and the material and equipment loads that will be encountered during installation of the system.

### SECTION 3302 CONSTRUCTION SAFEGUARDS

**3302.1 Alterations, repairs and additions.** Required exits, existing structural elements, fire protection devices and sanitary safeguards shall be maintained at all times during alterations, repairs or additions to any building or structure.

#### Exceptions:

1. Where such required elements or devices are being altered or repaired, adequate substitute provisions shall be made.
2. Maintenance of such elements and devices is not required where the existing building is not occupied.

**3302.2 Manner of removal.** Waste materials shall be removed in a manner that prevents injury or damage to persons, adjoining properties and public rights-of-way.

**3302.3 Fire safety during construction.** Fire safety during construction shall comply with the applicable requirements of this code and the applicable provisions of Chapter 33 of the *International Fire Code*.

### SECTION 3303 DEMOLITION

**3303.1 Construction documents.** Construction documents and a schedule for demolition shall be submitted where required by the *building official*. Where such information is required, work shall not be done until such construction documents or schedule, or both, are approved.

**3303.2 Pedestrian protection.** The work of demolishing any building shall not be commenced until pedestrian protection is in place as required by this chapter.

**3303.3 Means of egress.** A *horizontal exit* shall not be destroyed unless and until a substitute means of egress has been provided and approved.

**3303.4 Vacant lot.** Where a structure has been demolished or removed, the vacant lot shall be filled and maintained to the existing grade or in accordance with the ordinances of the jurisdiction having authority.

**3303.5 Water accumulation.** Provision shall be made to prevent the accumulation of water or damage to any foundations on the premises or the adjoining property.

**3303.6 Utility connections.** Service utility connections shall be discontinued and capped in accordance with the approved rules and the requirements of the applicable governing authority.

**3303.7 Fire safety during demolition.** Fire safety during demolition shall comply with the applicable requirements of this code and the applicable provisions of Chapter 33 of the *International Fire Code*.

### SECTION 3304 SITE WORK

**3304.1 Excavation and fill.** Excavation and fill for buildings and structures shall be constructed or protected so as not to endanger life or property. Stumps and roots shall be removed from the soil to a depth of not less than 12 inches (305 mm) below the surface of the ground in the area to be

## SAFEGUARDS DURING CONSTRUCTION

occupied by the building. Wood forms that have been used in placing concrete, if within the ground or between foundation sills and the ground, shall be removed before a building is occupied or used for any purpose. Before completion, loose or casual wood shall be removed from direct contact with the ground under the building.

**3304.1.1 Slope limits.** Slopes for permanent fill shall be not steeper than one unit vertical in two units horizontal (50-percent slope). Cut slopes for permanent excavations shall be not steeper than one unit vertical in two units horizontal (50-percent slope). Deviation from the foregoing limitations for cut slopes shall be permitted only upon the presentation of a soil investigation report acceptable to the *building official*.

**3304.1.2 Surcharge.** Fill or other surcharge *loads* shall not be placed adjacent to any building or structure unless such building or structure is capable of withstanding the additional *loads* caused by the fill or surcharge. Existing footings or foundations that can be affected by any excavation shall be underpinned adequately or otherwise protected against settlement and shall be protected against lateral movement.

**3304.1.3 Footings on adjacent slopes.** For footings on adjacent slopes, see Chapter 18.

**3304.1.4 Fill supporting foundations.** Fill to be used to support the foundations of any building or structure shall comply with Section 1804.6. *Special inspections* of compacted fill shall be in accordance with Section 1705.6.

## SECTION 3305 SANITARY

**3305.1 Facilities required.** Sanitary facilities shall be provided during construction, remodeling or demolition activities in accordance with the *International Plumbing Code*.

## SECTION 3306 PROTECTION OF PEDESTRIANS

**[BS] 3306.1 Protection required.** Pedestrians shall be protected during construction, remodeling and demolition activities as required by this chapter and Table 3306.1. Signs shall be provided to direct pedestrian traffic.

**[BS] 3306.2 Walkways.** A walkway shall be provided for pedestrian travel in front of every construction and demolition site unless the applicable governing authority authorizes the sidewalk to be fenced or closed. A walkway shall be provided for pedestrian travel that leads from a *building* entrance or exit of an occupied structure to a public way. Walkways shall be of sufficient width to accommodate the pedestrian traffic, but shall be not less than 4 feet (1219 mm) in width. Walkways shall be provided with a durable walking surface. Walkways shall be *accessible* in accordance with Chapter 11 and shall be designed to support all imposed loads, and the design *live load* shall be not less than 150 pounds per square foot (psf) (7.2 kN/m<sup>2</sup>).

**[BS] 3306.3 Directional barricades.** Pedestrian traffic shall be protected by a directional barricade where the walkway extends into the street. The directional barricade shall be of sufficient size and construction to direct vehicular traffic away from the pedestrian path.

**[BS] 3306.4 Construction railings.** Construction railings shall be not less than 42 inches (1067 mm) in height and shall be sufficient to direct pedestrians around construction areas.

**[BS] 3306.5 Barriers.** Barriers shall be not less than 8 feet (2438 mm) in height and shall be placed on the side of the walkway nearest the construction. Barriers shall extend the entire length of the construction site. Openings in such barriers shall be protected by doors that are normally kept closed.

**[BS] 3306.6 Barrier design.** Barriers shall be designed to resist *loads* required in Chapter 16 unless constructed as follows:

1. Barriers shall be provided with 2-inch by 4-inch (51 mm by 102 mm) top and bottom plates.
2. The barrier material shall be boards not less than  $\frac{3}{4}$ -inch (19.1 mm) thick or *wood structural panels* not less than  $\frac{1}{4}$ -inch (6.4 mm) thick.
3. Wood structural use panels shall be bonded with an adhesive identical to that for exterior wood structural use panels.
4. Wood structural use panels  $\frac{1}{4}$  inch (6.4 mm) or  $\frac{5}{16}$  inch (7.9 mm) in thickness shall have studs spaced not more than 2 feet (610 mm) on center.
5. Wood structural use panels  $\frac{3}{8}$  inch (9.5 mm) or  $\frac{1}{2}$  inch (12.7 mm) in thickness shall have studs spaced not more than 4 feet (1219 mm) on center provided

TABLE 3306.1  
PROTECTION OF PEDESTRIANS

HEIGHT OF CONSTRUCTION	DISTANCE FROM CONSTRUCTION TO LOT LINE	TYPE OF PROTECTION REQUIRED
8 feet or less	Less than 5 feet	Construction railings
	5 feet or more	None
More than 8 feet	Less than 5 feet	Barrier and covered walkway
	5 feet or more, but not more than one-fourth the height of construction	Barrier and covered walkway
	5 feet or more, but between one-fourth and one-half the height of construction	Barrier
	5 feet or more, but exceeding one-half the height of construction	None

For SI: 1 foot = 304.8 mm.

that a 2-inch by 4-inch (51 mm by 102 mm) stiffener is placed horizontally at mid-height where the stud spacing is greater than 2 feet (610 mm) on center.

6. Wood structural use panels  $\frac{5}{8}$  inch (15.9 mm) or thicker shall not span over 8 feet (2438 mm).

**[BS] 3306.7 Covered walkways.** Covered walkways shall have a clear height of not less than 8 feet (2438 mm) as measured from the floor surface to the canopy overhead. Adequate lighting shall be provided at all times. Covered walkways shall be designed to support all imposed loads. The design *live load* shall be not less than 150 psf (7.2 kN/m<sup>2</sup>) for the entire structure.

**Exception:** Roofs and supporting structures of covered walkways for new, *light-frame construction* not exceeding two *stories* above grade plane are permitted to be designed for a *live load* of 75 psf (3.6 kN/m<sup>2</sup>) or the loads imposed on them, whichever is greater. In lieu of such designs, the roof and supporting structure of a covered walkway are permitted to be constructed as follows:

1. Footings shall be continuous 2-inch by 6-inch (51 mm by 152 mm) members.
2. Posts not less than 4 inches by 6 inches (102 mm by 152 mm) shall be provided on both sides of the roof and spaced not more than 12 feet (3658 mm) on center.
3. Stringers not less than 4 inches by 12 inches (102 mm by 305 mm) shall be placed on edge upon the posts.
4. Joists resting on the stringers shall be not less than 2 inches by 8 inches (51 mm by 203 mm) and shall be spaced not more than 2 feet (610 mm) on center.
5. The deck shall be planks not less than 2 inches (51 mm) thick or *wood structural panels* with an exterior exposure durability classification not less than  $\frac{23}{32}$  inch (18.3 mm) thick nailed to the joists.
6. Each post shall be knee braced to joists and stringers by members not less than 2 inches by 4 inches (51 mm by 102 mm); 4 feet (1219 mm) in length.
7. A curb that is not less than 2 inches by 4 inches (51 mm by 102 mm) shall be set on edge along the outside edge of the deck.

**[BS] 3306.8 Repair, maintenance and removal.** Pedestrian protection required by this chapter shall be maintained in place and kept in good order for the entire length of time pedestrians are subject to being endangered. The *owner* or the *owner's* authorized agent, on completion of the construction activity, shall immediately remove walkways, debris and other obstructions and leave such public property in as good a condition as it was before such work was commenced.

**[BS] 3306.9 Adjacent to excavations.** Every excavation on a site located 5 feet (1524 mm) or less from the street *lot line* shall be enclosed with a barrier not less than 6 feet (1829 mm) in height. Where located more than 5 feet (1524 mm) from the street *lot line*, a barrier shall be erected where

required by the *building official*. Barriers shall be of adequate strength to resist wind pressure as specified in Chapter 16.

## SECTION 3307 PROTECTION OF ADJOINING PROPERTY

**[BS] 3307.1 Protection required.** Adjoining public and private property shall be protected from damage during construction, remodeling and demolition work. Protection shall be provided for footings, foundations, party walls, chimneys, skylights and roofs. Provisions shall be made to control water runoff and erosion during construction or demolition activities. The person making or causing an excavation to be made shall provide written notice to the *owners* of adjoining buildings advising them that the excavation is to be made and that the adjoining buildings should be protected. Said notification shall be delivered not less than 10 days prior to the scheduled starting date of the excavation.

**[BS] 3307.2 Excavation retention systems.** Where a retention system is used to provide support of an excavation for protection of adjacent *structures*, the system shall conform to the requirements in Sections 3307.2.1 through 3307.2.3.

**[BS] 3307.2.1 Excavation retention system design.** Excavation retention systems shall be designed by a *registered design professional* to provide vertical and lateral support.

**[BS] 3307.2.2 Excavation retention system monitoring.** The retention system design shall include requirements for monitoring of the system and adjacent structures for horizontal and vertical movement.

**[BS] 3307.2.3 Retention system removal.** Elements of the system shall only be removed or decommissioned where adequate replacement support is provided by back-fill or by the new structure. Removal or decommissioning shall be performed in such a manner that protects the adjacent property.

## SECTION 3308 TEMPORARY USE OF STREETS, ALLEYS AND PUBLIC PROPERTY

**3308.1 Storage and handling of materials.** The temporary use of streets or public property for the storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public shall comply with the provisions of the applicable governing authority and this chapter.

**3308.1.1 Obstructions.** Construction materials and equipment shall not be placed or stored so as to obstruct access to fire hydrants, standpipes, fire or police alarm boxes, catch basins or manholes, nor shall such material or equipment be located within 20 feet (6096 mm) of a street intersection, or placed so as to obstruct normal observations of traffic signals or to hinder the use of public transit loading platforms.

## SAFEGUARDS DURING CONSTRUCTION

**3308.2 Utility fixtures.** Building materials, fences, sheds or any obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, fire department connection, utility pole, manhole, fire alarm box or catch basin, or so as to interfere with the passage of water in the gutter. Protection against damage shall be provided to such utility fixtures during the progress of the work, but sight of them shall not be obstructed.

### SECTION 3309 FIRE EXTINGUISHERS

**[F] 3309.1 Where required.** Structures under construction, *alteration* or demolition shall be provided with not fewer than one *approved* portable fire extinguisher in accordance with Section 906 and sized for not less than ordinary hazard as follows:

1. At each *stairway* on all floor levels where combustible materials have accumulated.
2. In every storage and construction shed.
3. Additional portable fire extinguishers shall be provided where special hazards exist, such as the storage and use of flammable and combustible liquids.

**[F] 3309.2 Fire hazards.** The provisions of this code and the *International Fire Code* shall be strictly observed to safeguard against all fire hazards attendant upon construction operations.

### SECTION 3310 MEANS OF EGRESS

**3310.1 Stairways required.** Where building construction exceeds 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access, a temporary or permanent *stairway* shall be provided. As construction progresses, such *stairway* shall be extended to within one floor of the highest point of construction having secured decking or flooring.

**[F] 3310.2 Maintenance of means of egress.** *Means of egress* and required *accessible means of egress* shall be maintained at all times during construction, demolition, remodeling or *alterations* and *additions* to any building.

**Exception:** Existing *means of egress* need not be maintained where *approved* temporary *means of egress* systems and facilities are provided.

### SECTION 3311 STANDPIPES

**[F] 3311.1 Where required.** In buildings required to have standpipes by Section 905.3.1, not fewer than one standpipe shall be provided for use during construction. Such standpipes shall be installed prior to construction exceeding 40 feet (12 192 mm) in height above the lowest level of fire department vehicle access. Such standpipes shall be provided with fire department hose connections at locations adjacent to *stairways* complying with Section 3310.1. As

construction progresses, such standpipes shall be extended to within one floor of the highest point of construction having secured decking or flooring.

**[F] 3311.2 Buildings being demolished.** Where a building is being demolished and a standpipe exists within such a building, such standpipe shall be maintained in an operable condition so as to be available for use by the fire department. Such standpipe shall be demolished with the building but shall not be demolished more than one floor below the floor being demolished.

**[F] 3311.3 Detailed requirements.** Standpipes shall be installed in accordance with the provisions of Chapter 9.

**Exception:** Standpipes shall be either temporary or permanent in nature, and with or without a water supply, provided that such standpipes conform to the requirements of Section 905 as to capacity, outlets and materials.

### SECTION 3312 AUTOMATIC SPRINKLER SYSTEM

**[F] 3312.1 Completion before occupancy.** In buildings where an *automatic sprinkler system* is required by this code, it shall be unlawful to occupy any portion of a building or structure until the *automatic sprinkler system* installation has been tested and *approved*, except as provided in Section 111.3.

**[F] 3312.2 Operation of valves.** Operation of sprinkler control valves shall be permitted only by properly authorized personnel and shall be accompanied by notification of duly designated parties. When the sprinkler protection is being regularly turned off and on to facilitate connection of newly completed segments, the sprinkler control valves shall be checked at the end of each work period to ascertain that protection is in service.

### SECTION 3313 WATER SUPPLY FOR FIRE PROTECTION

**[F] 3313.1 Where required.** An *approved* water supply for fire protection, either temporary or permanent, shall be made available as soon as combustible building materials arrive on the site, on commencement of vertical combustible construction, and on installation of a standpipe system in buildings under construction, in accordance with Sections 3313.2 through 3313.5.

**Exception:** The *fire code official* is authorized to reduce the fire-flow requirements for isolated buildings or a group of buildings in rural areas or small communities where the development of full fire-flow requirements is impractical.

**[F] 3313.2 Combustible building materials.** When combustible building materials of the building under construction are delivered to a site, a minimum fire flow of 500 gallons per minute (1893 L/m) shall be provided. The fire hydrant used to provide this fire flow supply shall be within 500 feet (152 m) of the combustible building materials, as measured along an approved fire apparatus access



lane. Where the site configuration is such that one fire hydrant cannot be located within 500 feet (152 m) of all combustible building materials, additional fire hydrants shall be required to provide coverage in accordance with this section.

**[F] 3313.3 Vertical construction of Types III, IV and V construction.** Prior to commencement of vertical construction of Type III, IV or V buildings that utilize any combustible building materials, the fire flow required by Sections 3313.3.1 through 3313.3.3 shall be provided, accompanied by fire hydrants in sufficient quantity to deliver the required fire flow and proper coverage.

**[F] 3313.3.1 Fire separation up to 30 feet.** Where a building of Type III, IV or V construction has a *fire separation distance* of less than 30 feet (9144 mm) from property lot lines, and an adjacent property has an *existing structure* or otherwise can be built on, the water supply shall provide either a minimum of 500 gallons per minute (1893 L/m), or the entire fire flow required for the building when constructed, whichever is greater.

**[F] 3313.3.2 Fire separation of 30 feet up to 60 feet.** Where a building of Type III, IV or V construction has a *fire separation distance* of 30 feet (9144 mm) up to 60 feet (18 288 mm) from property lot lines, and an adjacent property has an *existing structure* or otherwise can be built on, the water supply shall provide a minimum of 500 gallons per minute (1893 L/m), or 50 percent of the fire flow required for the building when constructed, whichever is greater.

**[F] 3313.3.3 Fire separation of 60 feet or greater.** Where a building of Type III, IV or V construction has a fire separation of 60 feet (18 288 mm) or greater from a property lot line, a water supply of 500 gallons per minute (1893 L/m) shall be provided.

**[F] 3313.4 Vertical construction, Types I and II construction.** If combustible building materials are delivered to the construction site, water supply in accordance with Section 3313.2 shall be provided. Additional water supply for fire flow is not required prior to commencing vertical construction of Type I and II buildings.

**[F] 3313.5 Standpipe supply.** Regardless of the presence of combustible building materials, the construction type or the *fire separation distance*, where a standpipe is required in accordance with Section 3311, a water supply providing a minimum flow of 500 gallons per minute (1893 L/m) shall be provided. The fire hydrant used for this water supply shall be located within 100 feet (30 480 mm) of the fire department connection supplying the standpipe.

aggregate area exceeding 50,000 square feet (4645 m<sup>2</sup>) per story or as required by the fire code official.

## SECTION 3314

### FIRE WATCH DURING CONSTRUCTION

**[F] 3314.1 Fire watch during combustible construction.** A fire watch shall be provided during nonworking hours for construction that exceeds 40 feet (12 192 mm) in height above the lowest adjacent grade at any point along the building perimeter, for new multistory construction with an



## CHAPTER 34

# RESERVED

*Action taken during the 2012 Code Development Process removed Chapter 34, Existing Structures, from the IBC. The provisions of this chapter are contained in the International Existing Building Code. See Section 101.4.7.*





## CHAPTER 35

# REFERENCED STANDARDS

---

### User note:

*About this chapter: The International Building Code® contains numerous references to standards promulgated by other organizations that are used to provide requirements for materials and methods of construction. This chapter contains a comprehensive list of all standards that are referenced in this code. These standards, in essence, are part of this code to the extent of the reference to the standard.*

*This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 102.4.*

---

## AA

Aluminum Association  
1400 Crystal Drive, Suite 430  
Arlington, VA 22202

**ADM—2020: Aluminum Design Manual**  
1604.3.5, 2002.1

**ASM 35—00: Aluminum Sheet Metal Work in Building Construction (Fourth Edition)**  
2002.1

---

## AAMA

American Architectural Manufacturers Association  
1900 E Golf Road, Suite 1250  
Schaumburg, IL 60173

**711—20: Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products**  
1404.4

**714—19: Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal around Exterior Wall Openings in Buildings**  
1404.4

**1402—09: Standard Specifications for Aluminum Siding, Soffit and Fascia**  
1403.5.1

**2502—19: Comparative Analysis Procedure for Window and Door Products**  
1709.5

**AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors, and Skylights**  
1709.5.1, 2405.5

---

## ACI

American Concrete Institute  
38800 Country Club Drive  
Farmington Hills, MI 48331-3439

**117—10: Specification for Tolerances for Concrete Construction and Materials**  
1901.7.1

**216.1—14: Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies**  
Table 721.1(2), 722.1

**318—19: Building Code Requirements for Structural Concrete**  
722.2.4.3, 1604.3.2, 1616.2.1, 1616.3.1, 1704.5, Table 1705.3, 1705.3.2, 1808.8.2, Table 1808.8.2, 1808.8.5, 1808.8.6, 1810.1.3, 1810.2.4.1, 1810.3.2.1.1, 1810.3.2.1.2, 1810.3.8, 1810.3.9.4.2.1, 1810.3.9.4.2.2, 1810.3.10.1, 1810.3.11, 1810.3.11.1, 1810.3.12, 1810.3.13, 1901.2, 1901.3, 1902.1, 1903.1, 1904.1, 1904.2, 1905.1, 1905.1.1, 1905.1.2, 1905.1.3, 1905.1.4, 1905.1.5, 1905.1.6, 1905.1.7, 1905.1.8, 1908.1, 2108.3, 2206.1

**550.5—18: Code Requirements for the Design of Precast Concrete Diaphragms for Earthquake Motions**  
Table 1705.3

**ITG—7-09: Specification for Tolerances for Precast Concrete**  
1901.7.2

## REFERENCED STANDARDS

### AISC

American Institute of Steel  
130 East Randolph Street, Suite 2000  
Chicago, IL 60601-6219

**ANSI/AISC 341—16: Seismic Provisions for Structural Steel Buildings**

1705.13.1.1, 1705.13.1.2, 1705.14.1.1, 1705.14.1.2, 1810.3.5.3.1, 2205.2.1.1, 2205.2.1.2, 2205.2.2, 2206.2.1

**ANSI/AISC 358—16/s1—18: Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications, Including Supplement No. 1**

2205.2.1.1, 2205.2.1.2

**ANSI/AISC 360—16: Specification for Structural Steel Buildings**

722.5.2.2.1, 1604.3.3, 1705.2.1, 2202.1, 2203.1, 2205.1, 2205.2.1.1, 2206.1

### AISI

American Iron and Steel Institute  
25 Massachusetts Avenue, NW Suite 800  
Washington, DC 20001

**AISI S100—16(2020) w/S2—20: North American Specification for the Design of Cold-Formed Steel Structural Members, 2016 Edition (Reaffirmed 2020), with Supplement 2, 2020 Edition**

1604.3.3, 1905.1.8, 2202.1, 2203.1, 2210.1, 2210.2

**AISI S202—20: Code of Standard Practice for Cold-formed Steel Framing, 2020**

2211.1.3.1

**AISI S220—20: North American Standard for Cold-Formed Steel Nonstructural Framing**

2202.1, 2203.1, 2211.2, Table 2506.2, Table 2507.2

**AISI S230—2019: Standard for Cold-formed Steel Framing—Prescriptive Method for One- and Two-family Dwellings, 2019**

1609.1.1, 1609.1.1.1, 2211.1.2

**AISI S240—20: North American Standard for Cold-Formed Steel Structural Framing, 2020**

2202.1, 2203.1, 2211.1, 2211.1.1.1, 2211.1.3.3, Table 2506.2, Table 2507.2, Table 2603.12.1, Table 2603.12.2

**AISI S400—20: North American Standard for Seismic Design of Cold-formed Steel Structural Systems, 2020**

2210.2, 2211.1.1.1, 2211.1.1.2

### ALI

Automotive Lift Institute, Inc.  
P.O. Box 85  
Cortland, NY 13045

**ALI ALCTV—2016: Standard for Automotive Lifts—Safety Requirements for Construction, Testing and Validation (ANSI)**

Table 3001.3

### AMCA

Air Movement and Control Association International  
30 West University Drive  
Arlington Heights, IL 60004

**540—13: Test Method for Louvers Impacted by Wind Borne Debris**

1609.2.1

### ANSI

American National Standards Institute  
25 West 43rd Street, Fourth Floor  
New York, NY 10036

**A13.1—2020: Scheme for the Identification of Piping Systems**

415.11.7.5

**A108.1A—17: Installation of Ceramic Tile in the Wet-set Method, with Portland Cement Mortar**

2103.2.3

**A108.1B—17: Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-set or Latex-Portland Cement Mortar**

2103.2.3

**ANSI—continued**

- A108.4—09: Installation of Ceramic Tile with Organic Adhesives or Water-cleanable Tile-setting Epoxy Adhesive**  
2103.2.3.6
- A108.5—19: Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex-Portland Cement Mortar**  
2103.2.3.1, 2103.2.3.2
- A108.6—19: Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy**  
2103.2.3.3
- A108.8—19: Installation of Ceramic Tile with Chemical-resistant Furan Resin Mortar and Grout**  
2103.2.3.4
- A108.9—19: Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout**  
2103.2.3.5
- A108.10—17: Installation of Grout in Tilework**  
2103.2.3.7
- A118.1—18: American National Standard Specifications for Dry-Set Cement Mortar**  
2103.2.3.1
- A118.3—20: American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy and Water Cleanable Tile-setting Epoxy Adhesive**  
2103.2.3.3
- A118.4—18: American National Standard Specifications for Modified Dry-set Cement Mortar**  
2103.2.3.2, 2103.2.4
- A118.5—99: American National Standard Specifications for Chemical Resistant Furan Mortars and Grouts for Tile Installation**  
2103.2.3.4
- A118.6—19: American National Standard Specifications for Standard Cement Grouts for Tile Installation**  
2103.2.3.7
- A118.8—99: American National Standard Specifications for Modified Epoxy Emulsion Mortar/Grout**  
2103.2.3.5
- A136.1—19: American National Standard Specifications for the Installation of Ceramic Tile**  
2103.2.3.6
- A137.1—19: American National Standard Specifications for Ceramic Tile**  
202
- A137.3—17: American National Standard Specification for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs**  
202
- Z 97.1—14: Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test**  
2406.1.2, 2406.2, Table 2406.2(2), 2406.3.1, 2407.1, 2407.1.4, 2408.2.1, 2408.3, 2409.2, 2409.3, 2409.4.1

---

**APA**

APA - Engineered Wood Association  
7011 South 19th Street  
Tacoma, WA 98466-7400

- ANSI 117—2020: Standard Specification for Structural Glued Laminated Timber of Softwood Species**  
2306.1
- ANSI/APA A190.1—2017: Structural Glued Laminated Timber**  
2303.1.3, 2306.1
- ANSI/APA PRG 320—2019: Standard for Performance-rated Cross-laminated Timber**  
602.4, 2303.1.4
- ANSI/APA PRP 210—2019: Standard for Performance-Rated Engineered Wood Siding**  
2303.1.5, 2304.7, 2306.3, Table 2306.3(1)
- ANSI/APA PRR 410—16: Standard for Performance-Rated Engineered Wood Rim Boards**  
2303.1.13
- APA PDS Supplement 1—12: Design and Fabrication of Plywood Curved Panels (revised 2013)**  
2306.1
- APA PDS Supplement 2—12: Design and Fabrication of Plywood-lumber Beams (revised 2013)**  
2306.1

## REFERENCED STANDARDS

### APA—continued

**APA PDS Supplement 3—12: Design and Fabrication of Plywood Stressed-skin Panels (revised 2013)**

2306.1

**APA PDS Supplement 4—12: Design and Fabrication of Plywood Sandwich Panels (revised 2013)**

2306.1

**APA PDS Supplement 5—16: Design and Fabrication of All-plywood Beams (revised 2013)**

2306.1

**APA PDS—20: Panel Design Specification**

2306.1

**APA R540—19: Builder Tips: Proper Storage and Handling of Glulam Beams**

2306.1

**APA S475—20: Glued Laminated Beam Design Tables**

2306.1

**APA S560—20: Field Notching and Drilling of Glued Laminated Timber Beams**

2306.1

**APA T300—16: Glulam Connection Details**

2306.1

**APA X440—17: Product Guide: Glulam**

2306.1

**APA X450—18: Glulam in Residential Construction—Building—Construction Guide**

2306.1

## ASABE

American Society of Agricultural and Biological Engineers  
2950 Niles Road  
St. Joseph, MI 49085

**EP 484.3 DEC2017: Diaphragm Design of Metal-clad, Wood-frame Rectangular Buildings**

2306.1

**EP 486.3 SEP2017: Shallow-post and Pier Foundation Design**

2306.1

**EP 559.1 W/Corr. AUG2010(R2014): Design Requirements and Bending Properties for Mechanically Laminated Wood Assemblies**

2306.1

## ASCE/SEI

American Society of Civil Engineers  
Structural Engineering Institute  
1801 Alexander Bell Drive  
Reston, VA 20191

**7—16 with Supplement 1: Minimum Design Loads and Associated Criteria for Buildings and Other Structures**

202, Table 1504.2, 1602.1, Table 1604.3, 1604.5, Table 1604.5, 1604.8.2, 1604.9, 1605.1, 1605.1.1, 1605.2, 1606.3, 1607.9.1, 1607.9.1.1, 1607.9.1.2, 1607.10, 1607.14.1, 1607.17, 1608.1, 1608.2, Figure 1608.2(1), 1608.3, 1609.1.1, 1609.2, 1609.3, Figure 1609.3(5), Figure 1609.3(6), Figure 1609.3(7), Figure 1609.3(8), Figure 1609.3(9), Figure 1609.3(10), Figure 1609.3(11), Figure 1609.3(12), 1609.5.1, 1609.5.3, 1611.1, 1611.2, 1612.2, 1613.1, 1613.2.2, 1613.2.3, Table 1613.2.3(1), Table 1613.2.3(2), 1613.2.5, 1613.2.5.1, 1613.2.5.2, 1613.3, 1614.1, 1615.1, 1705.13, 1705.13.1.1, 1705.13.1.2, 1705.13.4, 1705.14.1.1, 1705.14.1.2, 1705.14.2, 1705.14.3, 1705.14.4, 1709.5, 1709.5.3.1, 1802.1, 1803.5.12, 1806.1, 1808.3, 1808.3.1, 1809.13, 1810.3.1.1, 1810.3.6.1, 1810.3.8, 1810.3.9.2, 1810.3.9.4, 1810.3.9.4.1, 1810.3.9.4.2, 1810.3.11.2, 1810.3.12, 1902.1, 1905.1.2, 1905.1.7, 1905.1.8, 2205.2.1.1, 2205.2.1.2, 2205.2.2, 2206.2.1, 2209.1, 2209.2, 2210.2, 2211.1.1.1, Table 2304.6.1, Table 2306.3(3), Table 2308.7.5, 2404.1, 2505.1, 2505.2, 2506.2.1

**8—20: Standard Specification for the Design of Cold-formed Stainless Steel Structural Members**

1604.3.3, 2210.1, 2210.2

**19—16: Structural Applications of Steel Cables for Buildings**

2208.1

**24—14: Flood Resistant Design and Construction**

1202.4.2, 1202.4.4, 1612.2, 1612.4, 2702.1.8, 3001.3



**ASCE/SEI—continued****29—19: Standard Calculation Methods for Structural Fire Protection**

722.1

**32—01: Design and Construction of Frost Protected Shallow Foundations**

1809.5

**49—12: Wind Tunnel Testing for Buildings and Other Structures**

1609.1.1

**55—16: Tensile Membrane Structures**

3102.2

---

**ASHRAE**ASHRAE  
1791 Tullie Circle NE  
Atlanta, GA 30329USA**170—2017: Ventilation of Health Care Facilities**

1020.6

---

**ASME**American Society of Mechanical Engineers  
Two Park Avenue  
New York, NY 10016**A17.1—2019/CSA B44—19: Safety Code for Elevators and Escalators**907.3.3, 911.1.6, 1009.4.1, 1607.11.1, 3001.2, Table 3001.3, 3001.4, 3001.5, 3002.5, 3003.2, 3007.1,  
3008.1.4, 3008.7.1**A17.7—2007/CSA B44—07(R2019): Performance-based Safety Code for Elevators and Escalators**

Table 3001.3, 3001.5, 3002.5

**A18.1—2020: Safety Standard for Platform Lifts and Stairway Chairlifts**

1110.9, Table 3001.3

**A90.1—2020: Safety Standard for Belt Manlifts**

Table 3001.3

**B16.18—2018: Cast Copper Alloy Solder Joint Pressure Fittings**

909.13.1

**B16.22—2018: Wrought Copper and Copper Alloy Solder Joint Pressure Fittings**

909.13.1

**B20.1—2021: Safety Standard for Conveyors and Related Equipment**

Table 3001.3, 3004.3

**B31.3—2020: Process Piping**

415.11.7

---

**ASSP**American Society of Safety Professionals  
520 N. Northwest Highway  
Park Ridge, IL 60068**ANSI/ASSE Z359.1—2019: The Fall Protection Code**

1015.6, 1015.7

---

**ASTM**ASTM International  
100 Barr Harbor Drive, P.O. Box C700  
West Conshohocken, PA 19428**A6/A6M—2017A: Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes and Sheet Piling**

1810.3.2.3, 1810.3.5.3.1, 1810.3.5.3.3

**A36/A36M—14: Specification for Carbon Structural Steel**

1810.3.2.3

**A153/A153M—2016A: Specification for Zinc Coating (Hot-dip) on Iron and Steel Hardware**

2304.10.6

## REFERENCED STANDARDS

### ASTM—continued

- A240/A240M—17: Standard Specification for Chromium and Chromium-nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications**  
Table 1507.4.3(1)
- A252—2010(2018): Specification for Welded and Seamless Steel Pipe Piles**  
1810.3.2.3
- A283/A283M—2018: Specification for Low and Intermediate Tensile Strength Carbon Steel Plates**  
1810.3.2.3
- A416/A416M—2017A: Specification for Steel Strand, Uncoated Seven-wire for Prestressed Concrete**  
1810.3.2.2
- A463/A463M—15: Standard Specification for Steel Sheet, Aluminum-coated, by the Hot-dip Process**  
Table 1507.4.3(2)
- A572/A572M—2018: Specification for High-strength Low-alloy Columbium-Vanadium Structural Steel**  
1810.3.2.3
- A588/A588M—15: Specification for High-strength Low-alloy Structural Steel with 50 ksi (345 MPa) Minimum Yield Point with Atmospheric Corrosion Resistance**  
1810.3.2.3
- A615/A615M—15ae1: Specification for Deformed and Plain Carbon-steel Bars for Concrete Reinforcement**  
1704.5, 1810.3.10.2
- A653/A653M—2017: Specification for Steel Sheet, Zinc-coated Galvanized or Zinc-iron Alloy-coated Galvannealed by the Hot-dip Process**  
Table 1507.4.3(1), Table 1507.4.3(2), 2304.10.6.1
- A690/A690M—13a(2018): Standard Specification for High-strength Low-alloy Nickel, Copper, Phosphorus Steel H-piles and Sheet Piling with Atmospheric Corrosion Resistance for Use in Marine Environments**  
1810.3.2.3
- A706/A706M—2016: Specification for Low-alloy Steel Deformed and Plain Bars for Concrete Reinforcement**  
1704.5, Table 1705.3, 2107.3, 2108.3
- A722/A722M—2018: Specification for High-strength Steel Bars for Prestressed Concrete**  
1810.3.10.2
- A755/A755M—2016E1: Specification for Steel Sheet, Metallic-coated by the Hot-dip Process and Prepainted by the Coil-coating Process for Exterior Exposed Building Products**  
Table 1507.4.3(1), Table 1507.4.3(2)
- A792/A792M—10(2015): Specification for Steel Sheet, 55% Aluminum-zinc Alloy-coated by the Hot-dip Process**  
Table 1507.4.3(1), Table 1507.4.3(2)
- A875/A875M—13: Standard Specification for Steel Sheet, Zinc-5%, Aluminum Alloy-coated by the Hot-dip Process**  
Table 1507.4.3(2)
- A924/A924M—2017A: Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-dip Process**  
Table 1507.4.3(1)
- B42—2015A: Specification for Seamless Copper Pipe, Standard Sizes**  
909.13.1
- B43—15: Specification for Seamless Red Brass Pipe, Standard Sizes**  
909.13.1
- B68/B68M—11: Specification for Seamless Copper Tube, Bright Annealed (Metric)**  
909.13.1
- B88—2016: Specification for Seamless Copper Water Tube**  
909.13.1
- B101—12: Specification for Lead-coated Copper Sheet and Strip for Building Construction**  
1403.5.3, Table 1507.2.8.2, Table 1507.4.3(1)
- B209—14: Specification for Aluminum and Aluminum Alloy Steel and Plate**  
Table 1507.4.3(1)
- B251/B251M—2017: Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube**  
909.13.1
- B280—2018: Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service**  
909.13.1

## ASTM—continued

- B370—12: Specification for Copper Sheet and Strip for Building Construction**  
1403.5.2, Table 1507.2.8.2, Table 1507.4.3(1)
- B695—2004(2016): Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel Strip for Building Construction**  
2304.10.6.1, 2304.10.6.3
- C5—2018: Specification for Quicklime for Structural Purposes**  
2109.2.4.8.7, Table 2507.2
- C22/C22M—00(2015): Specification for Gypsum**  
Table 2506.2
- C27—1998(2018): Specification for Standard Classification of Fireclay and High-alumina Refractory Brick**  
2111.6
- C28/C28M—10(2015): Specification for Gypsum Plasters**  
Table 2507.2
- C31/C31M—2018B: Practice for Making and Curing Concrete Test Specimens in the Field**  
Table 1705.3
- C33/C33M—2018: Specification for Concrete Aggregates**  
722.3.1.4, 722.4.1.1.3
- C35/C35—01(2014): Specification for Inorganic Aggregates for Use in Gypsum Plaster**  
Table 2507.2
- C55—2017: Specification for Concrete Building Brick**  
Table 722.3.2
- C59/C59M—00(2015): Specification for Gypsum Casting Plaster and Molding Plaster**  
Table 2507.2
- C61/C61M—00(2015): Specification for Gypsum Keene's Cement**  
Table 2507.2
- C62—2017: Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)**  
1807.1.6.3
- C67/C67M—2018: Test Methods of Sampling and Testing Brick and Structural Clay Tile**  
722.4.1.1.1, 2109.2.1.1
- C73—2017: Specification for Calcium Silicate Brick (Sand-lime Brick)**  
Table 722.3.2
- C90—2016A: Specification for Loadbearing Concrete Masonry Units**  
Table 722.3.2, 1807.1.6.3, 2114.3
- C91/C91M—2018: Specification for Masonry Cement**  
Table 2507.2
- C94/C94M—2017A: Specification for Ready-mixed Concrete**  
110.3.1
- C140/C140M—2018: Test Method Sampling and Testing Concrete Masonry Units and Related Units**  
722.3.1.2
- C141/C141M—14: Standard Specification for Hydrated Hydraulic Lime for Structural Purposes**  
2109.2.4.8.7
- C150/C150M—2018: Specification for Portland Cement**  
Table 2507.2
- C172/C172M—2017: Practice for Sampling Freshly Mixed Concrete**  
Table 1705.3
- C199—1984(2016): Test Method for Pier Test for Refractory Mortars**  
2111.6, 2111.9, 2113.12
- C206—14: Specification for Finishing Hydrated Lime**  
2109.2.4.8.7, Table 2507.2
- C208—2012(2017)E1: Specification for Cellulosic Fiber Insulating Board**  
Table 1508.2, 2303.1.6

## REFERENCED STANDARDS

### ASTM—continued

- C216—2017A: Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)**  
Table 721.1(2), 1807.1.6.3
- C270—14a: Specification for Mortar for Unit Masonry**  
2103.2.4
- C315—2007(2016): Specification for Clay Flue Liners and Chimney Pots**  
2111.9, 2113.11.1, Table 2113.16(1)
- C317/C317M—2000(2015): Specification for Gypsum Concrete**  
2514.1
- C330/C330M—2017A: Specification for Lightweight Aggregates for Structural Concrete**  
202
- C331/C331M—2017: Specification for Lightweight Aggregates for Concrete Masonry Units**  
722.3.1.4, 722.4.1.1.3
- C406/C406M—15: Specification for Roofing Slate**  
1507.7.5
- C472—99(2014): Standard Test Methods for Physical Testing of Gypsum, Gypsum Plasters and Gypsum Concrete**  
Table 2506.2
- C473—2017: Test Methods for Physical Testing of Gypsum Panel Products**  
Table 2506.2
- C474—15: Test Methods for Joint Treatment Materials for Gypsum Board Construction**  
Table 2506.2
- C475/C475M—2017: Specification for Joint Compound and Joint Tape for Finishing Gypsum Board**  
Table 2506.2
- C514—04(2014): Specification for Nails for the Application of Gypsum Board**  
Table 721.1(2), Table 721.1(3), Table 2506.2
- C516—2008(2014)E1: Specifications for Vermiculite Loose Fill Thermal Insulation**  
722.3.1.4, 722.4.1.1.3
- C547—2017: Specification for Mineral Fiber Pipe Insulation**  
Table 721.1(2), Table 721.1(3)
- C549—06(2012): Specification for Perlite Loose Fill Insulation**  
722.3.1.4, 722.4.1.1.3
- C552—2017E1: Standard Specification for Cellular Glass Thermal Insulation**  
Table 1508.2
- C557—2003(2017): Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing**  
Table 2506.2, 2508.4
- C578—2018: Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation**  
Table 1508.2, 2603.10, Table 2603.12.1, Table 2603.12.2, Table 2603.13.1, Table 2603.13.2
- C587—2004(2018): Specification for Gypsum Veneer Plaster**  
Table 2507.2
- C595/C595M—2018: Specification for Blended Hydraulic Cements**  
Table 2507.2
- C631—09(2014): Specification for Bonding Compounds for Interior Gypsum Plastering**  
Table 2507.2
- C635/C635M—2017: Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings**  
2506.2.1
- C636/C636M—13: Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels**  
808.1.1.1
- C652—2017A: Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)**  
1807.1.6.3
- C726—2017: Standard Specification for Mineral Wool Roof Insulation Board**  
Table 1508.2



## ASTM—continued

- C728—2017A: Standard Specification for Perlite Thermal Insulation Board**  
Table 1508.2
- C744—2016: Specification for Prefaced Concrete and Calcium Silicate Masonry Units**  
Table 722.3.2
- C754—2018: Specification for Installation of Steel Framing Members to Receive Screw-attached Gypsum Panel Products**  
Table 2508.1, Table 2511.1.1
- C836/C836M—2018: Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course**  
1507.14.2
- C840—2018A: Specification for Application and Finishing of Gypsum Board**  
Table 2508.1, 2509.2
- C841—2003(2018): Specification for Installation of Interior Lathing and Furring**  
Table 2508.1, Table 2511.1.1
- C842—05(2015): Specification for Application of Interior Gypsum Plaster**  
Table 2511.1.1, 2511.3, 2511.4
- C843—2017: Specification for Application of Gypsum Veneer Plaster**  
Table 2511.1.1
- C844—2015: Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster**  
Table 2508.1
- C847—14a: Specification for Metal Lath**  
Table 2507.2
- C887—13: Specification for Packaged, Dry Combined Materials for Surface Bonding Mortar**  
1805.2.2, 2103.2.2
- C897—15: Specification for Aggregate for Job-mixed Portland Cement-based Plasters**  
Table 2507.2
- C920—2018: Standard for Specification for Elastomeric Joint Sealants**  
703.7, Table 2506.2
- C926—2018B: Specification for Application of Portland Cement-based Plaster**  
2109.2.4.8.6, 2109.2.4.8.8, 2510.3, Table 2511.1.1, 2511.3, 2511.4, 2512.1, 2512.1.2, 2512.2, 2512.6, 2512.8.2, 2512.9, 2513.7
- C932—06(2013): Specification for Surface-applied Bonding Compounds for Exterior Plastering**  
Table 2507.2
- C933—2018: Specification for Welded Wire Lath**  
Table 2507.2
- C946—2018: Standard Practice for Construction of Dry-Stacked, Surface-Bonded Walls**  
2103.2.2, 2114.5
- C954—2018: Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 inch (0.84 mm) to 0.112 inch (2.84 mm) in Thickness**  
Table 2506.2, Table 2507.2
- C956—04(2015): Specification for Installation of Cast-in-place Reinforced Gypsum Concrete**  
2514.1
- C957/C957M—2017: Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane with Integral Wearing Surface**  
1507.14.2
- C1002—2018: Specification for Steel Self-piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs**  
722.7.2.2, Table 2506.2, Table 2507.2
- C1007—11a(2015): Specification for Installation of Load Bearing (Transverse and Axial) Steel Studs and Related Accessories**  
Table 2508.1, Table 2511.1.1
- C1029—15: Specification for Spray-applied Rigid Cellular Polyurethane Thermal Insulation**  
1507.13.2
- C1032—2018: Specification for Woven Wire Plaster Base**  
Table 2507.2

## REFERENCED STANDARDS

### ASTM—continued

- C1047—2018: Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base**  
Table 2506.2, Table 2507.2
- C1063—2018B: Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster**  
2109.2.4.8.5, 2510.3, Table 2511.1.1, 2512.1.1
- C1088—2018: Specification for Thin Veneer Brick Units Made from Clay or Shale**  
Table 721.1(2)
- C1157/C1157M—2017: Standard Performance Specification for Hydraulic Cement**  
Table 2507.2
- C1167—2011(2017): Specification for Clay Roof Tiles**  
1507.3.4
- C1177/C1177M—2017: Specification for Glass Mat Gypsum Substrate for Use as Sheathing**  
Table 1508.2, Table 2506.2
- C1178/C1178M—2018: Specification for Glass Mat Water-resistant Gypsum Backing Panel**  
Table 2506.2, Table 2509.2
- C1186—2008(2016): Specification for Flat Fiber Cement Sheets**  
1403.10, 1404.16.1, 1404.16.2
- C1261—2013(2017)E1: Specification for Firebox Brick for Residential Fireplaces**  
2111.6, 2111.9
- C1278/C1278M—2017: Specification for Fiber-reinforced Gypsum Panels**  
Table 1508.2, Table 2506.2
- C1280—13a: Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing**  
Table 2508.1, 2508.2
- C1283—2015: Practice for Installing Clay Flue Lining**  
2113.9.1, 2113.12
- C1288—2017: Standard Specification for Discrete Nonasbestos Fiber-cement Interior Substrate Sheets**  
Table 2509.2
- C1289—2018: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board**  
Table 1508.2, 2603.10, Table 2603.12.1, Table 2603.12.2
- C1313/C1313M—13: Standard Specification for Sheet Radiant Barriers for Building Construction Applications**  
1510.4
- C1325—2018: Standard Specification for Fiber-mat Reinforced Cementitious Backer Units**  
Table 2509.2
- C1328/C1328M—12: Specification for Plastic (Stucco Cement)**  
Table 2507.2
- C1364—2017: Standard Specification for Architectural Cast Stone**  
2103.1
- C1372—17: Standard Specification for Dry-Cast Segmental Retaining Wall Units**  
1807.2.4
- C1396/C1396M—2017: Specification for Gypsum Board**  
Figure 722.5.1(2), Figure 722.5.1(3), Table 2506.2
- C1492—2003(2016): Standard Specification for Concrete Roof Tile**  
1507.3.5
- C1568—08(2013): Standard Test Method for Wind Resistance of Concrete and Clay Roof Tiles (Mechanical Uplift Resistance Method)**  
1504.3.1.1
- C1569—03(2016): Standard Test Method for Wind Resistance of Concrete and Clay Roof Tiles (Wind Tunnel Method)**  
1504.3.1.2
- C1570—03(2016): Standard Test Method for Wind Resistance of Concrete and Clay Roof Tiles (Air Permeability Method)**  
1504.3.1.3
- C1600/C1600M—2017: Standard Specification for Rapid Hardening Hydraulic Cement**  
Table 2507.2

## ASTM—continued

- C1629/C1629M—2018A: Standard Classification for Abuse-resistant Nondecorated Interior Gypsum Panel Products and Fiber-reinforced Cement Panels**  
403.2.2.1, 403.2.2.2, 403.2.2.4
- C1658/C1658M—2018: Standard Specification for Glass Mat Gypsum Panels**  
Table 2506.2
- C1670/C1670M—2018: Standard Specification for Adhered Manufactured Stone Masonry Veneer Units**  
2103.1
- C1707—18: Standard Specification for Pozzolanic Hydraulic Lime for Structural Purposes**  
2109.2.4.8.7
- C1766—2015: Standard Specification for Factory-laminated Gypsum Panel Products**  
Table 2506.2
- C1788—14: Standard Specification for Non Metallic Plaster Bases (Lath) Used with Portland Cement Based Plaster in Vertical Wall Applications**  
2109.2.4.8.5
- D25—2012(2017): Specification for Round Timber Piles**  
1810.3.2.4, 2303.1.12
- D41/D41M—2011(2016): Specification for Asphalt Primer Used in Roofing, Dampproofing and Waterproofing**  
Table 1507.10.2
- D43/D43M—2000(2018): Specification for Coal Tar Primer Used in Roofing, Dampproofing and Waterproofing**  
Table 1507.10.2
- D56—2016A: Test Method for Flash Point by Tag Closed Cup Tester**  
202
- D86—2017: Test Method for Distillation of Petroleum Products and Liquid Fuels at Atmospheric Pressure**  
202
- D92—12b: Test Method for Flash and Fire Points by Cleveland Open Cup Tester**  
202
- D93—2018: Test Methods for Flash Point by Pensky-Martens Closed Cup Tester**  
202
- D226/D226M—2017: Specification for Asphalt-saturated Organic Felt Used in Roofing and Waterproofing**  
1403.2, 1505.2, 1507.1.1, Table 1507.1.1(1), 1507.3.3, Table 1507.8, 1507.9.5, Table 1507.10.2, 1507.17.3, 1507.17.4.1
- D227/D227M—2003(2018): Specification for Coal-tar-saturated Organic Felt Used in Roofing and Waterproofing**  
Table 1507.10.2
- D312/D312M—2016M: Specification for Asphalt Used in Roofing**  
Table 1507.10.2
- D422—63(2007)e2: Test Method for Particle-size Analysis of Soils**  
1803.5.3
- D448—2012(2017): Standard Classification for Sizes of Aggregate for Road and Bridge Construction**  
1507.12.3
- D450/D450M—2017(2018): Specification for Coal-tar Pitch Used in Roofing, Dampproofing and Waterproofing**  
Table 1507.10.2
- D635—14: Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position**  
2606.4
- D1143/D1143M—2007(2013)E1: Test Methods for Deep Foundations Under Static Axial Compressive Load**  
1810.3.3.1.2
- D1227—13: Specification for Emulsified Asphalt Used as a Protective Coating for Roofing**  
Table 1507.10.2
- D1557—12e1: Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lb/ft<sup>3</sup> (2,700 kN m/m<sup>3</sup>)]**  
1705.6, 1804.6
- D1863/D1863M—2005(2018): Specification for Mineral Aggregate Used on Built-up Roofs**  
Table 1504.9, Table 1507.10.2
- D1929—16: Standard Test Method for Determining Ignition Temperature of Plastics**  
402.6.4.4, 406.7.2, 2606.4

## REFERENCED STANDARDS

### ASTM—continued

- D1970/D1970M—2017A: Specification for Self-adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roof Underlayment for Ice Dam Protection**  
1507.1.1, 1507.3.9, 1507.5.7, 1507.8.8, 1507.9.9, 1507.11.2.1, 1507.17.4.1
- D2178/D2178M—15A: Specification for Asphalt Glass Felt Used in Roofing and Waterproofing**  
Table 1507.10.2
- D2487—2017: Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)**  
Table 1610.1, 1803.5.1
- D2626/D2626M—04(2012)e1: Specification for Asphalt Saturated and Coated Organic Felt Base Sheet Used in Roofing**  
Table 1507.1.1(1), 1507.3.3, Table 1507.10.2
- D2822/D2822M—2005(2011): Specification for Asphalt Roof Cement, Asbestos Containing**  
Table 1507.10.2
- D2823/D2823M—05(2011)e1: Specification for Asphalt Roof Coatings, Asbestos Containing**  
Table 1507.10.2
- D2824/D2824M—2018: Standard Specification for Aluminum-pigmented Asphalt Roof Coatings, Nonfibered and Fibered without Asbestos**  
Table 1507.10.2
- D2843—16: Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics**  
2606.4
- D2859—2016: Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials**  
804.4.1, 804.4.2
- D2898—2010(2017): Test Methods for Accelerated Weathering of Fire-retardant-treated Wood for Fire Testing**  
1505.1, 2303.2.4, 2303.2.6
- D3019/D3019M—2017: Specification for Lap Cement Used with Asphalt Roll Roofing, Nonfibered, Asbestos Fibered and Nonasbestos Fibered**  
Table 1507.10.2
- D3161/D3161M—2016A: Test Method for Wind Resistance of Steep Slope Roofing Products (Fan Induced Method)**  
1504.2, Table 1504.2, 1504.4.3
- D3200—1974(2017): Standard Specification and Test Method for Establishing Recommended Design Stresses for Round Timber Construction Poles**  
2303.1.12
- D3201/D3201M—13: Test Method for Hygroscopic Properties of Fire-retardant Wood and Wood-base Products**  
2303.2.7
- D3278—96(2011): Test Methods for Flash Point of Liquids by Small Scale Closed-cup Apparatus**  
202
- D3462/D3462M—2016: Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules**  
1507.2.4
- D3468/D3468M—99(2013)e1: Specification for Liquid-applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing**  
1507.14.2
- D3498—03(2011): Standard Specification for Adhesives for Field-Gluing Plywood to Lumber Framing for Floor Systems**  
703.7
- D3679—2017: Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding**  
1403.9, 1404.14
- D3689/D3689M—07(2013)e1: Test Methods for Deep Foundations under Static Axial Tensile Load**  
1810.3.3.1.5
- D3737—2018E1: Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)**  
2303.1.3
- D3746/D3746M—1985(2015)E1: Test Method for Impact Resistance of Bituminous Roofing Systems**  
1504.8
- D3747—79(2007): Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation**  
Table 1507.10.2
- D3909/D3909M—14: Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules**  
1507.2.8.2, 1507.6.5, Table 1507.10.2



## ASTM—continued

- D3957—2009(2015): Standard Practices for Establishing Stress Grades for Structural Members Used in Log Buildings**  
2303.1.11
- D4022/D4022M—07(2012)e1: Specification for Coal Tar Roof Cement, Asbestos Containing**  
Table 1507.10.2
- D4272—15: Test Method for Total Energy Impact of Plastic Films by Dart Drop**  
1504.8
- D4318—10e1: Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils**  
1803.5.3
- D4434/D4434M—2015: Specification for Poly (Vinyl Chloride) Sheet Roofing**  
Table 1507.12.2
- D4479/D4479M—2007(2018): Specification for Asphalt Roof Coatings—Asbestos-free**  
Table 1507.10.2
- D4586/D4586M—2007(2018): Specification for Asphalt Roof Cement—Asbestos-free**  
Table 1507.10.2
- D4601/D4601M—04(2012)e1: Specification for Asphalt-coated Glass Fiber Base Sheet Used in Roofing**  
Table 1507.10.2, 1507.11.2.1
- D4637/D4637M—2015: Specification for EPDM Sheet Used in Single-ply Roof Membrane**  
Table 1507.12.2
- D4829—11: Test Method for Expansion Index of Soils**  
1803.5.3
- D4869/D4869M—2016A: Specification for Asphalt-saturated (Organic Felt) Underlayment Used in Steep Slope Roofing**  
1507.1.1, Table 1507.1.1(1), 1507.17.3, 1507.17.4.1
- D4897/D4897M—2016: Specification for Asphalt-coated Glass Fiber Venting Base Sheet Used in Roofing**  
Table 1507.10.2
- D4945—2017: Test Method for High-strain Dynamic Testing of Deep Foundations**  
1705.10, 1810.3.3.1.2
- D4990—97a(2013): Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing**  
Table 1507.10.2
- D5019—07a: Specification for Reinforced Nonvulcanized Polymeric Sheet Used in Roofing Membrane**  
Table 1507.12.2
- D5055—2016: Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-joists**  
2303.1.2
- D5456—2018: Specification for Evaluation of Structural Composite Lumber Products**  
2303.1.10
- D5516—2018: Test Method of Evaluating the Flexural Properties of Fire-retardant Treated Softwood Plywood Exposed to Elevated Temperatures**  
2303.2.5.1
- D5643/D5643M—2006(2018): Specification for Coal Tar Roof Cement, Asbestos-free**  
Table 1507.10.2
- D5664—2017: Test Methods for Evaluating the Effects of Fire-retardant Treatments and Elevated Temperatures on Strength Properties of Fire-retardant-treated Lumber**  
2303.2.5.2
- D5665/D5665M—99a(2014)e1: Specification for Thermoplastic Fabrics Used in Cold-applied Roofing and Waterproofing**  
Table 1507.10.2
- D5726—98(2013): Specification for Thermoplastic Fabrics Used in Hot-applied Roofing and Waterproofing**  
Table 1507.10.2
- D5882—16: Standard Test Method for Low Strain Impact Integrity Testing of Deep Foundations**  
1705.10
- D6083/D6083M—2018: Specification for Liquid Applied Acrylic Coating Used in Roofing**  
Table 1507.10.2, Table 1507.13.3
- D6162/D6162M—2016: Specification for Styrene-butadiene-styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements**  
1507.11.2

## REFERENCED STANDARDS

### ASTM—continued

- D6163/D6163M—2016: Specification for Styrene-butadiene-styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements**  
1507.11.2
- D6164/D6164M—2016: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements**  
1507.11.2
- D6222/D6222M—2016: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements**  
1507.11.2
- D6223/D6223M—2016: Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements**  
1507.11.2
- D6298—2016: Specification for Fiberglass Reinforced Styrene-butadiene-styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface**  
1507.11.2
- D6305—08(2015)e1: Practice for Calculating Bending Strength Design Adjustment Factors for Fire-retardant-treated Plywood Roof Sheathing**  
2303.2.5.1
- D6380/D6380M—2003(2018): Standard Specification for Asphalt Roll Roofing (Organic Felt)**  
Table 1507.1.1(1), 1507.2.8.2, 1507.3.3, 1507.6.5
- D6464—2003A(2017): Standard Specification for Expandable Foam Adhesives for Fastening Gypsum Wallboard to Wood Framing**  
Table 2506.2, 2508.4
- D6509/D6509M—2016: Standard Specification for Atactic Polypropylene (APP) Modified Bituminous Base Sheet Materials Using Glass Fiber Reinforcements**  
1507.11.2
- D6694/D6694M—08(2013)E1: Standard Specification for Liquid-applied Silicone Coating Used in Spray Polyurethane Foam Roofing Systems**  
Table 1507.13.3
- D6754/D6754M—2015: Standard Specification for Ketone Ethylene Ester Based Sheet Roofing**  
Table 1507.12.2
- D6757/D6757M—2018: Specification for Underlayment Felt Containing Inorganic Fibers Used in Steep Slope Roofing**  
1507.1.1, Table 1507.1.1(1), 1507.17.3, 1507.17.4.1
- D6760—16: Standard Test Method for Integrity Testing of Concrete Deep Foundations by Ultrasonic Crosshole Testing**  
1705.10
- D6841—2016: Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-retardant Treated Lumber**  
2303.2.5.2
- D6878/D6878M—2017: Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing**  
Table 1507.12.2
- D6947/D6947M—2016: Standard Specification for Liquid Applied Moisture Cured Polyurethane Coating Used in Spray Polyurethane Foam Roofing System**  
Table 1507.13.3
- D7032—2017: Standard Specification for Establishing Performance Ratings for Wood-plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails)**  
705.2.3.1, 2612.2, 2612.4, 2612.5.1
- D7147—2011(2018): Specification for Testing and Establishing Allowable Loads of Joist Hangers**  
2303.5, 2304.10.4
- D7158/D7158M—2019: Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)**  
1504.2, Table 1504.2
- D7254—2017: Standard Specification for Polypropylene (PP) Siding**  
1403.12
- D7425/D7425M—13: Standard Specification for Spray Polyurethane Foam Used for Roofing Applications**  
1507.13.2
- D7655/D7655M—2012(2017): Standard Classification for Size of Aggregate Used as Ballast for Roof Membrane Systems**  
1507.12.3

## ASTM—continued

- D7672—14E1: Standard Specification for Evaluating Structural Capacities of Rim Board Products and Assemblies**  
2303.1.13
- D7949—14: Standard Test Methods for Thermal Integrity Profiling of Concrete Deep Foundations**  
1705.10
- E84—2018B: Standard Test Methods for Surface Burning Characteristics of Building Materials**  
202, 402.6.4.4, 406.7.2, 424.2, 602.4.1.1, 602.4.2.1, 602.4.3.1, 720.1, 720.4, 803.1.2, 803.5.2, 803.10, 803.11, 803.12, 803.13, 806.7, 1402.5, 1403.12.1, 1406.9, 1406.10.1, 1408.9, 1408.10.1, 1511.6.2, 1511.6.3, 2303.2, 2603.3, 2603.4.1.13, 2603.5.4, 2603.5.5, 2603.7, 2604.2.4, 2606.4, 2612.3, 2614.3, 3105.3
- E90—2009(2016): Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements**  
1206.2, 1206.2.1
- E96/E96M—2016: Standard Test Methods for Water Vapor Transmission of Materials**  
202, 1202.3, 1404.3
- E108—2017: Standard Test Methods for Fire Tests of Roof Coverings**  
1505.1, 2603.6, 2610.2, 2610.3
- E119—2018B: Standard Test Methods for Fire Tests of Building Construction and Materials**  
703.2.1.1, 703.2.1.3, 703.2.1.4, 703.2.1.5, 703.2.2, 703.4, 703.6, 704.12, 705.7, 705.8.5, 707.6, 712.1.13.2, 714.4.1, 714.5.1, 715.3, 715.4, 715.4.1, Table 716.1(1), Table 716.1(2), Table 716.1(3), 716.1.2.3, 716.2.5.1.1, 716.2.5.4, 716.3.2.1.1, 717.3.1, 717.5.2, 717.5.3, 717.6.1, 717.6.2, Table 721.1(1), 2103.1, 2603.5.1
- E136—2019: Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C**  
703.3.1
- E283—2004(2012): Test Method for Determining Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences across the Specimen**  
202
- E330/E330M—14: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference**  
1709.5.2, 1709.5.2.1, 1709.5.3.1
- E331—2000(2016): Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference**  
1402.2, 1403.2
- E336—17a: Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings**  
1206.2
- E492—2009(2016)E1: Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-ceiling Assemblies Using the Tapping Machine**  
1206.3
- E605/E605M—93(2015)e1: Test Method for Thickness and Density of Sprayed Fire-resistive Material (SFRM) Applied to Structural Members**  
1705.15.4.1, 1705.15.4.2, 1705.15.4.5, 1705.15.5
- E648—2017A: Standard Test Method for Critical Radiant Flux of Floor-covering Systems Using a Radiant Heat Energy Source**  
406.2.4, 424.2, 804.2, 804.3
- E681—09(2015): Test Methods for Concentration Limits of Flammability of Chemical Vapors and Gases**  
202
- E736/E736M—2017: Test Method for Cohesion/Adhesion of Sprayed Fire-resistive Materials Applied to Structural Members**  
704.13.3.2, 1705.15.6
- E814—2013A(2017): Test Method for Fire Tests of Penetration Firestop Systems**  
202, 714.4.1.2, 714.4.2, 714.5.1.2
- E970—2017: Standard Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source**  
720.3.1
- E1007—16: Test Method for Field Measurement of Tapping Machine Impact Sound Transmission through Floor-Ceiling Assemblies and Associated Support Structures**  
1206.3
- E1300—2016: Practice for Determining Load Resistance of Glass in Buildings**  
2404.1, 2404.2, 2404.3.1, 2404.3.2, 2404.3.3, 2404.3.4, 2404.3.5

## REFERENCED STANDARDS

### ASTM—continued

- E1354—2017: Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter**  
424.2, 602.4.1.1, 602.4.2.1, 602.4.3.1, 1402.5
- E1592—2005(2017): Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference**  
1504.4.2
- E1602—2003(2017): Guide for Construction of Solid Fuel-burning Masonry Heaters**  
2112.2
- E1886—2013A: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials**  
1609.2, 1709.5.3.1
- E1966—2017: Standard Test Method for Fire-resistive Joint Systems**  
202, 715.3.1, 1709.5.3.1
- E1996—2017: Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes**  
1609.2, 1609.2.2, 1709.5.3.1
- E2072—14: Standard Specification for Photoluminescent (Phosphorescent) Safety Markings**  
1025.4
- E2174—2018: Standard Practice for On-site Inspection of Installed Fire Stops**  
1705.18.1
- E2178—13: Standard Test Method for Air Permeance of Building Materials**  
202
- E2273—2018: Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies**  
1407.4.1, 2510.6.2
- E2307—15BE1: Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using the Intermediate-scale, Multistory Test Apparatus**  
715.4
- E2353—2016: Standard Test Methods for Performance of Glazing in Permanent Railing Systems, Guards and Balustrades**  
2407.1.2
- E2392 / E2392M—10(2016): Standard Guide for Design of Earthen Wall Building Systems**  
2109.2.4.8.9.2
- E2393—10a(2015): Standard Practice for On-site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers**  
1705.18.2
- E2404—2017: Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) and Wood Wall or Ceiling Coverings, Facing and Veneers to Assess Surface Burning Characteristics**  
803.5.2, 803.12, 1402.5
- E2556/E2556M—2010(2016): Standard Specification for Vapor Permeable Flexible Sheet Water-resistive Barriers Intended for Mechanical Attachment**  
1403.2, 2510.6.1
- E2568—2017A: Standard Specification for PB Exterior Insulation and Finish Systems**  
1407.2
- E2570/E2570M—07(2014)e1: Standard Test Method for Evaluating Water-resistive Barrier (WRB) Coatings Used under Exterior Insulation and Finish Systems (EIFS) for EIFS with Drainage**  
1407.4.1.1, 1705.17.1
- E2573—2017: Standard Practice for Specimen Preparation and Mounting of Site-fabricated Stretch Systems to Assess Surface Burning Characteristics**  
803.10
- E2579—2015: Standard Practice for Specimen Preparation and Mounting of Wood Products to Assess Surface Burning Characteristics**  
803.11
- E2599—2018: Standard Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics**  
2614.3



## REFERENCED STANDARDS

## ASTM—continued

- E2634—2018: Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems**  
1903.4
- E2652—16: Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer at 750°C**  
703.3.1
- E2751/E2751M—2017A: Practice for Design and Performance of Supported Laminated Glass Walkways**  
2409.1
- E2925—17: Standard Specification for Manufactured Polymeric Drainage and Ventilation Materials Used to Provide a Rainscreen Function**  
2510.6.2
- F547—2017: Terminology of Nails for Use with Wood and Wood-base Materials**  
Table 2506.2
- F1667—2018: Specification for Driven Fasteners: Nails, Spikes and Staples**  
Table 721.1(2), Table 721.1(3), 1507.2.5, 1507.16.5, 2303.6, Table 2304.10.2, 2304.10.6, Table 2506.2, Table 2603.13.1, Table 2603.13.2
- F2006—17: Standard/Safety Specification for Window Fall Prevention Devices for Nonemergency Escape (Egress) and Rescue (Ingress) Windows**  
1015.8
- F2090—17: Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms**  
1015.8, 1015.8.1
- F2200—2017: Standard Specification for Automated Vehicular Gate Construction**  
3110.2
- G152—13: Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials**  
1504.7
- G154—2016A: Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials**  
1504.7
- G155—13: Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials**  
1504.7

---

**AWC**

American Wood Council  
222 Catocin Circle SE, Suite 201  
Leesburg, VA 20175

- ANSI/AWC NDS—2018: National Design Specification (NDS) for Wood Construction—with 2018 NDS Supplement**  
202, 722.1, Table 1604.3, 1809.12, 1810.3.2.4, Table 1810.3.2.6, 1905.1.8, 2304.13, 2306.1, Table 2306.2(1), Table 2306.2(2), Table 2306.3(1), Table 2306.3(2), 2307.1, Table 2603.13.2
- ANSI/AWC PWF—2021: Permanent Wood Foundation Design Specification**  
1805.2, 1807.1.4, 2304.10.6.2
- ANSI/AWC SDPWS—2021: Special Design Provisions for Wind and Seismic**  
202, 2305.1, 2305.2, 2305.3, 2306.1, 2306.2, 2306.3, Table 2306.3(1), Table 2306.3(3), 2307.1
- ANSI/AWC WFCM—2018: Wood Frame Construction Manual for One- and Two-Family Dwellings**  
1609.1.1, 1609.1.1.1, 2302.1, 2308.2.4, 2308.6.7.2, 2309.1
- AWC STJR—2021: Span Tables for Joists and Rafters**  
2306.1.1, 2308.4.2.1, 2308.7.1, 2308.7.2
- AWC WCD No. 4—2003: Wood Construction Data—Plank and Beam Framing for Residential Buildings**  
2306.1.2

---

**AWCI**

Association of the Wall and Ceiling Industry  
513 West Broad Street, Suite 210  
Falls Church, VA 22046

- 12-B—14: Technical Manual 12B, Third Edition; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-resistive Materials; an Annotated Guide**  
1705.16

## REFERENCED STANDARDS

### AWPA

American Wood Protection Association  
P.O. Box 361784  
Birmingham, AL 35236-1784

**C1—03: All Timber Products—Preservative Treatment by Pressure Processes**  
1505.6

**M4—15: Standard for the Care of Preservative-treated Wood Products**  
1810.3.2.4.1, 2303.1.9

**U1—20: USE CATEGORY SYSTEM: User Specification for Treated Wood Except Commodity Specification H**  
Table 1507.9.6, 1807.1.4, 1807.3.1, 1809.12, 1810.3.2.4.1, 2303.1.9, 2304.12.1, 2304.12.2, 2304.12.2.6, 2304.12.2.7, 2304.12.2.8

### AWS

American Welding Society  
8669 NW 36 Street, #130  
Miami, FL 33166-6672

**D1.4/D1.4M—2018: Structural Welding Code—Steel Reinforcing Bars**  
1704.5, Table 1705.3, 1705.3.1, 2107.3

### BHMA

Builders Hardware Manufacturers' Association  
355 Lexington Avenue, 15th Floor  
New York, NY 10017

**A156.10—2017: Power Operated Pedestrian Doors**  
1010.3.2

**A156.19—2020: Standard for Power Assist and Low Energy Power Operated Doors**  
1010.3.2

**A156.27—2019: Power and Manual Operated Revolving Pedestrian Doors**  
1010.3.1.1

**A156.38—2020: Low Energy Power Operated Sliding and Folding Doors**  
1010.3.2

### CEN

European Committee for Standardization (CEN)  
Rue de la Science 23  
Brussels, Belgium 1000

**BS EN 15250—2007: Slow Heat Release Appliances Fired by Solid Fuel Requirements and Test Methods**  
2112.2, 2112.5

**EN 1081—98: Resilient Floor Coverings—Determination of the Electrical Resistance**  
406.7.1

### CPA

Composite Panel Association  
19465 Deerfield Avenue, Suite 306  
Leesburg, VA 20176

**ANSI A135.4—2012: Basic Hardboard**  
1403.3.1, 2303.1.7

**ANSI A135.5—2012: Prefinished Hardboard Paneling**  
2303.1.7, 2304.7

**ANSI A135.6—2012: Engineered Wood Siding**  
1403.3.2, 2303.1.7

**ANSI A208.1—2016: Particleboard**  
2303.1.8, 2303.1.8.1

---

## CPSC

Consumer Product Safety Commission  
4330 East/West Highway  
Bethesda, MD 20814

- 16 CFR Part 1201 (2002): Safety Standard for Architectural Glazing Material**  
2406.2, Table 2406.2(1), 2406.3.1, 2407.1, 2407.1.4, 2408.2.1, 2408.3, 2409.2, 2409.4.1
- 16 CFR Part 1209 (2002): Interim Safety Standard for Cellulose Insulation**  
720.6
- 16 CFR Part 1404 (2002): Cellulose Insulation**  
720.6
- 16 CFR Part 1500 (2009): Hazardous Substances and Articles; Administration and Enforcement Regulations**  
202
- 16 CFR Part 1500.44 (2009): Method for Determining Extremely Flammable and Flammable Solids**  
202
- 16 CFR Part 1507 (2002): Fireworks Devices**  
202
- 16 CFR Part 1630 (2007): Standard for the Surface Flammability of Carpets and Rugs**  
804.4.1

---

## CSA

Canadian Standards Association  
8501 East Pleasant Valley Road  
Cleveland, OH 44131

- AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specifications for Windows, Doors and Unit Skylights**  
1709.5.1, 2405.5
- ASME A17.1—2019/CSA B44—2019: Safety Code for Elevators and Escalators**  
907.3.3, 911.1.6, 1009.4.1, 1607.11.1, 3001.2, Table 3001.3, 3001.5, 3002.5, 3003.2, 3007.1, 3008.1.4, 3008.7.1
- ASME A17.7—2007/CSA B44.7—07(R2017): Performance-based Safety Code for Elevators and Escalators**  
Table 3001.3, 3001.5, 3002.5

---

## CSSB

Cedar Shake & Shingle Bureau  
P. O. Box 1178  
Sumas, WA 98295-1178

- CSSB—97: Grading and Packing Rules for Western Red Cedar Shakes and Western Red Shingles of the Cedar Shake and Shingle Bureau**  
Table 1507.8.5, Table 1507.9.6

---

## DASMA

Door & Access Systems Manufacturers Association International  
1300 Sumner Avenue  
Cleveland, OH 44115

- ANSI/DASMA 107—2017: Room Fire Test Standard for Garage Doors Using Foam Plastic Insulation**  
2603.4.1.9
- ANSI/DASMA 108—2017: Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference**  
1709.5.2.1
- ANSI/DASMA 115—2017: Standard Method for Testing Sectional Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure**  
1609.2.3

## REFERENCED STANDARDS

### DHA

Decorative Hardwoods Association  
42777 Trade West Dr  
Sterling, VA 20166

**ANSI/HPVA HP-1—2016: American National Standard for Hardwood and Decorative Plywood**  
2303.3, 2304.7

### DOC

U.S. Department of Commerce  
National Institute of Standards and Technology  
100 Bureau Drive  
Gaithersburg, MD 20899

**PS 1—19: Structural Plywood**  
2303.1.5, 2304.7, Table 2304.8(4), Table 2304.8(5), Table 2306.2(1), Table 2306.2(2)

**PS 2—18: Performance Standard for Wood-based Structural-use Panels**  
2303.1.5, 2304.7, Table 2304.8(5), Table 2306.2(1), Table 2306.2(2)

**PS 20—05: American Softwood Lumber Standard**  
202, 1810.3.2.4, 2303.1.1

### DOL

U.S. Department of Labor  
Occupational Safety and Health Administration  
c/o Superintendent of Documents  
U.S. Government Printing Office  
Washington, DC 20210

**29 CFR Part 1910.1000 (2015): Air Contaminants**  
202

### DOTn

U.S. Department of Transportation  
Office of Hazardous Material Safety  
1200 New Jersey Avenue, SE  
East Building, 2nd Floor  
Washington, DC 20590

**49 CFR 173.192—2011: Packaging for Certain Toxic Gases in Hazard Zone A**  
Table 415.6.5

**49 CFR Parts 100–185—2015: Hazardous Materials Regulations**  
202

**49 CFR Parts 173–178—2015: Specification of Transportation of Explosive and Other Dangerous Articles, UN 0335, UN 0336 Shipping Containers**  
202

**49 CFR Parts 173.137—(2009): Shippers—General Requirements for Shipments and Packaging—Class 8—Assignment of Packing Group**  
202

### EN

European Committee for Standardization  
Rue de la Science 23 B  
Brussels, Belgium 1040 Belgium

**EN 459-1—15: Building Lime. Definitions, Specifications and Conformity Criteria**  
2109.2.4.8.7

### FEMA

Federal Emergency Management Agency  
500 C Street S.W.  
Washington, DC 20472

**FEMA-TB-11—01: Crawlspace Construction for Buildings Located in Special Flood Hazard Areas**  
1805.1.2.1



---

**FM**

FM Approvals  
Headquarters Office  
1151 Boston-Providence Turnpike  
P.O. Box 9102  
Norwood, MA 02062

**4430—2012: Approval Standard for Heat and Smoke Vents**

910.3.1

**4450—(1989): Approval Standard for Class 1 Insulated Steel Deck Roofs—with Supplements through July 1992**

1510.2

**4470—2016: Approval Standard for Single-ply Polymer-modified Bitumen Sheet, Built-up Roof (BUR) and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction**

1504.8

**4474—2011: American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures**

1504.4.1, 1504.4.2, 1504.4.3

**4880—2017: American National Standard for Evaluating the Fire Performance Insulated Building Panel Assemblies and Interior Finish Materials**

2603.4, 2603.9

---

**GA**

Gypsum Association  
962 Wayne Avenue, Suite 620  
Silver Spring, MD 20910

**GA-216—2018: Application and Finishing of Gypsum Panel Products**

Table 2508.1, 2509.2

**GA-600—2018: Fire-resistance and Sound Control Design Manual, 22nd Edition**

Table 721.1(1), Table 721.1(2), Table 721.1(3)

---

**ICC**

International Code Council, Inc.  
500 New Jersey Ave NW 6th Floor  
Washington, DC 20001

**ICC 300—17: ICC Standard on Bleachers, Folding and Telescopic Seating and Grandstands**

1030.1.1, 1030.7, 1607.19

**ICC 400—17: Standard on Design and Construction of Log Structures**

2302.1

**ICC 500—2020: ICC/NSSA Standard for the Design and Construction of Storm Shelters**

202, 423.1, 423.2, 423.3.1, 423.3.2, 423.4, 423.5, 1031.2, 1604.5.1, 1604.10

**ICC 600—2020: Standard for Residential Construction in High-wind Regions**

1609.1.1, 1609.1.1.1, 2308.2.4

**ICC 900/SRCC 300—2020: Solar Thermal System Standard**

3111.2.1

**ICC 901/SRCC 100—2020: Solar Thermal Collector Standard**

3111.2.1

**ICC 1100—18: Standard for Spray-applied Foam Plastic Insulation**

2603.1.1

**ICC A117.1—17: Accessible and Usable Buildings and Facilities**

202, 907.5.2.3.3, 1009.8.2, 1009.9, 1009.11, 1010.2.13.1, 1012.1, 1012.6.5, 1012.10, 1013.4, 1023.9, 1102.1, 1108.2, 1110.1, 1110.2, 1110.5.1, 1110.5.2, 1112.3, 1112.4, 1112.5, 1112.5.2, 1207.1

**IEBC—21: International Existing Building Code®**

101.4.7, 102.6, 116.5, 201.3, Table 504.3, Table 504.4, 2701.1, 2801.1, 3113.1.1

**IECC—21: International Energy Conservation Code®**

101.4.6, 201.3, 202, 1202.1, 1202.4.3.2, 1301.1.1

## REFERENCED STANDARDS

### ICC—continued

#### IFC—21: International Fire Code®

101.4.5, 102.6, 102.6.2, 201.3, 202, 307.1, Table 307.1(1), Table 307.1(2), 307.1.1, 403.4.5, 404.2, 406.2.9, 406.6.4.4, 406.7, 406.8, 407.4, 410.2.6, 411.1, 412.1, 412.5.1, 413.1, 414.1.1, 414.1.2, 414.1.2.1, 414.2, Table 414.2.5(1), Table 414.2.5(2), 414.2.5.1, 414.2.5.2, 414.2.5.3, 414.3, 414.5, 414.5.1, Table 414.5.1, 414.5.2, 414.5.3, 414.6, 415.2, 415.6.1, 415.6.2, 415.6.3, 415.6.4, 415.6.4.1, 415.6.4.4, Table 415.6.5, 415.8.2, 415.9, 415.9.1, 415.9.1.3, 415.9.1.4, 415.9.1.6, 415.9.1.7, 415.9.1.8, 415.9.2, 415.9.3, 415.10, 415.11, 415.11.1.7, 415.11.5, 415.11.8.2, 415.11.10.3, 415.11.11.1, 416.1, 416.2.3, 416.4, 419.1, 422.3.1, 426.1, 426.1.4, 427.1, 427.2.3, 428.1, 428.2, 428.3, Table 504.3, Table 504.4, Table 506.2, 507.4, 507.8.1.1.1, 507.8.1.1.2, 507.8.1.1.3, Table 509.1, 705.8.1, 707.1, 707.4, Table 716.1(2), 716.2.5.4.1, 716.3.2.1.1.1, 806.3, 901.2, 901.3, 901.5, 901.6.3, 901.6.4, 903.2.7.1, Table 903.2.11.6, 903.2.12, 903.5, 904.2.2, 904.11.3, 905.1, 905.3.6, 905.3.7, 906.1, Table 906.1, 906.4, 907.1.1, 907.2.5, 907.2.6, 907.2.8, 907.2.13.2, 907.2.15, 907.2.16, 907.2.23, 907.5.2.2, 907.6.6, 907.6.6.3, 907.8, 909.6.3, 909.12.1, 909.19, 909.20, 910.2.2, 910.5, 912.4.3, 915.1, 915.6, 916.7, 916.11, 918.1, 1002.1, 1002.2, 1010.2.14, 1202.5.2, 1202.6, 1507.15, 1512.1, Table 1604.5, 2603.4.1.12, 2701.1, 2702.1.3, 2702.2.3, 2702.2.7, 2702.2.10, 2702.2.13, 2702.2.15, 2702.4, 3003.3, 3008.1.3, 3102.1, 3102.8.3, 3103.1, 3111.1.2, 3111.2, 3111.3, 3111.3.4, 3111.3.5, 3302.3, 3303.7, 3309.2

#### IFGC—21: International Fuel Gas Code®

101.4.1, 201.3, Table 307.1(1), 415.9.2, 2113.11.1.2, 2113.15, 2702.2.6, 2801.1

#### IMC—21: International Mechanical Code®

101.4.2, 201.3, Table 307.1(1), 406.2.9, 406.6.2, 406.8.1, 407.2.7, 409.3, 412.5.6, 414.1.2, 414.3, 415.9.1, 415.9.2, 415.9.3, 415.11.12, 416.2.3, 420.9, 420.10, 420.11.1, 421.4, 422.7, 426.1.4, 427.2.2, 427.2.3, 602.4.2.5, 602.4.3.5, 602.4.4.3, 603.1, 603.1.1, 603.1.2, 712.1.6, 715.4, 715.7, 717.2.2, 717.5.2, 717.5.3, 717.6.1, 717.6.2, 717.6.3, 718.5, 720.1, 720.7, 903.2.11.4, 904.2.2, 904.13, 907.3.1, 909.1, 909.10.2, 909.13.1, 910.4.7, 1006.2.2.3, 1011.16, 1020.6.1, 1202.1, 1202.2.2, 1202.4.3.2, 1202.5.2.1, 1202.6, 1209.3, 2702.2.5, 2801.1, 3111.2

#### IPC—21: International Plumbing Code®

101.4.3, 201.3, 415.9.3, 603.1.2, 718.5, 903.3.5, 1205.3.3, 1503.4, 1805.4.3, 2901.1, Table 2902.1, 3111.2, 3305.1

#### IPMC—21: International Property Maintenance Code®

101.4.4, 102.6, 102.6.2, 103.3, 2701.1, 2801.1

#### IPSDC—21: International Private Sewage Disposal Code®

101.4.3, 2901.1

#### IRC—21: International Residential Code®

101.2, 102.6.1, 104.2.1, 110.3.3, 305.2.3, 308.2.4, 308.3.2, 308.5.4, 310.1, 310.4.1, 310.4.2, 2308.1

#### ISPSC—21: International Swimming Pool and Spa Code®

3109.1

#### IWUIC—21: International Wildland-Urban Interface Code®

Table 1505.1

#### SBCCI SSTD 11—97: Test Standard for Determining Wind Resistance of Concrete or Clay Roof Tiles

1504.3.1.1, 1504.3.1.2, 1504.3.1.3

## ISO

International Organization for Standardization  
Chemin de Blandonnet 8  
CP 401 1214 Vernier  
Geneva, Switzerland

#### ISO 668—2013: Series 1 Freight Containers—Classifications, Dimensions and Ratings

Table 3115.8.5.3

#### ISO 1496-1—2013: Series 1 Freight Containers—Specification and Testing - Part 1: General Cargo Containers for General Purposes

3115.8, Table 3115.8.5.3

#### ISO 6346—1995: Freight Containers—Code, Identification and Marking with Amendment 3 - 2012

3115.3

#### ISO 8115—86: Cotton Bales—Dimensions and Density

Table 307.1(1), Table 415.11.1.1.1

#### ISO 8336—09: Fiber-cement Flat Sheets—Product Specification and Test Methods

1403.10, 1404.16.1, 1404.16.2, Table 2509.2

---

## MHI

Material Handling Institute  
8720 Red Oak Blvd. Suite 201  
Charlotte, NC 28217

**ANSI MH29.1—08: Safety Requirements for Industrial Scissors Lifts**  
Table 3001.3

**ANSI/MH16.1—12: Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks**  
Table 1705.13.7

---

## NAAMM

National Association of Architectural Metal Manufacturers  
800 Roosevelt Road, Bldg. C, Suite 312  
Glen Ellyn, IL 60137

**FP 1001—18: Guide Specifications for Design of Metal Flag Poles**  
1609.1.1

---

## NCMA

National Concrete Masonry Association  
13750 Sunrise Valley  
Herndon, VA 20171

**TEK 5—8B(2005): Detailing Concrete Masonry Fire Walls**  
Table 721.1(2)

---

## NFPA

National Fire Protection Association  
1 Batterymarch Park  
Quincy, MA 02169-7471

**04—21: Standard for Integrated Fire Protection and Life Safety System Testing**  
901.6.2.1, 901.6.2.2

**10—21: Standard for Portable Fire Extinguishers**  
906.2, Table 906.3(1), Table 906.3(2), 906.3.2, 906.3.4

**11—16: Standard for Low-, Medium, and High Expansion Foam**  
904.7

**12—15: Standard on Carbon Dioxide Extinguishing Systems**  
904.8, 904.13

**12A—18: Standard on Halon 1301 Fire Extinguishing Systems**  
904.9

**13—19: Standard for Installation of Sprinkler Systems**  
403.3.3, 712.1.3.1, 903.3.1.1, 903.3.2, 903.3.8.2, 903.3.8.5, 904.13, 905.3.4, 907.6.4, 1019.3

**13D—19: Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes**  
903.3.1.3

**13R—19: Standard for the Installation of Sprinkler Systems in Low-rise Residential Occupancies**  
903.3.1.2, 903.3.5.2, 903.4

**14—19: Standard for the Installation of Standpipe and Hose System**  
905.2, 905.3.4, 905.4.2, 905.6.2, 905.8

**16—19: Standard for the Installation of Foam-water Sprinkler and Foam-water Spray Systems**  
904.7, 904.13

**17—20: Standard for Dry Chemical Extinguishing Systems**  
904.6, 904.13

**17A—20: Standard for Wet Chemical Extinguishing Systems**  
904.5, 904.13

**20—19: Standard for the Installation of Stationary Pumps for Fire Protection**  
412.2.4.1, 913.1, 913.2, 913.2.1, 913.5

**30—21: Flammable and Combustible Liquids Code**  
415.6.1, 415.6.2, 507.8.1.1.1, 507.8.1.1.2

## REFERENCED STANDARDS

### NFPA—continued

- 30A—21: Code for Motor Fuel Dispensing Facilities and Repair Garages**  
406.2.9.2
- 31—20: Standard for the Installation of Oil-burning Equipment**  
2113.15
- 32—16: Standard for Dry Cleaning Facilities**  
415.9.3
- 40—19: Standard for the Storage and Handling of Cellulose Nitrate Film**  
409.1
- 45—19: Standard on Fire Protection Laboratories Using Chemicals**  
428.3.7
- 58—20: Liquefied Petroleum Gas Code**  
415.9.2
- 61—20: Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Product Facilities**  
426.1
- 70—20: National Electrical Code**  
108.3, 406.2.7, 406.2.9, 412.5.7, 415.11.1.8, Table 509.1, 904.3.1, 907.6.1, 909.12.2, 909.16.3, 910.4.6, 1204.4.1, 2701.1, 2702.1.3, 3111.3
- 72—19: National Fire Alarm and Signaling Code**  
407.4.4.5, 407.4.4.5.1, 901.6, 903.4.1, 904.3.5, 907.1.2, 907.2, 907.2.6, 907.2.9.3, 907.2.11, 907.2.13.2, 907.3, 907.3.3, 907.3.4, 907.5.2.1.2, 907.5.2.2, 907.5.2.2.5, 907.6, 907.6.1, 907.6.2, 907.6.6, 907.7, 907.7.1, 907.7.2, 911.1.6, 917.1, 2702.2.4, 3005.5, 3007.7
- 80—19: Standard for Fire Doors and Other Opening Protectives**  
410.2.5, 509.4.2, 716.1, 716.2.5.1, 716.2.6.4, 716.2.9, 716.3.4.1, 716.3.5, 716.4.3, 1010.3.3
- 82—19: Standard on Incinerators and Waste and Linen Handling Systems and Equipment**  
713.13
- 85—19: Boiler and Combustion System Hazards Code**  
426.1
- 92—18: Standard for Smoke Control Systems**  
909.7, 909.8
- 99—21: Health Care Facilities Code**  
407.11, 422.6, 425.1
- 101—21: Life Safety Code**  
1030.6.2
- 105—19: Standard for Smoke Door Assemblies and Other Opening Protectives**  
405.4.2, 710.5.2.2, 716.2.10, 909.20.4.1
- 110—19: Standard for Emergency and Standby Power Systems**  
2702.1.3
- 111—19: Standard on Stored Electrical Energy Emergency and Standby Power Systems**  
2702.1.3
- 120—20: Standard for Fire Prevention and Control in Coal Mines**  
426.1
- 170—18: Standard for Fire Safety and Emergency Symbols**  
1025.2.6.1
- 211—19: Standard for Chimneys, Fireplaces, Vents and Solid Fuel-burning Appliances**  
2112.5
- 221—21: Standard for High Challenge Fire Walls, Fire Walls and Fire Barrier Walls**  
706.2, Table 716.1(2)
- 252—17: Standard Methods of Fire Tests of Door Assemblies**  
Table 716.1(1), 716.1.1, 716.1.2.2.1, 716.2.1.1, 716.2.1.2, 716.2.2.1, 716.2.2.2, 716.2.2.3.1, 716.2.5.1.1
- 253—19: Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source**  
406.2.4, 424.2, 804.2, 804.3
- 257—17: Standard for Fire Test for Window and Glass Block Assemblies**  
Table 716.1(1), 716.1.1, 716.1.2.2.2, 716.3.1.1, 716.3.1.2, 716.3.2.1.3, 716.3.4



**NFPA—continued**

- 259—18: Standard Test Method for Potential Heat of Building Materials**  
2603.4.1.10, 2603.5.3
- 265—19: Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls**  
803.5.1, 803.5.1.1
- 268—19: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source**  
1405.1.1.1, 1405.1.1.1.1, 1405.1.1.1.2, 2603.5.7
- 275—17: Standard Method of Fire Tests for the Evaluation of Thermal Barriers**  
508.4.4.1, 509.4.1.1, 1406.10.2, 1408.10.2, 2603.4
- 276—19: Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-deck Roofing Components**  
1508.1, 2603.3, 2603.4.1.5
- 285—19: Standard Fire Test Method for the Evaluation of Fire Propagation Characteristics of Exterior Nonload-bearing Wall Assemblies Containing Combustible Components**  
718.2.6, 1402.5, 1406.10.3, 1408.10.4, 1511.6.2, 2603.5.5
- 286—15: Standard Methods of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth**  
402.6.4.4, 424.2, 803.1.1, 803.1.1.1, 803.11, 803.12, 803.13, 1406.10.2, 1408.10.3, 2603.7, 2603.9, 2604.2.4, 2614.4, 3105.3
- 288—17: Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal in Fire-resistance-rated Floor Systems**  
712.1.13.1
- 289—19: Standard Method of Fire Test for Individual Fuel Packages**  
402.6.2, 402.6.4.5, 424.2, 806.4
- 409—16: Standard for Aircraft Hangars**  
412.3.6, Table 412.3.6, 412.3.6.1, 412.5.5
- 418—16: Standard for Heliports**  
412.7.4
- 484—19: Standard for Combustible Metals**  
426.1
- 652—19: Standard on the Fundamentals of Combustible Dust**  
426.1
- 654—20: Standard for the Prevention of Fire and Dust Explosions from the Manufacturing, Processing and Handling of Combustible Particulate Solids**  
426.1
- 655—17: Standard for the Prevention of Sulfur Fires and Explosions**  
426.1
- 664—20: Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities**  
426.1
- 701—19: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films**  
410.2.6, 424.2, 806.4, 3102.3, 3102.3.1, 3102.6.1.1, 3105.3
- 704—17: Standard System for the Identification of the Hazards of Materials for Emergency Response**  
202, 415.5.2
- 720—15: Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment**  
915.5.1, 915.5.2
- 750—19: Standard on Water Mist Fire Protection Systems**  
202, 904.11.1.1, 904.13
- 1124—17: Code for the Manufacture, Transportation and Storage of Fireworks and Pyrotechnic Articles**  
415.6.4.1
- 2001—18: Standard on Clean Agent Fire Extinguishing Systems**  
904.10
- 2010—20: Standard for Fixed Aerosol Fire-extinguishing Systems**  
904.12

## REFERENCED STANDARDS

### PCI

Precast Prestressed Concrete Institute  
8770 West Bryn Mawr, Suite 1150  
Chicago, IL 60631-3517

**PCI 124—18: Specification for Fire Resistance of Precast Prestressed Concrete**  
722.1, 722.2.3.1

**PCI 128—19: Specification for Glass Fiber Reinforced Concrete Panels**  
1903.3

### PTI

Post-Tensioning Institute  
38800 Country Club Drive  
Farmington Hills, MI 48331

**PTI DC—10.5-19: Standard Requirements for Design and Analysis of Shallow Post-Tensioned Concrete Foundations on Expansive and Stable Soils**  
1808.6.2

### RMI

Rack Manufacturers Institute  
8720 Red Oak Boulevard, Suite 201  
Charlotte, NC 28217

**ANSI MH16.1—12: Specification for the Design, Testing and Utilization of Industrial Steel Storage Racks**  
2209.1

**ANSI MH16.3—16: Specification for the Design, Testing and Utilization of Industrial Steel Cantilevered Storage Racks**  
2209.2

### SBCA

Structural Building Components Association  
6300 Enterprise Lane  
Madison, WI 53719

**ANSI/SBCA FS 100—2012(R2018): Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing Used in Exterior Wall Covering Assemblies**  
2603.10

### SDI

Steel Deck Institute  
2661 Clearview Road #3  
Allison Park, PA 15101

**SDI NC—2017: Standard for Noncomposite Steel Floor Deck**  
2210.1.1.1

**SDI RD—2017: Standard for Steel Roof Deck**  
2210.1.1.2

**SDI-C—2017: Standard for Composite Steel Floor Deck—Slabs**  
2210.1.1.3

**SDI-QA/QC—2017: Standard for Quality Control and Quality Assurance for Installation of Steel Deck**  
1705.2.2

### SJI

Steel Joist Institute  
140 Evans Street, Suite 203  
Florence, SC 29501

**SJI 100—20: 45th Edition Standard Specifications, Load Tables and Weight Tables for K-Series, LH-Series, DLH-Series and Joist Girders**  
1604.3.3, 2203.1, 2207.1

**SJI 200—15: 2nd Edition Standard Specifications, Weight Tables and Bridging Tables for CJ-Series Composite Steel Joists**  
1604.3.3, 2203.1, 2207.1

---

## SPRI

Single-Ply Roofing Institute  
465 Waverly Oaks Road, Suite 421  
Waltham, MA 02452

**ANSI/SPRI RP-4—2019: Wind Design Standard**  
1504.5

**ANSI/SPRI VF-1—2017: External Fire Design Standard for Vegetative Roofs**  
1505.10

**ANSI/SPRI/FM 4435/ES-1—2017: Test Standard for Edge Systems Used with Low Slope Roofing Systems**  
1504.6

**ANSI/SPRI GT-1—2016: Test Standard for Gutter Systems**  
1504.6.1

---

## SRCC

Solar Rating & Certification Corporation  
400 High Point Drive, Suite 400  
Cocoa, FL 32926

**ICC 900/SRCC 300—2020: Solar Thermal System Standard**  
3111.2.1

**ICC 901/SRCC 100—2020: Solar Thermal Collector Standard**  
3111.2.1

---

## TIA

Telecommunications Industry Association  
1320 N. Courthouse Road #200  
Arlington, VA 22201

**ANSI/TIA 222-H—2017: Structural Standard for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures**  
1609.1.1, 3108.1, 3108.2

---

## TMS

The Masonry Society  
105 South Sunset Street, Suite Q  
Longmont, CO 80501-6172

**216—2014: Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies**  
Table 721.1(2), 722.1

**302—2018: Standard Method for Determining the Sound Transmission Ratings for Masonry Walls**  
1208.2.1

**402—2016: Building Code Requirements for Masonry Structures**  
1404.6, 1404.6.2, 1404.10, 1604.3.4, 1705.4, 1807.1.6.3.2, 1808.9, 2101.2, 2106.1, 2107.1, 2107.2, 2107.3, 2108.1, 2108.2, 2108.3, 2109.1, 2109.1.1, 2109.2, 2110.1, 2114.1, 2114.4

**403—2017: Direct Design Handbook for Masonry Structures**  
2101.2

**404—2016: Standard for the Design of Architectural Cast Stone**  
2101.2

**504—2016: Standard for the Fabrication of Architectural Cast Stone**  
2103.1

**602—2016: Specification for Masonry Structures**  
1404.6.1, 1705.4, 1705.4.1, 1807.1.6.3, 2103.1, 2103.2.1, 2103.3, 2103.4, 2104.1, 2105.1

**604—2016: Standard for the Installation of Architectural Cast Stone**  
2104.1

## REFERENCED STANDARDS

### TPI

Truss Plate Institute  
2670 Crain Highway, Suite 203  
Waldorf, MD 20601

**TPI 1—2014: National Design Standard for Metal-plate-connected Wood Truss Construction**  
2303.4.6, 2306.1

### UL

UL LLC  
333 Pfingsten Road  
Northbrook, IL 60062

- 9—2009: Fire Tests of Window Assemblies—with Revisions through February 2015**  
Table 716.1(1), 716.1.1, 716.1.2.2.2, 716.2.1.3, 716.3.1.1, 716.3.1.2, 716.3.2.1.3, 716.3.4, 1013.5
- 10A—2009: Tin Clad Fire Doors—with Revisions through July 2018**  
716.2.1
- 10B—2008: Fire Tests of Door Assemblies—with Revisions through February 2015**  
Table 716.1(1), 716.1.1, 716.1.2.2.1, 716.2.1.2, 716.2.2.2, 716.2.2.3.1, 716.2.5.1.1
- 10C—2016: Positive Pressure Fire Tests of Door Assemblies**  
Table 716.1(1), 716.1.1, 716.1.2.2.1, 716.2.1.1, 716.2.2.1, 716.2.2.2, 716.2.2.3.1, 716.2.5.1.1, 1010.2.9.3
- 10D—2017: Standard for Fire Tests of Fire Protective Curtain Assemblies**  
716.4
- 14B—2008: Sliding Hardware for Standard Horizontally Mounted Tin Clad Fire Doors—with Revisions through July 2017**  
716.2.1
- 14C—2006: Swinging Hardware for Standard Tin Clad Fire Doors Mounted Singly and in Pairs—with Revisions through July 2017**  
716.2.1
- 55A—2004: Materials for Built-up Roof Coverings**  
1507.10.2
- 103—2010: Factory-built Chimneys, for Residential Type and Building Heating Appliances—with Revisions through March 2017**  
718.2.5.1
- 127—2011: Factory-built Fireplaces—with Revisions through July 2016**  
718.2.5.1, 2111.12
- 199E—2004: Outline of Investigation for Fire Testing of Sprinklers and Water Spray Nozzles for Protection of Deep Fat Fryers**  
904.13.4.1
- 217—2015: Single and Multiple Station Smoke Alarms—with Revisions through November 2016**  
907.2.11
- 263—11: Fire Tests of Building Construction and Materials—with Revisions through March 2018**  
703.2, 703.2.1.3, 703.2.1.5, 703.2.2, 703.4, 703.4, 704.12, 705.7, 705.8.5, 707.6, 712.1.13.2, 714.4.1, 714.5.1, 715.3, Table 716.1(1), Table 716.1(3), 716.1.2.3, 716.2.5.1.1, 716.2.5.4, 716.3.2.1.1, 717.3.1, 717.5.2, 717.5.3, 717.6.1, 717.6.2, Table 721.1(1), 2103.1, 2603.5.1
- 268—2016: Smoke Detectors for Fire Alarm Systems—with revisions through July 2016**  
407.9, 907.2.6.2, 907.2.11.7
- 294—2018: Access Control System Units—with Revisions through October 2018**  
1010.2.11, 1010.2.12, 1010.2.13.1, 1010.2.14
- 300—2005(R2010): Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment—with Revisions through December 2014**  
904.13
- 300A—2006: Outline of Investigation for Extinguishing System Units for Residential Range Top Cooking Surfaces**  
904.14.1.1
- 305—2012: Panic Hardware—with Revisions through March 2017**  
1010.2.9.3
- 325—2017: Door, Drapery, Gate, Louver and Window Operations and Systems**  
406.2.1, 3110.3
- 555—2006: Fire Dampers—with Revisions through October 2016**  
717.3.1



## UL—continued

- 555C—2014: Ceiling Dampers—with Revisions through May 2017**  
717.3.1
- 555S—2014: Smoke Dampers—with Revisions through October 2016**  
717.3.1
- 580—2006: Test for Uplift Resistance of Roof Assemblies—with Revisions through October 2018**  
1504.4.1, 1504.4.2
- 641—2010: Type L Low-temperature Venting Systems—with Revisions through April 2018**  
2113.11.1.4
- 710B—2011: Recirculating Systems—with Revisions through August 2014**  
904.13
- 723—2018: Test for Surface Burning Characteristics of Building Materials**  
202, 402.6.4.4, 406.7.2, 720.1, 720.4, 803.1.2, 803.5.2, 803.10, 803.11, 803.12, 803.13, 806.7, 1402.5, 1403.12.1, 1406.9, 1406.10.1, 1408.9, 1408.10.1, 1511.6.2, 1511.6.3, 2303.2, 2603.3, 2603.4.1.13, 2603.5.4, 2603.5.5, 2603.7, 2604.2.4, 2606.4, 2612.3, 2614.3, 3105.3
- 723S—2006: Drop-Out Ceilings Installed Beneath Automatic Sprinklers**  
2606.7.4
- 790—2004: Standard Test Methods for Fire Tests of Roof Coverings—with Revisions through October 2018**  
1505.1, 2603.6, 2610.2, 2610.3
- 793—2008: Automatically Operated Roof Vents for Smoke and Heat—with Revisions through March 2017**  
910.3.1
- 864—2014: Control Units and Accessories for Fire Alarm Systems—with Revisions through March 2018**  
909.12
- 924—2016: Safety Emergency Lighting and Power Equipment—with Revisions through May 2018**  
1013.5
- 1040—1996: Fire Test of Insulated Wall Construction—with Revisions through April 2017**  
1406.10.2, 2603.9
- 1256—02: Fire Test of Roof Deck Construction—with Revisions through August 2018**  
1508.1, 2603.3, 2603.4.1.5
- 1479—2015: Fire Tests of Penetration Firestops**  
202, 714.4.1.2, 714.4.2, 714.5.1.2, 714.5.4
- 1482—2011: Solid-fuel Type Room Heaters—with Revisions through August 2015**  
2112.2, 2112.5
- 1489—2016: Fire Resistant Pipe Protection Systems Carrying Combustible Liquids**  
403.4.8.2
- 1703—2002: Flat-plate Photovoltaic Modules and Panels—with Revisions through September 2018**  
1507.17.5, 3111.3.1
- 1715—97: Fire Test of Interior Finish Material—with Revisions through April 2017**  
1406.10.2, 2603.9, 2614.4
- 1741—2010: Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources—with Revisions through February 2018**  
3111.3.1
- 1777—2007: Chimney Liners—with Revisions through April 2014**  
2113.11.1, 2113.19
- 1784—2015: Air Leakage Tests of Door Assemblies**  
405.4.3, 710.5.2.2, 710.5.2.2.1, 716.2.1.4, 716.2.9.1, 716.2.9.3, 3006.3, 3007.6.3, 3008.6.3
- 1897—2015: Uplift Tests for Roof Covering Systems**  
1504.4.1, 1504.4.3
- 1975—06: Fire Tests for Foamed Plastics Used for Decorative Purposes**  
402.6.2, 402.6.4.5, 424.2
- 1994—2015: Luminous Egress Path Marking Systems**  
411.6, 1008.2.1, 1025.2.1, 1025.2.3, 1025.2.4, 1025.2.5, 1025.4
- 2034—2017: Single- and Multiple-station Carbon Monoxide Alarms—with Revisions through September 2018**  
915.4.2, 915.4.4

## REFERENCED STANDARDS

### UL—continued

- 2075—2013: Standard for Gas and Vapor Detectors and Sensors—with Revisions through December 2017**  
915.5.1, 915.5.3
- 2079—2015: Tests for Fire Resistance of Building Joint Systems**  
202, 715.3.1, 715.8
- 2196—2017: Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables**  
909.20.7.1, 913.2.2, 2702.3, 3007.8.1, 3008.8.2
- 2200—2012: Stationary Engine Generator Assemblies—with Revisions through October 2015**  
2702.1.1
- 2202—2009: Electric Vehicle (EV) Charging System Equipment—with Revisions through February 2018**  
406.2.7
- 2594—2016: Electric Vehicle Supply Equipment**  
406.2.7
- 2703—2014: Mounting Systems, Mounting Devices, Clamping/Retention Devices and Ground Lugs for Use with Flat-plate Photovoltaic Modules and Panels—with Revisions through December 2019**  
1505.9
- 7103—19: Outline of Investigation for Building-Integrated Photovoltaic Roof Coverings**  
Table 1504.2, 1507.16.6
- 61730-1—2017: Photovoltaic (PV) Module Safety Qualification - Part 1: Requirements for Construction**  
1507.16.6, 1507.17.5, 3111.3.1
- 61730-2—2017: Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing**  
1507.16.6, 1507.17.5, 3111.3.1

---

## ULC

Underwriters Laboratories of Canada  
13775 Commerce Parkway  
Richmond, BC V6V 2V4

- CAN/ULC S 102.2—2018: Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Coverings and Miscellaneous Materials and Assemblies**  
720.2, 720.3, 720.4

---

## USC

United States Code  
732 North Capitol Street NW  
Washington, DC 20401-0003

- 18 USC Part 1, Ch. 40: Importation, Manufacture, Distribution and Storage of Explosive Materials**  
202

---

## WCLIB

West Coast Lumber Inspection Bureau  
P.O. Box 23145  
Portland, OR 97223

- AITC 104—03: Typical Construction Details**  
2306.1
- AITC 110—01: Standard Appearance Grades for Structural Glued Laminated Timber**  
2306.1
- AITC 113—10: Standard for Dimensions of Structural Glued Laminated Timber**  
2306.1
- AITC 119—96: Standard Specifications for Structural Glued Laminated Timber of Hardwood Species**  
2306.1
- AITC 200—09: Manufacturing Quality Control Systems Manual for Structural Glued Laminated Timber**  
2306.1

## REFERENCED STANDARDS

---

### WDMA

Window and Door Manufacturers Association  
2025 M Street NW, Suite 800  
Washington, DC 20006

**AAMA/WDMA/CSA 101/I.S.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Skylights**  
1709.5.1, 2405.5

---

### WRI

Wire Reinforcement Institute, Inc.  
942 Main Street, Suite 300  
Hartford, CT 06103

**WRI/CRSI—81: Design of Slab-on-ground Foundations—with 1996 Update**  
1808.6.2





## APPENDIX A

# EMPLOYEE QUALIFICATIONS

*Deleted in its entirety.*





## APPENDIX B

# BOARD OF APPEALS

*Deleted in its entirety.*







## APPENDIX C

# GROUP U—AGRICULTURAL BUILDINGS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

### User note:

**About this appendix:** Agricultural buildings are given special consideration in Appendix C. Often such buildings have unique uses and structural needs. Where an agricultural building is surrounded by 60 feet of open area on all sides, size limits are waived. Automatic sprinkler protection may be required.

### SECTION C101 GENERAL

**C101.1 Scope.** The provisions of this appendix shall apply exclusively to *agricultural buildings*. Such buildings shall be classified as Group U and shall include the following uses:

1. Livestock shelters or buildings, including shade structures and milking barns.
2. Poultry buildings or shelters.
3. Barns.
4. Storage of equipment and machinery used exclusively in agriculture.
5. Horticultural structures, including detached production *greenhouses* and crop protection shelters.
6. Sheds.
7. Grain silos.
8. Stables.

### SECTION C102 ALLOWABLE HEIGHT AND AREA

**C102.1 General.** Buildings classified as Group U Agricultural shall not exceed the area or height limits specified in Table C102.1.

**C102.2 One-story unlimited area.** The area of a one-story Group U *agricultural building* shall not be limited if the building is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width.

**C102.3 Two-story unlimited area.** The area of a two-story Group U *agricultural building* shall not be limited if the building is surrounded and adjoined by *public ways* or *yards* not less than 60 feet (18 288 mm) in width and is provided with an *approved automatic sprinkler system* throughout in accordance with Section 903.3.1.1.

### SECTION C103 MIXED OCCUPANCIES

**C103.1 Mixed occupancies.** Mixed occupancies shall be protected in accordance with Section 508.

### SECTION C104 EXITS

**C104.1 Exit facilities.** Exits shall be provided in accordance with Chapters 10 and 11.

#### Exceptions:

1. The maximum travel distance from any point in the building to an approved *exit* shall not exceed 300 feet (91 440 mm).
2. One *exit* is required for each 15,000 square feet (1393.5 m<sup>2</sup>) of area or fraction thereof.

**TABLE C102.1**  
**BASIC ALLOWABLE AREA FOR A GROUP U, ONE STORY IN HEIGHT AND MAXIMUM HEIGHT OF SUCH OCCUPANCY**

I		II		III and IV		V	
A	B	A	B	III A and IV	III B	A	B
<b>ALLOWABLE AREA (square feet)<sup>a</sup></b>							
Unlimited	60,000	27,100	18,000	27,100	18,000	21,100	12,000
<b>MAXIMUM HEIGHT IN STORIES</b>							
Unlimited	12	4	2	4	2	3	2
<b>MAXIMUM HEIGHT IN FEET</b>							
Unlimited	160	65	55	65	55	50	40

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

a. See Section C102 for unlimited area under certain conditions.



## APPENDIX D

# FIRE DISTRICTS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

---

### User note:

**About this appendix:** Appendix D establishes a framework by which a jurisdiction can establish a portion of a jurisdiction as a fire district. Fire districts are often designated in a more densely developed portion of a city where limiting the potential spread of fire is a key consideration. Specific construction types and users are prohibited in a fire district.

---

### SECTION D101 GENERAL

**D101.1 Scope.** The fire district shall include such territory or portion as outlined in an ordinance or law entitled “An Ordinance (Resolution) Creating and Establishing a Fire District.” Wherever, in such ordinance creating and establishing a fire district, reference is made to the fire district, it shall be construed to mean the fire district designated and referred to in this appendix.

**D101.1.1 Mapping.** The fire district complying with the provisions of Section D101.1 shall be shown on a map that shall be available to the public.

**D101.2 Establishment of area.** For the purpose of this code, the fire district shall include that territory or area as described in Sections D101.2.1 through D101.2.3.

**D101.2.1 Adjoining blocks.** Two or more adjoining blocks, exclusive of intervening streets, where not less than 50 percent of the ground area is built upon and more than 50 percent of the built-on area is devoted to hotels and motels of Group R-1; Group B occupancies; theaters, nightclubs, restaurants of Group A-1 and A-2 occupancies; garages, express and freight depots, warehouses and storage buildings used for the storage of finished products (not located with and forming a part of a manufactured or industrial plant); or Group S occupancy. Where the average height of a building is two and one-half stories or more, a block should be considered if the ground area built upon is not less than 40 percent.

**D101.2.2 Buffer zone.** Where four contiguous blocks or more comprise a fire district, there shall be a buffer zone of 200 feet (60 960 mm) around the perimeter of such district. Streets, rights-of-way and other open spaces not subject to building construction can be included in the 200-foot (60 960 mm) buffer zone.

**D101.2.3 Developed blocks.** Where blocks adjacent to the fire district have developed to the extent that not less than 25 percent of the ground area is built upon and 40 percent or more of the built-on area is devoted to the occupancies specified in Section D101.2.1, they can be considered for inclusion in the fire district, and can form all or a portion of the 200-foot (60 960 mm) buffer zone required in Section D101.2.2.

### SECTION D102 BUILDING RESTRICTIONS

**D102.1 Types of construction permitted.** Within the fire district every building hereafter erected shall be Type I, II, III or IV, except as permitted in Section D104.

**D102.2 Other specific requirements.**

**D102.2.1 Exterior walls.** Exterior walls of buildings located in the fire district shall comply with the requirements in Table 601 except as required in Section D102.2.6.

**D102.2.2 Group H prohibited.** Group H occupancies shall be prohibited from location within the fire district.

**D102.2.3 Construction type.** Every building shall be constructed as required based on the type of construction indicated in Chapter 6.

**D102.2.4 Roof covering.** *Roof covering* in the fire district shall conform to the requirements of Class A or B roof coverings as defined in Section 1505.

**D102.2.5 Structural fire rating.** Walls, floors, roofs and their supporting structural members shall be not less than 1-hour fire-resistance-rated construction.

#### Exceptions:

1. Buildings of Type IV-HT construction.
2. Buildings equipped throughout with an *automatic sprinkler system* in accordance with Section 903.3.1.1.
3. Automobile parking structures.
4. Buildings surrounded on all sides by a permanently open space of not less than 30 feet (9144 mm).
5. Partitions complying with Section 603.1, Item 11.

**D102.2.6 Exterior walls.** Exterior *load-bearing walls* of Type II buildings shall have a *fire-resistance rating* of 2 hours or more where such walls are located within 30 feet (9144 mm) of a common property line or an assumed property line. Exterior *nonload-bearing walls* of Type II buildings located within 30 feet (9144 mm) of a common property line or an assumed property line shall have *fire-*

## APPENDIX D—FIRE DISTRICTS

*resistance ratings* as required by Table 601, but not less than 1 hour. *Exterior walls* located more than 30 feet (9144 mm) from a common property line or an assumed property line shall comply with Table 601.

**Exception:** In the case of one-story buildings that are 2,000 square feet (186 m<sup>2</sup>) or less in area, *exterior walls* located more than 15 feet (4572 mm) from a common property line or an assumed property line need only comply with Table 601.

**D102.2.7 Architectural trim.** Architectural trim on buildings located in the fire district shall be constructed of *approved* noncombustible materials or *fire-retardant-treated wood*.

**D102.2.8 Permanent canopies.** Permanent canopies are permitted to extend over adjacent open spaces provided that all of the following are met:

1. The canopy and its supports shall be of noncombustible material, *fire-retardant-treated wood*, Type IV construction or of 1-hour fire-resistance-rated construction.

**Exception:** Any textile covering for the canopy shall be flame resistant as determined by tests conducted in accordance with NFPA 701 after both accelerated water leaching and accelerated weathering.

2. Any canopy covering, other than textiles, shall have a *flame spread index* not greater than 25 when tested in accordance with ASTM E84 or UL 723 in the form intended for use.
3. The canopy shall have one long side open.
4. The maximum horizontal width of the canopy shall be not greater than 15 feet (4572 mm).
5. The *fire resistance* of *exterior walls* shall not be reduced.

**D102.2.9 Roof structures.** Structures, except aerial supports 12 feet (3658 mm) high or less, flagpoles, water tanks and cooling towers, placed above the roof of any building within the fire district shall be of noncombustible material and shall be supported by construction of noncombustible material.

**D102.2.10 Plastic signs.** The use of plastics complying with Section 2611 for signs is permitted provided that the structure of the sign in which the plastic is mounted or installed is noncombustible.

**D102.2.11 Plastic veneer.** Exterior plastic *veneer* is not permitted in the fire district.

### SECTION D103 CHANGES TO BUILDINGS

**D103.1 Existing buildings within the fire district.** An existing building shall not be increased in height or area unless it is of a type of construction permitted for new buildings within the fire district or is altered to comply with the requirements for such type of construction. Nor shall any existing building be extended on any side, nor square foot-

age or floors added within the existing building unless such modifications are of a type of construction permitted for new buildings within the fire district.

**D103.2 Other alterations.** Nothing in Section D103.1 shall prohibit other alterations within the fire district provided that such *alterations* do not create a change of occupancy that is otherwise prohibited or increase the fire hazard.

**D103.3 Moving buildings.** Buildings shall not hereafter be moved into the fire district or to another lot in the fire district unless the building is of a type of construction permitted in the fire district.

### SECTION D104 BUILDINGS LOCATED PARTIALLY IN THE FIRE DISTRICT

**D104.1 General.** Any building located partially in the fire district shall be of a type of construction required for the fire district, unless the major portion of such building lies outside of the fire district and all portions of it extend not more than 10 feet (3048 mm) inside the boundaries of the fire district.

### SECTION D105 EXCEPTIONS TO RESTRICTIONS IN FIRE DISTRICT

**D105.1 General.** The preceding provisions of this appendix shall not apply in the following instances:

1. Temporary buildings used in connection with duly authorized construction.
2. A *private garage* used exclusively as such, not more than one *story* in height, nor more than 650 square feet (60 m<sup>2</sup>) in area, located on the same lot with a *dwelling*.
3. Fences not over 8 feet (2438 mm) high.
4. Coal tipples, material bins and trestles of Type IV construction.
5. Water tanks and cooling towers conforming to Sections 1510.3 and 1510.4.
6. *Greenhouses* less than 15 feet (4572 mm) high.
7. Porches on dwellings not over one *story* in height, and not over 10 feet (3048 mm) wide from the face of the building, provided that such porch does not come within 5 feet (1524 mm) of any property line.
8. Sheds open on a long side not over 15 feet (4572 mm) high and 500 square feet (46 m<sup>2</sup>) in area.
9. One- and two-family *dwellings* where of a type of construction not permitted in the fire district can be extended 25 percent of the floor area existing at the time of inclusion in the fire district by any type of construction permitted by this code.
10. Wood decks less than 600 square feet (56 m<sup>2</sup>) where constructed of 2-inch (51 mm) nominal wood, pressure treated for exterior use.
11. Wood *veneers* on *exterior walls* conforming to Section 1404.5.



12. Exterior plastic *veneer* complying with Section 2605.2 where installed on *exterior walls* required to have a *fire-resistance rating* not less than 1 hour, provided that the exterior plastic *veneer* does not exhibit sustained flaming as defined in NFPA 268.

## SECTION D106 REFERENCED STANDARDS

**D106.1 General.** See Table D106.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.

**TABLE D106.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
ASTM E84—2018B	<i>Test Method for Surface Burning Characteristics of Building Materials</i>	D102.2.8
NFPA 268—17	<i>Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source</i>	D105.1
NFPA 701—19	<i>Methods of Fire Tests for Flame-Propagation of Textiles and Films</i>	D102.2.8
UL 723—2018	<i>Standard for Test for Surface Burning Characteristics of Building Materials</i>	D102.2.8



## APPENDIX E

# SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

### User note:

**About this appendix:** The Architectural and Transportation Barriers Compliance Board (U.S. Access Board) has revised and updated its accessibility guidelines for buildings and facilities covered by the Americans with Disabilities Act (ADA) and the Architectural Barriers Act (ABA). Appendix E includes scoping requirements contained in the 2010 ADA Standards for Accessible Design that are not in Chapter 11 and not otherwise mentioned or mainstreamed throughout the code. Items in this appendix address subjects not typically addressed in building codes (for example, beds, room signage, transportation facilities).

### SECTION E101 GENERAL

**E101.1 Scope.** The provisions of this appendix shall control the supplementary requirements for the design and construction of facilities for *accessibility* for individuals with disabilities.

**E101.2 Design.** Technical requirements for items herein shall comply with this code and ICC A117.1.

### SECTION E102 DEFINITIONS

**E102.1 General.** The following words and terms shall, for the purposes of this appendix, have the meanings shown herein. Refer to Chapter 2 of this code for general definitions.

**CLOSED-CIRCUIT TELEPHONE.** A telephone with a dedicated line such as a house phone, courtesy phone or phone that must be used to gain entrance to a facility.

**MAILBOXES.** Receptacles for the receipt of documents, packages or other deliverable matter. *Mailboxes* include, but are not limited to, post office boxes and receptacles provided by commercial mail-receiving agencies, apartment houses and schools.

**TRANSIENT LODGING.** A building, facility or portion thereof, excluding inpatient *medical care* facilities and long-term care facilities, that contains one or more *dwelling units* or *sleeping units*. Examples of *transient lodging* include, but are not limited to, resorts, *group homes*, hotels, motels, *dormitories*, homeless shelters, halfway houses and social service lodging.

### SECTION E103 ACCESSIBLE ROUTE

**E103.1 Raised platforms.** In banquet rooms or spaces where a head table or speaker's lectern is located on a raised platform, an *accessible* route shall be provided to the platform.

### SECTION E104 SPECIAL OCCUPANCIES

**E104.1 General.** *Transient lodging* facilities shall be provided with accessible features in accordance with Section E104.2. Group I-3 occupancies shall be provided with accessible features in accordance with Section E104.2.

**E104.2 Communication features.** *Accessible* communication features shall be provided in accordance with Sections E104.2.1 through E104.2.4.

**E104.2.1 Transient lodging.** In *transient lodging* facilities, *sleeping units* with accessible communication features shall be provided in accordance with Table E104.2.1. Units required to comply with Table E104.2.1 shall be dispersed among the various classes of units.

**E104.2.2 Group I-3.** In Group I-3 occupancies at least 2 percent of the total number of general holding *cells* and general housing *cells* equipped with audible emergency notification systems, and not less than one cell, shall be provided with visual notification devices. Permanently installed telephones within the cell shall comply with Section E104.2.4.

**E104.2.3 Dwelling units and sleeping units.** Where *dwelling units* and *sleeping units* are altered or added, the requirements of Section E104.2 shall apply only to the units being altered or added until the number of units with accessible communication features complies with the minimum number required for new construction.

**E104.2.4 Notification devices.** Visual notification devices shall be provided to alert room occupants of incoming telephone calls and a door knock or bell. Notification devices shall not be connected to visual alarm signal appliances. Permanently installed telephones shall have volume controls and an electrical outlet complying with ICC A117.1 located within 48 inches (1219 mm) of the telephone to facilitate the use of a TTY.

## APPENDIX E—SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS

## SECTION E105 OTHER FEATURES AND FACILITIES

**E105.1 Portable toilets and bathing rooms.** Where multiple single-user portable toilet or bathing units are clustered at a single location, at least 5 percent, but not less than one toilet unit or bathing unit at each cluster, shall be *accessible*. Signs containing the International Symbol of Accessibility shall identify accessible portable toilets and bathing units.

**Exception:** Portable toilet units provided for use exclusively by construction personnel on a construction site.

**E105.2 Laundry equipment.** Where provided in spaces required to be *accessible*, washing machines and clothes dryers shall comply with this section.

**E105.2.1 Washing machines.** Where three or fewer washing machines are provided, one or more shall be *accessible*. Where more than three washing machines are provided, two or more shall be *accessible*.

**E105.2.2 Clothes dryers.** Where three or fewer clothes dryers are provided, one or more shall be *accessible*. Where more than three clothes dryers are provided, two or more shall be *accessible*.

**E105.3 Gaming machines, depositories, vending machines, change machines and similar equipment.** Not fewer than one of each type of depository, vending machine, change machine and similar equipment shall be *accessible*. Two percent of gaming machines shall be *accessible* and provided with a front approach. *Accessible* gaming machines shall be distributed throughout the different types of gaming machines provided.

**Exception:** Drive-up-only depositories are not required to comply with this section.

**E105.4 Mailboxes.** Where *mailboxes* are provided in an interior location, 5 percent of the total, but not less than one, of each type shall be *accessible*. In residential and institutional facilities, where *mailboxes* are provided for each *dwelling unit* or *sleeping unit*, *accessible mailboxes* shall be provided for each unit required to be an *Accessible unit*.

**E105.5 Automatic teller machines and fare machines.** Where automatic teller machines or self-service fare vending, collection or adjustment machines are provided, not fewer than one machine of each type at each location where such machines are provided shall be *accessible*. Where bins are provided for envelopes, wastepaper or other purposes, not fewer than one of each type shall be *accessible*.

**E105.6 Two-way communication systems.** Where two-way communication systems are provided to gain admittance to a building or facility or to restricted areas within a building or facility, the system shall be *accessible*.

## SECTION E106 TELEPHONES

**E106.1 General.** Where coin-operated public pay telephones, coinless public pay telephones, public *closed-circuit telephones*, courtesy phones or other types of public telephones are provided, accessible public telephones shall be provided in accordance with Sections E106.2 through E106.5 for each type of public telephone provided. For purposes of this section, a bank of telephones shall be considered to consist of two or more adjacent telephones.

**E106.2 Wheelchair-accessible telephones.** Where public telephones are provided, wheelchair-accessible telephones shall be provided in accordance with Table E106.2.

**Exception:** Drive-up-only public telephones are not required to be *accessible*.

TABLE E106.2  
WHEELCHAIR-ACCESSIBLE TELEPHONES

NUMBER OF TELEPHONES PROVIDED ON A FLOOR, LEVEL OR EXTERIOR SITE	MINIMUM REQUIRED NUMBER OF WHEELCHAIR-ACCESSIBLE TELEPHONES
1 or more single unit	1 per floor, level and exterior site
1 bank	1 per floor, level and exterior site
2 or more banks	1 per bank

TABLE E104.2.1  
DWELLING OR SLEEPING UNITS WITH ACCESSIBLE COMMUNICATION FEATURES

TOTAL NUMBER OF DWELLING OR SLEEPING UNITS PROVIDED	MINIMUM REQUIRED NUMBER OF DWELLING OR SLEEPING UNITS WITH ACCESSIBLE COMMUNICATION FEATURES
1	1
2 to 25	2
26 to 50	4
51 to 75	7
76 to 100	9
101 to 150	12
151 to 200	14
201 to 300	17
301 to 400	20
401 to 500	22
501 to 1,000	5% of total
1,001 and over	50 plus 3 for each 100 over 1,000



## APPENDIX E—SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS

**E106.3 Volume controls.** All public telephones provided shall have accessible volume control.

**E106.4 TTYs.** TTYs shall be provided in accordance with Sections E106.4.1 through E106.4.9.

**E106.4.1 Bank requirement.** Where four or more public pay telephones are provided at a bank of telephones, at least one public TTY shall be provided at that bank.

**Exception:** TTYs are not required at banks of telephones located within 200 feet (60 960 mm) of, and on the same floor as, a bank containing a public TTY.

**E106.4.2 Floor requirement.** Where four or more public pay telephones are provided on a floor of a privately owned building, one or more public TTY shall be provided on that floor. Where one public pay telephone or more, is provided on a floor of a publicly owned building, not fewer than one public TTY shall be provided on that floor.

**E106.4.3 Building requirement.** Where four or more public pay telephones are provided in a privately owned building, one or more public TTY shall be provided in the building. Where at least one public pay telephone is provided in a publicly owned building, one or more public TTY shall be provided in the building.

**E106.4.4 Site requirement.** Where four or more public pay telephones are provided on a site, one or more public TTY shall be provided on the site.

**E106.4.5 Rest stops, emergency road stops and service plazas.** Where a public pay telephone is provided at a public rest stop, emergency road stop or service plaza, at least one public TTY shall be provided.

**E106.4.6 Hospitals.** Where a public pay telephone is provided in or adjacent to a hospital emergency room, hospital recovery room or hospital waiting room, one or more public TTY shall be provided at each such location.

**E106.4.7 Transportation facilities.** Transportation facilities shall be provided with TTYs in accordance with Sections E109.2.5 and E110.2 in addition to the TTYs required by Sections E106.4.1 through E106.4.4.

**E106.4.8 Detention and correctional facilities.** In detention and correctional facilities, where a public pay telephone is provided in a secured area used only by detainees or inmates and security personnel, then not fewer than one TTY shall be provided in not fewer than one secured area.

**E106.4.9 Signs.** Public TTYs shall be identified by the International Symbol of TTY complying with ICC A117.1. Directional signs indicating the location of the nearest public TTY shall be provided at banks of public pay telephones not containing a public TTY. Additionally, where signs provide direction to public pay telephones, they shall provide direction to public TTYs. Such signs shall comply with visual signage requirements in ICC A117.1 and shall include the International Symbol of TTY.

**E106.5 Shelves for portable TTYs.** Where a bank of telephones in the interior of a building consists of three or more

public pay telephones, not fewer than one public pay telephone at the bank shall be provided with a shelf and an electrical outlet.

**Exceptions:**

1. In secured areas of detention and correctional facilities, if shelves and outlets are prohibited for purposes of security or safety shelves and outlets for TTYs are not required to be provided.
2. The shelf and electrical outlet shall not be required at a bank of telephones with a TTY.

## SECTION E107 SIGNAGE

**E107.1 Signs.** Required accessible portable toilets and bathing facilities shall be identified by the International Symbol of Accessibility.

**E107.2 Designations.** Interior and exterior signs identifying permanent rooms and spaces shall be visual characters, raised characters and braille complying with ICC A117.1. Where pictograms are provided as designations of interior rooms and spaces, the pictograms shall have visual characters, raised characters and braille complying with ICC A117.1.

**Exceptions:**

1. Exterior signs that are not located at the door to the space they serve are not required to comply.
2. Building directories, menus, seat and row designations in assembly areas, occupant names, building addresses and company names and logos are not required to comply.
3. Signs in parking facilities are not required to comply.
4. Temporary (seven days or less) signs are not required to comply.
5. In detention and correctional facilities, signs not located in public areas are not required to comply.

**E107.3 Directional and informational signs.** Signs that provide direction to, or information about, permanent interior spaces of the site and facilities shall contain visual characters complying with ICC A117.1.

**Exception:** Building directories, personnel names, company or occupant names and logos, menus and temporary (seven days or less) signs are not required to comply with ICC A117.1.

**E107.4 Other signs.** Signage indicating special accessibility provisions shall be provided as follows:

1. At bus stops and terminals, signage must be provided in accordance with Section E108.4.
2. At fixed facilities and stations, signage must be provided in accordance with Sections E109.2.2 through E109.2.2.3.
3. At airports, terminal information systems must be provided in accordance with Section E110.3.

## APPENDIX E—SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS

### SECTION E108 BUS STOPS

**E108.1 General.** Bus stops shall comply with Sections E108.2 through E108.5.

**E108.2 Bus boarding and alighting areas.** Bus boarding and alighting areas shall comply with Sections E108.2.1 through E108.2.4.

**E108.2.1 Surface.** Bus boarding and alighting areas shall have a firm, stable surface.

**E108.2.2 Dimensions.** Bus boarding and alighting areas shall have a clear length of 96 inches (2440 mm) minimum, measured perpendicular to the curb or vehicle roadway edge, and a clear width of 60 inches (1525 mm) minimum, measured parallel to the vehicle roadway.

**E108.2.3 Connection.** Bus boarding and alighting areas shall be connected to streets, sidewalks or pedestrian paths by an *accessible route* complying with Section 1104.

**E108.2.4 Slope.** Parallel to the roadway, the slope of the bus boarding and alighting area shall be the same as the roadway, to the maximum extent practicable. For water drainage, a maximum slope of 1:48 perpendicular to the roadway is allowed.

**E108.3 Bus shelters.** Where provided, new or replaced bus shelters shall provide a minimum clear floor or ground space complying with ICC A117.1, Section 305, entirely within the shelter. Such shelters shall be connected by an *accessible route* to the boarding area required by Section E108.2.

**E108.4 Signs.** New bus route identification signs shall have finish and contrast complying with ICC A117.1. Additionally, to the maximum extent practicable, new bus route identification signs shall provide visual characters complying with ICC A117.1.

**Exception:** Bus schedules, timetables and maps that are posted at the bus stop or bus bay are not required to meet this requirement.

**E108.5 Bus stop siting.** Bus stop sites shall be chosen such that, to the maximum extent practicable, the areas where lifts or *ramps* are to be deployed comply with Sections E108.2 and E108.3.

### SECTION E109 TRANSPORTATION FACILITIES AND STATIONS

**E109.1 General.** Fixed transportation facilities and stations shall comply with the applicable provisions of Section E109.2.

**E109.2 New construction.** New stations in rapid rail, light rail, commuter rail, intercity rail, high speed rail and other fixed guideway systems shall comply with Sections E109.2.1 through E109.2.8.

**E109.2.1 Station entrances.** Where different entrances to a station serve different transportation fixed routes or groups of fixed routes, at least one entrance serving each group or route shall comply with Section 1104.

**E109.2.2 Signs.** Signage in fixed transportation facilities and stations shall comply with Sections E109.2.2.1 through E109.2.2.3.

#### **E109.2.2.1 Raised character and braille signs.**

Where signs are provided at entrances to stations identifying the station or the entrance, or both, at least one sign at each entrance shall be raised characters and braille. A minimum of one raised character and braille sign identifying the specific station shall be provided on each platform or boarding area. Such signs shall be placed in uniform locations at entrances and on platforms or boarding areas within the transit system to the maximum extent practicable.

#### **Exceptions:**

1. Where the station does not have a defined entrance but signs are provided, the raised characters and braille signs shall be placed in a central location.
2. Signs are not required to be raised characters and braille where audible signs are remotely transmitted to hand-held receivers, or are user or proximity actuated.

**E109.2.2.2 Identification signs.** Stations covered by this section shall have identification signs containing visual characters complying with ICC A117.1. Signs shall be clearly visible and within the sightlines of a standing or sitting passenger from within the train on both sides when not obstructed by another train.

**E109.2.2.3 Informational signs.** Lists of stations, routes and destinations served by the station that are located on boarding areas, platforms or *mezzanines* shall provide visual characters complying with ICC A117.1. Signs covered by this provision shall, to the maximum extent practicable, be placed in uniform locations within the transit system.

**E109.2.3 Fare machines.** Self-service fare vending, collection and adjustment machines shall comply with ICC A117.1, Section 707. Where self-service fare vending, collection or adjustment machines are provided for the use of the general public, at least one accessible machine of each type provided shall be provided at each accessible point of entry and *exit*.

**E109.2.4 Rail-to-platform height.** Station platforms shall be positioned to coordinate with vehicles in accordance with the applicable provisions of 36 CFR, Part 1192. Low-level platforms shall be 8 inches (250 mm) minimum above top of rail.

**Exception:** Where vehicles are boarded from sidewalks or street level, low-level platforms shall be permitted to be less than 8 inches (250 mm).

**E109.2.5 TTYs.** Where a public pay telephone is provided in a transit facility (as defined by the Department of Transportation), at least one public TTY complying with ICC A117.1, Section 704.4, shall be provided in the station. In addition, where one or more public pay telephones serve a particular entrance to a

## APPENDIX E—SUPPLEMENTARY ACCESSIBILITY REQUIREMENTS

transportation facility, at least one TTY telephone complying with ICC A117.1, Section 704.4, shall be provided to serve that entrance.

**E109.2.6 Track crossings.** Where a *circulation path* serving boarding platforms crosses tracks, an *accessible* route shall be provided.

**Exception:** Openings for wheel flanges shall be permitted to be 2½ inches (64 mm) maximum.

**E109.2.7 Public address systems.** Where public address systems convey audible information to the public, the same or equivalent information shall be provided in a visual format.

**E109.2.8 Clocks.** Where clocks are provided for use by the general public, the clock face shall be uncluttered so that its elements are clearly visible. Hands, numerals and digits shall contrast with the background either light-on-dark or dark-on-light. Where clocks are mounted overhead, numerals and digits shall comply with visual character requirements.

**TABLE E111.1  
REFERENCED STANDARDS**

STANDARD ACRONYM	STANDARD NAME	SECTIONS HEREIN REFERENCED
DOJ 36 CFR Part 1192	<i>Americans with Disabilities Act (ADA) Accessibility Guidelines for Transportation Vehicles (ADAAG).</i> Washington, DC: Department of Justice, 1991	E109.2.4
IBC 2021	<i>International Building Code</i>	E102.1
ICC A117.1-2017	<i>Accessible and Usable Buildings and Facilities</i>	E101.2, E104.2.4, E106.4.9, E107.2, E107.3, E108.3, E108.4, E109.2.2.2, E109.2.2.3, E109.2.3, E109.2.5, E110.2

## SECTION E110 AIRPORTS

**E110.1 New construction.** New construction of airports shall comply with Sections E110.2 through E110.4.

**E110.2 TTYs.** Where public pay telephones are provided, at least one TTY shall be provided in compliance with ICC A117.1, Section 704.4. Additionally, if four or more public pay telephones are located in a main terminal outside the security areas, a concourse within the security areas or a baggage claim area in a terminal, at least one public TTY complying with ICC A117.1, Section 704.4, shall also be provided in each such location.

**E110.3 Terminal information systems.** Where terminal information systems convey audible information to the public, the same or equivalent information shall be provided in a visual format.

**E110.4 Clocks.** Where clocks are provided for use by the general public, the clock face shall be uncluttered so that its elements are clearly visible. Hands, numerals and digits shall contrast with the background either light-on-dark or dark-on-light. Where clocks are mounted overhead, numerals and digits shall comply with visual character requirements.

## SECTION E111 REFERENCED STANDARDS

**E111.1 General.** See Table E111.1 for standards that are referenced in various sections of this appendix. Standards are listed by the standard identification with the effective date, standard title, and the section or sections of this appendix that reference the standard.





## APPENDIX F

# RODENTPROOFING

*Deleted in its entirety.*





## APPENDIX G

# FLOOD-RESISTANT CONSTRUCTION

*Deleted in its entirety.*







## APPENDIX H

# SIGNS

*Deleted in its entirety.*





## APPENDIX I

# PATIO COVERS

*Deleted in its entirety.*







## APPENDIX J

# GRADING

*Deleted in its entirety.*





## APPENDIX K

# ADMINISTRATIVE PROVISIONS

*Deleted in its entirety.*







## APPENDIX L

# EARTHQUAKE RECORDING INSTRUMENTATION

*Deleted in its entirety.*





## APPENDIX M

# TSUNAMI-GENERATED FLOOD HAZARDS

*Deleted in its entirety.*







## APPENDIX N

# REPLICABLE BUILDINGS

*Deleted in its entirety.*





## [A] APPENDIX O

# PERFORMANCE-BASED APPLICATION

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

### User notes:

**About this appendix:** Appendix O provides an optional design, review and approval framework for use by the building official. Typical uses would include cases of alternate methods in Chapter 1, select areas of the code that require a rational analysis such as Section 909 and elsewhere. It simply extracts the relevant administrative provisions from the ICC Performance Code into a more concise, usable appendix format for a jurisdiction confronted with such a need. Currently there are multiple, varying jurisdictional rules and procedures in many communities regarding procedure and none in even more. The building official is often left alone to reach decisions not just on the merits of a design, but must first also decide on the submittal and review process. As an appendix, the provisions herein are entirely optional to a jurisdiction. This appendix can be adopted, adopted with local modifications, or even used on a case-by-case basis as part of a Memorandum of Understanding or similar legal agreement between the jurisdiction and the owner/design team. It simply represents another tool for the jurisdiction to reach for in cases of need; it neither encourages nor creates any additional opportunity for performance-based design.

**Code development reminder:** Code change proposals to this appendix will be considered by the Administrative Code Development Committee during the 2022 (Group B) Code Development Cycle.

### [A] SECTION O101 GENERAL

**O101.1 Introduction.** The following administrative provisions are excerpted from the *ICC Performance Code for Buildings and Facilities* and can be used in conjunction with the Alternate Methods provisions in Chapter 1, or for a review of submittals requiring a rational analysis or performance-based design. These provisions provide an established framework for the building official in terms of the design expertise needed, the necessary submittals, a review framework and related items.

**O101.2 Qualifications.** Registered design professionals shall possess the knowledge, skills and abilities necessary to demonstrate compliance with this code.

**O101.3 Construction document preparation.** Construction documents required by this code shall be prepared in adequate detail and submitted for review and approval in accordance with Section 107.

**O101.3.1 Review.** Construction documents submitted in accordance with this code shall be reviewed for code compliance with the appropriate code provisions in accordance with Section 107.

**O101.4 Construction.** Construction shall comply with the approved construction documents submitted in accordance with this code, and shall be verified and approved to demonstrate compliance with this code.

**O101.4.1 Facility operating policies and procedures.** Policies, operations, training and procedures shall comply with approved documents submitted in accordance with this code, and shall be verified and approved to demonstrate compliance with this code.

**O101.4.2 Maintenance.** Maintenance of the performance-based design shall be ensured throughout the life of the building or portion thereof.

**O101.4.3 Changes.** The owner or the owner's authorized agent shall be responsible to ensure that any change to the

facility, process, or system does not increase the hazard level beyond that originally designed without approval and that changes shall be documented in accordance with the code.

**O101.5 Documentation.** The registered design professional shall prepare appropriate documentation for the project, clearly detailing the approach and rationale for the design submittal, the construction and the future use of the building, facility or process.

**O101.5.1 Reports and manuals.** The design report shall document the steps taken in the design analysis, clearly identifying the criteria, parameters, inputs, assumptions, sensitivities and limitations involved in the analysis. The design report shall clearly identify bounding conditions, assumptions and sensitivities that clarify the expected uses and limitations of the performance analysis. This report shall verify that the design approach is in compliance with the applicable codes and acceptable methods and shall be submitted for concurrence by the building official prior to the construction documents being completed. The report shall document the design features to be incorporated based on the analysis.

The design report shall address the following:

1. Project scope.
2. Goals and objectives.
3. Performance criteria.
4. Hazard scenarios.
5. Design fire loads and hazards.
6. Final design.
7. Evaluation.
8. Bounding conditions and critical design assumptions.
9. Critical design features.
10. System design and operational requirements.
11. Operational and maintenance requirements.

## APPENDIX O—PERFORMANCE-BASED APPLICATION

12. Commissioning testing requirements and acceptance criteria.
13. Frequency of certificate renewal.
14. Supporting documents and references.
15. Preliminary site and floor plans.

**O101.5.2 Design submittal.** Applicable construction documents shall be submitted to the building official for review. The documents shall be submitted in accordance with the jurisdiction's procedures and in sufficient detail to obtain appropriate permits.

**O101.6 Review.** Construction documents submitted in accordance with this code shall be reviewed for code compliance with the appropriate code provisions.

**O101.6.1 Peer review.** The owner or the owner's authorized agent shall be responsible for retaining and furnishing the services of a registered design professional or recognized expert, who will perform as a peer reviewer, where required and approved by the building official.

**O101.6.2 Costs.** The costs of special services, including contract review, where required by the building official, shall be borne by the owner or the owner's authorized agent.

**O101.7 Permits.** Prior to the start of construction, appropriate permits shall be obtained in accordance with the jurisdiction's procedures and applicable codes.

**O101.8 Verification of compliance.** Upon completion of the project, documentation shall be prepared that verifies performance and prescriptive code provisions have been met. Where required by the building official, the registered design professional shall file a report that verifies bounding conditions are met.

**O101.9 Extent of documentation.** Approved construction documents, the operations and maintenance manual, inspection and testing records, and certificates of occupancy with conditions shall be included in the project documentation of the building official's records.

**O101.10 Analysis of change.** The registered design professional shall evaluate the existing building, facilities, premises, processes, and contents, and the applicable documentation of the proposed change as it affects portions of the building, facility, premises, processes and contents that were previously designed for compliance under a performance-based code. Prior to any change that was not documented in a previously approved design, the registered design professional shall examine the applicable design documents, bounding conditions, operation and maintenance manuals, and deed restrictions.



# INDEX

## A

### ACCESS OPENINGS

Attic . . . . .	1209.2
Crawl space . . . . .	1209.1
Doors . . . . .	712.1.13.2
Fire damper . . . . .	717.4
Fire department . . . . .	402.7.5
Mechanical appliances . . . . .	1209.3
Refuse/laundry chutes . . . . .	713.13.3

### ACCESSIBILITY . . . . . Chapter 11, 1009, Appendix E

Airport . . . . .	E110
Airport control towers . . . . .	412.2.6
Assembly . . . . .	1009.1, 1109.2, 1110.12, 1111
Bus stops . . . . .	E108
Construction sites . . . . .	1103.2.5
Controls . . . . .	1110.15
Detectable warnings . . . . .	1110.11
Detention and correctional facilities . . . . .	1103.2.13, 1108.5.5, 1109.4.2, E104.1
Dining areas . . . . .	1109.2.9, 1110.12
Dressing rooms . . . . .	1110.14
Drinking fountains . . . . .	1110.5
Dwelling units . . . . .	1103.2.3, 1105.1.7, 1108
Egress (see ACCESSIBLE MEANS OF EGRESS). . . . .	1009
Electrical Vehicle Charging Stations . . . . .	1107
Elevators . . . . .	1009.2.1, 1009.4, 1009.7.3, 1110.8, 3001.2, 3001.4
Employee work areas . . . . .	1103.2.2, 1104.3.1
Entrances . . . . .	1105
Exceptions . . . . .	1103.2, 1104.4, 1108.7
Fuel dispensing . . . . .	1110.14
Gaming tables and machines . . . . .	1110.16, E105.3
Institutional . . . . .	1103.2.12, 1103.2.13, 1108, 1110.12.2, E104.2.2
Judicial facilities . . . . .	1109.4, 1110.12.2
Kitchens . . . . .	1110.4
Laundry . . . . .	E105.2
Lifts . . . . .	1009.5, 1110.9
Live/work unit . . . . .	508.5.9, 1108.6.2.1
Parking and passenger loading facilities . . . . .	1106
Performance areas . . . . .	1109.2.8
Platform . . . . .	1109.2.8, E103.1
Press box . . . . .	1104.3.2
Ramps . . . . .	1012

### Recreational facilities

(see RECREATION FACILITIES) . . . . 1104.2, 1111

Religious worship, places of . . . . .	1103.2.8
Residential . . . . .	1103.2.3, 1103.2.11, 1108, E104
Route . . . . .	202, 1003.4, 1104, 1108.4, E104
Saunas and steam rooms . . . . .	1110.7
Scoping . . . . .	1101, 1103.1, E101.1
Seating . . . . .	1109.2, 1110.12
Service facility . . . . .	1110.13
Signage . . . . .	1009.8, 1009.11, 1111, E107
Sleeping units . . . . .	1105.1.7, 1108
Storage . . . . .	1109.3, 1110.10
Technical standard . . . . .	1102.1, E101.2
Telephone . . . . .	E106
Toilet and bathing facilities . . . . .	1108.6.1.1, 1110.2, 1110.3, E105.1
Train and light-rail stations . . . . .	E109
Transient lodging . . . . .	1103.2.11, 1108.6.1, E104.2
Utility . . . . .	1103.2.4

### ACCESSIBLE MEANS OF EGRESS . . . . . 202, 1009

Areas of refuge (see AREA OF REFUGE)	
Assembly . . . . .	1009.1, 1030.8
Elevators . . . . .	1009.2.1, 1009.4, 1009.8
Existing building . . . . .	1009.1
Exterior area for assisted rescue (see EXTERIOR AREA FOR ASSISTED RESCUE)	
Horizontal exit (see HORIZONTAL EXIT)	
Mezzanine . . . . .	1009.1
Platform lift . . . . .	1009.5
Required . . . . .	1009.1
Signage . . . . .	1009.8, 1009.11, 3002.3
Stairways . . . . .	1009.3

### ACCESSORY OCCUPANCIES

As occupancy exceptions . . . . .	303.1.2, 303.1.4, 305.1.1, 311.1.1, 312.1
Live/work units . . . . .	508.5
Mixed occupancy buildings . . . . .	508.2
Height . . . . .	508.2.2
Occupancy classification . . . . .	508.2.1
Separations . . . . .	508.2.4
Unlimited area buildings . . . . .	507.1.1

### ADDITION . . . . . 101.4.7, 202, D103.1

Means of egress . . . . .	3302.1, 3310
---------------------------	--------------

### ADDRESS IDENTIFICATION . . . . . 502.1

### ADMINISTRATION . . . . . Chapter 1

### ADOBE CONSTRUCTION . . . . . 202, 2109.2

## INDEX

**AEROSOL PRODUCTS** . . . . . 202, 307.1, 311.2,  
414.1.2.1, 414.2.5, 907.2.17

**AGGREGATE** . . . . . 202

Ballast . . . . . 1504.9

**AGRICULTURAL BUILDINGS**  
(see **GROUP U**) . . . . . 202, 306.2, 312.1,  
1103.2.4, Appendix C, G114.1

**AIR CONDITIONING (see **MECHANICAL**)**

**AIRCRAFT HANGARS** . . . . . 412.3

Aircraft paint hangars . . . . . 412.5, 507.10

Basements . . . . . 412.3.2

Construction . . . . . 412.3.1, 412.3.6, 412.5.2

Fire area . . . . . 412.3.6.2

Fire suppression system . . . . . 412.3.6, 412.5.5

Heliports and helistops . . . . . 412.7, 905.3.6, 1607.6

Residential. . . . . 412.4, 907.2.22

Unlimited height and area . . . . . 507.10

**AIRCRAFT MANUFACTURING FACILITIES** . . . . 412.6

**AIRCRAFT-RELATED OCCUPANCIES** . . . . 412, E110

Airport traffic control towers. . . . . 412.2, 907.2.23

Alarms and detection. . . . . 412.2.3.1, 907.2.23

Construction type . . . . . 412.2.1, 412.5.2, 412.6

Egress . . . . . 412.2.2, 412.2.5.1, 412.6.1, 412.7.3

Finishing . . . . . 412.3.5

Fire suppression . . . . . 412.2.4, 412.3.6, 412.5.5

Separation. . . . . 412.3.6.2, 412.4.1

**AIR-INFLATED OR**  
**AIR-SUPPORTED STRUCTURES** . . . . . 202,  
2702.2.14, 3102

**AISLE** . . . . . 202, 1018, 1030.9, 1030.14

Aisle accessways . . . . . 202, 1018.4, 1030.13

Assembly seating . . . . . 1018.2, 1030.6

Bleachers . . . . . 1030.1.1

Business . . . . . 1018.3

Check-out . . . . . 1110.13.1

Construction . . . . . 1030.12

Converging . . . . . 1030.9.3

Egress . . . . . 1018, 1030

Folding and telescopic seating . . . . . 1030.1.1

Grandstands . . . . . 1030.1.1

Mercantile . . . . . 1018.3, 1018.4

Obstructions . . . . . 1030.9.6.1

Tables . . . . . 1030.13.1

Temporary structures . . . . . 3103.4

Transitions. . . . . 1030.10

Width . . . . . 1030.9.1

**ALARM SYSTEMS, EMERGENCY** . . . . . 908

**ALARMS, FIRE (see **FIRE ALARM AND SMOKE DETECTION SYSTEMS**)**

**ALARMS, VISIBLE** . . . . . 907.5.2.3

Common areas . . . . . 907.5.2.3.1

Employee work areas. . . . . 907.5.2.3.1

Group I-1 . . . . . 907.5.2.3.2

Group R-1 . . . . . 907.5.2.3.2

Group R-2 . . . . . 907.5.2.3.3

Public areas . . . . . 907.5.2.3.1

**ALARMS, VOICE** . . . . . 907.5.2.2

Amusement buildings, special . . . . 411.4, 907.2.13.3

Covered and open mall buildings. . . . . 402.7.4,  
907.2.21

Emergency power . . . . . 2702.2

High-rise buildings . . . . . 403.4.4, 907.2.14

Occupant evacuation elevators . . . . . 3008.9

Underground buildings. . . . . 405.8.2, 907.2.20

**ALLOWABLE STRESS DESIGN** . . . . . 202

Load combinations . . . . . 1605, 1605.2

Masonry design . . . . . 2107

Wood design . . . . . 2102.1, 2306

**ALTERATIONS** . . . . . 101.4.7, 202, D103.1

Means of egress. . . . . 3302.1, 3310.2

**ALTERNATING TREAD DEVICES** . . . . . 202, 1011.14

Construction . . . . . 1011.14.2

Equipment platform . . . . . 505.3

Heliports . . . . . 412.7.3

Technical production areas . . . . . 410.5.3.4

**ALTERNATIVE MATERIALS,**  
**DESIGN AND METHODS** . . . . . 104.11, Appendix O

**ALUMINUM** . . . . . Chapter 20, 1403.5.1, 1604.3.5

**AMBULATORY CARE FACILITIES** . . . . . 202, 304.1,  
422, TABLE 509.1,  
709.5, TABLE 1020.3

Emergency and standby power . . . . . 2702.2

Fire protection and detection . . . . . 903.2.2, 903.3.2,  
907.2.2.1

Incapable of self-preservation . . . . . 202

Medical gas systems . . . . . 427

Smoke compartment . . . . . 422.2, 422.3,  
909.5.3, 1026.4.1

**AMUSEMENT AREA, SPECIAL** . . . . . 202, 411

Alarm and detection . . . . . 411.2, 411.4, 907.2.13

Classification . . . . . 411.1

Emergency voice/alarm  
communications system . . . . . 411.4, 907.2.13.3

Exit marking . . . . . 411.6, 411.6.1

Interior finish. . . . . 411.7

Puzzle room . . . . . 411.5

Sprinklers protection . . . . . 411.2

**AMUSEMENT PARK STRUCTURES** . . . . . 303

Accessibility . . . . . 1111.4.8

**ANCHOR BUILDING (see **COVERED MALL AND OPEN MALL BUILDING**)** . . . . . 202, 402

Construction type . . . . . 402.4.1.2, 507.13

Means of egress . . . . .	402.8.4.1	<b>AREA FOR ASSISTED RESCUE, EXTERIOR</b> (see <b>EXTERIOR AREA FOR ASSISTED RESCUE</b> )	
Occupant load . . . . .	402.8.2.3	<b>AREA OF REFUGE</b> (see also <b>ACCESSIBLE MEANS OF EGRESS</b> ) . . . . .	202
Separation . . . . .	402.4.2.2, 402.4.2.3	Requirements . . . . .	709.4.2, 1009.6
Sprinkler protection . . . . .	402.5	Signage . . . . .	1009.9, 1009.10, 1009.11, 1013.4, 1112.4
<b>ANCHORAGE</b> . . . . .	1604.8	Two-way communication . . . . .	1009.6.5, 1009.8
Braced wall line sills . . . . .	2308.3.1.1, 2308.3.1.2, 2308.6.7, 2308.6.7.3	Where required . . . . .	1009.2, 1009.3.3, 1009.4.2
Concrete . . . . .	1901.3	<b>ASSEMBLY OCCUPANCY (GROUP A)</b> . . . . .	303, 1030
Conventional light-frame construction . . . . .	2308.3.1, 2308.4.10	Accessibility . . . . .	1109.2, 1109.4, 1110.2.1, 1111, E103.1
Decks . . . . .	1604.8.3	Alarms and detection . . . . .	907.2.1
Seismic anchorage for masonry chimneys . . . . .	2113.4	Area . . . . .	503, 506, 507, 508
Seismic anchorage for masonry fireplaces . . . . .	2111.5	Bleachers (see <b>BLEACHERS</b> )	
Walls . . . . .	1604.8.2	Folding and telescopic seating (see <b>BLEACHERS</b> )	
Wood sill plates . . . . .	2308.3.1	General . . . . .	303.1
<b>APARTMENT HOUSES</b> . . . . .	310.3, 1108.6.2.2	Grandstands (see <b>GRANDSTANDS</b> )	
<b>APPEALS</b> . . . . .	113, Appendix B, G106	Group-specific provisions	
<b>APPROVED AGENCY</b> . . . . .	104.4, 202, 1703.1	A-1 . . . . .	303.2
<b>ARCHITECT</b> (see definitions for <b>REGISTERED DESIGN PROFESSIONAL</b> and <b>REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE</b> )		A-2 . . . . .	303.3
<b>ARCHITECTURAL TRIM</b> . . . . .	603.1, 1405.1.2	A-3 . . . . .	303.4
<b>AREA, BUILDING</b> . . . . .	Chapter 5, 202, 506, Table 506.2	A-4 . . . . .	303.5
Accessory uses . . . . .	508.2.3	A-5 . . . . .	303.6
Aircraft hangars, residential . . . . .	412.4.5	Motion picture theater . . . . .	409, 507.12
Allowable area determination . . . . .	506.2, 506.3	Special amusement buildings . . . . .	411
Basements . . . . .	506.1.3	Stages and platforms . . . . .	410
Buildings on same lot . . . . .	503.1.2	Height . . . . .	503, 504, 505, 508, 510
Covered and open mall building . . . . .	402.4.1, 402.4.1.1	Incidental uses . . . . .	509
Enclosed parking garage . . . . .	406.6.1, 510.3	Interior finishes . . . . .	Table 803.13, 804
Equipment platforms . . . . .	505.3.1	Live load . . . . .	Table 1607.1
Frontage bonus . . . . .	506.3	Means of egress	
Incidental uses . . . . .	509.3	Aisles . . . . .	1018.2, 1030.9, 1030.10, 1030.11
Limitations . . . . .	503, 506	Assembly spaces . . . . .	1030
Membrane structures . . . . .	3102.4	Exit signs . . . . .	1013.1
Mezzanines . . . . .	505.2.1	Guards . . . . .	1015.2, 1030.17
Mixed construction types . . . . .	3102.6	Main exit . . . . .	1030.3
Mixed occupancy . . . . .	508.2.3, 508.3.2, 508.4.2	Open air . . . . .	1005.3.1, 1005.3.2, 1006.3, 1009.6.4, 1019.3, 1027, 1030.6.2
Modifications . . . . .	506, 510	Panic hardware . . . . .	1010.2.9, 1010.4.1
Occupied roof . . . . .	503.1.4	Smoke-protected . . . . .	1005.3.1, 1005.3.2, 1006.3, 1009.6.4, 1019.3, 1027, 1030.6.2
Open mall building . . . . .	402.4.1	Travel distance . . . . .	1017.2, 1006.3, 1030.7, 1006.2.1
Open parking garage . . . . .	406.5.4, 406.5.4.1, 406.5.5, 510.2, 510.3, 510.4, 510.7, 510.8, 510.9	Mixed occupancies . . . . .	508.3, 508.4
Private garages and carports . . . . .	406.3.1	Accessory . . . . .	508.2
Special provisions . . . . .	510	Education . . . . .	303.1.3
Unlimited area . . . . .	503.1.1, 503.1.3, 506.1.1, 506.2, 507	Live/work units . . . . .	508.5
		Mall buildings . . . . .	402

## INDEX

Other occupancies . . . . .	303.1.1, 303.1.2, 303.1.3
Parking below/above . . . . .	510.7, 510.9
Religious facilities . . . . .	303.1.4
Special mixed . . . . .	510.2
Motion picture theaters . . . . .	409, 507.12
Occupancy exceptions . . . . .	303.1.1, 303.1.2, 303.1.3, 303.1.4, 305.1.1, 305.2.1
Plumbing fixtures . . . . .	2902
Risk category . . . . .	Table 1604.5
Seating, fixed (see SEATING, FIXED)	
Seating, open-air assembly seating . . . . .	1030.6.3
Seating, smoke-protected . . . . .	1030.6.2
Sprinkler protection . . . . .	410, 504.3, 506.2, 507.4 507.6, 507.7, 507.12, 903.2.1
Stages and platforms . . . . .	410, 905.3.4
Standpipes . . . . .	905.3.2, 905.3.4, 905.5.1
Unlimited area . . . . .	507.4, 507.4.1, 507.6, 507.7, 507.12
<b>ASSISTED LIVING</b> (see GROUP I-1 and GROUP R-4) . . . . .	308.2, 310.5, 420
<b>ATMOSPHERIC ICE LOADS</b> . . . . .	1614
<b>ATRIUM</b> . . . . .	202, 404
Alarms and detection . . . . .	404.4, 907.2.15
Enclosure . . . . .	404.6, 707.3.6
Interior finish . . . . .	404.8
Means of egress . . . . .	404.9, 404.10, 404.11, 1006.3.2, 1017.3, 1019.3, 1023.2, 1028.2
Smoke control . . . . .	404.5, 909
Sprinkler protection . . . . .	404.3
Standby power . . . . .	404.7
Travel distance . . . . .	404.9, 1006.2.1, 1006.3, 1017.2
Use . . . . .	404.2
<b>ATTIC</b> . . . . .	202
Access . . . . .	1209.2
Combustible storage . . . . .	413.2
Draftstopping . . . . .	718.4
Insulation . . . . .	720.3.1
Live load . . . . .	1607.1
Unusable space fire protection . . . . .	711.2.6
Ventilation . . . . .	1202.2
<b>AUDITORIUM</b> (see ASSEMBLY OCCUPANCY) . . . . .	303, 305.1.1
Accessibility . . . . .	1109.2
Foyers and lobbies . . . . .	1030.4
Interior balconies . . . . .	1030.5
Motion picture projection rooms . . . . .	409
Stages and platforms . . . . .	410
<b>AUTOMOBILE PARKING GARAGE</b> (see GARAGE, AUTOMOBILE PARKING)	

<b>AWNINGS</b> . . . . .	202, 3105
Design and construction . . . . .	3105.2
Drainage, water . . . . .	3201.4
Encroachment, public right-of-way . . . . .	3202.2.3, 3202.3.1, 3202.4
Fire district . . . . .	D102.2.8
Live load . . . . .	1607.1, 1607.14.2.1, 1607.14.3
Materials . . . . .	3105.3
Motor vehicle service stations (canopies) . . . . .	406.7.2
Permanent . . . . .	D102.2.8
Plastic . . . . .	2606.10

**B****BALCONIES**

Accessibility . . . . .	1109.2.4
Assembly . . . . .	1030.5
Construction, exterior . . . . .	705.2.3.1
Documents . . . . .	107.2.5, 110.3.7
Guards . . . . .	1015.2
Live load . . . . .	Table 1607.1
Means of egress . . . . .	1021, 1030.5
Open mall building . . . . .	402.4.3, 402.5
Projection . . . . .	705.2, 705.2.3.1
Public right-of-way encroachments . . . . .	3202.3.2, 3202.3.3
Travel distance . . . . .	1017.2.1

**BARBECUES** . . . . . 2801**BARRIERS**

Fire (see FIRE BARRIER)	
Pedestrian protection . . . . .	3306
Smoke (see SMOKE BARRIER)	
Vehicle . . . . .	202, 406.4.2, 1607.10
<b>BASEMENT (see UNDERGROUND BUILDINGS)</b> . . . . .	202
Aircraft hangars . . . . .	412.3.2
Area modification . . . . .	506.1.3
Emergency escape . . . . .	1031
Exits . . . . .	1006.3.4
Flood loads . . . . .	1612.1, 1612.4
Height modifications for . . . . .	510.5
Prohibited . . . . .	415.6, 415.7, 415.8, 415.11.6.2, 418.1, 421.2
Rodentproofing . . . . .	Appendix F
Sprinkler protection . . . . .	903.2.11.1
Waterproofing and dampproofing . . . . .	1805

**BASEMENT WALLS**

Soil loads . . . . .	1610.1
Waterproofing and dampproofing . . . . .	1805



<b>BATH AND BATHING ROOMS</b> <b>(see TOILETS AND TOILET ROOMS)</b> . . . Chapter 29,	
	101.4.3,
	105.2, 3114
<b>BAY AND ORIEL WINDOWS</b> . . . . .	705.2.4,
	1406.2, 1408.2
Public right-of-way encroachments. . . . .	3202.3.2,
	3202.3.3
<b>BLEACHERS</b> . . . . .	202, 303.6, 1030.1.1, 1030.17
Accessibility . . . . .	1104.3.2, 1109.2
Egress. . . . .	1030.1.1, 1030.17
Live load . . . . .	Table 1607.1, 1607.19
Occupant load. . . . .	1004.6
Separation . . . . .	903.2.1.5.1, 1030.1.1.1
<b>BLOCK (see CONCRETE BLOCK AND GLASS UNIT MASONRY)</b>	
<b>BOARD OF APPEALS</b> . . . . .	104.8, 113, Appendix B
Alternate members . . . . .	B101.3.2
Application for appeal . . . . .	B101.1
Board decision . . . . .	B101.7
Limitations on authority. . . . .	113.2
Membership of board . . . . .	B101.3
Notice of meeting . . . . .	B101.5
Qualifications . . . . .	113.3, B101.3.1
<b>BOILER ROOM</b>	
Exits . . . . .	1006.2.2.1
<b>BOLTS</b> . . . . .	2204.2
Anchor rods . . . . .	1901.3, 1905, 2204.3
<b>BONDING, MASONRY</b> . . . . .	1805.2.2, 2103.2.2,
	2113.3.1, 2510.7
<b>BRACED WALL LINE</b> . . . . .	202
Bracing . . . . .	2308.6
Seismic requirements . . . . .	2308.6.6.2, 2308.6.8,
	2308.6.10.2
Sill anchorage . . . . .	2308.6.7.3
Spacing . . . . .	2308.6.1
Support . . . . .	2308.6.8
<b>BRACED WALL PANEL</b> . . . . .	202
Alternative bracing . . . . .	2308.6.5.1, 2308.6.5.2
Connections . . . . .	2308.6.7
Length. . . . .	2308.6.4
Location . . . . .	2308.6.2
Method . . . . .	2308.6.3
<b>BRICK (see MASONRY)</b>	
<b>BUILDING</b>	
Area (see AREA, BUILDING) . . . . .	202, 502.1,
	503, 505, 506, 507, 508, 510
Demolition. . . . .	3303
Existing . . . . .	101.4.7
Fire walls. . . . .	706.1
Height (see HEIGHT, BUILDING) . . . . .	502.1, 503,
	504, 505, 508, 510
Occupancy classification . . . . .	Chapter 3
Party walls . . . . .	706.1.1
Replicable . . . . .	Appendix n
<b>BUILDING DEPARTMENT</b> . . . . .	103
<b>BUILDING OFFICIAL</b> . . . . .	202
Duties and powers. . . . .	103, 104
Qualifications . . . . .	Appendix A
Records . . . . .	104.7
Termination . . . . .	A101.4
<b>BUILT-UP ROOFS</b> . . . . .	202, 1507.10
<b>BUSINESS OCCUPANCY</b>	
<b>(GROUP B)</b> . . . . .	303.1.1, 303.1.2, 304
Alarms and detection. . . . .	907.2.2
Ambulatory care facilities. . . . .	304, 422
Area . . . . .	503, 505, 506, 507, 508
Height . . . . .	503, 504, 505, 508, 510
Higher education laboratories . . . . .	428, 2702.2
Incidental uses. . . . .	509
Interior finishes . . . . .	Table 803.13, 804
Live load . . . . .	Table 1607.1
Means of egress	
Aisles . . . . .	1018.3
Stairway, exit access . . . . .	1019
Travel distance. . . . .	1006.3, 1017.2, 1006.2.1
Mixed occupancies . . . . .	508.2, 508.3, 508.4
Accessory . . . . .	303.1.2, 508.2
Ambulatory care facilities. . . . .	422
Assembly . . . . .	303.1.2
Educational . . . . .	303.1, 304.1
Live/work units . . . . .	508.5
Mall buildings . . . . .	402
Parking below/above . . . . .	510.7, 510.8, 510.9
Special mixed. . . . .	510.2
Occupancy exceptions . . . . .	303.1.1, 303.1.2
Plumbing fixtures . . . . .	2902
Risk category. . . . .	Table 1604.5
Sprinkler protection . . . . .	903.2.2
Unlimited area . . . . .	507.4, 507.5, 507.13
<b>C</b>	
<b>CABLES, STEEL STRUCTURAL</b> . . . . .	2208
<b>CALCULATED FIRE RESISTANCE</b> <b>(see FIRE RESISTANCE, CALCULATED)</b>	
<b>CANOPIES</b> . . . . .	202, 706.5.2, 3105
Design and construction . . . . .	3105.2
Drainage, water . . . . .	3201.4
Encroachment, public right-of-way . . . . .	3202.3.1
Fire district . . . . .	D102.2.8

## INDEX

Live load . . . . . Table 1607.1, 1607.14.2.1  
 Materials . . . . . 3105.3  
 Motor vehicle related . . . . . 406.2.2, 406.7.2  
 Permanent . . . . . 3105, D102.2.8  
 Plastic . . . . . 2606.10

**CARBON MONOXIDE ALARMS AND DETECTION** . . . . . 202, 915

**CARE FACILITIES (see HEALTH CARE)**

**CARE PROVIDER STATIONS** . . . . . 407.2.2

**CARE SUITES** . . . . . 202, 407.4.4

**CARPET** . . . . . 105.2  
 Floor covering . . . . . 804.2, 804.3  
 Textile ceiling finish . . . . . 803.6  
 Textile wall coverings . . . . . 803.5

**CATWALKS (see TECHNICAL PRODUCTION AREAS)**  
 Construction . . . . . 410.2.2  
 Live Load . . . . . Table 1607.1  
 Means of egress . . . . . 410.5, 1011.16  
 Sprinkler protection . . . . . 410.6

**CEILING**  
 Acoustical . . . . . 808  
 Height . . . . . 406.2.2, 409.2, 909.20.4.3,  
 1003.2, 1011.3, 1012.5.2,  
 1204.2.2, 1208.2  
 Interior finish . . . . . 803  
 Penetration of fire-resistant  
 assemblies . . . . . 713.4, 716.1.2.3, 716.3.4  
 Suspended acoustical . . . . . 808.1.1, 2506.2.1

**CELLULOSE NITRATE FILM** . . . . . 409.1, 903.2.5.3

**CERAMIC TILE**  
 Mortar . . . . . 2103.2.3

**CERTIFICATE OF OCCUPANCY** . . . . . 106.2, 111

**CHANGE OF OCCUPANCY** . . . . . 101.4.7, 111.1,  
 116.5, 202, 3113.1.1, D103.2

**CHILD CARE (see DAY CARE)** . . . . . 305.2, 308.5

**CHIMNEYS** . . . . . 202  
 Factory-built . . . . . 718.2.5  
 Flashing . . . . . 1503.5  
 Masonry . . . . . 2111, 2112, 2113  
 Protection from adjacent construction . . . . . 3307.1

**CHURCHES (see RELIGIOUS WORSHIP, PLACES OF)**

**CLAY ROOF TILE** . . . . . 1507.3  
 Testing . . . . . 1504.3

**CLINIC**  
 Hospital  
 [see INSTITUTIONAL (GROUP I-2)] . . . . . 308.2  
 Outpatient  
 (see AMBULATORY CARE FACILITIES) . . . . . 202,  
 304.1, 422

**COAL POCKETS** . . . . . 426.1.6

**CODES** . . . . . Chapter 35, 101.2, 101.4,  
 102.2, 102.4, 102.6

**COLD-FORMED STEEL** . . . . . 202, 2210  
 Light-frame construction . . . . . 2211  
 Special inspection . . . . . 1705.2.2, 1705.2.4,  
 1705.12.2, 1705.13.3

**COMBUSTIBLE DUSTS** . . . . . 202, 307.4, 414.5.1, 426.1

**COMBUSTIBLE LIQUIDS** . . . . . 202, 307.1, 307.4, 307.5,  
 414.2.5, 414.5.3, 415.9.2,  
 415.10.1, 418.6

**COMBUSTIBLE MATERIAL**  
 Concealed spaces . . . . . 413.2, 718.5  
 Exterior side of exterior wall . . . . . 1405  
 High-pile stock or rack storage . . . . . 413.1, 910.2.2  
 Type I and Type II . . . . . 603, 805

**COMBUSTIBLE PROJECTIONS** . . . . . 705.2, 705.2.3.1

**COMBUSTIBLE STORAGE** . . . . . 413, 910.2.2

**COMMON PATH OF EGRESS TRAVEL** . . . . . 1006.2.1

**COMPARTMENTATION**  
 Ambulatory care facilities . . . . . 422.2, 422.3  
 Group I-2 . . . . . 407.5, 407.6  
 Group I-3 . . . . . 408.6  
 Laboratory suites . . . . . 428.3  
 Underground buildings . . . . . 405.4, 405.5.2

**COMPRESSED GAS** . . . . . 307.2, 415.11.8

**CONCEALED SPACES** . . . . . 413.2, 718

**CONCRETE** . . . . . Chapter 19  
 ACI . . . . . 1901.2, 1903.1, 1905  
 Anchorage . . . . . 1901.3  
 Calculated fire resistance . . . . . 722.2  
 Construction documents . . . . . 1901.5  
 Durability . . . . . 1904  
 Footings . . . . . 1809  
 Foundation walls . . . . . 1807.1.5, 1808.8  
 Materials . . . . . 1705.3.2, 1903  
 Plain, structural . . . . . 1906  
 Reinforced gypsum concrete . . . . . 2514  
 Rodentproofing . . . . . Appendix F  
 Roof tile . . . . . 1504.3, 1507.3  
 Shotcrete . . . . . 1908  
 Slab, minimum . . . . . 1907  
 Special inspections . . . . . 1705.3, Table 1705.3  
 Specifications . . . . . 1903  
 Strength testing . . . . . 1705.3.2  
 Wood support . . . . . 2304.13

**CONCRETE MASONRY**  
 Calculated fire resistance . . . . . 722.3  
 Construction . . . . . 2104  
 Design . . . . . 2101.2, 2108, 2109  
 Materials . . . . . 2103.1

Surface bonding . . . . .	2103.2.2, 2109.2	Type II . . . . .	Table 601, 602.2, 603
Wood support . . . . .	2304.13	Type III. . . . .	Table 601, 602.3
<b>CONCRETE ROOF TILE</b> . . . . .	1507.3	Type IV . . . . .	Table 601, 602.4
Wind resistance . . . . .	1504.3, 1609.5.3	Type V . . . . .	Table 601, 602.5
<b>CONDOMINIUM (see APARTMENT HOUSES)</b>		Underground buildings . . . . .	405.2
<b>CONDUIT,</b>		<b>CONTRACTOR'S RESPONSIBILITIES</b> . . . . .	901.5, 1704.4
<b>PENETRATION PROTECTION</b> . . . . .	713.3, 1023.5	<b>CONTROL AREA</b> . . . . .	414.2, 707.3.8
<b>CONFLICTS IN CODE</b> . . . . .	102, 104.10.1	Construction . . . . .	414.2.1
<b>CONGREGATE</b>		Fire-resistance rating . . . . .	414.2.4
<b>LIVING FACILITIES</b> . . . . .	202, 310.2, 310.3, 310.4	Maximum allowed quantities . . . . .	414.2.2
<b>CONSTRUCTION (see SAFEGUARDS DURING CONSTRUCTION)</b>		Number . . . . .	414.2.3
<b>CONSTRUCTION DOCUMENTS</b> . . . . .	107, 202, 1603	<b>CONVENTIONAL LIGHT-FRAME CONSTRUCTION</b> . . . . .	202, 2302.1, 2308
Alarms and detection . . . . .	907.1.1	Additional seismic requirements . . . . .	2308
Balconies . . . . .	107.2.5	Braced wall lines . . . . .	2308.6
Concrete construction . . . . .	1901.5	Connections and fasteners . . . . .	2308.1.2
Design load-bearing capacity . . . . .	1803.6	Design of elements . . . . .	2308.8
Exterior walls . . . . .	107.2.4	Floor joists . . . . .	2308.4.2
Fire protection . . . . .	107.2.2	Foundation plates or sills . . . . .	2308.3
Fire-resistant joint systems . . . . .	715	Girders . . . . .	2308.4.1
Flood . . . . .	107.2.6.1, 1603.1.7	Limitations . . . . .	2308.2
Floor live load . . . . .	1603.1.1	Roof and ceiling framing . . . . .	2308.7
Geotechnical . . . . .	1603.1.6	Wall framing . . . . .	2308.5
Means of egress . . . . .	107.2.3	<b>CONVEYING SYSTEMS</b> . . . . .	3004
Penetrations . . . . .	714	<b>CORNICES</b>	
Permit application . . . . .	105.1	Definition . . . . .	202
Relocation . . . . .	107.2.8	Draftstopping . . . . .	718.2.6
Retention . . . . .	107.5	Live load . . . . .	Table 1607.1
Review . . . . .	107.3	Masonry . . . . .	2104.1.2
Roof assemblies . . . . .	1503	Projection . . . . .	705.2, 705.2.3.1
Roof live load . . . . .	1603.1.2	Public right-of-way encroachments . . . . .	3202.3.2, 3202.3.3
Roof rain load data . . . . .	1603.1.9	<b>CORRIDOR (see CORRIDOR PROTECTION, EXIT ACCESS, FIRE PARTITIONS and SERVICE CORRIDORS)</b> . . . . .	1020
Roof snow load . . . . .	1603.1.3	Air movement . . . . .	1020.5
Seismic . . . . .	1603.1.5, 1705.14.2, 1705.14.3	Continuity . . . . .	1020.6
Site plan . . . . .	107.2.6	Covered and open mall buildings . . . . .	402.8.1, 402.8.6
Special loads . . . . .	1603.1.8	Dead end . . . . .	1020.4
Temporary structures . . . . .	3103.2	Elevation change . . . . .	1003.5
Wind data . . . . .	1603.1.4	Encroachment . . . . .	1020.3
<b>CONSTRUCTION JOINTS</b>		Group H-5 . . . . .	415.11.2
Shotcrete . . . . .	1908	Group I-1 . . . . .	420.7, 420.8
<b>CONSTRUCTION TYPES</b> . . . . .	Chapter 6, 202	Group I-2 . . . . .	407.2, 407.3, 407.4.1, 407.4.3
Aircraft-related occupancies . . . . .	412.2.1, Table 412.3.6, 412.5.2	Headroom . . . . .	1003.2, 1003.3
Classification . . . . .	602	HPM service . . . . .	903.2.5.2
Combustible material in		Live load . . . . .	Table 1607.1
Type I and Type II construction . . . . .	603, 805	Walls . . . . .	708.1, 1020.1
Covered and open mall buildings . . . . .	402.4.1	Width/capacity . . . . .	1003.3.3, 1003.6, 1005.3.2, 1005.7, 1020.3, 1020.4
Fire district . . . . .	D102.2.3		
Fire resistance . . . . .	Table 601, Table 705.5		
High-rise . . . . .	403.2		
Type I . . . . .	Table 601, 602.2, 603		

## INDEX

**CORRIDOR PROTECTION, EXIT ACCESS**

Construction, fire protection	708.1,
	Table 1020.2, 1020.7
Doors	716.2.2.1
Elevator hoistway opening	3006.2.1
Glazing	716.2.5.3
Group I-1	420.7, 420.8
Group I-2	407.3
Interior finish	Table 803.13, 804.4
Opening protection	716
Ventilation	1020.6, 1020.6.1

<b>CORROSIVES</b>	202, 307.2, 307.6, Table 414.2.5(1),
	414.3, 415.10.3,
	Table 415.11.1.1.1

<b>COURTS (see YARDS OR COURTS)</b>	1205
-------------------------------------	------

**COVERED AND OPEN MALL BUILDINGS** 402

Alarms and detection	402.7.4, 907.2.21, 2702.2
Anchor buildings	402.4.1.2, 402.4.2.2,
	402.4.2.3, 402.5,
	402.8.2.3, 402.8.4.1
Construction type	402.4
Fire department	402.3, 402.7.5
Interior finish	402.6.1
Kiosk	402.6.2
Means of egress	402.8
Occupant load	402.8.2
Open mall construction	402.4.3
Open space	402.2
Parking structures	402.4.1.3, 402.4.2.3
Perimeter line	402.1.1
Play structures	402.6.3, 424
Separation	402.4.2
Signs	402.6.4
Smoke control	402.7.2
Sprinkler protection	402.5
Standby power	402.7.3
Standpipe system	402.7.1, 905.3.3
Travel distance	402.8.5, 1006.2.1, 1006.3,
	1017.2, 2902.3.2, 2902.3.3, 2902.5

**COVERED WALKWAY**

(see PEDESTRIAN WALKWAY)	3104, 3306.7
--------------------------	--------------

**CRAWL SPACE**

Access	1209.1
Drainage	1805.1.2
Unusable space fire protection	711.2.6
Ventilation	1202.4

<b>CRIPPLE WALL</b>	202, 2308.5.6,
	2308.6.6, 2308.6.8.3

<b>CROSS-LAMINATED TIMBER</b>	602.4, 602.4.4.2,
	2303.1.4

Floors	2304.11.3.1
--------	-------------

Roofs	2304.11.4.1
<b>CRYOGENIC</b>	202, Table 307.1(1), 307.4,
	307.5, Table 414.5.1, Table 415.11.1.1.1

**D****DAMP-PROOFING AND WATERPROOFING** 1805

Required	1805.2, 1805.3
Subsoil drainage system	1805.4
<b>DAY CARE</b>	305.2, 308.5, 310.4.1
Accessibility	1103.2.12
Adult care	308.5
Child care	308.5, 310.4.1
Egress	308.5, Table 1004.5, 1006.2.2.4

<b>DEAD END</b>	415.11.3.3, 1020.5, 1021.1
-----------------	----------------------------

<b>DEAD LOAD</b>	202, 1606
------------------	-----------

Foundation design load	1808.3
------------------------	--------

**DECK**

Anchorage	1604.8.3
Live loads	Table 1607.1

<b>DEFLECTIONS</b>	1604.3.1
--------------------	----------

Framing supporting glass	2403.3
Preconstruction load tests	1709.3.1
Wood diaphragms	2305
Wood shear walls	2305

<b>DEMOLITION</b>	3303
-------------------	------

<b>DESIGN STRENGTH</b>	202
------------------------	-----

Conformance to standards	1706.1
New materials	1706.2

<b>DESIGNATED SEISMIC SYSTEM</b>	202, 1704.3.2,
	1704.4, 1704.5

Seismic certification	1705.14.3
Special inspection	1705.13.4

<b>DIAPHRAGMS</b>	202
-------------------	-----

Analysis	1604.4
Ceilings	2508.6
Special inspection	1705.5.1, 1705.12.1,
	1705.13.2

Wood	2305, 2306.2
------	--------------

<b>DOORS</b>	1010
--------------	------

Atrium enclosures	404.6
Configuration	1007
Delayed egress	1010.2.13
Dwelling unit separations	406.3.2, 412.4.1
Education	1010.2.8
Emergency escape	1031.2
Fabrication (HPM) areas	415.11.1.2
Fire	
(see OPENING PROTECTIVES)	716.2, 1023.4
Glazing	715.7, 716.2.5, 716.3, 1404.13



Hardware (see LOCKS AND LATCHES) . . . . 1005.7.1,  
1010.2, 1010.2.9  
Hazardous storage . . . . . 415.11.6.7  
Horizontal sliding . . . . . 1010.3.3  
I-1 occupancies . . . . . 1010.2.14  
I-2 occupancies . . . . . 407.3.1, 1010.2.14  
I-3 occupancies . . . . . 408.3, 408.4, 408.8.4, 1010.2.15  
Landings . . . . . 1010.1.4, 1010.1.5  
Locks for toilet facilities . . . . . 2902.4  
Operation . . . . . 1010.1.3, 1010.2, 1010.2.9  
Panic and fire exit hardware . . . . . 1010.2.9, 1010.4.1  
Power-operated . . . . . 1010.3.2  
Revolving . . . . . 1010.3.1  
Security . . . . . 402.8.8, 1010.2.10, 1010.3.4  
Sensor release . . . . . 1010.2.12  
Side swinging . . . . . 1010.1.2  
Smoke . . . . . 710.5  
Stairways . . . . . 1010.2.7  
Stairways, high-rise . . . . . 403.5.3  
Structural testing, exterior . . . . . 1709.5  
Thresholds . . . . . 1003.5, 1010.1.4, 1010.1.6  
Vestibule . . . . . 1010.1.7  
Width . . . . . 1010.1.1, 1010.1.1.1  
**DORMITORIES** . . . . . 202, 310.3, 310.4, 420.11.1  
Accessibility . . . . . 1108.6.2.3, 1108.6.3  
Cooking . . . . . 420.11, 904.14  
Fire alarms and smoke alarms . . . . . 420.5  
Separations . . . . . 420.2, 420.3  
Sprinkler protection . . . . . 420.4  
**DRAFTSTOPPING** . . . . . 202  
Attics . . . . . 718.4  
Floor-ceiling assemblies . . . . . 718.3  
**DRINKING FOUNTAINS** . . . . . 1110.5, 2902.5, 2902.6  
Accessibility . . . . . 1110.5.1, 1110.5.2, 1110.6, 1112.3  
**DRY CLEANING PLANTS** . . . . . 415.9.3  
**DRYING ROOMS** . . . . . 417  
**DUMBWAITERS** . . . . . 713.14  
**DWELLING UNITS** . . . . . 202, 310.3, 310.4  
Accessibility . . . . . 1103.2.3, 1103.2.12,  
1105.1.8, 1106.3, 1108  
Alarms and detection . . . . . 420.5, 907.2.8,  
907.2.9, 907.2.12  
Area . . . . . 1208.3, 1208.4  
Efficiency dwelling unit . . . . . 202, 1208.4  
Group R . . . . . 310  
Live/work units (see LIVE/WORK UNITS)  
Plumbing fixtures required . . . . . Table 2902.1  
Scoping . . . . . 101.2  
Separation . . . . . 420.2, 420.3  
Sound transmission . . . . . 1206  
Sprinkler protection . . . . . 420.4, 903.2.8

## E

**EARTHQUAKE LOADS (see SEISMIC)** . . . . . 1613  
**EARTHQUAKE  
RECORDING EQUIPMENT** . . . . . Appendix L  
**EAVES (see COMBUSTIBLE PROJECTIONS AND  
CORNICES)**  
**EDUCATIONAL OCCUPANCY (GROUP E)** . . . . . 305  
Accessibility . . . . . 1109.2, 1110.5.1, 1110.5.2  
Alarms and detection . . . . . 907.2.3  
Area . . . . . 503, 505, 506, 507, 508  
Height . . . . . 503, 504, 505, 508  
Incidental uses . . . . . 509  
Interior finishes . . . . . Table 803.13, 804  
Live load . . . . . Table 1607.1  
Locking . . . . . 1010.2.8  
Means of egress  
Aisles . . . . . 1018.2, 1018.5  
Corridors . . . . . 1020.2, 1020.3  
Panic hardware . . . . . 1010.2.9  
Stairway, exit access . . . . . 1019  
Travel distance . . . . . 1017.2, 1006.3.3, 1006.2.1  
Mixed occupancies . . . . . 508.3, 508.4  
Accessory . . . . . 303.1.3, 508.2  
Assembly . . . . . 303.1.3  
Day care . . . . . 305.2, 308.4, 310.4.1  
Education for students  
above the 12th grade . . . . . 304, 307.1, 427  
Gyms (see GYMNASIUMS) . . . . . 303.1.3  
Libraries (see LIBRARIES) . . . . . 303.4  
Religious facilities . . . . . 305.2  
Stages and platforms . . . . . 410  
Plumbing fixtures . . . . . 2902  
Risk category . . . . . Table 1604.5  
Sprinkler protection . . . . . 903.2.3  
Unlimited area . . . . . 507.11  
**EGRESS (see MEANS OF EGRESS)** . . . . . Chapter 10  
**ELECTRIC VEHICLE  
CHARGING STATION** . . . . . 202, 406.2.7, 1107  
**ELECTRICAL** . . . . . Chapter 27, 105.2, 112,  
Table 509.1, Appendix K  
**ELEVATOR** . . . . . Chapter 30  
Accessibility . . . . . 1009.2.1, 1009.4,  
1009.8, 1110.8, 3001.4  
Car size . . . . . 403.6.1, 3001.4, 3002.4  
Construction . . . . . 713.14, 1607.11.1  
Conveying systems . . . . . 3004  
Emergency communication . . . . . 3001.2  
Emergency operations . . . . . 3002.3, 3002.5,  
3003, 3007.1, 3008.1.4  
Fire service access . . . . . 403.6.1, 3007  
Glass . . . . . 2409, 3002.8

## INDEX

- High-rise . . . . . 403.2.2, 403.4.8, 403.6  
 Hoistway enclosures . . . . . 403.2.2, 713, 1023.4,  
     1024.3, 3002, 3007.5, 3008.5  
 Hoistway lighting . . . . . 3007.5.2  
 Hoistway pressurization . . . . . 909.21  
 Hoistway rated corridor opening . . . . . 3006.2.1  
 Keys . . . . . 3003.3  
 Lobby. . . . . 1009.4, 1009.8, 3006, 3007.6, 3008.6  
 Machine rooms . . . . . Table 1607.1, 3005  
 Means of egress . . . . . 403.6, 1003.7, 1009.2.1,  
     1009.4, 3008  
 Number of elevator cars in hoistway . . . . . 3002.2  
 Occupant evacuation elevators . . . . . 403.6.2, 3008  
 Personnel and material hoists . . . . . 3004.4  
 Roof access. . . . . 1011.12.2  
 Shaft enclosure . . . . . 712, 3006  
 Signs . . . . . 914, 1009.10, 3002.3, 3007.6.5, 3008.6.5  
 Stairway to elevator equipment. . . . . 1011.12.1  
 Standards . . . . . 3001.3  
 Standby power . . . . . 2702.2, 3007.8, 3008.8  
 System monitoring. . . . . 3007.7, 3008.7  
 Underground . . . . . 405.4.3
- EMERGENCY COMMUNICATIONS**  
 Accessible means of egress . . . . . 1009.8  
 Alarms (see FIRE ALARMS)  
 Elevator . . . . . 3001.2  
 Elevators, occupant evacuation . . . . . 3008.6.6  
 Fire command center . . . . . 403.4.6, 911, 3007.7,  
     3008.6.6, 3008.7  
 Radio coverage . . . . . 403.4.5, 916
- EMERGENCY ESCAPE AND RESCUE OPENINGS** . . . . . 202, 1031  
 Required . . . . . Table 1006.3.4(1), Table 1006.3.4(2),  
     1031.2  
 Window wells. . . . . 1031.5, 1031.6
- EMERGENCY LIGHTING** . . . . . 1008.3, 1204.5
- EMERGENCY POWER** . . . . . 2702  
 Exit signs . . . . . 1013.6.3, 2702.2  
 Hazardous . . . . . 415.11.11, 2702.2  
 Higher education laboratory . . . . . 428.3.6, 2702.2  
 High-rise . . . . . 403.4.8, 2702.2  
 Means of egress illumination. . . . . 1008.3, 2702.2  
 Semiconductor fabrication. . . . . 415.11.11, 2702.2  
 Underground buildings . . . . . 405.8, 2702.2
- EMERGENCY RESPONDERS**  
 Additional exit stairway . . . . . 403.5.2  
 Elevators . . . . . 403.6, 1009.2.1, 3002.4,  
     3003, 3007, 3008  
 Fire command center . . . . . 403.4.6, 911, 3007.7,  
     3008.6.6, 3008.7
- Mall access . . . . . 402.7.5  
 Radio coverage . . . . . 403.4.5, 918  
 Roof access . . . . . 1011.12  
 Safety features . . . . . 914
- EMPIRICAL DESIGN OF MASONRY**  
 Adobe construction . . . . . 2109  
 Dry-stack masonry . . . . . 2114  
 Special inspection . . . . . 1705.4
- EMPLOYEE**  
 Accessibility for work areas . . . . . 907.5.2.3.1,  
     1103.2.2, 1104.3.1  
 Deputies to building official . . . . . 103.3  
 Liability . . . . . 104.8  
 Qualifications . . . . . A101  
 Termination of employment . . . . . A101.4  
 Toilet facilities. . . . . 2902.3
- ENCROACHMENTS INTO THE PUBLIC RIGHT-OF-WAY** . . . . . Chapter 32
- END-JOINTED LUMBER** . . . . . 2303.1.1.2  
 Relocated structures . . . . . 101.4.7, D103.3  
 Rodentproofing. . . . . Appendix F
- ENERGY EFFICIENCY** . . . . . Chapter 13, 101.4.6, 110.3.9
- ENGINEER (see definition for REGISTERED DESIGN PROFESSIONAL)**
- EQUIPMENT PLATFORM** . . . . . 505.3  
 Area limitation . . . . . 505.2.1, 505.2.1.1, 505.3.1  
 Automatic sprinkler system . . . . . 505.3.2
- EQUIVALENT OPENING FACTOR** . . . . . Figure 705.7
- ESCALATORS** . . . . . 3004  
 Floor opening protection . . . . . 712.1.3  
 Means of egress. . . . . 1003.7
- ESSENTIAL FACILITIES (see RISK CATEGORY)** . . . . . 202, Table 1604.5
- EXCAVATION, GRADING AND FILL** . . . . . 1804, 3304
- EXISTING BUILDING** . . . . . 101.4.7, 102.6, 202,  
     705.3, 912.2.2, 915.1  
 Additions . . . . . D103.1  
 Alteration . . . . . D103.1  
 Change of occupancy . . . . . D103.2  
 Flood-resistant . . . . . 104.2.1, Appendix G  
 Historic . . . . . 101.4.7  
 Relocated structures . . . . . D103.3  
 Repairs. . . . . 101.4.7, 116.5  
 Rodentproofing. . . . . Appendix F
- EXIT (see MEANS OF EGRESS)** . . . . . 1022, 1023, 1024,  
     1025, 1026, 1027  
 Atrium. . . . . 404.10, 1023.2  
 Boiler room. . . . . 1006.2.1.1  
 Configuration . . . . . 1007  
 Construction. . . . . 713.2, 1019, 1023.2  
 Doorways . . . . . 1007

Dwellings . . . . .	1006.2.2.6, 1006.3.4.1	Stages, Platforms and Technical Production Areas . . . . .	410.5
Electrical rooms . . . . .	1006.2.2.4	Stairways, exit access . . . . .	1019
Enclosure . . . . .	707.3.2, 1023.2	Underground buildings . . . . .	405.7
Fire resistance . . . . .	707.3, 1019, 1023.2	<b>EXIT DISCHARGE</b> <b>(see MEANS OF EGRESS)</b> . . . . .	1023.3, 1023.12.1, 1024.4, 1028, 1029
Furnace rooms . . . . .	1006.2.2.1	Atrium . . . . .	404.11
Group H-5 . . . . .	415.11.6.6	Barriers . . . . .	1023.8
High rise . . . . .	403.5, 403.6, 1025	Courts . . . . .	1029
Horizontal . . . . .	707.3.5, 1026	Exit passageway . . . . .	1024.4
Incinerator rooms . . . . .	1006.2.2.1	Horizontal exit . . . . .	1028.2
Interior finish . . . . .	Table 803.13, 804	Lobbies . . . . .	1028.2
Luminous . . . . .	403.5.5, 411.6.1, 1008.2.1, 1013.5, 1025	Marquees . . . . .	3106.4
Mall buildings . . . . .	402.8	Public way . . . . .	1028.5
Number, minimum . . . . .	402.8.3, 403.5, 1006	Termination . . . . .	1023.3
Occupant load . . . . .	402.8.2, 1004.2, 1006.3.2	Vestibules . . . . .	1028.2
Passageway . . . . .	707.3.4, 1024	<b>EXIT SIGNS</b> . . . . .	1013
Ramps, exterior . . . . .	1027	Accessibility . . . . .	1013.4
Ramps, interior . . . . .	1023	Floor level exit signs . . . . .	1013.2
Refrigerated room . . . . .	1006.2.2.2, 1006.2.2.3	Group R-1 . . . . .	1013.2
Refuge area . . . . .	407.5.3, 408.6.2, 420.6.1, 422.3.2	Illumination . . . . .	1013.3, 1013.5, 1013.6
Stairways, exterior . . . . .	1027	Required . . . . .	1013.1
Stairways, interior . . . . .	1023	Special amusement buildings . . . . .	411.6
Stories . . . . .	1004.2.3, 1006.3, 1017.3.1	<b>EXPLOSIVES</b> . . . . .	202, Table 414.5.1, Table 415.6.5
Travel distance . . . . .	404.9, 407.5.2, 410.5.3.2, 412.6	Detached building . . . . .	415.6.5, 415.8
Underground buildings . . . . .	405.7	Explosion control . . . . .	414.5.1
<b>EXIT ACCESS</b> <b>(see MEANS OF EGRESS)</b> . . . . .	1016, 1017, 1018, 1019, 1020, 1021	<b>EXPOSURE CATEGORY (see WIND LOAD)</b> . . . . .	1609.4
Aircraft related . . . . .	412.2.2, 412.4.2, 412.7.3	<b>EXTERIOR AREAS FOR ASSISTED RESCUE</b> Requirements . . . . .	1009.7
Aisles . . . . .	1018	Signage . . . . .	1009.9, 1009.10, 1009.11
Ambulatory care facilities . . . . .	422.3	Where required . . . . .	1009.2
Atrium . . . . .	404.9, 404.10, 404.11, 1006.3.2, 1017.3.2, 1019.3	<b>EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS)</b> . . . . .	1407
Balconies . . . . .	1017.2.1, 1021	Special inspection . . . . .	1705.17
Common path . . . . .	1006.2.1	<b>EXTERIOR WALL</b> <b>(see WALLS, EXTERIOR)</b> . . . . .	Chapter 14, 107.2.4, 202, Table 601, 602, 705
Corridors . . . . .	1020		
Doors . . . . .	1005.7, 1006.2, 1007, 1010, 1022.2		
Group H . . . . .	415.11.3.3		
Group I-2 . . . . .	407.4, 407.5.4		
Group I-3 . . . . .	408.2, 408.3, 408.6.3		
High rise . . . . .	403.5		
Higher education laboratories . . . . .	428.3.5		
Intervening space . . . . .	1016.2		
Malls . . . . .	402.8		
Motor-vehicle-related occupancies . . . . .	406.5.7		
Path of egress travel, common . . . . .	1006.2.1		
Play structures . . . . .	424.4		
Ramps . . . . .	1019		
Seating at tables . . . . .	1030.13.1		
Single exit . . . . .	1006.2, 1006.3.3		

## F

<b>FACTORY OCCUPANCY (GROUP F)</b> . . . . .	306
Alarm and detection . . . . .	907.2.4
Area . . . . .	503, 503.1.1, 505, 506, 507, 508
Equipment platforms . . . . .	505.3
Groups	
Low-hazard occupancy . . . . .	306.3
Moderate-hazard occupancy . . . . .	306.2
Height . . . . .	503, 504, 505, 508
Incidental uses . . . . .	509
Interior finishes . . . . .	Table 803.13, 804

Live load	Table 1607.1
Means of Egress	
Aisles	1018.5
Dead end corridor	1020.5
Stairway, exit access	1019
Travel distance	1006.2, 1006.3, 1017.2, 1017.2.2, 1006.2.1
Mixed occupancies	508.2, 508.3, 508.4
Plumbing fixtures	2902
Risk category	Table 1604.5
Sprinkler protection	903.2.4
Unlimited area	507.3, 507.4, 507.5
<b>FARM BUILDINGS</b>	Table 1604.3, Appendix C
<b>FEES, PERMIT</b>	109
Refunds	109.6
Related fees	109.5
Work commencing before issuance	109.4
<b>FENCES</b>	105.2, 312.1
<b>FIBERBOARD</b>	202, 2303.1.6
Shear wall	Table 2306.3(2)
<b>FILL MATERIAL</b>	1804, 3304
<b>FINGER-JOINTED LUMBER</b> (see <b>END-JOINTED LUMBER</b> )	
<b>FIRE ALARM AND SMOKE DETECTION SYSTEMS</b>	
Aerosol storage	907.2.17
Aircraft hangars, residential	412.4.3, 907.2.22
Airport traffic control towers	412.2.3.1, 907.2.23
Ambulatory care facilities	422.5, 907.2.2.1
Assembly	907.2.1
Atriums	404.4, 907.2.15
Audible alarm	907.5.2.1
Battery room	907.2.23
Construction documents	907.1.1
Covered and open mall building	402.7, 907.2.21
Education	907.2.3
Emergency alarm system	908
Factory	907.2.4
Group H	907.2.5
Group I	907.2.6, 907.5.2.3.2
Group M	907.2.7
Group R	420.5, 907.2.8, 907.2.9, 907.2.11, 907.2.12, 907.5.2.3.2, 907.5.2.3.3
High-rise	403.4.1, 403.4.2, 907.2.14
Live/work	508.5.7
Lumber mills	907.2.18
Occupancy requirements	907.2
Play structure	424.3
Special amusement buildings	411.2, 411.4, 907.2.13
Underground buildings	405.6, 907.2.19, 907.2.20

Visible alarm. . . . .	907.5.2.3
<b>FIRE ALARM BOX, MANUAL</b> . . . . .	907.4.2
<b>FIRE AREA</b> . . . . .	202, 901.7
Ambulatory care facilities . . . . .	903.2.2, 907.2.2
Assembly . . . . .	903.2.1
Education . . . . .	903.2.3
Enclosed parking garages . . . . .	903.2.10
Factory . . . . .	903.2.4
Institutional . . . . .	903.2.6
Mercantile . . . . .	903.2.7
Residential . . . . .	903.2.8
Storage . . . . .	903.2.9, 903.2.10
<b>FIRE BARRIERS</b> . . . . .	202, 707
Continuity . . . . .	707.5, 713.5
Exterior walls . . . . .	Table 705.5, 707.4, 713.6
Fire-resistance rating of walls . . . . .	603.1, 703, 707.3, 713.4
Glazing, rated . . . . .	716.3.4
Incidental . . . . .	509.4.1
Inspection . . . . .	110.3.8
Joints . . . . .	707.8, 713.9, 715, 2508.5
Marking . . . . .	703.5
Materials . . . . .	707.2, 713.3
Opening protection . . . . .	707.6, 707.10, 713.7, 713.10, 714.4, 716, 717.5.2
Penetrations . . . . .	707.7, 713.8
Shaft enclosure . . . . .	713.1
Special provisions	
Aircraft hangars . . . . .	412.3.4, 412.4.1
Atriums . . . . .	404.3, 404.6
Covered and open mall buildings . . . . .	402.4.2
Fire pumps . . . . .	403.3.4, 913.2.1
Flammable finishes . . . . .	416.2
Group H-2 . . . . .	415.9.1.2, 426.1.2
Group H-3 and H-4 . . . . .	415.10
Group H-5 . . . . .	415.11.1.2, 415.11.1.5, 415.11.6.1, 415.11.7.4
Group I-3 . . . . .	408.5, 408.7
Hazardous materials . . . . .	414.2.1
Higher education laboratories . . . . .	428.3
High-rise . . . . .	403.2.1.2, 403.2.2, 403.3, 403.4.8.1
Organic coating . . . . .	418.4, 418.5, 418.6
Stages and platforms . . . . .	410.5.1, 410.5.2
<b>FIRE COMMAND CENTER</b> . . . . .	403.4.6, 412.2.3.2, 911, 3007.7, 3008.6.6, 3008.7
<b>FIRE DAMPERS</b> . . . . .	202, 717.2, 717.3, 717.4, 717.5
<b>FIRE DEPARTMENT</b> (see <b>EMERGENCY RESPONDERS</b> )	
<b>FIRE DETECTION SYSTEM (see FIRE ALARM AND SMOKE DETECTION SYSTEMS)</b>	
<b>FIRE DISTRICT</b> . . . . .	Appendix D



<b>FIRE DOOR</b>		
(see <b>OPENING PROTECTIVES</b> )	716, 1023.4	
<b>FIRE ESCAPE</b>	412.7.3	
<b>FIRE EXTINGUISHERS, PORTABLE</b>	906, 3309	
<b>FIRE EXTINGUISHING SYSTEMS</b>	416.5, 417.4,	
	903, 904	
<b>FIRE PARTITION</b>	202, 708	
Continuity	708.4	
Elevator lobby	3006.3	
Exterior walls	Table 705.5, 708.5	
Fireblocks and draftstops	708.4.2	
Fire-resistance rating	603.1, 703, 708.3	
Glazing, rated	716.3.4	
Inspection	110.3.8	
Joint treatment gypsum	2508.5	
Joints	708.8, 715	
Marking	703.5	
Materials	708.2	
Opening protection	708.5, 714.4, 716, 717.5.4	
Penetrations	708.7, 708.9, 714, 717	
Special provisions		
Covered and open mall buildings	402.4.2.1	
Group I-1, R-1, R-2, R-3, R-4	420.2	
Group I-3	408.7	
Supporting construction	708.4.1	
<b>FIRE PREVENTION</b>	101.4.5	
<b>FIRE PROTECTION</b>		
Explosion control	414.5.1, 415.6, 421.6, 426.1.4	
Fire extinguishers, portable	906	
Glazing, rated	716.1.2.3	
Smoke and heat removal	910	
Smoke control systems	909	
Sprinkler systems, automatic	903	
<b>FIRE PROTECTION SYSTEMS</b>	Chapter 9, 107.2.2	
<b>FIRE PROTECTIVE</b>		
<b>CURTAIN ASSEMBLY</b>	202, 716.4	
<b>FIRE PUMPS</b>	403.3.2, 902.1, 913, 914.2	
<b>FIRE RESISTANCE</b>		
Calculated	722	
Conditions of restraint	703.2.1.3	
Ducts and air transfer openings	717	
Exterior walls	705.5, Table 705.5, 708.5	
Fire district	D102.2.5	
High-rise	403.2	
Joint systems	715	
Multiple use fire assemblies	702.1	
Prescriptive	721	
Ratings	Chapter 6, 703, 705.5, 707.3.10	
Roof assemblies	1505	
Structural members	704	
Tests	703	
Thermal and sound insulating materials	720.1	
<b>FIRE RESISTANCE, CALCULATED</b>	722	
Clay brick and tile masonry	722.4	
Concrete assemblies	722.2	
Concrete masonry	722.3	
Steel assemblies	722.5	
Wood assemblies	722.6	
<b>FIRE SEPARATION DISTANCE</b>	202, Table 705.5	
Exterior walls	1405.1.1.1.1, 1405.1.1.1.2	
Ground-mounted photovoltaic systems	3111.3.5	
<b>FIRE SERVICE</b>		
<b>ACCESS ELEVATORS</b>	403.6.1, 3007	
<b>FIRE WALLS</b>	202, 706	
Aircraft hangar	412.3.6.2	
Combustible framing	706.7	
Continuity	706.5, 706.6	
Exterior walls	Table 705.5, 706.5.1	
Fire-resistance rating	703, 706.4	
Glazing, rated	716.3.4	
Inspection	110.3.8	
Joints	706.10, 715	
Materials	706.3	
Opening protection	706.8, 706.11, 714.4,	
	716, 717.5.1	
Penetration	706.9, 714.4	
Special provisions		
Covered and open mall buildings	402.4.2.2	
Group H-5	415.11.1.6	
Structural stability	706.2	
<b>FIRE WINDOWS (see <b>OPENING PROTECTIVES</b>)</b>		
<b>FIREBLOCKING</b>	718.2	
Chimneys	718.2.5.1, 2113.20	
Fireplaces	2111.13	
Wood construction	718.2.1, 718.2.7, 1405.1.3	
Wood stairways	718.2.4	
<b>FIREPLACES, FACTORY-BUILT</b>	2111.14.1	
<b>FIREPLACES, MASONRY</b>	202	
Clearance to combustibles	2111.12	
Drawings	2111.2	
General provisions	2111	
Hearth extension	2111.10, 2111.11	
Steel units	2111.6.1	
<b>FIRE-RESISTANT CONSTRUCTION</b>	701.1	
<b>FIRE-RETARDANT-TREATED WOOD</b>	202, 2303.2	
Awnings	3105.2	
Balconies	705.2.3.1	
Canopies	3105.3	
Concealed spaces	718.5	
Fastening	2304.10.6	
Fire wall vertical continuity	706.6	
Partitions	603.1	

## INDEX

- Platforms . . . . . 410.3  
 Projections . . . . . 705.2.3  
 Roof construction . . . . Table 601, 705.11, 706.6, 1505  
 Shakes and shingles . . . . . 1505.6  
 Type I and II construction . . . . . 603.1  
 Type III construction . . . . . 602.3  
 Type IV construction . . . . . 602.4  
 Veneer . . . . . 1404.5
- FIREWORKS** . . . . . 202, 307.2, 307.3, 307.5
- FLAMESPREAD** . . . . . 202, 803.1.2, Table 803.13
- FLAMMABLE FINISHES** . . . . . 307.1, 416
- FLAMMABLE LIQUIDS** . . . . . 307.4, 307.5, 406.8.2,  
 412, 414, 415
- FLAMMABLE SOLIDS** . . . . . 307.5, 415
- FLASHING**  
 Roof . . . . . 1503.2, 1507.2.8, 1507.3.9,  
 1507.5.7, 1507.7.7, 1507.8.8,  
 1507.9.9, 1512.5  
 Wall, veneer . . . . . 1404.4, 1404.12.7
- FLOOD HAZARD AREAS** . . . . . 202, 1612.3,  
 3114, Appendix G  
 Coastal A zone . . . . . 202, 1402.7, 1603.1.7,  
 1612.2, 1612.4  
 Coastal high hazard area . . . . . 202, 1402.7, 1603.1.7,  
 1612.2, 1612.4  
 Flood insurance rate map . . . . . 202, 1603.1.7, 1612.3
- FLOOD-RESISTANT CONSTRUCTION** . . . . Appendix G  
 Accessibility . . . . . 1108.7.5  
 Administration . . . . . 107.2.6.1, G101, G106  
 Elevation certification . . . . . 110.3.3  
 Existing . . . . . 101.4.7  
 Flood elevation . . . . . 107.2.6.1, 1612  
 Flood loads . . . . . 1603.1, 1603.1.7, 1612, 3001.2  
 Flood resistance . . . . . 1402.6, 1402.7  
 Grading and fill . . . . . 1804.5, 1805.1.2.1  
 Historic buildings . . . . . G106.3  
 Interior finishes . . . . . 802.4  
 Manufactured homes . . . . . G109  
 Modifications . . . . . 104.10.1  
 Public restrooms . . . . . 3114  
 Recreation vehicles . . . . . G110  
 Site improvements . . . . . G108  
 Site plan . . . . . 107.2.6  
 Subdivisions . . . . . G107  
 Tank . . . . . G111  
 Temporary . . . . . G113  
 Utility . . . . . G114
- FLOOR CONSTRUCTION**  
 (see **FLOOR CONSTRUCTION, WOOD**)  
 Draftstopping . . . . . 718.3  
 Finishes . . . . . 804, 805, 1003.4, 1209.1
- Fire resistance . . . . . Table 601, 711  
 Loads (see **FLOOR LOADS**)  
 Materials . . . . . Chapter 6  
 Penetration of fire-resistant assemblies . . . . . 711,  
 714.5, 717.2, 717.6
- FLOOR CONSTRUCTION, WOOD**  
 Beams and girders . . . . . 2304.12.1.1, 2308.4.1  
 Bridging/blocking . . . . . 2308.4.6, 2308.7.8  
 Diaphragms . . . . . 2305.1  
 Fastening schedule . . . . . 2304.10.2  
 Framing . . . . . 2304.4, 2304.11.1.2, 2304.11.3,  
 Table 2304.11, 2308.4  
 Joists . . . . . 2308.4.2  
 Sheathing . . . . . 2304.8
- FLOOR LEVEL** . . . . . 1003.5, 1010.1.4
- FLOOR LOADS**  
 Construction documents . . . . . 107.2  
 Live . . . . . 1603.1.1, 1607  
 Posting . . . . . 106.1
- FLOOR OPENING PROTECTION**  
 (see **VERTICAL OPENING PROTECTION**)
- FLOOR/CEILING**  
 (see **FLOOR CONSTRUCTION**)
- FOAM PLASTICS**  
 Attics . . . . . 720.1, 2603.4.1.6  
 Cladding attachment . . . . . 2603.11, 2603.12, 2603.13  
 Cold storage . . . . . 2603.3, 2603.4.1.2, 2603.5  
 Concealed . . . . . 603  
 Covered mall and  
 open mall buildings . . . . . 402.6.2, 402.6.4.5  
 Crawl space . . . . . 2603.4.1.6  
 Doors . . . . . 2603.4.1.7, 2603.4.1.9  
 Exterior wall covering . . . . . Chapter 14, 806.5  
 Exterior walls of  
 multistory buildings . . . . . 1403.13, 2603.5  
 Interior finish . . . . . 2603.9, 2604  
 Label/identification . . . . . 2603.2  
 Metal composite materials (MCM) . . . . . 1406.12  
 Plenums . . . . . 2603.7, 2604.1.1  
 Roofing . . . . . 2603.4.1.5  
 Siding backer board . . . . . 2603.4.1.10  
 Stages and platform scenery . . . . . 410.2.6  
 Surface burning characteristics . . . . . 2603.3  
 Termites, protection from . . . . . 2603.8  
 Thermal barrier requirements . . . . . 2603.5.2  
 Trim . . . . . 806.5, 2604.2  
 Type I and II construction . . . . . 603.1  
 Walk-in coolers . . . . . 2603.4.1.3  
 Wind resistance . . . . . 2603.10

<b>FOLDING AND TELESCOPIC SEATING</b> (see BLEACHERS) . . . . .	202, 1030.1.1
<b>FOOD COURT</b> . . . . .	202
Occupant load . . . . .	402.8.2.4
Separation . . . . .	402.4.2
<b>FOUNDATION (see FOUNDATION, DEEP and FOUNDATION, SHALLOW)</b> . . . . .	Chapter 16
Basement . . . . .	1610, 1805.1.1, 1806.3, 1807
Concrete . . . . .	1808.8, 1809.8, 1810.3.2.1
Dampproofing . . . . .	1805.2
Encroachment, public right-of-way . . . . .	3202.1
Formwork . . . . .	3304.1
Geotechnical investigation (see SOILS AND FOUNDATIONS) . . . . .	1803
Inspection . . . . .	110.3.1
Load-bearing value . . . . .	1806, 1808, 1810
Masonry . . . . .	1808.9
Pedestrian protection . . . . .	3306.9
Pier (see FOUNDATION, SHALLOW)	
Pile (see FOUNDATION, DEEP)	
Plates or sills . . . . .	2308.3.1
Protection from adjacent construction . . . . .	3303.5, 3307.1
Rodentproofing . . . . .	Appendix F
Special inspections . . . . .	1705.3, 1705.4.2, 1705.7, 1705.8, 1705.9
Steel . . . . .	1809.11, 1810.3.2.2, 1810.3.5.3
Timber . . . . .	1809.12, 1810.3.2.4
Waterproofing . . . . .	1805.3
<b>FOUNDATION, DEEP</b> . . . . .	202, 1810
Drilled shaft . . . . .	202
Existing . . . . .	1810.1.2
Geotechnical investigation . . . . .	1803.5.5
Grade beams . . . . .	1810.3.12
Helical pile . . . . .	202, 1810.3.1.5, Table 1810.3.2.6, 1810.3.3.1.9, 1810.3.5.3, 1810.4.11, 1810.4.12
Micropile . . . . .	202, Table 1808.8.1, Table 1810.3.2.6, 1810.3.5.2.3, 1810.3.10, 1810.4.10
Piles . . . . .	Table 1808.8.1, 1810
<b>FOUNDATION, SHALLOW</b> . . . . .	202, 1809
Pier and curtain wall . . . . .	1809.10
Slab-on-ground . . . . .	1808.6.2
Strip footing . . . . .	1808.8, 1809
<b>FOYERS</b> . . . . .	
Assembly occupancy . . . . .	1030.4, 1030.9.5
Corridors . . . . .	1020.7
Covered and open mall building . . . . .	402.1
<b>FRAME INSPECTION</b> . . . . .	110.3.4
<b>FRATERNITIES</b> . . . . .	310.4
<b>FROST PROTECTION</b> . . . . .	1809.5
<b>FURNACE ROOMS</b> . . . . .	1006.2.2.1
<b>G</b>	
<b>GALLERIES (see TECHNICAL PRODUCTION AREAS)</b>	
<b>GAMING</b> . . . . .	202, 303.3, Table 1004.5, 1110.16, Table 2902.1, E105.3
<b>GARAGE, AUTOMOBILE PARKING</b> (see PARKING GARAGES)	
<b>GARAGE, REPAIR</b> . . . . .	406.8
Floor surface . . . . .	406.2.4
Gas detection system . . . . .	406.8.2, 916
Sprinkler protection . . . . .	406.8.3, 903.2.9.1
Ventilation . . . . .	406.8.1
<b>GARAGES, TRUCK AND BUS</b>	
Live load . . . . .	1607.8
Sprinkler protection . . . . .	903.2.10.1
<b>GARAGES AND CARPORTS, PRIVATE</b>	
Area limitations . . . . .	406.3.1
Classification . . . . .	406.3.1
Parking surfaces . . . . .	406.2.4
Separation . . . . .	406.2.5, 406.3.2
<b>GAS</b> . . . . .	101.4.1, 105.2, 112
Accessibility . . . . .	1110.14
Gas detection system . . . . .	406.8.2, 415.11.8, 421.5, 916
Hydrogen cutoff room . . . . .	421.6
Motor fuel-dispensing . . . . .	406.7
<b>GATES</b> . . . . .	1010.4
Vehicular . . . . .	406.2.1, 3110
<b>GIFT SHOPS</b> . . . . .	407.2.4
<b>GIRDERS</b> . . . . .	
Fire resistance . . . . .	Table 601
Materials . . . . .	Chapter 6
Wood construction . . . . .	2304.12.1.1, 2308.4.1
<b>GLASS (see GLAZING)</b>	
<b>GLASS BLOCK (see GLASS UNIT MASONRY)</b>	
<b>GLASS UNIT MASONRY</b> . . . . .	202, 2110
Atrium enclosure . . . . .	404.6
Fire resistance . . . . .	2110.1.1
Hazardous locations . . . . .	2406.1.3
<b>GLAZING</b> . . . . .	
Athletic facilities . . . . .	2408
Atrium enclosure . . . . .	404.6
Doors . . . . .	705.8, 709.5, 710.5, 716.2.5.3, 1404.13, 1709.1
Elevator hoistway and car . . . . .	2409.2, 2409.3, 2409.4
Fire doors . . . . .	716.2.2.3.1, 716.2.5
Fire windows . . . . .	703.3, 716.2.1
Group I-3 . . . . .	408.7

## INDEX

Guards. . . . .	1015.2.1, 2406.4.4, 2407	Ramps . . . . .	1012.9
Handrail . . . . .	1011.11, 2407	Residential . . . . .	1015.3
Identification . . . . .	2403.1, 2406.3	Roof access . . . . .	1015.7
Impact loads . . . . .	2406.1, 2408.2.1, 2408.3	Screen porches . . . . .	1015.5
Impact resistant. . . . .	1609.2	Stairs . . . . .	1015.2
Jalousies . . . . .	2403.5	Vehicle barrier . . . . .	406.4.2, 1607.10
Label/identification. . . . .	716.1.2.2.1, 716.1.2.2.2, 716.2.9.1, 716.2.9.5, 716.3.5.2	Windows. . . . .	1015.8
Loads. . . . .	2404	<b>GUTTERS</b> . . . . .	1502.4
Louvered windows. . . . .	2403.5	<b>GYMNASIUMS</b> . . . . .	303.4
Opening protection . . . . .	716.1.2.3	Group E . . . . .	303.1.3
Replacement. . . . .	2402	Live load. . . . .	Table 1607.1
Safety . . . . .	716.1.2.1, 2406	Occupant load . . . . .	1004.5
Security . . . . .	408.7	<b>GYP SUM</b> . . . . .	Chapter 25
Skylights . . . . .	2405	Board . . . . .	Chapter 25, 202
Sloped . . . . .	2404.2, 2405	Ceiling diaphragms . . . . .	2508.6
Supports . . . . .	2403.2	Concrete, reinforced gypsum. . . . .	2514
Swimming pools . . . . .	2406.4.5	Construction. . . . .	2508
Testing. . . . .	1709.5, 2406.1.1, 2408.2.1	Draftstopping . . . . .	718.3.1
Veneer. . . . .	1404.12	Exterior soffit . . . . .	Table 2506.2
Vertical . . . . .	2404.1	Fastening . . . . .	Table 2306.3(3), 2508.1
Walkways . . . . .	2409.1	Fire resistance . . . . .	719, 722.2.1.4, 722.6.2
<b>GRADING</b> . . . . .	Appendix J	Fire-resistant joint treatment . . . . .	2508.5
<b>GRAIN ELEVATORS</b> . . . . .	426.1.5	Inspection. . . . .	2503
<b>GRANDSTANDS (see BLEACHERS)</b> . . . . .	202, 1030.1.1	Lath . . . . .	2507, 2510
<b>GREENHOUSES</b> . . . . .	303.4, 309.1, 312.1.1, 3112	Lathing and furring for cement plaster . . . . .	719, 2510
Accessibility. . . . .	3112.2	Lathing and plastering . . . . .	2507
Area. . . . .	503, 506, Table 506.2, 508	Materials. . . . .	2506
Definition . . . . .	202	Panel products . . . . .	Chapter 25, 202
Deflections. . . . .	Table 1604.3	Performance. . . . .	2502
Glazing, glass and lighting . . . . .	2405, 3112.4	Plaster, exposed aggregate . . . . .	2513
Live load . . . . .	1607.14.2.1	Plaster, exterior . . . . .	2512
Membrane structure . . . . .	3102, 3112.6	Plaster, interior . . . . .	2511
Plastic . . . . .	2606.11, 3112.5	Shear wall construction . . . . .	2211.1.1, Table 2306.3(3), 2308.6.3, 2505
Wind load . . . . .	1609.2	Sheathing. . . . .	Table 2308.5.11
<b>GRIDIRON (see TECHNICAL PRODUCTION AREAS)</b>		Showers and water closets . . . . .	2509
<b>GRINDING ROOMS</b> . . . . .	426.1.2	Stucco . . . . .	2510
<b>GROSS LEASABLE AREA</b>		Veneer base. . . . .	2507.2
(see COVERED and OPEN MALL BUILDINGS)		Veneer plaster . . . . .	2507.2
<b>GROUP HOME [see RESIDENTIAL (GROUP R-4)]</b>		Vertical and horizontal assemblies. . . . .	2504
<b>GROUT</b> . . . . .	714.4.1.1, 714.5.1	Wallboard. . . . .	Table 2506.2
<b>GUARDS</b> . . . . .	1015	Water-resistant backing board . . . . .	2506.2, 2509.2
Assembly seating . . . . .	1030.1.1, 1030.17		
Equipment platform . . . . .	505.3.3		
Exceptions. . . . .	1015.2		
Glazing . . . . .	1015.2.1, 2406.4.4, 2407		
Height . . . . .	1015.3		
Loads. . . . .	1607.9		
Mechanical equipment . . . . .	1015.6		
Opening limitations . . . . .	1015.4		
Parking garage . . . . .	406.4.1		

## H

<b>HANDRAILS</b> . . . . .	1014
Alternating tread devices . . . . .	1011.14
Assembly aisles . . . . .	1030.16
Construction. . . . .	1014.4, 1014.5, 1014.6
Extensions . . . . .	1014.6
Glazing. . . . .	2407



Graspability . . . . .	1014.3	Location on property . . . . .	414.6.1.2, 415.6
Guards . . . . .	1015.3	Low hazard . . . . .	306.3, 311.3
Height . . . . .	1014.2	Means of egress	
Loads . . . . .	1607.9	Corridors . . . . .	415.11.2
Location . . . . .	1014.1, 1014.7, 1014.8, 1014.9	One means of egress. . . . .	Table 1006.3.4(1), Table 1006.3.4(2)
Ramps . . . . .	1012.8	Panic hardware . . . . .	1006.2.2.2, 1006.2.2.3, 1006.2.2.4, 1010.2.9
Stairs. . . . .	1011.11	Stairway, exit access . . . . .	1019
<b>HARDBOARD</b> . . . . .	202, 1403.3.2, 2303.1.7	Travel distance. . . . .	1006.3, 1006.2.1, Table 1017.2
<b>HARDWARE (see DOORS and LOCKS AND LATCHING)</b>		Mixed occupancies . . . . .	508.3, 508.4
<b>HARDWOOD</b>		Accessory . . . . .	508.2
Fastening . . . . .	2304.10	Moderate hazard . . . . .	306.2, 311.2
Quality. . . . .	2303.3	Multiple hazards . . . . .	306.2, 311.2
Veneer . . . . .	1403.3.2	Occupancy exceptions . . . . .	307.1
<b>HAZARDOUS MATERIALS</b> . . . . .	307, 414, 415	Plumbing fixtures . . . . .	Chapter 29
Compliance with International Fire Code . . . . .	307.2	Risk category. . . . .	Table 1604.5
Control areas . . . . .	414.2	Separation from other occupancies. . . . .	415.6.1, 508.1, 508.2.4, 508.3.3, 508.4
Explosion control . . . . .	414.5.1, Table 414.5.1, 415.11.6.5, 426.1.4	Smoke and heat removal. . . . .	910.2
Mercantile occupancies . . . . .	309.2	Special provisions based on materials	
Reporting . . . . .	414.1.3	Combustible liquids . . . . .	Table 307.1(1), 307.4, 307.5, 414.2.5, 414.5.3, 415.9.2
Sprinkler protection. . . . .	Table 414.2.5(1), Table 414.2.5(2), 415.4, 415.11.12, 903.2.5	Corrosives . . . . .	307.6, Table 414.2.5(1), 414.3, 415.10.3, Table 415.11.1.1.1
Ventilation . . . . .	414.3, 415.9.1.7, 415.11.1.6, 415.11.1.8.1, 415.11.3.2, 415.11.6.8, 415.11.7.4, 415.11.8, 415.11.11, 1202.6	Explosives . . . . .	202, 307.3, 307.3.1, Table 415.6.5
Weather protection . . . . .	414.6.1	Flammable liquids . . . . .	307.4, 307.5, 415.9.1,
<b>HAZARDOUS OCCUPANCY</b>		Flammable solids . . . . .	307.5, 415.11.1.1.1
<b>(GROUP H), (see HAZARDOUS MATERIALS)</b> . . . . .	307, 414, 415	Health-hazard materials. . . . .	202, Table 414.2.5(1), 415.6, Table 415.11.1.1.1, 415.11.6.1, 415.11.7.2
Alarms and detection . . . . .	415.3, 415.5, 415.11.2, 415.11.4, 415.11.6.9, 415.11.8, 901.6.3, 907.2.5, 908.1, 908.2	Irritants. . . . .	Table 414.2.5(1), Table 415.11.1.1.1
Area . . . . .	503, 505, 506, 507, 508	Liquid, highly toxic and toxic . . . . .	307.6, Table 414.2.5(1), 415.8.3, 415.9.3, Table 415.11.1.1.1, 418
Dispersing. . . . .	414.5, 414.6, 415.6	Oxidizers, liquid and solid . . . . .	Table 414.2.5(1), Table 414.5.1, 415.8.4, Table 415.11.1.1.1
Gas detection systems . . . . .	415.11.7	Pyrophoric materials . . . . .	Table 307.1(1), 307.4, Table 414.5.1, 415.7.1, 415.8.4, Table 415.11.1.1.1
Group provisions		Sensitizers . . . . .	Table 415.11.1.1.1
H-1 (detonation) . . . . .	307.3, 415.6.2, 415.7, 415.6.4.1, 415.7.1	Solids, highly toxic and toxic . . . . .	307.6, Table 414.2.5(1), 415.10.4, Table 415.11.1.1.1, 908.3
H-2 (deflagration) . . . . .	307.4, 415.8, 415.9	Unstable materials . . . . .	307.3, Table 414.2.5(1), 415.5.4, Table 415.11.1.1.1, Table 414.5.1
H-3 (physical hazard) . . . . .	415.10, 307.5, 415.8		
H-4 (health hazard) . . . . .	307.6, 415.10		
H-5 (semiconductor) . . . . .	307.7, 415.11		
Height . . . . .	415.7, 415.8.1, 415.9.1.1, 426.1.1, 503, 504, 505, 506		
Incidental uses . . . . .	509		
Interior finishes . . . . .	416.2.1, 416.3.1, Table 803.13, 804		
Live load . . . . .	Table 1607.1		

## INDEX

Water-reactive materials . . . . .	Table 414.5.1, 415.8.3, 415.8.4, 415.8.5, 415.11, Table 415.11.1.1.1
Special provisions—General	
Detached buildings . . . . .	202, 415.6.2, 415.8
Dry cleaning (see DRY CLEANING PLANTS)	
Equipment platforms . . . . .	505.3
Fire district	
Fire separation distance . . . . .	415.6
Grain elevators . . . . .	426.1, 426.1.5
Grinding rooms . . . . .	426.1.2
Higher education laboratories . . . . .	426
Sprinkle protection. . . . .	415.4, 415.11.6.4, 415.11.9, 415.11.10.1, 415.11.11, 705.8.1, 903.2.5
Standby, emergency power. . . . .	2702.2
Storage . . . . .	413, 414.1, 414.2.5, 414.5, 414.6, 415.6, Table 415.6.5, 415.7.1, 415.9.1, 426.1
Unlimited area . . . . .	507.8, 507.9, 507.10
<b>HEADROOM</b> . . . . .	406.2.2, 505.2, 1003.2, 1003.3, 1010.1.1, 1010.1.1.1, 1011.3, 1012.5.2, 1208.2
<b>HEALTH CARE</b> (see <b>INSTITUTIONAL I-1</b> and <b>INSTITUTIONAL I-2</b> )	
Ambulatory care facilities . . . . .	202, 422
Clinic, outpatient . . . . .	304.1
Hospitals . . . . .	308.3
<b>HEALTH-HAZARD MATERIALS</b> . . . . .	307.2, Table 414.2.5(1), 415.2, 415.11.1.1.1
<b>HEAT VENTS</b> . . . . .	910
<b>HEATING (see MECHANICAL)</b> . . . . .	101.4.2
Aircraft hangars . . . . .	412.3.4
Fire pump rooms . . . . .	913.3
Fireplace . . . . .	2111
Masonry heaters . . . . .	2112
Parking garages . . . . .	406.2.9
Repair garages . . . . .	406.2.9
<b>HEIGHT, BUILDING</b> . . . . .	503, 504, 505, 508, 510
Limitations . . . . .	503
Mixed construction types . . . . .	510
Modifications . . . . .	504
Roof structures . . . . .	504.3, 1511
<b>HELIPORT</b>	
Definition . . . . .	202
Live loads . . . . .	1607.6
<b>HIGHER EDUCATION LABORATORIES</b> . . . . .	202, 428
<b>HIGH-PILED COMBUSTIBLE STORAGE</b> . . . . .	413, 907.2.16, 910.2.2

**HIGH-PRESSURE DECORATIVE****EXTERIOR-GRADE****COMPACT LAMINATES** . . . . . 1408**HIGH-RISE BUILDINGS** . . . . . 403

Alarms and detection . . . . .	403.4.1, 403.4.2, 907.2.14
Application . . . . .	403.1
Construction . . . . .	403.2
Elevators . . . . .	403.6, 1009.2.1, 3007, 3008
Emergency power . . . . .	403.4.8, 2702.2
Emergency systems . . . . .	403.4
Fire command station . . . . .	403.4.6
Fire department communication . . . . .	403.4.4, 403.4.5
Fire service elevators . . . . .	403.6.1, 3007
Occupant evacuation elevators . . . . .	403.6.2, 3008
Smoke removal . . . . .	403.4.7
Smokeproof enclosure . . . . .	403.5.4, 1023.12
Sprayed fire-resistant materials (SFRM) . . . . .	403.2.3
Sprinkler protection . . . . .	403.3, 903.2.11.3
Stairways . . . . .	403.5, 1023, 1025
Standby power . . . . .	403.4.8, 2702.2
Structural integrity . . . . .	403.2.2, 1616
Super high-rise (over 420 feet) . . . . .	403.2.1, 403.2.2, 403.2.3, 403.3.1, 403.5.2

Voice alarm . . . . .	403.4.4, 907.2.14
-----------------------	-------------------

Zones . . . . .	907.6.3, 907.6.4
-----------------	------------------

**HISTORIC BUILDINGS** . . . . . 101.4.7

Flood provisions . . . . .	G106.3
----------------------------	--------

**HORIZONTAL ASSEMBLY** . . . . . 711

Continuity . . . . .	509.4.1, 711.2.2, 711.2.3, 713.11, 713.12
----------------------	--

Fire-resistance rating . . . . .	603.1, 703, 704.4.2, 707.3.10, 711.2.4
----------------------------------	---

Glazing, rated . . . . .	716.3.4
--------------------------	---------

Group I-1 . . . . .	420.3
---------------------	-------

Group R . . . . .	420.3
-------------------	-------

Incidental . . . . .	509.4
----------------------	-------

Insulation . . . . .	720, 807, 808
----------------------	---------------

Joints . . . . .	715, 2508.4
------------------	-------------

Nonfire-resistance rating . . . . .	711.3
-------------------------------------	-------

Opening protection . . . . .	712.1.13.1, 714.5, 716, 717.6
------------------------------	-------------------------------

Shaft enclosure . . . . .	713.1
---------------------------	-------

## Special provisions

Atrium . . . . .	404.3, 404.6
------------------	--------------

Covered and open mall buildings . . . . .	402.4.2.3, 402.8.7
---	-----------------------

Fire pumps . . . . .	913.2.1
----------------------	---------

Flammable finishes . . . . .	416.2
------------------------------	-------

Group H-2 . . . . .	415.9.1.1, 415.9.1.2
---------------------	----------------------

Group H-5 . . . . .	415.11.1.2, 415.11.6.1
---------------------	------------------------

Group I-2 . . . . .	407.5
---------------------	-------

Groups H-3 and H-4 . . . . .	415.10.2
------------------------------	----------

Groups I-1, R-1, R-2, R-3 and R-4 ..... 420.3  
 Hazardous materials ..... 414.2  
 High-rise ..... 403.2.1, 403.3  
 Organic coating ..... 418.4, 418.5, 418.6  
 Stages and platforms ..... 410.3, 410.4.1  
**HORIZONTAL EXIT** ..... 1026  
   Accessible means of egress ..... 1009.2, 1009.2.1,  
     1009.3, 1009.4, 1009.6, 1009.6.2  
   Doors ..... 1026.3  
   Exit discharge ..... 1028.2  
   Fire resistance ..... 1026.2  
   Institutional I-2 occupancy ..... 407.4, 1026.1  
   Institutional I-3 occupancy ..... 408.2, 1026.1  
   Refuge area (see REFUGE AREAS)  
**HORIZONTAL FIRE SEPARATION**  
   (see HORIZONTAL ASSEMBLIES)  
**HOSE CONNECTIONS** (see STANDPIPE REQUIRED)  
**HOSPITALS AND**  
**PSYCHIATRIC HOSPITALS**  
   (see INSTITUTIONAL, GROUP I-2). ..... 308.3, 407  
**HPM ROOM** ..... 415.11.5  
**HURRICANE SHELTER** (see STORM SHELTER)  
**HURRICANE SHUTTERS** ..... 1609.2  
**HYDROGEN FUEL GAS ROOMS** ..... 421, Table 509.1  
**HYPERBARIC FACILITIES** ..... 425

## I

**ICE-SENSITIVE STRUCTURE** ..... 202  
   Atmospheric ice loads ..... 1614.1  
**IDENTIFICATION, REQUIREMENTS FOR**  
   Fire barriers ..... 703.4  
   Fire partitions ..... 703.4  
   Fire wall ..... 703.4  
   Glazing ..... 2403.1, 2406.3  
   Inspection certificate ..... 202  
   Labeling ..... 1703.5  
   Preservative-treated wood ..... 2303.1.9.1  
   Smoke barrier ..... 703.4  
   Smoke partition ..... 703.4  
   Steel ..... 2202.1  
**IMPACT LOAD** ..... 202, 1603.1.1, 1607.11, 2406.1  
**INCIDENTAL USES**  
   Area ..... 509.3  
   Occupancy classification ..... 509.2  
   Separation and protection ..... 509.4  
**INCINERATOR ROOMS** ..... Table 509.1, 713.13,  
     1006.2.2.1  
**INDUSTRIAL**  
   [see FACTORY OCCUPANCY (see GROUP F)]  
**INSPECTIONS** ..... 110, 1704, 1705

Alternative methods and materials ..... 1705.1.1  
 Approval required ..... 110.6  
 Concrete construction ..... 110.3.1, 110.3.2,  
     110.3.11, 1705.3  
 Concrete slab ..... 110.3.2  
 EIFS ..... 110.3.11, 1705.17  
 Energy efficiency ..... 110.3.9  
 Fabricators ..... 1704.2.5  
 Fees ..... 109  
 Final ..... 110.3.12  
 Fire-extinguishing systems ..... 904.4  
 Fire-resistant materials ..... 110.3.11, 1705.15,  
     1705.16  
 Fire-resistant penetrations ..... 110.3.8, 1705.18  
 Flood hazard ..... 110.3.3, 110.3.12.1  
 Footing or foundation ..... 110.3.1, 110.3.11, 1705.3,  
     1705.4, 1705.7, 1705.8, 1705.9  
 Frame ..... 110.3.4  
 Lath gypsum board and  
   gypsum panel products ..... 110.3.6, 2503  
 Liability ..... 104.8  
 Masonry ..... 110.3.11, 1705.4  
 Preliminary ..... 110.2  
 Required ..... 110.3  
 Right of entry ..... 104.6  
 Seismic ..... 1705.13  
 Smoke control ..... 909.18.8, 1705.19  
 Soils ..... 110.3.11, 1705.6  
 Special (see SPECIAL INSPECTIONS  
   AND TESTS) ..... 110.3.11, 1704, 1705  
 Sprayed fire-resistant materials ..... 1705.15  
 Sprinkler protection ..... 903.5  
 Steel ..... 110.3.4, 110.3.11, 1705.2  
 Third party ..... 110.4  
 Welding ..... 110.3.11, 1705.2, 2204.1  
 Wind ..... 110.3.11, 1705.12  
 Wood ..... 110.3.11, 1705.5  
**INSTITUTIONAL I-1 [see INSTITUTIONAL OCCU-  
 PANCY (see GROUP I) and RESIDENTIAL (see  
 GROUP R-4)]**  
 Accessibility ..... 1106.2, 1108.2, 1108.3,  
     1108.4, 1108.5.1  
 Alarm and detection ..... 420.5, 907.2.6.1, 907.2.10,  
     907.2.11.2, 907.5.2.3.2  
 Combustible decorations ..... 806.1  
 Cooking ..... 420.8, 420.9  
 Means of egress  
   Aisles ..... 1018.5  
   Corridors ..... 1020.2  
   Stairway, exit access ..... 1019  
   Travel distance ..... 1006.3, 1017.2

## INDEX

- Occupancy conditions . . . . . 308.2.1, 308.2.2  
Occupancy exceptions . . . . . 308.2.3, 308.2.4  
Separation . . . . . 420.2, 420.3, 420.6  
Spaces open to corridors . . . . . 420.7, 420.8  
Sprinkler protection . . . . . 420.5, 903.2.6, 903.3.2
- INSTITUTIONAL I-2 [see INSTITUTIONAL OCCUPANCY (see GROUP I)]** . . . . . 308.3, 407
- Accessibility . . . . . 1106.4, 1106.5, 1106.9.2, 1108.5.2, 1108.5.3, 1108.5.4  
Alarms and detection . . . . . 407.8, 407.9  
Care suites . . . . . 407.4.4  
Combustible decorations . . . . . 806.1  
Cooking . . . . . 407.2.6, 407.2.7  
Electrical systems . . . . . 407.11, 2702.2  
Hyperbaric facilities . . . . . 425  
Means of egress . . . . . 407.4  
    Aisles . . . . . 1018.5  
    Corridors . . . . . 407.2, 407.3, 407.4, 1020.3, 407.4.3  
    Doors . . . . . 407.3.1, 407.2.6, 1010.2.14, 1010.2.12, 407.4.4.3, 407.4.4.4, 407.6  
    Hardware . . . . . 1010.2.10, 1010.2.14, 407.4.1.1  
    Lighting . . . . . 1008.2, 1008.3  
    Stairway, exit access . . . . . 1019.4  
    Stairways, exterior exit . . . . . 1027.2  
    Travel distance . . . . . 407.4.2  
Medical gas systems . . . . . 427  
Occupancy condition . . . . . 308.3.1  
Occupancy exceptions . . . . . 308.3.2  
Smoke barriers . . . . . 407.5  
Smoke compartment . . . . . 407.2.1, 407.2.3, 407.5  
Smoke partitions . . . . . 407.3  
Sprinkler protection . . . . . 407.7, 903.2.6, 903.3.2  
Yards . . . . . 407.10
- INSTITUTIONAL I-3 [see INSTITUTIONAL OCCUPANCY (see GROUP I)]** . . . . . 308.4, 408
- Accessibility . . . . . 1103.2.13, 1106.4, 1108.5.5, 1109.4.2, E104.2.2, E106.4.8  
Alarm and detection . . . . . 408.10, 907.2.6.3  
Combustible decorations . . . . . 806.1  
Means of egress . . . . . 408.2, 408.3, 408.4  
Occupancy condition . . . . . 308.4  
Security glazing . . . . . 408.7  
Separation . . . . . 408.5, 408.6  
Smoke barrier . . . . . 408.6  
Smoke compartment . . . . . 408.4.1, 408.6, 408.9  
Sprinkler protection . . . . . 408.11, 903.2.6  
Standby/emergency power . . . . . 2702.2
- INSTITUTIONAL I-4 [see INSTITUTIONAL OCCUPANCY (GROUP I)]** . . . . . 308.5
- Accessibility . . . . . 1103.2.12  
Alarms and detection . . . . . 907.2.6
- Educational . . . . . 308.5.1  
Means of egress . . . . . Table 1006.2.1, Table 1017.2  
    Corridor . . . . . 1020.2  
    Hardware . . . . . 1010.2.8, 1010.2.13.1  
Sprinkler protection . . . . . 903.2.6
- INSTITUTIONAL OCCUPANCY (GROUP I)** . . . . . 308
- Accessory . . . . . 508.2  
Adult care . . . . . 308.5  
Area . . . . . 503, 505, 506, 507, 508  
Child care . . . . . 303.1.3, 308.5, 310.4  
Group specific provisions  
    Group I-1 (see INSTITUTIONAL I-1) . . . . . 308.2  
    Group I-2 (see INSTITUTIONAL I-2) . . . . . 407, 308.3  
    Group I-3 (see INSTITUTIONAL I-3) . . . . . 408, 308.4  
    Group I-4 (see INSTITUTIONAL I-4) . . . . . 308.1, 308.5  
Height . . . . . 503, 504, 505, 508  
Incidental uses . . . . . 509  
Interior finishes . . . . . Table 803.13, 804  
Live load . . . . . Table 1607.1  
Means of egress  
    Corridors . . . . . 1020.3  
    Stairway, exit access . . . . . 1019  
    Travel distance . . . . . 407, 1006.3, 1017.2, 1006.2.1  
Mixed occupancies . . . . . 508.3, 508.4  
Occupancy exceptions . . . . . 303.1.1, 303.1.2, 308.2.3, 308.2.4, 308.3.2, 308.5.1, 308.5.4, 310.4.1  
Plumbing fixtures . . . . . 2902  
Risk category . . . . . Table 1604.5  
Standby, emergency power . . . . . 2702.2
- INSULATION**
- Concealed . . . . . 720.2  
Duct insulation . . . . . 720.1  
Exposed . . . . . 720.3  
Fiberboard . . . . . 720.1, Table 1508.2, 2303.1.6.2, 2303.1.6.3  
Foam plastic (see FOAM PLASTICS) . . . . . 720.1  
Loose fill . . . . . 720.4, 720.6  
Pipe insulation . . . . . 720.1, 720.7  
Reflective plastic core . . . . . 2614  
Roof . . . . . 720.5, 1508  
Sound . . . . . 720, 807, 1206  
Thermal . . . . . 720, 807, 1508
- INTERIOR ENVIRONMENT**
- Lighting . . . . . 1204  
Rodentproofing . . . . . Appendix F  
Sound transmission . . . . . 1206  
Space dimensions . . . . . 1208  
Temperature control . . . . . 1203  
Ventilation . . . . . 409.3, 414.3, 415.9.1.7, 1202.5  
Yards or courts . . . . . 1205.2, 1205.3



- INTERIOR FINISHES** ..... Chapter 8
- Acoustical ceiling systems ..... 807, 808
  - Application ..... 803.13, 804.4
  - Atriums ..... 404.8
  - Children's play structures ..... 424
  - Covered and open mall buildings ..... 402.6
  - Decorative materials ..... 419, 802.3, 806
  - Floor finish ..... 804, 805
  - Foam plastic insulation ..... 2603.3, 2603.4
  - Foam plastic trim ..... 806.5, 2604.2
  - Insulation ..... 807
  - Light-transmitting plastics ..... 2606
  - Signs ..... 402.6.4, 2611
  - Trim ..... 806.7, 806.8
  - Wall and ceiling finishes ..... 803
  - Wet location ..... 1210
- INTERMODAL SHIPPING CONTAINER** ..... 202, 3115
- INTERPRETATION, CODE** ..... 104.1
- J**
- JAILS**  
[see **INSTITUTIONAL (see GROUP I-3)**] ..... 308.5, 408
- JOINT**
- Gypsum board ..... 2508.5
  - Lumber sheathing ..... 2308.7.11
  - Waterproofing ..... 1805.3.3
- JOINTS, FIRE-RESISTANT SYSTEMS** ..... 715
- Special inspection ..... 1705.18
- K**
- KIOSKS** ..... 402.6.2
- KITCHENS** ..... 303.3, 306.2
- Accessibility ..... 1110.4
  - Dimensions ..... 1209
  - Means of egress ..... 1016.2
  - Occupant load ..... Table 1004.5
  - Sinks ..... Table 2902.1
- L**
- LABORATORIES**
- Classification of ..... 304.1, 307.1.1
  - Hazardous materials ..... 414, 415
  - Higher education laboratories ..... 304.4, 428
  - Incidental uses ..... Table 509.1
- LADDERS**
- Boiler, incinerator and furnace rooms ..... 1006.2.2.1
  - Construction ..... 1011.15, 1011.16, 1014.2, 1014.6, 1015.3, 1015.4
  - Emergency escape window wells ..... 1031.5.2
  - Group I-3 ..... 408.3.5, 1011.15, 1011.16
  - Heliport ..... 412.7.3
  - Refrigeration machinery room ..... 1006.2.2.2
  - Ships ladders ..... 408.3.5, 1011.15
  - Stage ..... 410.5.3.4
- LAMINATED TIMBER, STRUCTURAL GLUED** ..... 602.4, 2303.1, 2303.1.3, 2304.12.2.4, 2306.1, 2308.4.3, 2308.7.9
- LANDINGS**
- Doors ..... 1010.1.5
  - Ramp ..... 1012.6
  - Stair ..... 1011.6
- LATH, METAL OR WIRE** ..... Table 2507.2
- LAUNDRIES** ..... 304.1, 306.2, Table 509.1
- LAUNDRY CHUTE** ..... 713.13, 903.2.11.2
- LEGAL**
- Federal and state authority ..... 102.2
  - Liability ..... 104.8
  - Notice of violation ..... 114.2, 116.3
  - Registered design professional ..... 107.1, 107.3.4
  - Right of entry ..... 104.6
  - Unsafe buildings or systems ..... 116
  - Violation penalties ..... 114.4
- LIBRARIES**
- Classification, other than school ..... 303.1.3, 303.4
  - Classification, school ..... 303.1.3, 305.1
  - Live load ..... Table 1607.1
- LIGHT, REQUIRED** ..... 1204
- Artificial ..... 1204.3
  - Emergency (see **EMERGENCY LIGHTING**)
  - Means of egress ..... 1008.2
  - Natural ..... 1204.2
  - Stairways ..... 1204.4
  - Yards and courts ..... 1205
- LIGHT-FRAME CONSTRUCTION**
- Cold-formed steel ..... 2211
  - Conventional (wood) ..... 2308
  - Definition ..... 202
- LIGHTS, PLASTIC CEILING DIFFUSERS** ..... 2606.7
- LINEN CHUTE** ..... 713.13, 903.2.11.2
- LINTEL**
- Adobe ..... 2109.2.4.9
  - Fire resistance ..... 704.11
  - Masonry, wood support ..... 2304.13
- LIQUEFIED PETROLEUM GAS** ..... Table 414.5.1, 415.9.2
- LIVE LOADS** ..... 202, 1607
- Construction documents ..... 107.2, 1603.1.1
  - Posting of ..... 106.1

## INDEX

<b>LIVE/WORK UNITS</b> .....	202, 310.3, 508.5
Accessibility .....	1108.6.2.1
Separation .....	508.1
<b>LOAD AND RESISTANCE</b>	
<b>FACTOR DESIGN (LRFD)</b> .....	1602.1
Factored load .....	202, 1604.2
Limit state .....	202, 1604.2
Load combinations .....	1605
Load factor .....	202
Resistance factor .....	202
Wood design .....	2302.1, 2307
<b>LOAD COMBINATIONS</b> .....	1605
Allowable stress design .....	1605, 1605.2
Alternative allowable stress load combinations .....	1605.2
Load and resistance factor design .....	1605
Strength design .....	1605
<b>LOADS</b> .....	106, 202
Atmospheric ice .....	1614
Combinations .....	1605
Dead .....	202, 1606
Factored load .....	202, 1604.2
Flood .....	1603.1.7, 1612
Impact .....	202, 1607.11
Live .....	508.5.8, 1603.1.1, 1607
Load effects .....	202
Nominal load .....	202, 1604.2
Rain .....	1603.1.9, 1611
Seismic .....	1603.1.5, 1613
Snow .....	1603.1.3, 1608
Soil lateral .....	1610
Tsunami .....	1615
Wind .....	1603.1.4, 1609
<b>LOBBIES</b>	
Assembly occupancy .....	1030.4
Elevator .....	405.4.3, 1009.2.1, 1009.4, 3006, 3007.6, 3008.6
Exit discharge .....	1028.2
Underground buildings .....	405.4.3
<b>LOCKS AND LATCHES</b> .....	1010.2, 1010.2.9
Delayed egress locks .....	1010.2.13
Electromagnetically locked .....	1010.2.11
Group I-2 .....	407.4.1.1, 1010.2.14
Group I-3 .....	408.4, 1010.2.15
High-rise .....	403.5.3
Sensor release .....	1010.2.12
Toilet rooms .....	2902.3.5
<b>LODGING HOUSES</b> .....	202, 310.4, 310.4.2
<b>LUMBER</b>	
General provisions .....	Chapter 23
Quality standards .....	2303

## M

**MAINTENANCE**

Means of egress .....	1002.1, 3310.2
Property .....	101.4.4

**MALL (see COVERED MALL AND OPEN MALL BUILDINGS)**

<b>MANUAL FIRE ALARM BOX</b> .....	907.4.2
------------------------------------	---------

**MANUFACTURED HOMES**

Flood resistant .....	G109
-----------------------	------

<b>MARQUEES</b> .....	202, 3106, H113
-----------------------	-----------------

Construction .....	3106.5
Drainage, water .....	3201.4
Live load .....	Table 1607.1, 1607.13
Prohibited location .....	3106.4
Roof construction .....	3106.3

**MASONRY**

Adhered veneer .....	1404.10
Adobe .....	2109
Anchorage .....	1604.8.2
Anchored veneer .....	1404.6
Architectural cast stone .....	2103.1
Calculated fire resistance .....	722.4
Chimneys .....	2113
Construction .....	2104
Dampproofing .....	1805.2.2
Design, methods .....	2101.2, 2107, 2108, 2109
Fire resistance, calculated .....	722.3.2, 722.3.4
Fireplaces .....	2111
Floor anchorage .....	1604.8.2
Foundation walls .....	1807.1.5
Foundations, adobe .....	2109.2.4.5
Glass unit .....	2110
Grouted .....	202
Heaters .....	2112
Inspection, special .....	1705.4
Joint reinforcement .....	2103.4
Materials .....	2103
Penetrations .....	714
Quality assurance .....	2105
Rodentproofing .....	Appendix F
Roof anchorage .....	1604.8.1
Seismic provisions .....	2106
Serviceability .....	1604.3.4
Supported by wood .....	2304.13
Surface bonding .....	2103.2.2
Veneer .....	1404.6, 1404.10, 2101.2.1, 2308.6.10
Wall, composite .....	202
Wall, hollow .....	202
Wall anchorage .....	1604.8.2
Waterproofing .....	1805.3.2
Wythe .....	202

**MASS NOTIFICATION SYSTEMS** ..... 917**MATERIALS**

Alternates	104.11
Aluminum	Chapter 20
Concrete	Chapter 19
Glass and glazing	Chapter 24
Gypsum	Chapter 25
Masonry	Chapter 21
Noncombustible	703.4
Plastic	Chapter 26
Steel	Chapter 22
Testing (see TESTING)	1707
Wood	Chapter 23

**MEANS OF APPEALS** ..... 113, Appendix B**MEANS OF EGRESS** ..... Chapter 10, 202

Accessible	1009, 2702.2
Aircraft related	412.2.2, 412.2.5.1, 412.4.2, 412.6.1, 412.7.3
Alternating tread device	412.7.3, 1006.2.2.1, 1006.2.2.2, 1011.14
Ambulatory care facilities	422.3.1, 422.3.3
Assembly	1009.1, 1030
Atrium	404.9, 404.11, 707.3.6
Capacity	1005.3
Ceiling height	1003.2
Child care facilities (see DAY CARE)	
Configuration	1007
Construction drawings	107.2.3
Convergence	1005.6
Covered and open mall buildings	402.8
Day care facilities	308.5, 310.4.1, 1006.2.2.4
Distribution	1005.5
Doors	1005.7, 1006.2, 1010, 1022.2, 2702.2
During construction	3303.3, 3310
Elevation change	1003.5
Elevators	403.5.2, 403.6.2, 1003.7, 1009, 3008
Emergency escape and rescue	1031
Encroachment	1005.7
Equipment platform	505.3
Escalators	1003.7
Evacuation plans	1002.2
Existing buildings	3310
Exit (see EXIT)	1022, 1027
Exit access (see EXIT ACCESS)	1016, 1021
Exit discharge (see EXIT DISCHARGE)	1028
Exit enclosures	1023.2
Exit passageway (see EXIT PASSAGWAY)	1024
Exit signs	1013, 2702.2
Fire escapes	412.7.3
Fire safety plans	1002.2
Floor surface	804, 1003.4

Gates	1010.4
Group I-2	407.2, 407.3, 407.4, 1019.4
Group I-3	408.2, 408.3, 408.4, 408.6, 408.8, 1019.4
Guards	1015
Handrails	1014
Hazardous materials	414.6.1.2, 415.11.2, 415.11.6.6
Headroom	1003.2, 1003.3
Heliports, Helistops	412.7.3
High-hazard Group H	415.11.2
High-rise	403.5, 403.6
Illumination	1008, 2702.2
Interior finish	803.13, 804
Ladders (see LADDERS)	
Live loads	Table 1607.1
Live/work units	508.5.3
Mezzanines	505.2.2, 505.2.3, 1004.2.2, 1009.1
Moving walk	1003.7
Number	1001.2, 1006
Occupant load	1004
Parking	406.5.7
Protruding objects	1003.3, 1005.7
Ramps	1012, 1019, 1027
Scoping	101.3, 108.2, 1001.1
Seating, fixed	1009.1, 1030
Special amusement	411.6
Stages	410.2.3, 410.5
Stairways	403.5, 404.6, 1005.3.1, 1011, 1019, 1023, 1027
Temporary structures	3103.4
Travel distance (see TRAVEL DISTANCE)	1006.2.1, 1017
Turnstile	1010.5
Underground buildings	405.5.1, 405.7
Width	1005.1, 1005.2, 1005.4, 1011.2, 1012.5.1, 1020.3, 1030.6, 1030.8

**MECHANICAL (see AIR CONDITIONING, HEATING, REFRIGERATION AND VENTILATION)** ..... 101.4.2

Access	1011.12, 1208.3
Air transfer openings	705.10, 706.11, 707.10, 708.9, 709.8, 712.1.6, 713.10, 714.1.1, 717
Chimneys (see CHIMNEYS)	
Code	Chapter 28
Disconnected	3303.6
Ducts	704.8, 705.10, 706.11, 707.10, 708.9, 709.8, 710.8, 712.1.6, 712.1.10.3, 713.10, 714.1.1, 717
Encroachment, public right-of-way	3202.3.2
Equipment on roof	1510, 1511.2

## INDEX

Equipment platforms . . . . . 505.3  
 Fireplaces . . . . . 2111  
 Incidental use room . . . . . Table 509.1  
 Motion picture projection room . . . . . 409.3  
 Permit required . . . . . 105.1, 105.2  
 Roof access . . . . . 1011.12  
 Seismic inspection and testing . . . 1704.3.2, 1705.13.7  
 Smoke control system . . . . . 909  
 Systems . . . . . Chapter 28, 202

**MECHANICALLY LAMINATED DECKING** . . . 2304.9.3

**MEDICAL GAS SYSTEMS** . . . . . 427

**MEMBRANE ROOF COVERINGS** . . . . . 1507.11,  
 1507.12, 1507.13

**MEMBRANE STRUCTURES** . . . . . 2702.2, 3102

**MERCANTILE OCCUPANCY (GROUP M)** . . . . . 309

Accessible . . . . . 1110.13  
 Alarm and detection . . . . . 907.2.7  
 Area . . . . . 503, 505, 506, 507, 508  
 Covered and open mall buildings . . . . . 402  
 Hazardous material display and storage . . . . . 414.2.5  
 Height . . . . . 503, 504, 505, 508  
 Incidental uses . . . . . 509  
 Interior finishes . . . . . Table 803.13, 804  
 Live load . . . . . Table 1607.1  
 Means of egress  
   Aisles . . . . . 1018.3, 1018.4  
   Stairway, exit access . . . . . 1019  
   Travel distance . . . . . 402.8, 1006.3,  
   1017.2, 1006.2.1  
 Mixed occupancies . . . . . 508.3, 508.4  
   Accessory . . . . . 508.2  
   Live/work units . . . . . 508.5  
   Mall buildings . . . . . 402  
   Parking below/above . . . . . 510.2, 510.7, 510.8, 510.9  
   Special mixed . . . . . 510.2  
 Occupancy exceptions . . . . . 307.1.1  
 Plumbing fixtures . . . . . 2902  
 Sprinkler protection . . . . . 903.2.7  
 Standpipes . . . . . 905.3.3  
 Unlimited area . . . . . 507.4, 507.5, 507.13

**METAL**  
 Aluminum . . . . . Chapter 20  
 Roof coverings . . . . . 1504.4.2, 1507.4, 1507.5  
 Steel . . . . . Chapter 22  
 Veneer . . . . . 1403.5

**METAL COMPOSITE MATERIALS** . . . . . 1406

**MEZZANINES** . . . . . 505  
 Accessibility . . . . . 1104.4, 1109.2.4, 1109.2.9  
 Area limitations . . . . . 505.2.1, 505.2.1.1, 505.3.1  
 Egress . . . . . 505.2.2, 505.2.3, 1009.1

Equipment platforms . . . . . 505.3  
 Guards . . . . . 505.3.3, 1015.1  
 Height . . . . . 505.2  
 Occupant load . . . . . 1004.2.2  
 Stairways . . . . . 712.1.11, 1011.14, 1019, 1023.2

**MIRRORS** . . . . . 1010.1, 2406.1

**MIXED OCCUPANCY**  
 (see **OCCUPANCY SEPARATION**)

**MODIFICATIONS** . . . . . 104.4, 104.10

**MOISTURE PROTECTION** . . . . . 1210, 1402.2, 1503

**MONASTERIES** . . . . . 310.3

**MORTAR** . . . . . 202  
 Ceramic tile . . . . . 2103.2.3  
 Dampproofing . . . . . 1805.2.2  
 Fire resistance . . . . . 714.4.1, 715.5  
 Glass unit masonry . . . . . 2110.1.1  
 Masonry . . . . . 2103.2  
 Rodentproofing . . . . . Appendix f

**MOTELS** . . . . . 310.2, 310.3

**MOTION PICTURE PROJECTION ROOMS** . . . . . 409  
 Construction . . . . . 409.2  
 Exhaust air . . . . . 409.3.2, 409.3.3  
 Lighting control . . . . . 409.4  
 Projection room . . . . . 409.3  
 Supply air . . . . . 409.3.1  
 Ventilation . . . . . 409.3

**MOTOR FUEL-DISPENSING SYSTEM** . . . . . 406.7  
 Accessibility . . . . . 1107.3

**MOTOR VEHICLE FACILITIES** . . . . . 304, 311, 406

**MOVING, BUILDINGS** . . . . . 101.4.7, D103.3

**MOVING WALKS** . . . . . 3004.2  
 Means of egress . . . . . 1003.7

## N

**NAILING** . . . . . 202, 2303.6, 2304, 2304.10

**NONCOMBUSTIBLE BUILDING MATERIAL** . . . . . 703.4

**NURSES STATIONS**  
 (see **CARE PROVIDER STATIONS**)

**NURSING HOMES**  
 [see **INSTITUTIONAL (GROUP I-2)**] . . . . . 308.3, 407

## O

**OCCUPANCY**  
 Accessory . . . . . 507.1.1, 508.2  
 Certificates (see **CERTIFICATE OF OCCUPANCY**)  
 Change (see **CHANGE OF OCCUPANCY**)  
 Floor loads . . . . . Table 1607.1  
 Height in mixed occupancy buildings . . . . . 504.2  
 Roofs  
 Special . . . . . Chapter 4



<b>OCCUPANCY CLASSIFICATION</b> . . . . .	Chapter 3
Covered and open mall buildings . . . . .	402
Detailed requirements . . . . .	Chapter 4
Exceptions . . . . .	303.1.1, 303.1.4, 305.1.1, 305.2.1, 305.2.3, 307.1.1, 308.2.3, 308.2.4, 308.3.2, 308.5.1, 308.5.4, 310.4.1, 311.1.1
HPM . . . . .	415.11
Mixed . . . . .	508, 510
Occupied roofs . . . . .	302.1, 503.1.4
<b>OCCUPANCY SEPARATION</b> . . . . .	
Accessory . . . . .	508.2
Aircraft related . . . . .	412.4.1
Nonseparated use method . . . . .	508.3
Separated use method . . . . .	508.4
Special provisions . . . . .	510
Unlimited area buildings . . . . .	507.1.1, 507.4.1, 507.8
<b>OCCUPANT EVACUATION</b> . . . . .	
<b>ELEVATORS</b> . . . . .	403.5.2, 403.6.2, 3008
<b>OCCUPANT LOAD</b> . . . . .	
Business . . . . .	Table 1004.5, 1004.8
Calculated . . . . .	1004.5
Certificate of occupancy . . . . .	111
Covered and open mall building . . . . .	402.8.2
Cumulative . . . . .	1004.2
Increased . . . . .	1004.5.1
Multiple function . . . . .	1004.3
Multiple occupancies . . . . .	1004.4
Outdoors . . . . .	1004.7
Seating, fixed . . . . .	1004.6
Signs . . . . .	1004.9
<b>OCCUPIED ROOFS</b> . . . . .	503.1.4
<b>OFFICE BUILDINGS (see GROUP B OCCUPANCIES)</b> . . . . .	
Classification . . . . .	304
Live loads . . . . .	Table 1607.1, 1607.5
<b>OPEN MALL BUILDINGS (see COVERED AND OPEN MALL BUILDINGS)</b> . . . . .	
<b>OPENING PROTECTION, EXTERIOR WALLS</b> . . . . .	705.8
<b>OPENING PROTECTION, FLOORS (see VERTICAL OPENING PROTECTION)</b> . . . . .	
<b>OPENING PROTECTIVES</b> . . . . .	705.8, 706.8, 707.6, 708.6, 709.5, 712.1.13.1, 713.7, 716
Automatic-closing devices . . . . .	909.5.3
Fire door and shutter assemblies . . . . .	705.8.2, 712.1.13.1, 716.2.1
Fire windows . . . . .	716.3.4
Glass unit masonry (see GLASS UNIT MASONRY) . . . . .	2110.1.1
Glazing . . . . .	716.1.2
<b>ORGANIC COATINGS</b> . . . . .	418
<b>ORGANIC PEROXIDES</b> . . . . .	307.4, 307.5
<b>OXIDIZERS, LIQUID AND SOLID</b> . . . . .	307.3, 307.4, 307.5
<b>P</b>	
<b>PLAY STRUCTURES</b> . . . . .	424
Accessibility . . . . .	1111
Covered and open mall building . . . . .	402.6.3
<b>PANIC HARDWARE</b> . . . . .	202, 1006.2.2.2, 1006.2.2.4, 1010.2.8, 1010.2.9, 1010.4.1
<b>PARAPET, EXTERIOR WALL</b> . . . . .	705.11, 2109.2.4.3
Construction . . . . .	705.11.1
Fire wall . . . . .	706.6
Height . . . . .	705.11.1
<b>PARKING, ACCESSIBLE</b> . . . . .	1106, 1112.1
<b>PARKING GARAGES</b> . . . . .	406.4, 406.5, 406.6
Accessibility . . . . .	1105.1.2, 1106.2, 1106.9.4, 1112.1
Barriers, vehicle . . . . .	202, 406.4.2, 1607.10
Classification . . . . .	311, 312, 406.3, 406.4
Construction type . . . . .	406.5.1, Table 601
Enclosed (see PARKING GARAGE, ENCLOSED) . . . . .	406.6
Gates . . . . .	406.2.1, 3110
Guards . . . . .	406.4.1, 2407.1.3
Height, clear . . . . .	406.2.2
Live loads . . . . .	Table 1607.1, 1607.12.1.3
Means of egress . . . . .	1006.2.2.5, 1006.3, 1019
Mechanical-access garages . . . . .	406.6.4
Occupancy separation . . . . .	508, 510
Open (see PARKING GARAGE, OPEN) . . . . .	406.5
Special provisions . . . . .	510
Sprinkler protection . . . . .	903.2.10
Underground . . . . .	405
Vertical openings . . . . .	712.1.10
<b>PARKING GARAGES, ENCLOSED</b> . . . . .	406.6
Area and height [see STORAGE OCCUPANCY (GROUP S)] . . . . .	406.6.1
Means of egress . . . . .	1006.2.2.5, 1006.3, 1012.1
Sprinkler protection . . . . .	406.6.3
Ventilation . . . . .	406.6.2
<b>PARKING GARAGES, OPEN</b> . . . . .	202, 406.5
Area and height [see STORAGE OCCUPANCY (GROUP S)] . . . . .	406.5, 406.5.1, Table 406.5.4
Construction type . . . . .	406.5.1
Means of egress . . . . .	406.5.7, Table 1006.2.1, 1006.3, 1009.3, 1009.4, 1012.1, 1017.3, 1019, 1020.2, 1028.2
Mixed occupancy . . . . .	406.5.3
Standpipes . . . . .	406.5.8
Ventilation . . . . .	406.5.10

## INDEX

<b>PARTICLEBOARD</b> .....	202
Draftstopping .....	718.3.1
Moisture protection .....	1402.2, 1404.2
Quality .....	2303.1.8
Veneer .....	1404.5
Wall bracing .....	2308.6.3
<b>PARTITIONS</b> .....	
Fabric partition .....	202, 1607.16.1
Fire (see FIRE PARTITION) .....	
Live loads .....	1607.5, 1607.16
Materials .....	602.4, 603.1
Occupancy, specific .....	708.1
Smoke (see SMOKE PARTITION) .....	
Toilets .....	1210
<b>PARTY WALLS</b> .....	
(see FIRE WALLS) .....	706.1.1, Table 716.1(3)
<b>PASSAGEWAY, EXIT (see EXIT)</b> .....	1024
<b>PASSENGER STATIONS</b> .....	303.4
<b>PATIO COVERS</b> .....	2606.10, Appendix I
<b>PEDESTRIAN</b> .....	
Protection at construction site .....	3303.2, 3306
Walkways and tunnels .....	3104, 3202.3.4
<b>PENALTIES</b> .....	114.4
<b>PENETRATION-FIRESTOP SYSTEM</b> .....	
Fire-rated horizontal assemblies .....	714.5.2
Fire-rated walls .....	714.4.2
<b>PENETRATIONS</b> .....	714, 717
Fire-resistant assemblies .....	
Exterior wall .....	705.10
Fire barrier .....	707.7, 707.10
Fire partition .....	708.7, 708.9
Fire wall .....	706.9, 706.11
Horizontal assemblies .....	714.5
Installation .....	714.2
Shaft enclosures .....	712.1, 713.1, 713.8, 713.10
Smoke barriers .....	709.6, 709.8, 714.5.4
Smoke partitions .....	710.6, 710.7
Special inspection .....	1705.18
Walls .....	714.4
Nonfire-resistant assemblies .....	714.6
<b>PERFORMANCE CATEGORY</b> .....	
Definition .....	202
Wood structural panels .....	2303.1.5
<b>PERFORMANCE-BASED</b> .....	Appendix O
<b>PERLITE</b> .....	Table 721.1(1), Table 2507.2
<b>PERMITS</b> .....	105
Application for .....	104.2, 105.1, 105.3
Drawings and specifications .....	107.2.1
Expiration .....	105.5
Fees .....	109
Liability for issuing .....	104.8
Placement of permit .....	105.7
Plan review .....	104.2, 107.3
Suspension or revocation .....	105.6
Time limitations .....	105.3.2, 105.5
<b>PHOTOVOLTAIC PANEL SYSTEMS</b> .....	202
Ballasted, seismic design .....	1613.3
Fire classification .....	1505.8, 1505.9
Panels/modules .....	1512
Photovoltaic module .....	202
Photovoltaic panel .....	202
Roof live loads .....	1607.14.4
Rooftop mounted .....	1511.7
<b>PIER FOUNDATIONS (see FOUNDATION, SHALLOW)</b> .....	
<b>PILE FOUNDATIONS (see FOUNDATION, DEEP)</b> .....	
<b>PIPES</b> .....	
Embedded in fire protection .....	704.8
Insulation covering .....	720.1, 720.7
Penetration protection .....	714, 1023.5
Under platform .....	410.3
<b>PLAN REVIEW</b> .....	107.3
<b>PLASTER</b> .....	
Fire-resistance requirements .....	719
Gypsum .....	719.1, 719.2
Inspection .....	110.3.6
Portland cement .....	719.5, Table 2507.2,
Table 2511.1.1	
<b>PLASTIC</b> .....	Chapter 26
Approval for use .....	2606.2
Composites .....	2612
Core insulation, reflective plastic .....	2614
Decking .....	1409, 2612
Fiber-reinforced polymer .....	2613
Finish and trim, exterior .....	2602.1
Finish and trim, interior .....	2602, 2604
Light-transmitting panels .....	2401.1, 2607
Roof panels .....	2609
Signs .....	402.6.4, 2611, D102.2.10, H107.1.1
Thermal barrier .....	2603.4
Veneer .....	1403.8, 2605, D102.2.11
Walls, exterior .....	2603.4.1.4, 2603.5
<b>PLASTIC, FOAM</b> .....	
Insulation (see FOAM PLASTICS) .....	2603
Interior finish .....	803.4, 2603.9
Malls .....	402.6.2, 402.6.4.5
Play structures .....	424.2
Stages and platforms .....	410.2.6
<b>PLASTIC, LIGHT-TRANSMITTING</b> .....	
Awnings and patio covers .....	2606.10
Bathroom accessories .....	2606.9
Exterior wall panels .....	2607
Fiberglass-reinforced polymer .....	2613.4

Fiber-reinforced polymer . . . . .	2613.4
Glazing . . . . .	2608
Greenhouses . . . . .	2609
Light-diffusing systems . . . . .	2606.7
Roof panels . . . . .	2609
Signs, interior . . . . .	2611
Skylight . . . . .	2610
Solar collectors . . . . .	2606.12
Structural requirements . . . . .	2606.5
Unprotected openings . . . . .	2608.1, 2608.2
Veneer, exterior . . . . .	603.1, 2605
Wall panels . . . . .	2607
<b>PLATFORM (see STAGES AND PLATFORMS)</b> . . .	410
Construction . . . . .	410.3
Temporary . . . . .	410.3.1
<b>PLATFORM, EQUIPMENT</b> <b>(see EQUIPMENT PLATFORM)</b>	
<b>PLATFORM LIFTS, WHEELCHAIR</b>	
Accessibility . . . . .	1110.9
Accessible means of egress . . . . .	1009.2, 1009.5, 1110.9, 2702.2
<b>PRESCRIPTIVE FIRE RESISTANCE</b> . . . . .	721
<b>PRESERVATIVE-TREATED WOOD</b> . . . . .	202
Fastenings . . . . .	2304.10.6
Quality . . . . .	2303.1.9
Required . . . . .	2304.12
Shakes, roof covering . . . . .	1507.9.6, 1507.9.8
<b>PRIVATE GARAGE</b> . . . . .	202, 406.3, 1010.1.2, 1502.4
Accessibility . . . . .	1103.2.4, 1106.6
<b>PROJECTION ROOMS</b>	
Motion picture . . . . .	409
<b>PROJECTIONS, COMBUSTIBLE</b> . . . . .	705.2.3, 705.2.3.1
<b>PROPERTY LINE</b> <b>(see FIRE SEPARATION DISTANCE)</b> . . . . .	705.3
<b>PROPERTY MAINTENANCE</b> . . . . .	101.4.4
<b>PROSCENIUM</b>	
Opening protection . . . . .	410.2.5
Wall . . . . .	410.2.4
<b>PSYCHIATRIC HOSPITALS</b> <b>[see INSTITUTIONAL (see GROUP I-2)]</b> . . . . .	308.4
<b>PUBLIC ADDRESS SYSTEM</b> <b>(see EMERGENCY COMMUNICATIONS)</b>	
Covered and open mall buildings . . . . .	402.7, 907.2.20, 2702.2
Special amusement buildings . . . . .	411.5
<b>PUBLIC PROPERTY</b> . . . . .	Chapter 32, Chapter 33
<b>PUBLIC RIGHT-OF-WAY</b>	
Encroachments . . . . .	Chapter 32
<b>PUZZLE ROOM</b> . . . . .	202, 411.5
<b>PYROPHORIC MATERIALS</b> . . . . .	Table 307.1(1), 307.4

## R

### RAILING (see GUARDS and HANDRAILS)

<b>RAMPS</b> . . . . .	1012
Assembly occupancy . . . . .	1030.14
Construction . . . . .	1012.2, 1012.5.3, 1012.7, 1012.10
Exit . . . . .	1023
Exit access . . . . .	1019
Exterior . . . . .	1027
Guards . . . . .	1012.9, 1015, 1607.9
Handrails . . . . .	1012.8, 1014, 1607.9
Interior . . . . .	1012.2
Landings . . . . .	1012.6
Parking garage . . . . .	406.4.3
Slope . . . . .	1012.2

### RECREATIONAL FACILITIES

Accessibility . . . . .	1111
Amusement rides . . . . .	1111.4.8
Animal containment areas . . . . .	1111.4.7
Areas of sports activity . . . . .	202, 1111.4.1
Boat slips . . . . .	1111.4.9
Bowling lanes . . . . .	1111.4.3
Boxing rings . . . . .	1111.4.5
Court sports . . . . .	1111.4.4
Exercise equipment . . . . .	1111.4.10
Fishing piers . . . . .	1111.4.11
Gaming . . . . .	1110.16
Hot tubs . . . . .	1111.4.14
Miniature golf . . . . .	1111.4.12
Play areas . . . . .	1111.4.13
Referee stands . . . . .	1111.4.6
Shooting facilities . . . . .	1111.4.15
Swimming pools . . . . .	1111.4.14
Team or player seating . . . . .	1111.4.2
Play structure . . . . .	402.6.3, 424
Special amusement areas (see AMUSEMENT AREAS, SPECIAL)	

<b>REFERENCED STANDARDS</b> . . . . .	Chapter 35
Applicability . . . . .	102.3, 102.4
Fire resistance . . . . .	703.2
List . . . . .	Chapter 35
Organizations . . . . .	Chapter 35

### REFORMATORIES

<b>[see INSTITUTIONAL (GROUP I-3)]</b> . . . . .	308.4
--	-------

### REFRIGERATION (see MECHANICAL)

Machinery room . . . . .	1006.2.2.2
--------------------------	------------

### REFUGE AREAS (see HORIZONTAL EXIT, SMOKE COMPARTMENTS, STORM SHELTERS)

407.5.3, 408.6.2, 420.6.1, 422.3.2, 423, 423.3, 423.4, 1026.4
--

<b>REFUSE CHUTE</b> . . . . .	713.13
-------------------------------	--------

## REINFORCEMENT

Masonry.....	2103.4
Shotcrete.....	1908

## RELIGIOUS WORSHIP. PLACES OF

Accessibility. . . . .	1103.2.8, 1109.2.4
Alarms and detection. . . . .	907.2.1
Balcony . . . . .	1030.5, 1109.2.4
Classification . . . . .	303.1.4, 303.4, 305.1.1, 305.2.1, 308.5.2
Door operations. . . . .	1010.2.10
Egress . . . . .	1030
Interior finishes . . . . .	Table 803.13, 804
Unlimited area . . . . .	507.6, 507.7

## RELOCATING, BUILDING . . . . .101.4.7, 107.2.8, 3113

Compliance . . . . .	3113.1.1
Inspection agencies. . . . .	3113.4
Manufacturer's data plate . . . . .	3113.3
Supplemental information . . . . .	3113.2

## REPAIRS, BUILDING ..... 101.4.7, 202

Flood .....	1612.1
Minor .....	105.2.2
Permit required .....	105.1

**RESIDENTIAL OCCUPANCY (GROUP R).....310**

Accessibility . . . . .	1103.2.3, 1103.2.11, 1105.1.8, 1106.3, 1108, 1108.2, 1108.3, 1108.4, E104.2
Alarm and detection . . . . .	907.2.8, 907.2.9, 907.2.11, 907.2.12, 907.5.2.3.2, 907.5.2.3.3
Area . . . . .	503, 505, 506, 508, 510
Cooking . . . . .	420.10, 420.11
Draftstopping . . . . .	708.4.2, 718.4
Group provisions	
Group R-1 (transient) . . . . .	310.2
Group R-2 (apartment) . . . . .	310.3
Group R-3 (two dwellings per building) . . . . .	310.4
Group R-4 (group homes) . . . . .	310.5
Height . . . . .	503, 504, 505, 508, 510
Incidental uses . . . . .	509
Interior finishes . . . . .	Table 803.13, 804
Live load . . . . .	Table 1607.1
Live/work units . . . . .	508.5
Means of egress	
Aisles . . . . .	1018.5
Corridors . . . . .	1020.2, 1020.3
Doors . . . . .	1010.1.1
Emergency escape and rescue . . . . .	1031.2
Exit signs . . . . .	1013.1, 1013.2
Single exits . . . . .	1006.3
Stairway, exit access . . . . .	1019
Travel distance . . . . .	1006.3.3, 1017.2, 1006.2.1

Mixed occupancies	508.3, 508.4
Accessory	508.2, G112.1
Live/work units	508.5
Parking, private	406.2.8, 406.3
Parking below/above	510.4, 510.7, 510.9
Special mixed	510.2
Plumbing fixtures	2902
Risk category	Table 1604.5
Special provisions	510.2, 510.5, 510.6
Separation	419, 420, 508.2.4, 508.3.3
Swimming pools	3109.1
Sprinkler protection	903.2.8, 903.3.2
<b>STAINING WALLS</b>	1807.2, 2304.12.2.8
Flood provisions	G112.4
Seismic	1803.5.12

## REVIEWING STANDS

(see BLEACHERS AND GRANDSTANDS)

**RISERS, STAIR (see STAIRWAY CONSTRUCTION)**

Alternating tread devices . . . . .	1011.14
Assembly . . . . .	1011.5.2, 1030.10, 1030.14
Closed . . . . .	1011.5.5.3
General . . . . .	1011.5
Spiral . . . . .	1011.10
Uniformity . . . . .	1011.5.4

**RISK CATEGORY (Structural Design) . . . . 202, 1604.5**

Multiple occupancies ..... 1604.5.1

**RODENTPROOFING** .....1201.1, Appendix F

**ROLL ROOFING.....1507.6**

**ROOF, OCCUPIED** ..... 503.1.4

**ROOF ACCESS** .....1011.12

**ROOF ASSEMBLIES AND  
ROOFTOP STRUCTURES ..... 202**

Cooling towers . . . . .	1511.4
Drainage. . . . .	1504, 3201.4
Fire classification . . . . .	1505
Fire district . . . . .	D102.2.9
Height modifications. . . . .	504.3
Impact resistance. . . . .	1504.8
Insulation . . . . .	1508
Materials. . . . .	1506
Mechanical equipment screen . . . . .	1511.6
Parapet walls . . . . .	1503.2, 1503.3
Penthouses . . . . .	1511.2
Photovoltaic panels and modules . . . .	1511.7, 1512.1
Radiant barrier . . . . .	202, 1510
Roof ventilation . . . . .	202
Tanks . . . . .	1511.3
Towers, spires, domes and cupolas. . . . .	1511.5
Weather protection. . . . .	1503
Wind resistance . . . . .	1504.1, 1504.3, 1504.4, 1609.5



**ROOF CONSTRUCTION**

Construction walkways . . . . .	3306.7
Coverings (see ROOF COVERINGS) . . . . .	1609.5.2
Deck . . . . .	1609.5.1
Draftstopping . . . . .	718.4
Fire resistance . . . . .	Table 601
Fireblocking . . . . .	718.2
Live loads . . . . .	Table 1607.1, 1607.13, 3111.1.2
Materials . . . . .	Chapter 6
Penetration of fire-resistant assemblies . . . . .	714
Protection from adjacent construction . . . . .	3307.1
Rain loads . . . . .	1611
Roof structures . . . . .	504.3, 1510, D102.2.9
Signs, roof mounted . . . . .	H110
Slope, minimum . . . . .	Chapter 15
Snow load . . . . .	1608
Solar systems, rooftop-mounted . . . . .	3111.1, 3111.3.2
Trusses . . . . .	2211.1.3, 2303.4, 2308.7.13
Ventilation . . . . .	1202.2
Wood (see ROOF CONSTRUCTION, WOOD)	

**ROOF CONSTRUCTION, WOOD** . . . . . 602.4, 602.5

Anchorage to walls . . . . .	1604.8.2
Attic access . . . . .	1209.2
Ceiling joists . . . . .	2308.7.1
Diaphragms . . . . .	2305.1, 2306.2
Fastening requirements . . . . .	2304.10
Fire-retardant-treated . . . . .	Table 601, 603.1
Framing . . . . .	2304.11.4, 2308.7
Rafters . . . . .	2306.1.1, 2308.7.2
Sheathing . . . . .	2304.8.2, 2308.7.10
Trusses . . . . .	2303.4, 2308.7.13
Ventilation, attic . . . . .	1202.2
Wind uplift . . . . .	2308.7.5

**ROOF COVERINGS** . . . . . 1507

Asphalt shingles . . . . .	1507.2
Built up . . . . .	1507.10
Clay tile . . . . .	1507.3
Concrete tile . . . . .	1507.3
Fire district . . . . .	D102.2.4
Fire resistance . . . . .	603.1, 1505
Flashing . . . . .	1503.2, 1503.5, 1507.2.8, 1507.3.9, 1507.5.7, 1507.7.7, 1507.8.8, 1507.9.9
Impact resistance . . . . .	1504.8
Insulation . . . . .	1508
Liquid-applied coating . . . . .	1507.14
Membrane . . . . .	3102
Metal roof panels . . . . .	1507.4
Metal roof shingles . . . . .	1507.5
Modified bitumen . . . . .	1507.11

Photovoltaic roof panels, building-integrated . . . . .	1507.17
Photovoltaic shingles . . . . .	1507.16
Plastics, light-transmitting panels . . . . .	2609
Reroofing . . . . .	202, 1512
Roll . . . . .	1507.6
Roof recover . . . . .	202, 1512.2.1
Roof replacement . . . . .	202, 1512.2
Single-ply membrane . . . . .	202, 1507.12
Slate shingles . . . . .	1507.7
Sprayed polyurethane foam . . . . .	1507.13
Thermoplastic single-ply . . . . .	1507.13
Wind loads . . . . .	1504.1, 1609.5
Wood shakes . . . . .	1507.9
Wood shingles . . . . .	1507.8

**ROOF DRAINAGE** . . . . . 1502

Scuppers . . . . .	202, 1502.3
--------------------	-------------

**ROOF REPLACEMENT/RECOVERING** . . . . . 1512.2**ROOF STRUCTURE (see ROOF ASSEMBLIES and ROOFTOP STRUCTURES)****ROOM DIMENSIONS** . . . . . 1209**ROOMING HOUSE (see BOARDING HOUSE)** . . . . . 310**S****SAFEGUARDS DURING****CONSTRUCTION** . . . . . Chapter 33

Accessibility . . . . .	1103.2.5
Adjoining property protection . . . . .	3307
Construction . . . . .	3302
Demolition . . . . .	3303
Excavations . . . . .	1804.1
Fire extinguishers . . . . .	3309
Fire watch . . . . .	3314
Means of egress . . . . .	3310
Protection of pedestrians . . . . .	3306
Sanitary facilities . . . . .	3305
Site work . . . . .	3304
Sprinkler protection . . . . .	3312
Standpipes . . . . .	3308.1.1, 3311
Temporary use of streets, alleys and public property . . . . .	3308

**SAFETY GLAZING** . . . . . 716.1.2.1, 2406**SCHOOLS**

[see EDUCATIONAL OCCUPANCY (GROUP E)]

**SEATING**

Accessibility . . . . .	1109.2, 1110.12
Tables . . . . .	1030.9, 1030.13.1

**SEATING, FIXED** . . . . . 1030

Accessibility . . . . .	1109.2, 1110.12
Aisles . . . . .	1030.9, 1030.13
Bleachers (see BLEACHERS)	

## INDEX

- Grandstands (see GRANDSTANDS)
- Guards. . . . . 1030.17
- Live load . . . . . Table 1607.1
- Occupant load. . . . . 1004.6
- Stability . . . . . 1030.15
- Temporary. . . . . 108
- SECURITY GLAZING** . . . . . 408.7
- SECURITY GRILLES** . . . . . 402.8.8, 1010.3.4
- SEISMIC** . . . . . 1613
- Cold-formed steel . . . . . 2210.2, 2211.1.1
- Construction documents . . . . . 107, 1603.1.5
- Earthquake recording equipment . . . . . Appendix I
- Fire resistance. . . . . 704.12
- Geotechnical investigation . . . . . 1803.5.11, 1803.5.12
- Glazing . . . . . 2404
- Loads. . . . . 1613
- Mapped acceleration parameters . . . . . 1613.2.1
- Masonry. . . . . 2106
- Membrane structure . . . . . 3102.7
- Seismic design category . . . . . 202, 1613.2.5
- Seismic detailing . . . . . 1604
- Site class. . . . . 202, 1613.2.2
- Site coefficients . . . . . 202, 1613.2.4
- Special inspection . . . . . 1705.13
- Statement of special inspections. . . . . 1704.3.2
- Steel . . . . . 2205.2, 2206.2
- Structural observations . . . . . 1704.6.1
- Structural testing . . . . . 1705.14
- Wood. . . . . 2305, 2308.6.6, 2308.6.8, 2308.6.10
- SERVICE SINKS** . . . . . 1110.3, Table 2902.1
- SERVICE STATION**  
(see **MOTOR FUEL-DISPENSING FACILITIES**)
- SHAFT ENCLOSURE**  
(see **VERTICAL OPENING PROTECTION**). . . . . 713
- Continuity . . . . . 713.5, 713.11, 713.12
- Elevators . . . . . 713.14
- Exceptions. . . . . 712.1, 1019, 1023
- Exterior walls. . . . . 713.6
- Fire-resistance rating. . . . . 707.3.1, 713.4
- Group I-3 . . . . . 408.5
- High-rise buildings. . . . . 403.2.1.2, 403.2.3,  
403.3.1.1, 403.5.1
- Joints. . . . . 713.9, 715
- Materials . . . . . 713.3
- Opening protection . . . . . 713.8, 713.10, 714, 717.5.3
- Penetration . . . . . 713.8
- Refuse and laundry chutes . . . . . 713.13
- Required . . . . . 712.1
- SHEAR WALL**
- Gypsum board and plaster . . . . . 2505
- Masonry . . . . . 202
- Wood . . . . . 202, 2305.1, 2306.3
- SHEATHING**
- Clearance from earth . . . . . 2304.12.1.2
- Fastening . . . . . 2304.10
- Fiberboard . . . . . Table 2306.3(2)
- Floor. . . . . 2304.8, 2308.4.7
- Gypsum . . . . . Table 2506.2, 2508
- Moisture protection. . . . . 2304.12.1.2
- Roof . . . . . 2304.8
- Roof sheathing. . . . . 2308.7.10
- Wall . . . . . 2304.6, 2308.5.11
- Wood structural panels . . . . . 2303.1.5
- SHIPPING CONTAINERS**  
(see **INTERMODAL SHIPPING CONTAINERS**)
- SHOPPING CENTERS**  
(see **COVERED AND OPEN MALL BUILDINGS**)
- SHOTCRETE** . . . . . 1908
- SHUTTERS, FIRE**  
(see **OPENING PROTECTIVES**). . . . . 716.2.1
- SIDEWALKS** . . . . . 105.2, G112.4
- Live loads. . . . . Table 1607.1
- SIGNS** . . . . . 3107, Appendix H
- Accessibility . . . . . 1013.4, 1111, E106.4.9,  
E107, E109.2.2
- Accessible means of egress . . . . . 1009.8.2,  
1009.9, 1009.11
- Animated devices. . . . . H108
- Construction. . . . . H105, H107
- Covered and open mall building. . . . . 402.6.4
- Doors . . . . . 1010.2.4, 1010.2.12, 1010.2.13
- Electrical. . . . . H106
- Elevators . . . . . 1110.8, 1112.3, 3002.3,  
3007.6.5, 3008.6.5
- Encroachment, public right-of-way. . . . . 3202.3.1
- Exit . . . . . 1013, 2702.2
- Floor loads . . . . . 106.1
- Ground . . . . . H109
- Height limitation . . . . . H109.1, H112.4
- Illumination. . . . . H106.1
- Luminous . . . . . 403.5.5, 1013.5, 1025
- Marquee . . . . . H113
- Obstruction. . . . . 1003.3.2, 1003.3.3, H103
- Occupant load, assembly. . . . . 1004.9
- Parking spaces. . . . . 1112.1
- Plastic. . . . . 2611, D102.2.10
- Portable . . . . . H114
- Projecting. . . . . H112
- Protruding objects . . . . . 1003.3
- Roof . . . . . H110
- Stairway identification . . . . . 1023.8, 1023.9,  
1112.3, 1112.4

Standpipe control valve . . . . .	905.7.1	<b>SMOKE COMPARTMENT</b> . . . . .	202, 407, 408, 422
Toilet room . . . . .	1112.1, 1112.3, 2902.4, 2902.4.1	Refuge area (see REFUGE AREA)	
Transportation . . . . .	E108.4, E109.2.2	<b>SMOKE CONTROL</b> . . . . .	909
Variable message . . . . .	1112.5	Amusement buildings, special . . . . .	411.1
Walls . . . . .	703.4, H111	Atrium buildings . . . . .	404.5
<b>SITE DRAWINGS</b> . . . . .	107.2.6	Covered and open mall building . . . . .	402.7.2
<b>SITE WORK</b> . . . . .	3304	Group I-3 . . . . .	408.9
<b>SKYLIGHTS</b> . . . . .	2405, 3106.3	High-rise (smoke removal) . . . . .	403.4.7, 1023.12
Light, required . . . . .	1204.2	Special inspections . . . . .	1705.19
Loads . . . . .	2404	Stages . . . . .	410.2.7.2
Plastic . . . . .	2610	Standby power systems . . . . .	909.11, 909.20.7.2, 2702.2
Protection from adjacent construction . . . . .	3307.1	Underground buildings . . . . .	405.5
Vertical opening protective . . . . .	712.1.15	<b>SMOKE DAMPERS</b> . . . . .	202, 717.2, 717.3, 717.4, 717.5
<b>SLAB ON GROUND, CONCRETE</b> . . . . .	1907, 2304.12.1.4	<b>SMOKE DETECTORS</b> . . . . .	202
<b>SLATE SHINGLES</b> . . . . .	1507.7	Covered and open mall building . . . . .	402.8.6.1, 907.2.21
<b>SLEEPING UNITS</b> . . . . .	202	High-rise buildings . . . . .	403.4.1, 907.2.14
Accessibility . . . . .	1103.2.11, 1103.2.13, 1105.1.7, 1106.3, 1106.9.2, 1108	HPM . . . . .	415.11.10.3
Cooking appliances . . . . .	420.11, 420.11.2	Institutional I-2 . . . . .	407.8
Group I . . . . .	308	Smoke-activated doors . . . . .	716.2.6.6
Group R . . . . .	310	Special amusement buildings . . . . .	411.4
Scoping . . . . .	101.2	Underground buildings . . . . .	907.2.19
Separation . . . . .	420.2, 420.3	<b>SMOKE DEVELOPMENT</b> . . . . .	202, 803.1.2, Table 803.13
<b>SMOKE ALARMS</b> . . . . .	202	<b>SMOKE EXHAUST SYSTEMS</b>	
Bathrooms . . . . .	907.2.11.4	Underground buildings . . . . .	405.5, 907.2.19, 909.2
Cooking appliances . . . . .	907.2.11.3	<b>SMOKE PARTITIONS</b> . . . . .	202, 710
Live/work unit . . . . .	508.5.7, 907.2.11.2	Continuity . . . . .	710.4
Multiple-station . . . . .	907.2.11	Doors . . . . .	710.5
Residential aircraft hangars . . . . .	412.4.3, 412.4.4, 907.2.22	Ducts and air transfer openings . . . . .	710.8
Residential occupancies . . . . .	420.6, 907.2.11	Fire-resistance rating . . . . .	710.3
Single-station . . . . .	907.2.11	Inspection . . . . .	110.3.8
<b>SMOKE BARRIERS</b> . . . . .	202	Joints . . . . .	710.7
Construction . . . . .	407.5, 709.4, 909.5	Marking . . . . .	703.4, 703.5
Doors . . . . .	709.5, 716.2.2.1, 909.5.3	Materials . . . . .	710.2
Fire-resistance rating . . . . .	703, 709.3	Opening protection . . . . .	710.5, 717.5.7
Glazing, rated . . . . .	716.3.4	Penetrations . . . . .	710.6
Inspection . . . . .	110.3.8	Special provisions	
Joints . . . . .	709.7, 715	Atriums . . . . .	404.6
Marking . . . . .	703.4, 703.5	Group I-2 . . . . .	407.3
Materials . . . . .	709.2	<b>SMOKE REMOVAL (High rise)</b> . . . . .	403.4.7
Opening protection . . . . .	709.5, 714.4, 714.5.4, 716, 717.5.5, 909.5.3	<b>SMOKE VENTS</b> . . . . .	410.2.7.1, 910
Penetrations . . . . .	709.6, 714	<b>SMOKEPROOF ENCLOSURES</b> . . . . .	202, 403.5.4, 1023.12
Smoke control . . . . .	909.5	Design . . . . .	909.20
Special provisions		<b>SNOW LOAD</b> . . . . .	1608
Ambulatory care facilities . . . . .	422.2, 422.3, 709.5.1	Glazing . . . . .	2404
Group I-1 . . . . .	420.6, 709.5.1	<b>SOILS AND FOUNDATIONS</b>	
Group I-2 . . . . .	407.5	(see FOUNDATION) . . . . .	Chapter 18
Group I-3 . . . . .	408.6, 408.7	Depth of footings . . . . .	1809.4
Underground . . . . .	405.4.2, 405.4.3	Evacuation, grading and fill . . . . .	1804, 3304, J106, J107

## INDEX

Expansive . . . . .	1803.5.3, 1808.6	Statement of special inspections . . . . .	1704.3
Flood hazard . . . . .	1804.5	Structural observations . . . . .	1704.6
Footing and foundations . . . . .	1808	Testing seismic resistance . . . . .	1705.13
Footing on or adjacent to slopes . . . . .	1808.7, 3304.1.3	<b>SPECIAL INSPECTOR</b> . . . . .	202
Foundation walls . . . . .	1807.1.5, 3304.1.4	Qualifications . . . . .	1704.2.1
Geotechnical investigations . . . . .	1803	<b>SPIRAL STAIRWAYS</b> . . . . .	1011.10
Grading . . . . .	1804.4, Appendix j	Construction . . . . .	1011.2, 1011.3, 1011.10
Load-bearing values . . . . .	1806	Exceptions . . . . .	1011.5.2, 1011.5.3, 1011.5.5.3, 1011.10
Soil boring and sampling . . . . .	1803.4	Group I-3 . . . . .	408.3.4
Soil lateral load . . . . .	1610	Live/work . . . . .	508.5.5
Special inspection . . . . .	1705.6	Stages . . . . .	410.5.3.4
<b>SOLAR ENERGY SYSTEMS</b> . . . . .	3111	<b>SPORTS ACTIVITY, AREA OF</b> <b>(see RECREATIONAL FACILITIES)</b> . . . . .	202, 1111.4.1
Photovoltaic systems . . . . .	3111.3	<b>SPRAY APPLICATION OF</b> <b>FLAMMABLE FINISHES</b> . . . . .	416
Roof live load . . . . .	3111.1.2	<b>SPRAYED FIRE-RESISTANT MATERIALS</b> . . . . .	202
Solar thermal systems . . . . .	3111.2	Application . . . . .	704.13
Wind resistance . . . . .	3111.1.1	Inspection . . . . .	1705.15, 1705.16
<b>SORORITIES</b> . . . . .	310.3	Steel column calculated fire resistance . . . . .	722.5.2.2
<b>SOUND TRANSMISSION</b> . . . . .	1206	<b>SPRINKLER SYSTEM, AUTOMATIC</b> . . . . .	903, 3312
<b>SOUND-INSULATING MATERIALS</b> <b>(see INSULATON)</b> . . . . .	720	Exempt locations . . . . .	903.3.1.1.1, 903.3.1.1.2
<b>SPECIAL CONSTRUCTION</b> . . . . .	Chapter 31	Fire department location . . . . .	912
Automatic vehicular gates . . . . .	3110	Limited area sprinkler systems . . . . .	903.3.8
Awnings and canopies (see AWNINGS and CANOPIES) . . . . .	3105	Signs . . . . .	914.2
Marquees (see MARQUEES) . . . . .	3106	<b>SPRINKLER SYSTEM, REQUIRED</b> . . . . .	903
Membrane structures (see MEMBRANE STRUCTURES) . . . . .	3102	Aircraft related . . . . .	412.2.4, 412.3.6, 412.4.5
New materials . . . . .	1702	Ambulatory care facilities . . . . .	422.4, 903.2.2
Pedestrian walkways and tunnels (see WALKWAYS and TUNNELED WALKWAYS) . . . . .	3104	Amusement areas, special . . . . .	411.2
Signs (see SIGNS) . . . . .	3107	Assembly . . . . .	903.2.1, 1030.6.2.3
Solar energy systems . . . . .	3111	Atrium . . . . .	404.3
Swimming pool enclosures and safety devices (see SWIMMING POOL) . . . . .	3109	Basements . . . . .	903.2.11.1
Telecommunication and broadcast towers (see TOWERS) . . . . .	3108	Building area . . . . .	506.2
Temporary structures (see TEMPORARY STRUCTURES) . . . . .	3103	Combustible storage . . . . .	413
<b>SPECIAL INSPECTIONS AND TESTS</b> <b>(see INSPECTIONS)</b> . . . . .	Chapter 17, 110.3.10	Commercial kitchen . . . . .	903.2.11.5
Alternative test procedure . . . . .	1707	Construction . . . . .	903.2.12
Approvals . . . . .	1703	Covered and open mall building . . . . .	402.5
Continuous special inspection . . . . .	202	Drying rooms . . . . .	417.4
Contractor responsibilities . . . . .	1704.4	Education . . . . .	903.2.3
Design strengths of materials . . . . .	1706	Exempt locations . . . . .	903.3.1.1.1, 903.3.1.1.2
General . . . . .	1701	Factory . . . . .	903.2.4
In-situ load tests . . . . .	1708	Fire areas . . . . .	707.3.10
Periodic special inspection . . . . .	202	Hazardous materials . . . . .	Table 414.2.5(1), Table 414.2.5(2), 903.2.11.4
Preconstruction load tests . . . . .	1709	Hazardous occupancies . . . . .	415.4, 415.11.7.4, 415.11.12, 705.8.1, 903.2.5
Special inspections . . . . .	1705	Height increase . . . . .	Table 504.3
		High-rise buildings . . . . .	403.3, 903.2.11.3
		Incidental uses . . . . .	Table 509.1
		Institutional . . . . .	407.7, 408.11, 420.5, 903.2.6, 903.3.2



- Laundry chutes, refuse chutes,  
termination rooms and  
incinerator rooms . . . . . 713.13, 903.2.11.2
- Live/work units . . . . . 508.5.7, 903.2.8
- Mercantile . . . . . 903.2.7
- Mezzanines . . . . . 505.2.1, 505.2.3, 505.3.2
- Multistory buildings . . . . . 903.2.11.3
- Occupied roofs . . . . . 503.1.4
- Parking garages . . . . . 406.6.3, 903.2.9.1, 903.2.10.1
- Play structures . . . . . 424.3
- Residential . . . . . 420.4, 903.2.8, 903.3.2
- Special amusement buildings . . . . . 411.2
- Spray finishing booth . . . . . 416.5
- Stages . . . . . 410.6
- Storage . . . . . 903.2.9, 903.2.10
- Supervision  
(see **SPRINKLER SYSTEM,  
SUPERVISION**) . . . . . 903.4
- Underground buildings . . . . . 405.3, 903.2.11.1
- Unlimited area . . . . . 507
- SPRINKLER SYSTEM, SUPERVISION** . . . . . 903.4
- Service . . . . . 901.6
- Underground buildings . . . . . 405.3
- STAGES AND PLATFORMS** . . . . . 202, 303, 410
- Dressing rooms . . . . . 410.4
- Fire barrier wall . . . . . 410.4.1, 410.4.2
- Floor finish and floor covering . . . . . 410.2, 410.3,  
804.4, 805.1
- Horizontal assembly . . . . . 410.4.1, 410.4.2
- Means of egress . . . . . 410.5
- Platform, temporary . . . . . 410.3.1
- Platform construction . . . . . 410.3, 603.1
- Proscenium curtain . . . . . 410.2.5
- Proscenium wall . . . . . 410.2.4
- Roof vents . . . . . 410.2.7.1
- Scenery . . . . . 410.2.6
- Smoke control . . . . . 410.2.7.2
- Sprinkler protection . . . . . 410.6
- Stage construction . . . . . 410.2, 603.1
- Standpipes . . . . . 410.7, 905.3.4
- Technical production areas . . . . . 202, 410.2.2, 410.5.3
- Ventilation . . . . . 410.2.7
- STAIRWAY (see ALTERNATING TREAD DEVICES,  
SPIRAL STAIRWAYS, STAIRWAY CONSTRUCTION  
and STAIRWAY ENCLOSURE)**
- STAIRWAY CONSTRUCTION**
- Alternating tread . . . . . 1011.14
- Circular (see **Curved**)
- Construction . . . . . 1011.7
- Curved . . . . . 1011.4, 1011.9
- Discharge barrier . . . . . 1023.8
- During construction . . . . . 3310.1
- Elevators . . . . . 1011.12.1, 1023.4, 1023.10, 3002.7
- Enclosure under . . . . . 1011.7.3, 1011.7.4
- Exit access . . . . . 1019
- Exterior exit . . . . . 1027, 1028.2
- Fireblocking . . . . . 718.2.4
- Guards . . . . . 1015.2, 1015.3, 1607.9
- Handrails . . . . . 1011.11, 1014, 1607.9
- Headroom . . . . . 1011.3
- Illumination . . . . . 1008.2, 1204.4, 1204.5
- Interior exit . . . . . 1023
- Ladders . . . . . 408.3.5, 410.5.3.4, 1011.15, 1011.16
- Landings . . . . . 1011.6, 1011.8
- Live load . . . . . Table 1607.1, 1607.9
- Locking . . . . . 1010.2.7
- Luminous . . . . . 403.5.5, 411.6.1, 1025
- Roof access . . . . . 1011.12
- Seismic anchorage . . . . . 2308.4.10
- Spiral  
(see **SPIRAL STAIRWAYS**) . . . . . 408.3.4, 410.5.3.4,  
508.5.5, 1011.10
- Stepped aisles . . . . . 1030.14.2
- Transitions . . . . . 1030.9.7, 1030.9.8, 1030.10
- Travel distance . . . . . 1017.3.1
- Treads and risers . . . . . 1011.4, 1011.5
- Width/capacity . . . . . 1005.3.1, 1011.2
- Winders . . . . . 1011.4, 1011.5, 1011.10
- STAIRWAY ENCLOSURE** . . . . . 713.1, 1019, 1023
- Accessibility . . . . . 1009.3
- Construction . . . . . 1019, 1023.2
- Discharge . . . . . 1023.3.1, 1028.2
- Doors . . . . . 716.2.6.1, 1010.2.7
- Elevators within . . . . . 1023.4, 3002.7
- Exit access . . . . . 1019
- Exterior walls . . . . . 705.2, 707.4, 708.5,  
713.6, 1023.2, 1027.6
- Fire-resistant construction . . . . . 1019.2, 1023.2
- Group I-2 . . . . . 1019.4
- Group I-3 . . . . . 408.3.8, 1019.4
- High-rise . . . . . 403.5
- Penetrations . . . . . 1023.5
- Pressurization . . . . . 909.6, 909.20.5, 1023.12
- Smokeproof . . . . . 403.5.4, 405.7.2, 909.20, 1023.12
- Space below, use . . . . . 1011.7.3, 1011.7.4
- Ventilation . . . . . 1023.6
- STANDARDS (see REFERENCED STANDARDS)**
- STANDBY POWER** . . . . . 2702.1, 2702.2, 2702.4
- Atriums . . . . . 404.7, 2702.2
- Covered and open mall buildings . . . . . 402.7.3, 2702.2
- Elevators . . . . . 1009.4, 2702.2, 3003.1, 3007.8, 3008.8
- Fuel line piping protection . . . . . 2702.1.2

## INDEX

Hazardous occupancy . . . . .	414.5.2, 415.11.11, 421.7, 2702.2	<b>STOP WORK ORDERS</b> . . . . .	115
High-rise . . . . .	403.4.8, 2702.2	<b>STORAGE OCCUPANCY (GROUP S)</b> . . . . .	311
Horizontal sliding doors . . . . .	1010.3.3, 2702.2	Accessibility . . . . .	1109.3
Membrane structures . . . . .	2702.2	Accessory . . . . .	311.1.1
Platform lifts . . . . .	1009.5, 2702.2	Area . . . . .	406.5.4, 406.5.5, 406.6.1, 503, 505, 506, 507, 508
Smoke control . . . . .	909.11, 2702.2	Equipment platforms . . . . .	505.2
Smokeproof enclosure . . . . .	909.20.7.2, 2702.2	Group provisions	
Special inspection . . . . .	1705.13.6	Hazard storage, low, Group S-2 . . . . .	311.3
Underground buildings . . . . .	405.8, 2702.2	Hazard storage, moderate, Group S-1 . . . . .	311.2
<b>STANDPIPE AND HOSE SYSTEMS</b>		Hazardous material display and storage . . . . .	414.2.5
(see <b>STANDPIPES, REQUIRED</b> ) . . . . .	905, 3106.4, 3308.1.1, 3311	Height . . . . .	406.5.4, 406.6.1, 503, 504, 505, 508, 510
Cabinet locks . . . . .	905.7.2	Incidental uses . . . . .	509
Dry . . . . .	905.8	Interior finishes . . . . .	Table 803.13, 804
Hose connection location . . . . .	905.1, 905.4, 905.5, 905.6, 912	Live loads . . . . .	Table 1607.1
<b>STANDPIPES, REQUIRED</b>		Means of egress	
Assembly . . . . .	905.3.1, 905.3.2, 905.3.4	Aisles . . . . .	1018.5
Covered and open mall buildings . . . . .	402.7.1, 905.3.3	Stairway, exit access . . . . .	1019
During construction . . . . .	905.10, 3311	Travel distance . . . . .	1006.3, 1017.2, 1017.2.2, 1006.2.1
Elevators, fire service access . . . . .	3007.9	Mixed occupancies . . . . .	508.3, 508.4
Helistops . . . . .	905.3.6	Accessory . . . . .	311.1.1, 508.2
Marinas . . . . .	905.3.7	Parking above/below . . . . .	510.3, 510.4, 510.7, 510.8, 510.9
Parking garages . . . . .	406.5.8	Special mixed . . . . .	510.2
Roof gardens and landscaped roofs . . . . .	905.3.8	Occupancy exception . . . . .	311.1.1
Stages . . . . .	410.7, 905.3.4	Plumbing fixtures . . . . .	2902
Underground buildings . . . . .	405.9, 905.3.5	Special provisions	
<b>STATE LAW</b> . . . . .	102.2	Aircraft related occupancies . . . . .	412
<b>STEEL</b> . . . . .	Chapter 22	High-piled combustible . . . . .	413
Bolting . . . . .	2204.2	Parking garages . . . . .	406, 510
Cable structures . . . . .	2208	Sprinkler protection . . . . .	903.2.10
Calculated fire resistance . . . . .	722.5	Unlimited area . . . . .	507.3, 507.4, 507.5
Cold-formed . . . . .	202, 2210, 2211	<b>STORM SHELTER</b> . . . . .	423
Composite structural steel and concrete . . . . .	2206	Education . . . . .	423.5
Conditions of restraint . . . . .	703.2.1.3	Emergency operation facilities . . . . .	423.4
Decks . . . . .	2210.1.1	Refuge area (see <b>REFUGE AREA</b> )	
Identification . . . . .	2202	Risk category . . . . .	1604.5.1
Joists . . . . .	202, 2207	<b>STRENGTH</b>	
Open-web joist . . . . .	2207	Design requirements . . . . .	1604.2
Parapet walls . . . . .	1503.3, 1503.5	Masonry . . . . .	202
Protection . . . . .	2203	Nominal . . . . .	202
Seismic provisions . . . . .	2205.2, 2206.2, 2207.1.1, 2210.2, 2211.1.1	Required . . . . .	202
Special inspections . . . . .	1705.3	<b>STRENGTH DESIGN</b> . . . . .	202, 1604.1
Storage racks . . . . .	2209	Factored load . . . . .	202
Structural steel . . . . .	2205	Limit state . . . . .	202
Welding . . . . .	2204.1	Load combinations . . . . .	1605
<b>STONE VENEER</b> . . . . .	1404.7	Load factor . . . . .	202
Slab-type . . . . .	1404.8	Masonry . . . . .	2108
		<b>STRUCTURAL DESIGN</b> . . . . .	Chapter 16, 107.2.7
		Aluminum . . . . .	Chapter 20

Concrete . . . . .	Chapter 19	Halon systems . . . . .	904.9
Foundations . . . . .	Chapter 18	Personnel and material hoists . . . . .	3004.4
Masonry . . . . .	Chapter 21	Roof tile . . . . .	1504.3.1
Steel . . . . .	Chapter 22	Seismic . . . . .	1704.2
Wood . . . . .	Chapter 23	Smoke control . . . . .	909.3, 909.5.2, 909.10.2, 909.12.1, 909.13.3, 909.18, 909.20.7.3, 909.21.7, 1705.19
<b>STRUCTURAL OBSERVATION</b> . . . . .	202, 1704.6	Soils . . . . .	1803
<b>STUCCO</b> . . . . .	2512	Sound transmission . . . . .	1208
<b>SUSCEPTIBLE BAY</b> . . . . .	202	Sprinkler protection . . . . .	903.5
Ponding instability . . . . .	1611.2	Structural (see SPECIAL INSPECTIONS AND TESTS)	
<b>SWIMMING POOL</b> . . . . .	3109	Wet chemical systems . . . . .	904.5
Accessibility . . . . .	1111.2, 1111.3, 1111.4.13	<b>THEATERS [see ASSEMBLY OCCUPANCY (GROUP A), PROJECTION ROOMS and STAGES AND PLAT- FORMS]</b>	
Flood provisions . . . . .	G112.5	<b>THERMAL BARRIER, FOAM PLASTIC INSULATION</b> . . . . .	2603.4, 2603.5.2
Glass . . . . .	2406.4	<b>THERMAL-INSULATING MATERIALS (see INSULATION)</b> . . . . .	712
Toilet facilities for public pools . . . . .	2902.1.1, Table 2902.1	<b>TILE</b> . . . . .	202
<b>T</b>		Ceramic (see CERAMIC TILE)	
<b>TECHNICAL PRODUCTION AREAS</b> . . . . .	410.2.2, 410.5.3	Fire resistance, clay or shale . . . . .	721.1
<b>TELEPHONE EXCHANGES</b> . . . . .	304	<b>TOILETS and TOILET ROOMS</b> . . . . .	Chapter 29, 3305
<b>TELESCOPIC SEATING (see FOLDING AND TELESCOPIC SEATING)</b>		Accessible . . . . .	1110.2, 1110.3, 1607.9.2
<b>TEMPORARY STRUCTURES</b> . . . . .	3103	Construction/finish materials . . . . .	1210
Certificate of occupancy . . . . .	108.3, 111.3	Door locking . . . . .	1110.2.1.6, 2902.3.5
Conformance . . . . .	108.2, 3103.1.1	Family or assisted-use . . . . .	1110.2.1, 2902.1.3, 2902.2.1
Construction documents . . . . .	3103.2	Fixture count . . . . .	Table 2902.1
Encroachment, public rights-of-way . . . . .	3202.3	Grab bar live loads . . . . .	1607.9.2
Flood provisions . . . . .	G113	Lavatory distribution . . . . .	2902.1.4
Means of egress . . . . .	3103.4	Location . . . . .	2902.3.1, 2902.3.2, 2902.3.3, 2903.3.6
Permit . . . . .	108.1, 3103.1.2	Partitions . . . . .	1210.3
Power, temporary . . . . .	108.3, 112.2	Privacy . . . . .	1210.3
Termination of approval . . . . .	108.4	Public facilities . . . . .	2902.3, 3114
<b>TENANT SEPARATION</b>		Signs . . . . .	1112.1, 1112.3, 2902.4, 2902.4.1
Covered and open mall building . . . . .	402.4.2.1, 708.1	Single user . . . . .	2902.1.3
<b>TENTS (see TEMPORARY STRUCTURES)</b>		Ventilation . . . . .	1202.5.2.1
<b>TERMITES, PROTECTION FROM</b> . . . . .	2304.12	<b>TORNADO SHELTER (see STORM SHELTER)</b>	
<b>TERRA COTTA</b> . . . . .	1404.9	<b>TOWERS</b>	
<b>TESTING</b>		Airport traffic control . . . . .	412.2
Automatic fire-extinguishing systems . . . . .	904.4	Cooling . . . . .	1511.4
Automatic water mist systems . . . . .	904.11.3	Location and access . . . . .	3108.2
Building official required . . . . .	104.11.1	Radio . . . . .	3108
Carbon dioxide systems . . . . .	904.8	Television . . . . .	3108
Clean agent system . . . . .	904.10	<b>TOXIC MATERIALS (see HIGH-HAZARD OCCUPANCY (GROUP H))</b>	
Dry chemical systems . . . . .	904.6	Classification . . . . .	307.6, 414, 415
Emergency and standby power . . . . .	2702.4	Gas detection system . . . . .	415.11.7, 421.5, 908.3
Fire alarm systems . . . . .	907.7, 907.8	<b>TRANSPORTATION</b> . . . . .	E108, E109, E110
Fire pumps . . . . .	913.5	<b>TRAVEL DISTANCE</b>	
Fire-resistant materials . . . . .	703.2	Area of refuge . . . . .	1009.6.1
Foam systems . . . . .	904.7	Assembly seating . . . . .	1030.7
Glazing . . . . .	2406, 2408.2.1		

## INDEX

Atrium .....	404.9
Balcony, exterior .....	1017.2.1
Care suites (Group I-2) .....	407.4.2, 407.4.4
Common path of travel .....	1006.2.1
Drinking fountains .....	2902.5
Exit access .....	1017.2
Mall .....	402.8.5, 402.8.6
Measurement .....	1017.3
Refrigeration machinery/ refrigerated rooms .....	1006.2.2.2, 1006.2.2.3
Smoke compartments (Group I-2 and I-3) .....	407.5, 408.6, 408.9
Special amusement area .....	411.2
Stories with one exit .....	1006.3.4
Toilet facilities .....	2902.3.2, 2902.3.3
<b>TREADS, STAIR (see STAIRWAY CONSTRUCTION)</b>	
Concentrated live load .....	Table 1607.1
<b>TREATED WOOD</b> .....	202
Fire-retardant-treated wood .....	2303.2
Pressure-treated wood .....	2303.1.9
Stress adjustments .....	2306.1.3
<b>TRUSSES</b>	
Cold-formed steel .....	2211.1.3
Fire resistance .....	704.5
Materials .....	Chapter 6
Metal-plate-connected wood .....	2303.4.6
Wood .....	2303.4
<b>TSUNAMI</b> .....	202
Flood hazard .....	Appendix M
Loads .....	1615
<b>TUNNELED WALKWAY</b> .....	3104, 3202.1
<b>TURNSTILES</b> .....	1010.5

## U

<b>UMBRELLA STRUCTURE</b> .....	202, 3103
<b>UNDERGROUND BUILDINGS</b> .....	405
Alarms and detection .....	405.6
Compartmentation .....	405.4
Construction type .....	405.2
Elevators .....	405.4.3
Emergency power loads .....	405.8, 2702.2
Means of egress .....	405.7
Smoke barrier .....	405.4.2, 405.4.3
Smoke exhaust/control .....	405.5
Smokeproof enclosure .....	405.7.2, 1023.12
Sprinkler protection .....	405.3
Standby power .....	405.8, 2702.2
Standpipe system .....	405.9, 905.3.5
<b>UNDERLAYMENT</b> .....	202, 1507.1.1, 1507.2.3, 1507.3.3, 1507.4.5, 1507.5.3, 1507.6.3, 1507.7.3, 1507.8.3,

Table 1507.8, 1507.9.3, 1507.16.3, 1507.17.3	
Application .....	1507.1.1, 1507.3.3, 1507.17.4
Ice barrier .....	1507.1.2, 1507.2.7, 1507.5.4, 1507.6.4, 1507.7.4, 1507.8.4, 1507.9.4, 1507.16.4

**UNLIMITED AREA BUILDINGS** .....**UNSAFE STRUCTURES AND EQUIPMENT (see STRUCTURES, UNSAFE)** .....

Appeals .....	113, Appendix B
Revocation of permit .....	105.6
Stop work orders .....	115
Utilities disconnection .....	112.3

**UNSTABLE MATERIALS** .....**UNUSABLE SPACE** .....**USE AND OCCUPANCY** .....

Accessory .....	508.2
Classification .....	302.1
Detailed requirements based on occupancy and use .....	Chapter 4
Incidental uses .....	509, Table 509.1
Mixed .....	508.3, 508.4
Use designation .....	302.2

**UTILITIES** .....

Service connection .....	112.1
Service disconnection .....	112.3
Temporary connection .....	112.2

**UTILITY AND MISCELLANEOUS OCCUPANCY (GROUP U)** .....

Accessibility .....	1103.2.4, 1104.3.1
Agricultural buildings .....	Appendix C
Area .....	503, 505, 506, 507, 508
Flood provisions .....	Appendix G
Height .....	503, 504, 508
Incidental uses .....	509
Live loads .....	Table 1607.1
Means of egress	
Exit signs .....	1013.1
Stairway, exit access .....	1019
Mixed occupancies .....	508.3, 508.4
Special provisions	
Private garages and carports .....	406.3
Residential aircraft hangars .....	412.4
Sprinkler protection .....	903.2.11
Travel distance .....	1006.2.1, 1006.3, 1017.1

## V

**VALUATION OR VALUE (see FEES, PERMIT)** .. 109.3  
**VEGETATIVE**



Artificial decorative . . . . . 419, 419.1  
Vegetative roofs . . . . . 202, 1507.15  
**VEHICLE BARRIER SYSTEMS** . . . . . 202, 406.4.2, 1607.10  
**VEHICLE SHOW ROOMS** . . . . . 304  
**VEHICULAR FUELING** . . . . . 406.7  
**VEHICULAR GATES** . . . . . 202, 3110  
**VEHICULAR REPAIR** . . . . . 406.8  
**VENEER**  
Cement plaster . . . . . 1404.15  
Fastening . . . . . 1404.17  
Fiber-cement siding . . . . . 1404.16  
Glazing . . . . . 1404.12  
Masonry, adhered. . . . . 1404.10, 2101.2.1, 2103.2.4  
Masonry, anchored. . . . . 1404.6, 2101.2.1  
Metal . . . . . 1404.11  
Plastic . . . . . 2605  
Slab-type. . . . . 1404.8  
Stone . . . . . 1404.7  
Terra cotta . . . . . 1404.9  
Vinyl . . . . . 1404.14  
Wood . . . . . 1404.5  
**VENTILATION (see MECHANICAL).** . . . . . 101.4.2  
Aircraft paint hangars . . . . . 412.5.6  
Attic. . . . . 1202.2, 1503.4  
Bathrooms . . . . . 1202.5.2.1  
Crawl space . . . . . 1202.4  
Exhaust, hazardous . . . . . 1202.6  
Exhaust, HPM. . . . . 415.11.1.6  
Hazardous . . . . . 414.3, 415.9.1.7, 415.11.1.6, 415.11.1.8.1, 415.11.3.2, 415.11.6.4, 415.11.6.8, 415.11.7.4, 415.11.11.1, 415.11.11.2  
High-rise stairways . . . . . 1023.11  
HPM service corridors . . . . . 415.11.3.2  
Live/work unit . . . . . 508.5.10  
Mechanical . . . . . 1202.1  
Natural . . . . . 1202.5  
Parking . . . . . 406.5.2, 406.5.5, 406.5.10, 406.6.2  
Projection rooms. . . . . 409.3  
Repair garages . . . . . 406.8.1  
Roof . . . . . 1202.2  
Smoke exhaust. . . . . 910  
Smoke removal, high-rise buildings . . . . . 403.4.7  
Smokeproof enclosure . . . . . 909.20.3, 909.20.4, 909.20.6, 1023.12  
Spray rooms and spaces . . . . . 416.2.2, 416.3  
Stages. . . . . 410.2.5, 410.2.7  
Under-floor ventilation. . . . . 1202.4  
**VENTS, PENETRATION PROTECTION** . . . . . 714

**VERMICULITE, FIRE RESISTANT** . . . . . 721  
**VERTICAL OPENING PROTECTION**  
Atriums . . . . . 404.6  
Duct penetrations . . . . . 717.1  
Elevators . . . . . 713.14, 3007.6.1, 3008.6.1  
Exceptions . . . . . 1019, 1023.2  
Group I-3 . . . . . 408.5  
High-rise . . . . . 403.2.1.2, 403.2.2, 403.5.1  
Live/work units . . . . . 508.5.6  
Open parking garages . . . . . 406.5.9  
Permitted vertical openings . . . . . 712  
Shaft enclosure . . . . . 713, 1019, 1023.2  
**VESTIBULES, EXIT DISCHARGE** . . . . . 1028.2  
**VINYL**  
Expanded . . . . . 202, 803.7, 803.8  
Rigid . . . . . 1404.14  
**VIOLATIONS** . . . . . 114  
**VOICE ALARM (see ALARMS, VOICE)**

**W**

**WALKWAY** . . . . . 3104  
During construction . . . . . 3306  
Encroachment, public right-of-way . . . . . 3202.3.4  
Fire resistance . . . . . Table 601  
Live load . . . . . Table 1607.1  
Materials per construction type . . . . . Chapter 6  
Opening protection . . . . . 716, 717  
**WALL, EXTERIOR** . . . . . 705, 1401  
Bearing . . . . . Chapter 6  
Combustible wall covering. . . . . 1405  
Coverings . . . . . 1404  
Drawings . . . . . 107.2.4  
Exterior Insulation and Finish Systems (EIFS) . . . 1407  
Exterior structural members . . . . . 704.10  
Fire district . . . . . D102.1, D102.2.6  
Fire-resistance ratings . . . . . 703, 705.5, Table 705.5, 706.5.1, 707.4, 1402.4  
Flashing, veneered walls . . . . . 1404.4, 1404.10.1  
Foam plastic insulation . . . . . 2603.4.1.4, 2603.5  
Glazing, rated . . . . . 715.7  
Joints . . . . . 705.9, 714  
Light-transmitting plastic panels . . . . . 2607  
Materials . . . . . 705.4, 1403.1, 1405  
Metal Composite Materials (MCM) . . . . . 1406  
Nonbearing . . . . . Chapter 6  
Opening protection . . . . . 705.8, 705.10, 716.2.5.4  
Parapets . . . . . 705.11  
Performance requirements . . . . . 1402  
Projections . . . . . 705.2

## INDEX

- Structural stability . . . . . 705.6
- Vapor retarders . . . . . 1404.3
- Veneer (see VENEER)
- Weather resistance . . . . . 1402.2, 1404.2, 1406.6, 1407.4
- Weather-resistant barriers . . . . . 1404.2
- WALL, FIRE (see FIRE WALLS)**
- WALL, FOUNDATION (see FOUNDATIONS)**
- WALL, INTERIOR**
  - Finishes . . . . . 803, 1210.2
  - Opening protection . . . . . 716, 717
- WALL, INTERIOR NONBEARING (see PARTITIONS)**
- WALL, MASONRY** . . . . . 202
  - Wood contact . . . . . 2304.12.1.3, 2304.12.2.1
- WALL, PARAPET** . . . . . 705.11, 1503.3, 2109.2.4.3
- WALL, PARTY (see FIRE WALLS)**
- WALL, PENETRATIONS** . . . . . 714.4
- WALL, RETAINING (see RETAINING WALL)**
- WALL, VENEERED (see VENEER)** . . . . . Chapter 14
- WALL, WOOD CONSTRUCTION**
  - Bracing . . . . . 2308.6
  - Cutting, notching, boring . . . . . 2308.5.9
  - Exterior framing . . . . . 2308.5
  - Fastening schedule . . . . . Table 2304.10.2
  - Framing . . . . . 2304.3, 2308.5
  - Interior bearing partition . . . . . 2308.5.4
  - Interior nonbearing partition . . . . . 2308.5.1
  - Openings . . . . . 2308.5.5
  - Shear walls . . . . . 2305.1, 2306.3
  - Sheathing (see SHEATHING)
  - Studs . . . . . 2308.5.1
  - Top plates . . . . . 2308.5.3.2
- WATER-REACTIVE MATERIALS** . . . . . Table 307.1(1), 307.4, 307.5. 415.8.4
- WEATHER PROTECTION**
  - Exterior walls . . . . . 1404.2
  - Roofs . . . . . 1503
- WEATHER-EXPOSED SURFACES**
- WELDING** . . . . . 2204.1
  - Materials, verification of
    - steel reinforcement . . . . . 1705.3.2
  - Special inspections . . . . . 1705.2, 1705.3.1, 1705.13.3
  - Splices of reinforcement in masonry . . . . . 2107.3, 2108.3
- WIND LOAD** . . . . . 1609
  - Basic design wind speed . . . . . 1609.3
  - Construction documents . . . . . 107, 1603.1.4
  - Exposure category . . . . . 1609.4
  - Glazing . . . . . 1609.2, 2404
  - Hurricane-prone regions . . . . . 202
  - Masonry, empirical design . . . . . 2109.1.1
  - Nominal design wind speed . . . . . 1609.3.1
  - Roofs . . . . . 1504.1, 1609.5, 2308.7.5
  - Seismic detailing required . . . . . 1604.10
  - Special inspection . . . . . 1705.12
  - Statement of special inspections . . . . . 1704.3
  - Structural observation . . . . . 1704.6.2
  - Wind tunnel testing . . . . . 1504.3.1.2, 1609.1.1
  - Windborne debris region . . . . . 202
- WINDERS, STAIR (see STAIRWAY CONSTRUCTION)**
- WINDOW**
  - Accessibility
  - Emergency egress . . . . . 1031
  - Exterior, structural testing . . . . . 1709.5
  - Fire
    - (see OPENING PROTECTIVES) . . . . . 716.2, 716.2.8
  - Glass (see GLAZING) . . . . . 1404.13
  - Guards . . . . . 1015.8
  - Required light . . . . . 1204.1, 1204.2
  - Wells . . . . . 1031.6
- WIRES, PENETRATION PROTECTION** . . . . . 714
- WOOD** . . . . . Chapter 23
  - Allowable stress design . . . . . 2306
  - Bracing, walls . . . . . 2308.6
  - Calculated fire resistance . . . . . 722.6
  - Ceiling framing . . . . . 2308.7
  - Connectors and fasteners . . . . . 2304.10
  - Contacting concrete,
    - masonry or earth . . . . . 2304.12.1.3, 2304.12.1.4, 2304.12.2.1, 2304.12.2.2, 2304.12.2.6
  - Decay, protection against . . . . . 2304.12
  - Diaphragms . . . . . 2305.1, 2305.2, 2306.2
  - Draftstopping . . . . . 718.3, 718.4
  - End-jointed lumber . . . . . 2303.1.1.2
  - Fiberboard . . . . . 2303.1.5, Table 2306.3(2)
  - Fireblocking . . . . . 718.2
  - Fire-retardant treated . . . . . 2303.2
  - Floor and roof framing
    - (see FLOOR CONSTRUCTION, WOOD) . . . . . 2304.4
  - Floor sheathing . . . . . 2304.8
  - Foundation . . . . . 1807.1.4, 2308.6.7.4
  - Grade, lumber . . . . . 2303.1.1
  - Hardboard . . . . . 2303.1.7
  - Heavy timber construction . . . . . 602.4, 2304.11
  - Hurricane shutters . . . . . 1609.2
  - I-joist . . . . . 2303.1.2
  - Inspection, special . . . . . 1705.5, 1705.12.1, 1705.13.2
  - Lateral force-resisting systems . . . . . 2305
  - Light-frame construction, conventional . . . . . 2308
  - Load and resistance factor design . . . . . 2307
  - Moisture content . . . . . 2303.1.9.2, 2303.2.6
  - Nails and staples . . . . . 2303.6
  - Plywood, hardwood . . . . . 2303.3

Preservative treated . . . . .	1402.5, 1402.6, 2303.1.9
Roof framing (see ROOF CONSTRUCTION, WOOD) . . . . .	2304.4
Roof sheathing . . . . .	2304.8
Seismic provisions . . . . .	2305, 2306, 2308.6.6, 2308.6.8, 2308.6.10
Shear walls . . . . .	2305, 2306.3
Standards and quality, minimum . . . . .	2303
Structural panels . . . . .	202, 2303.1.5
Supporting concrete or masonry . . . . .	2304.13
Termite, protection against . . . . .	2304.12
Trusses . . . . .	2303.4
Veneer . . . . .	Chapter 14
Wall framing (see WALL, WOOD CONSTRUCTION) . . . . .	2304.3
Wall sheathing, exterior . . . . .	2304.6
Wood Frame Construction Manual . . . . .	2309
<b>WOOD SHINGLES AND SHAKES . . . . .</b>	<b>1507.8, 1507.9</b>
<b>WOOD STRUCTURAL PANELS</b> <b>(see WOOD) . . . . .</b>	<b>202, 2303.1.5</b>
Bracing . . . . .	2308.6
Decorative . . . . .	2303.3
Diaphragms . . . . .	2305.2, 2306.2
Fastening . . . . .	2304.10
Fire-retardant-treated . . . . .	2303.2
Performance category . . . . .	202
Quality . . . . .	2303.1.5
Roof sheathing . . . . .	2304.8, 2308.7.10
Seismic shear panels . . . . .	2305.1, 2308.6.6.2
Shear walls . . . . .	2306.3
Sheathing . . . . .	2304.6.1
Standards . . . . .	2306.1
Subfloors . . . . .	805.1.1
Veneer . . . . .	1404.5

## Y

<b>YARDS OR COURTS . . . . .</b>	<b>202, 1201.1, 1205</b>
Exit discharge . . . . .	1027.4, 1029.1
Group I-2 . . . . .	407.10
Group I-3 . . . . .	408.3.6, 408.6.2
Light, natural . . . . .	1204
Occupant load . . . . .	1004.7
Parking garage, open . . . . .	406.5.5
Unlimited area building . . . . .	507.2, 507.2.1





## RESOURCE A

# RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI)

---

### User note:

**About this resource:** *The typical process of inspecting projects by inspectors driving to job sites and performing on-site inspections has certain challenges that impact timeliness and resource efficiencies both for building construction and safety industry and regulating jurisdictions. The time spent driving to job sites, particularly in larger cities with busy traffic patterns, takes up a substantial part of the day, reducing the number of inspections possible to complete and creating a backlog of requested inspections.*

*To address some of the challenges, many jurisdictions have implemented remote virtual inspections (RVI) for more routine and simpler inspections such as water heater replacements or other, similar items. RVI is an alternative to on-site inspections using a video call with the inspector. With advances in technology and availability of sophisticated smart phones and tablets, RVI have become more common, and some jurisdictions plan to implement them for more complicated and larger inspection items or projects.*

*To assist the building construction industry and member jurisdictions in adoption of an RVI program, in May 2020, the International Code Council® (ICC®) published Recommended Practices for Remote Virtual Inspections (RVI). This publication offers a comprehensive framework for both local jurisdictions and building industry professionals that desire to implement a remote inspection program.*

---



# Recommended Practices for Remote Virtual Inspections (RVI)



## **Recommended Practices for Remote Virtual Inspections (RVI)**

Second Printing: September 2020

ISBN: 978-1-952468-23-0

COPYRIGHT © 2020  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This publication is a copyrighted work owned by the International Code Council, Inc. ("ICC"). Without advance written permission from the ICC, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example and not limitation, photocopying, or recording by or in an information storage and retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

The information contained in this document is believed to be accurate; however, it is being provided for informational purposes only and is intended for use only as a reference for recommended practices. Publication of this document by the ICC should not be construed as the ICC engaging in or rendering engineering, legal or other professional services. Use of the information contained in this publication should not be considered by the user as a substitute for the advice of a registered professional engineer, attorney or other professional. If such advice is required, it should be sought through the services of a registered professional engineer, licensed attorney or other professional. This Recommended Practices document does not intend to overrule national building codes or local practices, but to provide a reference for minimum levels of quality to safeguard health, property and general welfare.

Trademarks: "International Code Council," the "International Code Council" logo, "ICC," the "ICC" logo and other names and trademarks appearing in this book are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission. Errata on various ICC publications may be available at [www.iccsafe.org/errata](http://www.iccsafe.org/errata).

PRINTED IN THE USA



# Table of Contents

Table of Contents . . . . .	i
Preface . . . . .	1
About the International Code Council® . . . . .	2
1.0 Introduction. . . . .	3
Purpose and Scope . . . . .	3
2.0 Definitions and Acronyms . . . . .	3
3.0 Remote Virtual Inspection Process . . . . .	3
Customer: Requesting a Remote Virtual Inspection . . . . .	4
AHJ: Scheduling Remote Virtual Inspection . . . . .	5
Customer: Prepare for Remote Virtual Inspection . . . . .	6
Customer: Prepare to Receive Remote Virtual Inspection Call . . . . .	6
What to Expect During the Inspection . . . . .	7
Inspection Results . . . . .	7
Maintaining Records of Inspections . . . . .	8
4.0 Training and Communication . . . . .	8
Staff Training. . . . .	8
Customer/Applicant. . . . .	9
Additional Considerations. . . . .	9
5.0 Appendix A (Examples of Potential Activities). . . . .	10



## Preface

Technological advances have created enormous possibilities in all aspects of life, including the building construction and safety industry. Digital and online tools for building design, construction and administrative functions, such as permit application, plan review, inspection and commissioning, have drastically increased the efficiency and accuracy of achieving safe and resilient communities. Local, state and national governments have taken advantage of advancing technologies and have incorporated various levels of digitization into their processes in order to save time and reduce costs. Examples of such efforts include online offering of permit applications, payment of permit fees, submittal of plans and digital plan review.

The speed of adoption and implementation of technology, however, varies by geographic region and depends on a number of factors, including the availability of financial resources and the infrastructure needed to support the technology. Many Authorities Having Jurisdiction (AHJs) have implemented technology at various levels with good success and have embraced greater reliance on digitization as time goes by.

The 2020 global coronavirus pandemic created an impetus in speeding the implementation of modern technologies and taking advantage of new ideas in a much shorter time frame. The spread of COVID-19 and the closing of most businesses and social activities in many parts of the world to create social distancing resulted in many sectors of the economy searching to find new solutions for conducting business.

Many AHJs needed to come up with solutions to perform all aspects of codes and standards administration from remote locations and/or home offices. One such solution using available technology is Remote Virtual Inspections (RVI).

RVI is a method of inspection that allows the needed inspections to proceed in a timely manner by the owner or contractor located on the jobsite and the inspector or inspection teams performing the inspection remotely. While this practice gained good acceptance and implementation during the weeks and months of COVID-19 social distancing, its advantages are so great that it will likely become a popular and routine tool for the foreseeable future.



The advantages and opportunities created by RVI locally, nationally and globally are enormous, allowing those with technical expertise in their specific subjects to offer their services across the globe. Building code specialists, inspectors and consultants will be able to provide services and consulting from far distances and to help building safety and resiliency anywhere needed at the local, national or global level.

*Recommended Practices for Remote Virtual Inspections* (RVI) was developed based on study, research, and discussions related to items that should be considered and addressed for an effective and consistent RVI program and to assist AHJs in implementing the readily available technologies in the adoption and implementation of their own RVI program.

ICC welcomes your comments and feedback to improve future editions of this Recommended Practices publication. Submit feedback at [www.iccsafe.org/RVI](http://www.iccsafe.org/RVI).

## About the International Code Council®

The International Code Council is a nonprofit association that provides a wide range of building safety solutions including product evaluation, accreditation, certification, codification and training. It develops model codes and standards used worldwide to construct safe, sustainable, affordable and resilient structures. The mission of the Code Council is to provide the highest quality codes, standards, products and services for all concerned with the safety and performance of the built environment. ICC Evaluation Service (ICC-ES) is the industry leader in performing technical evaluations for code compliance fostering safe and sustainable design and construction.

### Washington DC Headquarters:

500 New Jersey Avenue, NW, 6th Floor  
Washington, DC 20001-2070

### Regional Offices:

- Eastern Regional Office (BIR)
- Central Regional Office (CH)
- Western Regional Office (LA)
- Distribution Center (Lenexa, KS)

888-ICC-SAFE (888-422-7233)

[www.iccsafe.org](http://www.iccsafe.org)

### Family of Solutions:





## 1.0 Introduction

Hand-held devices such as smartphones and tablets have capabilities for real time, online communication of videos and photos. Use of advanced tools and technologies, combined with the power of such hand-held devices, has made it possible for anyone to observe the construction activities of a jobsite from any location, near or thousands of miles away. Using Remote Virtual Inspection (RVI) allows construction projects to continue without impediment and allows the Authority Having Jurisdiction (AHJ) to continue to provide the vital services needed for construction of safe buildings.

### Purpose and Scope

The purpose and scope of these Recommended Practices is to provide guidance to the Authority Having Jurisdiction (AHJ) when implementing a Remote Virtual Inspection (RVI) program as well as to the construction industry user. This document specifically addresses implementation and administration of RVI. These procedures are organized in a fashion that can be readily implemented by the AHJ as part of their inspection procedures. This document also provides recommended practices to construction industry professionals submitting to an RVI.

Until recently, Remote Virtual Inspections have been conducted only by a few AHJs at varying levels. As a result, there has not been a standardized program that addresses how to prepare for, conduct and participate in these types of inspections.

## 2.0 Definitions and Acronyms

1. **RVI: Remote Virtual Inspection:** Remote Virtual Inspection, also known as RVI, is a form of visual inspection which uses visual or electronic aids to allow an inspector or team of inspectors to observe products and/or materials from a distance because the objects are inaccessible or are in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.
2. **AHJ: Authority Having Jurisdiction.**

## 3.0 Remote Virtual Inspection Process

Remote Virtual Inspections (RVI) may provide benefits to AHJs and customers alike. In certain circumstances, an RVI may provide a better quality inspection with an increase in efficiency and cost savings. It will increase the efficiency of the inspection process utilizing modern technology. Depending on the location and complexity of a project, some limitations may impact its use. In cases where an RVI is not suitable or technology fails to provide sufficient visual clarity (i.e., poor/no service or Wi-Fi, poor lighting, etc.), an onsite inspection may be required. Subject to local approval, the AHJ may choose to use an approved third-party inspection agency or utilize staff inspectors. Where Wi-Fi and/or cellular recep-

tion are poor or not available, some AHJs may consider allowing the contractor to provide an acceptable electronic documentation of the area that needs an inspection for review by the assigned inspector or team of inspectors.

A clear understanding of the RVI requirements and communication throughout the process by both parties is paramount to the completion of a successful inspection. The inspector will check all aspects of the permitted construction project to the adopted codes and other applicable laws and regulations no differently than if it were an onsite inspection. Identification of the project jobsite location, posted address and its location within the building will be a critical part of the process.

The applicable Codes and Standards to be used for RVI are the same as the adopted codes and referenced standards of the AHJ. The implementation of the RVI is intended to achieve the same results as the typical in-person site inspection by applying the provisions of adopted codes such as the IBC®, IRC®, IPC®, IFC® and other applicable and adopted International Codes.



### Customer: Requesting a Remote Virtual Inspection

1. Ensure there is an active permit issued or certificate application filed or obtain the appropriate one prior to attempting to schedule an inspection for the project in question.
2. Electronically sign a notice indicating that the permit holder of record or representative:
  - 2.1. Consents to the use of the remote inspections.
  - 2.2. Is responsible for their own safety during the remote inspection.
  - 2.3. Allows the complete use of the videos and photos of the remote inspection by the AHJ.
  - 2.4. Certifies they are making available the site and inspection items truthfully and to the best of their ability.
  - 2.5. Is responsible for compliance with all codes and standards applicable to the project.
  - 2.6. Acknowledges that participation in the remote inspection program is voluntary (if not a mandatory program within the AHJ's jurisdiction).
  - 2.7. Acknowledges that the decision to perform an RVI is at the sole discretion of the AHJ.

3. Prior to contacting the department to schedule the inspection, confirm that the minimum criteria for a remote inspection are met. See Appendix A for examples of qualified inspection activities.
  - 3.1. Note that some types of inspections may be too complex or otherwise not compatible for remote inspections.
4. Call or go online to schedule an appointment for inspection with the AHJ.
5. Must be at least 18 years old or with an adult to perform the virtual inspection.
6. When scheduling the inspection, provide the address, permit number, and type and number of requested inspections.

### AHJ: Scheduling Remote Virtual Inspection

1. Schedule Inspection Time.
  - 1.1. All remote inspections scheduled should be requested by the customer a minimum of one business day prior to the desired inspection date.
  - 1.2. Schedule inspection either online or by telephone.
  - 1.3. Schedule sufficient time for the type of inspection requested.
  - 1.4. AHJ to send an inspection confirmation email or text to the customer with the date, approximate time of RVI and name of inspector.
  - 1.5. Send notice of customer consent and acknowledgment for electronic signature. Must be returned by customer prior to inspection scheduled time.
2. Time slots for inspections.
  - 2.1. Anticipated length of inspections per type (i.e., water heater installation, HVAC replacement, etc.) needs to be established.
  - 2.2. Each customer will be given an approximate time window for inspection.
3. Post the earliest available time for remote inspections and the latest time of the day a remote inspection may be scheduled Monday through Friday or other days selected by the AHJ.
4. Schedule after-hours or emergency inspections on a case-by-case basis.
5. Determine the types of inspections allowed for remote inspections. See Appendix A for examples of qualified inspection activities.
  - 5.1. All inspections may qualify for an RVI, depending on the AHJ's resources and policies.
6. Determine which type of videotelephony is available for use and is compatible with the AHJ's permitting software and videotelephony equipment.
  - 6.1. Videotelephony platform examples: FaceTime, Google Duo, Zoom, WhatsApp, Skype, Tango, WebEx, Microsoft Teams, GoTo-Meeting, etc.



## Customer: Prepare for Remote Virtual Inspection

1. Prior to the inspection, ensure that:
  - 1.1. The jobsite is safe at all times for the individual(s) using the device during the remote inspection including health safety.
  - 1.2. The device (smartphone, tablet, drone, etc.) is fully charged and has a suitably charged additional power supply (battery pack).
  - 1.3. The use of a noise-canceling headset is recommended.
  - 1.4. The jobsite has high-speed Wi-Fi connectivity or minimum 4G cellular service with a strong signal.
  - 1.5. The necessary tools based on type of inspection are readily available.
    - 1.5.1. For example, carry a flashlight, tape measure, level, step ladder (for close ups of ceiling), GFCI tester, etc. An extending pole for the video device, such as selfie pole, may be very helpful in taking the smartphone or other video device closer to the point of inspection in various places such as very high ceilings.
2. Have approved plans, permit card, and other necessary construction documents available onsite.
3. Make sure good lighting is available and clear the area of any unnecessary objects.
4. All features applicable to the required inspection must be visible at the time of the remote inspection. These features must be captured sufficiently and clearly for the inspector to evaluate.
5. If at any point the inspector believes that the remote inspection process is not allowing them to properly assess compliance, they may require that a site inspection be conducted at a future date or instruct the customer to make different arrangements.
  - 5.1. In areas within the jobsite where there is no Wi-Fi or cell service, at the sole discretion of the inspector, the contractor may be allowed to provide video and/or photographic documentation of the item(s) to be inspected for review by the authorized inspector at a later time.
6. The onsite inspection may be conducted by an approved third-party inspection agency or by the AHJ's inspection staff.

## Customer: Prepare to Receive Remote Virtual Inspection Call

1. Ensure that the lens and screen of any device being used to capture images or video has been cleaned. Dust, grit, smudges, etc., might interfere with the image quality and distorting the inspector's view.
2. To minimize interruptions during the RVI and to ensure that the video feed will be uninterrupted, make sure that all notifications are turned off in the Settings of the mobile device used for the RVI. Should the video be interrupted, the inspection could be delayed or have to be rescheduled.
3. Be prepared to answer the inspector's call at any time during the scheduled timeframe. Be cooperative and closely follow the inspector's instructions.



4. As each site and inspection is different, allot the proper amount of time for the type of inspection and accessibility of the site.
5. Carefully follow the inspector's instructions for where to direct the device and for covering the site. Do not rush the inspector but allow him or her adequate time to conduct the RVI to his or her satisfaction.
6. As much as possible, minimize background noise as that can interfere with communication with the inspector.

## What to Expect During the Inspection

1. Begin inspection at the street view looking at the structure with the address or other required jobsite identification in the video display.
  - 1.1. Inspector may also verify location through GPS/Geotagging where the service is available.
2. Follow the directions of the inspector with respect to the order and direction of inspection.
3. As the inspection progresses, write down any items that the inspector finds that need to be corrected. Be sure the notes are detailed and ask questions of or seek clarification from the inspector at the time of the RVI.
4. If provided a permit card, do not write on it. During the next in-person visit, the inspector should update it then.
5. In most cases, the inspector will relay the results of the inspection before the end of the RVI of passing, failing or not ready for inspection.
6. Do not cover any work needing corrections until corrections are verified by reinspection. Reinspection fees may apply in accordance with the AHJ's policies.
7. Note: At a minimum, there must be an adult of the required legal age on site who will represent the owner/representative during the entire duration of the RVI.
8. The owner/representative must be able to verbally communicate with the remote inspector at all times during the inspection.

## Inspection Results

1. Results of the inspection will be entered into the AHJ's permit database as soon as practicable after the RVI is completed. It is important to note that the inspection was completed using the RVI process.
2. Where an approval tag for utility connections is required, the AHJ should work directly with the utility company.
3. Following the inspection:
  - 3.1. Inspection comments will be available on the AHJ's website, within the AHJ's normal timelines, indicating passing or failing with the list of corrections when applicable.
  - 3.2. In addition, the inspector may email the inspection information upon request to the customer as soon as inspection information is available.

- 3.3. The inspector will determine whether additional fee(s) for reinspection is required.
4. Scheduling a reinspection or the next inspection needed is based on availability of time slots.
5. The authorized inspector may provide an option for the owner/representative to submit electronic documentation that a deficiency or deficiencies have been corrected.
6. It is incumbent on the owner/representative to provide the address and permit number on all submitted correspondence or communications.

## Maintaining Records of Inspections

Required inspection records, including, but not limited to, correction notices, electronic media, recordings or photo documentation, shall be maintained in accordance with the AHJ's policy, laws, regulations, and applicable codes, and may be subject to disclosure.

## 4.0 Training and Communication

Training and effective communication of processes, procedures and requirements are essential and a critical part to the success of any program. This program is no different as it lends itself to new technology, new programs, and methods that are in many cases, new to the building construction and safety industry. Therefore, training of the AHJ's staff as well as the building industry on the various programs and procedures will save time and money and make the administrative and enforcement process a positive experience with minimal confusion. Training also leads to better communications between an AHJ and its customers.



## Staff Training

1. Ensure all staff are trained in the appropriate areas of responsibility.
2. Permit Technicians:
  - 2.1. Review of approved permit applications relative to RVI requirements.
  - 2.2. Required departmental approvals are complete.
  - 2.3. Fee collection process.
  - 2.4. Required documents for the project (plans, calculations, etc.).
3. Remote Inspection Staff:
  - 3.1. Inspection software and hardware.
  - 3.2. Remote inspection procedures.
  - 3.3. Types of platforms used (Facetime, Skype, etc.).
  - 3.4. Reinspection fee procedures.
  - 3.5. Recording inspection results in permit tracking system.

## Customer/Applicant

1. Ensure the owner and representative are trained in their areas of responsibility.
2. Permit applicant:
  - 2.1. Knowledge of the AHJ's departmental approvals required for the project.
  - 2.2. Knowledge of the AHJ's RVI protocol.
  - 2.3. Ensuring project meets RVI protocol.
  - 2.4. Ensure that the project is ready for the RVI at the scheduled time.
  - 2.5. Comply with the inspector's direction.
3. Owner/Contractor/Subcontractor:
  - 3.1. Requesting remote inspection process.
  - 3.2. Knowledge of remote inspections procedures.
  - 3.3. Platform required (Facetime, Skype, Google Duo, etc.).
  - 3.4. Jobsite communication requirements (Wi-Fi, 4G, etc.).
  - 3.5. Communication skills.

## Additional Considerations

1. Adopt basic online security practices. Consult with your IT department for guidance.
2. Consult with your legal counsel to ensure compliance with all federal, state and local requirements related to your RVI program. For example, you may want to consult counsel to find out whether a homeowner's release is needed to conduct an RVI.
3. Ensure that all staff have access to the codes and standards that are applicable to what they are inspecting. The Code Council's Digital Codes Library (<https://codes.iccsafe.org/>) offers online access to all ICC model codes and standards and most state codes.
4. Document lessons learned to improve your RVI program and to support potential long-term establishment of virtual inspection processes.



## 5.0 Appendix A (Examples of Potential Activities)

The following are a few examples of construction activities that may be considered to be included in a RVI Program. This list is not all-inclusive. The determination of whether an inspection can be conducted remotely is at the sole discretion of the AHJ.

- Plumbing system repairs or fixture replacements.
- Construction trailer installations.
- Swimming pool excavations.
- Gas line repairs or gas utility clearance.
- Electric utility clearances.
- HVAC direct replacement or repair.
- Minor residential electrical.
- Miscellaneous repair/exterior repair or upgrades (stucco, windows, etc.).
- Re-roofing/roof covering replacement.
- Water heater or water softener direct replacement.
- New residential plumbing rough-in.
- New residential rough framing inspections.
- Residential rooftop-mounted photovoltaic panel systems.
- HUD manufactured home installation verification.
- Any other inspection approved by the AHJ.



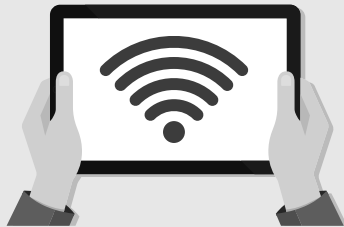




# KEYS TO SUCCESS FOR REMOTE VIRTUAL INSPECTIONS

## The Value of Communication

### WHAT ARE REMOTE VIRTUAL INSPECTIONS (RVI)?

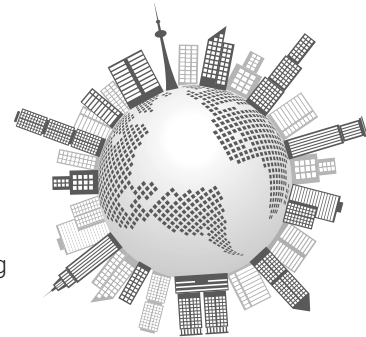


Remote Virtual Inspections, also known as RVI, are a form of inspections which use visual or electronic aids to allow an inspector or team of inspectors to observe certain types of construction, products and/or materials from a distance.

RVI are a solution to help inspectors observe construction and objects that might be inaccessible or in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.

### RVI BENEFITS

- Construction projects can continue without impediment
- Building professionals can continue providing services with minimal health risk during pandemics such as COVID-19
- Authorities Having Jurisdiction (AHJs), testing agencies, manufacturers, laboratories, home builders and contractors are able to provide the vital services needed on all levels for the construction of safe buildings
- Inspectors can continue providing services remotely while saving time and money
- Safe and resilient construction projects can continue to grow and thrive anywhere needed at the local, national or global level



### THE FOUNDATION OF SUCCESS: TRAINING AND COMMUNICATION



With the use of new technology, new programs, and methods, AHJs, testing agencies, manufacturers, laboratories, home builders and contractors can implement effective training of these programs to their staff to create a foundation for successful Remote Virtual Inspections.

A clear understanding of RVI requirements and communication throughout the process by all parties involved is paramount to the completion of successful inspections.



### Recommended Practices for Remote Virtual Inspections (RVI)

## THE KEY STEPS TO A REMOTE VIRTUAL INSPECTION



## LEARN MORE

Read the full version of our Recommended Practices for Virtual Remote Inspections [here](#).

20-13018

## Recommended Practices for Remote Virtual Inspections (RVI)



People Helping People Build a Safer World®

# Get FREE access to hundreds of ICC resources and view the largest collection of code titles

*ICC's Digital Codes Library ([codes.iccsafe.org](https://codes.iccsafe.org)) conveniently provides access to the latest code text while on the go, at home or in the office, in an easy-to-navigate format.*



Available anywhere 24/7

Use on any mobile or digital device

View over 800+ ICC titles

19-17590

Learn how to use this powerful tool at [codes.iccsafe.org](https://codes.iccsafe.org)

# Recommended Practices for Remote Virtual Inspections (RVI)

*Recommended Practices for Remote Virtual Inspections (RVI)* is the most complete source of information on remote inspections. RVI is an alternative to on-site inspections using a video call on a 4G or WiFi telephony (smartphone, tablet, etc.) in order to interact with the inspector. It is a comprehensive tool for local jurisdictions and the building industry alike that desire to implement a remote inspection program.

This publication covers the RVI process, inspection scheduling, preparation, what the owner/contractor should expect, training and communications, and recording and maintaining records. While all types of inspections may not be suitable for RVI, a list of potential construction activities suitable for remote inspections is provided.

RVI also lends itself to connect seamlessly as part of an overall online program that will allow jurisdictions to provide complete services to the public utilizing the latest technology. Online permitting and electronic plan review, together with remote virtual inspections, can provide a complete program that keeps the construction industry moving while providing a healthy environment for all participants.

ISBN 978-1-952468-23-0



9 781952 468230

Item No. 7072S1



## ICC FAMILY OF SOLUTIONS

Evaluation Service • Accreditation Service • General Code  
S. K. Ghosh Associates • ANCR • NTA • Certification  
Digital Code Library • Membership • Plan Review • Publications

[www.iccsafe.org](http://www.iccsafe.org) • 1-888-ICC-SAFE (422-7233)



## EDITORIAL CHANGES – SECOND PRINTING

Page 2-9, definition [BS] **DIAPHRAGM**: sub-definitions have been added and now read . . .

**Diaphragm, blocked.** In light-frame construction, a diaphragm in which all sheathing edges not occurring on a framing member are supported on and fastened to blocking.

**Diaphragm boundary.** In light-frame construction, a location where shear is transferred into or out of the diaphragm sheathing. Transfer is either to a boundary element or to another force-resisting element.

**Diaphragm chord.** A diaphragm boundary element perpendicular to the applied load that is assumed to take axial stresses due to the diaphragm moment.

**Diaphragm, unblocked.** A diaphragm that has edge nailing at supporting members only. Blocking between supporting structural members at panel edges is not included. Diaphragm panels are field nailed to supporting members.

Page 2-9, definition [BS] **DRILLED SHAFT**: sub-definition has been added and now reads . . .

**Socketed drilled shaft.** A drilled shaft with a permanent pipe or tube casing that extends down to bedrock and an uncased socket drilled into the bedrock.

Page 2-13, definition [BS] **FIRE-RETARDANT-TREATED WOOD**: line 4 now reads . . . reduced surface-burning characteristics and resist propaga-

Page 2-29, definition [BS] **STRUCTURAL COMPOSITE LUMBER** now reads . . .

[BS] **STRUCTURAL COMPOSITE LUMBER.** Structural member manufactured using wood elements bonded together with exterior adhesives. Examples of *structural composite lumber* are:

**Laminated strand lumber (LSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths not less than 150 times the least dimension of the wood strand elements.

**Laminated veneer lumber (LVL).** A composite of wood veneer sheet elements with wood fibers primarily oriented along the length of the member, where the veneer element thicknesses are 0.25 inches (6.4 mm) or less.

**Oriented strand lumber (OSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inches (2.54 mm) or less and their average lengths not less than 75 times and less than 150 times the least dimension of the strand elements.

**Parallel strand lumber (PSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member where the least dimension of the wood strand elements is 0.25 inches (6.4 mm) or less and their average lengths not less than 300 times the least dimension of the wood strand elements.

Page 2-32, definition [BS] **WOOD STRUCTURAL PANEL** now reads . . .

[BS] **WOOD STRUCTURAL PANEL.** A panel manufactured from *veneers*, wood strands or wafers or a combination of *veneer* and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of *wood structural panels* are:

**Composite panels.** A wood structural panel that is comprised of wood veneer and reconstituted wood-based material and bonded together with waterproof adhesive.

**Oriented strand board (OSB).** A mat-formed wood structural panel comprised of thin rectangular wood strands arranged in cross-aligned layers with surface layers normally arranged in the long panel direction and bonded with waterproof adhesive.

**Plywood.** A wood structural panel comprised of plies of wood veneer arranged in cross-aligned layers. The plies are bonded with waterproof adhesive that cures on application of heat and pressure.

Page 4-5, Section [BS] **403.2.2.1**: lines 6 and 7 now read . . . ASTM C1629/C1629M when tested from the exterior side of the enclosure.

Page 4-5, Section [BS] **403.2.2.2**: now reads . . .

[BS] **403.2.2.2 Wall assembly materials—hard body impact.** The panels making up the enclosures for *interior exit stairways* and elevator hoistway enclosures that are not exposed to the interior of the enclosure shall be in accordance with one of the following:

Page 4-6, Section [BS] **403.2.2.4**: lines 3 and 4 now read . . . that required by Sections 403.2.2.1 for Soft Body Impact Classification Level 2 and 403.2.2.2 for Hard

Page 4-11, Section **406.2.7**: line 8 now reads . . . shall be provided in accordance with Section 1107.

Page 4-23, Section **411.3 Fire alarm system** title now reads . . . [F] **411.3 Automatic smoke detection.**

Page 4-23, Section **411.3**: line 4 now reads . . . Section 907.2.12.

## EDITORIAL CHANGES

Page 7-91, **TABLE 722.6.2(1)**: column 1, row 3 now reads . . .

$\frac{15}{32}$ -inch wood structural panel bonded with exterior glue
---

Page 7-91, **TABLE 722.6.2(1)**: column 1, row 4 now reads . . .

$\frac{19}{32}$ -inch wood structural panel bonded with exterior glue
---

Page 11-15, **Section 1110.13**: line 2 now reads . . . accessible features in accordance with Sections 1110.13.1

Page 14-4, **TABLE 1404.3(2)**: now reads . . .

**TABLE 1404.3(2)**  
**VAPOR RETARDER OPTIONS**

CLIMATE ZONE	VAPOR RETARDER CLASS		
	I	II	III <sup>a</sup>
1, 2	Not permitted	Not Permitted	Permitted
3	Not permitted	Permitted	Permitted
4 (except Marine)	Not permitted	Permitted	See Table 1404.3(3)
Marine 4, 5, 6, 7, 8	Permitted	Permitted	See Table 1404.3(3)

a. See also Sections 1404.3.1 and 1404.3.2.

Page 14-4, **Section 1404.3.1** has been relocated to Section 1404.3 on page 14-3 and now reads . . .

**1404.3 Vapor retarders.** Vapor retarder materials shall be classified in accordance with Table 1404.3(1). A vapor retarder shall be provided on the interior side of frame walls in accordance with Tables 1404.3(2) and 1404.3(3), or an approved design using accepted engineering practice for hygrothermal analysis. The appropriate climate zone shall be selected in accordance with Chapter 3 of the *International Energy Conservation Code*.

Where a Class II vapor retarder is used in combination with foam plastic insulating sheathing installed as continuous insulation on the exterior side of frame walls, the continuous insulation shall comply with Table 1404.3(4) and the Class II vapor retarder shall have a vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B). Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.

**Exceptions:**

1. Basement walls.
2. Below-grade portion of any wall.
3. Construction where accumulation, condensation or freezing of moisture will not damage the materials.
4. Class I and II vapor retarders with vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B) shall be allowed on the interior side of any frame wall in all climate zones.

Page 14-4, **TABLE 1404.3.1** table number now reads . . . **TABLE 1404.3(4)**

Page 14-4, **Section 1404.3.2** has been deleted

Page 14-4, **Section 1404.3.2.1** has been renumbered and now reads . . . **1404.3.1 Spray foam plastic insulation for moisture control with Class III vapor retarders.**

Page 14-4, **Section 1404.3.2.1**: lines 7 and 8 now read . . . be deemed to meet the continuous insulation moisture control requirement where the spray foam *R*-value meets

Page 14-4, **Section 1404.3.2.1.1** has been renumbered and now reads . . . **1404.3.2 Hybrid insulation for moisture control with Class III vapor retarders.**

Page 16-5, **TABLE 1604.5**: column 2, row 4, bullet 2, line 2 now reads . . . 300 and a cumulative occupant load of these public assembly spaces of greater than 2,500.

Page 16-10, **TABLE 1607.1—continued**: column 6, row 2 now reads . . . Section 1607.14.2

Page 16-43, **Section 1613.3**: line 13 now reads . . . by nonlinear response-history or other *approved* analysis or

Page 18-15, **Section 1808.8.2**: line 8 now reads . . . Section 20.5.1.3.5 of ACI 318. Concrete cover shall be

Page 18-15, **TABLE 1808.8.2**: column 2, row 2 now reads . . . In accordance with Section 20.5 of ACI 318

Page 18-15, **TABLE 1808.8.2**: column 2, row 3, line 3 now reads . . . In accordance with Section 20.5.1.3.3 of ACI 318

Page 18-15, **TABLE 1808.8.2:** column 2, row 4, line 2 now reads . . . In accordance with Section 20.5.1.3.3 of ACI 318

Page 19-3, **Section 1905.1.5:** paragraph 2 now reads . . . 18.13.1.1 – *Foundations resisting earthquake-induced forces or transferring earthquake-induced forces between a structure and ground shall comply with the requirements of 18.13 and other applicable provisions of ACI 318 unless modified by Chapter 18 of the International Building Code.*

Page 19-4, **Section 1905.1.8:** paragraph 1, line 2 now reads . . . Sections 17.10.5.2, 17.10.5.3(d) and 17.10.6.2 to read as

Page 19-4, **Section 1905.1.8:** bullet point 1 now reads . . .

- 17.10.5.2 – *Where the tensile component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor tensile force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.10.5.3. The anchor design tensile strength shall be determined in accordance with 17.10.5.4.*

Page 19-4, **Section 1905.1.8:** bullet point 1, Exception now reads . . . **Exception:** *Anchors designed to resist wall out-of-plane forces with design strengths equal to or greater than the force determined in accordance with ASCE 7 Equation 12.11-1 or 12.14-10 shall be deemed to satisfy Section 17.10.5.3(d).*

Page 19-4, **Section 1905.1.8:** bullet point 2 now reads . . .

- 17.10.5.3(d) – *The anchor or group of anchors shall be designed for the maximum tension obtained from design load combinations that include  $E$ , with  $E$  increased by  $\Omega_0$ . The anchor design tensile strength shall be calculated from 17.10.5.4.*

Page 19-4, **Section 1905.1.8:** bullet point 3 now reads . . .

- 17.10.6.2 – *Where the shear component of the strength-level earthquake force applied to anchors exceeds 20 percent of the total factored anchor shear force associated with the same load combination, anchors and their attachments shall be designed in accordance with 17.10.6.3. The anchor design shear strength for resisting earthquake forces shall be determined in accordance with 17.7.*

Page 19-4, **Section 1905.1.8:** bullet point 3, Exception 1 now reads . . .

1. *For the calculation of the in-plane shear strength of anchor bolts attaching wood sill plates of bearing or nonbearing walls of light-frame wood structures to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.7.2 and 17.7.3 need not be computed and 17.10.6.3 shall be deemed to be satisfied provided all of the following are met:*

Page 19-4, **Section 1905.1.8:** bullet point 3, Exception 2 now reads . . .

2. *For the calculation of the in-plane shear strength of anchor bolts attaching cold-formed steel track of bearing or nonbearing walls of light-frame construction to foundations or foundation stem walls, the in-plane shear strength in accordance with 17.7.2 and 17.7.3 need not be computed and 17.10.6.3 shall be deemed to be satisfied provided all of the following are met:*

Page 19-4, **Section 1905.1.8:** bullet point 3, Exceptions 2.1 through 2.5 now read . . .

- 2.1. *The maximum anchor nominal diameter is  $5/8$  inch (16 mm).*
- 2.2. *Anchors are embedded into concrete a minimum of 7 inches (178 mm).*
- 2.3. *Anchors are located a minimum of  $1\frac{3}{4}$  inches (45 mm) from the edge of the concrete parallel to the length of the track.*
- 2.4. *Anchors are located a minimum of 15 anchor diameters from the edge of the concrete perpendicular to the length of the track.*
- 2.5. *The track is 33 to 68 mil (0.84 mm to 1.73 mm) designation thickness.*

Page 19-4, **Section 1905.1.8:** paragraph 19, line 4 now reads . . . with AISI S100 Section J3.3.1.

Page 19-5, **Section 1905.1.8:** bullet point 3, Exception 3 now reads . . .

3. *In light-frame construction bearing or nonbearing walls, shear strength of concrete anchors less than or equal to 1 inch [25 mm] in diameter attaching sill plate or track to foundation or foundation stem wall need not satisfy 17.10.6.3(a) through (c) when the design strength of the anchors is determined in accordance with 17.7.2.1(c).*

Page 33-5, **Section [F] 3313.5:** line 4 now reads . . . accordance with Section 3311, a water supply providing a

Page 35-1, Referenced Standard **AAMA 714—20** now reads . . .

## **714—19: Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal around Exterior Wall Openings in Buildings**

1404.4

**EDITORIAL CHANGES**

Page 35-24, Referenced Standard **NFPA 45—19** now reads . . .

**45—19: Standard on Fire Protection Laboratories Using Chemicals**

428.3.7

Page 35-27, Referenced Standard **TMS** standard number 216—2013 now reads . . . 216—2014

Page APPENDIX H-4, **Section H116.1:** line 1 now reads . . . **H116.1 General.** See Table H116.1 for standards that are

For the complete errata history of this code, please visit: <https://www.iccsafe.org/errata-central/>



# Valuable Guides to Changes in the 2021 I-Codes®

## SIGNIFICANT CHANGES TO THE 2021 INTERNATIONAL CODES®

Practical resources that offer a comprehensive analysis of the critical changes made between the 2018 and 2021 editions of the codes. Authored by ICC code experts, these useful tools are “must-have” guides to the many important changes in the 2021 International Codes.

Key changes are identified then followed by in-depth, expert discussion of how the change affects real world application. A full-color photo, table or illustration is included for each change to further clarify application.



**SIGNIFICANT CHANGES TO  
THE IBC®, 2021 EDITION**  
#7024S21



**SIGNIFICANT CHANGES TO THE  
IRC®, 2021 EDITION**  
#7101S21



**SIGNIFICANT CHANGES TO THE  
IFC®, 2021 EDITION**  
#7404S21



**SIGNIFICANT CHANGES TO THE  
IPC®/IMC®/IFGC®, 2021 EDITION**  
#7202S21



**SIGNIFICANT CHANGES TO THE  
IECC®, 2021 EDITION**  
#7808S21

**New to the series!**

20-19101

**Order Your Helpful Guides Today! 1-800-786-4452 | [www.iccsafe.org/books](http://www.iccsafe.org/books)**



# ☒ Specify and ☒ Approve *with* Confidence



## When facing new or unfamiliar materials, look for an ICC-ES Evaluation Report or Listing before approving for installation.

ICC-ES® **Evaluation Reports** are the most widely accepted and trusted technical reports for code compliance.

ICC-ES **Building Product Listings** and **PMG Listings** show product compliance with applicable standard(s) referenced in the building and plumbing codes as well as other applicable codes.

When you specify or approve products or materials with an ICC-ES report, building product listing or PMG listing, you avoid delays on projects and improve your bottom line.

ICC-ES is a subsidiary of ICC®, the publisher of the codes used throughout the U.S. and many global markets, so you can be confident in their code expertise.

**[www.icc-es.org](http://www.icc-es.org) | 800-423-6587**



Look for the Trusted Marks of Conformity



A subsidiary of



INTERNATIONAL  
CODE  
COUNCIL®

20-18859



# S. K. Ghosh Associates LLC, Seismic and Building Code Consulting

S. K. Ghosh Associates LLC (SKGA) serves as a technical resource on structural codes and standards.

Our technical support includes:

- **Publications** – various code support materials to aid in the learning and comprehension of specific codes.
- **Code Masters** – a condensed explanation of difficult code requirements on a particular structural topic in a durable reference tool.
- **Seminars** – continuing education (with PDH).
- **Computer Programs** – tools that make code-compliance quick and simple with intuitive interfaces, easy-to-use workflow, and detailed output reports.
- **Seismic and Building Code Consultancy** – on code compliance and other aspects of structural design.

Learn more about our robust list of services and support material at **[skghoshassociates.com](http://skghoshassociates.com)** or call **847-991-2700**.



S. K. GHOSH  
ASSOCIATES™





# Telework with ICC Digital Codes Premium

## An essential online platform for all code users

ICC's Digital Codes is the most trusted and authentic source of model codes and standards, which conveniently provides access to the latest code text from across the United States. With a Premium subscription, users can further enhance their code experience with powerful features such as team collaboration and access sharing, bookmarks, notes, errata and revision history, and more.



Never miss a code update

Available anywhere 24/7

Use on any mobile or digital device

View hundreds of code titles and standards

20-18933

***Go Beyond the Codes with a Premium Subscription***  
Start Your 14-Day Premium trial at ***codes.iccsafe.org/trial***



**2021**  
**Edition**

# **ARKANSAS**

# **FIRE PREVENTION CODE**

## **VOLUME III RESIDENTIAL**

**Based on the 2021 International  
Residential Code®**



# ARKANSAS FIRE PREVENTION CODE

## 2021 EDITION



### VOLUME III

**Based on the 2021  
International Residential  
Code®**

2021 Arkansas Fire Prevention Code, Volume III–Residential

First Printing: October 2022

ISBN: 978-1-958581-56-8 (loose-leaf edition)

COPYRIGHT © 2022  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This 2021 *Arkansas Fire Prevention Code* contains substantial copyrighted material from the 2021 *International Residential Code*®, second printing, which is a copyrighted work owned by the International Code Council, Inc. (“ICC”). Without separate written permission from the copyright owner, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example, and not limitation, photocopying or recording by or in an information storage and/or retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

Trademarks: “International Code Council,” the “International Code Council” logo, “ICC,” the “ICC” logo, “International Residential Code,” “IRC” and other names and trademarks appearing in this publication are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission.

PRINTED IN THE USA

T028247





## TO THE PEOPLE OF THE STATE OF ARKANSAS:

The *Arkansas Fire Prevention Code* ("AFPC" or "Fire Code" or "Code") 2021 edition, which supersedes the 2012 edition, has been developed to assist in preventing and controlling fires in and outside of structures in the State of Arkansas. The proper use of this Code can result in saving lives and property through the prevention of fires in our state.

I encourage Arkansas cities and counties to join with the Arkansas State Fire Marshal's Office in our effort to enforce the AFPC by adopting the Fire Code as a local ordinance. The adoption of the AFPC 2021 edition is important, and it is my hope that every citizen will use this Code to their fullest advantage in fire prevention.

## ORDER

Pursuant to the authority vested in the Director of the Division of Arkansas State Police by Section 6 of Act 254 of 1955 (A.C.A. §12-13-105), as amended, I promulgate these rules for the prevention of fire hazards in the State of Arkansas. The rules are set out in detail in the copy attached hereto.

IT IS THEREFORE ORDERED that said rules are to become effective January 1, 2023, in compliance with the Administrative Procedure Act of the State of Arkansas (A.C.A. §25-15-201 through §25-15-214), and shall be known as the *Arkansas Fire Prevention Code*, 2021 edition.

IN WITNESS WHEREOF, I have hereto affixed my signature as Director of the Division of Arkansas State Police this June 20, 2022.

A handwritten signature in black ink, appearing to read "William J. Bryant".

Colonel William J. Bryant  
Director, Arkansas State Police  
Arkansas Department of Public Safety



## FOREWORD

The *Arkansas Fire Prevention Code* was developed using the nationally and internationally recognized and accepted *International Fire Code*, *International Building Code* and *International Residential Code*, with revisions based on recommendations from Arkansas-based subject matter experts.

- There are countless individuals who contributed to the 2021 successful revision of the *Arkansas Fire Prevention Code*. The following Arkansans unselfishly devoted their time and expertise to serve on the informal Arkansas Fire Prevention Code Revision Committee. The State Fire Marshal's Office extends its heartfelt thanks to everyone who participated in the revision process:
- Wally Bailey, Director of Community Development, City of Fort Smith
- James Birchfield, Senior Manager, Fire Code Compliance, Walmart
- Barry Burke, Inspector, State Fire Marshal's Office
- Brian Cotton, Associate Vice Chancellor of Operations, UAMS, Design and Construction
- Charles Covington, Chief State Electrical Inspector, AR Department of Labor
- Jimmie Deer, Building Official, City of Fort Smith
- Roderick Edwards, President, Triple-S Alarm Co., Inc.
- James Engstrom, President, H. James Engstrom and Associates, Inc.
- Jake Feemster, Fire Marshal, Bentonville Fire Department
- Steven Ferren, Executive Vice President, Arkansas Oil Marketers Association
- Dennis Free, Inspector, State Fire Marshal's Office
- Dustin Free, Captain, North Little Rock Fire Department
- (William) Guy Grady, Fire Inspector, Searcy Fire Department
- Paul Hankins, Area Supervisor, Arkansas Department of Human Services Child Care Licensing Division
- J.D. Harper, Executive Director, Arkansas Manufactured Housing Association
- Jimmy Hart, Judge, Conway County Judge
- Joe Hillard, Director of Engineering, Cromwell Architects & Engineers
- Joseph Jerabeck, Captain, Rogers Fire Department
- Kevin Lang, Fire Chief, Paragould Fire Department
- Chris A. Lorton, Commercial Building Inspector, City of Rogers
- Robert Medford, Fire Chief, Camden Fire Department
- Duane Miller, Fire Marshal, Springdale Fire Department
- Robert Morgan, Inspector Supervisor, Arkansas Department of Environmental Quality
- Michael Moyer, Captain, ASP/Regulatory and Building Operations
- Kevin Pfalser, Director, Liquefied Petroleum Gas Board
- Tim Quetsch, Engineer, Arkansas Department of Environmental Quality
- Jerry Robinson, Fire Marshal, North Little Rock Fire Department
- Bill Rumsey, Captain, Rogers Fire Department, Community Risk Reduction Division
- Mike Scott, Chief Building Official, City of Hot Springs
- Brian Sloat, Fire Marshal, Fayetteville Fire Department
- Matthew Swaim, Architect, WER Architects/Planners
- Darrell Tessman, Assistant Director, ADE Facilities and Transportation
- Clayton Vaden, Architect, Lewis Architects Engineers
- Phil Watkins, Building Official, City of Searcy
- Mark Wheeler, Vice President/District Manager, VSC Fire and Security
- Jason Wills, Fire Marshal, Jonesboro Fire Department
- Keith Wingfield, President, River Rock Builders
- Lorel Hoffman, President, Austin Permit Services
- Mark Whitaker, Plan Reviewer, State Fire Marshal's Office

The intent of the *Arkansas Fire Prevention Code* is to reduce the number of fires in Arkansas and reduce the number of other hazard-related concerns. The *Arkansas Fire Prevention Code* establishes minimum rules dealing with fire and building safety.

Written communications for the State Fire Marshal's Office should be directed to:

State Fire Marshal's Office  
Division of Arkansas State Police  
Arkansas Department of Public Safety  
1 State Police Plaza Drive  
Little Rock, AR 72209

The State Fire Marshal's Office can be contacted by telephone at 501-618-8624 (until further notice). The fax number for the State Fire Marshal's Office is 501-618-8621 (until further notice).



Major Lindsey Williams  
State Fire Marshal's Office  
Division of Arkansas State Police  
Arkansas Department of Public Safety

# STATE OF ARKANSAS

## ARKANSAS FIRE PREVENTION CODE RULES

### 2021 EDITION

### DEFINITIONS

- These Rules are promulgated by the Director of the Division of Arkansas State Police, who serves by operation of law as the Arkansas State Fire Marshal under the authority granted by Arkansas Act 254 of 1955, codified at A.C.A. §12-13-101 to A.C.A. §12-13-116, as amended. The purpose of these Rules is to aid in the implementation, interpretation and enforcement of the *Arkansas Fire Prevention Code* (AFPC), 2021 Edition.

- The *International Fire Code*, 2021 edition, the *International Building Code*, 2021 edition, and the *International Residential Code*, 2021 edition, as published by the International Code Council and the rules, as amended and adopted by the Arkansas State Fire Marshal, shall constitute the *Arkansas Fire Prevention Code*, 2021 edition. These Rules shall be effective January 1, 2023.

The following shall be defined as:

INTERNATIONAL PLUMBING CODE shall mean the *Arkansas State Plumbing Code*.

INTERNATIONAL PRIVATE SEWAGE DISPOSAL CODE is replaced by “Arkansas Department of Health Rules and Regulations Pertaining to Onsite Wastewater Systems.”

- INTERNATIONAL MECHANICAL CODE shall mean the *mechanical code for Arkansas*.

INTERNATIONAL FUEL GAS CODE shall mean the *Arkansas State Gas Code*.

INTERNATIONAL ENERGY CONSERVATION CODE shall mean the *Arkansas Energy Code*.

INTERNATIONAL FIRE CODE shall mean the *Arkansas Fire Prevention Code*, Volume I.

INTERNATIONAL BUILDING CODE shall mean the *Arkansas Fire Prevention Code*, Volume II.

INTERNATIONAL RESIDENTIAL CODE shall mean the *Arkansas Fire Prevention Code*, Volume III.

- NATIONAL ELECTRICAL CODE shall mean the *electrical code for the State of Arkansas*.

BUILDING OFFICIAL shall mean any governmental official having authority to enforce that aspect of the Code.

Dotted lines in the margin indicate Arkansas revisions.



Solid stars in the margin indicate Arkansas deletions.



# TABLE OF CONTENTS

<b>Part I—Administrative</b> . . . . .	<b>1-1</b>	R307 Toilet, Bath and Shower Spaces . . . . .	3-41
<b>CHAPTER 1 SCOPE AND ADMINISTRATION</b> . . . . .	<b>1-1</b>	R308 Glazing . . . . .	3-41
<b>PART 1—SCOPE AND APPLICATION</b> . . . . .	<b>1-1</b>	R309 Garages and Carports . . . . .	3-46
Section		R310 Emergency Escape and Rescue Openings . . . . .	3-46
R101 Scope and General Requirements . . . . .	1-1	R311 Means of Egress . . . . .	3-48
R102 Applicability . . . . .	1-1	R312 Guards and Window Fall Protection . . . . .	3-51
<b>PART 2—ADMINISTRATION AND ENFORCEMENT</b> . . . . .	<b>1-2</b>	R313 Automatic Fire Sprinkler Systems . . . . .	3-52
Section		R314 Smoke Alarms . . . . .	3-52
R103 Department of Building Safety . . . . .	1-2	R315 Carbon Monoxide Alarms . . . . .	3-53
R104 Duties and Powers of the Building Official . . . . .	1-2	R316 Foam Plastic . . . . .	3-54
R105 Permits . . . . .	1-3	R317 Protection of Wood and Wood-based Products against Decay . . . . .	3-56
R106 Construction Documents . . . . .	1-6	R318 Protection against Subterranean Termites . . . . .	3-57
R107 Temporary Structures and Uses . . . . .	1-7	R319 Site Address . . . . .	3-58
R108 Fees . . . . .	1-7	R320 Accessibility . . . . .	3-58
R109 Inspections . . . . .	1-7	R321 Elevators and Platform Lifts . . . . .	3-58
R110 Certificate of Occupancy . . . . .	1-8	R322 Flood-resistant Construction . . . . .	3-58
R111 Service Utilities . . . . .	1-9	R323 Storm Shelters . . . . .	3-63
R112 Board of Appeals . . . . .	1-9	R324 Solar Energy Systems . . . . .	3-63
R113 Violations . . . . .	1-9	R325 Mezzanines . . . . .	3-65
R114 Stop Work Order . . . . .	1-9	R326 Habitable Attics . . . . .	3-65
<b>Part II—Definitions</b> . . . . .	<b>2-1</b>	R327 Swimming Pools, Spas and Hot Tubs . . . . .	3-66
<b>CHAPTER 2 DEFINITIONS</b> . . . . .	<b>2-1</b>	R328 Energy Storage Systems . . . . .	3-66
Section		R329 Stationary Engine Generators . . . . .	3-66
R201 General . . . . .	2-1	R330 Stationary Fuel Cell Power Systems . . . . .	3-67
R202 Definitions . . . . .	2-1	<b>CHAPTER 4 FOUNDATIONS</b> . . . . .	<b>4-1</b>
<b>Part III—Building Planning and Construction</b> . . . . .	<b>3-1</b>	Section	
<b>CHAPTER 3 BUILDING PLANNING</b> . . . . .	<b>3-1</b>	R401 General . . . . .	4-1
Section		R402 Materials . . . . .	4-1
R301 Design Criteria . . . . .	3-1	R403 Footings . . . . .	4-2
R302 Fire-resistant Construction . . . . .	3-33	R404 Foundation and Retaining Walls . . . . .	4-22
R303 Light, Ventilation and Heating . . . . .	3-39	R405 Foundation Drainage . . . . .	4-42
R304 Minimum Room Areas . . . . .	3-40	R406 Foundation Waterproofing and Dampproofing . . . . .	4-43
R305 Ceiling Height . . . . .	3-41	R407 Columns . . . . .	4-44
R306 Sanitation . . . . .	3-41	R408 Under-floor Space . . . . .	4-44
		<b>CHAPTER 5 FLOORS</b> . . . . .	<b>5-1</b>
		Section	
		R501 General . . . . .	5-1
		R502 Wood Floor Framing . . . . .	5-1



## TABLE OF CONTENTS

R503 Floor Sheathing .....	5-10
R504 Pressure Preservative-treated Wood Floors (On Ground) .....	5-12
R505 Cold-formed Steel Floor Framing .....	5-12
R506 Concrete Floors (On Ground) .....	5-21
R507 Exterior Decks .....	5-25

## CHAPTER 6 WALL CONSTRUCTION ..... 6-1

### Section

R601 General .....	6-1
R602 Wood Wall Framing .....	6-1
R603 Cold-formed Steel Wall Framing .....	6-54
R604 Wood Structural Panels .....	6-88
R605 Particleboard .....	6-89
R606 General Masonry Construction .....	6-89
R607 Glass Unit Masonry .....	6-105
R608 Exterior Concrete Wall Construction .....	6-107
R609 Exterior Windows and Doors .....	6-179
R610 Structural Insulated Panel Wall Construction .....	6-180

## CHAPTER 7 WALL COVERING..... 7-1

### Section

R701 General .....	7-1
R702 Interior Covering .....	7-1
R703 Exterior Covering .....	7-7
R704 Soffits .....	7-27

## CHAPTER 8 ROOF-CEILING CONSTRUCTION..... 8-1

### Section

R801 General .....	8-1
R802 Wood Roof Framing .....	8-1
R803 Roof Sheathing .....	8-30
R804 Cold-formed Steel Roof Framing .....	8-30
R805 Ceiling Finishes .....	8-46
R806 Roof Ventilation .....	8-46
R807 Attic Access .....	8-48

## CHAPTER 9 ROOF ASSEMBLIES ..... 9-1

### Section

R901 General .....	9-1
R902 Fire Classification .....	9-1
R903 Weather Protection .....	9-1
R904 Materials .....	9-2
R905 Requirements for Roof Coverings .....	9-2

R906 Roof Insulation .....	9-14
R907 Rooftop-mounted Photovoltaic Panel Systems .....	9-14
R908 Reroofing .....	9-14

## CHAPTER 10 CHIMNEYS AND FIREPLACES.....10-1

### Section

R1001 Masonry Fireplaces .....	10-1
R1002 Masonry Heaters .....	10-5
R1003 Masonry Chimneys .....	10-5
R1004 Factory-built Fireplaces .....	10-10
R1005 Factory-built Chimneys .....	10-10
R1006 Exterior Air Supply .....	10-11

## Part IV—Energy Conservation .....11-1

## CHAPTER 11 ENERGY EFFICIENCY Deleted in its entirety Refer to the Arkansas Energy Code .....11-1

## Part V—Mechanical.....12-1

## CHAPTER 12 MECHANICAL ADMINISTRATION.....12-1

### Section

M1201 General .....	12-1
M1202 Existing Mechanical Systems .....	12-1

## CHAPTER 13 GENERAL MECHANICAL SYSTEM REQUIREMENTS.....13-1

### Section

M1301 General .....	13-1
M1302 Approval .....	13-1
M1303 Labeling of Appliances .....	13-1
M1304 Type of Fuel .....	13-1
M1305 Appliance Access .....	13-2
M1306 Clearances from Combustible Construction .....	13-3
M1307 Appliance Installation .....	13-3
M1308 Mechanical Systems Installation .....	13-6

## CHAPTER 14 HEATING AND COOLING EQUIPMENT AND APPLIANCES .....14-1

### Section

M1401 General .....	14-1
M1402 Central Furnaces .....	14-1

## TABLE OF CONTENTS

M1403 Heat Pump Equipment . . . . .	14-1	M1902 Sauna Heaters . . . . .	19-1
M1404 Refrigeration Cooling Equipment . . . . .	14-1	M1903 Stationary Fuel Cell Power Plants . . . . .	19-1
M1405 Baseboard Convectors . . . . .	14-1	M1904 Gaseous Hydrogen Systems . . . . .	19-1
M1406 Radiant Heating Systems . . . . .	14-2		
M1407 Duct Heaters . . . . .	14-2	<b>CHAPTER 20 BOILERS AND</b>	
M1408 Vented Floor Furnaces . . . . .	14-2	<b>WATER HEATERS . . . . .</b>	<b>20-1</b>
M1409 Vented Wall Furnaces . . . . .	14-3	Section	
M1410 Vented Room Heaters . . . . .	14-3	M2001 Boilers . . . . .	20-1
M1411 Heating and Cooling Equipment . . . . .	14-3	M2002 Operating and Safety Controls . . . . .	20-1
M1412 Absorption Cooling Equipment . . . . .	14-5	M2003 Expansion Tanks . . . . .	20-1
M1413 Evaporative Cooling Equipment . . . . .	14-5	M2004 Water Heaters Used for Space Heating . . . . .	20-2
M1414 Fireplace Stoves . . . . .	14-5	M2005 Water Heaters . . . . .	20-2
M1415 Masonry Heaters . . . . .	14-5	M2006 Pool Heaters . . . . .	20-2
<b>CHAPTER 15 EXHAUST SYSTEMS . . . . .</b>	<b>15-1</b>	<b>CHAPTER 21 HYDRONIC PIPING . . . . .</b>	<b>21-1</b>
Section		Section	
M1501 General . . . . .	15-1	M2101 Hydronic Piping Systems Installation . . . . .	21-1
M1502 Clothes Dryer Exhaust . . . . .	15-1	M2102 Baseboard Convectors . . . . .	21-4
M1503 Domestic Cooking Exhaust Equipment . . . . .	15-2	M2103 Floor Heating Systems . . . . .	21-5
M1504 Exhaust Ducts and Exhaust Openings . . . . .	15-3	M2104 Low Temperature Piping . . . . .	21-5
M1505 Mechanical Ventilation . . . . .	15-3	M2105 Ground-Source Heat-Pump System Loop Piping . . . . .	21-6
<b>CHAPTER 16 DUCT SYSTEMS . . . . .</b>	<b>16-1</b>	<b>CHAPTER 22 SPECIAL PIPING AND</b>	
Section		<b>STORAGE SYSTEMS . . . . .</b>	<b>22-1</b>
M1601 Duct Construction . . . . .	16-1	Section	
M1602 Return Air . . . . .	16-4	M2201 Oil Tanks . . . . .	22-1
		M2202 Oil Piping, Fitting and Connections . . . . .	22-1
<b>CHAPTER 17 COMBUSTION AIR . . . . .</b>	<b>17-1</b>	M2203 Installation . . . . .	22-1
Section		M2204 Oil Pumps and Valves . . . . .	22-2
M1701 General . . . . .	17-1		
		<b>CHAPTER 23 SOLAR THERMAL</b>	
<b>CHAPTER 18 CHIMNEYS AND VENTS . . . . .</b>	<b>18-1</b>	<b>ENERGY SYSTEMS . . . . .</b>	<b>23-1</b>
Section		Section	
M1801 General . . . . .	18-1	M2301 Solar Thermal Energy Systems . . . . .	23-1
M1802 Vent Components . . . . .	18-2		
M1803 Chimney and Vent Connectors . . . . .	18-2	<b>Part VI—Fuel Gas . . . . .</b>	<b>24-1</b>
M1804 Vents . . . . .	18-3		
M1805 Masonry and Factory-built Chimneys . . . . .	18-4	<b>CHAPTER 24 FUEL GAS</b>	
		<b>Deleted in its entirety</b>	
<b>CHAPTER 19 SPECIAL APPLIANCES,</b>		<b>Refer to the Arkansas State</b>	
<b>EQUIPMENT AND SYSTEMS . . . . .</b>	<b>19-1</b>	<b>Gas Code . . . . .</b>	<b>24-1</b>
Section			
M1901 Ranges and Ovens . . . . .	19-1		

## TABLE OF CONTENTS

*Part VII—Plumbing . . . . . 25-1*

<b>CHAPTER 25 PLUMBING ADMINISTRATION</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	25-1

<b>CHAPTER 26 GENERAL PLUMBING REQUIREMENTS</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	26-1

<b>CHAPTER 27 PLUMBING FIXTURES</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	27-1

<b>CHAPTER 28 WATER HEATERS</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	28-1

<b>CHAPTER 29 WATER SUPPLY AND DISTRIBUTION</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	29-1

<b>CHAPTER 30 SANITARY DRAINAGE</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	30-1

<b>CHAPTER 31 VENTS</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	31-1

<b>CHAPTER 32 TRAPS</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	32-1

<b>CHAPTER 33 STORM DRAINAGE</b>	
Deleted in its entirety	
Refer to the Arkansas State Plumbing Code . . . . .	33-1

*Part VIII—Electrical . . . . . 34-1*

<b>CHAPTER 34 GENERAL REQUIREMENTS</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	34-1

<b>CHAPTER 35 ELECTRICAL DEFINITIONS</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	35-1

<b>CHAPTER 36 SERVICES</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	36-1

<b>CHAPTER 37 BRANCH CIRCUIT AND FEEDER REQUIREMENTS</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	37-1

<b>CHAPTER 38 WIRING METHODS</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	38-1

<b>CHAPTER 39 POWER AND LIGHTING DISTRIBUTION</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	39-1

<b>CHAPTER 40 DEVICES AND LUMINAIRES</b>	
Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners. . . . .	40-1

## TABLE OF CONTENTS

<b>CHAPTER 41 APPLIANCE INSTALLATION</b> Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners..... 41-1	<b>APPENDIX AE MANUFACTURED HOUSING USED AS DWELLINGS</b> Deleted in its entirety .....AE-1
<b>CHAPTER 42 SWIMMING POOLS</b> Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners..... 41-1	<b>APPENDIX AF RADON CONTROL METHODS</b> Deleted in its entirety .....AF-1
<b>CHAPTER 43 CLASS 2 REMOTE-CONTROL, SIGNALING AND POWER- LIMITED CIRCUITS</b> Delete Chapter and refer to the National Electrical Code of the National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners..... 43-1	<b>APPENDIX AG PIPING STANDARDS FOR VARIOUS APPLICATIONS</b> Deleted in its entirety ..... AG-1
<i>Part IX—Referenced Standards ..... 44-1</i>	<b>APPENDIX AH PATIO COVERS</b> Deleted in its entirety ..... AH-1
<b>CHAPTER 44 REFERENCED STANDARDS .... 44-1</b>	<b>APPENDIX AI PRIVATE SEWAGE DISPOSAL</b> Deleted in its entirety ..... AI-1
<b>APPENDIX AA SIZING AND CAPACITIES OF GAS PIPING</b> Deleted in its entirety ..... AA-1	<b>APPENDIX AJ EXISTING BUILDINGS AND STRUCTURES</b> Deleted in its entirety ..... AJ-1
<b>APPENDIX AB SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS</b> Deleted in its entirety ..... AB-1	<b>APPENDIX AK SOUND TRANSMISSION</b> Deleted in its entirety ..... AK-1
<b>APPENDIX AC EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS</b> Deleted in its entirety ..... AC-1	<b>APPENDIX AL PERMIT FEES</b> Deleted in its entirety .....AL-1
<b>APPENDIX AD RECOMMENDED PROCEDURE FOR SAFETY INSPECTION OF AN EXISTING APPLIANCE INSTALLATION</b> Deleted in its entirety ..... AD-1	<b>APPENDIX AM HOME DAY CARE—R-3 OCCUPANCY</b> Deleted in its entirety..... AM-1
	<b>APPENDIX AN VENTING METHODS</b> Deleted in its entirety .....AN-1
	<b>APPENDIX AO AUTOMATIC VEHICULAR GATES</b> Deleted in its entirety ..... AO-1
	<b>APPENDIX AP SIZING OF WATER PIPING SYSTEM</b> Deleted in its entirety .....AP-1
	<b>APPENDIX AQ TINY HOUSES</b> Deleted in its entirety ..... AQ-1
	<b>APPENDIX AR LIGHT STRAW-CLAY CONSTRUCTION</b> Deleted in its entirety .....AR-1



**TABLE OF CONTENTS**

<b>APPENDIX AS STRAWBALE CONSTRUCTION</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AS-1</b>

<b>APPENDIX AT SOLAR-READY PROVISIONS— DETACHED ONE- AND TWO-FAMILY DWELLINGS AND TOWNHOUSES</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AT-1</b>

<b>APPENDIX AU COB CONSTRUCTION (MONOLITHIC ADOBE)</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AU-1</b>

<b>APPENDIX AV BOARD OF APPEALS</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AV-1</b>

<b>APPENDIX AW 3D-PRINTED BUILDING CONSTRUCTION</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AW-1</b>

<b>APPENDIX AX ZERO ENERGY RESIDENTIAL BUILDING PROVISIONS</b>	
<b>Deleted in its entirety . . . . .</b>	<b>AX-1</b>

<b>INDEX . . . . .</b>	<b>INDEX-1</b>
------------------------	----------------

<b>RESOURCE A RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI) . . .</b>	<b>Resource A-1</b>
--	---------------------

# Part I—Administrative

## CHAPTER 1 SCOPE AND ADMINISTRATION

### User note:

**About this chapter:** Chapter 1 establishes the limits of applicability of this code and describes how the code is to be applied and enforced. Chapter 1 is in two parts: Part 1—Scope and Application (Sections R101–R102) and Part 2—Administration and Enforcement (Sections R103–R114). Section R101 identifies which buildings and structures come under its purview and references other I-Codes as applicable. Standards and codes are scoped to the extent referenced (see Section R102.4).

The one- and two-family dwelling code is intended to be adopted as a legally enforceable document, and it cannot be effective without adequate provisions for its administration and enforcement. The provisions of Chapter 1 establish the authority and duties of the building official appointed by the authority having jurisdiction and also establish the rights and privileges of the design professional, contractor and property owner.

### PART 1—SCOPE AND APPLICATION

reasonable level of safety to fire fighters and emergency responders during emergency operations.

#### SECTION R101 SCOPE AND GENERAL REQUIREMENTS

**R101.1 Title.** These provisions shall be known as the *Arkansas Fire Prevention Code*, Volume III of Arkansas, and shall be cited as such and will be referred to herein as “this code.”

**R101.2 Scope.** The provisions of this code shall apply to the construction, *alteration*, movement, enlargement, replacement, *repair*, equipment, use and occupancy, location, removal and demolition of detached one- and two-family dwellings and *townhouses* not more than three stories above *grade plane* in height with a separate means of egress and their *accessory structures* not more than three stories above *grade plane* in height.

**Exception:** The following shall be permitted to be constructed in accordance with this code where provided with an automatic sprinkler system complying with Section P2904:

1. Live/work units located in townhouses and complying with the requirements of Section 508.5 of the *International Building Code*.
2. Owner-occupied *lodging houses* with five or fewer guestrooms.
3. A care facility with five or fewer persons receiving custodial care within a *dwelling unit*.
4. A care facility with five or fewer persons receiving medical care within a *dwelling unit*.
5. A care facility for five or fewer persons receiving care that are within a single-family dwelling.

**R101.3 Purpose.** The purpose of this code is to establish minimum requirements to provide a reasonable level of safety, health and general welfare through affordability, structural strength, means of egress, stability, sanitation, light and ventilation, energy conservation and safety to life and property from fire and other hazards and to provide a

#### SECTION R102 APPLICABILITY

**R102.1 General.** Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern.

**R102.2 Other laws.** The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

**R102.3 Application of references.** References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

**R102.4 Referenced codes and standards.** The codes and standards referenced in this code shall be considered part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections R102.4.1 and R102.4.2.

**Exception:** Where enforcement of a code provision would violate the conditions of the *listing* of the *equipment* or *appliance*, the conditions of the *listing* and manufacturer’s instructions shall apply.

**R102.4.1 Conflicts.** Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**R102.4.2 Provisions in referenced codes and standards.** Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

## SCOPE AND ADMINISTRATION

**R102.5 Appendices.** Provisions in the appendices shall not apply unless specifically referenced in the adopting ordinance. Appendices AA through AW are **NOT** adopted by the State of Arkansas and shall not apply unless adopted by local ordinance.

**R102.6 Partial invalidity.** In the event any part or provision of this code is held to be illegal or void, this shall not have the effect of making void or illegal any of the other parts or provisions.

**R102.7 Existing structures.** The legal occupancy of any structure existing on the date of adoption of this code shall be permitted to continue without change, except as is specifically covered in this code, the *International Property Maintenance Code* or the *International Fire Code*, or as is deemed necessary by the *building official* for the general safety and welfare of the occupants and the public.

**R102.7.1 Additions, alterations or repairs.** *Additions, alterations* or repairs to any structure shall conform to the requirements for a new structure without requiring the existing structure to comply with the requirements of this code, unless otherwise stated. *Additions, alterations, repairs* and relocations shall not cause an existing structure to become less compliant with the provisions of this code than the existing building or structure was prior to the *addition, alteration* or *repair*. An existing building together with its *additions* shall comply with the height limits of this code. Where the *alteration* causes the use or occupancy to be changed to one not within the scope of this code, the provisions of the *International Existing Building Code* shall apply.

## PART 2—ADMINISTRATION AND ENFORCEMENT

### SECTION R103 DEPARTMENT OF BUILDING SAFETY

**R103.1 Creation of enforcement agency.** The department of building safety is hereby created and the official in charge thereof shall be known as the *building official*.

**R103.2 Appointment.** The *building official* shall be appointed by the *jurisdiction*.

**R103.3 Deputies.** In accordance with the prescribed procedures of this *jurisdiction* and with the concurrence of the appointing authority, the *building official* shall have the authority to appoint a deputy *building official*, the related technical officers, inspectors, plan examiners and other employees. Such employees shall have powers as delegated by the *building official*.

### SECTION R104 DUTIES AND POWERS OF THE BUILDING OFFICIAL

**R104.1 General.** The *building official* is hereby authorized and directed to enforce the provisions of this code. The *building official* shall have the authority to render interpretations of this code and to adopt policies and procedures in

order to clarify the application of its provisions. Such interpretations, policies and procedures shall be in compliance with the intent and purpose of this code. Such policies and procedures shall not have the effect of waiving requirements specifically provided for in this code.

**R104.2 Applications and permits.** The *building official* shall receive applications, review *construction documents* and issue *permits* for the erection and *alteration* of buildings and structures, inspect the premises for which such permits have been issued and enforce compliance with the provisions of this code.

**R104.3 Notices and orders.** The *building official* shall issue necessary notices or orders to ensure compliance with this code.

**R104.4 Inspections.** The *building official* shall make the required inspections, or the *building official* shall have the authority to accept reports of inspection by *approved agencies* or individuals. Reports of such inspections shall be in writing and be certified by a responsible officer of such *approved agency* or by the responsible individual. The *building official* is authorized to engage such expert opinion as deemed necessary to report on unusual technical issues that arise, subject to the approval of the appointing authority.

**R104.5 Identification.** The *building official* shall carry proper identification when inspecting structures or premises in the performance of duties under this code.

**R104.6 Right of entry.** Where it is necessary to make an inspection to enforce the provisions of this code, or where the *building official* has reasonable cause to believe that there exists in a structure or upon a premises a condition that is contrary to or in violation of this code that makes the structure or premises unsafe, dangerous or hazardous, the *building official* or designee is authorized to enter the structure or premises at reasonable times to inspect or to perform the duties imposed by this code, provided that if such structure or premises be occupied that credentials be presented to the occupant and entry requested. If such structure or premises is unoccupied, the *building official* shall first make a reasonable effort to locate the *owner*, the *owner's* authorized agent, or other *person* having charge or control of the structure or premises and request entry. If entry is refused, the *building official* shall have recourse to the remedies provided by law to secure entry.

**R104.7 Department records.** The *building official* shall keep official records of applications received, *permits* and certificates issued, fees collected, reports of inspections, and notices and orders issued. Such records shall be retained in the official records for the period required for the retention of public records.

**R104.8 Liability.** The *building official*, member of the board of appeals or employee charged with the enforcement of this code, while acting for the *jurisdiction* in good faith and without malice in the discharge of the duties required by this code or other pertinent law or ordinance, shall not thereby be rendered civilly or criminally liable personally and is hereby relieved from personal liability for any damage accruing to

persons or property as a result of any act or by reason of an act or omission in the discharge of official duties.

**R104.8.1 Legal defense.** Any suit or criminal complaint instituted against an officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by legal representatives of the *jurisdiction* until the final termination of the proceedings. The *building official* or any subordinate shall not be liable for cost in any action, suit or proceeding that is instituted in pursuance of the provisions of this code.

**R104.9 Approved materials and equipment.** Materials, *equipment* and devices *approved* by the *building official* shall be constructed and installed in accordance with such approval.

**R104.9.1 Used materials and equipment.** Used materials, *equipment* and devices shall not be reused unless *approved* by the *building official*.

**R104.10 Modifications.** Where there are practical difficulties involved in carrying out the provisions of this code, the *building official* shall have the authority to grant modifications for individual cases, provided the *building official* shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, life and fire safety or structural requirements. The details of action granting modifications shall be recorded and entered in the files of the department of building safety.

**R104.10.1 Flood hazard areas.** The *building official* shall not grant modifications to any provisions required in flood hazard areas as established by Table R301.2 unless a determination has been made that:

1. There is good and sufficient cause showing that the unique characteristics of the size, configuration or topography of the site render the elevation standards of Section R322 inappropriate.
2. Failure to grant the modification would result in exceptional hardship by rendering the lot undevelopable.
3. The granting of modification will not result in increased flood heights, additional threats to public safety, extraordinary public expense, cause fraud on or victimization of the public, or conflict with existing laws or ordinances.
4. The modification is the minimum necessary to afford relief, considering the flood hazard.
5. Written notice specifying the difference between the design flood elevation and the elevation to which the building is to be built, stating that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced floor elevation and stating that construction below the design flood elevation increases risks to life and property, has been submitted to the applicant.

**R104.11 Alternative materials, design and methods of construction and equipment.** The provisions of this code

are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code. The *building official* shall have the authority to approve an alternative material, design or method of construction upon application of the *owner* or the *owner's* authorized agent. The *building official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety. Compliance with the specific performance-based provisions of the International Codes shall be an alternative to the specific requirements of this code. Where the alternative material, design or method of construction is not *approved*, the *building official* shall respond in writing, stating the reasons why the alternative was not *approved*.

**R104.11.1 Tests.** Where there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the *building official* shall have the authority to require tests as evidence of compliance to be made at no expense to the *jurisdiction*. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the *building official* shall approve the testing procedures. Tests shall be performed by an *approved* agency. Reports of such tests shall be retained by the *building official* for the period required for retention of public records.

## SECTION R105 PERMITS

**R105.1 Required.** Any *owner* or *owner's* authorized agent who intends to construct, enlarge, alter, *repair*, move, demolish or change the occupancy of a building or structure, or to erect, install, enlarge, alter, *repair*, remove, convert or replace any electrical, gas, mechanical or plumbing system, the installation of which is regulated by this code, or to cause any such work to be performed, shall first make application to the *building official* and obtain the required *permit*.

**R105.2 Work exempt from permit.** Exemption from *permit* requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this *jurisdiction*. *Permits* shall not be required for the following:

### Building:

1. Other than *storm shelters*, one-story detached *accessory structures*, provided that the floor area does not exceed 200 square feet (18.58 m<sup>2</sup>).
2. Fences not over 7 feet (2134 mm) high.
3. Retaining walls that are not over 4 feet (1219 mm) in height measured from the bottom of the footing



## SCOPE AND ADMINISTRATION

- to the top of the wall, unless supporting a surcharge.
4. Water tanks supported directly upon *grade* if the capacity does not exceed 5,000 gallons (18 927 L) and the ratio of height to diameter or width does not exceed 2 to 1.
  5. Sidewalks and driveways.
  6. Painting, papering, tiling, carpeting, cabinets, counter tops and similar finish work.
  7. Prefabricated swimming pools that are less than 24 inches (610 mm) deep.
  8. Swings and other playground equipment.
  9. Window awnings supported by an exterior wall that do not project more than 54 inches (1372 mm) from the exterior wall and do not require additional support.
  10. Decks not exceeding 200 square feet (18.58 m<sup>2</sup>) in area, that are not more than 30 inches (762 mm) above *grade* at any point, are not attached to a dwelling and do not serve the exit door required by Section R311.4.

### Electrical:

1. *Listed* cord-and-plug connected temporary decorative lighting.
2. Reinstallation of attachment plug receptacles but not the outlets therefor.
3. Replacement of branch circuit overcurrent devices of the required capacity in the same location.
4. Electrical wiring, devices, *appliances*, apparatus or *equipment* operating at less than 25 volts and not capable of supplying more than 50 watts of energy.
5. Minor repair work, including the replacement of lamps or the connection of *approved* portable electrical equipment to *approved* permanently installed receptacles.

### Gas:

1. Portable heating, cooking or clothes drying *appliances*.
2. Replacement of any minor part that does not alter approval of *equipment* or make such *equipment* unsafe.
3. Portable-fuel-cell *appliances* that are not connected to a fixed piping system and are not interconnected to a power grid.

### Mechanical:

1. Portable heating *appliances*.
2. Portable ventilation *appliances*.
3. Portable cooling units.
4. Steam, hot- or chilled-water piping within any heating or cooling *equipment* regulated by this code.

5. Replacement of any minor part that does not alter approval of *equipment* or make such *equipment* unsafe.
6. Portable evaporative coolers.
7. Self-contained refrigeration systems containing 10 pounds (4.54 kg) or less of refrigerant or that are actuated by motors of 1 horsepower (746 W) or less.
8. Portable-fuel-cell *appliances* that are not connected to a fixed piping system and are not interconnected to a power grid.

### Plumbing:

1. The stopping of leaks in drains, water, soil, waste or vent pipe; provided, however, that if any concealed trap, drainpipe, water, soil, waste or vent pipe becomes defective and it becomes necessary to remove and replace the same with new material, such work shall be considered as new work and a *permit* shall be obtained and inspection made as provided in this code.
2. The clearing of stoppages or the repairing of leaks in pipes, valves or fixtures, and the removal and reinstallation of water closets, provided such repairs do not involve or require the replacement or rearrangement of valves, pipes or fixtures.

**R105.2.1 Emergency repairs.** Where *equipment* replacements and repairs must be performed in an emergency situation, the *permit* application shall be submitted within the next working business day to the *building official*.

**R105.2.2 Repairs.** Application or notice to the *building official* is not required for ordinary repairs to structures, replacement of lamps or the connection of *approved* portable electrical equipment to *approved* permanently installed receptacles. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load-bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall ordinary repairs include *addition* to, *alteration* of, replacement or relocation of any water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

**R105.2.3 Public service agencies.** A *permit* shall not be required for the installation, *alteration* or *repair* of generation, transmission, distribution, metering or other related equipment that is under the ownership and control of public service agencies by established right.

**R105.3 Application for permit.** To obtain a *permit*, the applicant shall first file an application therefor in writing on a form furnished by the department of building safety for that purpose. Such application shall:

1. Identify and describe the work to be covered by the *permit* for which application is made.

2. Describe the land on which the proposed work is to be done by legal description, street address or similar description that will readily identify and definitely locate the proposed building or work.
3. Indicate the use and occupancy for which the proposed work is intended.
4. Be accompanied by *construction documents* and other information as required in Section R106.1.
5. State the valuation of the proposed work.
6. Be signed by the applicant or the applicant's authorized agent.
7. Give such other data and information as required by the *building official*.

**R105.3.1 Action on application.** The *building official* shall examine or cause to be examined applications for *permits* and amendments thereto within a reasonable time after filing. If the application or the *construction documents* do not conform to the requirements of pertinent laws, the *building official* shall reject such application in writing stating the reasons therefor. If the *building official* is satisfied that the proposed work conforms to the requirements of this code and laws and ordinances applicable thereto, the *building official* shall issue a *permit* therefor as soon as practicable.

**R105.3.1.1 Determination of substantially improved or substantially damaged existing buildings in flood hazard areas.** For applications for reconstruction, rehabilitation, *addition*, *alteration*, *repair* or other improvement of existing buildings or structures located in a flood hazard area as established by Table R301.2, the *building official* shall examine or cause to be examined the *construction documents* and shall make a determination with regard to the value of the proposed work. For buildings that have sustained damage of any origin, the value of the proposed work shall include the cost to repair the building or structure to its predamaged condition. If the *building official* finds that the value of proposed work equals or exceeds 50 percent of the market value of the building or structure before the damage has occurred or the improvement is started, the proposed work is a substantial improvement or *repair* of substantial damage and the building official shall require existing portions of the entire building or structure to meet the requirements of Section R322.

For the purpose of this determination, a substantial improvement shall mean any *repair*, reconstruction, rehabilitation, addition or improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the building or structure before the improvement or *repair* is started. Where the building or structure has sustained substantial damage, repairs necessary to restore the building or structure to its predamaged condition shall be considered substantial improvements regardless of the actual repair work

performed. The term shall not include either of the following:

1. Improvements to a building or structure that are required to correct existing health, sanitary or safety code violations identified by the building official and that are the minimum necessary to ensure safe living conditions.
2. Any *alteration* of a *historic building* or structure, provided that the *alteration* will not preclude the continued designation as a *historic building* or structure. For the purposes of this exclusion, a *historic building* shall be any of the following:
  - 2.1. Listed or preliminarily determined to be eligible for listing in the National Register of Historic Places.
  - 2.2. Determined by the Secretary of the US Department of Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined to qualify as an historic district.
  - 2.3. Designated as historic under a state or local historic preservation program that is approved by the Department of Interior.

**R105.3.2 Time limitation of application.** An application for a *permit* for any proposed work shall be deemed to have been abandoned 180 days after the date of filing unless such application has been pursued in good faith or a *permit* has been issued; except that the *building official* is authorized to grant one or more extensions of time for additional periods not exceeding 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.

**R105.4 Validity of permit.** The issuance or granting of a *permit* shall not be construed to be a *permit* for, or an *approval* of, any violation of any of the provisions of this code or of any other ordinance of the *jurisdiction*. *Permits* presuming to give authority to violate or cancel the provisions of this code or other ordinances of the *jurisdiction* shall not be valid. The issuance of a *permit* based on *construction documents* and other data shall not prevent the *building official* from requiring the correction of errors in the *construction documents* and other data. The *building official* is authorized to prevent occupancy or use of a structure where in violation of this code or of any other ordinances of this *jurisdiction*.

**R105.5 Expiration.** Every *permit* issued shall become invalid unless the work authorized by such *permit* is commenced within 180 days after its issuance or after commencement of work if more than 180 days pass between inspections. The building official is authorized to grant, in writing, one or more extensions of time, for periods not more

## SCOPE AND ADMINISTRATION

than 180 days each. The extension shall be requested in writing and justifiable cause demonstrated.

**R105.6 Suspension or revocation.** The *building official* is authorized to suspend or revoke a *permit* issued under the provisions of this code wherever the *permit* is issued in error or on the basis of incorrect, inaccurate or incomplete information, or in violation of any ordinance or regulation or any of the provisions of this code.

**R105.7 Placement of permit.** The building *permit* or a copy shall be kept on the site of the work until the completion of the project.

**R105.8 Responsibility.** It shall be the duty of every *person* who performs work for the installation or *repair* of building, structure, electrical, gas, mechanical or plumbing systems, for which this code is applicable, to comply with this code.

**R105.9 Preliminary inspection.** Before issuing a *permit*, the *building official* is authorized to examine or cause to be examined buildings, structures and sites for which an application has been filed.

## SECTION R106 CONSTRUCTION DOCUMENTS

**R106.1 Submittal documents.** Submittal documents consisting of *construction documents*, and other data shall be submitted in two or more sets, or in a digital format where allowed by the *building official*, with each application for a *permit*. The *construction documents* shall be prepared by a *registered design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed. Where special conditions exist, the *building official* is authorized to require additional *construction documents* to be prepared by a *registered design professional*.

**Exception:** The *building official* is authorized to waive the submission of *construction documents* and other data not required to be prepared by a *registered design professional* if it is found that the nature of the work applied for is such that reviewing of *construction documents* is not necessary to obtain compliance with this code.

**R106.1.1 Information on construction documents.** *Construction documents* shall be drawn upon suitable material. Electronic media documents are permitted to be submitted where *approved* by the *building official*. *Construction documents* shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules and regulations, as determined by the *building official*.

**R106.1.2 Manufacturer's installation instructions.** Manufacturer's installation instructions, as required by this code, shall be available on the job site at the time of inspection.

**R106.1.3 Information on braced wall design.** For buildings and structures utilizing braced wall design, and where required by the *building official*, *braced wall lines* shall be identified on the *construction documents*. Parti-

ment information including, but not limited to, bracing methods, location and length of *braced wall panels* and foundation requirements of *braced wall panels* at top and bottom shall be provided.

**R106.1.4 Information for construction in flood hazard areas.** For buildings and structures located in whole or in part in flood hazard areas as established by Table R301.2, *construction documents* shall include:

1. Delineation of flood hazard areas, floodway boundaries and flood zones and the design flood elevation, as appropriate.
2. The elevation of the proposed lowest floor, including *basement*; in areas of shallow flooding (AO Zones), the height of the proposed lowest floor, including *basement*, above the highest adjacent *grade*.
3. The elevation of the bottom of the lowest horizontal structural member in coastal high-hazard areas (V Zone) and in Coastal A Zones where such zones are delineated on flood hazard maps identified in Table R301.2 or otherwise delineated by the *jurisdiction*.
4. If design flood elevations are not included on the community's Flood Insurance Rate Map (FIRM), the *building official* and the applicant shall obtain and reasonably utilize any design flood elevation and floodway data available from other sources.

**R106.1.5 Information on storm shelters.** *Construction documents* for *storm shelters* shall include the information required in ICC 500.

**R106.2 Site plan or plot plan.** The *construction documents* submitted with the application for *permit* shall be accompanied by a site plan showing the size and location of new construction and existing structures on the site and distances from *lot lines*. In the case of demolition, the site plan shall show construction to be demolished and the location and size of existing structures and construction that are to remain on the site or plot. The *building official* is authorized to waive or modify the requirement for a site plan where the application for *permit* is for *alteration* or *repair* or where otherwise warranted.

**R106.3 Examination of documents.** The *building official* shall examine or cause to be examined *construction documents* for code compliance.

**R106.3.1 Approval of construction documents.** Where the *building official* issues a *permit*, the *construction documents* shall be *approved* in writing or by a stamp that states "REVIEWED FOR CODE COMPLIANCE." One set of *construction documents* so reviewed shall be retained by the *building official*. The other set shall be returned to the applicant, shall be kept at the site of work and shall be open to inspection by the *building official* or a duly authorized representative.

**R106.3.2 Previous approvals.** This code shall not require changes in the *construction documents*, construction or designated occupancy of a structure for which a lawful *permit* has been heretofore issued or otherwise



lawfully authorized, and the construction of which has been pursued in good faith within 180 days after the effective date of this code and has not been abandoned.

**R106.3.3 Phased approval.** The *building official* is authorized to issue a *permit* for the construction of foundations or any other part of a building or structure before the *construction documents* for the whole building or structure have been submitted, provided that adequate information and detailed statements have been filed complying with pertinent requirements of this code. The holder of such *permit* for the foundation or other parts of a building or structure shall proceed at the holder's own risk with the building operation and without assurance that a *permit* for the entire structure will be granted.

**R106.4 Amended construction documents.** Work shall be installed in accordance with the *approved construction documents*, and any changes made during construction that are not in compliance with the *approved construction documents* shall be resubmitted for approval as an amended set of *construction documents*.

**R106.5 Retention of construction documents.** One set of *approved construction documents* shall be retained by the *building official* for a period of not less than 180 days from date of completion of the permitted work, or as required by state or local laws.

## SECTION R107 TEMPORARY STRUCTURES AND USES

**R107.1 General.** The *building official* is authorized to issue a *permit* for temporary structures and temporary uses. Such *permits* shall be limited as to time of service, but shall not be permitted for more than 180 days. The *building official* is authorized to grant extensions for demonstrated cause.

**R107.2 Conformance.** Temporary structures and uses shall conform to the structural strength, fire safety, means of egress, light, *ventilation* and sanitary requirements of this code as necessary to ensure the public health, safety and general welfare.

**R107.3 Temporary power.** The *building official* is authorized to give permission to temporarily supply and use power in part of an electric installation before such installation has been fully completed and the final certificate of completion has been issued. The part covered by the temporary certificate shall comply with the requirements specified for temporary lighting, heat or power in NFPA 70.

**R107.4 Termination of approval.** The *building official* is authorized to terminate such *permit* for a temporary structure or use and to order the temporary structure or use to be discontinued.

## SECTION R108 FEES

**R108.1 Payment of fees.** A *permit* shall not be valid until the fees prescribed by law have been paid, nor shall an

amendment to a *permit* be released until the additional fee, if any, has been paid.

**R108.2 Schedule of permit fees.** On buildings, structures, electrical, gas, mechanical and plumbing systems or *alterations* requiring a *permit*, a fee for each *permit* shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

**R108.3 Building permit valuations.** Building *permit* valuation shall include total value of the work for which a *permit* is being issued, such as electrical, gas, mechanical, plumbing equipment and other permanent systems, including materials and labor.

**R108.4 Related fees.** The payment of the fee for the construction, *alteration*, removal or demolition for work done in connection to or concurrently with the work authorized by a building *permit* shall not relieve the applicant or holder of the *permit* from the payment of other fees that are prescribed by law.

**R108.5 Refunds.** The *building official* is authorized to establish a refund policy.

**R108.6 Work commencing before permit issuance.** Any *person* who commences work requiring a *permit* on a building, structure, electrical, gas, mechanical or plumbing system before obtaining the necessary *permits* shall be subject to a fee established by the applicable governing authority that shall be in addition to the required *permit* fees.

## SECTION R109 INSPECTIONS

**R109.1 Types of inspections.** For on-site construction, from time to time the *building official*, upon notification from the *permit* holder or his agent, shall make or cause to be made any necessary inspections and shall either approve that portion of the construction as completed or shall notify the *permit* holder or his or her agent wherein the same fails to comply with this code.

**R109.1.1 Foundation inspection.** Inspection of the foundation shall be made after poles or piers are set or trenches or *basement* areas are excavated and any required forms erected and any required reinforcing steel is in place and supported prior to the placing of concrete. The foundation inspection shall include excavations for thickened slabs intended for the support of bearing walls, partitions, structural supports, or equipment and special requirements for wood foundations.

**R109.1.2 Plumbing, mechanical, gas and electrical systems inspection.** Rough inspection of plumbing, mechanical, gas and electrical systems shall be made prior to covering or concealment, before fixtures or *appliances* are set or installed, and prior to framing inspection.

**Exception:** Backfilling of ground-source heat pump loop systems tested in accordance with Section M2105.28 prior to inspection shall be permitted.

**R109.1.3 Floodplain inspections.** For construction in flood hazard areas as established by Table R301.2, upon



## SCOPE AND ADMINISTRATION

placement of the lowest floor, including *basement*, and prior to further vertical construction, the *building official* shall require submission of documentation, prepared and sealed by a *registered design professional*, of the elevation of the lowest floor, including *basement*, required in Section R322.

**R109.1.4 Frame and masonry inspection.** Inspection of framing and masonry construction shall be made after the roof, masonry, framing, firestopping, draftstopping and bracing are in place and after the plumbing, mechanical and electrical rough inspections are *approved*.

**R109.1.5 Other inspections.** In addition to inspections in Sections R109.1.1 through R109.1.4, the *building official* shall have the authority to make or require any other inspections to ascertain compliance with this code and other laws enforced by the *building official*.

**R109.1.5.1 Fire-resistance-rated construction inspection.** Where fire-resistance-rated construction is required between *dwelling units* or due to location on property, the *building official* shall require an inspection of such construction after lathing or gypsum board or gypsum panel products are in place, but before any plaster is applied, or before board or panel joints and fasteners are taped and finished.

**R109.1.6 Final inspection.** Final inspection shall be made after the permitted work is complete and prior to occupancy.

**R109.1.6.1 Elevation documentation.** If located in a flood hazard area, the documentation of elevations required in Section R322.1.10 shall be submitted to the *building official* prior to the final inspection.

**R109.2 Inspection agencies.** The *building official* is authorized to accept reports of *approved* agencies, provided such agencies satisfy the requirements as to qualifications and reliability.

**R109.3 Inspection requests.** It shall be the duty of the *permit* holder or their agent to notify the *building official* that such work is ready for inspection. It shall be the duty of the *person* requesting any inspections required by this code to provide access to and means for inspection of such work.

**R109.4 Approval required.** Work shall not be done beyond the point indicated in each successive inspection without first obtaining the approval of the *building official*. The *building official*, upon notification, shall make the requested inspections and shall either indicate the portion of the construction that is satisfactory as completed, or shall notify the *permit* holder or an agent of the *permit* holder wherein the same fails to comply with this code. Any portions that do not comply shall be corrected and such portion shall not be covered or concealed until authorized by the *building official*.

## SECTION R110 CERTIFICATE OF OCCUPANCY

**R110.1 Use and change of occupancy.** A building or structure shall not be used or occupied in whole or in part, and a

*change of occupancy* of a building or structure or portion thereof shall not be made, until the *building official* has issued a certificate of occupancy therefor as provided herein. Issuance of a certificate of occupancy shall not be construed as an approval of a violation of the provisions of this code or of other ordinances of the *jurisdiction*. Certificates presuming to give authority to violate or cancel the provisions of this code or other ordinances of the *jurisdiction* shall not be valid.

### Exceptions:

1. Certificates of occupancy are not required for work exempt from *permits* under Section R105.2.
2. Accessory buildings or structures.

**R110.2 Change in use.** Changes in the character or use of an existing structure shall not be made except as specified in Sections 506 and 507 of the *International Existing Building Code*.

**R110.3 Certificate issued.** After the *building official* inspects the building or structure and does not find violations of the provisions of this code or other laws that are enforced by the department, the *building official* shall issue a certificate of occupancy containing the following:

1. The *permit* number.
2. The address of the structure.
3. The name and address of the *owner* or the owner's authorized agent.
4. A description of that portion of the structure for which the certificate is issued.
5. A statement that the described portion of the structure has been inspected for compliance with the requirements of this code.
6. The name of the *building official*.
7. The edition of the code under which the *permit* was issued.
8. Where an automatic sprinkler system is provided and whether the sprinkler system is required.
9. Any special stipulations and conditions of the building *permit*.

**R110.4 Temporary occupancy.** The *building official* is authorized to issue a temporary certificate of occupancy before the completion of the entire work covered by the *permit*, provided that such portion or portions shall be occupied safely. The *building official* shall set a time period during which the temporary certificate of occupancy is valid.

**R110.5 Revocation.** The *building official* is authorized to suspend or revoke a certificate of occupancy issued under the provisions of this code, in writing, wherever the certificate is issued in error, or on the basis of incorrect information supplied, or where it is determined that the building or structure or portion thereof is in violation of the provisions of this code or other ordinance of the *jurisdiction*.

## SECTION R111 SERVICE UTILITIES

**R111.1 Connection of service utilities.** A *person* shall not make connections from a utility, a source of energy, fuel, or power to any building or system that is regulated by this code for which a *permit* is required, until *approved* by the *building official*.

**R111.2 Temporary connection.** The *building official* shall have the authority to authorize the temporary connection of the building or system to the utility, source of energy, fuel or power.

**R111.3 Authority to disconnect service utilities.** The *building official* shall have the authority to authorize disconnection of utility service to the building, structure or system regulated by this code and the referenced codes and standards set forth in Section R102.4 in case of emergency where necessary to eliminate an immediate hazard to life or property or where such utility connection has been made without the approval required by Section R111.1 or R111.2. The *building official* shall notify the serving utility and where possible the *owner* or the owner's authorized agent and occupant of the building, structure or service system of the decision to disconnect prior to taking such action. If not notified prior to disconnection, the *owner*, the owner's authorized agent or occupant of the building, structure or service system shall be notified in writing as soon as practical thereafter.

## SECTION R112 BOARD OF APPEALS

**R112.1 General.** In order to hear and decide appeals of orders, decisions or determinations made by the *building official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. The *building official* shall be an ex officio member of said board but shall not have a vote on any matter before the board. The board of appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render decisions and findings in writing to the appellant with a duplicate copy to the *building official*.

**R112.2 Limitations on authority.** An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an equally good or better form of construction is proposed. The board shall not have authority to waive requirements of this code.

**R112.3 Qualifications.** The board of appeals shall consist of members who are qualified by experience and training to pass judgment on matters pertaining to building construction and are not employees of the *jurisdiction*.

**R112.4 Administration.** The *building official* shall take immediate action in accordance with the decision of the board.

## SECTION R113 VIOLATIONS

**R113.1 Unlawful acts.** It shall be unlawful for any *person*, firm or corporation to erect, construct, alter, extend, *repair*, move, remove, demolish or occupy any building, structure or equipment regulated by this code, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

**R113.2 Notice of violation.** The *building official* is authorized to serve a notice of violation or order on the *person* responsible for the erection, construction, *alteration*, extension, *repair*, moving, removal, demolition or occupancy of a building or structure in violation of the provisions of this code, or in violation of a detail statement or a plan *approved* thereunder, or in violation of a *permit* or certificate issued under the provisions of this code. Such order shall direct the discontinuance of the illegal action or condition and the abatement of the violation.

**R113.3 Prosecution of violation.** If the notice of violation is not complied with in the time prescribed by such notice, the *building official* is authorized to request the legal counsel of the *jurisdiction* to institute the appropriate proceeding at law or in equity to restrain, correct or abate such violation, or to require the removal or termination of the unlawful occupancy of the building or structure in violation of the provisions of this code or of the order or direction made pursuant thereto.

**R113.4 Violation penalties.** Any *person* who violates a provision of this code or fails to comply with any of the requirements thereof or who erects, constructs, alters or repairs a building or structure in violation of the *approved construction documents* or directive of the *building official*, or of a *permit* or certificate issued under the provisions of this code, shall be subject to penalties as prescribed by law.

## SECTION R114 STOP WORK ORDER

**R114.1 Authority.** Where the *building official* finds any work regulated by this code being performed in a manner contrary to the provisions of this code or in a dangerous or unsafe manner, the *building official* is authorized to issue a stop work order.

**R114.2 Issuance.** The stop work order shall be in writing and shall be given to the *owner* of the property, the owner's authorized agent or the *person* performing the work. Upon issuance of a stop work order, the cited work shall immediately cease. The stop work order shall state the reason for the order and the conditions under which the cited work is authorized to resume.

**R114.3 Emergencies.** Where an emergency exists, the *building official* shall not be required to give a written notice prior to stopping the work.

**R114.4 Failure to comply.** Any *person* who shall continue any work after having been served with a stop work order, except such work as that *person* is directed to perform to remove a violation or unsafe condition, shall be subject to fines established by the authority having jurisdiction.



## Part II—Definitions

### CHAPTER 2 DEFINITIONS

#### User notes:

**About this chapter:** Codes, by their very nature, are technical documents. Every word, term and punctuation mark can add to or change the meaning of a technical requirement. It is necessary to maintain a consensus on the specific meaning of each term contained in the code. Chapter 2 performs this function by stating clearly what specific terms mean for the purpose of the code.

**Code development reminder:** Code change proposals to definitions in this chapter preceded by a bracketed letter are considered by the IRC—Building Code Development Committee [RB], the IRC—Mechanical/Plumbing Code Development Committee [MP] or the IECC—Residential Code Development Committee [RE] during the Group B (2022) Code Development Cycle.

#### SECTION R201 GENERAL

**R201.1 Scope.** Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, have the meanings indicated in this chapter.

**R201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

**R201.3 Terms defined in other codes.** Where terms are not defined in this code such terms shall have the meanings ascribed in other code publications of the International Code Council.

**R201.4 Terms not defined.** Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

#### SECTION R202 DEFINITIONS

**[RE] ABOVE-GRADE WALL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ACCESS (TO).** That which enables a device, an *appliance* or equipment to be reached by *ready access* or by a means that first requires the removal or movement of a panel, door or similar obstruction.

**[RB] ACCESSORY STRUCTURE.** A structure that is accessory to and incidental to that of the *dwelling(s)* and that is located on the same *lot*.

**[RB] ADDITION.** An extension or increase in floor area, number of stories or height of a building or structure. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ADHERED STONE OR MASONRY VENEER.** Stone or masonry veneer secured and supported through the adhesion of an *approved* bonding material applied to an *approved* backing.

**[MP] AIR ADMITTANCE VALVE.** A one-way valve designed to allow air into the plumbing drainage system where a negative pressure develops in the piping. This device shall close by gravity and seal the terminal under conditions of zero differential pressure (no flow conditions) and under positive internal pressure.

**[RE] AIR BARRIER.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] AIR BREAK (DRAINAGE SYSTEM).** An arrangement where a discharge pipe from a fixture, *appliance* or device drains indirectly into a receptor below the flood-level rim of the receptor and above the trap seal.

**[MP] AIR CIRCULATION, FORCED.** A means of providing space conditioning utilizing movement of air through ducts or plenums by mechanical means.

**[MP] AIR GAP, DRAINAGE SYSTEM.** The unobstructed vertical distance through free atmosphere between the outlet of a waste pipe and the flood-level rim of the fixture or receptor into which it is discharging.

**[MP] AIR GAP, WATER-DISTRIBUTION SYSTEM.** The unobstructed vertical distance through free atmosphere between the lowest opening from a water supply discharge to the flood-level rim of a plumbing fixture.

**[MP] AIR-CONDITIONING SYSTEM.** A system that consists of heat exchangers, blowers, filters, supply, exhaust and return-air systems, and shall include any apparatus installed in connection therewith.

**[RB] AIR-IMPERMEABLE INSULATION.** An insulation having an air permeance equal to or less than 0.02 L/s-m<sup>2</sup> at 75 Pa pressure differential as tested in accordance with ASTM E283 or E2178.

**[RB] ALTERATION.** Any construction, retrofit or renovation to an existing structure other than *repair* or *addition* that requires a *permit*. Also, a change in a building, electrical, gas, mechanical or plumbing system that involves an extension, *addition* or change to the arrangement, type or purpose of the original installation that requires a *permit*. For the definition applicable in Chapter 11, see Section N1101.6.



## DEFINITIONS

**[RB] ALTERNATING TREAD DEVICE.** A device that has a series of steps between 50 and 70 degrees (0.87 and 1.22 rad) from horizontal, usually attached to a center support rail in an alternating manner so that the user does not have both feet on the same level at the same time.

**[RB] ANCHORED STONE OR MASONRY VENEER.** Stone or masonry veneer secured with *approved* mechanical fasteners to an *approved* backing.

**[MP] ANCHORS.** See “*Supports*.”

**[MP] ANTISIPHON.** A term applied to valves or mechanical devices that eliminate siphonage.

**[MP] APPLIANCE.** A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

**[RB] APPROVED.** Acceptable to the *building official*.

**[RB] APPROVED AGENCY.** An established and recognized agency that is regularly engaged in conducting tests, furnishing inspection services or furnishing product certification, and has been *approved* by the building official.

**[MP] APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

**[RB] ASPECT RATIO.** The ratio of longest to shortest perpendicular dimensions, or for wall sections, the ratio of height to length.

**[RB] ATTIC.** The unfinished space between the ceiling assembly and the *roof assembly*.

**[RB] ATTIC, HABITABLE.** A finished or unfinished *habitable space* within an attic.

**[RE] AUTOMATIC.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] BACKFLOW, DRAINAGE.** A reversal of flow in the drainage system.

**[MP] BACKFLOW, WATER DISTRIBUTION.** The flow of water or other liquids into the potable water-supply piping from any sources other than its intended source. Back-siphonage is one type of backflow.

**[MP] BACKFLOW PREVENTER.** A backflow prevention assembly, a backflow prevention device or other means or method to prevent backflow into the potable water supply.

**[MP] BACKFLOW PREVENTER, REDUCED-PRESSURE-ZONE TYPE.** A backflow-prevention device consisting of two independently acting check valves, internally force loaded to a normally closed position and separated by an intermediate chamber (or zone) in which there is an automatic relief means of venting to atmosphere internally loaded to a normally open position between two tightly closing shutoff valves and with means for testing for tightness of the checks and opening of relief means.

**[MP] BACKPRESSURE.** Pressure created by any means in the water distribution system that by being in excess of the pressure in the water supply mains causes a potential back-flow condition.

**[MP] BACKPRESSURE, LOW HEAD.** A pressure less than or equal to 4.33 psi (29.88 kPa) or the pressure exerted by a 10-foot (3048 mm) column of water.

**[MP] BACKSIPHONAGE.** The flowing back of used or contaminated water from piping into a potable water-supply pipe due to a negative pressure in such pipe.

**[MP] BACKWATER VALVE.** A device installed in a drain or pipe to prevent backflow of sewage.

**[MP] BALANCED VENTILATION.** Any combination of concurrently operating mechanical exhaust and mechanical supply whereby the total mechanical exhaust airflow rate is within 10 percent of the total mechanical supply airflow rate.

**[MP] BALANCED VENTILATION SYSTEM.** A ventilation system where the total supply airflow and total exhaust airflow are simultaneously within 10 percent of their averages. The balanced ventilation system airflow is the average of the supply and exhaust airflows.

**[RB] BASEMENT.** A *story* that is not a *story above grade plane* (see “*Story above grade plane*”).

**[RE] BASEMENT WALL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] BASIC WIND SPEED.** Three-second gust speed at 33 feet (10 058 mm) above the ground in Exposure C (see Section R301.2.1) as given in Figure R301.2(5)A.

**[MP] BATHROOM GROUP.** A group of fixtures, including or excluding a bidet, consisting of a water closet, lavatory, and bathtub or shower. Such fixtures are located together on the same floor level.

**[MP] BEND.** A drainage fitting, designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line (see “*Elbow*” and “*Sweep*”).

**[MP] BOILER.** A self-contained *appliance* from which hot water is circulated for heating purposes and then returned to the boiler, and that operates at water pressures not exceeding 160 pounds per square inch gage (psig) (1102 kPa gauge) and at water temperatures not exceeding 250°F (121°C).

**[RB] BOND BEAM.** A horizontal grouted element within masonry in which reinforcement is embedded.

**[RB] BRACED WALL LINE.** A straight line through the building plan that represents the location of the lateral resistance provided by the wall bracing.

**[RB] BRACED WALL LINE, CONTINUOUSLY SHEATHED.** A *braced wall line* with structural sheathing applied to all sheathable surfaces including the areas above and below openings.

**[RB] BRACED WALL PANEL.** A full-height section of wall constructed to resist in-plane shear loads through interaction of framing members, sheathing material and anchors. The panel’s length meets the requirements of its particular bracing method, and contributes toward the total amount of bracing required along its *braced wall line* in accordance with Section R602.10.1.

**[MP] BRANCH.** Any part of the piping system other than a riser, main or stack.

**[MP] BRANCH, FIXTURE.** See “*Fixture branch, drainage.*”

**[MP] BRANCH, HORIZONTAL.** See “*Horizontal branch, drainage.*”

**[MP] BRANCH, MAIN.** A water-distribution pipe that extends horizontally off a main or riser to convey water to branches or fixture groups.

**[MP] BRANCH, VENT.** A vent connecting two or more individual vents with a vent stack or stack vent.

**[MP] BRANCH INTERVAL.** A vertical measurement of distance, 8 feet (2438 mm) or more in *developed length*, between the connections of *horizontal* branches to a drainage stack. Measurements are taken down the stack from the highest *horizontal* branch connection.

**[MP] BTU/H.** The *listed* maximum capacity of an *appliance*, absorption unit or burner expressed in British thermal units input per hour.

**[RB] BUILDING.** Any one- or two-family dwelling or *town-house*, or portion thereof, used or intended to be used for human habitation, for living, sleeping, cooking or eating purposes, or any combination thereof, or any *accessory structure*. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] BUILDING, EXISTING.** Existing building is a building erected prior to the adoption of this code, or one for which a legal building *permit* has been issued.

**[MP] BUILDING DRAIN.** The lowest piping that collects the discharge from all other drainage piping inside the house and extends 30 inches (762 mm) in *developed length* of pipe, beyond the exterior walls and conveys the drainage to the *building sewer*.

**[RB] BUILDING LINE.** The line established by law, beyond which a building shall not extend, except as specifically provided by law.

**[RB] BUILDING OFFICIAL.** The officer or other designated authority charged with the administration and enforcement of this code, or a duly authorized representative. For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] BUILDING SEWER.** That part of the drainage system that extends from the end of the *building drain* and conveys its discharge to a public sewer, private sewer, individual sewage-disposal system or other point of disposal.

**[RE] BUILDING SITE.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] BUILDING THERMAL ENVELOPE.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] BUILDING-INTEGRATED PHOTOVOLTAIC PRODUCT.** A building product that incorporates *photovoltaic modules* and functions as a component of the building envelope.

**[RB] BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL (BIPV Roof Panel).** A *photovoltaic panel* that functions as a component of the building envelope.

**[RB] BUILT-UP ROOF COVERING.** Two or more layers of felt cemented together and surfaced with a cap sheet, mineral aggregate, smooth coating or similar surfacing material.

**[RB] CAP PLATE.** The top plate of the double top plates used in *structural insulated panel* (SIP) construction. The cap plate is cut to match the *panel thickness* such that it overlaps the wood structural panel facing on both sides.

**[RB] CARBON MONOXIDE ALARM.** A single- or multiple-station alarm intended to detect carbon monoxide gas and alert occupants by a distinct audible signal. It incorporates a sensor, control components and an alarm notification appliance in a single unit.

**[RB] CARBON MONOXIDE DETECTOR.** A device with an integral sensor to detect carbon monoxide gas and transmit an alarm signal to a connected alarm control unit.

**[RB] CEILING HEIGHT.** The clear vertical distance from the finished floor to the finished ceiling.

**[RB] CEMENT PLASTER.** A mixture of Portland or blended cement, Portland cement or blended cement and hydrated lime, masonry cement or plastic cement and aggregate and other *approved* materials as specified in this code.

**[RB] CHANGE OF OCCUPANCY.** A change in the use of a building or portion of a building that involves a change in the application of the requirements of this code.

**[MP] CHIMNEY.** A primary vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning *appliance* to the outside atmosphere.

**[MP] CHIMNEY CONNECTOR.** A pipe that connects a fuel-burning *appliance* to a chimney.

**[MP] CHIMNEY TYPES.**

**Residential-type appliance.** An *approved* chimney for removing the products of combustion from fuel-burning, residential-type *appliances* producing combustion gases not in excess of 1,000°F (538°C) under normal operating conditions, and capable of producing combustion gases of 1,400°F (760°C) during intermittent forces firing for periods up to 1 hour. All temperatures shall be measured at the *appliance* flue outlet. Residential-type *appliance* chimneys include masonry and factory-built types.

**[MP] CIRCUIT VENT.** A vent that connects to a horizontal drainage branch and vents two traps to not more than eight traps or trapped fixtures connected into a battery.

**[MP] CIRCULATING HOT WATER SYSTEM.** A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to fixtures and back to the water-heating equipment. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] CLADDING.** The exterior materials that cover the surface of the building envelope that is directly loaded by the wind.

## DEFINITIONS

**[MP] CLEANOUT.** An access opening in the drainage system utilized for the removal of obstructions. Types of cleanouts include a removable plug or cap, and a removable fixture or fixture trap.

**[RE] CLIMATE ZONE.** A geographical region based on climatic criteria as specified in this code. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] CLOSET.** A small room or chamber used for storage.

**[RB] COLLAPSIBLE SOILS.** Soils that exhibit volumetric reduction in response to partial or full wetting under load.

**[MP] COLLECTION PIPE.** Unpressurized pipe used within the collection system that drains on-site nonpotable water or rainwater to a storage tank by gravity.

**[MP] COMBINATION WASTE AND VENT SYSTEM.** A specially designed system of waste piping embodying the horizontal wet venting of one or more sinks, lavatories or floor drains by means of a common waste and vent pipe adequately sized to provide free movement of air above the flow line of the drain.

**[RB] COMBUSTIBLE MATERIAL.** Any material not defined as noncombustible.

**[MP] COMBUSTION AIR.** The air provided to fuel-burning equipment including air for fuel combustion, draft hood dilution and *ventilation* of the equipment enclosure.

**[MP] COMMON VENT.** A single pipe venting two trap arms within the same *branch interval*, either back-to-back or one above the other.

**[RB] COMPRESSIBLE SOILS.** Soils that exhibit volumetric reduction in response to the application of load even in the absence of wetting or drying.

**[MP] CONDENSATE.** The liquid that separates from a gas due to a reduction in temperature; for example, water that condenses from flue gases and water that condenses from air circulating through the cooling coil in air conditioning equipment.

**[MP] CONDENSING APPLIANCE.** An *appliance* that condenses water generated by the burning of fuels.

**[RB] CONDITIONED AIR.** Air treated to control its temperature, relative humidity or quality.

**[RE] CONDITIONED FLOOR AREA.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] CONDITIONED SPACE.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] CONSTRUCTION DOCUMENTS.** Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*. Construction drawings shall be drawn to an appropriate scale.

**[MP] CONTAMINATION.** A high-hazard or health-hazard impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids or waste.

**[RE] CONTINUOUS AIR BARRIER.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] CONTINUOUS INSULATION (ci).** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] CONTINUOUS WASTE.** A drain from two or more similar adjacent fixtures connected to a single trap.

**[MP] CONTROL, LIMIT.** An automatic control responsive to changes in liquid flow or level, pressure, or temperature for limiting the operation of an *appliance*.

**[MP] CONTROL, PRIMARY SAFETY.** A safety control responsive directly to flame properties that senses the presence or absence of flame and, in event of ignition failure or unintentional flame extinguishment, automatically causes shutdown of mechanical equipment.

**[MP] CONVECTOR.** A system incorporating a heating element in an enclosure in which air enters an opening below the heating element, is heated and leaves the enclosure through an opening located above the heating element.

**[RB] CORE.** The lightweight middle section of a *structural insulated panel*, composed of foam plastic insulation, that provides the link between the two facing shells.

**[RB] CORROSION RESISTANCE.** The ability of a material to withstand deterioration of its surface or its properties where exposed to its environment.

**[RB] COURT.** A space, open and unobstructed to the sky, located at or above *grade* level on a *lot* and bounded on three or more sides by walls or a building.

**[RB] CRAWL SPACE.** An underfloor space that is not a *basement*.

**[RE] CRAWL SPACE WALL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] CRIPPLE WALL.** A framed wall extending from the top of the foundation to the underside of the floor framing of the first *story above grade plane*.

**[RB] CRIPPLE WALL CLEAR HEIGHT.** The vertical height of a *cripple wall* from the top of the foundation to the underside of floor framing above.

**[MP] CROSS CONNECTION.** Any connection between two otherwise separate piping systems that allows a flow from one system to the other.

**[RB] CROSS-LAMINATED TIMBER.** A prefabricated engineered wood product consisting of not less than three layers of solid-sawn lumber or *structural composite lumber* where the adjacent layers are cross-oriented and bonded with structural adhesive to form a solid wood element.

**[RE] CURTAIN WALL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] DALLE GLASS.** A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

**[MP] DAMPER, VOLUME.** A device that will restrict, retard or direct the flow of air in any duct, or the products of combustion of heat-producing equipment, vent connector, vent or chimney.



## DEFINITIONS

**[RB] DEAD LOADS.** The weight of the materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, *stairways*, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and fixed service equipment.

**[RB] DECORATIVE GLASS.** A carved, leaded or Dalle glass or glazing material with a purpose that is decorative or artistic, not functional; with coloring, texture or other design qualities or components that cannot be removed without destroying the glazing material; and with a surface, or assembly into which it is incorporated, that is divided into segments.

**[RE] DEMAND RECIRCULATION WATER SYSTEM.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] DESIGN PROFESSIONAL.** See “*Registered design professional*.”

**[MP] DEVELOPED LENGTH.** The length of a pipeline measured along the center line of the pipe and fittings.

**[MP] DIAMETER.** Unless specifically stated, the term “diameter” is the nominal diameter as designated by the *approved* material standard.

**[RB] DIAPHRAGM.** A horizontal or nearly horizontal system acting to transmit lateral forces to the vertical resisting elements. Where the term “*diaphragm*” is used, it includes horizontal bracing systems.

**[MP] DILUTION AIR.** Air that enters a draft hood or draft regulator and mixes with flue gases.

**[MP] DIRECT SYSTEM.** A solar thermal system in which the gas or liquid in the solar collector loop is not separated from the load.

**[MP] DIRECT-VENT APPLIANCE.** A fuel-burning *appliance* with a sealed combustion system that draws all air for combustion from the outside atmosphere and discharges all flue gases to the outside atmosphere.

**[MP] DRAFT.** The pressure difference existing between the *appliance* or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the *appliance* to the atmosphere.

**Induced draft.** The pressure difference created by the action of a fan, blower or ejector, that is located between the *appliance* and the chimney or vent termination.

**Natural draft.** The pressure difference created by a vent or chimney because of its height, and the temperature difference between the flue gases and the atmosphere.

**[MP] DRAFT HOOD.** A device built into an *appliance*, or a part of the vent connector from an *appliance*, that is designed to provide for the ready escape of the flue gases from the *appliance* in the event of no draft, backdraft or stoppage beyond the draft hood; prevent a backdraft from entering the *appliance*; and neutralize the effect of stack action of the chimney or gas vent on the operation of the *appliance*.

**[MP] DRAFT REGULATOR.** A device that functions to maintain a desired draft in the *appliance* by automatically reducing the draft to the desired value.

**[RB] DRAFT STOP.** A material, device or construction installed to restrict the movement of air within open spaces of concealed areas of building components such as crawl spaces, floor-ceiling assemblies, roof-ceiling assemblies and *attics*.

**[MP] DRAIN.** Any pipe that carries soil and waterborne wastes in a building drainage system.

**[MP] DRAINAGE FITTING.** A pipe fitting designed to provide connections in the drainage system that have provisions for establishing the desired slope in the system. These fittings are made from a variety of both metals and plastics. The methods of coupling provide for required slope in the system.

**[MP] DRAIN-BACK SYSTEM.** A solar thermal system in which the fluid in the solar collector loop is drained from the collector into a holding tank under prescribed circumstances.

**[RE] DUCT.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] DUCT SYSTEM.** A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling *equipment* and *appliances*.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] DWELLING.** Any building that contains one or two *dwelling units* used, intended, or designed to be built, used, rented, leased, let or hired out to be occupied, or that are occupied for living purposes.

**[RB] DWELLING UNIT.** A single unit providing complete independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation. For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] DWV.** Abbreviated term for drain, waste and vent piping as used in common plumbing practice.

**[MP] EFFECTIVE OPENING.** The minimum cross-sectional area at the point of water-supply discharge, measured or expressed in terms of diameter of a circle and if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable to *air gap*.)

**[MP] ELBOW.** A pressure pipe fitting designed to provide an exact change in direction of a pipe run. An elbow provides a sharp turn in the flow path (see “*Bend*” and “*Sweep*”).

**[RB] EMERGENCY ESCAPE AND RESCUE OPENING.** An operable exterior window, door or other similar device that provides for a means of escape and access for rescue in the event of an emergency. (See also “*Grade floor emergency escape and rescue opening*.”)

**[RE] ENERGY ANALYSIS.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] ENERGY COST.** For the definition applicable in Chapter 11, see Section N1101.6.



## DEFINITIONS

**[RE] ENERGY SIMULATION TOOL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ENERGY STORAGE SYSTEMS (ESS).** One device or multiple devices, assembled together, capable of storing electrical energy to be supplied at a future time.

**[RB] ENGINEERED WOOD RIM BOARD.** A full-depth *structural composite lumber*, wood structural panel, structural glued laminated timber or prefabricated wood I-joist member designed to transfer horizontal (shear) and vertical (compression) loads, provide attachment for *diaphragm* sheathing, siding and exterior deck ledgers and provide lateral support at the ends of floor or roof joists or rafters.

**[MP] EQUIPMENT.** Piping, ducts, vents, control devices and other components of systems other than *appliances* that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

**[MP] EQUIVALENT LENGTH.** For determining friction losses in a piping system, the effect of a particular fitting equal to the friction loss through a straight piping length of the same nominal diameter.

**[RE] ERI REFERENCE DESIGN.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ESCARPMENT.** With respect to topographic wind effects, a cliff or steep slope generally separating two levels or gently sloping areas.

**[MP] ESSENTIALLY NONTOXIC TRANSFER FLUIDS.** Fluids having a Gosselin rating of 1, including propylene glycol; mineral oil; polydimethyl oil oxane; hydrochlorofluorocarbon, chlorofluorocarbon and hydrofluorocarbon refrigerants; and FDA-approved boiler water additives for steam boilers.

**[MP] ESSENTIALLY TOXIC TRANSFER FLUIDS.** Soil, water or graywater and fluids having a Gosselin rating of 2 or more including ethylene glycol, hydrocarbon oils, ammonia refrigerants and hydrazine.

**[MP] EVAPORATIVE COOLER.** A device used for reducing air temperature by the process of evaporating water into an airstream.

**[MP] EXCESS AIR.** Air that passes through the combustion chamber and the *appliance* flue in excess of what is theoretically required for complete combustion.

**[MP] EXHAUST HOOD, FULL OPENING.** An exhaust hood with an opening not less than the diameter of the connecting vent.

**[MP] EXISTING INSTALLATIONS.** Any plumbing system regulated by this code that was legally installed prior to the effective date of this code, or for which a *permit* to install has been issued.

**[RB] EXPANSIVE SOILS.** Soils that exhibit volumetric increase or decrease (swelling or shrinking) in response to partial or full wetting or drying under load.

**[RB] EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS).** EIFS are nonstructural, nonload-bearing exterior wall cladding systems that consist of an insulation board attached either adhesively or mechanically, or both, to the substrate; an integrally reinforced base coat; and a textured protective finish coat.

**[RB] EXTERIOR INSULATION AND FINISH SYSTEMS (EIFS) WITH DRAINAGE.** An EIFS that incorporates a means of drainage applied over a *water-resistive barrier*.

**[RB] EXTERIOR WALL.** An above-grade wall that defines the exterior boundaries of a building. Includes between-floor spandrels, peripheral edges of floors, roof and basement knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and *basement walls* with an average below-grade wall area that is less than 50 percent of the total opaque and nonopaque area of that enclosing side.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] EXTERIOR WALL COVERING.** A material or assembly of materials applied on the exterior side of exterior walls for the purpose of providing a weather-resistive barrier, insulation or for aesthetics, including but not limited to, veneers, siding, exterior insulation and finish systems, architectural *trim* and embellishments such as cornices, soffits, and fascias.

**[RB] FACING.** The wood structural panel facings that form the two outmost rigid layers of the *structural insulated panel*.

**[MP] FACTORY-BUILT CHIMNEY.** A *listed* and *labeled* chimney composed of factory-made components assembled in the field in accordance with the manufacturer's instructions and the conditions of the *listing*.

**[MP] FACTORY-MADE AIR DUCT.** A *listed* and *labeled* duct manufactured in a factory and assembled in the field in accordance with the manufacturer's instructions and conditions of the *listing*.

**[RE] FENESTRATION.** Products classified as either vertical fenestration or *skylights and sloped glazing*, installed in such a manner as to preserve the weather-resistant barrier of the wall or roof in which they are installed. Fenestration includes products with glass or other transparent or translucent materials.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] FENESTRATION, VERTICAL.** Windows that are fixed or movable, opaque doors, glazed doors, glazed block and combination opaque and glazed doors installed in a wall at less than 15 degrees (0.26 rad) from vertical.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] FENESTRATION PRODUCT, SITE-BUILT.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] FIBER-CEMENT (BACKERBOARD, SIDING, SOFFIT, TRIM AND UNDERLAYMENT) PRODUCTS.** Manufactured thin section composites of hydraulic cementitious matrices and discrete nonasbestos fibers.

**[RB] FIRE SEPARATION DISTANCE.** The distance measured from the building face to one of the following:

1. To the closest interior *lot line*.
2. To the centerline of a street, an alley or public way.
3. To an imaginary line between two buildings on the *lot*.

The distance shall be measured at a right angle from the face of the wall.

**[RB] FIREBLOCKING.** Building materials or materials *approved* for use as fireblocking, installed to resist the free passage of flame to other areas of the building through concealed spaces.

**[RB] FIREPLACE.** An assembly consisting of a hearth and fire chamber of *noncombustible material* and provided with a chimney, for use with solid fuels.

**[MP] FIREPLACE STOVE.** A free-standing, chimney-connected solid-fuel-burning heater designed to be operated with the fire chamber doors in either the open or closed position.

**[RB] FIREPLACE THROAT.** The opening between the top of the firebox and the smoke chamber.

**[RB] FIRE-RETARDANT-TREATED WOOD.** Wood products that, when impregnated with chemicals by a pressure process or other means during manufacture, exhibit reduced surface burning characteristics and resist propagation of fire.

**Other means during manufacture.** A process where the wood raw material is treated with a fire-retardant formulation while undergoing creation as a finished product.

**Pressure process.** A process for treating wood using an initial vacuum followed by the introduction of pressure above atmospheric.

**[MP] FIXTURE.** See “*Plumbing fixture*.”

**[MP] FIXTURE BRANCH, DRAINAGE.** A drain serving two or more fixtures that discharges into another portion of the drainage system.

**[MP] FIXTURE BRANCH, WATER-SUPPLY.** A water-supply pipe between the fixture supply and a main water-distribution pipe or fixture group main.

**[MP] FIXTURE DRAIN.** The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

**[MP] FIXTURE FITTING.**

**Supply fitting.** A fitting that controls the volume or directional flow or both of water and that is either attached to or accessed from a fixture or is used with an open or atmospheric discharge.

**Waste fitting.** A combination of components that conveys the sanitary waste from the outlet of a fixture to the connection of the sanitary drainage system.

**[MP] FIXTURE GROUP, MAIN.** The main water-distribution pipe (or secondary branch) serving a plumbing fixture grouping such as a bath, kitchen or laundry area to which two or more individual fixture branch pipes are connected.

**[MP] FIXTURE SUPPLY.** The water-supply pipe connecting a fixture or fixture fitting to a fixture branch.

**[MP] FIXTURE UNIT, DRAINAGE (d.f.u.).** A measure of probable discharge into the drainage system by various types of plumbing fixtures, used to size DWV piping systems. The drainage fixture-unit value for a particular fixture depends on its volume rate of drainage discharge, on the time duration of a single drainage operation and on the average time between successive operations.

**[MP] FIXTURE UNIT, WATER-SUPPLY (w.s.f.u.).** A measure of the probable hydraulic demand on the water supply by various types of plumbing fixtures used to size water-piping systems. The water-supply fixture-unit value for a particular fixture depends on its volume rate of supply, on the time duration of a single supply operation and on the average time between successive operations.

**[RB] FLAME SPREAD.** The propagation of flame over a surface.

**[RB] FLAME SPREAD INDEX.** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E84 or UL 723.

**[MP] FLEXIBLE AIR CONNECTOR.** A conduit for transferring air between an air duct or plenum and an air terminal unit, an air inlet or an air outlet. Such conduit is limited in its use, length and location.

**[RB] FLIGHT.** A continuous run of rectangular treads or *winders* or combination thereof from one landing to another.

**[MP] FLOOD-LEVEL RIM.** The edge of the receptor or fixture from which water overflows.

**[MP] FLOOR DRAIN.** A plumbing fixture for recess in the floor having a floor-level strainer intended for the purpose of the collection and disposal of wastewater used in cleaning the floor and for the collection and disposal of accidental spillage to the floor.

**[MP] FLOOR FURNACE.** A self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space, and with means for lighting the *appliance* from such space.

**[MP] FLOW PRESSURE.** The static pressure reading in the water-supply pipe near the faucet or water outlet while the faucet or water outlet is open and flowing at capacity.

**[MP] FLUE.** See “*Vent*.”

**[MP] FLUE, APPLIANCE.** The passages within an *appliance* through which combustion products pass from the combustion chamber to the flue collar.

**[MP] FLUE COLLAR.** The portion of a fuel-burning *appliance* designed for the attachment of a draft hood, vent connector or venting system.

**[MP] FLUE GASES.** Products of combustion plus excess air in *appliance* flues or heat exchangers.

## DEFINITIONS

**[MP] FLUSH VALVE.** A device located at the bottom of a flush tank that is operated to flush water closets.

**[MP] FLUSHOMETER TANK.** A device integrated within an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

**[MP] FLUSHOMETER VALVE.** A flushometer valve is a device that discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.

**[RB] FOAM BACKER BOARD.** Foam plastic used in siding applications where the foam plastic is a component of the siding.

**[RB] FOAM PLASTIC INSULATION.** A plastic that is intentionally expanded by the use of a foaming agent to produce a reduced-density plastic containing voids consisting of open or closed cells distributed throughout the plastic for thermal insulating or acoustic purposes and that has a density less than 20 pounds per cubic foot (320 kg/m<sup>3</sup>) unless it is used as interior *trim*.

**[RB] FOAM PLASTIC INTERIOR TRIM.** Exposed foam plastic used as picture molds, chair rails, crown moldings, baseboards, *handrails*, ceiling beams, door *trim* and window *trim* and similar decorative or protective materials used in fixed applications.

**[RB] FUEL CELL POWER SYSTEM, STATIONARY.** A stationary energy generation system that converts the chemical energy of a fuel and oxidant to electric energy (DC or AC electricity) by an electrochemical process.

**Field-fabricated fuel cell power system.** A *stationary fuel cell power system* that is assembled at the job site and is not a preengineered or prepackaged factory-assembled fuel cell power system.

**Preengineered fuel cell power system.** A *stationary fuel cell power system* consisting of components and modules that are produced in a factory, and shipped to the job site for assembly.

**Prepackaged fuel cell power system.** A *stationary fuel cell power system* that is factory assembled as a single, complete unit and shipped as a complete unit for installation at the job site.

**[MP] FUEL-PIPING SYSTEM.** All piping, tubing, valves and fittings used to connect fuel utilization equipment to the point of fuel delivery.

**[MP] FULL-OPEN VALVE.** A water control or shutoff component in the water supply system piping that, where adjusted for maximum flow, the flow path through the component's closure member is not a restriction in the component's through-flow area.

**[MP] FULLWAY VALVE.** A valve that in the full open position has an opening cross-sectional area that is not less than 85 percent of the cross-sectional area of the connecting pipe.

**[MP] FURNACE.** A vented heating *appliance* designed or arranged to discharge heated air into a *conditioned space* or through a duct or ducts.

**[RB] GLASS MAT GYPSUM PANEL.** A gypsum panel consisting of a noncombustible core primarily of gypsum, surfaced with glass mat partially or completely embedded in the core.

**[RB] GLAZING AREA.** The interior surface area of all glazed fenestration, including the area of sash, curbing or other framing elements, that enclose *conditioned space*. Includes the area of glazed fenestration assemblies in walls bounding conditioned *basements*.

**[RB] GRADE.** The finished ground level adjoining the building at all exterior walls.

**[MP] GRADE, PIPING.** See “*Slope*.”

**[RB] GRADE FLOOR EMERGENCY ESCAPE AND RESCUE OPENING.** An emergency escape and rescue opening located such that the bottom of the clear opening is not more than 44 inches (1118 mm) above or below the finished ground level adjacent to the opening. (See also “*Emergency escape and rescue opening*.”)

**[RB] GRADE PLANE.** A reference plane representing the average of the finished ground level adjoining the building at all exterior walls. Where the finished ground level slopes away from the exterior walls, the reference plane shall be established by the lowest points within the area between the building and the *lot line* or, where the *lot line* is more than 6 feet (1829 mm) from the building between the structure and a point 6 feet (1829 mm) from the building.

**[MP] GRAYWATER.** Waste discharged from lavatories, bathtubs, showers, clothes washers and laundry trays.

**[MP] GRIDDED WATER DISTRIBUTION SYSTEM.** A water distribution system where every water distribution pipe is interconnected so as to provide two or more paths to each fixture supply pipe.

**[RB] GROSS AREA OF EXTERIOR WALLS.** The normal projection of all *exterior walls*, including the area of all windows and doors installed therein.

**[MP] GROUND-SOURCE HEAT PUMP LOOP SYSTEM.** Piping buried in horizontal or vertical excavations or placed in a body of water for the purpose of transporting heat transfer liquid to and from a heat pump. Included in this definition are closed loop systems in which the liquid is recirculated and open loop systems in which the liquid is drawn from a well or other source.

**[RB] GUARD.** A building component or a system of building components located near the open sides of elevated walking surfaces that minimizes the possibility of a fall from the walking surface to the lower level.

**[RB] GUESTROOM.** Any room or rooms used or intended to be used by one or more guests for living or sleeping purposes.



## DEFINITIONS

**[RB] GYPSUM BOARD.** The generic name for a family of sheet products consisting of a noncombustible core primarily of gypsum with paper surfacing. Gypsum wallboard, gypsum sheathing, gypsum base for gypsum *veneer* plaster, exterior gypsum soffit board, predecorated gypsum board and water-resistant gypsum backing board complying with the standards listed in Section R702.3 and Part IX of this code are types of gypsum board.

**[RB] GYPSUM PANEL PRODUCT.** The general name for a family of sheet products consisting essentially of gypsum.

**[RB] GYPSUM SHEATHING.** Gypsum panel products specifically manufactured with enhanced water resistance for use as a substrate for exterior surface materials.

**[RB] GYPSUM WALLBOARD.** A gypsum board used primarily as interior surfacing for building structures.

**[RB] HABITABLE SPACE.** A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaces and similar areas are not considered *habitable spaces*.

**[RB] HANDRAIL.** A horizontal or sloping rail intended for grasping by the hand for guidance or support.

**[MP] HANGERS.** See “*Supports*.”

**[MP] HAZARDOUS LOCATION.** Any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances.

**[MP] HEAT PUMP.** An *appliance* having heating or heating and cooling capability and that uses refrigerants to extract heat from air, liquid or other sources.

**[RE] HEATED SLAB.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] HEIGHT, BUILDING.** The vertical distance from *grade plane* to the average height of the highest roof surface.

**[RB] HEIGHT, STORY.** The vertical distance from top to top of two successive tiers of beams or finished floor surfaces; and, for the topmost *story*, from the top of the floor finish to the top of the ceiling joists or, where there is not a ceiling, to the top of the roof rafters.

**[RE] HIGH-EFFICACY LIGHT SOURCES.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] HIGH-TEMPERATURE (H.T.) CHIMNEY.** A high-temperature chimney complying with the requirements of UL 103. A Type H.T. chimney is identifiable by the markings “Type H.T.” on each chimney pipe section.

**[RB] HILL.** With respect to topographic wind effects, a land surface characterized by strong relief in any horizontal direction.

**[RB] HISTORIC BUILDING.** A building or structure that is one or more of the following:

1. Listed, or certified as eligible for listing, by the State Historic Preservation Officer or the Keeper of the National Register of Historic Places in the National Register of Historic Places.

2. Designated as historic under an applicable state or local law.
3. Certified as a contributing resource within a National Register-listed, or a state-designated or locally designated historic district.

For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] HORIZONTAL BRANCH, DRAINAGE.** A drain pipe extending laterally from a soil or waste stack or *building drain*, that receives the discharge from one or more *fixture drains*.

**[MP] HORIZONTAL PIPE.** Any pipe or fitting that makes an angle of less than 45 degrees (0.79 rad) with the horizontal.

**[MP] HOT WATER.** Water at a temperature greater than 120°F (49°C).

**[RB] HURRICANE-PRONE REGIONS.** Areas vulnerable to hurricanes, defined as the US Atlantic Ocean and Gulf of Mexico coasts where the ultimate design wind speed,  $V_{ult}$ , is greater than 115 miles per hour (51 m/s), and Hawaii, Puerto Rico, Guam, Virgin Islands and America Samoa.

**[MP] HYDROGEN-GENERATING APPLIANCE.** A self-contained package or factory-matched packages of integrated systems for generating gaseous hydrogen. Hydrogen-generating *appliances* utilize electrolysis, reformation, chemical or other processes to generate hydrogen.

**[MP] IGNITION SOURCE.** A flame, spark or hot surface capable of igniting flammable vapors or fumes. Such sources include *appliance* burners, burner ignitions and electrical switching devices.

**[RB] IMPACT PROTECTIVE SYSTEM.** Construction that has been shown by testing to withstand the impact of test missiles and that is applied, attached, or locked over exterior glazing.

**[MP] INDIRECT SYSTEM.** A solar thermal system in which the gas or liquid in the solar collector loop circulates between the solar collector and a heat exchanger and such gas or liquid is not drained from the system or supplied to the load during normal operation.

**[MP] INDIRECT WASTE PIPE.** A waste pipe that discharges into the drainage system through an *air gap* into a trap, fixture or receptor.

**[MP] INDIVIDUAL SEWAGE DISPOSAL SYSTEM.** A system for disposal of sewage by means of a septic tank or mechanical treatment, designed for use apart from a public sewer to serve a single establishment or building.

**[MP] INDIVIDUAL VENT.** A pipe installed to vent a single *fixture drain* that connects with the vent system above or terminates independently outside the building.

**[MP] INDIVIDUAL WATER SUPPLY.** A supply other than an *approved* public water supply that serves one or more families.

**[RE] INFILTRATION.** For the definition applicable in Chapter 11, see Section N1101.6.



## DEFINITIONS

**[RB] INSULATED SIDING.** A type of continuous insulation, with manufacturer-installed insulating material as an integral part of the cladding product, having a minimum *R*-value of *R*-2. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] INSULATED VINYL SIDING.** A vinyl cladding product, with manufacturer-installed foam plastic insulating material as an integral part of the cladding product, having a thermal resistance of not less than *R*-2.

**[RB] INSULATING CONCRETE FORM (ICF).** A concrete forming system using stay-in-place forms of rigid foam plastic insulation, a hybrid of cement and foam insulation, a hybrid of cement and wood chips, or other insulating material for constructing cast-in-place concrete walls.

**[RB] INSULATING SHEATHING.** A rigid panel or board insulation material having a thermal resistance of not less than *R*-2 of the core material with properties suitable for use on walls, floors, roofs or foundations.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] INTERMODAL SHIPPING CONTAINER.** A six-sided steel unit originally constructed as a general cargo container used for the transport of goods and materials.

**[RB] JURISDICTION.** The governmental unit that has adopted this code.

**[RB] KITCHEN.** An area used, or designated to be used, for the preparation of food.

**[RB] LABEL.** An identification applied on a product by the manufacturer that contains the name of the manufacturer, the function and performance characteristics of the product or material, and the name and identification of an *approved agency* and that indicates that the representative sample of the product or material has been tested and evaluated by an *approved agency*. (See also “*Manufacturer’s designation*” and “*Mark*.”)

**[RB] LABELED.** Equipment, materials or products to which have been affixed a *label*, seal, symbol or other identifying *mark* of a nationally recognized testing laboratory, *approved agency* or other organization concerned with product evaluation that maintains periodic inspection of the production of such *labeled* items and whose labeling indicates either that the *equipment*, material or product meets identified standards or has been tested and found suitable for a specified purpose. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] LIGHT-FRAME CONSTRUCTION.** Construction whose vertical and horizontal structural elements are primarily formed by a system of repetitive wood or cold-formed steel framing members.

**[RB] LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the code official and concerned with evaluation of products or services that maintains periodic inspection of production of *listed equipment* or materials or periodic evaluation of services and whose listing states either that the *equipment*,

material, product or service meets identified standards or has been tested and found suitable for a specified purpose. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] LIVE LOADS.** Those loads produced by the use and occupancy of the building or other structure and do not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

**[RB] LIVE/WORK UNIT.** A *dwelling unit* or sleeping unit in which a significant portion of the space includes a non-residential use that is operated by the tenant.

**[MP] LIVING SPACE.** Space within a *dwelling unit* utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

**[MP] LOCAL EXHAUST.** An exhaust system that uses one or more fans to exhaust air from a specific room or rooms within a dwelling.

**[MP] LOCKING-TYPE TAMPER-RESISTANT CAP.** A cap designed to be unlocked by a specially designed tool or key to prevent removal of the cap by means of hand-loosening or by commonly available tools.

**[RB] LODGING HOUSE.** A one-family dwelling where one or more occupants are primarily permanent in nature, and rent is paid for guestrooms.

**[RB] LOT.** A measured portion or parcel of land considered as a unit having fixed boundaries.

**[RB] LOT LINE.** The line that bounds a plot of ground described as a lot in the title to the property.

**[RE] LOW-VOLTAGE LIGHTING.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] MACERATING TOILET SYSTEMS.** A system comprised of a sump with macerating pump and with connections for a water closet and other plumbing fixtures, that is designed to accept, grind and pump wastes to an *approved* point of discharge.

**[MP] MAIN.** The principal pipe artery to which branches may be connected.

**[MP] MAIN SEWER.** See “*Public sewer*.”

**[MP] MANIFOLD WATER DISTRIBUTION SYSTEMS.** A fabricated piping arrangement in which a large supply main is fitted with multiple branches in close proximity in which water is distributed separately to fixtures from each branch.

**[RE] MANUAL.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] MANUFACTURED HOME.** A structure, transportable in one or more sections, that in the traveling mode is 8 body feet (2438 body mm) or more in width or 40 body feet (12 192 body mm) or more in length, or, where erected on site, is 320 square feet (30 m<sup>2</sup>) or more, and that is built on a permanent chassis and designed to be used as a *dwelling* with or without a permanent foundation where connected to the required utilities, and includes the plumbing, heating, air-conditioning and electrical systems contained therein; except

## DEFINITIONS

that such term shall include any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the secretary (HUD) and complies with the standards established under this title. For mobile homes built prior to June 15, 1976, a *label* certifying compliance to the Standard for Mobile Homes, NFPA 501, in effect at the time of manufacture is required. For the purpose of these provisions, a mobile home shall be considered to be a *manufactured home*.

**[RB] MANUFACTURER'S DESIGNATION.** An identification applied on a product by the manufacturer indicating that a product or material complies with a specified standard or set of rules. (See also "*Mark*" and "*Label*.")

**[RB] MANUFACTURER'S INSTALLATION INSTRUCTIONS.** Printed instructions included with equipment as part of the conditions of their *listing* and *labeling*.

**[RB] MARK.** An identification applied on a product by the manufacturer indicating the name of the manufacturer and the function of a product or material. (See also "*Manufacturer's designation*" and "*Label*.")

**[RB] MASONRY, SOLID.** Masonry consisting of *solid masonry* units laid contiguously with the joints between the units filled with mortar.

**[RB] MASONRY CHIMNEY.** A field-constructed chimney composed of *solid masonry* units, bricks, stones or concrete.

**[RB] MASONRY HEATER.** A masonry heater is a solid fuel burning heating *appliance* constructed predominantly of concrete or *solid masonry* having a mass of not less than 1,100 pounds (500 kg), excluding the chimney and foundation. It is designed to absorb and store a substantial portion of heat from a fire built in the firebox by routing exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox includes not less than one 180-degree (3.14-rad) change in flow direction before entering the chimney and that deliver heat by radiation through the masonry surface of the heater.

**[RB] MASONRY UNIT.** Brick, tile, stone, architectural cast stone, glass block or concrete block conforming to the requirements specified in Section 2103 of the *International Building Code*.

**Clay.** A building unit larger in size than a brick, composed of burned clay, shale, fire clay or mixtures thereof.

**Concrete.** A building unit or block larger in size than 12 inches by 4 inches by 4 inches (305 mm by 102 mm by 102 mm) made of cement and suitable aggregates.

**Glass.** Nonload-bearing masonry composed of glass units bonded by mortar.

**Hollow.** A *masonry unit* with a net cross-sectional area in any plane parallel to the loadbearing surface that is less than 75 percent of its gross cross-sectional area measured in the same plane.

**Solid.** A *masonry unit* with a net cross-sectional area in every plane parallel to the loadbearing surface that is 75 percent or more of its cross-sectional area measured in the same plane.

**[RB] MEAN ROOF HEIGHT.** The average of the roof eave height and the height to the highest point on the roof surface, except that eave height shall be used for roof angle of less than or equal to 10 degrees (0.18 rad).

**[MP] MECHANICAL DRAFT SYSTEM.** A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

**Forced draft venting system.** A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static pressure.

**Induced draft venting system.** A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

**Power venting system.** A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

**[MP] MECHANICAL EXHAUST SYSTEM.** A system for removing air from a room or space by mechanical means.

**[MP] MECHANICAL JOINT.**

1. A connection between pipes, fittings or pipes and fittings that is not welded, brazed, caulked, soldered, solvent cemented or heat fused.
2. A general form of gastight or liquid-tight connections obtained by the joining of parts through a positive holding mechanical construction such as, but not limited to, flanged, screwed, clamped or flared connections.

**[MP] MECHANICAL SYSTEM.** A system specifically addressed and regulated in this code and composed of components, devices, *appliances* and *equipment*.

**[RB] METAL ROOF PANEL.** An interlocking metal sheet having an installed weather exposure of not less than 3 square feet (0.28 m<sup>2</sup>) per sheet.

**[RB] METAL ROOF SHINGLE.** An interlocking metal sheet having an installed weather exposure less than 3 square feet (0.28 m<sup>2</sup>) per sheet.

**[RB] MEZZANINE.** An intermediate level or levels between the floor and ceiling of any *story*.

**[RB] MODIFIED BITUMEN ROOF COVERING.** One or more layers of polymer modified asphalt sheets. The sheet materials shall be fully adhered or mechanically attached to the substrate or held in place with an *approved* ballast layer.

**[RB] MULTIPLE-STATION SMOKE ALARM.** Two or more single-station alarm devices that are capable of inter-connection such that actuation of one causes all integral or separate audible alarms to operate.

**[RB] NAILABLE SUBSTRATE.** A product or material such as framing, sheathing or furring, composed of wood or wood-based materials, or other materials and fasteners providing equivalent fastener withdrawal resistance.

## DEFINITIONS

**[MP] NATURAL DRAFT SYSTEM.** A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

**[RB] NATURALLY DURABLE WOOD.** The heartwood of the following species with the exception that an occasional piece with corner sapwood is permitted if 90 percent or more of the width of each side on which it occurs is heartwood.

**Decay resistant.** Redwood, cedar, black locust and black walnut.

**Termite resistant.** Alaska yellow cedar, redwood, Eastern red cedar and Western red cedar including all sapwood of Western red cedar.

**[RB] NONCOMBUSTIBLE MATERIAL.** A material that passes ASTM E136.

**[RB] NOSING.** The leading edge of treads of stairs and of landings at the top of *stairway* flights.

**[RB] OCCUPIED SPACE.** The total area of all buildings or structures on any *lot* or parcel of ground projected on a horizontal plane, excluding permitted projections as allowed by this code.

**[MP] OFFSET.** A combination of fittings that makes two changes in direction, bringing one section of the pipe out of line and into a line parallel with the other section.

**[MP] ON-SITE NONPOTABLE WATER REUSE SYSTEMS.** Water systems for the collection, treatment, storage, distribution, and reuse of nonpotable water generated on site, including but not limited to graywater systems. This definition does not include rainwater harvesting systems.

**[RE] OPAQUE DOOR.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] OWNER.** Any person, agent, firm or corporation having a legal or equitable interest in the property.

**[RB] PAN FLASHING.** Corrosion-resistant flashing at the base of an opening that is integrated into the building exterior wall to direct water to the exterior and is premanufactured, fabricated, formed or applied at the job site.

**[RB] PANEL THICKNESS.** Thickness of core plus two layers of structural wood panel facings.

**[MP] PELLET FUEL-BURNING APPLIANCE.** A closed combustion, vented *appliance* equipped with a fuel feed mechanism for burning processed pellets of solid fuel of a specified size and composition.

**[MP] PELLET VENT.** A vent *listed* and *labeled* for use with a *listed* pellet fuel-burning *appliance*.

**[RB] PERFORMANCE CATEGORY.** A designation of wood structural panels as related to the panel performance used in Chapters 4, 5, 6 and 8.

**[RB] PERMIT.** An official document or certificate issued by the *building official* that authorizes performance of a specified activity.

**[RB] PERSON.** An individual, heirs, executors, administrators or assigns, and a firm, partnership or corporation, its or their successors or assigns, or the agent of any of the aforesaid.

**[RB] PHOTOVOLTAIC MODULE.** A complete, environmentally protected unit consisting of solar cells, optics and other components, exclusive of a tracker, designed to generate DC power where exposed to sunlight.

**[RB] PHOTOVOLTAIC PANEL.** A collection of *photovoltaic modules* mechanically fastened together, wired, and designed to provide a field-installable unit.

**[RB] PHOTOVOLTAIC PANEL SYSTEM.** A system that incorporates discrete photovoltaic panels that convert solar radiation into electricity, including rack support systems.

**[RB] PHOTOVOLTAIC SHINGLES.** A *roof covering* that resembles shingles and that incorporates *photovoltaic modules*.

**[MP] PITCH.** See “*Slope*.”

**[RB] PLASTIC COMPOSITE.** A generic designation that refers to wood-plastic composites and plastic lumber.

**[RB] PLATFORM CONSTRUCTION.** A method of construction by which floor framing bears on load bearing walls that are not continuous through the *story* levels or floor framing.

**[MP] PLENUM.** A chamber that forms part of an air-circulation system other than the *occupied space* being conditioned.

**[MP] PLUMBING.** For the purpose of this code, plumbing refers to those installations, repairs, maintenance and *alterations* regulated by Chapters 25 through 33.

**[MP] PLUMBING APPLIANCE.** An energized household *appliance* with plumbing connections, such as a dishwasher, food waste disposer, clothes washer or water heater.

**[MP] PLUMBING APPURTENANCE.** A device or assembly that is an adjunct to the basic plumbing system and does not demand additional water supply or add any discharge load to the system. It is presumed that it performs some useful function in the operation, maintenance, servicing, economy or safety of the plumbing system. Examples include filters, relief valves and aerators.

**[MP] PLUMBING FIXTURE.** A receptacle or device that is connected to a water supply system or discharges to a drainage system or both. Such receptacles or devices require a supply of water; or discharge liquid waste or liquidborne solid waste; or require a supply of water and discharge waste to a drainage system.

**[MP] PLUMBING SYSTEMS.** Includes the water distribution pipes; plumbing fixtures and traps; water-treating or water-using equipment; soil, waste and vent pipes; and building drains; in addition to their respective connections, devices and appurtenances within a structure or premises; and the water service, building sewer and building storm sewer serving such structure or premises.

**[MP] POLLUTION.** A low-hazard or nonhealth-hazard impairment of the quality of the potable water to a degree that does not create a hazard to the public health and that does adversely and unreasonably affect the aesthetic qualities of such potable water for domestic use.



**[RB] POLYPROPYLENE SIDING.** A shaped material, made principally from polypropylene homopolymer, or copolymer, that in some cases contains fillers or reinforcements, that is used to clad exterior walls or buildings.

**[MP] PORTABLE-FUEL-CELL APPLIANCE.** A fuel cell generator of electricity that is not fixed in place. A portable-fuel-cell *appliance* utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.

**[RB] POSITIVE ROOF DRAINAGE.** The drainage condition in which consideration has been made for the loading deflections of the *roof deck*, and additional slope has been provided to ensure drainage of the roof within 48 hours of precipitation.

**[MP] POTABLE WATER.** Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming in bacteriological and chemical quality to the requirements of the public health authority having *jurisdiction*.

**[RB] PRECAST CONCRETE.** A structural concrete element cast elsewhere than its final position in the structure.

**[RB] PRECAST CONCRETE FOUNDATION WALLS.** Preengineered, *precast concrete* wall panels that are designed to withstand specified stresses and used to build below-grade foundations.

**[MP] PRESS-CONNECT JOINT.** A permanent mechanical joint incorporating an elastomeric seal or an elastomeric seal and corrosion-resistant grip or bite ring. The joint is made with a pressing tool and jaw or ring approved by the fitting manufacturer.

**[MP] PRESSURE-RELIEF VALVE.** A pressure-actuated valve held closed by a spring or other means and designed to automatically relieve pressure at the pressure at which it is set.

**[RE] PROPOSED DESIGN.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] PUBLIC SEWER.** A common sewer directly controlled by public authority.

**[MP] PUBLIC WATER MAIN.** A water-supply pipe for public use controlled by public authority.

**[RB] PUBLIC WAY.** Any street, alley or other parcel of land open to the outside air leading to a public street, that has been deeded, dedicated or otherwise permanently appropriated to the public for public use and that has a clear width and height of not less than 10 feet (3048 mm).

**[MP] PURGE.** To clear of air, gas or other foreign substances.

**[MP] PUSH-FIT FITTING.** A mechanical fitting that joins pipes or tubes and achieves a seal by mating the pipe or tube into the fitting.

**[MP] QUICK-CLOSING VALVE.** A valve or faucet that closes automatically when released manually or controlled by mechanical means for fast-action closing.

**[RB] RAMP.** A walking surface that has a running slope steeper than 1 unit vertical in 20 units horizontal (5-percent slope).

**[RE] RATED DESIGN.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] READY ACCESS (TO).** That which enables a device, *appliance* or equipment to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction.

**[MP] RECEPTOR.** A fixture or device that receives the discharge from indirect waste pipes.

**[MP] RECLAIMED WATER.** Nonpotable water that has been derived from the treatment of wastewater by a facility or system licensed or permitted to produce water meeting the *jurisdiction's* water requirements for its intended uses. Also known as "recycled water."

**[MP] REFRIGERANT.** A substance used to produce refrigeration by its expansion or evaporation.

**[MP] REFRIGERANT COMPRESSOR.** A specific machine, with or without accessories, for compressing a given refrigerant vapor.

**[MP] REFRIGERATING SYSTEM.** A combination of interconnected parts forming a closed circuit in which refrigerant is circulated for the purpose of extracting, then rejecting, heat. A direct refrigerating system is one in which the evaporator or condenser of the refrigerating system is in direct contact with the air or other substances to be cooled or heated. An indirect refrigerating system is one in which a secondary coolant cooled or heated by the refrigerating system is circulated to the air or other substance to be cooled or heated.

**[RB] REGISTERED DESIGN PROFESSIONAL.** An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or *jurisdiction* in which the project is to be constructed.

**[MP] RELIEF VALVE, VACUUM.** A device to prevent excessive buildup of vacuum in a pressure vessel.

**[RB] REPAIR.** The reconstruction, replacement or renewal of any part of an existing building for the purpose of its maintenance or to correct damage.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] REROOFING.** The process of recovering or replacing an existing *roof covering*. See "*Roof recover*."

For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] RESIDENTIAL BUILDING.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] RETURN AIR.** Air removed from an *approved conditioned space* or location and recirculated or exhausted.

**[RB] RIDGE.** With respect to topographic wind effects, an elongated crest of a *hill* characterized by strong relief in two directions.

**[MP] RISER (PLUMBING).** A water pipe that extends vertically one full *story* or more to convey water to branches or to a group of fixtures.



## DEFINITIONS

**[RB] RISER (STAIR).** The vertical component of a step or stair.

**[RB] ROOF ASSEMBLY.** A system designed to provide weather protection and resistance to design loads. The system consists of a *roof covering* and *roof deck* or a single component serving as both the *roof covering* and the *roof deck*. A *roof assembly* can include an underlayment, thermal barrier, ignition barrier, insulation or a vapor retarder. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ROOF COATING.** A fluid-applied, adhered coating used for roof maintenance or *roof repair*, or as a component of a *roof covering* system or *roof assembly*.

**[RB] ROOF COVERING.** The covering applied to the *roof deck* for weather resistance, fire classification or appearance.

**[RB] ROOF COVERING SYSTEM.** See “*Roof assembly*.”

**[RB] ROOF DECK.** The flat or sloped surface not including its supporting members or vertical supports.

**[RB] ROOF RECOVER.** The process of installing an additional *roof covering* over an existing roof covering without removing the existing roof covering. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ROOF REPAIR.** Reconstruction or renewal of any part of an existing roof for the purposes of its maintenance. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] ROOF REPLACEMENT.** The process of removing the existing *roof covering*, repairing any damaged substrate and installing a new *roof covering*. For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] ROOM HEATER.** A free-standing heating *appliance* installed in the space being heated and not connected to ducts.

**[MP] ROUGH-IN.** The installation of the parts of the plumbing system that must be completed prior to the installation of fixtures. This includes DWV, water supply and built-in fixture supports.

**[RB] RUNNING BOND.** The placement of *masonry units* such that head joints in successive courses are horizontally offset not less than one-quarter the unit length.

**[RE] R-VALUE (THERMAL RESISTANCE).** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] SANITARY SEWER.** A sewer that carries sewage and excludes storm, surface and groundwater.

**[RB] SCUPPER.** An opening in a wall or parapet that allows water to drain from a roof.

**[RB] SEISMIC DESIGN CATEGORY (SDC).** A classification assigned to a structure based on its occupancy category and the severity of the design earthquake ground motion at the site.

**[MP] SEPTIC TANK.** A watertight receptor that receives the discharge of a building sanitary drainage system and is constructed so as to separate solids from the liquid, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open joint or perforated piping or a seepage pit.

**[RE] SERVICE WATER HEATING.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] SEWAGE.** Any liquid waste containing animal matter, vegetable matter or other impurity in suspension or solution.

**[MP] SEWAGE PUMP.** A permanently installed mechanical device for removing sewage or liquid waste from a sump.

**[RB] SHALL.** The term, where used in the code, is construed as mandatory.

**[RB] SHEAR WALL.** A general term for walls that are designed and constructed to resist racking from seismic and wind by use of masonry, concrete, cold-formed steel or wood framing in accordance with Chapter 6 of this code and the associated limitations in Section R301.2 of this code.

**[RB] SHINGLE FASHION.** A method of installing roof or wall coverings, *water-resistive barriers*, flashing or other building components such that upper layers of material are placed overlapping lower layers of material to provide drainage and protect against water intrusion at unsealed penetrations and joints or in combination with sealed joints.

**[RB] SINGLE-PLY MEMBRANE.** A roofing membrane that is field applied using one layer of membrane material (either homogeneous or composite) rather than multiple layers.

**[RB] SINGLE-STATION SMOKE ALARM.** An assembly incorporating the detector, control equipment and alarm sounding device in one unit that is operated from a power supply either in the unit or obtained at the point of installation.

**[RE] SKYLIGHT.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] SKYLIGHT, UNIT.** A factory assembled, glazed fenestration unit, containing one panel of glazing material, that allows for natural daylighting through an opening in the *roof assembly* while preserving the weather-resistant barrier of the roof.

**[RB] SKYLIGHTS AND SLOPED GLAZING.** Glass or other transparent or translucent glazing material installed at a slope of 15 degrees (0.26 rad) or more from vertical. *Unit skylights*, *tubular daylighting devices* and glazing materials in solariums, *sunrooms*, roofs and sloped walls are included in this definition. For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] SLEEPING UNIT.** A single unit that provides rooms or spaces for one or more persons, includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not sleeping units.

**[MP] SLIP JOINT.** A mechanical-type joint used primarily on fixture traps. The joint tightness is obtained by compressing a friction-type washer such as rubber, nylon, neoprene, lead or special packing material against the pipe by the tightening of a (slip) nut.

**[MP] SLOPE.** The fall (pitch) of a line of pipe in reference to a horizontal plane. In drainage, the slope is expressed as the fall in units vertical per units horizontal (percent) for a length of pipe.

**[RB] SMOKE-DEVELOPED INDEX.** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E84 or UL 723.

**[MP] SOIL STACK OR PIPE.** A pipe that conveys sewage containing fecal material.

**[RB] SOLAR ENERGY SYSTEM.** A system that converts solar radiation to usable energy, including *photovoltaic panel systems* and *solar thermal systems*.

**[RE] SOLAR HEAT GAIN COEFFICIENT (SHGC).** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] SOLAR THERMAL COLLECTOR.** Components in a *solar thermal system* that collect and convert solar radiation to thermal energy.

**[MP] SOLAR THERMAL SYSTEM.** A system that converts solar radiation to thermal energy for use in heating or cooling.

**[RB] SOLID MASONRY.** Load-bearing or nonload-bearing construction using *masonry units* where the net cross-sectional area of each unit in any plane parallel to the bearing surface is not less than 75 percent of its gross cross-sectional area. *Solid masonry* units shall conform to ASTM C55, C62, C73, C145 or C216.

**[RB] SPLINE.** A strip of wood structural panel cut from the same material used for the panel facings, used to connect two structural insulated panels. The strip (spline) fits into a groove cut into the vertical edges of the two structural insulated panels to be joined. Splines are used behind each facing of the structural insulated panels being connected as shown in Figure R610.8.

**[MP] STACK.** Any main vertical DWV line, including offsets, that extends one or more stories as directly as possible to its vent terminal.

**[RB] STACK BOND.** The placement of *masonry units* in a bond pattern is such that head joints in successive courses are vertically aligned. For the purpose of this code, requirements for stack bond shall apply to all masonry laid in other than *running bond*.

**[MP] STACK VENT.** The extension of soil or waste stack above the highest horizontal drain connected.

**[RB] STAIR.** A change in elevation, consisting of one or more *risers*.

**[RB] STAIRWAY.** One or more flights of stairs, either interior or exterior, with the necessary landings and connecting platforms to form a continuous and uninterrupted passage from one level to another.

**[RB] STAIRWAY, SPIRAL.** A stairway with a plan view of closed circular form and uniform section-shaped treads radiating from a minimum-diameter circle.

**[RE] STANDARD REFERENCE DESIGN.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] STANDARD TRUSS.** Any construction that does not permit the roof-ceiling insulation to achieve the required *R*-value over the exterior walls.

**[MP] STATIONARY FUEL CELL POWER PLANT.** A self-contained package or factory-matched packages that constitute an automatically operated assembly of integrated systems for generating useful electrical energy and recoverable thermal energy that is permanently connected and fixed in place.

**[MP] STORM SEWER, DRAIN.** A pipe used for conveying rainwater, surface water, subsurface water and similar liquid waste.

**[RB] STORM SHELTER.** A building, structure or portion thereof, constructed in accordance with ICC 500 and designated for use during a severe wind storm event, such as a hurricane or tornado.

**[RB] STORY.** That portion of a building included between the upper surface of a floor and the upper surface of the floor or roof next above.

**[RB] STORY ABOVE GRADE PLANE.** Any *story* having its finished floor surface entirely above *grade plane*, or in which the finished surface of the floor next above is either of the following:

1. More than 6 feet (1829 mm) above *grade plane*.
2. More than 12 feet (3658 mm) above the finished ground level at any point.

**[RB] STRUCTURAL COMPOSITE LUMBER.** Structural members manufactured using wood elements bonded together with exterior adhesives.

Examples of structural composite lumber are:

**Laminated strand lumber (LSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths are not less than 150 times the least dimension of the wood strand elements.

**Laminated veneer lumber (LVL).** A composite of wood veneer elements with wood fibers primarily oriented along the length of the member, where the veneer element thicknesses are 0.25 inch (6.4 mm) or less.

**Oriented strand lumber (OSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.10 inch (2.54 mm) or less and their average lengths are not less than 75 times and less than 150 times the least dimension of the wood strand elements.

**Parallel strand lumber (PSL).** A composite of wood strand elements with wood fibers primarily oriented along the length of the member, where the least dimension of the wood strand elements is 0.25 inch (6.4 mm) or less and their average lengths are not less than 300 times the least dimension of the wood strand elements.

## DEFINITIONS

**[RB] STRUCTURAL INSULATED PANEL (SIP).** A structural sandwich panel that consists of a lightweight foam plastic core securely laminated between two thin, rigid wood structural panel facings.

**[RB] STRUCTURE.** That which is built or constructed.

**[RB] SUBSOIL DRAIN.** A drain that collects subsurface water or seepage water and conveys such water to a place of disposal.

**[MP] SUMP.** A tank or pit that receives sewage or waste, located below the normal *grade* of the gravity system and that must be emptied by mechanical means.

**[MP] SUMP PUMP.** A pump installed to empty a sump. These pumps are used for removing storm water only. The pump is selected for the specific head and volume of the load and is usually operated by level controllers.

**[RB] SUNROOM.** A one-story structure attached to a *dwelling* with a *glazing area* in excess of 40 percent of the gross area of the structure's exterior walls and roof.

For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] SUPPLY AIR.** Air delivered to a *conditioned space* through ducts or plenums from the heat exchanger of a heating, cooling or ventilating system.

**[MP] SUPPORTS.** Devices for supporting, hanging and securing pipes, fixtures and equipment.

**[MP] SWEEP.** A drainage fitting designed to provide a change in direction of a drain pipe of less than the angle specified by the amount necessary to establish the desired slope of the line. Sweeps provide a longer turning radius than bends and a less turbulent flow pattern (see “*Bend*” and “*Elbow*”).

**[MP] TEMPERATURE- AND PRESSURE-RELIEF (T AND P) VALVE.** A combination relief valve designed to function as both a temperature-relief and pressure-relief valve.

**[MP] TEMPERATURE-RELIEF VALVE.** A temperature-actuated valve designed to discharge automatically at the temperature at which it is set.

**[RB] TERMITE-RESISTANT MATERIAL.** Pressure-preservative-treated wood in accordance with the AWPA standards in Section R317.1, naturally durable termite-resistant wood, steel, concrete, masonry or other *approved* material.

**[RE] THERMAL ISOLATION.** For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] THERMAL RESISTANCE, R-VALUE.** See “*R-value*.”

**[RE] THERMAL TRANSMITTANCE, U-FACTOR.** See “*U-factor*.”

**[RE] THERMOSTAT.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] THIRD-PARTY CERTIFICATION AGENCY.** An *approved* agency operating a product or material certification system that incorporates initial product testing, assessment and surveillance of a manufacturer's quality control system.

**[MP] THIRD-PARTY CERTIFIED.** Certification obtained by the manufacturer indicating that the function and performance characteristics of a product or material have been determined by testing and ongoing surveillance by an *approved* third-party certification agency. Assertion of certification is in the form of identification in accordance with the requirements of the third-party certification agency.

**[RB] TOWNHOUSE.** A *building* that contains three or more attached *townhouse units*.

**[RB] TOWNHOUSE UNIT.** A single-family *dwelling unit* in a *townhouse* that extends from foundation to roof and that has a *yard* or *public way* on not less than two sides.

**[MP] TRAP.** A fitting, either separate or built into a fixture, that provides a liquid seal to prevent the emission of sewer gases without materially affecting the flow of sewage or wastewater through it.

**[MP] TRAP ARM.** That portion of a *fixture drain* between a trap weir and the vent fitting.

**[MP] TRAP PRIMER.** A device or system of piping to maintain a water seal in a trap, typically installed where infrequent use of the trap would result in evaporation of the trap seal, such as floor drains.

**[MP] TRAP SEAL.** The trap seal is the maximum vertical depth of liquid that a trap will retain, measured between the crown weir and the top of the dip of the trap.

**[RB] TRIM.** Picture molds, chair rails, baseboards, *hand-rails*, door and window frames, and similar decorative or protective materials used in fixed applications.

**[RB] TRUSS DESIGN DRAWING.** The graphic depiction of an individual truss, that describes the design and physical characteristics of the truss.

**[RB] TUBULAR DAYLIGHTING DEVICE (TDD).** A nonoperable fenestration unit primarily designed to transmit daylight from a roof surface to an interior ceiling via a tubular conduit. The basic unit consists of an exterior glazed weathering surface, a light-transmitting tube with a reflective interior surface, and an interior-sealing device such as a translucent ceiling panel. The unit may be factory assembled, or field assembled from a manufactured kit.

**[MP] TYPE L VENT.** A *listed* and *labeled* vent conforming to UL 641 for venting oil-burning *appliances listed* for use with Type L vents or with gas *appliances listed* for use with Type B vents.

**[RE] U-FACTOR (THERMAL TRANSMITTANCE).** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] UNDERLAYMENT.** One or more layers of felt, sheathing paper, nonbituminous saturated felt, or other *approved* material over which a roof covering, with a slope of 2 units vertical in 12 units horizontal (17-percent slope) or greater, is applied.

**[MP] VACUUM BREAKER.** A device that prevents back-siphonage of water by admitting atmospheric pressure through ports to the discharge side of the device.



**[RB] VAPOR DIFFUSION PORT.** An assembly constructed or installed within a *roof assembly* at an opening in the *roof deck* to convey water vapor from an unvented attic to the outside atmosphere.

**[RB] VAPOR PERMEABLE.** The property of having a moisture vapor permeance rating of 5 perms ( $2.9 \times 10^{-10}$  kg/Pa  $\times$  s  $\times$  m<sup>2</sup>) or greater, where tested in accordance with Procedure A or Procedure B of ASTM E96. A vapor permeable material permits the passage of moisture vapor.

**[RB] VAPOR RETARDER CLASS.** A measure of the ability of a material or assembly to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM E96 as follows:

Class I:  $\leq 0.1$  perm rating

Class II:  $> 0.1$  to  $\leq 1.0$  perm rating

Class III:  $> 1.0$  to  $\leq 10$  perm rating

**[MP] VENT.** A passageway for conveying flue gases from fuel-fired *appliances*, or their vent connectors, to the outside atmosphere.

**[MP] VENT COLLAR.** See “*Flue collar*.”

**[MP] VENT CONNECTOR.** That portion of a venting system that connects the flue collar or draft hood of an *appliance* to a vent.

**[MP] VENT DAMPER DEVICE, AUTOMATIC.** A device intended for installation in the venting system, in the outlet of an individual, automatically operated fuel-burning *appliance* and that is designed to open the venting system automatically where the *appliance* is in operation and to close off the venting system automatically where the *appliance* is in a standby or shutdown condition.

**[MP] VENT GASES.** Products of combustion from fuel-burning *appliances*, plus excess air and dilution air, in the venting system above the draft hood or draft regulator.

**[MP] VENT STACK.** A vertical vent pipe installed to provide circulation of air to and from the drainage system and that extends through one or more stories.

**[MP] VENT SYSTEM.** Piping installed to equalize pneumatic pressure in a drainage system to prevent trap seal loss or blowback due to siphonage or back pressure.

**[RB] VENTILATION.** The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RE] VENTILATION AIR.** For the definition applicable in Chapter 11, see Section N1101.6.

**[MP] VENTING.** Removal of combustion products to the outdoors.

**[MP] VENTING SYSTEM.** A continuous open passageway from the flue collar of an *appliance* to the outside atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and vent connector, if used, assembled to form the open passageway.

**[MP] VERTICAL PIPE.** Any pipe or fitting that makes an angle of 45 degrees (0.79 rad) or more with the horizontal.

**[RB] VINYL SIDING.** A shaped material, made principally from rigid polyvinyl chloride (PVC), that is used to cover exterior walls of buildings.

**[RE] VISIBLE TRANSMITTANCE (VT).** For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] WALL, RETAINING.** A wall not laterally supported at the top, that resists lateral soil load and other imposed loads.

**[RB] WALLS.** Walls shall be defined as follows:

**Load-bearing wall.** A wall supporting any vertical load in addition to its own weight.

**Nonbearing wall.** A wall which does not support vertical loads other than its own weight.

**[MP] WASTE.** Liquidborne waste that is free of fecal matter.

**[MP] WASTE PIPE OR STACK.** Piping that conveys only liquid sewage not containing fecal material.

**[MP] WASTE RECEPTOR.** A floor sink, standpipe, hub drain or a floor drain that receives the discharge of one or more indirect waste pipes.

**[MP] WATER DISTRIBUTION SYSTEM.** Piping that conveys water from the service to the plumbing fixtures, *appliances*, appurtenances, equipment, devices or other systems served, including fittings and control valves.

**[MP] WATER HEATER.** Any heating *appliance* or equipment that heats potable water and supplies such water to the potable hot water distribution system.

**[MP] WATER MAIN.** A water supply pipe for public use.

**[MP] WATER OUTLET.** A valved discharge opening, including a hose bibb, through which water is removed from the potable water system supplying water to a plumbing fixture or plumbing *appliance* that requires either an *air gap* or backflow prevention device for protection of the supply system.

**[MP] WATER SERVICE PIPE.** The outside pipe from the water main or other source of potable water supply to the water distribution system inside the building, terminating at the service valve.

**[MP] WATER SUPPLY SYSTEM.** The water service pipe, the water-distributing pipes and the necessary connecting pipes, fittings, control valves and appurtenances in or adjacent to the building or premises.

**[RB] WATER-RESISTIVE BARRIER.** A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

**[MP] WET VENT.** A vent that receives the discharge of wastes from other fixtures.

**[MP] WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM.** An exhaust system, supply system, or combination thereof that is designed to mechanically



## DEFINITIONS

exchange indoor air for outdoor air where operating continuously or through a programmed intermittent schedule to satisfy the whole-house ventilation rate.

For the definition applicable in Chapter 11, see Section N1101.6.

**[RB] WINDBORNE DEBRIS REGION.** Areas within *hurricane-prone regions* located in accordance with one of the following:

1. Within 1 mile (1.61 km) of the coastal mean high-water line where the ultimate design wind speed,  $V_{ult}$ , is 130 mph (58 m/s) or greater.
2. In areas where an Exposure D condition exists upwind at the waterline and the ultimate design wind speed,  $V_{ult}$ , is 140 mph (63 m/s) or greater; or Hawaii.

**[RB] WINDER.** A tread with nonparallel edges.

**[RB] WOOD STRUCTURAL PANEL.** A panel manufactured from veneers; or wood strands or wafers; bonded together with waterproof synthetic resins or other suitable bonding systems. Examples of wood structural panels are plywood, orientated strand board (OSB) or composite panels.

**[RB] YARD.** An open space, other than a court, unobstructed from the ground to the sky, except where specifically provided by this code, on the *lot* on which a building is situated.

**[RE] ZONE.** For the definition applicable in Chapter 11, see Section N1101.6.

# Part III—Building Planning and Construction

## CHAPTER 3 BUILDING PLANNING

### User note:

**About this chapter:** Chapter 3 contains a wide array of building planning requirements that are critical to designing a safe and usable building. This includes, but is not limited to, requirements related to general structural design, fire-resistant construction, light, ventilation, sanitation, plumbing fixture clearances, minimum room area and ceiling height, safety glazing, means of egress, automatic fire sprinkler systems, smoke and carbon monoxide alarm systems, accessibility, solar energy systems, swimming pools, spas and hot tubs.

### SECTION R301 DESIGN CRITERIA

**R301.1 Application.** Buildings and structures, and parts thereof, shall be constructed to safely support all loads, including dead loads, *live loads*, roof loads, flood loads, snow loads, wind loads and seismic loads as prescribed by this code. The construction of buildings and structures in accordance with the provisions of this code shall result in a system that provides a complete load path that meets the requirements for the transfer of loads from their point of origin through the load-resisting elements to the foundation. Buildings and structures constructed as prescribed by this code are deemed to comply with the requirements of this section.

**R301.1.1 Alternative provisions.** As an alternative to the requirements in Section R301.1, the following standards are permitted subject to the limitations of this code and the limitations therein. Where engineered design is used in conjunction with these standards, the design shall comply with the *International Building Code*.

1. AWC *Wood Frame Construction Manual* (WFCM).
2. AISI *Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings* (AIS S230).
3. ICC *Standard on the Design and Construction of Log Structures* (ICC 400).

**R301.1.2 Construction systems.** The requirements of this code are based on platform and balloon-frame construction for light-frame buildings. The requirements for concrete and masonry buildings are based on a balloon framing system. Other framing systems must have equivalent detailing to ensure force transfer, continuity and compatible deformations.

**R301.1.3 Engineered design.** Where a building of otherwise conventional construction contains structural elements exceeding the limits of Section R301 or otherwise not conforming to this code, these elements shall be designed in accordance with accepted engineering practice. The extent of such design need only demonstrate

compliance of nonconventional elements with other applicable provisions and shall be compatible with the performance of the conventional framed system. Engineered design in accordance with the *International Building Code* is permitted for buildings and structures, and parts thereof, included in the scope of this code.

**R301.1.4 Intermodal shipping containers.** Intermodal shipping containers that are repurposed for use as buildings or structures shall be designed in accordance with the structural provisions in Section 3115 of the *International Building Code*.

**R301.2 Climatic and geographic design criteria.** Buildings shall be constructed in accordance with the provisions of this code as limited by the provisions of this section. Additional criteria shall be established by the local *jurisdiction* and set forth in Table R301.2.

**R301.2.1 Wind design criteria.** Buildings and portions thereof shall be constructed in accordance with the wind provisions of this code using the ultimate design wind speed in Table R301.2 as determined from Figure R301.2(2). The structural provisions of this code for wind loads are not permitted where wind design is required as specified in Section R301.2.1.1. Where different construction methods and structural materials are used for various portions of a building, the applicable requirements of this section for each portion shall apply. Where not otherwise specified, the wind loads listed in Table R301.2.1(1) adjusted for height and exposure using Table R301.2.1(2) shall be used to determine design load performance requirements for wall coverings, curtain walls, roof coverings, exterior windows, skylights, garage doors and exterior doors. Asphalt shingles shall be designed for wind speeds in accordance with Section R905.2.4. *Metal roof shingles* shall be designed for wind speeds in accordance with Section R905.4.4. A continuous load path shall be provided to transmit the applicable uplift forces in Section R802.11 from the *roof assembly* to the foundation. Where ultimate design wind speeds in Figure R301.2(2) are less than the lowest wind speed indicated in the prescriptive provisions of this code, the lowest wind speed indicated in the prescriptive provisions of this code shall be used.

**R301.2.1.1 Wind limitations and wind design required.** The wind provisions of this code shall not apply to the design of buildings where wind design is required in accordance with Figure R301.2.1.1, or where the ultimate design wind speed,  $V_{ult}$ , in Figure R301.2(2) equals or exceeds 140 miles per hour (225 kph) in a special wind region.

**Exceptions:**

1. For concrete construction, the wind provisions of this code shall apply in accordance with the limitations of Sections R404 and R608.
2. For structural insulated panels, the wind provisions of this code shall apply in accordance with the limitations of Section R610.
3. For cold-formed steel *light-frame construction*, the wind provisions of this code shall apply in accordance with the limitations of Sections R505, R603 and R804.

In regions where wind design is required in accordance with Figure R301.2.1.1 or where the ultimate design wind speed,  $V_{ult}$ , in Figure R301.2(2) equals or exceeds 140 miles per hour (225 kph) in a special wind region, the design of buildings for wind loads shall be in accordance with one or more of the following methods:

1. AWC *Wood Frame Construction Manual* (WFCM).
2. ICC *Standard for Residential Construction in High-Wind Regions* (ICC 600).
3. ASCE *Minimum Design Loads for Buildings and Other Structures* (ASCE 7).
4. AISI *Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings* (AISI S230).
5. *International Building Code*.

The elements of design not addressed by the methods in Items 1 through 5 shall be in accordance with the provisions of this code.

Where ASCE 7 or the *International Building Code* is used for the design of the building, the wind speed map and exposure category requirements as specified in ASCE 7 and the *International Building Code* shall be used.

**R301.2.1.1.1 Sunrooms.** *Sunrooms* shall comply with AAMA/NPEA/NSA 2100. For the purpose of applying the criteria of AAMA/NPEA/NSA 2100 based on the intended use, *sunrooms* shall be identified as one of the following categories by the permit applicant, *design professional* or the property owner or owner's agent in the *construction documents*. Component and cladding pressures shall be used for the design of elements that do not qualify as main windforce-resisting systems. Main windforce-resisting system pressures shall be used for the design of elements assigned to provide support and stability for the overall *sunroom*.

**Category I:** A thermally isolated *sunroom* with walls that are open or enclosed with insect

screening or 0.5 mm (20 mil) maximum thickness plastic film. The space is nonhabitable and unconditioned.

**Category II:** A thermally isolated *sunroom* with enclosed walls. The openings are enclosed with translucent or transparent plastic or glass. The space is nonhabitable and unconditioned.

**Category III:** A thermally isolated *sunroom* with enclosed walls. The openings are enclosed with translucent or transparent plastic or glass. The *sunroom* fenestration complies with additional requirements for air infiltration resistance and water penetration resistance. The space is nonhabitable and unconditioned.

**Category IV:** A thermally isolated *sunroom* with enclosed walls. The *sunroom* is designed to be heated or cooled by a separate temperature control or system and is thermally isolated from the primary structure. The *sunroom* fenestration complies with additional requirements for water penetration resistance, air infiltration resistance and thermal performance. The space is nonhabitable and conditioned.

**Category V:** A *sunroom* with enclosed walls. The *sunroom* is designed to be heated or cooled and is open to the main structure. The *sunroom* fenestration complies with additional requirements for water penetration resistance, air infiltration resistance and thermal performance. The space is habitable and conditioned.

**R301.2.1.2 Protection of openings.** Exterior glazing in buildings located in *windborne debris regions* shall be protected from windborne debris. Glazed opening protection for windborne debris shall meet the requirements of the Large Missile Test of ASTM E1886 and ASTM E1996 as modified in Section 301.2.1.2.1. Garage door glazed opening protection for windborne debris shall meet the requirements of an *approved* impact-resisting standard or ANSI/DASMA 115.

**Exception:** *Wood structural panels* with a thickness of not less than  $\frac{7}{16}$  inch (11 mm) and a span of not more than 8 feet (2438 mm) shall be permitted for opening protection. Panels shall be precut and attached to the framing surrounding the opening containing the product with the glazed opening. Panels shall be predrilled as required for the anchorage method and shall be secured with the attachment hardware provided. Attachments shall be designed to resist the component and cladding loads determined in accordance with either Table R301.2.1(1) or ASCE 7, with the permanent corrosion-resistant attachment hardware provided and anchors permanently installed on the building. Attachment in accordance with Table R301.2.1.2 is permitted for buildings with a mean roof height of 45 feet (13 728 mm) or less where the ultimate design wind speed,  $V_{ult}$ , is 180 mph (290 kph) or less.

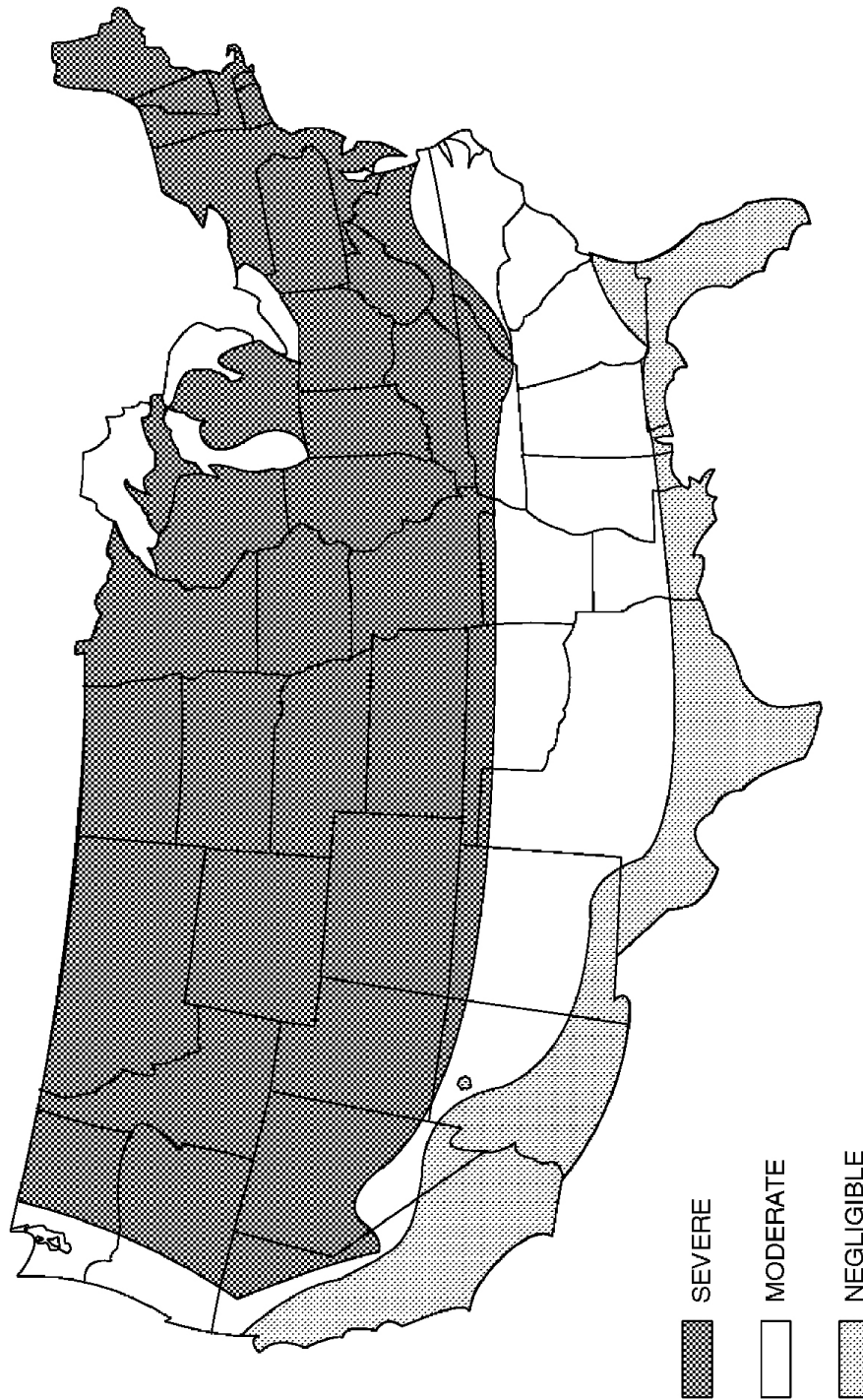
**TABLE R301.2  
CLIMATIC AND GEOGRAPHIC DESIGN CRITERIA**

GROUND SNOW LOAD <sup>o</sup>	WIND DESIGN			SEISMIC DESIGN CATEGORY <sup>i</sup>	SUBJECT TO DAMAGE FROM			ICE BARRIER UNDERLAYMENT REQUIRED <sup>n</sup>	FLOOD HAZARDS <sup>g</sup>	AIR FREEZING INDEX <sup>j</sup>	MEAN ANNUAL TEMP <sup>i</sup>
	Speed <sup>d</sup> (mph)	Topographic effects <sup>k</sup>	Special wind region <sup>l</sup>		Windborne debris zone <sup>m</sup>	Weathering <sup>a</sup>	Frost line depth <sup>b</sup>	Termite <sup>c</sup>			
—	—	—	—	—	—	—	—	—	—	—	—
<b>MANUAL J DESIGN CRITERIA<sup>a</sup></b>											
Elevation			Altitude correction factor <sup>e</sup>	Indoor winter design dry-bulb temperature	Coincident wet bulb	Indoor winter design dry-bulb temperature	Indoor winter design dry-bulb temperature	Outdoor winter design dry-bulb temperature	Heating temperature difference		
—			—	—	—	—	—	—	—	—	—
Latitude			Daily range	Summer design gains	Indoor summer design relative humidity	Indoor summer design dry-bulb temperature	Indoor summer design dry-bulb temperature	Outdoor summer design dry-bulb temperature	Cooling temperature difference		
—			—	—	—	—	—	—	—	—	—

For SI: 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

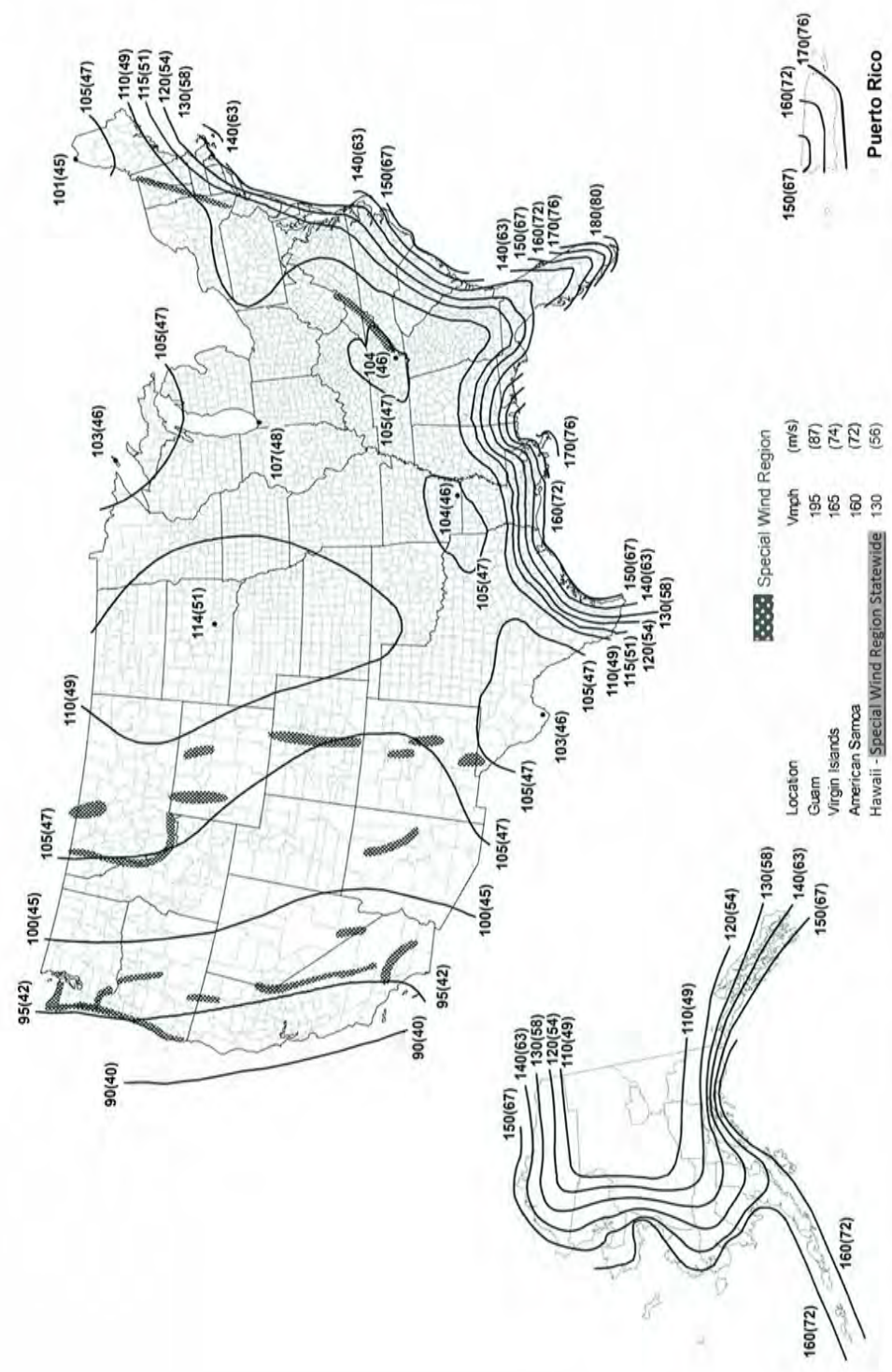
- a. Where weathering requires a higher strength concrete or grade of masonry than necessary to satisfy the structural requirements of this code, the frost line depth strength required for weathering shall govern. The weathering column shall be filled in with the weathering index, "negligible," "moderate" or "severe" for concrete as determined from Figure R301.2(1). The grade of masonry units shall be determined from ASTM C34, ASTM C55, ASTM C62, ASTM C73, ASTM C90, ASTM C129, ASTM C145, ASTM C216 or ASTM C652.
- b. Where the frost line depth requires deeper footings than indicated in Figure R403.1(1), the frost line depth strength required for weathering shall govern. The jurisdiction shall fill in the frost line depth column with the minimum depth of footing below finish grade.
- c. The jurisdiction shall fill in this part of the table to indicate the need for protection depending on whether there has been a history of local subterranean termite damage.
- d. The jurisdiction shall fill in this part of the table with the wind speed map [Figure R301.2(2)]. Wind exposure category shall be determined on a site-specific basis in accordance with Section R301.2.1.4.
- e. The jurisdiction shall fill in this section of the table to establish the design criteria using Table 10A from ACCA Manual J or established criteria determined by the jurisdiction.
- f. The jurisdiction shall fill in this part of the table with the seismic design category determined from Section R301.2.2.1.
- g. The jurisdiction shall fill in this part of the table with: the date of the jurisdiction's entry into the National Flood Insurance Program (date of adoption of the first code or ordinance for management of flood hazard areas); and the title and date of the currently effective Flood Insurance Study or other flood hazard study and maps adopted by the authority having jurisdiction, as amended.
- h. In accordance with Sections R905.1.2, R905.4.3.1, R905.5.3.1, R905.6.3.1, R905.7.3.1 and R905.8.3.1, where there has been a history of local damage from the effects of ice damming, the jurisdiction shall fill in this part of the table with "YES." Otherwise, the jurisdiction shall fill in this part of the table with "NO."
- i. The jurisdiction shall fill in this part of the table with the 100-year return period air freezing index (BF-days) from Figure R403.3(2) or from the 100-year (99 percent) value on the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°F)."
- j. The jurisdiction shall fill in this part of the table with the mean annual temperature from the National Climatic Data Center data table "Air Freezing Index-USA Method (Base 32°F)."
- k. In accordance with Section R301.2.1.5, where there is local historical data documenting structural damage to buildings due to topographic wind speed-up effects, the jurisdiction shall fill in this part of the table with "YES." Otherwise, the jurisdiction shall indicate "NO" in this part of the table.
- l. In accordance with Figure R301.2(2), where there is local historical data documenting unusual wind conditions, the jurisdiction shall fill in this part of the table with "YES" and identify any specific requirements. Otherwise, the jurisdiction shall indicate "NO" in this part of the table.
- m. In accordance with Section R301.2.1.2 the jurisdiction shall indicate the wind-borne debris wind zone(s). Otherwise, the jurisdiction shall indicate "NO" in this part of the table.
- n. The jurisdiction shall fill in these sections of the table to establish the design criteria using Table 1a or 1b from ACCA Manual J or established criteria determined by the jurisdiction.
- o. The jurisdiction shall fill in this section of the table using the Ground Snow Loads in Figures R301.2(3) and R301.2(4).





a. Alaska and Hawaii are classified as severe and negligible, respectively.  
b. Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by region classification. A severe classification is where weather conditions result in significant snowfall combined with extended periods during which there is little or no natural thawing, causing deicing salts to be used extensively.

FIGURE R301.2(1)  
WEATHERING PROBABILITY MAP FOR CONCRETE<sup>a, b</sup>

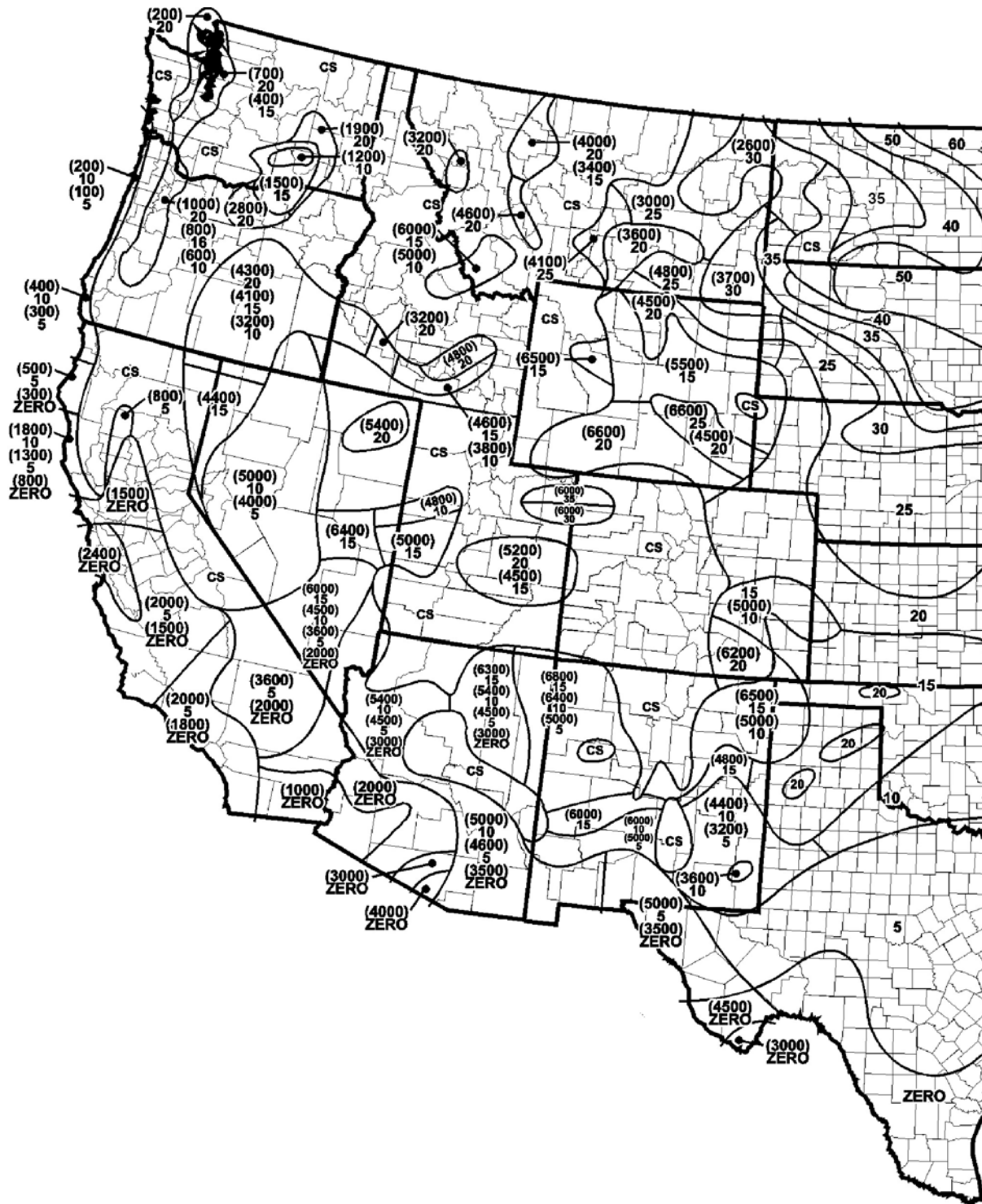


**Notes:**

1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation is permitted between contours. Point values are provided to aid with interpolation.
3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).
6. Location-specific basic wind speeds shall be determined using [www.atcouncil.org/windspeed](http://www.atcouncil.org/windspeed)

FIGURE R301.2(2)  
ULTIMATE DESIGN WIND SPEEDS

## BUILDING PLANNING



For SI: 1 foot = 34.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile = 1.61 km.

- In CS areas, site-specific case studies are required to establish ground snow loads. Extreme local variations in ground snow loads in these areas preclude mapping at this scale.
- Numbers in parentheses represent the upper elevation limits in feet for the ground snow load values presented below. Site-specific case studies are required to establish ground snow loads at elevations not covered.

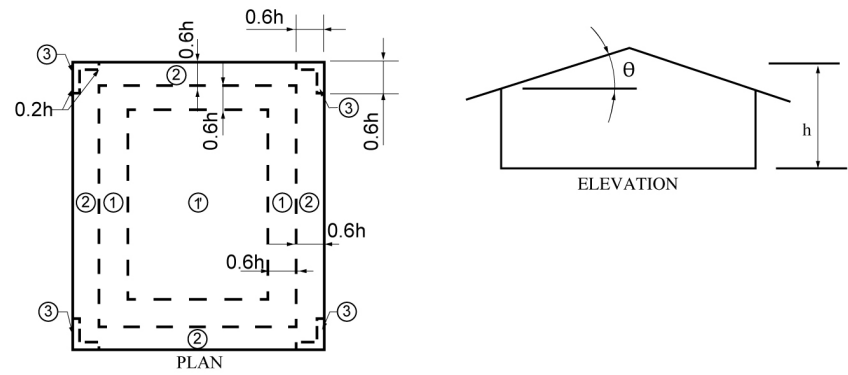
**FIGURE R301.2(3)**  
**GROUND SNOW LOADS,  $P_g$ , FOR THE UNITED STATES (lb/ft<sup>2</sup>)**



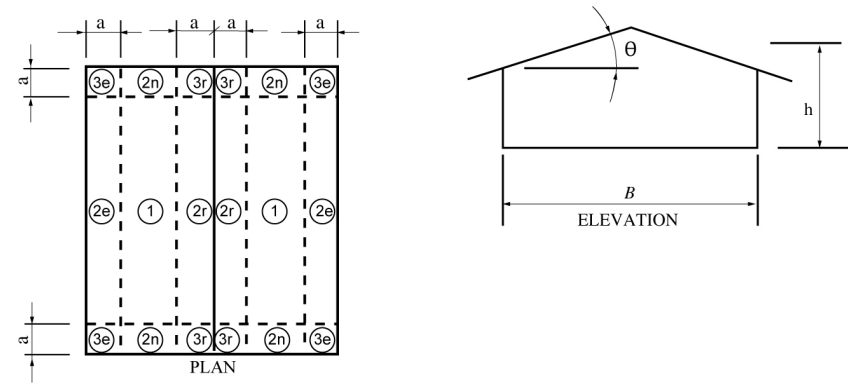




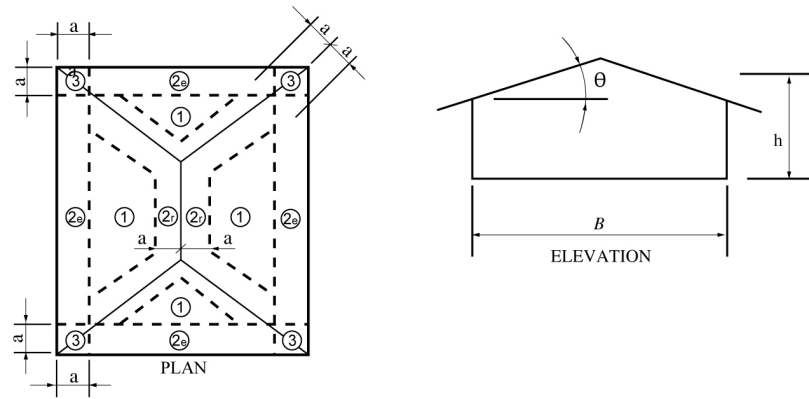
BUILDING PLANNING



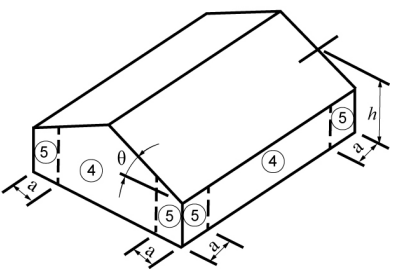
Gable and Flat Roofs  $\theta \leq 7^\circ$



Gable and Flat Roofs  $7^\circ < \theta \leq 45^\circ$



Hip Roofs  $7^\circ < \theta \leq 45^\circ$



For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.  
**Note:** a = 4 feet in all cases.

FIGURE R301.2.1  
COMPONENT AND CLADDING PRESSURE ZONES

**TABLE R301.2.1(1)**  
**COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf)<sup>a, b, c, d, e, f, g</sup>**

ZONE		EFFECTIVE WIND AREAS (square feet)		ULTIMATE DESIGN WIND SPEED, $V_{ult}$																										
				90.0		95.0		100.0		105.0		110.0		115.0		120.0		130.0		140.0		150.0		160.0		170.0		180.0		
		Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	
Flat and gable roof 0 to 7 degrees	1	3.6	-13.9	4.0	-15.5	4.4	-17.2	4.8	-19.0	5.3	-20.8	5.8	-22.7	6.3	-24.8	7.4	-29.1	8.6	-33.7	9.9	-38.7	11.2	-44.0	12.7	-49.7	14.2	-55.7			
	1	3.3	-13.0	3.7	-14.5	4.1	-16.0	4.5	-17.7	5.0	-19.4	5.4	-21.2	5.9	-23.1	7.0	-27.1	8.1	-31.4	9.3	-36.1	10.5	-41.1	11.9	-46.4	13.3	-52.0			
	1	3.0	-11.8	3.4	-13.1	3.8	-14.5	4.1	-16.0	4.5	-17.6	5.0	-19.2	5.4	-20.9	6.3	-24.5	7.4	-28.4	8.4	-32.6	9.6	-37.1	10.8	-41.9	12.2	-47.0			
	1	2.8	-10.8	3.1	-12.1	3.5	-13.4	3.8	-14.7	4.2	-16.2	4.6	-17.7	5.0	-19.2	5.9	-22.6	6.8	-26.2	7.8	-30.0	8.9	-34.2	10.0	-38.6	11.3	-43.3			
	2	3.6	-18.4	4.0	-20.5	4.4	-22.7	4.8	-25.0	5.3	-27.4	5.8	-30.0	6.3	-32.7	7.4	-38.3	8.6	-44.5	9.9	-51.0	11.2	-58.1	12.7	-65.6	14.2	-73.5			
	2	3.3	-17.2	3.7	-19.2	4.1	-21.2	4.5	-23.4	5.0	-25.7	5.4	-28.1	5.9	-30.6	7.0	-35.9	8.1	-41.6	9.3	-47.8	10.5	-54.3	11.9	-61.4	13.3	-68.8			
	2	3.0	-15.6	3.4	-17.4	3.8	-19.3	4.1	-21.3	4.5	-23.3	5.0	-25.5	5.4	-27.8	6.3	-32.6	7.4	-37.8	8.4	-43.4	9.6	-49.4	10.8	-55.8	12.2	-62.5			
	2	2.8	-14.4	3.1	-16.1	3.5	-17.8	3.8	-19.7	4.2	-21.6	4.6	-23.6	5.0	-25.7	5.9	-30.1	6.8	-35.0	7.8	-40.1	8.9	-45.7	10.0	-51.5	11.3	-57.8			
	3	3.6	-25.0	4.0	-27.9	4.4	-30.9	4.8	-34.1	5.3	-37.4	5.8	-40.9	6.3	-44.5	7.4	-52.2	8.6	-60.6	9.9	-69.6	11.2	-79.1	12.7	-89.4	14.2	-100.2			
	3	3.3	-22.6	3.7	-25.2	4.1	-28.0	4.5	-30.8	5.0	-33.8	5.4	-37.0	5.9	-40.3	7.0	-47.2	8.1	-54.8	9.3	-62.9	10.5	-71.6	11.9	-80.8	13.3	-90.6			
Gable roof > 7 to 20 degrees	3	3.0	-19.4	3.4	-21.7	3.8	-24.0	4.1	-26.5	4.5	-29.0	5.0	-31.7	5.4	-34.6	6.3	-40.6	7.4	-47.0	8.4	-54.0	9.6	-61.4	10.8	-69.4	12.2	-77.8			
	3	2.8	-17.4	3.1	-19.0	3.5	-21.0	3.8	-23.2	4.2	-25.5	4.6	-27.8	5.0	-30.3	5.9	-35.6	6.8	-41.2	7.8	-47.3	8.9	-53.9	10.0	-60.8	11.3	-68.2			
	1, 2e	5.4	-16.2	6.0	-18.0	6.7	-19.9	7.4	-22.0	8.1	-24.1	8.8	-26.4	9.6	-28.7	11.3	-33.7	13.1	39.1	15.0	44.9	17.1	-51.0	19.3	-57.6	21.6	-64.6			
	1, 2e	4.9	-16.2	5.4	-18.0	6.0	-19.9	6.6	-22.0	7.2	-24.1	7.9	-26.4	8.6	-28.7	10.1	-33.7	11.7	39.1	13.5	44.9	15.3	-51.0	17.3	-57.6	19.4	-64.6			
	1, 2e	4.1	-9.9	4.6	-11.0	5.1	-12.2	5.6	-13.4	6.1	-14.7	6.7	-16.1	7.3	-17.5	8.6	-20.6	10.0	-23.8	11.4	-27.4	13.0	-31.1	14.7	-35.2	16.4	-39.4			
	1, 2e	3.6	-5.0	4.0	-5.6	4.4	-6.2	4.8	-6.9	5.3	-7.5	5.8	-8.2	6.3	-9.0	7.4	-10.5	8.6	-12.2	9.9	-14.0	11.2	-15.9	12.7	-18.0	14.2	-20.2			
	2n, 2r, 3e	5.4	-23.6	6.0	-26.3	6.7	-29.1	7.4	-32.1	8.1	-35.2	8.8	-38.5	9.6	-41.9	11.3	-49.2	13.1	57.0	15.0	65.4	17.1	-74.5	19.3	-84.1	21.6	-94.2			
	2n, 2r, 3e	4.9	-20.3	5.4	-22.7	6.0	-25.1	6.6	-27.7	7.2	-30.4	7.9	-33.2	8.6	-36.2	10.1	-42.4	11.7	49.2	13.5	56.5	15.3	-64.3	17.3	-72.6	19.4	-81.4			
	2n, 2r, 3e	4.1	-16.0	4.6	-17.9	5.1	-19.8	5.6	-21.8	6.1	-24.0	6.7	-26.2	7.3	-28.5	8.6	-33.5	10.0	-38.8	11.4	-44.6	13.0	-50.7	14.7	-57.2	16.4	-64.2			
	2n, 2r, 3e	3.6	-12.8	4.0	-14.3	4.4	-15.8	4.8	-17.4	5.3	-19.1	5.8	-20.9	6.3	-22.8	7.4	-26.7	8.6	-31.0	9.9	-35.6	11.2	-40.5	12.7	-45.7	14.2	-51.3			
Gable roof > 20 to 27 degrees	3r	5.4	-28.0	6.0	-30.2	6.7	-34.6	7.4	-38.1	8.1	-41.8	8.8	-45.7	9.6	-49.8	11.3	-58.4	13.1	67.8	15.0	77.8	17.1	-88.5	19.3	-99.9	21.6	-112.0			
	3r	4.9	-24.0	5.4	-26.7	6.0	-29.6	6.6	-32.7	7.2	-35.9	7.9	-39.2	8.6	-42.7	10.1	-50.1	11.7	58.1	13.5	66.7	15.3	-75.9	17.3	-85.6	19.4	-96.0			
	3r	4.1	-18.7	4.6	-20.8	5.1	-23.1	5.6	-25.4	6.1	-27.9	6.7	-30.5	7.3	-33.2	8.6	-39.0	10.0	45.2	11.4	51.9	13.0	-59.0	14.7	-66.6	16.4	-74.7			
	3r	3.6	-14.7	4.0	-16.3	4.4	-18.1	4.8	-20.0	5.3	-21.9	5.8	-24.0	6.3	-26.1	7.4	-30.6	8.6	35.5	9.9	40.8	11.2	-46.4	12.7	-52.3	14.2	-58.7			
	1, 2e	6.5	-12.4	7.3	-13.9	8.0	-15.4	8.9	-16.9	9.7	-18.6	10.6	-20.3	11.6	-22.1	13.6	-26.0	15.8	30.1	18.1	34.6	20.6	-39.3	23.3	24.4	26.1	49.9			
	1, 2e	5.6	-12.4	6.3	-13.9	7.0	-15.4	7.7	-16.9	8.4	-18.6	9.2	-20.3	10.0	-22.1	11.7	-26.0	13.6	30.1	15.6	34.6	17.8	-39.3	20.1	44.4	22.5	49.8			
	1, 2e	4.4	-10.6	5.0	-11.8	5.5	-13.1	6.1	-14.4	6.6	-15.8	7.3	-17.3	7.9	-18.8	9.3	-22.1	10.8	25.6	12.3	29.4	14.0	-33.5	15.9	37.8	17.8	42.4			
	1, 2e	3.6	-9.1	4.0	-10.2	4.4	-11.3	4.8	-12.4	5.3	-13.6	5.8	-14.9	6.3	-16.2	7.4	-19.0	8.6	22.1	9.9	25.3	11.2	-28.8	12.7	32.5	14.2	36.5			
	2n, 2r, 3e	6.5	-19.9	7.3	-22.1	8.0	-24.5	8.9	-27.0	9.7	-29.7	10.6	-32.4	11.6	-35.3	13.6	-41.4	15.8	48.0	18.1	55.2	20.6	-62.8	23.3	23.3	26.1	79.4			
	2n, 2r, 3e	5.6	-17.4	6.3	-19.4	7.0	-21.5	7.7	-23.7	8.4	-26.0	9.2	-28.4	10.0	-31.0	11.7	-36.3	13.6	42.1	15.6	48.4	17.8	-55.0	20.1	20.1	22.5	69.6			
2n, 2r, 3e	4.4	-14.2	5.0	-15.8	5.5	-17.5	6.1	-19.3	6.6	-21.1	7.3	-23.1	7.9	-25.2	9.3	-29.5	10.8	34.2	12.3	39.3	14.0	-44.7	15.9	15.9	17.8	56.6				
2n, 2r, 3e	3.6	-11.7	4.0	-13.0	4.4	-14.5	4.8	-15.9	5.3	-17.5	5.8	-19.1	6.3	-20.8	7.4	-24.4	8.6	28.3	9.9	32.5	11.2	-37.0	12.7	12.7	14.2	46.8				
3r	10.0	6.5	-23.6	7.3	-26.3	8.0	-29.1	8.9	-32.1	9.7	-35.2	10.6	-38.5	11.6	-41.9	13.6	-49.2	15.8	57.0	18.1	65.4	20.6	-74.5	23.3	23.3	26.1	94.2			
3r	20.0	5.6	-19.9	6.3	-22.1	7.0	-24.5	7.7	-27.0	8.4	-29.7	9.2	-32.4	10.0	-35.3	11.7	-41.4	13.6	48.0	15.6	55.2	17.8	-62.8	20.1	20.1	22.5	79.4			
3r	50.0	4.4	-14.7	5.0	-16.3	5.5	-18.1	6.1	-20.0	6.6	-21.9	7.3	-24.0	7.9	-26.1	9.3	-30.6	10.8	35.5	12.3	40.8	14.0	-46.4	15.9	15.9	17.8	58.7			
3r	100.0	3.6	-14.7	4.0	-16.3	4.4	-18.1	4.8	-20.0	5.3	-21.9	5.8	-24.0	6.3	-26.1	7.4	-30.6	8.6	22.1	9.9	25.3	11.2	-28.8	12.7	32.5	14.2	36.5			

(continued)

## BUILDING PLANNING

TABLE R301.2.1(1)—continued  
 COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf) <sup>a, b, c, d, e, f, g</sup>

		EFFECTIVE WIND AREAS (square feet)		90.0		95.0		105.0		115.0		130.0		150.0		170.0		170.0	
				Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Gable roof > 27 to 45 degrees	1, 2e, 2r	10.0		8.0	-14.7	8.9	-16.3	9.9	-18.1	10.9	-20.0	12.0	-21.9	13.1	-24.0	14.2	-26.1	16.7	-30.6
	1, 2e, 2r	20.0		7.1	-12.4	7.9	-13.9	8.8	-15.4	9.7	-16.9	10.6	-18.6	11.6	-20.3	12.6	-22.1	14.8	-26.0
	1, 2e, 2r	50.0		5.9	-9.5	6.6	-10.6	7.3	-11.7	8.1	-12.9	8.9	-14.2	9.7	-15.5	10.5	-16.9	12.4	-19.8
	1, 2e, 2r	100.0		5.0	-7.3	5.6	-8.1	6.2	-9.0	6.9	-9.9	7.5	-10.8	8.2	-11.9	9.0	-12.9	10.5	-15.1
	2n, 3r	10.0		8.0	-16.2	8.9	-18.0	9.9	-19.9	10.9	-22.0	12.0	-24.1	13.1	-26.4	14.2	-28.7	16.7	-33.7
	2n, 3r	20.0		7.1	-14.4	7.9	-16.1	8.8	-17.8	9.7	-19.7	10.6	-21.6	11.6	-23.6	12.6	-25.7	14.8	-30.1
	2n, 3r	50.0		5.9	-12.2	6.6	-13.5	7.3	-15.0	8.1	-16.5	8.9	-18.2	9.7	-19.9	10.5	-21.6	12.4	-25.4
	2n, 3r	100.0		5.0	-10.4	5.6	-11.6	6.2	-12.9	6.9	-14.2	7.5	-15.6	8.2	-17.1	9.0	-18.6	10.5	-21.8
	3e	10.0		8.0	-19.9	8.9	-22.1	9.9	-24.5	10.9	-27.0	12.0	-29.7	13.1	-32.4	14.2	-35.3	16.7	-41.4
	3e	20.0		7.1	-17.6	7.9	-19.6	8.8	-21.8	9.7	-24.0	10.6	-26.3	11.6	-28.8	12.6	-31.3	14.8	-36.8
Hipped roof > 7 to 20 degrees <sup>f</sup>	3e	50.0		5.9	-14.7	6.6	-16.3	7.3	-18.1	8.1	-20.0	8.9	-21.9	9.7	-24.0	10.5	-26.1	12.4	-30.6
	3e	100.0		5.0	-12.4	5.6	-13.9	6.2	-15.4	6.9	-16.9	7.5	-18.6	8.2	-20.3	9.0	-22.1	10.5	-26.0
	1	10.0		6.5	-14.7	7.3	-16.3	8.0	-18.1	8.9	-20.0	9.7	-21.9	10.6	-24.0	11.6	-26.1	13.6	-30.6
	1	20.0		5.6	-14.7	6.3	-16.3	7.0	-18.1	7.7	-20.0	8.4	-21.9	9.2	-24.0	10.0	-26.1	11.7	-30.6
	1	50.0		4.4	-11.3	5.0	-12.6	5.5	-14.0	6.1	-15.4	6.6	-16.9	7.3	-18.5	7.9	-20.2	9.3	-23.7
	1	100.0		3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2
	2r	10.0		6.5	-19.1	7.3	-21.3	8.0	-23.6	8.9	-26.0	9.7	-28.6	10.6	-31.2	11.6	-34.0	13.6	-39.9
	2r	20.0		5.6	-17.2	6.3	-19.2	7.0	-21.3	7.7	-23.4	8.4	-25.7	9.2	-28.1	10.0	-30.6	11.7	-35.9
	2r	50.0		4.4	-14.7	5.0	-16.4	5.5	-18.2	6.1	-20.0	6.6	-22.0	7.3	-24.0	7.9	-26.1	9.3	-30.7
	2r	100.0		3.6	-12.8	4.0	-14.3	4.4	-15.8	4.8	-17.4	5.3	-19.1	5.8	-20.9	6.3	-22.8	7.4	-26.7
Hipped roof > 20 to 27 degrees	2e, 3	10.0		6.5	-20.6	7.3	-22.9	8.0	-25.4	8.9	-28.0	9.7	-30.8	10.6	-33.6	11.6	-36.6	13.6	-43.0
	2e, 3	20.0		5.6	-18.5	6.3	-20.6	7.0	-22.9	7.7	-25.2	8.4	-27.7	9.2	-30.3	10.0	-32.9	11.7	-38.7
	2e, 3	50.0		4.4	-15.8	5.0	-17.6	5.5	-19.5	6.1	-21.5	6.6	-23.6	7.3	-25.8	7.9	-28.0	9.3	-32.9
	2e, 3	100.0		3.6	-13.7	4.0	-15.3	4.4	-16.9	4.8	-18.7	5.3	-20.5	5.8	-22.4	6.3	-24.4	7.4	-28.6
	1	10.0		6.5	-11.7	7.3	-13.0	8.0	-14.5	8.9	-15.9	9.7	-17.5	10.6	-19.1	11.6	-20.8	13.6	-24.4
	1	20.0		5.6	-10.4	6.3	-11.6	7.0	-12.8	7.7	-14.1	8.4	-15.5	9.2	-16.9	10.0	-18.4	11.7	-21.6
	1	50.0		4.4	-8.6	5.0	-9.6	5.5	-10.6	6.1	-11.7	6.6	-12.8	7.3	-14.0	7.9	-15.3	9.3	-17.9
	1	100.0		3.6	-7.3	4.0	-8.1	4.4	-9.0	4.8	-9.9	5.3	-10.8	5.8	-11.9	6.3	-12.9	7.4	-15.1
	2e, 2r, 3	10.0		6.5	-16.2	7.3	-18.0	8.0	-19.9	8.9	-22.0	9.7	-24.1	10.6	-26.4	11.6	-28.7	13.6	-33.7
	2e, 2r, 3	20.0		5.6	-14.4	6.3	-16.1	7.0	-17.8	7.7	-19.7	8.4	-21.6	9.2	-23.6	10.0	-25.7	11.7	-30.1

(continued)

TABLE R301.2.1(1)—continued  
COMPONENT AND CLADDING LOADS FOR A BUILDING WITH A MEAN ROOF HEIGHT OF 30 FEET LOCATED IN EXPOSURE B (ASD) (psf) <sup>a, b, c, d, e, f, g</sup>

ZONE	EFFECTIVE WIND AREAS (square feet)	ULTIMATE DESIGN WIND SPEED, $V_{ult}$																									
		90.0		95.0		105.0		115.0		130.0		150.0		170.0		185.0		195.0		205.0		215.0		225.0			
		Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg		
Hipped roof > 27 to 45 degrees	1	6.2	-12.4	6.9	-13.9	7.7	-15.4	8.5	-16.9	9.3	-18.6	10.2	-20.3	11.1	-22.1	13.0	-26.0	15.1	-30.1	17.3	-34.6	19.7	-39.3	22.2	-44.4	24.9	-49.8
	1	5.4	-11.0	6.0	-12.3	6.7	-13.6	7.4	-15.0	8.1	-16.5	8.9	-18.0	9.6	-19.6	11.3	-23.0	13.1	-26.7	15.1	-30.7	17.1	-34.9	19.4	-39.4	21.7	-44.2
	1	4.4	-9.2	4.9	-10.2	5.4	-11.3	5.9	-12.5	6.5	-13.7	7.1	-15.0	7.7	-16.3	9.1	-19.2	10.5	-22.2	12.1	-25.5	13.8	-29.0	15.5	-32.8	17.4	-36.7
	1	3.6	-7.8	4.0	-8.7	4.4	-9.6	4.8	-10.6	5.3	-11.6	5.8	-12.7	6.3	-13.8	7.4	-16.2	8.6	-18.8	9.9	-21.6	11.2	-24.6	12.7	-27.8	14.2	-31.1
	2e	6.2	-14.8	6.9	-16.5	7.7	-18.3	8.5	-20.2	9.3	-22.1	10.2	-24.2	11.1	-26.3	13.0	-30.9	15.1	-35.9	17.3	-41.2	19.7	-46.8	22.2	-52.9	24.9	-59.3
	2e	5.4	-11.7	6.0	-13.0	6.7	-14.5	7.4	-15.9	8.1	-17.5	8.9	-19.1	9.6	-20.8	11.3	-24.4	13.1	-28.3	15.1	-32.5	17.1	-37.0	19.4	-41.8	21.7	-46.8
	2e	4.4	-7.3	4.9	-8.1	5.4	-9.0	5.9	-6.5	-10.8	7.1	-11.9	7.7	-12.9	9.1	-15.1	10.5	-17.6	12.1	-20.2	13.8	-22.9	15.5	-25.9	17.4	-29.0	
	2e	3.6	-7.3	4.0	-8.1	4.4	-9.0	4.8	-9.9	5.3	-10.8	5.8	-11.9	6.3	-12.9	7.4	-15.1	8.6	-17.6	9.9	-20.2	11.2	-22.9	12.7	-25.9	14.2	-29.0
	2r	6.2	-18.7	6.9	-20.9	7.7	-23.1	8.5	-25.5	9.3	-28.0	10.2	-30.6	11.1	-33.3	13.0	-39.1	15.1	-45.4	17.3	-52.1	19.7	-59.2	22.2	-66.9	24.9	-75.0
	2r	5.4	-15.7	6.0	-17.5	6.7	-19.4	7.4	-21.4	8.1	-23.5	8.9	-25.7	9.6	-28.0	11.3	-32.8	13.1	-38.1	15.1	-43.7	17.1	-49.8	19.4	-56.2	21.7	-63.0
	2r	4.4	-11.7	4.9	-13.1	5.4	-14.5	5.9	-16.0	6.5	-17.5	7.1	-19.2	7.7	-20.9	9.1	-24.5	10.5	-28.4	12.1	-32.6	13.8	-37.1	15.5	-41.9	17.4	-47.0
Wall	2r	3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2	8.6	-21.2	9.9	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
	3	6.2	-20.0	6.9	-22.3	7.7	-24.7	8.5	-27.2	9.3	-29.9	10.2	-32.7	11.1	-35.6	13.0	-41.7	15.1	-48.4	17.3	-55.6	19.7	-63.2	22.2	-71.4	24.9	-80.0
	3	5.4	-15.0	6.0	-16.8	6.7	-18.6	7.4	-20.5	8.1	-22.5	8.9	-24.6	9.6	-26.7	11.3	-31.4	13.1	-36.4	15.1	-41.8	17.1	-47.5	19.4	-53.7	21.7	-60.2
	3	4.4	-8.7	4.9	-9.7	5.4	-10.8	5.9	-11.9	6.5	-13.1	7.1	-14.3	7.7	-15.5	9.1	-18.2	10.5	-21.2	12.1	-24.3	13.8	-27.6	15.5	-31.2	17.4	-35.0
	3	3.6	-8.7	4.0	-9.7	4.4	-10.8	4.8	-11.9	5.3	-13.1	5.8	-14.3	6.3	-15.5	7.4	-18.2	8.6	-21.2	9.9	-24.3	11.2	-27.6	12.7	-31.2	14.2	-35.0
	4	8.7	-9.5	9.7	-10.6	10.8	-11.7	11.9	-12.9	13.1	-14.2	14.3	-15.5	15.5	-16.9	18.2	-19.8	21.2	-22.9	24.3	-26.3	27.6	-30.0	31.2	-33.8	35.0	-37.9
	4	8.3	-9.1	9.3	-10.1	10.3	-11.2	11.4	-12.4	12.5	-13.6	13.6	-14.8	14.8	-16.2	17.4	-19.0	20.2	-22.0	23.2	-25.3	26.4	-28.7	29.8	-32.4	33.4	-36.4
	4	7.8	-8.6	8.7	-9.5	9.7	-10.6	10.7	-11.7	11.7	-12.8	12.8	-14.0	13.9	-15.2	16.3	-17.9	18.9	-20.7	21.7	-23.8	24.7	-27.1	27.9	-30.6	31.3	-34.3
	4	7.4	-8.2	8.3	-9.1	9.2	-10.1	10.1	-11.1	11.1	-12.2	12.1	-13.3	13.2	-14.5	15.5	-17.1	18.0	-19.8	20.6	-22.7	23.5	-25.8	26.5	-29.2	29.7	-32.7
	4	6.5	-7.3	7.3	-8.1	8.0	-9.0	8.9	-9.9	9.7	-10.8	10.6	-11.9	11.6	-12.9	13.5	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0
	5	8.7	-11.7	9.7	-13.0	10.8	-14.5	11.9	-15.9	13.1	-17.5	14.3	-19.1	15.5	-20.8	18.2	-24.4	21.2	-28.3	24.3	-32.5	27.6	-37.0	31.2	-41.8	35.0	-46.8
	5	8.3	-10.9	9.3	-12.2	10.3	-13.5	11.4	-14.9	12.5	-16.3	13.6	-17.8	14.8	-19.4	17.4	-22.8	20.2	-26.4	23.2	-30.3	26.4	-34.5	29.8	-39.0	33.4	-43.7
	5	7.8	-9.9	8.7	-11.0	9.7	-12.2	10.7	-13.4	11.7	-14.7	12.8	-16.1	13.9	-17.5	16.3	-20.6	18.9	-23.9	21.7	-27.4	24.7	-31.2	27.9	-35.2	31.3	-39.5
	5	7.4	-9.1	8.3	-10.1	9.2	-11.2	10.1	-12.4	11.1	-13.6	12.1	-14.8	13.2	-16.1	15.5	-19.0	18.0	-22.0	20.6	-25.2	23.5	-28.7	26.5	-32.4	29.7	-36.3
	5	6.5	-7.3	7.3	-8.1	8.0	-9.0	8.9	-9.9	9.7	-10.8	10.6	-11.9	11.6	-12.9	13.6	-15.1	15.8	-17.6	18.1	-20.2	20.6	-22.9	23.3	-25.9	26.1	-29.0

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

- a. The effective wind area shall be equal to the span length multiplied by an effective width. This width shall be not less than one-third the span length. For cladding fasteners, the effective wind areas shall not be greater than the area that is tributary to an individual fastener.
- b. For effective areas between those given, the load shall be interpolated or the load associated with the lower effective areas shall be used.
- c. Table values shall be adjusted for height and exposure by multiplying by the adjustment coefficient in Table R301.2.1(2).
- d. See Figure R318.4 for locations of termite infestation probability zones.
- e. Plus and minus signs signify pressures acting toward and away from the building surfaces.
- f. Positive and negative design wind pressures shall not be less than 10 psf.
- g. Where the ratio of the building mean roof height to the building length or width is less than 0.8, uplift loads shall be permitted to be calculated in accordance with ASCE 7.



## BUILDING PLANNING

**R301.2.1.2.1 Application of ASTM E1996.** The text of Section 2.2 of ASTM E1996 shall be substituted as follows:

2.2 ASCE Standard:

ASCE 7-10 American Society of Civil Engineers *Minimum Design Loads for Buildings and Other Structures*

The text of Section 6.2.2 of ASTM E1996 shall be substituted as follows:

6.2.2 Unless otherwise specified, select the wind zone based on the ultimate design wind speed,  $V_{ult}$ , as follows:

6.2.2.1 Wind Zone 1–130 mph  $\leq$  ultimate design wind speed,  $V_{ult} < 140$  mph.

6.2.2.2 Wind Zone 2–140 mph  $\leq$  ultimate design wind speed,  $V_{ult} < 150$  mph at greater than 1 mile

(1.6 km) from the coastline. The coastline shall be measured from the mean high-water mark.

6.2.2.3 Wind Zone 3–150 mph (67 m/s)  $\leq$  ultimate design wind speed,  $V_{ult} \leq 170$  mph (76 m/s), or 140 mph (54 m/s)  $\leq$  ultimate design wind speed,  $V_{ult} \leq 170$  mph (76 m/s) and within 1 mile (1.6 km) of the coastline. The coastline shall be measured from the mean high-water mark.

6.2.2.4 Wind Zone 4–ultimate design wind speed,  $V_{ult} > 170$  mph (76 m/s).

**R301.2.1.3 Wind speed conversion.** Where referenced documents are based on nominal design wind speeds and do not provide the means for conversion between ultimate design wind speeds and nominal design wind speeds, the ultimate design wind speeds,  $V_{ult}$ , of Figure R301.2(2) shall be converted to nominal design wind speeds,  $V_{asd}$ , using Table R301.2.1.3.

**TABLE R301.2.1(2)**  
**HEIGHT AND EXPOSURE ADJUSTMENT COEFFICIENTS FOR Table R301.2.1(1)**

MEAN ROOF HEIGHT	EXPOSURE		
	B	C	D
15	0.82	1.21	1.47
20	0.89	1.29	1.55
25	0.94	1.35	1.61
30	1.00	1.40	1.66
35	1.05	1.45	1.70
40	1.09	1.49	1.74
45	1.12	1.53	1.78
50	1.16	1.56	1.81
55	1.19	1.59	1.84
60	1.22	1.62	1.87

**TABLE R301.2.1.2**  
**WINDBORNE DEBRIS PROTECTION FASTENING SCHEDULE FOR WOOD STRUCTURAL PANELS<sup>a, b, c, d</sup>**

FASTENER TYPE	FASTENER SPACING (inches) <sup>a, b</sup>		
	Panel span $\leq$ 4 feet	4 feet < panel span $\leq$ 6 feet	6 feet < panel span $\leq$ 8 feet
No. 8 wood-screw-based anchor with 2-inch embedment length	16	10	8
No. 10 wood-screw-based anchor with 2-inch embedment length	16	12	9
$\frac{1}{4}$ -inch lag-screw-based anchor with 2-inch embedment length	16	16	16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.448 N, 1 mile per hour = 0.447 m/s.

- This table is based on 180 mph ultimate design wind speeds,  $V_{ult}$ , and a 45-foot mean roof height.
- Fasteners shall be installed at opposing ends of the wood structural panel. Fasteners shall be located not less than 1 inch from the edge of the panel.
- Anchors shall penetrate through the exterior wall covering with an embedment length of not less than 2 inches into the building frame. Fasteners shall be located not less than  $2\frac{1}{2}$  inches from the edge of concrete block or concrete.
- Panels attached to masonry or masonry/stucco shall be attached using vibration-resistant anchors having an ultimate withdrawal capacity of not less than 1,500 pounds.

**TABLE R301.2.1.3**  
**WIND SPEED CONVERSIONS<sup>a</sup>**

$V_{ult}$	110	115	120	130	140	150	160	170	180	190	200
$V_{asd}$	85	89	93	101	108	116	124	132	139	147	155

For SI: 1 mile per hour = 0.447 m/s.

- Linear interpolation is permitted.

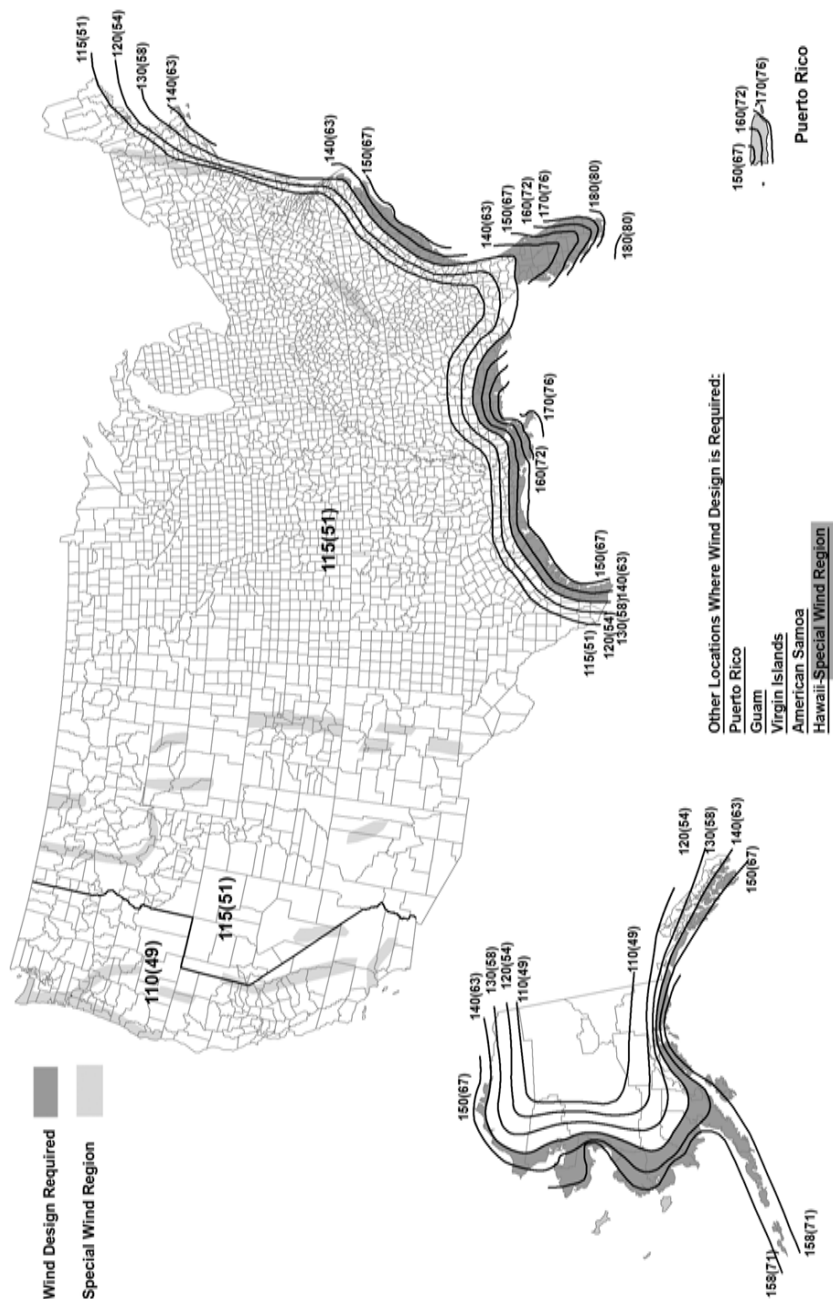


FIGURE R301.2.1.1  
REGIONS WHERE WIND DESIGN IS REQUIRED

## BUILDING PLANNING

**R301.2.1.4 Exposure category.** For each wind direction considered, an exposure category that adequately reflects the characteristics of ground surface irregularities shall be determined for the site at which the building or structure is to be constructed. For a site located in the transition zone between categories, the category resulting in the largest wind forces shall apply. Account shall be taken of variations in ground surface roughness that arise from natural topography and vegetation as well as from constructed features. For a site where multiple detached one- and two-family *dwelling*s, townhouses or other structures are to be constructed as part of a subdivision or master-planned community, or are otherwise designated as a developed area by the authority having *jurisdiction*, the exposure category for an individual structure shall be based on the site conditions that will exist at the time when all adjacent structures on the site have been constructed, provided that their construction is expected to begin within 1 year of the start of construction for the structure for which the exposure category is determined. For any given wind direction, the exposure in which a specific building or other structure is sited shall be assessed as being one of the following categories:

1. Exposure B. Urban and suburban areas, wooded areas or other terrain with numerous closely spaced obstructions having the size of single-family *dwelling*s or larger. Exposure B shall be assumed unless the site meets the definition of another type exposure.
2. Exposure C. Open terrain with scattered obstructions, including surface undulations or other irregularities, having heights generally less than 30 feet (9144 mm) extending more than 1,500 feet (457 m) from the building site in any quadrant. This exposure shall apply to any building located within Exposure B type terrain where the building is directly adjacent to open areas of Exposure C type terrain in any quadrant for a distance of more than 600 feet (183 m). This category includes flat, open country and grasslands.
3. Exposure D. Flat, unobstructed areas exposed to wind flowing over open water, smooth mud flats, salt flats and unbroken ice for a distance of not less than 5,000 feet (1524 m). This exposure shall apply only to those buildings and other structures exposed to the wind coming from over the unobstructed area. Exposure D extends downwind from the edge of the unobstructed area a distance of 600 feet (183 m) or 20 times the height of the building or structure, whichever is greater.

**R301.2.1.5 Topographic wind effects.** In areas designated in Table R301.2 as having local historical data documenting structural damage to buildings caused by wind speed-up at isolated *hills*, ridges and escarpments that are abrupt changes from the general topography of the area, topographic wind effects shall be considered in the design of the building in accordance with Section R301.2.1.5.1 or in accordance with the provisions of ASCE 7. See Figure R301.2.1.5.1(1) for topographic features for wind speed-up effect.

In these designated areas, topographic wind effects shall apply only to buildings sited on the top half of an isolated *hill*, *ridge* or escarpment where all of the following conditions exist:

1. The average slope of the top half of the *hill*, *ridge* or escarpment is 10 percent or greater.
2. The *hill*, *ridge* or escarpment is 60 feet (18 288 mm) or greater in height for Exposure B, 30 feet (9144 mm) or greater in height for Exposure C, and 15 feet (4572 mm) or greater in height for Exposure D.
3. The *hill*, *ridge* or escarpment is isolated or unobstructed by other topographic features of similar height in the upwind direction for a distance measured from its high point of 100 times its height or 2 miles (3.2 km), whichever is less. See Figure R301.2.1.5.1(3) for upwind obstruction.
4. The *hill*, *ridge* or escarpment protrudes by a factor of two or more above the height of other upwind topographic features located in any quadrant within a radius of 2 miles (3.2 km) measured from its high point.

**R301.2.1.5.1 Simplified topographic wind speed-up method.** As an alternative to the ASCE 7 topographic wind provisions, the provisions of Section R301.2.1.5.1 shall be permitted to be used to design for wind speed-up effects, where required by Section R301.2.1.5.

Structures located on the top half of isolated *hills*, ridges or escarpments meeting the conditions of Section R301.2.1.5 shall be designed for an increased basic wind speed as determined by Table R301.2.1.5.1. On the high side of an escarpment, the increased basic wind speed shall extend horizontally downwind from the edge of the escarpment 1.5 times the horizontal length of the upwind slope (1.5L) or 6 times the height of the escarpment (6H), whichever is greater. See Figure R301.2.1.5.1(2) for where wind speed increase is applied.

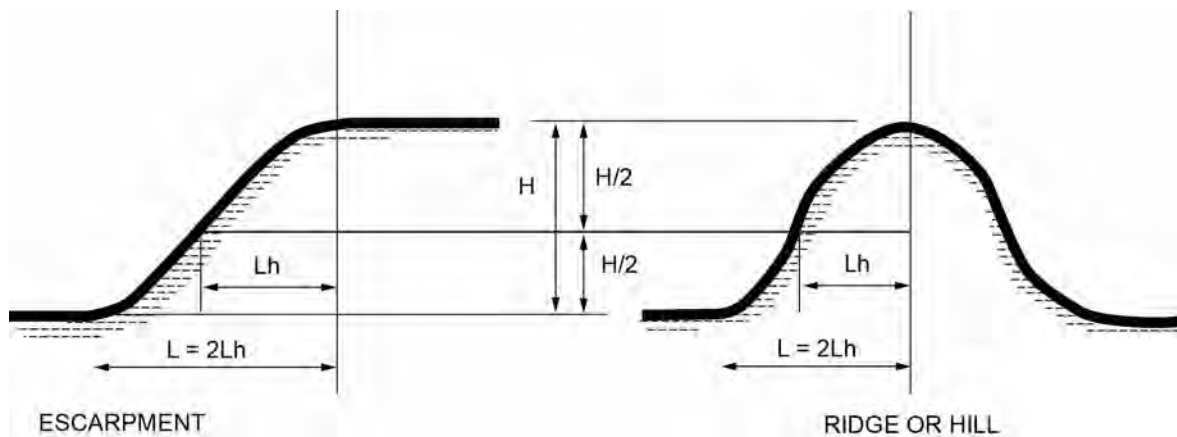
**TABLE R301.2.1.5.1**  
**ULTIMATE DESIGN WIND SPEED MODIFICATION FOR TOPOGRAPHIC WIND EFFECT<sup>a, b</sup>**

ULTIMATE DESIGN WIND SPEED FROM FIGURE R301.2(2) (mph)	AVERAGE SLOPE OF THE TOP HALF OF HILL, RIDGE OR ESCARPMENT (percent)						
	0.10	0.125	0.15	0.175	0.20	0.23	0.25
	Required ultimate design wind speed-up, modified for topographic wind speed-up (mph)						
95	114	119	123	127	131	137	140
100	120	125	129	134	138	144	147
105	126	131	135	141	145	151	154
110	132	137	142	147	152	158	162
115	138	143	148	154	159	165	169
120	144	149	155	160	166	172	176
130	156	162	168	174	179	NA	NA
140	168	174	181	NA	NA	NA	NA
150	180	NA	NA	NA	NA	NA	NA

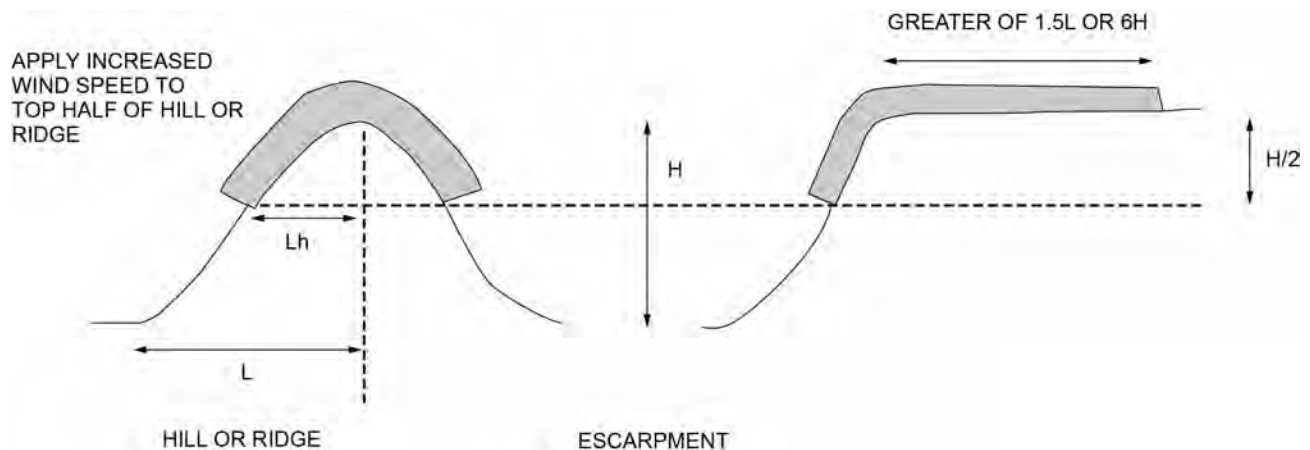
For SI: 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.

NA = Not Applicable.

- a. Table applies to a feature height of 500 feet or less and dwellings sited a distance equal or greater than half the feature height.
- b. Where the ultimate design wind speed as modified by Table R301.2.1.5.1 equals or exceeds 140 miles per hour, the building shall be considered as “wind design required” in accordance with Section R301.2.1.1.



**FIGURE R301.2.1.5.1(1)**  
**TOPOGRAPHIC FEATURES FOR WIND SPEED-UP EFFECT**



**FIGURE R301.2.1.5.1(2)**  
**ILLUSTRATION OF WHERE ON A TOPOGRAPHIC FEATURE, WIND SPEED INCREASE IS APPLIED**



## BUILDING PLANNING

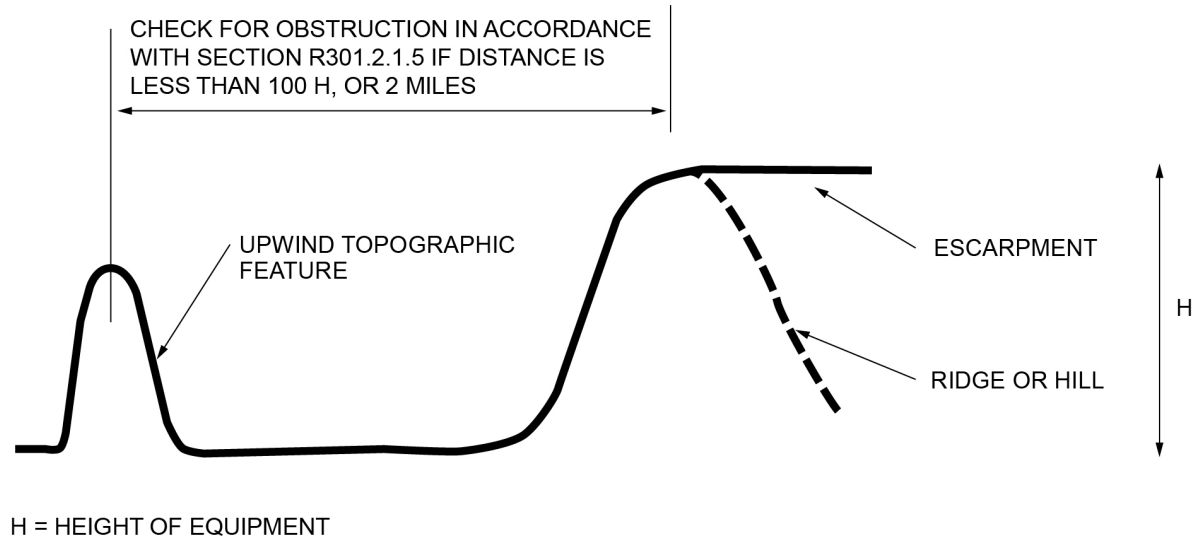


FIGURE R301.2.1.5.1(3)  
UPWIND OBSTRUCTION

**R301.2.2 Seismic provisions.** Buildings in *Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>* shall be constructed in accordance with the requirements of this section and other seismic requirements of this code. The seismic provisions of this code shall apply as follows:

1. Townhouses in *Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*.
2. Detached one- and two-family dwellings in *Seismic Design Categories, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*.

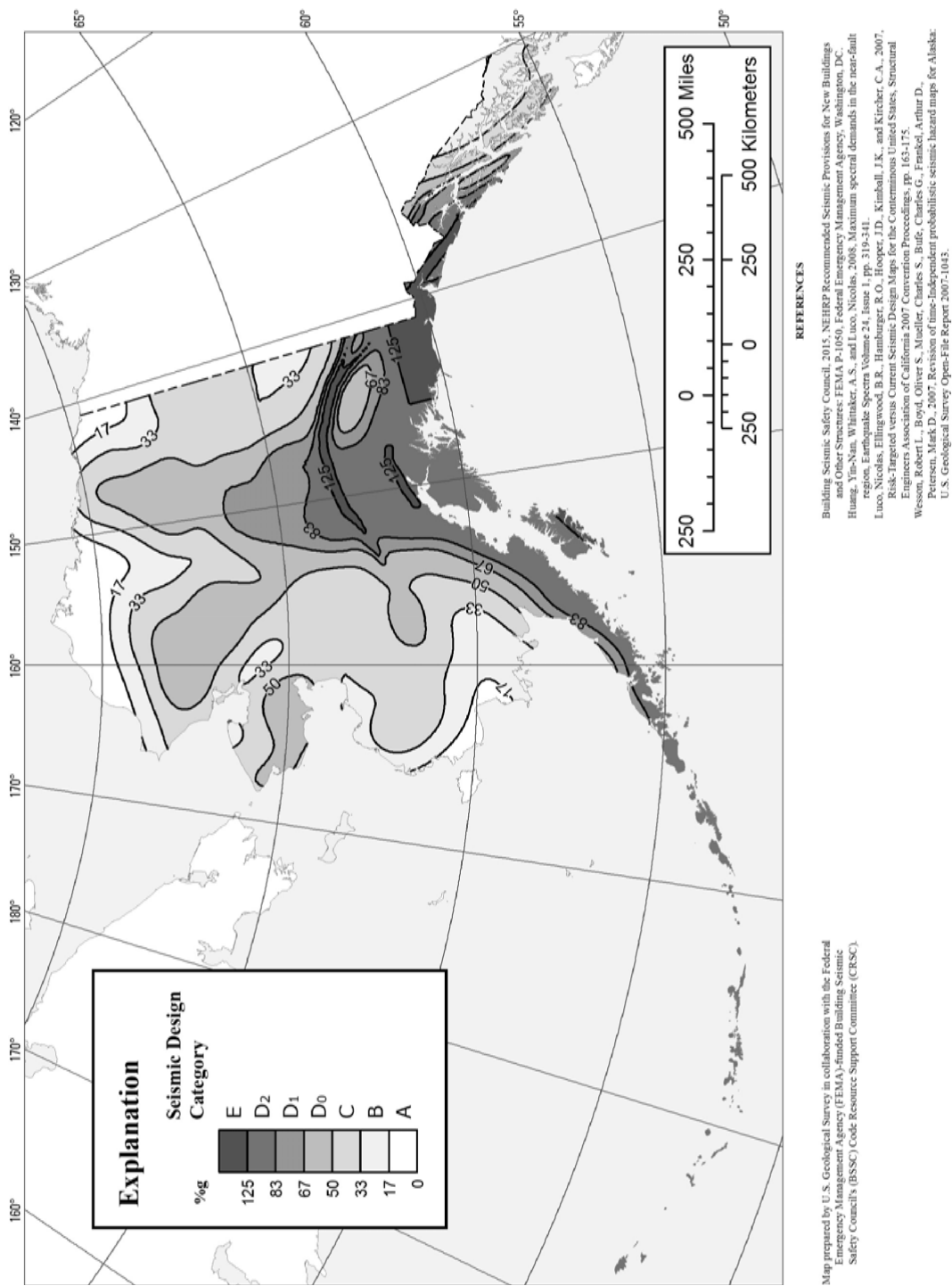
Buildings in Seismic Design Category E shall be designed to resist seismic loads in accordance with the *International Building Code*, except where the seismic design category is reclassified to a lower seismic design category in accordance with Section R301.2.2.1. Components of buildings not required to be designed to resist seismic loads shall be constructed in accordance with the provisions of this code.

**R301.2.2.1 Determination of seismic design category.** Buildings shall be assigned a seismic design category in accordance with Figures R301.2.2.1(1) through R301.2.2.1(6).

**R301.2.2.1.1 Alternate determination of seismic design category.** If soil conditions are determined by the building official to be Site Class A, B, or D, the seismic design category and short-period design spectral response accelerations,  $S_{DS}$ , for a site shall be allowed to be determined in accordance with Figures R301.2.2.1.1(1) through R301.2.2.1.1(6), or Section 1613.2 of the *International Building Code*. The value of  $S_{DS}$  determined in accordance with Section 1613.2 of the *International Building Code* is permitted to be used to set the seismic design category in accordance with Table R301.2.2.1.1, and to interpolate between values in Tables R602.10.3(3) and R603.9.2(1) and other seismic design requirements of this code.

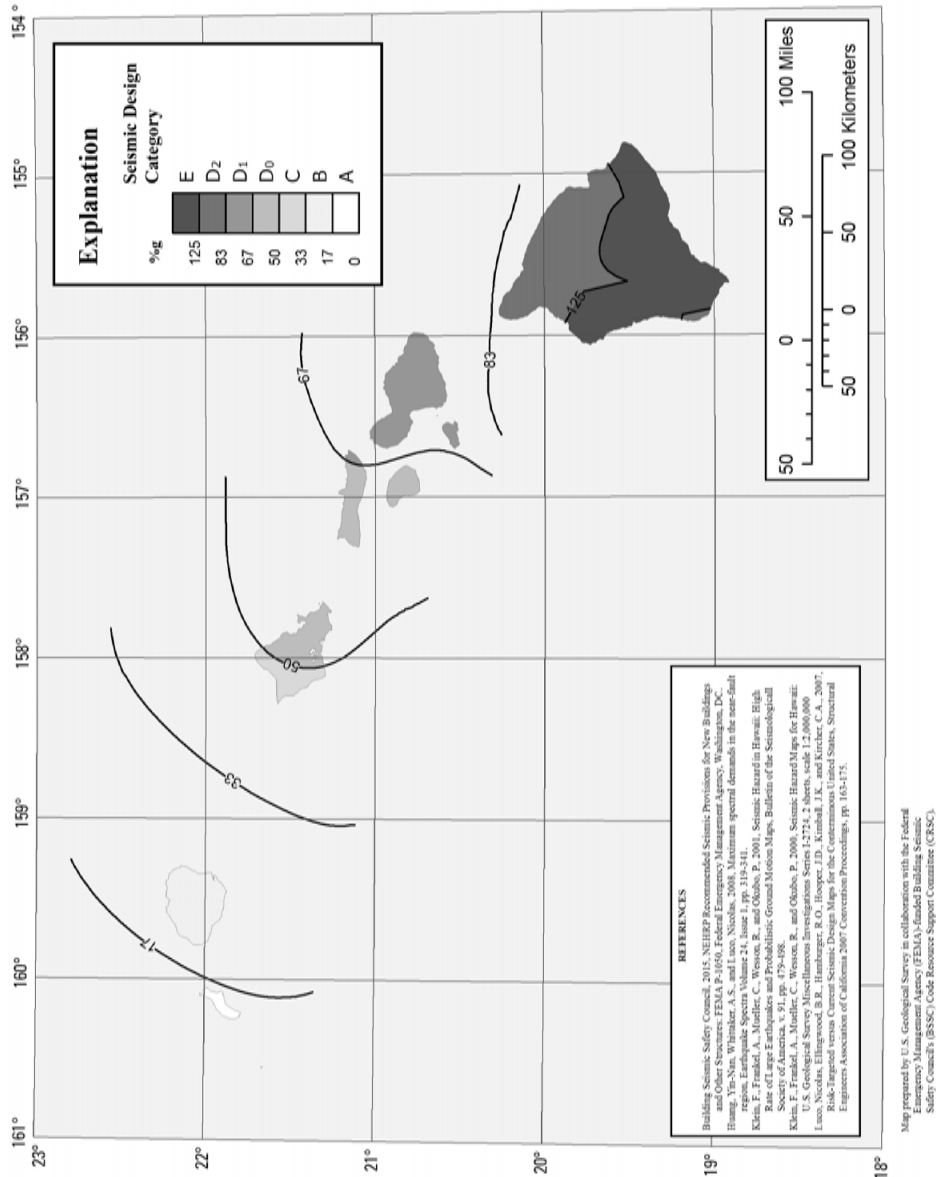
**R301.2.2.1.2 Alternative determination of Seismic Design Category E.** Buildings located in Seismic Design Category E in accordance with Figures R301.2.2.1(1) through R301.2.2.1(6), or Figures R301.2.2.1.1(1) through R301.2.2.1.1(6) where applicable, are permitted to be reclassified as being in Seismic Design Category D<sub>2</sub> provided that one of the following is done:

1. A more detailed evaluation of the seismic design category is made in accordance with the provisions and maps of the *International Building Code*. Buildings located in Seismic Design Category E in accordance with Table R301.2.2.1.1, but located in Seismic Design Category D in accordance with the *International Building Code*, shall be permitted to be designed using the Seismic Design Category D<sub>2</sub> requirements of this code.
2. Buildings located in Seismic Design Category E that conform to the following additional restrictions are permitted to be constructed in accordance with the provisions for Seismic Design Category D<sub>2</sub> of this code:
  - 2.1. All exterior shear wall lines or braced wall panels are in one plane vertically from the foundation to the uppermost story.
  - 2.2. Floors shall not cantilever past the exterior walls.
  - 2.3. The building is within the requirements of Section R301.2.2.6 for being considered as regular.



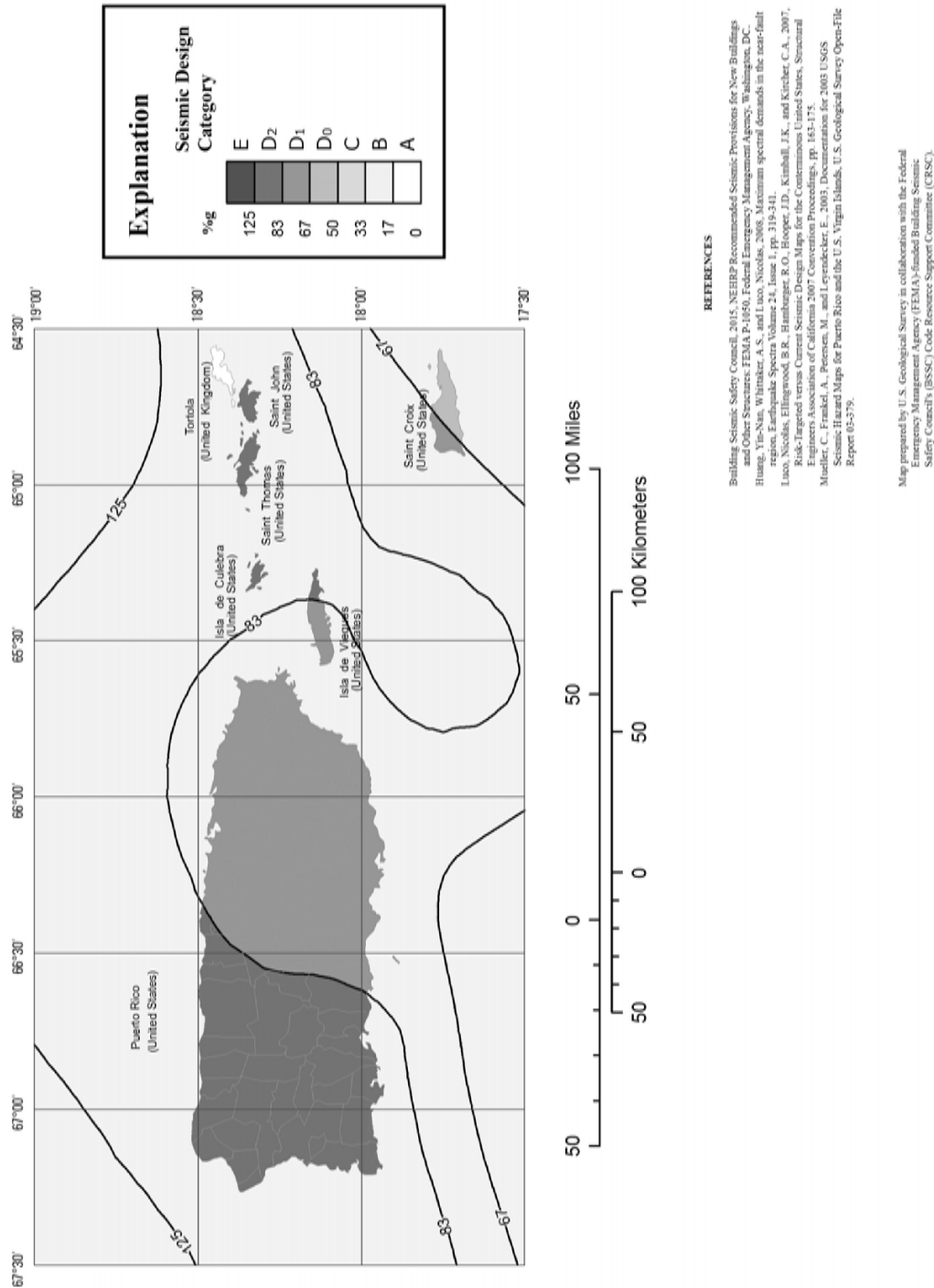
a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6) are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.

FIGURE R301.2.2.1(1)  
SEISMIC DESIGN CATEGORIES—ALASKA<sup>a</sup>



**FIGURE R301.2.2.1(2)**  
**SEISMIC DESIGN CATEGORIES—HAWAII<sup>a</sup>**

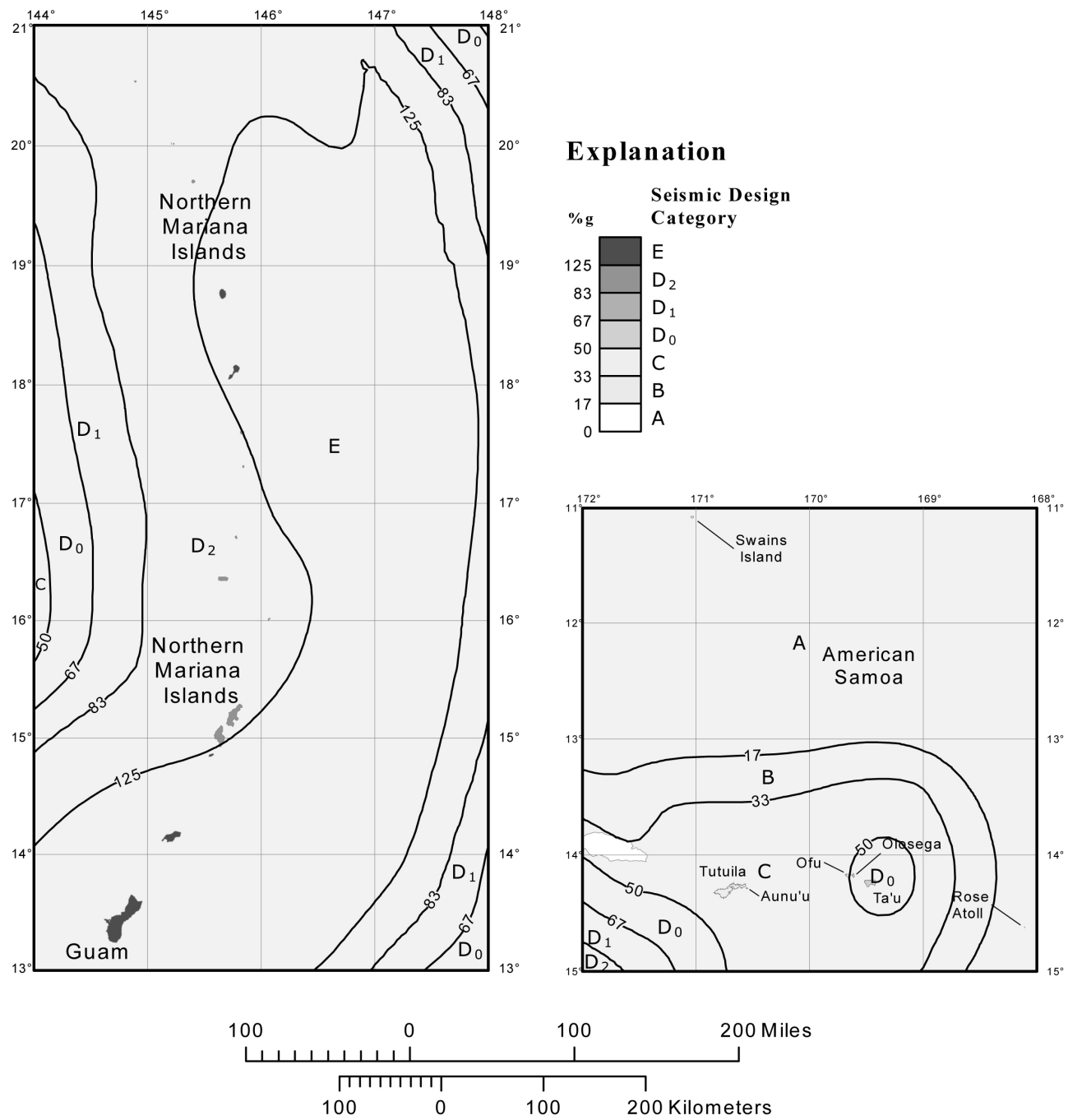
a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6) are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.



a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6) are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.

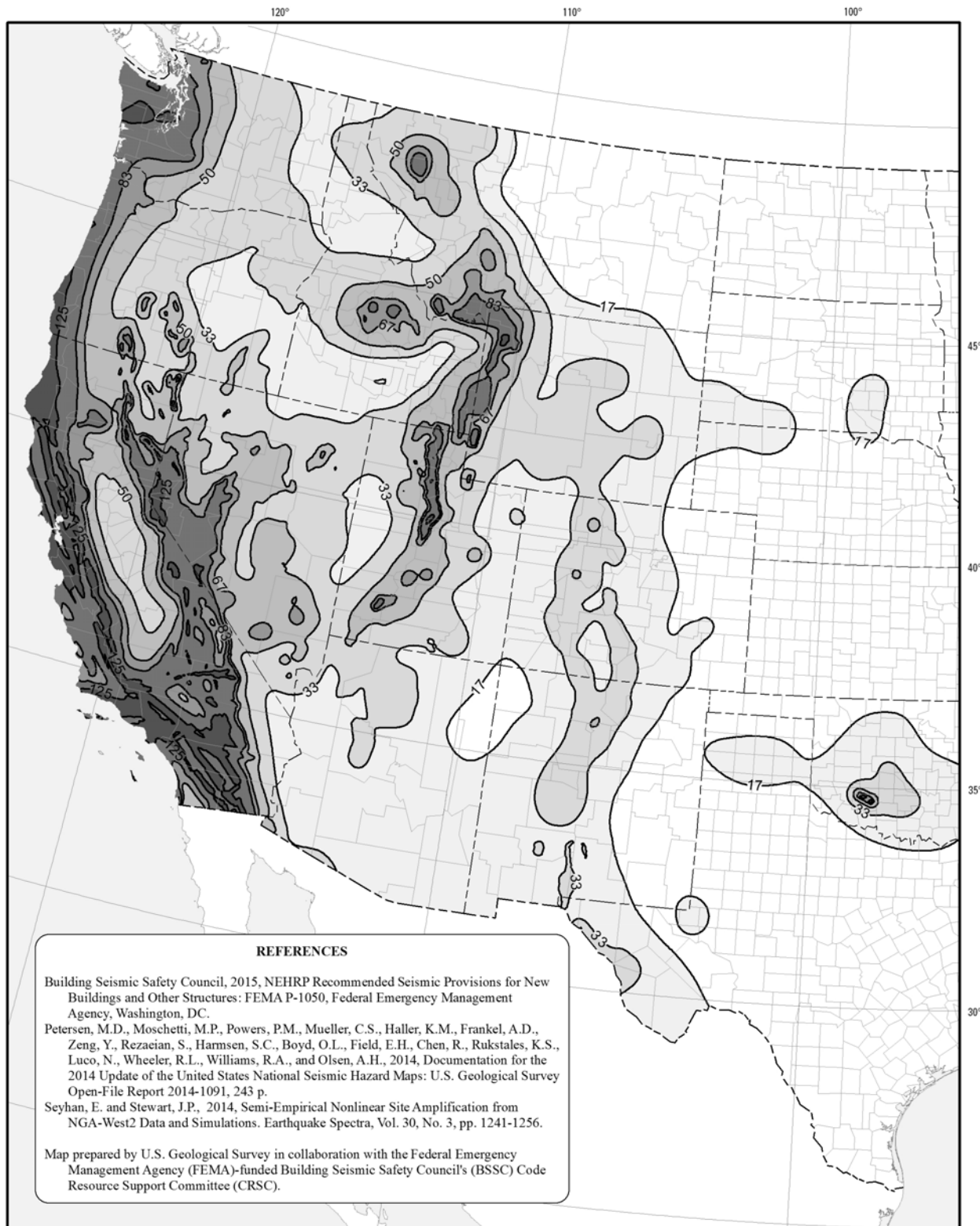
FIGURE R301.2.2.1(3)  
SEISMIC DESIGN CATEGORIES—PUERTO RICO<sup>a</sup>





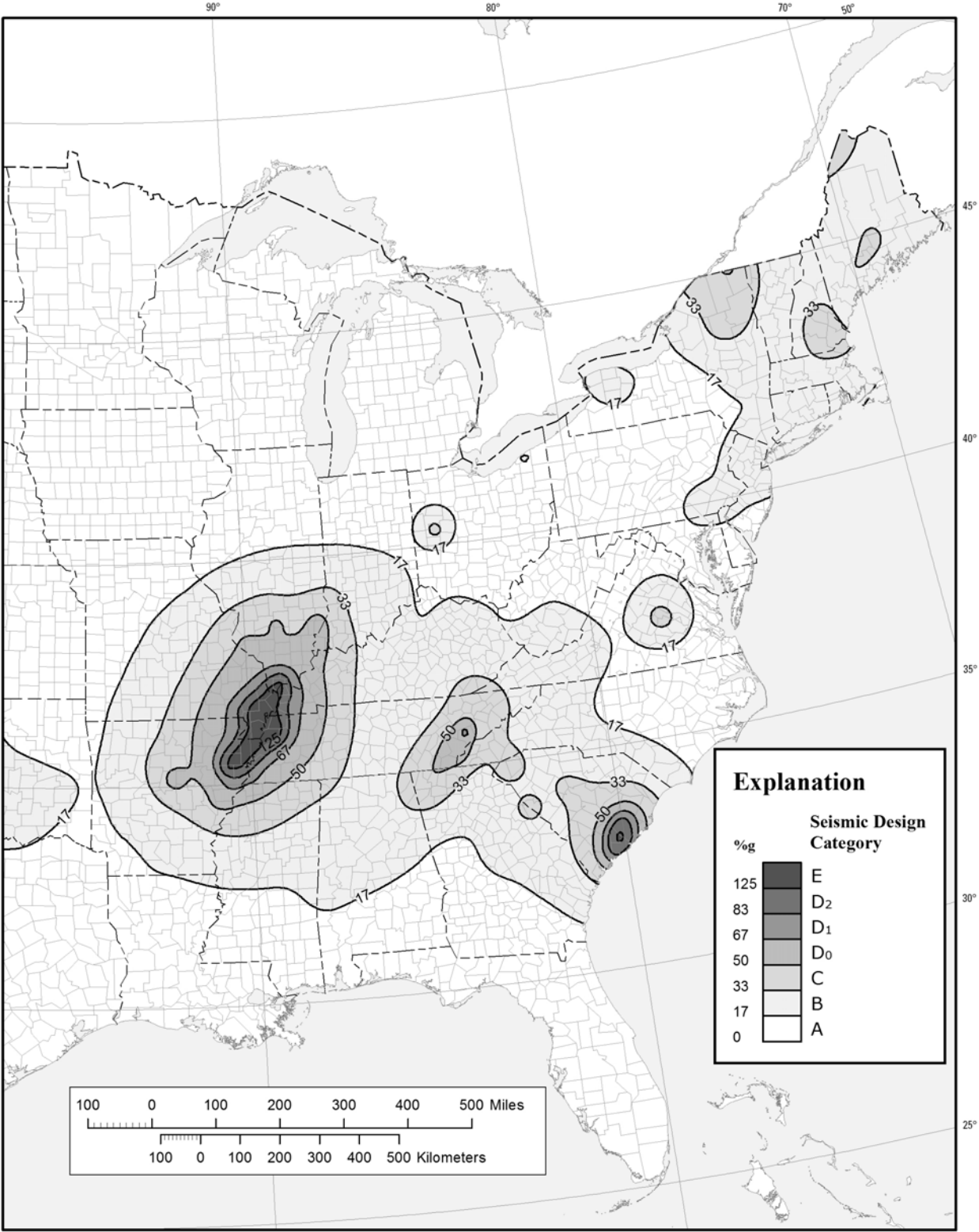
a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6) are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.

**FIGURE R301.2.2.1(4)**  
**SEISMIC DESIGN CATEGORIES—NORTHERN MARIANA ISLANDS AND AMERICAN SAMOA<sup>a</sup>**



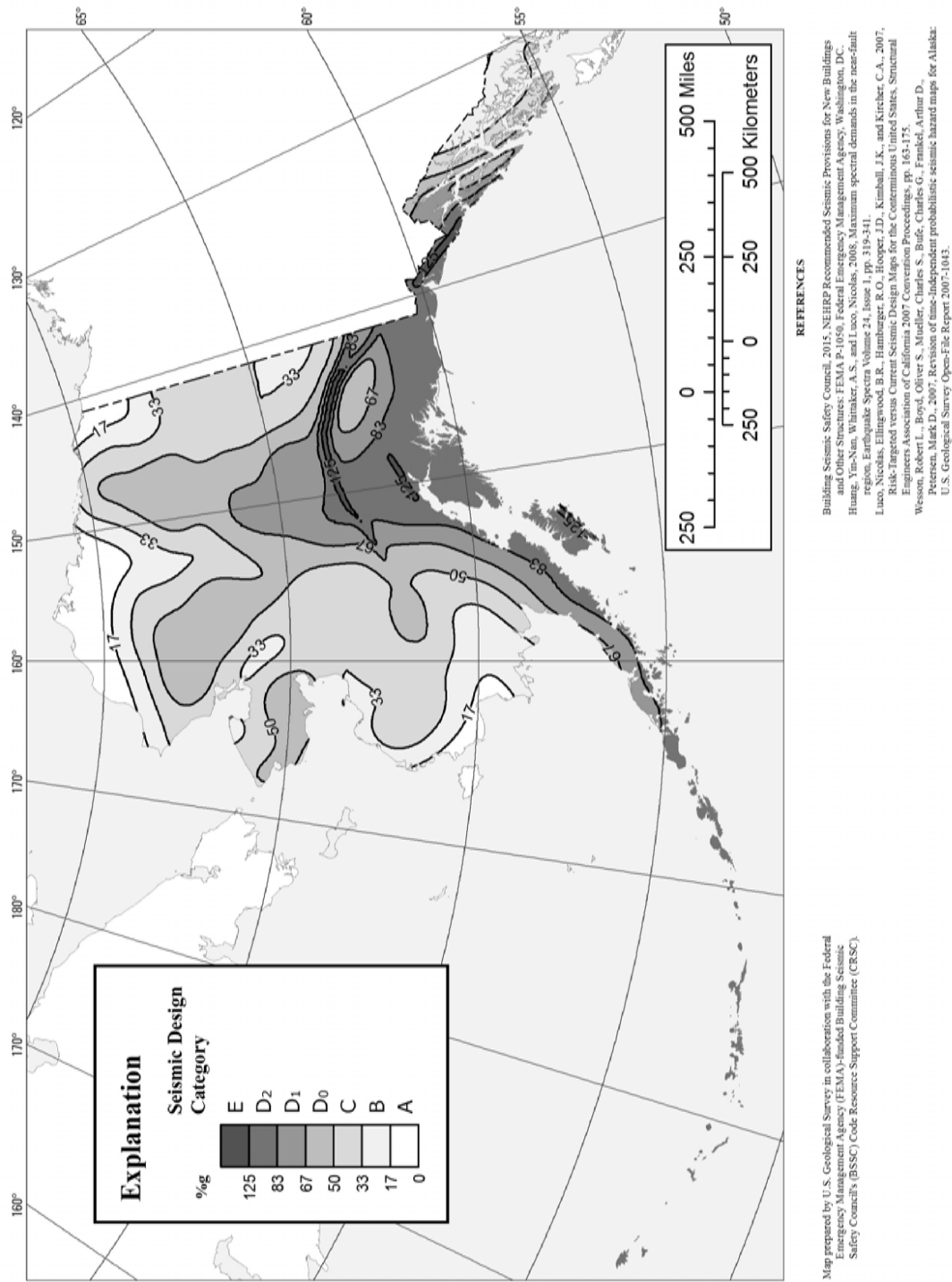
- a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6) are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.

**FIGURE R301.2.2.1(5)**  
**SEISMIC DESIGN CATEGORIES—UNITED STATES<sup>a</sup>**



a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1(1) through 301.2.2.1(6), are based on soil Site Class D, used as an assumed default, as defined in Section 1613.2.2 of the *International Building Code*.

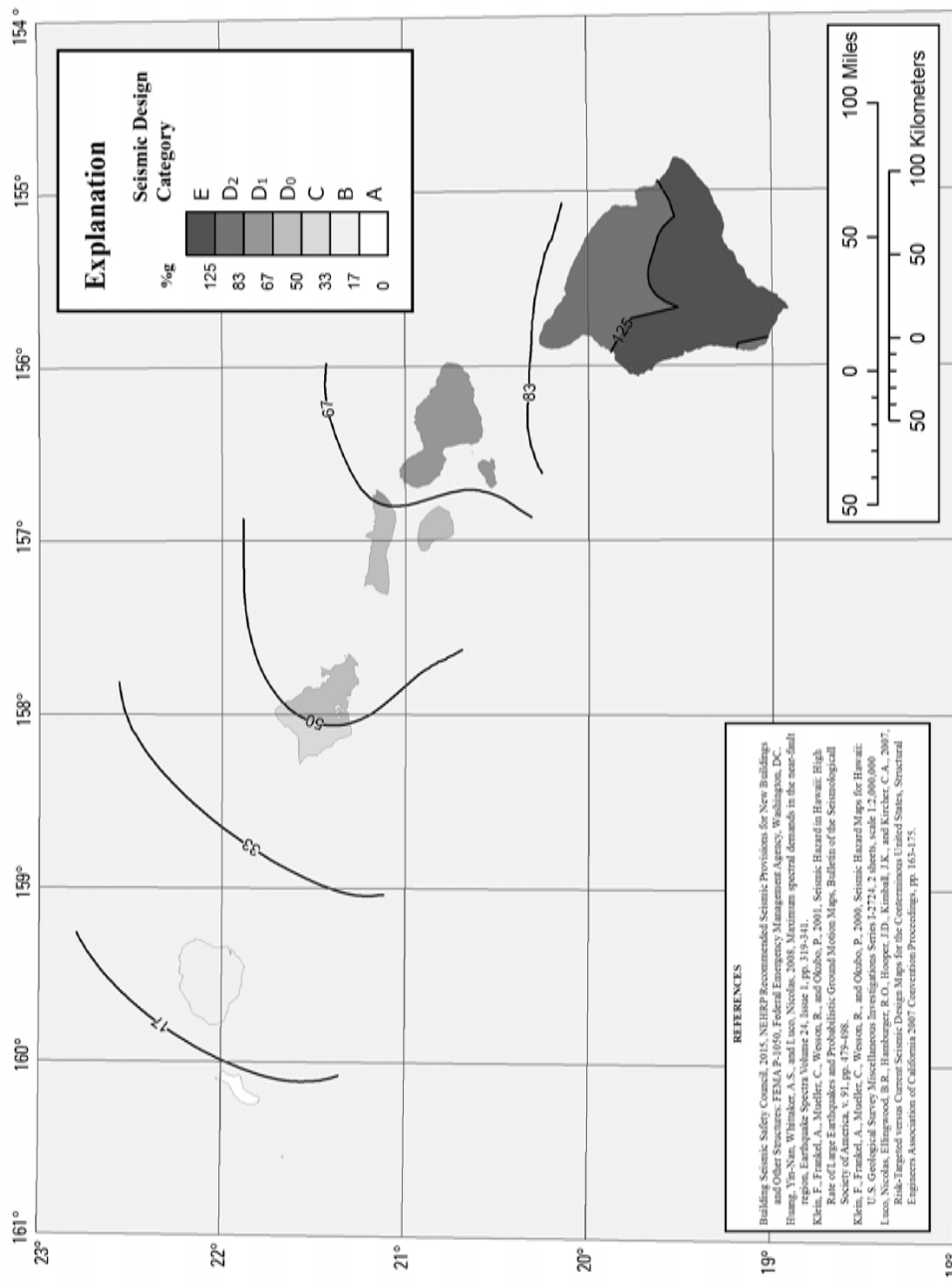
**FIGURE R301.2.2.1(6)**  
**SEISMIC DESIGN CATEGORIES—UNITED STATES<sup>a</sup>**



a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

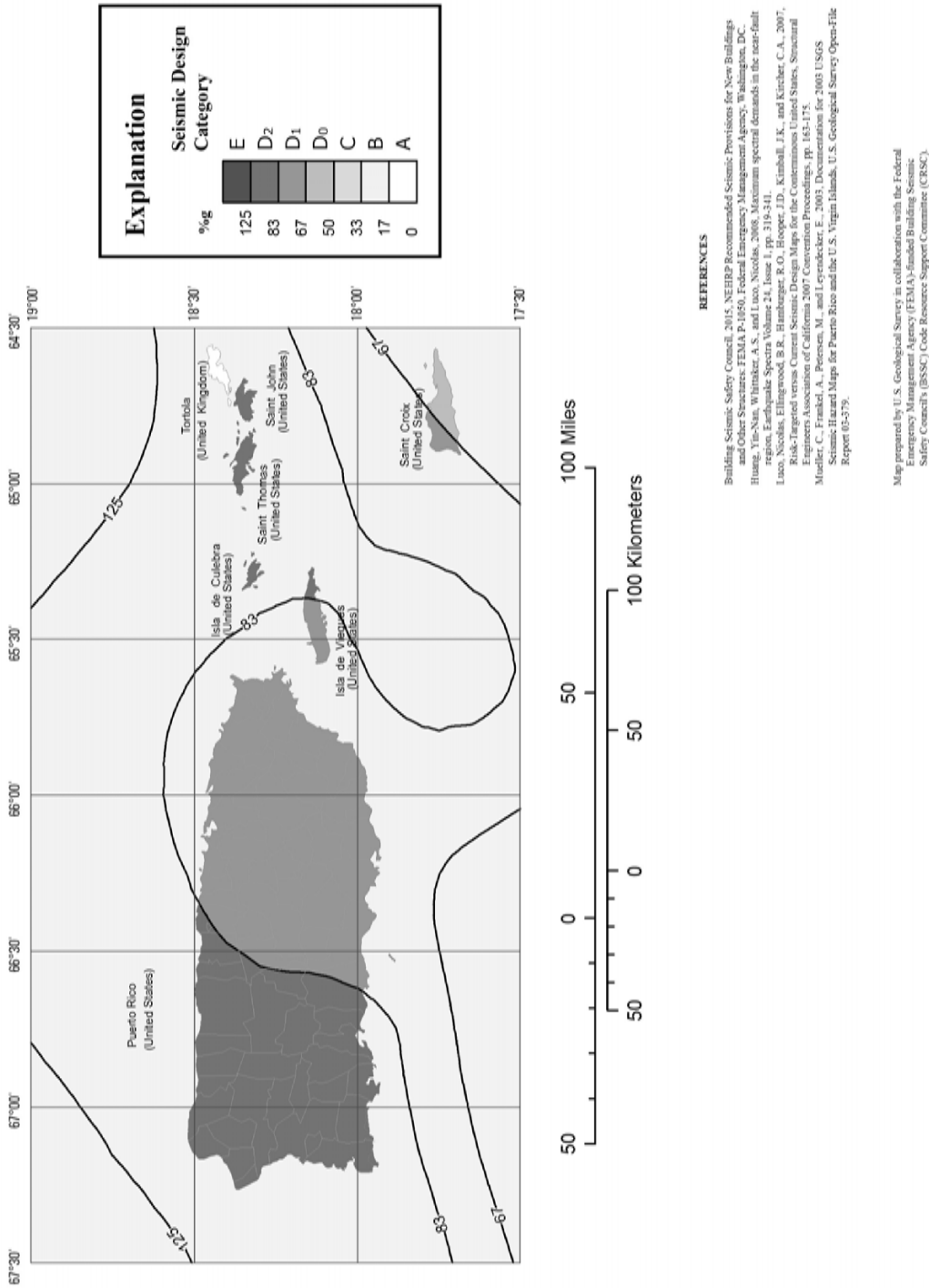
FIGURE R301.2.2.1.1(1)  
ALTERNATE SEISMIC DESIGN CATEGORIES—ALASKA<sup>a</sup>





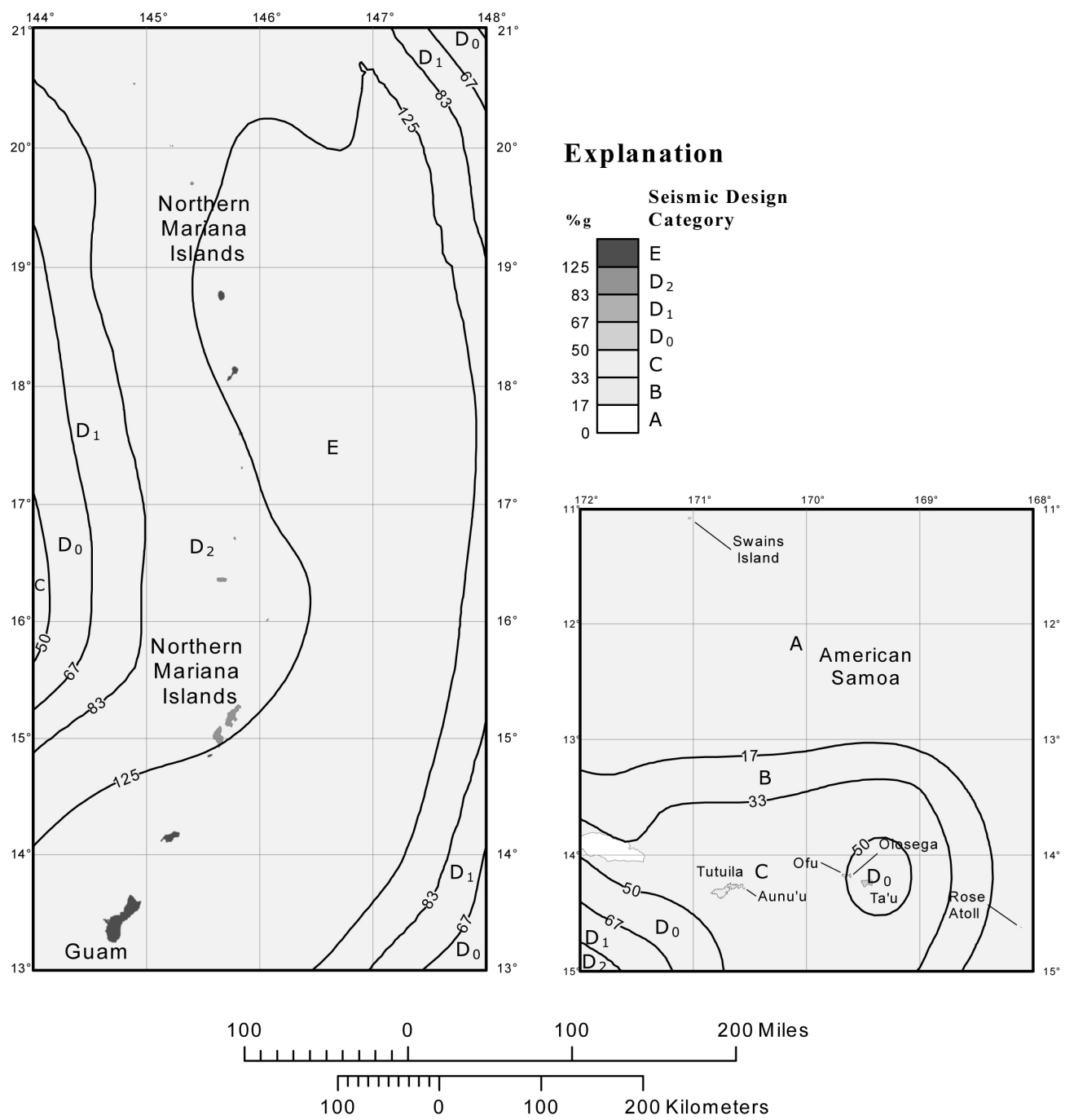
a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

FIGURE R301.2.2.1.1(2)  
ALTERNATE SEISMIC DESIGN CATEGORIES—HAWAII<sup>a</sup>



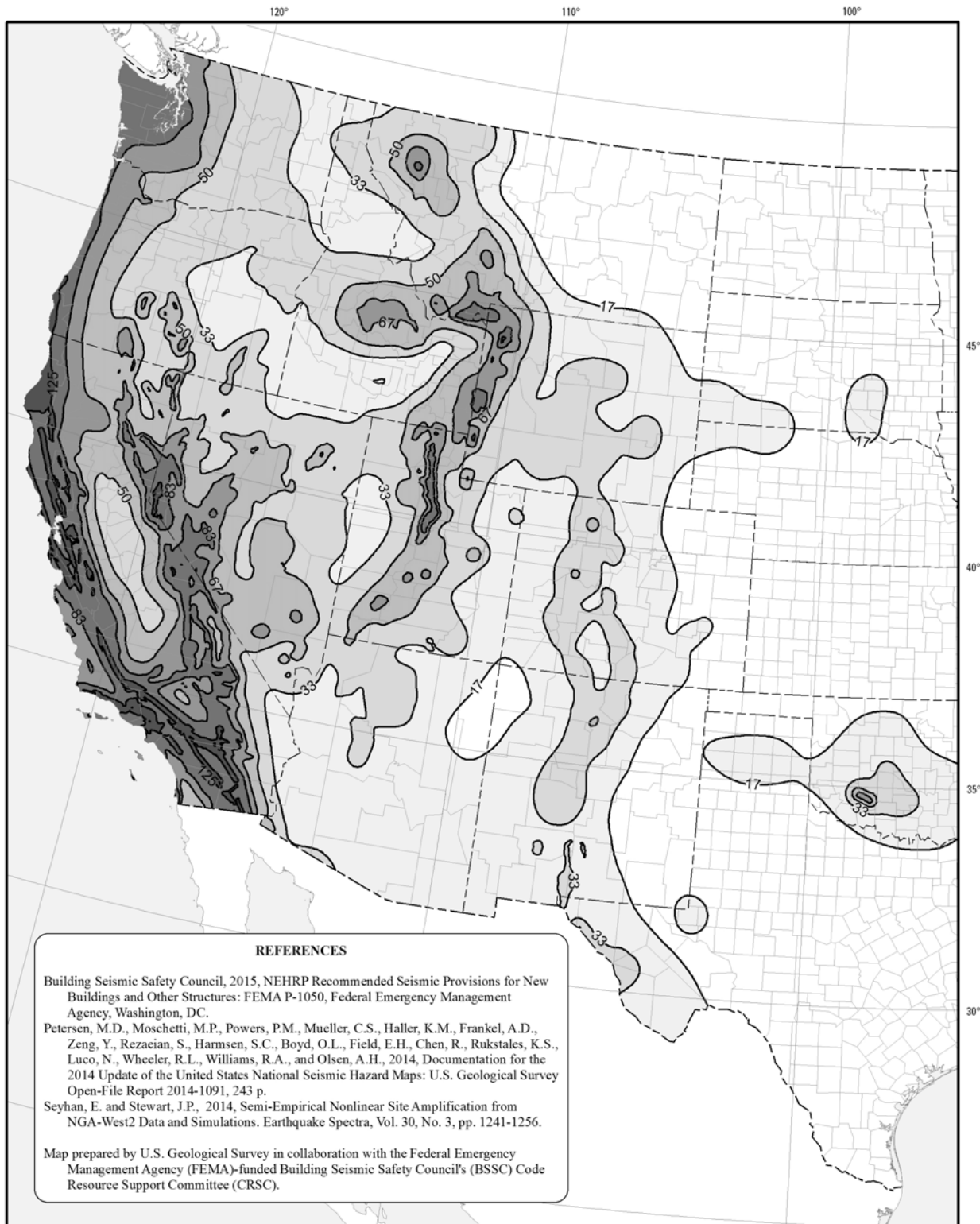
a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

FIGURE R301.2.2.1.1(3)  
ALTERNATE SEISMIC DESIGN CATEGORIES—PUERTO RICO<sup>a</sup>



a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

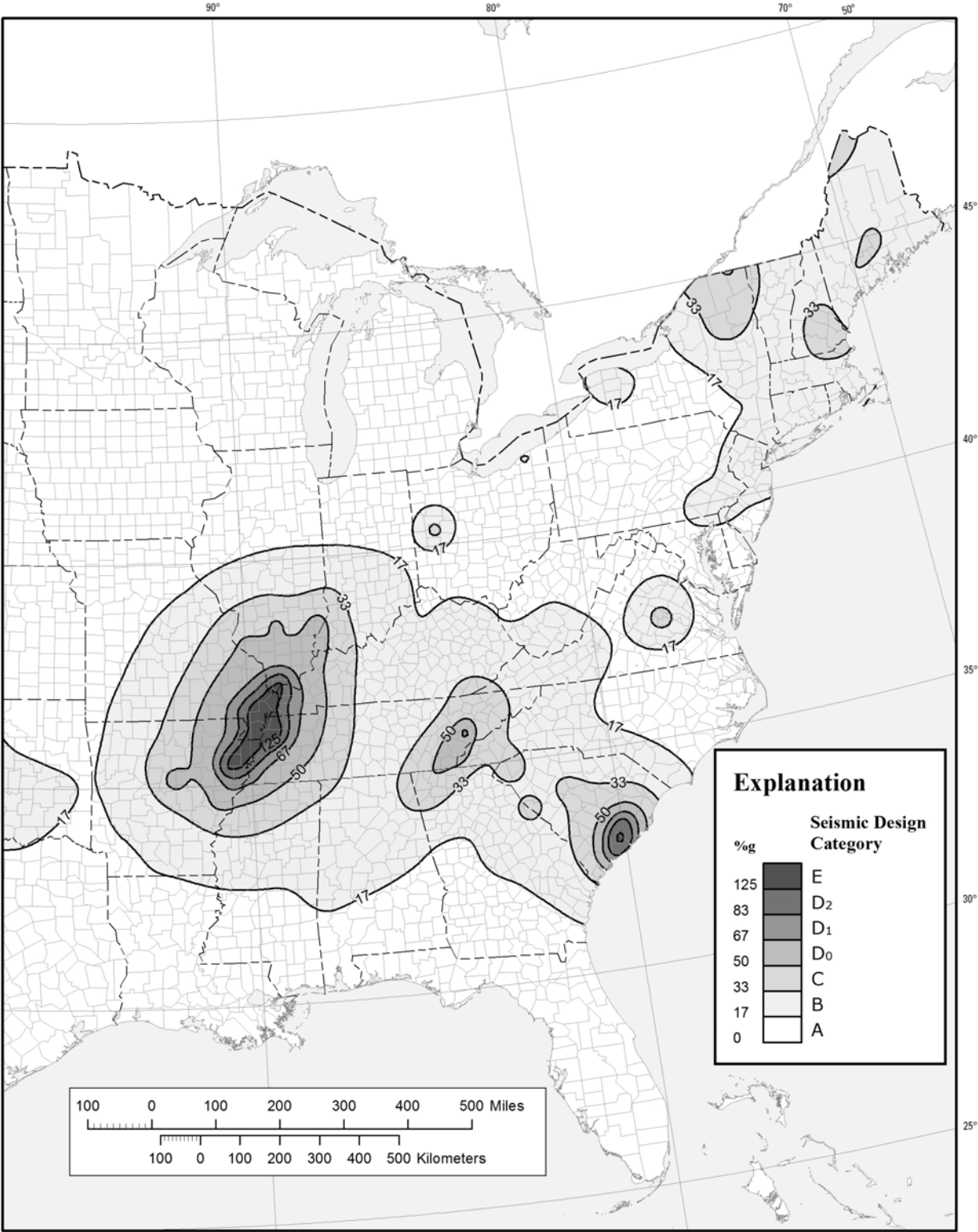
**FIGURE R301.2.2.1.1(4)**  
**ALTERNATE SEISMIC DESIGN CATEGORIES—NORTHERN MARIANA ISLANDS AND AMERICAN SAMOA<sup>a</sup>**



- a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

**FIGURE R301.2.2.1.1(5)**  
**ALTERNATE SEISMIC DESIGN CATEGORIES—UNITED STATES<sup>a</sup>**





a. The seismic design categories and corresponding short-period design spectral response accelerations,  $S_{DS}$ , shown in Figures R301.2.2.1.1(1) through 301.2.2.1.1(6) are permitted to be used where soil conditions are determined by the building official to be Site Class A, B or D.

**FIGURE R301.2.2.1.1(6)**  
**ALTERNATE SEISMIC DESIGN CATEGORIES—UNITED STATES<sup>a</sup>**

TABLE R301.2.2.1.1  
SEISMIC DESIGN CATEGORY DETERMINATION

CALCULATED $S_{DS}$	SEISMIC DESIGN CATEGORY
$S_{DS} \leq 0.17g$	A
$0.17g < S_{DS} \leq 0.33g$	B
$0.33g < S_{DS} \leq 0.50g$	C
$0.50g < S_{DS} \leq 0.67g$	$D_0$
$0.67g < S_{DS} \leq 0.83g$	$D_1$
$0.83g < S_{DS} \leq 1.25g$	$D_2$
$1.25g < S_{DS}$	E

**R301.2.2.2 Weights of materials.** Average dead loads shall not exceed 15 pounds per square foot (720 Pa) for the combined roof and ceiling assemblies (on a horizontal projection) or 10 pounds per square foot (480 Pa) for floor assemblies, except as further limited by Section R301.2.2. Dead loads for walls above *grade* shall not exceed:

1. Fifteen pounds per square foot (720 Pa) for exterior light-frame wood walls.
2. Fourteen pounds per square foot (670 Pa) for exterior light-frame cold-formed steel walls.
3. Ten pounds per square foot (480 Pa) for interior light-frame wood walls.
4. Five pounds per square foot (240 Pa) for interior light-frame cold-formed steel walls.
5. Eighty pounds per square foot (3830 Pa) for 8-inch-thick (203 mm) masonry walls.
6. Eighty-five pounds per square foot (4070 Pa) for 6-inch-thick (152 mm) concrete walls.
7. Ten pounds per square foot (480 Pa) for SIP walls.

**Exceptions:**

1. Roof and ceiling dead loads not exceeding 25 pounds per square foot (1190 Pa) shall be permitted provided that the wall bracing amounts in Section R602.10.3 are increased in accordance with Table R602.10.3(4).
2. Light-frame walls with stone or masonry veneer shall be permitted in accordance with the provisions of Sections R702.1 and R703.
3. Fireplaces and chimneys shall be permitted in accordance with Chapter 10.

**R301.2.2.3 Stone and masonry veneer.** Anchored stone and masonry veneer shall comply with the requirements of Sections R702.1 and R703.

**R301.2.2.4 Masonry construction.** Masonry construction in *Seismic Design Categories*  $D_0$  and  $D_1$  shall comply with the requirements of Section R606.12.1. Masonry construction in Seismic Design Category  $D_2$  shall comply with the requirements of Section R606.12.4.

**R301.2.2.5 Concrete construction.** Buildings with exterior above-*grade* concrete walls shall comply with PCA 100 or shall be designed in accordance with ACI 318.

**Exception:** Detached one- and two-family dwellings in Seismic Design Category C with exterior above-*grade* concrete walls are allowed to comply with the requirements of Section R608.

**R301.2.2.6 Irregular buildings.** The seismic provisions of this code shall not be used for structures, or portions thereof, located in *Seismic Design Categories* C,  $D_0$ ,  $D_1$  and  $D_2$  and considered to be irregular in accordance with this section. A building or portion of a building shall be considered to be irregular where one or more of the conditions defined in Items 1 through 8 occur. Irregular structures, or irregular portions of structures, shall be designed in accordance with accepted engineering practice to the extent the irregular features affect the performance of the remaining structural system. Where the forces associated with the irregularity are resisted by a structural system designed in accordance with accepted engineering practice, the remainder of the building shall be permitted to be designed using the provisions of this code.

1. **Shear wall or braced wall offsets out of plane.** Conditions where exterior *shear wall* lines or *braced wall panels* are not in one plane vertically from the foundation to the uppermost story in which they are required.

**Exception:** For wood *light-frame construction*, floors with cantilevers or setbacks not exceeding four times the nominal depth of the wood floor joists are permitted to support *braced wall panels* that are out of plane with *braced wall panels* below provided that all of the following are satisfied:

1. Floor joists are nominal 2 inches by 10 inches (51 mm by 254 mm) or larger and spaced not more than 16 inches (406 mm) on center.
2. The ratio of the back span to the cantilever is not less than 2 to 1.
3. Floor joists at ends of *braced wall panels* are doubled.

## BUILDING PLANNING

4. For wood-frame construction, a continuous rim joist is connected to ends of cantilever joists. Where spliced, the rim joists shall be spliced using a galvanized metal tie not less than 0.058 inch (1.5 mm) (16 gage) and 1½ inches (38 mm) wide fastened with six 16d nails on each side of the splice; or a block of the same size as the rim joist and of sufficient length to fit securely between the joist space at which the splice occurs, fastened with eight 16d nails on each side of the splice.
  5. Gravity loads carried at the end of cantilevered joists are limited to uniform wall and roof loads and the reactions from headers having a span of 8 feet (2438 mm) or less.
2. **Lateral support of roofs and floors.** Conditions where a section of floor or roof is not laterally supported by *shear walls* or *braced wall lines* on all edges.

**Exception:** Portions of floors that do not support *shear walls*, *braced wall panels* above, or roofs shall be permitted to extend not more than 6 feet (1829 mm) beyond a *shear wall* or *braced wall line*.

3. **Shear wall or braced wall offsets in plane.** Conditions where the end of a *braced wall panel* occurs over an opening in the wall below and extends more than 1 foot (305 mm) horizontally past the edge of the opening. This provision is applicable to *shear walls* and *braced wall panels* offset in plane and to *braced wall panels* offset out of plane in accordance with the exception to Item 1.

**Exception:** For wood light-frame wall construction, one end of a *braced wall panel* shall be permitted to extend more than 1 foot (305 mm) over an opening not more than 8 feet (2438 mm) in width in the wall below provided that the opening includes a header in accordance with all of the following:

1. The building width, loading condition and framing member species limitations of Table R602.7(1) shall apply.
2. The header is composed of:
  - 2.1. Not less than one 2 × 12 or two 2 × 10 for an opening not more than 4 feet (1219 mm) wide.
  - 2.2. Not less than two 2 × 12 or three 2 × 10 for an opening not more than 6 feet (1829 mm) in width.

- 2.3. Not less than three 2 × 12 or four 2 × 10 for an opening not more than 8 feet (2438 mm) in width.

3. The entire length of the *braced wall panel* does not occur over an opening in the wall below.

4. **Floor and roof opening.** Conditions where an opening in a floor or roof exceeds the lesser of 12 feet (3658 mm) or 50 percent of the least floor or roof dimension.
5. **Floor level offset.** Conditions where portions of a floor level are vertically offset.

**Exceptions:**

1. Framing supported directly by continuous foundations at the perimeter of the building.
2. For wood *light-frame construction*, floors shall be permitted to be vertically offset where the floor framing is lapped or tied together as required by Section R502.6.1.
6. **Perpendicular shear wall and wall bracing.** Conditions where *shear walls* and *braced wall lines* do not occur in two perpendicular directions.
7. **Wall bracing in stories containing masonry or concrete construction.** Conditions where stories above *grade plane* are partially or completely braced by wood wall framing in accordance with Section R602 or cold-formed steel wall framing in accordance with Section R603 include masonry or concrete construction. Where this irregularity applies, the entire story shall be designed in accordance with accepted engineering practice.

**Exceptions:** Fireplaces, chimneys and masonry veneer in accordance with this code.

8. **Hillside light-frame construction.** Conditions in which all of the following apply:
  - 8.1. The grade slope exceeds 1 unit vertical in 5 units horizontal where averaged across the full length of any side of the dwelling.
  - 8.2. The tallest cripple wall clear height exceeds 7 feet (2134 mm), or where a post and beam system occurs at the dwelling perimeter, the post and beam system tallest post clear height exceeds 7 feet (2134 mm).
  - 8.3. Of the total plan area below the lowest framed floor, whether open or enclosed, less than 50 percent is living space having interior wall finishes conforming to Section R702.

Where Item 8 is applicable, design in accordance with accepted engineering practice shall be provided for the floor immediately above the cripple walls or post and beam system and all structural elements and connections from this diaphragm down to and including connections to the foundation and design of the foundation to transfer lateral loads from the framing above.

**Exception:** *Light-frame construction* in which the lowest framed floor is supported directly on concrete or masonry walls over the full length of all sides except the downhill side of the dwelling need not be considered an irregular dwelling under Item 8.

**R301.2.2.7 Height limitations.** Wood-framed buildings shall be limited to three *stories* above *grade plane* or the limits given in Table R602.10.3(3). Wood-framed buildings in Seismic Design Category  $D_2$  exceeding two *stories* shall be designed for wind and seismic loads in accordance with accepted engineering practice. Cold-formed steel-framed buildings shall be limited to less than or equal to three *stories* above *grade plane* in accordance with AISI S230. *Mezzanines* as defined in Section R202 that comply with Section R325 shall not be considered as *stories*. *Structural insulated panel* buildings shall be limited to two *stories* above *grade plane*.

**R301.2.2.8 Cold-formed steel framing in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$ .** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  in addition to the requirements of this code, cold-formed steel framing shall comply with the requirements of AISI S230.

**R301.2.2.9 Masonry chimneys.** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , masonry chimneys shall be reinforced and anchored to the building in accordance with Sections R1003.3 and R1003.4.

**R301.2.2.10 Anchorage of water heaters.** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , and in *townhouses* in Seismic Design Category C, water heaters and thermal storage units shall be anchored against movement and overturning in accordance with Section M1307.2 or P2801.8.

**R301.2.3 Snow loads.** Wood-framed construction, cold-formed, steel-framed construction and masonry and concrete construction, and *structural insulated panel* construction in regions with ground snow loads 70 pounds per square foot (3.35 kPa) or less, shall be in accordance with Chapters 5, 6 and 8. Buildings in regions with ground snow loads greater than 70 pounds per square foot (3.35 kPa) shall be designed in accordance with accepted engineering practice.

**R301.2.4 Floodplain construction.** Buildings and structures constructed in whole or in part in flood hazard areas (including A or V Zones) as established in Table R301.2, and substantial improvement and *repair* of substantial damage of buildings and structures in flood hazard areas, shall be designed and constructed in accordance with Section R322. Buildings and structures that are located in more than one flood hazard area shall comply with the

provisions associated with the most restrictive flood hazard area. Buildings and structures located in whole or in part in identified floodways shall be designed and constructed in accordance with ASCE 24.

**R301.2.4.1 Alternative provisions.** As an alternative to the requirements in Section R322, ASCE 24 is permitted subject to the limitations of this code and the limitations therein.

**R301.3 Story height.** The wind and seismic provisions of this code shall apply to buildings with *story heights* not exceeding the following:

1. For wood wall framing, the *story height* shall not exceed 11 feet 7 inches (3531 mm) and the laterally unsupported bearing wall stud height permitted by Table R602.3(5).

**Exception:** A *story height* not exceeding 13 feet 7 inches (4140 mm) is permitted provided that the maximum wall stud clear height does not exceed 12 feet (3658 mm), the wall studs are in accordance with Exception 2 or 3 of Section R602.3.1 or an engineered design is provided for the wall framing members, and wall bracing for the building is in accordance with Section R602.10. Studs shall be laterally supported at the top and bottom plate in accordance with Section R602.3.

2. For cold-formed steel wall framing, the *story height* shall be not more than 11 feet 7 inches (3531 mm) and the unsupported bearing wall stud height shall be not more than 10 feet (3048 mm).
3. For masonry walls, the *story height* shall be not more than 13 feet 7 inches (4140 mm) and the bearing wall clear height shall be not more than 12 feet (3658 mm).

**Exception:** An additional 8 feet (2438 mm) of bearing wall clear height is permitted for gable end walls.

4. For insulating concrete form walls, the maximum *story height* shall not exceed 11 feet 7 inches (3531 mm) and the maximum unsupported wall height per *story* as permitted by Section R608 tables shall not exceed 10 feet (3048 mm).
5. For structural insulated panel (SIP) walls, the *story height* shall be not more than 11 feet 7 inches (3531 mm) and the bearing wall height per *story* as permitted by Section R610 tables shall not exceed 10 feet (3048 mm).

For walls other than wood-framed walls, individual walls or wall studs shall be permitted to exceed these limits as permitted by Chapter 6, provided that the *story heights* of this section are not exceeded. An engineered design shall be provided for the wall or wall framing members where the limits of Chapter 6 are exceeded. Where the *story height* limits of this section are exceeded, the design of the building, or the noncompliant portions thereof, to resist wind and seismic loads shall be in accordance with the *International Building Code*.



## BUILDING PLANNING

**R301.4 Dead load.** The actual weights of materials and construction shall be used for determining dead load with consideration for the dead load of fixed service equipment.

**R301.5 Live load.** The minimum uniformly distributed *live load* shall be as provided in Table R301.5.

**R301.6 Roof load.** The roof shall be designed for the *live load* indicated in Table R301.6 or the ground snow load indicated in Table R301.2, whichever is greater.

**R301.7 Deflection.** The allowable deflection of any structural member under the *live load* listed in Sections R301.5 and R301.6 or wind loads determined by Section R301.2.1 shall not exceed the values in Table R301.7.

**R301.8 Nominal sizes.** For the purposes of this code, dimensions of lumber specified shall be deemed to be nominal dimensions unless specifically designated as actual dimensions.

**TABLE R301.5**  
**MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS (in pounds per square foot)**

USE	UNIFORM LOAD (psf)	CONCENTRATED LOAD (lb)
Uninhabitable attics without storage <sup>b</sup>	10	—
Uninhabitable attics with limited storage <sup>b, g</sup>	20	—
Habitable attics and attics served with fixed stairs	30	—
Balconies (exterior) and decks <sup>c</sup>	40	—
Fire escapes	40	—
Guards	—	200 <sup>h, i</sup>
Guard in-fill components <sup>f</sup>	—	50 <sup>h</sup>
Handrail <sup>d</sup>	—	200 <sup>h</sup>
Passenger vehicle garages <sup>a</sup>	50 <sup>a</sup>	2,000 <sup>h</sup>
Areas other than sleeping areas	40	—
Sleeping areas	30	—
Stairs	40 <sup>c</sup>	300 <sup>c</sup>

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 square inch = 645 mm<sup>2</sup>, 1 pound = 4.45 N.

- Elevated garage floors shall be capable of supporting the uniformly distributed live load or a 2,000-pound concentrated load applied on an area of 4½ inches by 4½ inches, whichever produces the greater stresses.
- Uninhabitable attics without storage are those where the clear height between joists and rafters is not more than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. This live load need not be assumed to act concurrently with any other live load requirements.
- Individual stair treads shall be capable of supporting the uniformly distributed live load or a 300-pound concentrated load applied on an area of 2 inches by 2 inches, whichever produces the greater stresses.
- A single concentrated load applied in any direction at any point along the top. For a guard not required to serve as a handrail, the load need not be applied to the top element of the guard in a direction parallel to such element.
- See Section R507.1 for decks attached to exterior walls.
- Guard in-fill components (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.
- Uninhabitable attics with limited storage are those where the clear height between joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.  
The live load need only be applied to those portions of the joists or truss bottom chords where all of the following conditions are met:
  - The attic area is accessed from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is not less than 30 inches.
  - The slopes of the joists or truss bottom chords are not greater than 2 units vertical in 12 units horizontal.
  - Required insulation depth is less than the joist or truss bottom chord member depth.
 The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 pounds per square foot.
- Glazing used in handrail assemblies and guards shall be designed with a load adjustment factor of 4. The load adjustment factor shall be applied to each of the concentrated loads applied to the top of the rail, and to the load on the in-fill components. These loads shall be determined independent of one another, and loads are assumed not to occur with any other live load.
- Where the top of a guard system is not required to serve as a handrail, the single concentrated load shall be applied at any point along the top, in the vertical downward direction and in the horizontal direction away from the walking surface. Where the top of a guard is also serving as the handrail, a single concentrated load shall be applied in any direction at any point along the top. Concentrated loads shall not be applied concurrently.

**TABLE R301.6**  
**MINIMUM ROOF LIVE LOADS IN POUNDS-FORCE PER SQUARE FOOT OF HORIZONTAL PROJECTION**

ROOF SLOPE	TRIBUTARY LOADED AREA IN SQUARE FEET FOR ANY STRUCTURAL MEMBER		
	0 to 200	201 to 600	Over 600
Flat or rise less than 4 inches per foot (1:3)	20	16	12
Rise 4 inches per foot (1:3) to less than 12 inches per foot (1:1)	16	14	12
Rise 12 inches per foot (1:1) and greater	12	12	12

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square foot = 0.0479 kPa, 1 inch per foot = 83.3 mm/m.

**TABLE R301.7**  
**ALLOWABLE DEFLECTION OF STRUCTURAL MEMBERS<sup>b, c</sup>**

STRUCTURAL MEMBER	ALLOWABLE DEFLECTION
Rafters having slopes greater than 3:12 with finished ceiling not attached to rafters	$L/180$
Interior walls and partitions	$H/180$
Floors	$L/360$
Ceilings with brittle finishes (including plaster and stucco)	$L/360$
Ceilings with flexible finishes (including gypsum board)	$L/240$
All other structural members	$L/240$
Exterior walls—wind loads <sup>a</sup> with plaster or stucco finish	$H/360$
Exterior walls—wind loads <sup>a</sup> with other brittle finishes	$H/240$
Exterior walls—wind loads <sup>a</sup> with flexible finishes	$H/120^d$
Lintels supporting masonry veneer walls <sup>c</sup>	$L/600$

**Note:**  $L$  = span length,  $H$  = span height.

- For the purpose of the determining deflection limits herein, the wind load shall be permitted to be taken as 0.7 times the component and cladding (ASD) loads obtained from Table R301.2.1(1).
- For cantilever members,  $L$  shall be taken as twice the length of the cantilever.
- For aluminum structural members or panels used in roofs or walls of sunroom additions or patio covers, not supporting edge of glass or sandwich panels, the total load deflection shall not exceed  $L/60$ . For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed  $L/175$  for each glass lite or  $L/60$  for the entire length of the member, whichever is more stringent. For sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed  $L/120$ .
- Deflection for exterior walls with interior gypsum board finish shall be limited to an allowable deflection of  $H/180$ .
- Refer to Section R703.8.2. The dead load of supported materials shall be included when calculating the deflection of these members.

## SECTION R302 FIRE-RESISTANT CONSTRUCTION

**R302.1 Exterior walls.** Construction, projections, openings and penetrations of exterior walls of *dwelling*s and accessory buildings shall comply with Table R302.1(1); or *dwelling*s equipped throughout with an *automatic sprinkler system* installed in accordance with NFPA 13D shall comply with Table R302.1(2).

### Exceptions:

- Walls, projections, openings or penetrations in walls perpendicular to the line used to determine the *fire separation distance*.
- Walls of *individual dwelling units* and their *accessory structures* located on the same *lot*.
- Detached tool sheds and storage sheds, playhouses and similar structures exempted from *permits* are not required to provide wall protection based on location on the *lot*. Projections beyond the exterior wall shall not extend over the *lot line*.
- Detached garages accessory to a *dwelling* located within 2 feet (610 mm) of a *lot line* are permitted to have roof eave projections not exceeding 4 inches (102 mm).

- Foundation vents installed in compliance with this code are permitted.

**R302.2 Townhouses.** Walls separating *townhouse units* shall be constructed in accordance with Section R302.2.1 or R302.2.2 and shall comply with Sections 302.2.3 through 302.2.5.

**R302.2.1 Double walls.** Each *townhouse unit* shall be separated from other *townhouse units* by two 1-hour fire-resistance-rated wall assemblies tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *Arkansas Fire Prevention Code*, Volume II.

**R302.2.2 Common walls.** Common walls separating *townhouse units* shall be assigned a fire-resistance rating in accordance with Item 1 or 2 and shall be rated for fire exposure from both sides. Common walls shall extend to and be tight against the exterior sheathing of the exterior walls, or the inside face of exterior walls without stud cavities, and the underside of the roof sheathing. The common wall shared by two *townhouse units* shall be constructed without plumbing or mechanical equipment, ducts or vents, other than water-filled fire sprinkler piping in the cavity of the common wall. Electrical installations shall be in accordance with the *National Electrical Code*.

## BUILDING PLANNING

- of the National Fire Protection Association as adopted by
- the Arkansas Board of Electrical Examiners. Penetrations of the membrane of common walls for electrical outlet boxes shall be in accordance with Section R302.4.
- 1. Where an automatic sprinkler system in accordance with NFPA 13D is provided, the common wall shall be not less than a 1-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *Arkansas Fire Prevention Code*, Volume II.

2. Where an automatic sprinkler system in accordance with NFPA 13D is not provided, the common wall shall be not less than a 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *Arkansas Fire Prevention Code*, Volume II.

**Exception:** Common walls are permitted to extend to and be tight against the inside of the exterior walls if the cavity between the end of the common wall and the

**TABLE R302.1(1)**  
**EXTERIOR WALLS**

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E119, UL 263 or Section 703.3 of the <i>International Building Code</i> with exposure from both sides	0 feet
	Not fire-resistance rated	0 hours	≥ 5 feet
Projections	Not allowed	NA	< 2 feet
	Fire-resistance rated	1 hour on the underside, or heavy timber, or fire-retardant-treated wood <sup>a, b</sup>	≥ 2 feet to < 5 feet
	Not fire-resistance rated	0 hours	≥ 5 feet
Openings in walls	Not allowed	NA	< 3 feet
	25% maximum of wall area	0 hours	3 feet
	Unlimited	0 hours	5 feet
Penetrations	All	Comply with Section R302.4	< 3 feet
		None required	3 feet

For SI: 1 foot = 304.8 mm.

NA = Not Applicable.

- a. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave overhang if fireblocking is provided from the wall top plate to the underside of the roof sheathing.
- b. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the rake overhang where gable vent openings are not installed.

**TABLE R302.1(2)**  
**EXTERIOR WALLS—DWELLINGS WITH FIRE SPRINKLERS**

EXTERIOR WALL ELEMENT		MINIMUM FIRE-RESISTANCE RATING	MINIMUM FIRE SEPARATION DISTANCE
Walls	Fire-resistance rated	1 hour—tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the <i>International Building Code</i> with exposure from the outside	0 feet
	Not fire-resistance rated	0 hours	3 feet <sup>a</sup>
Projections	Not allowed	NA	< 2 feet
	Fire-resistance rated	1 hour on the underside, or heavy timber, or fire-retardant-treated wood <sup>b, c</sup>	2 feet <sup>a</sup>
	Not fire-resistance rated	0 hours	3 feet
Openings in walls	Not allowed	NA	< 3 feet
	Unlimited	0 hours	3 feet <sup>a</sup>
Penetrations	All	Comply with Section R302.4	< 3 feet
		None required	3 feet <sup>a</sup>

For SI: 1 foot = 304.8 mm.

NA = Not Applicable.

- a. For residential subdivisions where all dwellings are equipped throughout with an automatic sprinkler system installed in accordance with NFPA 13D, the fire separation distance for exterior walls not fire-resistance rated and for fire-resistance-rated projections shall be permitted to be reduced to 0 feet, and unlimited unprotected openings and penetrations shall be permitted, where the adjoining lot provides an open setback yard that is 6 feet or more in width on the opposite side of the property line.
- b. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the eave overhang if fireblocking is provided from the wall top plate to the underside of the roof sheathing.
- c. The fire-resistance rating shall be permitted to be reduced to 0 hours on the underside of the rake overhang where gable vent openings are not installed.

exterior sheathing is filled with a minimum of two 2-inch nominal thickness wood studs.

**R302.2.3 Continuity.** The fire-resistance-rated wall or assembly separating *townhouse units* shall be continuous from the foundation to the underside of the roof sheathing, deck or slab. The fire-resistance rating shall extend the full length of the wall or assembly, including wall extensions through and separating attached enclosed *accessory structures*.

**R302.2.4 Parapets for townhouses.** Parapets constructed in accordance with Section R302.2.5 shall be constructed for *townhouses* as an extension of exterior walls or common walls separating *townhouse units* in accordance with the following:

1. Where roof surfaces adjacent to the wall or walls are at the same elevation, the parapet shall extend not less than 30 inches (762 mm) above the roof surfaces.
2. Where roof surfaces adjacent to the wall or walls are at different elevations and the higher roof is not more than 30 inches (762 mm) above the lower roof, the parapet shall extend not less than 30 inches (762 mm) above the lower roof surface.

**Exception:** A parapet is not required in the preceding two cases where the roof covering complies with a minimum Class C rating as tested in accordance with ASTM E108 or UL 790 and the roof decking or sheathing is of *noncombustible materials* or fire-retardant-treated wood for a distance of 4 feet (1219 mm) on each side of the wall or walls, or one layer of  $\frac{5}{8}$ -inch (15.9 mm) Type X gypsum board is installed directly beneath the roof decking or sheathing, supported by not less than nominal 2-inch (51 mm) ledgers attached to the sides of the roof framing members, for a distance of not less than 4 feet (1219 mm) on each side of the wall or walls and any openings or penetrations in the roof are not within 4 feet (1219 mm) of the common walls. Fire-retardant-treated wood shall meet the requirements of Sections R802.1.5 and R803.2.1.2.

3. A parapet is not required where roof surfaces adjacent to the wall or walls are at different elevations and the higher roof is more than 30 inches (762 mm) above the lower roof. The common wall construction from the lower roof to the underside of the higher *roof deck* shall have not less than a 1-hour fire-resistance rating. The wall shall be rated for exposure from both sides.

**R302.2.5 Parapet construction.** Parapets shall have the same fire-resistance rating as that required for the supporting wall or walls. On any side adjacent to a roof surface, the parapet shall have noncombustible faces for the uppermost 18 inches (457 mm), to include counter-flashing and coping materials. Where the roof slopes

toward a parapet at slopes greater than 2 units vertical in 12 units horizontal (16.7-percent slope), the parapet shall extend to the same height as any portion of the roof within a distance of 3 feet (914 mm), and the height shall be not less than 30 inches (762 mm).

**R302.2.6 Structural independence.** Each *townhouse unit* shall be structurally independent.

#### Exceptions:

1. Foundations supporting exterior walls or common walls.
2. Structural roof and wall sheathing from each unit fastened to the common wall framing.
3. Nonstructural wall and roof coverings.
4. Flashing at termination of roof covering over common wall.
5. *Townhouse units* separated by a common wall as provided in Section R302.2.2, Item 1 or 2.
6. *Townhouse units* protected by a fire sprinkler system complying with Section P2904 or NFPA 13D.

**R302.3 Two-family dwellings.** *Dwelling units* in two-family dwellings shall be separated from each other by wall and floor assemblies having not less than a 1-hour fire-resistance rating where tested in accordance with ASTM E119, UL 263 or Section 703.2.2 of the *International Building Code*. Such separation shall be provided regardless of whether a *lot line* exists between the two *dwelling units* or not. Fire-resistance-rated floor/ceiling and wall assemblies shall extend to and be tight against the exterior wall, and wall assemblies shall extend from the foundation to the underside of the roof sheathing.

#### Exceptions:

1. A fire-resistance rating of  $\frac{1}{2}$  hour shall be permitted in buildings equipped throughout with an automatic sprinkler system installed in accordance with Section P2904.
2. Wall assemblies need not extend through attic spaces where the ceiling is protected by not less than  $\frac{5}{8}$ -inch (15.9 mm) Type X gypsum board, an attic draft stop constructed as specified in Section R302.12.1 is provided above and along the wall assembly separating the *dwellings* and the structural framing supporting the ceiling is protected by not less than  $\frac{1}{2}$ -inch (12.7 mm) gypsum board or equivalent.

**R302.3.1 Supporting construction.** Where floor assemblies are required to be fire-resistance rated by Section R302.3, the supporting construction of such assemblies shall have an equal or greater fire-resistance rating.

**R302.4 Dwelling unit rated penetrations.** Penetrations of wall or floor-ceiling assemblies required to be fire-resistance rated in accordance with Section R302.2 or R302.3 shall be protected in accordance with this section.



## BUILDING PLANNING

**R302.4.1 Through penetrations.** Through penetrations of fire-resistance-rated wall or floor assemblies shall comply with Section R302.4.1.1 or R302.4.1.2.

**Exceptions:**

1. Where the penetrating items are steel, ferrous or copper pipes, tubes or conduits, the annular space shall be protected as follows:
  - 1.1. In concrete or masonry wall or floor assemblies, concrete, grout or mortar shall be permitted where installed to the full thickness of the wall or floor assembly or the thickness required to maintain the fire-resistance rating, provided that both of the following are complied with:
    - 1.1.1. The nominal diameter of the penetrating item is not more than 6 inches (152 mm).
    - 1.1.2. The area of the opening through the wall does not exceed 144 square inches (92 900 mm<sup>2</sup>).
  - 1.2. The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste where subjected to ASTM E119 or UL 263 time temperature fire conditions under a positive pressure differential of not less than 0.01 inch of water (3 Pa) at the location of the penetration for the time period equivalent to the fire-resistance rating of the construction penetrated.
2. The annular space created by the penetration of water-filled fire sprinkler piping, provided that the annular space is filled using a material complying with Item 1.2 of Exception 1.

**R302.4.1.1 Fire-resistance-rated assembly.** Penetrations shall be installed as tested in the *approved* fire-resistance-rated assembly.

**R302.4.1.2 Penetration firestop system.** Penetrations shall be protected by an *approved* penetration firestop system installed as tested in accordance with ASTM E814 or UL 1479, with a positive pressure differential of not less than 0.01 inch of water (3 Pa) and shall have an F rating of not less than the required fire-resistance rating of the wall or floor-ceiling assembly penetrated.

**R302.4.2 Membrane penetrations.** Membrane penetrations shall comply with Section R302.4.1. Where walls are required to have a fire-resistance rating, recessed fixtures shall be installed so that the required fire-resistance rating will not be reduced.

**Exceptions:**

1. Membrane penetrations of not more than 2-hour fire-resistance-rated walls and partitions

by steel electrical boxes that do not exceed 16 square inches (0.0103 m<sup>2</sup>) in area provided that the aggregate area of the openings through the membrane does not exceed 100 square inches (0.0645 m<sup>2</sup>) in any 100 square feet (9.29 m<sup>2</sup>) of wall area. The annular space between the wall membrane and the box shall not exceed <sup>1</sup>/<sub>8</sub> inch (3.1 mm). Such boxes on opposite sides of the wall shall be separated by one of the following:

- 1.1. By a horizontal distance of not less than 24 inches (610 mm) where the wall or partition is constructed with individual noncommunicating stud cavities.
- 1.2. By a horizontal distance of not less than the depth of the wall cavity where the wall cavity is filled with cellulose loose-fill, rockwool or slag mineral wool insulation.
- 1.3. By solid fireblocking in accordance with Section R302.11.
- 1.4. By protecting both boxes with *listed* putty pads.
- 1.5. By other *listed* materials and methods.
2. Membrane penetrations by *listed* electrical boxes of any materials provided that the boxes have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the *listing*. The annular space between the wall membrane and the box shall not exceed <sup>1</sup>/<sub>8</sub> inch (3.1 mm) unless *listed* otherwise. Such boxes on opposite sides of the wall shall be separated by one of the following:
  - 2.1. By the horizontal distance specified in the *listing* of the electrical boxes.
  - 2.2. By solid fireblocking in accordance with Section R302.11.
  - 2.3. By protecting both boxes with *listed* putty pads.
  - 2.4. By other *listed* materials and methods.
3. The annular space created by the penetration of a fire sprinkler or water-filled fire sprinkler piping, provided that the annular space is covered by a metal escutcheon plate.
4. Ceiling membrane penetrations by *listed* luminaires or by luminaires protected with *listed* materials that have been tested for use in fire-resistance-rated assemblies and are installed in accordance with the instructions included in the *listing*.

**R302.5 Dwelling-garage opening and penetration protection.** Openings and penetrations through the walls or ceilings separating the *dwelling* from the garage shall be in accordance with Sections R302.5.1 through R302.5.3.

**R302.5.1 Opening protection.** Openings from a private garage directly into a room used for sleeping purposes shall not be permitted. Other openings between the garage and residence shall be equipped with solid wood doors not less than  $1\frac{3}{8}$  inches (35 mm) in thickness, solid or honeycomb-core steel doors not less than  $1\frac{3}{8}$  inches (35 mm) thick, or 20-minute fire-rated doors.

**R302.5.2 Duct penetration.** Ducts in the garage and ducts penetrating the walls or ceilings separating the dwelling from the garage shall be constructed of a minimum No. 26 gage (0.48 mm) sheet steel or other approved material and shall not have openings into the garage.

**R302.5.3 Other penetrations.** Penetrations through the separation required in Section R302.6 shall be protected as required by Section R302.11, Item 4.

**R302.6 Dwelling-garage fire separation.** The garage shall be separated as required by Table R302.6. Openings in garage walls shall comply with Section R302.5. Attachment of gypsum board shall comply with Table R702.3.5. The wall separation provisions of Table R302.6 shall not apply to garage walls that are perpendicular to the adjacent dwelling unit wall.

**R302.7 Under-stair protection.** Enclosed space under stairs that is accessed by a door or access panel shall have walls, under-stair surface and any soffits protected on the enclosed side with  $\frac{1}{2}$ -inch (12.7 mm) gypsum board.

**R302.8 Foam plastics.** For requirements for foam plastics, see Section R316.

**R302.8.1 Interior finish.** Foam plastics used as interior finishes shall comply with Section R316.5.10.

**R302.9 Flame spread index and smoke-developed index for wall and ceiling finishes.** Flame spread and smoke-developed indices for wall and ceiling finishes shall be in accordance with Sections R302.9.1 through R302.9.4.

**R302.9.1 Flame spread index.** Wall and ceiling finishes shall have a flame spread index of not greater than 200.

**Exception:** Flame spread index requirements for finishes shall not apply to trim defined as picture molds, chair rails, baseboards and handrails; to doors and windows or their frames; or to materials that are less than  $\frac{1}{28}$  inch (0.91 mm) in thickness cemented to the surface of walls or ceilings if these materials

exhibit flame spread index values not greater than those of paper of this thickness cemented to a noncombustible backing.

**R302.9.2 Smoke-developed index.** Wall and ceiling finishes shall have a *smoke-developed index* of not greater than 450.

**R302.9.3 Testing.** Tests shall be made in accordance with ASTM E84 or UL 723.

**R302.9.4 Alternative test method.** As an alternative to having a flame spread index of not greater than 200 and a *smoke-developed index* of not greater than 450 where tested in accordance with ASTM E84 or UL 723, wall and ceiling finishes shall be permitted to be tested in accordance with NFPA 286. Materials tested in accordance with NFPA 286 shall meet the following criteria:

The interior finish shall comply with the following:

1. During the 40 kW exposure, flames shall not spread to the ceiling.
2. The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
3. Flashover, as defined in NFPA 286, shall not occur.
4. The peak heat release rate throughout the test shall not exceed 800 kW.
5. The total smoke released throughout the test shall not exceed 1,000 m<sup>2</sup>.

**R302.9.5 High-density polyethylene (HDPE) and polypropylene (PP).** Where high-density polyethylene or polypropylene is used as an interior finish material, it shall be tested in accordance with NFPA 286 and comply with the criteria in Section R302.9.4.

**R302.10 Flame spread index and smoke-developed index for insulation.** Flame spread and *smoke-developed index* for insulation shall be in accordance with Sections R302.10.1 through R302.10.5.

**R302.10.1 Insulation.** Insulating materials installed within floor-ceiling assemblies, roof-ceiling assemblies, wall assemblies, crawl spaces and attics shall comply with the requirements of this section. They shall exhibit a flame spread index not to exceed 25 and a *smoke-developed index* not to exceed 450 where tested in accordance with ASTM E84 or UL 723. Insulating materials, where

**TABLE R302.6**  
**DWELLING-GARAGE SEPARATION**

SEPARATION	MATERIAL
From the residence and attics	Not less than $\frac{1}{2}$ -inch gypsum board or equivalent applied to the garage side
From habitable rooms above the garage	Not less than $\frac{5}{8}$ -inch Type X gypsum board or equivalent
Structure(s) supporting floor/ceiling assemblies used for separation required by this section	Not less than $\frac{1}{2}$ -inch gypsum board or equivalent
Garages located less than 3 feet from a dwelling unit on the same lot	Not less than $\frac{1}{2}$ -inch gypsum board or equivalent applied to the interior side of exterior walls that are within this area

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

## BUILDING PLANNING

tested in accordance with the requirements of this section, shall include facings, where used, such as vapor retarders, *vapor permeable* membranes and similar coverings.

**Exceptions:**

1. Where such materials are installed in concealed spaces, the flame spread index and *smoke-developed index* limitations do not apply to the facings, provided that the facing is installed in substantial contact with the unexposed surface of the ceiling, floor or wall finish.
2. Cellulose fiber loose-fill insulation that is not spray applied and that complies with the requirements of Section R302.10.3 shall not be required to meet the flame spread index requirements but shall be required to meet a *smoke-developed index* of not more than 450 where tested in accordance with CAN/ULC S102.2.
3. Foam plastic insulation shall comply with Section R316.

**R302.10.2 Loose-fill insulation.** Loose-fill insulation materials that cannot be mounted in the ASTM E84 or UL 723 apparatus without a screen or artificial supports shall comply with the flame spread and smoke-developed limits of Section R302.10.1 where tested in accordance with CAN/ULC S102.2.

**Exception:** Cellulosic fiber loose-fill insulation shall not be required to be tested in accordance with CAN/ULC S102.2, provided that such insulation complies with the requirements of Sections R302.10.1 and R302.10.3.

**R302.10.3 Cellulosic fiber loose-fill insulation.** Cellulosic fiber loose-fill insulation shall comply with CPSC 16 CFR, Parts 1209 and 1404. Each package of such insulating material shall be clearly *labeled* in accordance with CPSC 16 CFR, Parts 1209 and 1404.

**R302.10.4 Exposed attic insulation.** Exposed insulation materials installed on attic floors shall have a critical radiant flux of not less than 0.12 watt per square centimeter.

**R302.10.5 Testing.** Tests for critical radiant flux shall be made in accordance with ASTM E970.

**R302.11 Fireblocking.** In combustible construction, fireblocking shall be provided to cut off both vertical and horizontal concealed draft openings and to form an effective fire barrier between stories, and between a top story and the roof space.

Fireblocking shall be provided in wood-framed construction in the following locations:

1. In concealed spaces of stud walls and partitions, including furred spaces and parallel rows of studs or staggered studs, as follows:
  - 1.1. Vertically at the ceiling and floor levels.
  - 1.2. Horizontally at intervals not exceeding 10 feet (3048 mm).

2. At interconnections between concealed vertical and horizontal spaces such as occur at soffits, drop ceilings and cove ceilings.
3. In concealed spaces between stair stringers at the top and bottom of the run. Enclosed spaces under stairs shall comply with Section R302.7.
4. At openings around vents, pipes, ducts, cables and wires at ceiling and floor level, with an *approved* material to resist the free passage of flame and products of combustion. The material filling this annular space shall not be required to meet the ASTM E136 requirements.
5. For the fireblocking of chimneys and fireplaces, see Section R1003.19.
6. Fireblocking of cornices of a two-family *dwelling* is required at the line of *dwelling unit* separation.

**R302.11.1 Fireblocking materials.** Except as provided in Section R302.11, Item 4, fireblocking shall consist of the following materials.

1. Two-inch (51 mm) nominal lumber.
2. Two thicknesses of 1-inch (25.4 mm) nominal lumber with broken lap joints.
3. One thickness of  $2\frac{3}{32}$ -inch (18.3 mm) *wood structural panels* with joints backed by  $2\frac{3}{32}$ -inch (18.3 mm) *wood structural panels*.
4. One thickness of  $\frac{3}{4}$ -inch (19.1 mm) particleboard with joints backed by  $\frac{3}{4}$ -inch (19.1 mm) particleboard.
5. One-half-inch (12.7 mm) gypsum board.
6. One-quarter-inch (6.4 mm) cement-based millboard.
7. Batts or blankets of mineral wool or glass fiber or other *approved* materials installed in such a manner as to be securely retained in place.
8. Cellulose insulation installed as tested in accordance with ASTM E119 or UL 263, for the specific application.

**R302.11.1.1 Batts or blankets of mineral or glass fiber.** Batts or blankets of mineral or glass fiber or other *approved* nonrigid materials shall be permitted for compliance with the 10-foot (3048 mm) horizontal fireblocking in walls constructed using parallel rows of studs or staggered studs.

**R302.11.1.2 Unfaced fiberglass.** Unfaced fiberglass batt insulation used as fireblocking shall fill the entire cross section of the wall cavity to a height of not less than 16 inches (406 mm) measured vertically. Where piping, conduit or similar obstructions are encountered, the insulation shall be packed tightly around the obstruction.

**R302.11.1.3 Loose-fill insulation material.** Loose-fill insulation material shall not be used as a fireblock unless specifically tested in the form and manner

intended for use to demonstrate its ability to remain in place and to retard the spread of fire and hot gases.

**R302.11.2 Fireblocking integrity.** The integrity of fireblocks shall be maintained.

**R302.12 Draftstopping.** In combustible construction where there is usable space both above and below the concealed space of a floor-ceiling assembly, draftstops shall be installed so that the area of the concealed space does not exceed 1,000 square feet (92.9 m<sup>2</sup>). Draftstopping shall divide the concealed space into approximately equal areas. Where the assembly is enclosed by a floor membrane above and a ceiling membrane below, draftstopping shall be provided in floor-ceiling assemblies under the following circumstances:

1. Ceiling is suspended under the floor framing.
2. Floor framing is constructed of truss-type open-web or perforated members.

**R302.12.1 Materials.** Draftstopping materials shall be not less than 1/2-inch (12.7 mm) gypsum board, 3/8-inch (9.5 mm) *wood structural panels* or other *approved* materials adequately supported. Draftstopping shall be installed parallel to the floor framing members unless otherwise *approved* by the *building official*. The integrity of the draftstops shall be maintained.

**R302.13 Fire protection of floors.** Floor assemblies that are not required elsewhere in this code to be fire-resistance rated, shall be provided with a 1/2-inch (12.7 mm) gypsum wallboard membrane, 5/8-inch (16 mm) *wood structural panel* membrane, or equivalent on the underside of the floor framing member. Penetrations or openings for ducts, vents, electrical outlets, lighting, devices, luminaires, wires, speakers, drainage, piping and similar openings or penetrations shall be permitted.

**Exceptions:**

1. Floor assemblies located directly over a space protected by an automatic sprinkler system in accordance with Section P2904, NFPA 13D, or other *approved* equivalent sprinkler system.
2. Floor assemblies located directly over a *crawl space* not intended for storage or for the installation of fuel-fired or electric-powered heating appliances.
3. Portions of floor assemblies shall be permitted to be unprotected where complying with the following:
  - 3.1. The aggregate area of the unprotected portions does not exceed 80 square feet (7.4 m<sup>2</sup>) per story.
  - 3.2. Fireblocking in accordance with Section R302.11.1 is installed along the perimeter of the unprotected portion to separate the unprotected portion from the remainder of the floor assembly.
4. Wood floor assemblies using dimension lumber or *structural composite lumber* equal to or greater

than 2-inch by 10-inch (50.8 mm by 254 mm) nominal dimension, or other *approved* floor assemblies demonstrating equivalent fire performance.

**R302.14 Combustible insulation clearance.** Combustible insulation shall be separated not less than 3 inches (76 mm) from recessed luminaires, fan motors and other heat-producing devices.

**Exception:** Where heat-producing devices are *listed* for lesser clearances, combustible insulation complying with the listing requirements shall be separated in accordance with the conditions stipulated in the listing.

Recessed luminaires installed in the *building thermal envelope* shall meet the requirements of Section N1102.4.5 of this code.

## SECTION R303 LIGHT, VENTILATION AND HEATING

**R303.1 Habitable rooms.** Habitable rooms shall have an aggregate glazing area of not less than 8 percent of the floor area of such rooms. Natural *ventilation* shall be through windows, skylights, doors, louvers or other *approved* openings to the outdoor air. Such openings shall be provided with ready access or shall otherwise be readily controllable by the building occupants. The openable area to the outdoors shall be not less than 4 percent of the floor area being ventilated.

**Exceptions:**

1. For habitable rooms other than kitchens, the glazed areas need not be openable where the opening is not required by Section R310 and a whole-house mechanical *ventilation* system or a mechanical ventilation system capable of producing 0.35 air changes per hour in the habitable rooms is installed in accordance with Section M1505.
2. For kitchens, the glazed areas need not be openable where the opening is not required by Section R310 and a local exhaust system is installed in accordance with Section M1505.
3. The glazed areas need not be installed in rooms where Exception 1 is satisfied and artificial light is provided that is capable of producing an average illumination of 6 footcandles (65 lux) over the area of the room at a height of 30 inches (762 mm) above the floor level.
4. Use of *sunroom* and patio covers, as defined in Section R202, shall be permitted for natural *ventilation* if in excess of 40 percent of the exterior *sunroom* walls are open, or are enclosed only by insect screening.

**R303.2 Adjoining rooms.** For the purpose of determining light and *ventilation* requirements, rooms shall be considered to be a portion of an adjoining room where not less than one-half of the area of the common wall is open and unobstructed and provides an opening of not less than one-tenth of the



## BUILDING PLANNING

floor area of the interior room and not less than 25 square feet (2.3 m<sup>2</sup>).

**Exception:** Openings required for light or *ventilation* shall be permitted to open into a *sunroom* with thermal isolation or a patio cover, provided that there is an openable area between the adjoining room and the *sunroom* or patio cover of not less than one-tenth of the floor area of the interior room and not less than 20 square feet (2 m<sup>2</sup>). The minimum openable area to the outdoors shall be based on the total floor area being ventilated.

**R303.3 Bathrooms.** Bathrooms, water closet compartments and other similar rooms shall be provided with aggregate glazing area in windows of not less than 3 square feet (0.3 m<sup>2</sup>), one-half of which shall be openable.

**Exception:** The glazed areas shall not be required where artificial light and a local exhaust system are provided. The minimum local exhaust rates shall be determined in accordance with Section M1505. Exhaust air from the space shall be exhausted directly to the outdoors.

**R303.4 Mechanical ventilation.** Buildings and *dwelling units* complying with Section N1102.4.1 shall be provided with mechanical ventilation in accordance with Section M1505, or with other *approved* means of ventilation.

**R303.5 Opening location.** Outdoor intake and exhaust openings shall be located in accordance with Sections R303.5.1 and R303.5.2.

**R303.5.1 Intake openings.** Mechanical and gravity outdoor air intake openings shall be located not less than 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks.

For the purpose of this section, the exhaust from *dwelling unit* toilet rooms, bathrooms and *kitchens* shall not be considered as hazardous or noxious.

### Exceptions:

1. The 10-foot (3048 mm) separation is not required where the intake opening is located 3 feet (914 mm) or greater below the contaminant source.
2. Vents and chimneys serving fuel-burning *appliances* shall be terminated in accordance with the applicable provisions of Chapters 18 and 24.
3. Clothes dryer exhaust ducts shall be terminated in accordance with Section M1502.3.

**R303.5.2 Exhaust openings.** Exhaust air shall not be directed onto walkways.

**R303.6 Outside opening protection.** Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles having an opening size of not less than 1/4 inch (6 mm) and a maximum opening size of 1/2 inch (13 mm), in any dimension. Openings shall be protected against local weather conditions. Outdoor air exhaust and intake openings shall meet the provisions for exterior wall opening protectives in accordance with this code.

**R303.7 Interior stairway illumination.** Interior *stairways* shall be provided with an artificial light source to illuminate the landings and treads. The light source shall be capable of illuminating treads and landings to levels of not less than 1 footcandle (11 lux) as measured at the center of treads and landings. There shall be a wall switch at each floor level to control the light source where the *stairway* has six or more *risers*.

**Exception:** A switch is not required where remote, central or automatic control of lighting is provided.

**R303.8 Exterior stairway illumination.** Exterior *stairways* shall be provided with an artificial light source located at the top landing of the *stairway*. Exterior *stairways* providing access to a *basement* from the outdoor *grade* level shall be provided with an artificial light source located at the bottom landing of the *stairway*.

**R303.9 Required glazed openings.** Required glazed openings shall open directly onto a street or public alley, or a *yard* or court located on the same *lot* as the building.

### Exceptions:

1. Required glazed openings that face into a roofed porch where the porch abuts a street, *yard* or court and the longer side of the porch is not less than 65 percent unobstructed and the ceiling height is not less than 7 feet (2134 mm).
2. Eave projections shall not be considered as obstructing the clear open space of a *yard* or court.
3. Required glazed openings that face into the area under a deck, balcony, bay or floor cantilever where a clear vertical space not less than 36 inches (914 mm) in height is provided.

**R303.9.1 Sunroom additions.** Required glazed openings shall be permitted to open into *sunroom additions* or patio covers that abut a street, *yard* or court if in excess of 40 percent of the exterior *sunroom* walls are open, or are enclosed only by insect screening, and the ceiling height of the *sunroom* is not less than 7 feet (2134 mm).

**R303.10 Required heating.** Where the winter design temperature in Table R301.2 is below 60°F (16°C), every *dwelling unit* shall be provided with heating facilities capable of maintaining a room temperature of not less than 68°F (20°C) at a point 3 feet (914 mm) above the floor and 2 feet (610 mm) from exterior walls in habitable rooms at the design temperature. The installation of one or more portable space heaters shall not be used to achieve compliance with this section.

## SECTION R304 MINIMUM ROOM AREAS

**R304.1 Minimum area.** Habitable rooms shall have a floor area of not less than 70 square feet (6.5 m<sup>2</sup>).

**Exception:** Kitchens.

**R304.2 Minimum dimensions.** Habitable rooms shall be not less than 7 feet (2134 mm) in any horizontal dimension.

**Exception:** Kitchens.

**R304.3 Height effect on room area.** Portions of a room with a sloping ceiling measuring less than 5 feet (1524 mm) or a furred ceiling measuring less than 7 feet (2134 mm) from the finished floor to the finished ceiling shall not be considered as contributing to the minimum required habitable area for that room.

### SECTION R305 CEILING HEIGHT

**R305.1 Minimum height.** *Habitable space*, hallways and portions of *basements* containing these spaces shall have a ceiling height of not less than 7 feet (2134 mm). Bathrooms, toilet rooms and laundry rooms shall have a ceiling height of not less than 6 feet 8 inches (2032 mm).

#### Exceptions:

1. For rooms with sloped ceilings, the required floor area of the room shall have a ceiling height of not less than 5 feet (1524 mm) and not less than 50 percent of the required floor area shall have a ceiling height of not less than 7 feet (2134 mm).
2. The ceiling height above bathroom and toilet room fixtures shall be such that the fixture is capable of being used for its intended purpose. A shower or tub equipped with a showerhead shall have a ceiling height of not less than 6 feet 8 inches (2032 mm) above an area of not less than 30 inches (762 mm) by 30 inches (762 mm) at the showerhead.
3. Beams, girders, ducts or other obstructions in *basements* containing *habitable space* shall be permitted to project to within 6 feet 4 inches (1931 mm) of the finished floor.
4. Beams and girders spaced apart not less than 36 inches (914 mm) in clear finished width shall project not more than 78 inches (1981 mm) from the finished floor.

**R305.1.1 Basements.** Portions of *basements* that do not contain *habitable space* or hallways shall have a ceiling height of not less than 6 feet 8 inches (2032 mm).

**Exception:** At beams, girders, ducts or other obstructions, the ceiling height shall be not less than 6 feet 4 inches (1931 mm) from the finished floor.

### SECTION R306 SANITATION

**R306.1 Toilet facilities.** Every *dwelling unit* shall be provided with a water closet, lavatory, and a bathtub or shower.

**R306.2 Kitchen.** Each *dwelling unit* shall be provided with a kitchen area and every kitchen area shall be provided with a sink.

**R306.3 Sewage disposal.** Plumbing fixtures shall be connected to a sanitary sewer or to an *approved* private sewage disposal system.

**R306.4 Water supply to fixtures.** Plumbing fixtures shall be connected to an *approved* water supply. Kitchen sinks, lavatories, bathtubs, showers, bidets, laundry tubs and washing machine outlets shall be provided with hot and cold water.

### SECTION R307 TOILET, BATH AND SHOWER SPACES

**R307.1 Space required.** Fixtures shall be spaced in accordance with Figure R307.1, and in accordance with the requirements of Section P2705.1.

**R307.2 Bathtub and shower spaces.** Bathtub and shower floors and walls above bathtubs with installed shower heads and in shower compartments shall be finished with a nonabsorbent surface. Such wall surfaces shall extend to a height of not less than 6 feet (1829 mm) above the floor.

### SECTION R308 GLAZING

**R308.1 Identification.** Except as indicated in Section R308.1.1 each pane of glazing installed in hazardous locations as defined in Section R308.4 shall be provided with a manufacturer's designation specifying who applied the designation, the type of glass and the safety glazing standard with which it complies, and that is visible in the final installation. The designation shall be acid etched, sandblasted, ceramic-fired, laser etched, embossed, or be of a type that once applied cannot be removed without being destroyed. A *label* shall be permitted in lieu of the manufacturer's designation.

#### Exceptions:

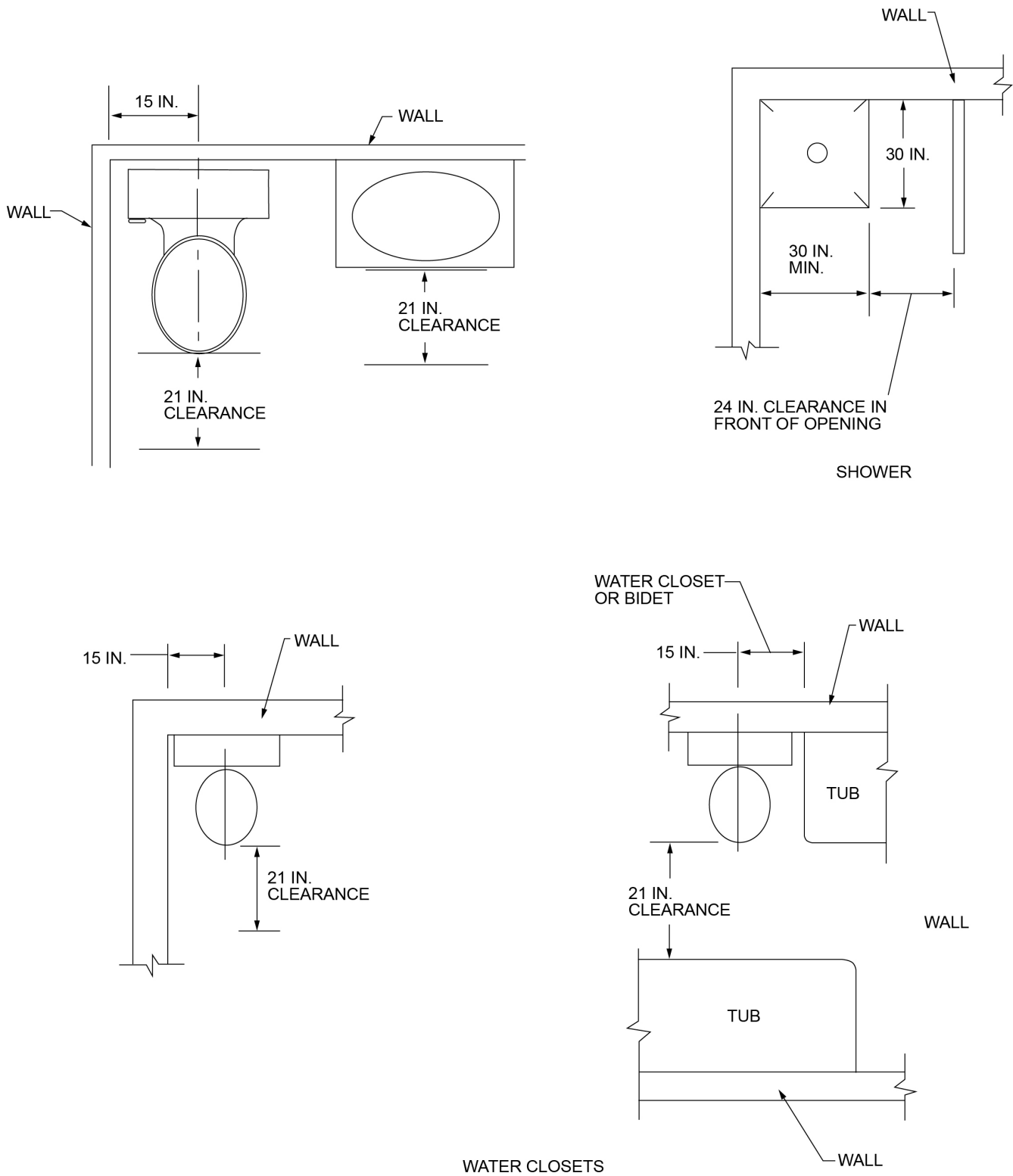
1. For other than tempered glass, manufacturer's designations are not required provided that the *building official* approves the use of a certificate, affidavit or other evidence confirming compliance with this code.
2. Tempered spandrel glass is permitted to be identified by the manufacturer with a removable paper designation.

**R308.1.1 Identification of multiple assemblies.** Multi-pane assemblies having individual panes not exceeding 1 square foot (0.09 m<sup>2</sup>) in exposed area shall have not less than one pane in the assembly identified in accordance with Section R308.1. Other panes in the assembly shall be labeled "CPSC 16 CFR 1201" or "ANSI Z97.1" as appropriate.

**R308.2 Louvered windows or жалюзи.** Regular, float, wired or patterned glass in жалюзи and louvered windows shall be not less than nominal  $\frac{3}{16}$  inch (5 mm) thick and not more than 48 inches (1219 mm) in length. Exposed glass edges shall be smooth.

**R308.2.1 Wired glass prohibited.** Wired glass with wire exposed on longitudinal edges shall not be used in жалюзи or louvered windows.

BUILDING PLANNING



For SI: 1 inch = 25.4 mm.

**FIGURE R307.1**  
**MINIMUM FIXTURE CLEARANCES**

**R308.3 Human impact loads.** Individual glazed areas, including glass mirrors in hazardous locations such as those indicated as defined in Section R308.4, shall pass the test requirements of Section R308.3.1.

**Exceptions:**

1. Louvered windows and jalousies shall comply with Section R308.2.
2. Mirrors and other glass panels mounted or hung on a surface that provides a continuous backing support.
3. Glass unit masonry complying with Section R607.

**R308.3.1 Impact test.** Where required by other sections of the code, glazing shall be tested in accordance with CPSC 16 CFR 1201. Glazing shall comply with the test criteria for Category II unless otherwise indicated in Table R308.3.1(1).

**Exception:** Glazing not in doors or enclosures for hot tubs, whirlpools, saunas, steam rooms, bathtubs and showers shall be permitted to be tested in accordance with ANSI Z97.1. Glazing shall comply with the test criteria for Class A unless otherwise indicated in Table R308.3.1(2).

**R308.4 Hazardous locations.** The locations specified in Sections R308.4.1 through R308.4.7 shall be considered to be specific hazardous locations for the purposes of glazing.

**R308.4.1 Glazing in doors.** Glazing in fixed and operable panels of swinging, sliding and bifold doors shall be considered to be a hazardous location.

**Exceptions:**

1. Glazed openings of a size through which a 3-inch-diameter (76 mm) sphere is unable to pass.
2. Decorative glazing.

**R308.4.2 Glazing adjacent to doors.** Glazing in an individual fixed or operable panel adjacent to a door shall be considered to be a hazardous location where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) above the floor or walking surface and it meets either of the following conditions:

1. Where the glazing is within 24 inches (610 mm) of either side of the door in the plane of the door in a closed position.
2. Where the glazing is on a wall less than 180 degrees (3.14 rad) from the plane of the door in a closed position and within 24 inches (610 mm) of the hinge side of an in-swinging door.

**Exceptions:**

1. Decorative glazing.
2. Where there is an intervening wall or other permanent barrier between the door and the glazing.
3. Where access through the door is to a closet or storage area 3 feet (914 mm) or less in depth. Glazing in this application shall comply with Section R308.4.3.
4. Glazing that is adjacent to the fixed panel of patio doors.

**R308.4.3 Glazing in windows.** Glazing in an individual fixed or operable panel that meets all of the following conditions shall be considered to be a hazardous location:

1. The exposed area of an individual pane is larger than 9 square feet (0.836 m<sup>2</sup>).
2. The bottom edge of the glazing is less than 18 inches (457 mm) above the floor.
3. The top edge of the glazing is more than 36 inches (914 mm) above the floor.

**TABLE R308.3.1(1)**  
**MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING CPSC 16 CFR 1201**

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZING IN STORM OR COMBINATION DOORS (Category Class)	GLAZING IN DOORS (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.3 (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.2 (Category Class)	GLAZING IN DOORS AND ENCLOSURES REGULATED BY SECTION 308.4.5 (Category Class)	SLIDING GLASS DOORS PATIO TYPE (Category Class)
9 square feet or less	I	I	NR	I	II	II
More than 9 square feet	II	II	II	II	II	II

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

NR = No Requirement.

**TABLE R308.3.1(2)**  
**MINIMUM CATEGORY CLASSIFICATION OF GLAZING USING ANSI Z97.1**

EXPOSED SURFACE AREA OF ONE SIDE OF ONE LITE	GLAZED PANELS REGULATED BY SECTION R308.4.3 (Category Class)	GLAZED PANELS REGULATED BY SECTION R308.4.2 (Category Class)	DOORS AND ENCLOSURES REGULATED BY SECTION R308.4.5 <sup>a</sup> (Category Class)
9 square feet or less	No requirement	B	A
More than 9 square feet	A	A	A

For SI: 1 square foot = 0.0929 m<sup>2</sup>.

a. Use is permitted only by the exception to Section R308.3.1.



## BUILDING PLANNING

4. One or more walking surfaces are within 36 inches (914 mm), measured horizontally and in a straight line, of the glazing.

**Exceptions:**

1. Decorative glazing.
2. Where glazing is adjacent to a walking surface and a horizontal rail is installed 34 to 38 inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and have a cross-sectional height of not less than 1½ inches (38 mm).
3. Outboard panes in insulating glass units and other multiple glazed panels where the bottom edge of the glass is 25 feet (7620 mm) or more above *grade*, a roof, walking surfaces or other horizontal [within 45 degrees (0.79 rad) of horizontal] surface adjacent to the glass exterior.

**R308.4.4 Glazing in guards and railings.** Glazing in *guards* and railings, including structural baluster panels and nonstructural in-fill panels, regardless of area or height above a walking surface shall be considered to be a hazardous location.

**R308.4.4.1 Structural glass baluster panels.** *Guards* with structural glass baluster panels shall be installed with an attached top rail or *handrail*. The top rail or *handrail* shall be supported by not less than three glass baluster panels, or shall be otherwise supported to remain in place should one glass baluster panel fail.

**Exception:** An attached top rail or *handrail* is not required where the glass baluster panels are laminated glass with two or more glass plies of equal thickness and of the same glass type.

**R308.4.5 Glazing and wet surfaces.** Glazing in walls, enclosures or fences containing or adjacent to hot tubs, spas, whirlpools, saunas, steam rooms, bathtubs, showers and indoor or outdoor swimming pools where the bottom exposed edge of the glazing is less than 60 inches (1524 mm) measured vertically above any standing or walking surface shall be considered to be a hazardous location. This shall apply to single glazing and each pane in multiple glazing.

**Exception:** Glazing that is more than 60 inches (1524 mm), measured horizontally, from the water's edge of a bathtub, hot tub, spa, whirlpool or swimming pool or from the edge of a shower, sauna or steam room.

**R308.4.6 Glazing adjacent to stairs and ramps.** Glazing where the bottom exposed edge of the glazing is less than 36 inches (914 mm) above the plane of the adjacent walking surface of *stairways*, landings between flights of stairs and *ramps* shall be considered to be a hazardous location.

**Exceptions:**

1. Where glazing is adjacent to a walking surface and a horizontal rail is installed at 34 to 38

inches (864 to 965 mm) above the walking surface. The rail shall be capable of withstanding a horizontal load of 50 pounds per linear foot (730 N/m) without contacting the glass and have a cross-sectional height of not less than 1½ inches (38 mm).

2. Glazing 36 inches (914 mm) or more measured horizontally from the walking surface.

**R308.4.7 Glazing adjacent to the bottom stair landing.**

Glazing adjacent to the landing at the bottom of a *stairway* where the glazing is less than 36 inches (914 mm) above the landing and within a 60-inch (1524 mm) horizontal arc less than 180 degrees (3.14 rad) from the bottom tread *nosings* shall be considered to be a hazardous location. (See Figure R308.4.7.)

**Exception:** Where the glazing is protected by a *guard* complying with Section R312 and the plane of the glass is more than 18 inches (457 mm) from the *guard*.

**R308.5 Site-built windows.** Site-built windows shall comply with Section 2404 of the *International Building Code*.

**R308.6 Skylights and sloped glazing.** *Skylights* and *sloped glazing* shall comply with the following sections.

**R308.6.1 Definitions.** The following terms are defined in Chapter 2:

**SKYLIGHT, UNIT.**

**SKYLIGHTS AND SLOPED GLAZING.**

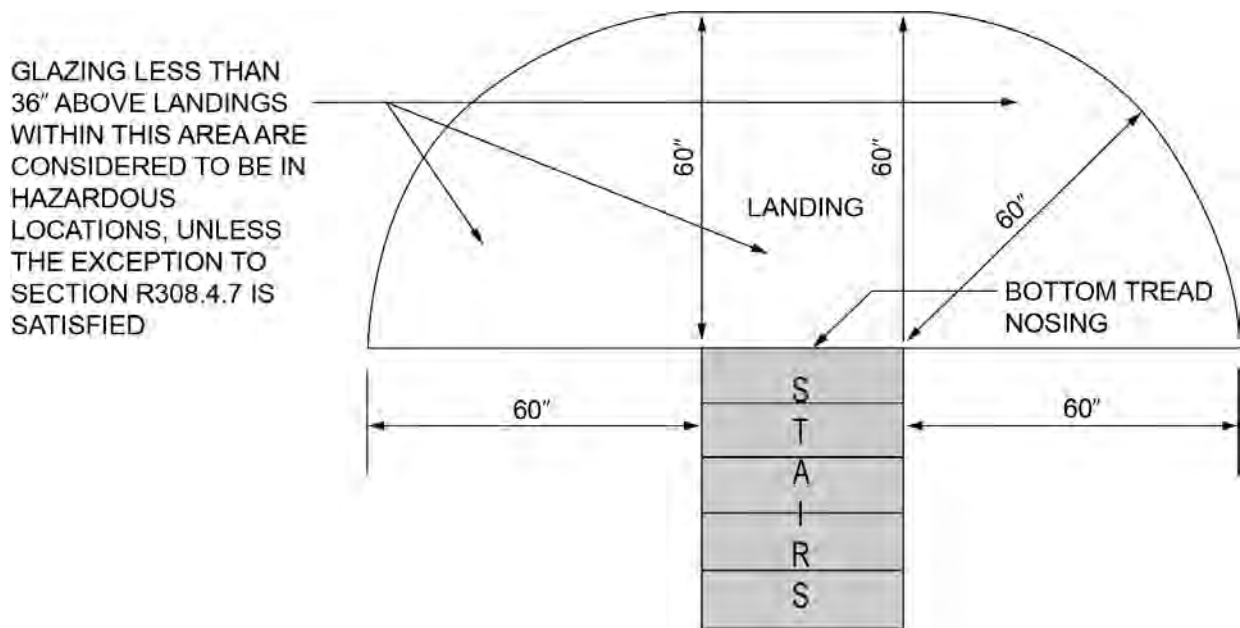
**TUBULAR DAYLIGHTING DEVICE (TDD).**

**R308.6.2 Materials.** Glazing materials shall be limited to the following:

1. Laminated glass with not less than a 0.015-inch (0.38 mm) polyvinyl butyral interlayer for glass panes 16 square feet (1.5 m<sup>2</sup>) or less in area located such that the highest point of the glass is not more than 12 feet (3658 mm) above a walking surface; for higher or larger sizes, the interlayer thickness shall be not less than 0.030 inch (0.76 mm).
2. Fully tempered glass.
3. Heat-strengthened glass.
4. Wired glass.
5. *Approved* rigid plastics.

**R308.6.3 Screens, general.** For fully tempered or heat-strengthened glass, a broken glass retention screen meeting the requirements of Section R308.6.7 shall be installed below the full area of the glass, except for fully tempered glass that meets Condition 1 or 2 listed in Section R308.6.5.

**R308.6.4 Screens with multiple glazing.** Where the inboard pane is fully tempered, heat-strengthened or wired glass, a broken glass retention screen meeting the requirements of Section R308.6.7 shall be installed below the full area of the glass, except for Condition 1 or 2 listed in Section R308.6.5. Other panes in the multiple glazing shall be of any type listed in Section R308.6.2.



For SI: 1 inch = 25.4 mm.

**FIGURE R308.4.7**  
**HAZARDOUS GLAZING LOCATIONS AT BOTTOM STAIR LANDINGS**

**R308.6.5 Screens not required.** Screens shall not be required where laminated glass complying with Item 1 of Section R308.6.2 is used as single glazing or the inboard pane in multiple glazing. Screens shall not be required where fully tempered glass is used as single glazing or the inboard pane in multiple glazing and either of the following conditions is met:

1. The glass area is 16 square feet (1.49 m<sup>2</sup>) or less; the highest point of glass is not more than 12 feet (3658 mm) above a walking surface; the nominal glass thickness is not more than  $\frac{3}{16}$  inch (4.8 mm); and for multiple glazing only the other pane or panes are fully tempered, laminated or wired glass.
2. The glass area is greater than 16 square feet (1.49 m<sup>2</sup>); the glass is sloped 30 degrees (0.52 rad) or less from vertical; and the highest point of glass is not more than 10 feet (3048 mm) above a walking surface.

**R308.6.6 Glass in greenhouses.** Any glazing material is permitted to be installed without screening in the sloped areas of greenhouses, provided that the greenhouse height at the ridge does not exceed 20 feet (6096 mm) above grade.

**R308.6.7 Screen characteristics.** The screen and its fastenings shall: be capable of supporting twice the weight of the glazing; be firmly and substantially fastened to the framing members; be installed within 4 inches (102 mm) of the glass; and have a mesh opening of not greater than 1 inch by 1 inch (25 mm by 25 mm).

**R308.6.8 Curbs for skylights.** *Unit skylights* installed in a roof with a pitch of less than three units vertical in 12 units horizontal (25-percent slope) shall be mounted on a curb extending not less than 4 inches (102 mm) above the plane of the roof, unless otherwise specified in the manufacturer's installation instructions.

**R308.6.9 Testing and labeling.** *Unit skylights* and *tubular daylighting devices* shall be tested by an *approved* independent laboratory, and bear a *label* identifying manufacturer, performance grade rating and *approved* inspection agency to indicate compliance with the requirements of AAMA/WDMA/CSA 101/I.S.2/A440.

**R308.6.9.1 Comparative analysis for glass-glazed unit skylights.** Structural wind load design pressures for glass-glazed *unit skylights* different than the size tested in accordance with Section R308.6.9 shall be permitted to be different than the design value of the tested unit where determined in accordance with one of the following comparative analysis methods:

1. Structural wind load design pressures for glass-glazed *unit skylights* smaller than the size tested in accordance with Section R308.6.9 shall be permitted to be higher than the design value of the tested unit provided that such higher pressures are determined by accepted engineering analysis. Components of the smaller unit shall be the same as those of the tested unit. Such calculated design pressures shall be validated by an additional test of the glass-glazed *unit skylight* having the highest allowable design pressure.
2. In accordance with WDMA I.S.11.

## BUILDING PLANNING

## SECTION R309 GARAGES AND CARPORTS

**R309.1 Floor surface.** Garage floor surfaces shall be of *approved noncombustible material*.

The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

**R309.2 Carports.** Carports shall be open on not less than two sides. Carport floor surfaces shall be of *approved noncombustible material*. Carports not open on two or more sides shall be considered to be a garage and shall comply with the provisions of this section for garages.

The area of floor used for parking of automobiles or other vehicles shall be sloped to facilitate the movement of liquids to a drain or toward the main vehicle entry doorway.

**Exception:** Asphalt surfaces shall be permitted at ground level in carports.

**R309.3 Flood hazard areas.** Garages and carports located in flood hazard areas as established by Table R301.2 shall be constructed in accordance with Section R322.

**R309.4 Automatic garage door openers.** Automatic garage door openers, if provided, shall be *listed* and *labeled* in accordance with UL 325.

**R309.5 Fire sprinklers.** Private garages shall be protected by fire sprinklers where the garage wall has been designed based on Table R302.1(2), Note a. Sprinklers in garages shall be connected to an automatic sprinkler system that complies with NFPA 13D. Garage sprinklers shall be residential sprinklers or quick-response sprinklers, designed to provide a density of 0.05 gpm/ft<sup>2</sup>. Garage doors shall not be considered obstructions with respect to sprinkler placement.

## SECTION R310 EMERGENCY ESCAPE AND RESCUE OPENINGS

**R310.1 Emergency escape and rescue opening required.** *Basements, habitable attics* and every sleeping room shall have not less than one operable *emergency escape and rescue opening*. Where *basements* contain one or more sleeping rooms, an *emergency escape and rescue opening* shall be required in each sleeping room. *Emergency escape and rescue openings* shall open directly into a *public way*, or to a *yard* or court having a minimum width of 36 inches (914 mm) that opens to a *public way*.

### Exceptions:

1. *Storm shelters* and *basements* used only to house mechanical *equipment* not exceeding a total floor area of 200 square feet (18.58 m<sup>2</sup>).
2. Where the *dwelling unit* or *townhouse unit* is equipped with an automatic sprinkler system installed in accordance with NFPA 13D, sleeping rooms in *basements* shall not be required to have *emergency escape and rescue openings* provided that the *basement* has one of the following:

2.1. One means of egress complying with Section R311 and one *emergency escape and rescue opening*.

2.2. Two means of egress complying with Section R311.

3. A *yard* shall not be required to open directly into a *public way* where the *yard* opens to an unobstructed path from the *yard* to the *public way*. Such path shall have a width of not less than 36 inches (914 mm).

**R310.1.1 Operational constraints and opening control devices.** *Emergency escape and rescue openings* shall be operational from the inside of the room without the use of keys, tools or special knowledge. Window opening control devices and fall prevention devices complying with ASTM F2090 shall be permitted for use on windows serving as a required *emergency escape and rescue opening* and shall be not more than 70 inches (178 cm) above the finished floor.

**R310.2 Emergency escape and rescue openings.** *Emergency escape and rescue openings* shall have minimum dimensions in accordance with Sections R310.2.1 through R310.2.4.

**R310.2.1 Minimum size.** *Emergency escape and rescue openings* shall have a net clear opening of not less than 5.7 square feet (0.530 m<sup>2</sup>).

**Exception:** The minimum net clear opening for *grade-floor emergency escape and rescue openings* shall be 5 square feet (0.465 m<sup>2</sup>).

**R310.2.2 Minimum dimensions.** The minimum net clear opening height dimension shall be 24 inches (610 mm). The minimum net clear opening width dimension shall be 20 inches (508 mm). The net clear opening dimensions shall be the result of normal operation of the opening.

**R310.2.3 Maximum height from floor.** *Emergency escape and rescue openings* shall have the bottom of the clear opening not greater than 44 inches (1118 mm) above the floor.

**R310.2.4 Emergency escape and rescue openings under decks, porches and cantilevers.** *Emergency escape and rescue openings* installed under decks, porches and cantilevers shall be fully openable and provide a path not less than 36 inches (914 mm) in height and 36 inches (914 mm) in width to a *yard* or court.

**R310.3 Emergency escape and rescue doors.** Where a door is provided as the required *emergency escape and rescue opening*, it shall be a side-hinged door or a sliding door.

**R310.4 Area wells.** An *emergency escape and rescue opening* where the bottom of the clear opening is below the adjacent grade shall be provided with an area well in accordance with Sections R310.4.1 through R310.4.4.

**R310.4.1 Minimum size.** The horizontal area of the area well shall be not less than 9 square feet (0.9 m<sup>2</sup>), with a horizontal projection and width of not less than 36 inches



horizontal projection and width of not less than 36 inches (914 mm). The size of the area well shall allow the *emergency escape and rescue opening* to be fully opened.

**Exception:** The ladder or steps required by Section R310.4.2 shall be permitted to encroach not more than 6 inches (152 mm) into the required dimensions of the area well.

**R310.4.2 Ladder and steps.** Area wells with a vertical depth greater than 44 inches (1118 mm) shall be equipped with an *approved*, permanently affixed ladder or steps. The ladder or steps shall not be obstructed by the *emergency escape and rescue opening* where the window or door is in the open position. Ladders or steps required by this section shall not be required to comply with Section R311.7.

**R310.4.2.1 Ladders.** Ladders and rungs shall have an inside width of not less than 12 inches (305 mm), shall project not less than 3 inches (76 mm) from the wall and shall be spaced not more than 18 inches (457 mm) on center vertically for the full height of the area well.

**R310.4.2.2 Steps.** Steps shall have an inside width of not less than 12 inches (305 mm), a minimum tread depth of 5 inches (127 mm) and a maximum *riser* height of 18 inches (457 mm) for the full height of the area well.

**R310.4.3 Drainage.** Area wells shall be designed for proper drainage by connecting to the building's foundation drainage system required by Section R405.1.

**Exception:** A drainage system for area wells is not required where the foundation is on well-drained soil or sand-gravel mixture soils in accordance with the United Soil Classification System, Group I Soils, as detailed in Table R405.1.

**R310.4.4 Bars, grilles, covers and screens.** Where bars, grilles, covers, screens or similar devices are placed over *emergency escape and rescue openings*, bulkhead enclosures or area wells that serve such openings, the minimum net clear opening size shall comply with Sections R310.2 through R310.2.2 and R310.4.1. Such devices shall be releasable or removable from the inside without the use of a key or tool or force greater than that required for the normal operation of the escape and rescue opening.

**R310.5 Replacement windows for emergency escape and rescue openings.** Replacement windows installed in buildings meeting the scope of this code shall be exempt from Sections R310.2 and R310.4.4, provided that the replacement window meets the following conditions:

1. The replacement window is the manufacturer's largest standard size window that will fit within the existing frame or existing rough opening. The replacement window is of the same operating style as the existing window or a style that provides for an equal or greater window opening area than the existing window.
2. The replacement window is not part of a change of occupancy.

**R310.6 Dwelling additions.** Where *dwelling additions* contain sleeping rooms, an *emergency escape and rescue opening* shall be provided in each new sleeping room. Where *dwelling additions* have *basements*, an *emergency escape and rescue opening* shall be provided in the new *basement*.

#### Exceptions:

1. An *emergency escape and rescue opening* is not required in a new *basement* that contains a sleeping room with an *emergency escape and rescue opening*.
2. An *emergency escape and rescue opening* is not required in a new *basement* where there is an *emergency escape and rescue opening* in an existing *basement* that is *accessed* from the new *basement*.
3. An operable window complying with Section 310.7.1 shall be acceptable as an *emergency escape and rescue opening*.

**R310.7 Alterations or repairs of existing basements.** New sleeping rooms created in an existing *basement* shall be provided with *emergency escape and rescue openings* in accordance with Section R310.1. Other than new sleeping rooms, where existing basements undergo alterations or repairs, an *emergency escape and rescue opening* is not required.

**Exception:** An operable window complying with Section 310.7.1 shall be acceptable as an *emergency escape and rescue opening*.

**R310.7.1 Existing emergency escape and rescue openings.** Where a *change of occupancy* would require an *emergency escape and rescue opening* in accordance with Section 310.1, operable windows serving as the *emergency escape and rescue opening* shall comply with the following:

1. An existing operable window shall provide a minimum net clear opening of 4 square feet (0.38 m<sup>2</sup>) with a minimum net clear opening height of 22 inches (559 mm) and a minimum net clear opening width of 20 inches (508 mm).
2. A replacement window where such window complies with both of the following:
  - 2.1. The replacement window meets the size requirements in Item 1.
  - 2.2. The replacement window is the manufacturer's largest standard-size window that will fit within the existing frame or existing rough opening. The replacement window shall be permitted to be of the same operating style as the existing window or a style that provides for an equal or greater window opening area than the existing window.



## SECTION R311 MEANS OF EGRESS

**R311.1 Means of egress.** *Dwellings* shall be provided with a means of egress in accordance with this section. The means of egress shall provide a continuous and unobstructed path of vertical and horizontal egress travel from all portions of the *dwelling* to the required egress door without requiring travel through a garage. The required egress door shall open directly into a *public way* or to a *yard* or court that opens to a *public way*.

**R311.2 Egress door.** Not less than one egress door shall be provided for each *dwelling unit*. The egress door shall be side-hinged, and shall provide a clear width of not less than 32 inches (813 mm) where measured between the face of the door and the stop, with the door open 90 degrees (1.57 rad). The clear height of the door opening shall be not less than 78 inches (1981 mm) in height measured from the top of the threshold to the bottom of the stop. Other doors shall not be required to comply with these minimum dimensions. Egress doors shall be readily openable from inside the *dwelling* without the use of a key or special knowledge or effort.

**R311.3 Floors and landings at exterior doors.** There shall be a landing or floor on each side of each exterior door. The width of each landing shall be not less than the door served. Landings shall have a dimension of not less than 36 inches (914 mm) measured in the direction of travel. The slope at exterior landings shall not exceed  $\frac{1}{4}$  unit vertical in 12 units horizontal (2 percent).

**Exception:** Exterior balconies less than 60 square feet (5.6 m<sup>2</sup>) and only *accessed* from a door are permitted to have a landing that is less than 36 inches (914 mm) measured in the direction of travel.

**R311.3.1 Floor elevations at the required egress doors.** Landings or finished floors at the required egress door shall be not more than  $1\frac{1}{2}$  inches (38 mm) lower than the top of the threshold.

**Exception:** The landing or floor on the exterior side shall be not more than  $7\frac{3}{4}$  inches (196 mm) below the top of the threshold provided that the door does not swing over the landing or floor.

Where exterior landings or floors serving the required egress door are not at *grade*, they shall be provided with access to *grade* by means of a *ramp* in accordance with Section R311.8 or a *stairway* in accordance with Section R311.7.

**R311.3.2 Floor elevations at other exterior doors.** Doors other than the required egress door shall be provided with landings or floors not more than  $7\frac{3}{4}$  inches (196 mm) below the top of the threshold.

**Exception:** A top landing is not required where a *stairway* of not more than two *risers* is located on the exterior side of the door, provided that the door does not swing over the *stairway*.

**R311.3.3 Storm and screen doors.** Storm and screen doors shall be permitted to swing over exterior stairs and landings.

**R311.4 Vertical egress.** Egress from habitable levels including habitable attics and *basements* that are not provided with an egress door in accordance with Section R311.2 shall be by a *ramp* in accordance with Section R311.8 or a *stairway* in accordance with Section R311.7.

**R311.5 Landing, deck, balcony and stair construction and attachment.** Exterior landings, decks, balconies, stairs and similar facilities shall be positively anchored to the primary structure to resist both vertical and lateral forces or shall be designed to be self-supporting. Attachment shall not be accomplished by use of toenails or nails subject to withdrawal.

**R311.6 Hallways.** The width of a hallway shall be not less than 3 feet (914 mm).

**R311.7 Stairways.** Where required by this code or provided, *stairways* shall comply with this section.

### Exceptions:

1. Stairways not within or serving a building, porch or deck.
2. Stairways leading to nonhabitable attics.
3. Stairways leading to *crawl spaces*.

**R311.7.1 Width.** *Stairways* shall be not less than 36 inches (914 mm) in clear width at all points above the permitted *handrail* height and below the required headroom height. The clear width of *stairways* at and below the *handrail* height, including treads and landings, shall be not less than  $31\frac{1}{2}$  inches (787 mm) where a *handrail* is installed on one side and 27 inches (698 mm) where *handrails* are installed on both sides.

**Exception:** The width of *spiral stairways* shall be in accordance with Section R311.7.10.1.

**R311.7.2 Headroom.** The headroom in *stairways* shall be not less than 6 feet 8 inches (2032 mm) measured vertically from the sloped line adjoining the tread *nosing* or from the floor surface of the landing or platform on that portion of the *stairway*.

### Exceptions:

1. Where the *nosings* of treads at the side of a flight extend under the edge of a floor opening through which the *stair* passes, the floor opening shall not project horizontally into the required headroom more than  $4\frac{3}{4}$  inches (121 mm).
2. The headroom for *spiral stairways* shall be in accordance with Section R311.7.10.1.

**R311.7.3 Vertical rise.** A flight of stairs shall not have a vertical rise greater than 12 feet 7 inches (3835 mm) between floor levels or landings.

**R311.7.4 Walkline.** The walkline across *winder* treads and landings shall be concentric to the turn and parallel to the direction of travel entering and exiting the turn. The walkline shall be located 12 inches (305 mm) from the inside of the turn. The 12-inch (305 mm) dimension shall be measured from the widest point of the clear stair width

at the walking surface. Where *winders* are adjacent within a flight, the point of the widest clear stair width of the adjacent *winders* shall be used.

**R311.7.5 Stair treads and risers.** *Stair* treads and *risers* shall meet the requirements of this section. For the purposes of this section, dimensions and dimensioned surfaces shall be exclusive of carpets, rugs or runners.

**R311.7.5.1 Risers.** The *riser* height shall be not more than  $7\frac{3}{4}$  inches (196 mm). The *riser* height shall be measured vertically between leading edges of the adjacent treads. The greatest *riser* height within any flight of stairs shall not exceed the smallest by more than  $\frac{3}{8}$  inch (9.5 mm). *Risers* shall be vertical or sloped from the underside of the *nosing* of the tread above at an angle not more than 30 degrees (0.51 rad) from the vertical. At open *risers*, openings located more than 30 inches (762 mm), as measured vertically, to the floor or *grade* below shall not permit the passage of a 4-inch-diameter (102 mm) sphere.

**Exceptions:**

1. The opening between adjacent treads is not limited on *spiral stairways*.
2. The *riser* height of *spiral stairways* shall be in accordance with Section R311.7.10.1.

**R311.7.5.2 Treads.** The tread depth shall be not less than 10 inches (254 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge. The greatest tread depth within any flight of stairs shall not exceed the smallest by more than  $\frac{3}{8}$  inch (9.5 mm).

**R311.7.5.2.1 Winder treads.** *Winder* treads shall have a tread depth of not less than 10 inches (254 mm) measured between the vertical planes of the foremost projection of adjacent treads at the intersections with the walkline. *Winder* treads shall have a tread depth of not less than 6 inches (152 mm) at any point within the clear width of the *stair*. Within any flight of stairs, the largest *winder* tread depth at the walkline shall not exceed the smallest *winder* tread by more than  $\frac{3}{8}$  inch (9.5 mm). Consistently shaped *winders* at the walkline shall be allowed within the same flight of stairs as rectangular treads and shall not be required to be within  $\frac{3}{8}$  inch (9.5 mm) of the rectangular tread depth.

**Exception:** The tread depth at *spiral stairways* shall be in accordance with Section R311.7.10.1.

**R311.7.5.3 Nosings.** *Nosings* at treads, landings and floors of *stairways* shall have a radius of curvature at the *nosing* not greater than  $\frac{9}{16}$  inch (14 mm) or a bevel not greater than  $\frac{1}{2}$  inch (12.7 mm). A *nosing* projection not less than  $\frac{3}{4}$  inch (19 mm) and not more

than  $1\frac{1}{4}$  inches (32 mm) shall be provided on *stairways*. The greatest *nosing* projection shall not exceed the smallest *nosing* projection by more than  $\frac{3}{8}$  inch (9.5 mm) within a *stairway*.

**Exception:** A *nosing* projection is not required where the tread depth is not less than 11 inches (279 mm).

**R311.7.5.4 Exterior plastic composite stair treads.** *Plastic composite* exterior stair treads shall comply with the provisions of this section and Section R507.2.2.

**R311.7.6 Landings for stairways.** There shall be a floor or landing at the top and bottom of each *stairway*. The width perpendicular to the direction of travel shall be not less than the width of the flight served. For landings of shapes other than square or rectangular, the depth at the walk line and the total area shall be not less than that of a quarter circle with a radius equal to the required landing width. Where the *stairway* has a straight run, the depth in the direction of travel shall be not less than 36 inches (914 mm).

**Exception:** A floor or landing is not required at the top of an interior flight of stairs, including stairs in an enclosed garage, provided that a door does not swing over the stairs.

**R311.7.7 Stairway walking surface.** The walking surface of treads and landings of *stairways* shall be sloped not steeper than 1 unit vertical in 48 units horizontal (2-percent slope).

**Exception:** Where the surface of a landing is required elsewhere in the code to drain surface water, the walking surface of the landing shall be sloped not steeper than 1 unit vertical in 20 units horizontal (5-percent slope) in the direction of travel.

**R311.7.8 Handrails.** *Handrails* shall be provided on not less than one side of each flight of stairs with four or more *risers*.

**R311.7.8.1 Height.** *Handrail* height, measured vertically from the sloped plane adjoining the tread *nosing*, or finish surface of ramp slope, shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm).

**Exceptions:**

1. The use of a volute, turnout or starting easing shall be allowed over the lowest tread.
2. Where *handrail* fittings or bendings are used to provide continuous transition between flights, transitions at *winder* treads, the transition from *handrail* to *guard*, or used at the start of a flight, the *handrail* height at the fittings or bendings shall be permitted to exceed 38 inches (965 mm).

## BUILDING PLANNING

**R311.7.8.2 Handrail projection.** *Handrails* shall not project more than  $4\frac{1}{2}$  inches (114 mm) on either side of the *stairway*.

**Exception:** Where *nosings* of landings, floors or passing flights project into the *stairway* reducing the clearance at passing *handrails*, *handrails* shall project not more than  $6\frac{1}{2}$  inches (165 mm) into the *stairway*, provided that the stair width and *handrail* clearance are not reduced to less than that required.

**R311.7.8.3 Handrail clearance.** *Handrails* adjacent to a wall shall have a space of not less than  $1\frac{1}{2}$  inches (38 mm) between the wall and the *handrails*.

**R311.7.8.4 Continuity.** *Handrails* shall be continuous for the full length of the flight, from a point directly above the top riser of the flight to a point directly above the lowest riser of the flight. *Handrail* ends shall be returned toward a wall, guard walking surface continuous to itself, or terminate to a post.

**Exceptions:**

1. *Handrail* continuity shall be permitted to be interrupted by a newel post at a turn in a flight with winders, at a landing, or over the lowest tread.
2. A volute, turnout or starting easing shall be allowed to terminate over the lowest tread and over the top landing.

**R311.7.8.5 Grip size.** Required *handrails* shall be of one of the following types or provide equivalent graspability.

1. Type I. *Handrails* with a circular cross section shall have an outside diameter of not less than  $1\frac{1}{4}$  inches (32 mm) and not greater than 2 inches (51 mm). If the *handrail* is not circular, it shall have a perimeter of not less than 4 inches (102 mm) and not greater than  $6\frac{1}{4}$  inches (160 mm) and a cross section of not more than  $2\frac{1}{4}$  inches (57 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).
2. Type II. *Handrails* with a perimeter greater than  $6\frac{1}{4}$  inches (160 mm) shall have a graspable finger recess area on both sides of the profile. The finger recess shall begin within  $\frac{3}{4}$  inch (19 mm) measured vertically from the tallest portion of the profile and have a depth of not less than  $\frac{5}{16}$  inch (8 mm) within  $\frac{7}{8}$  inch (22 mm) below the widest portion of the profile. This required depth shall continue for not less than  $\frac{3}{8}$  inch (10 mm) to a level that is not less than  $1\frac{3}{4}$  inches (45 mm) below the tallest portion of the profile. The width of the *handrail* above the recess shall be not less than  $1\frac{1}{4}$  inches (32 mm) and not more than  $2\frac{3}{4}$  inches (70 mm). Edges shall have a radius of not less than 0.01 inch (0.25 mm).

**R311.7.8.6 Exterior plastic composite handrails.** *Plastic composite* exterior *handrails* shall comply with the requirements of Section R507.2.2.

**R311.7.9 Illumination.** *Stairways* shall be provided with illumination in accordance with Sections R303.7 and R303.8.

**R311.7.10 Special stairways.** *Spiral stairways* and bulkhead enclosure *stairways* shall comply with the requirements of Section R311.7 except as specified in Sections R311.7.10.1 and R311.7.10.2.

**R311.7.10.1 Spiral stairways.** The clear width at and below the *handrails* at *spiral stairways* shall be not less than 26 inches (660 mm) and the walkline radius shall be not greater than  $24\frac{1}{2}$  inches (622 mm). Each tread shall have a depth of not less than  $6\frac{3}{4}$  inches (171 mm) at the walkline. Treads shall be identical, and the rise shall be not more than  $9\frac{1}{2}$  inches (241 mm). Headroom shall be not less than 6 feet 6 inches (1982 mm).

**R311.7.10.2 Bulkhead enclosure stairways.** *Stairways* serving bulkhead enclosures, not part of the required building egress, providing access from the outside *grade* level to the *basement* shall be exempt from the requirements of Sections R311.3 and R311.7 where the height from the *basement* finished floor level to *grade* adjacent to the *stairway* is not more than 8 feet (2438 mm) and the *grade* level opening to the *stairway* is covered by a bulkhead enclosure with hinged doors or other *approved* means.

**R311.7.11 Alternating tread devices.** Alternating tread devices shall not be used as an element of a means of egress. Alternating tread devices shall be permitted provided that a required means of egress *stairway* or *ramp* serves the same space at each adjoining level or where a means of egress is not required. The clear width at and below the *handrails* shall be not less than 20 inches (508 mm).

**Exception:** Alternating tread devices are allowed to be used as an element of a means of egress for lofts, *mezzanines* and similar areas of 200 gross square feet (18.6 m<sup>2</sup>) or less where such devices do not provide exclusive access to a kitchen or bathroom.

**R311.7.11.1 Treads of alternating tread devices.** Alternating tread devices shall have a tread depth of not less than 5 inches (127 mm), a projected tread depth of not less than  $8\frac{1}{2}$  inches (216 mm), a tread width of not less than 7 inches (178 mm) and a *riser* height of not more than  $9\frac{1}{2}$  inches (241 mm). The tread depth shall be measured horizontally between the vertical planes of the foremost projections of adjacent treads. The *riser* height shall be measured vertically between the leading edges of adjacent treads. The *riser* height and tread depth provided shall result in an angle of ascent from the horizontal of between 50 and 70 degrees (0.87 and 1.22 rad). The initial tread of the device shall begin at the same elevation as the platform, landing or floor surface.



**R311.7.11.2 Handrails of alternating tread devices.**

*Handrails* shall be provided on both sides of alternating tread devices and shall comply with Sections R311.7.8.2 through R311.7.8.6. *Handrail* height shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

**R311.7.12 Ship's ladders.** Ship's ladders shall not be used as an element of a means of egress. Ship's ladders shall be permitted provided that a required means of egress *stairway* or *ramp* serves the same space at each adjoining level or where a means of egress is not required. The clear width at and below the *handrails* shall be not less than 20 inches (508 mm).

**Exception:** Ship's ladders are allowed to be used as an element of a means of egress for lofts, *mezzanines* and similar areas of 200 gross square feet (18.6 m<sup>2</sup>) or less that do not provide exclusive access to a kitchen or bathroom.

**R311.7.12.1 Treads of ship's ladders.** Treads shall have a depth of not less than 5 inches (127 mm). The tread shall be projected such that the total of the tread depth plus the *nosing* projection is not less than 8½ inches (216 mm). The *riser* height shall be not more than 9½ inches (241 mm).

**R311.7.12.2 Handrails of ship's ladders.** *Handrails* shall be provided on both sides of ship's ladders and shall comply with Sections R311.7.8.2 through R311.7.8.6. *Handrail* height shall be uniform, not less than 30 inches (762 mm) and not more than 34 inches (864 mm).

**R311.8 Ramps.** Where required by this code or provided, *ramps* shall comply with this section.

**Exception:** Ramps not within or serving a building, porch or deck.

**R311.8.1 Maximum slope.** *Ramps* serving the egress door required by Section R311.2 shall have a slope of not more than 1 unit vertical in 12 units horizontal (8.3-percent slope).

Other *ramps* shall have a slope of not more than 1 unit vertical in 8 units horizontal (12.5 percent).

**Exception:** Where it is technically infeasible to comply because of site constraints, *ramps* shall have a slope of not more than 1 unit vertical in 8 units horizontal (12.5 percent).

**R311.8.2 Landings required.** There shall be a floor or landing at the top and bottom of each *ramp*, where doors open onto *ramps*, and where *ramps* change directions. The width of the landing perpendicular to the *ramp* slope shall be not less than the width of the *ramp*. The depth of the landing in the direction of the *ramp* slope shall be not less than 36 inches (914 mm).

**R311.8.3 Handrails required.** *Handrails* shall be provided on not less than one side of *ramps* exceeding a slope of 1 unit vertical in 12 units horizontal (8.33-percent slope).

**R311.8.3.1 Height.** *Handrail* height, measured above the finished surface of the *ramp* slope, shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm).

**R311.8.3.2 Grip size.** *Handrails* on *ramps* shall comply with Section R311.7.8.5.

**R311.8.3.3 Continuity.** *Handrails* where required on *ramps* shall be continuous for the full length of the *ramp*. *Handrail* ends shall be returned or shall terminate in newel posts or safety terminals. *Handrails* adjacent to a wall shall have a space of not less than 1½ inches (38 mm) between the wall and the *handrails*.

**SECTION R312****GUARDS AND WINDOW FALL PROTECTION**

**R312.1 Guards.** *Guards* shall be provided in accordance with Sections R312.1.1 through R312.1.4.

**R312.1.1 Where required.** *Guards* shall be provided for those portions of open-sided walking surfaces, including floors, stairs, *ramps* and landings that are located more than 30 inches (762 mm) measured vertically to the floor or *grade* below at any point within 36 inches (914 mm) horizontally to the edge of the open side. Insect screening shall not be considered as a *guard*.

**R312.1.2 Height.** Required *guards* at open-sided walking surfaces, including stairs, porches, balconies or landings, shall be not less than 36 inches (914 mm) in height as measured vertically above the adjacent walking surface or the line connecting the *nosings*.

**Exceptions:**

1. *Guards* on the open sides of stairs shall have a height of not less than 34 inches (864 mm) measured vertically from a line connecting the *nosings*.
2. Where the top of the *guard* serves as a *handrail* on the open sides of stairs, the top of the *guard* shall be not less than 34 inches (864 mm) and not more than 38 inches (965 mm) as measured vertically from a line connecting the *nosings*.

**R312.1.3 Opening limitations.** Required *guards* shall not have openings from the walking surface to the required *guard* height that allow passage of a sphere 4 inches (102 mm) in diameter.

**Exceptions:**

1. The triangular openings at the open side of *stair*, formed by the *riser*, tread and bottom rail of a *guard*, shall not allow passage of a sphere 6 inches (153 mm) in diameter.
2. *Guards* on the open side of stairs shall not have openings that allow passage of a sphere 4¾ inches (111 mm) in diameter.

**R312.1.4 Exterior plastic composite guards.** *Plastic composite* exterior *guards* shall comply with the requirements of Section R317.4.



## BUILDING PLANNING

**R312.2 Window fall protection.** Window fall protection shall be provided in accordance with Sections R312.2.1 and R312.2.2.

**R312.2.1 Window opening height.** In *dwelling units*, where the bottom of the clear opening of an operable window opening is located less than 24 inches (610 mm) above the finished floor and greater than 72 inches (1829 mm) above the finished *grade* or other surface below on the exterior of the building, the operable window shall comply with one of the following:

1. Operable window openings will not allow a 4-inch-diameter (102 mm) sphere to pass through where the openings are in their largest opened position.
2. Operable windows are provided with window opening control devices or fall prevention devices that comply with ASTM F2090.

**R312.2.2 Emergency escape and rescue openings.** Where an operable window serves as an *emergency escape and rescue opening*, a window opening control device or fall prevention device, after operation to release the control device or fall prevention device allowing the window to fully open, shall not reduce the net clear opening area of the window unit to less than the area required by Sections R310.2.1 and R310.2.2.

## SECTION R313 AUTOMATIC FIRE SPRINKLER SYSTEMS

**R313.1 Townhouse automatic fire sprinkler systems.** An automatic sprinkler system shall not be required in *townhouses*.

**R313.1.1 Design and installation.** Automatic sprinkler systems for *townhouses* shall be designed and installed in accordance with NFPA 13D when provided.

**R313.2 One- and two-family dwellings automatic sprinkler systems.** An automatic sprinkler system shall not be required in one- and two-family *dwellings*.

**R313.2.1 Design and installation.** Automatic sprinkler systems shall be designed and installed in accordance with NFPA 13D when provided.

## SECTION R314 SMOKE ALARMS

**R314.1 General.** Smoke alarms shall comply with NFPA 72 and Section R314.

**R314.1.1 Listings.** Smoke alarms shall be *listed* in accordance with UL 217. Combination smoke and carbon monoxide alarms shall be *listed* in accordance with UL 217 and UL 2034.

**R314.2 Where required.** Smoke alarms shall be provided in accordance with this section.

**R314.2.1 New construction.** Smoke alarms shall be provided in *dwelling units*.

**R314.2.2 Alterations, repairs and additions.** Where *alterations, repairs* or *additions* requiring a *permit* occur, the individual *dwelling unit* shall be equipped with smoke alarms located as required for new *dwellings*.

### Exceptions:

1. Work involving the exterior surfaces of *dwellings*, such as the replacement of roofing or siding, the addition or replacement of windows or doors, or the addition of a porch or deck.
2. Installation, *alteration* or repairs of plumbing or mechanical systems.

**R314.2.3 New and existing construction.** Every new and existing dwelling, including one- and two-family dwellings, and every new and existing dwelling unit within a townhouse shall be provided with an approved listed smoke alarm.

**R314.3 Location.** Smoke alarms shall be installed in the following locations:

1. In each sleeping room.
2. Outside each separate sleeping area in the immediate vicinity of the bedrooms.
3. On each additional story of the *dwelling*, including *basements* and *habitable attics* and not including crawl spaces and uninhabitable *attics*. In *dwellings* or *dwelling units* with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full *story* below the upper level.
4. Not less than 3 feet (914 mm) horizontally from the door or opening of a bathroom that contains a bathtub or shower unless this would prevent placement of a smoke alarm required by this section.
5. In the hallway and in the room open to the hallway in *dwelling units* where the ceiling height of a room open to a hallway serving bedrooms exceeds that of the hallway by 24 inches (610 mm) or more.

**R314.3.1 Installation near cooking appliances.** Smoke alarms shall not be installed in the following locations unless this would prevent placement of a smoke alarm in a location required by Section R314.3.

1. Ionization smoke alarms shall not be installed less than 20 feet (6096 mm) horizontally from a permanently installed cooking *appliance*.
2. Ionization smoke alarms with an alarm-silencing switch shall not be installed less than 10 feet (3048 mm) horizontally from a permanently installed cooking *appliance*.
3. Photoelectric smoke alarms shall not be installed less than 6 feet (1828 mm) horizontally from a permanently installed cooking *appliance*.
4. Smoke alarms *listed* and marked "helps reduce cooking nuisance alarms" shall not be installed

less than 6 feet (1828 mm) horizontally from a permanently installed cooking *appliance*.

**R314.4 Interconnection.** Where more than one smoke alarm is required to be installed within an individual *dwelling unit* in accordance with Section R314.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of smoke alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm.

**R314.5 Combination alarms.** Combination smoke and carbon monoxide alarms shall be permitted to be used in lieu of smoke alarms.

**R314.6 Power source.** Smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and, where primary power is interrupted, shall receive power from a battery. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection.

**Exceptions:**

1. Smoke alarms shall be permitted to be battery operated where installed in buildings without commercial power.
2. Smoke alarms installed in accordance with Section R314.2.2 shall be permitted to be battery powered.

**R314.7 Fire alarm systems.** Fire alarm systems shall be permitted to be used in lieu of smoke alarms and shall comply with Sections R314.7.1 through R314.7.4.

**R314.7.1 General.** Fire alarm systems shall comply with the provisions of this code and the household fire warning equipment provisions of NFPA 72. Smoke detectors shall be *listed* in accordance with UL 268.

**R314.7.2 Location.** Smoke detectors shall be installed in the locations specified in Section R314.3.

**R314.7.3 Permanent fixture.** Where a household fire alarm system is installed, it shall become a permanent fixture of the occupancy, owned by the homeowner.

**R314.7.4 Combination detectors.** Combination smoke and carbon monoxide detectors shall be permitted to be installed in fire alarm systems in lieu of smoke detectors, provided that they are *listed* in accordance with UL 268 and UL 2075.

## SECTION R315 CARBON MONOXIDE ALARMS

**R315.1 General.** Carbon monoxide alarms shall comply with Section R315.

**R315.1.1 Listings.** Carbon monoxide alarms shall be *listed* in accordance with UL 2034. Combination carbon monoxide and smoke alarms shall be *listed* in accordance with UL 217 and UL 2034.

**R315.2 Where required.** Carbon monoxide alarms shall be provided in accordance with Sections R315.2.1 and R315.2.2.

**R315.2.1 New construction.** For new construction, carbon monoxide alarms shall be provided in *dwelling units* where either or both of the following conditions exist.

1. The *dwelling unit* contains a fuel-fired *appliance*.
2. The *dwelling unit* has an attached garage with an opening that communicates with the *dwelling unit*.

**R315.2.2 Alterations, repairs and additions.** Where *alterations, repairs* or *additions* requiring a *permit* occur, the individual *dwelling unit* shall be equipped with carbon monoxide alarms located as required for new *dwelling units*.

**Exceptions:**

1. Work involving the exterior surfaces of *dwelling units*, such as the replacement of roofing or siding, or the addition or replacement of windows or doors, or the addition of a porch or deck.
2. Installation, *alteration* or repairs of plumbing systems.
3. Installation, alteration or repairs of mechanical systems that are not fuel fired.

**R315.3 Location.** Carbon monoxide alarms in *dwelling units* shall be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms. Where a fuel-burning *appliance* is located within a bedroom or its attached bathroom, a carbon monoxide alarm shall be installed within the bedroom.

**R315.4 Combination alarms.** Combination carbon monoxide and smoke alarms shall be permitted to be used in lieu of carbon monoxide alarms.

**R315.5 Interconnectivity.** Where more than one carbon monoxide alarm is required to be installed within an individual *dwelling unit* in accordance with Section R315.3, the alarm devices shall be interconnected in such a manner that the actuation of one alarm will activate all of the alarms in the individual *dwelling unit*. Physical interconnection of carbon monoxide alarms shall not be required where *listed* wireless alarms are installed and all alarms sound upon activation of one alarm.

**Exception:** Interconnection of carbon monoxide alarms in existing areas shall not be required where *alterations* or *repairs* do not result in removal of interior wall or ceiling finishes exposing the structure, unless there is an attic, *crawl space* or *basement* available that could provide access for interconnection without the removal of interior finishes.

**R315.6 Power source.** Carbon monoxide alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and, where primary power is interrupted, shall receive power from a

## BUILDING PLANNING

battery. Wiring shall be permanent and without a disconnecting switch other than those required for overcurrent protection.

**Exceptions:**

1. Carbon monoxide alarms shall be permitted to be battery operated where installed in buildings without commercial power.
2. Carbon monoxide alarms installed in accordance with Section R315.2.2 shall be permitted to be battery powered.

**R315.7 Carbon monoxide detection systems.** Carbon monoxide detection systems shall be permitted to be used in lieu of carbon monoxide alarms and shall comply with Sections R315.7.1 through R315.7.4.

**R315.7.1 General.** Household carbon monoxide detection systems shall comply with NFPA 720. Carbon monoxide detectors shall be *listed* in accordance with UL 2075.

**R315.7.2 Location.** Carbon monoxide detectors shall be installed in the locations specified in Section R315.3. These locations supersede the locations specified in NFPA 720.

**R315.7.3 Permanent fixture.** Where a household carbon monoxide detection system is installed, it shall become a permanent fixture of the occupancy and owned by the homeowner.

**R315.7.4 Combination detectors.** Combination carbon monoxide and smoke detectors installed in carbon monoxide detection systems in lieu of carbon monoxide detectors shall be *listed* in accordance with UL 268 and UL 2075.

## SECTION R316 FOAM PLASTIC

**R316.1 General.** The provisions of this section shall govern the materials, design, application, construction and installation of foam plastic materials.

**R316.2 Labeling and identification.** Packages and containers of foam plastic insulation and foam plastic insulation components delivered to the job site shall bear the *label* of an *approved agency* showing the manufacturer's name, the product listing, product identification and information sufficient to determine that the end use will comply with the requirements.

**R316.3 Surface burning characteristics.** Unless otherwise allowed in Section R316.5, foam plastic, or foam plastic cores used as a component in manufactured assemblies, used in building construction shall comply with Section R316.3.1 or R316.3.2. Loose-fill-type foam plastic insulation shall be tested as board stock for the flame spread index and *smoke-developed index*.

**Exception:** Spray foam plastic insulation more than 4 inches (102 mm) in thickness shall have a flame spread index of not more than 25 and a *smoke-developed index* of not more than 450 where tested at a thickness of 4

inches (102 mm) and at the density intended for use. Such spray foam plastic shall be separated from the interior of a building by  $\frac{1}{2}$ -inch (12.7 mm) gypsum wallboard or by a material that has been tested in accordance with NFPA 275, and shall meet the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test.

**R316.3.1 Foam plastic insulation 4 inches thick or less.** Foam plastic insulation installed at 4 inches (102 mm) in thickness or less shall have a flame spread index of not more than 75 and a *smoke-developed index* of not more than 450 where tested in the maximum thickness and density intended for use in accordance with ASTM E84 or UL 723.

**R316.3.2 Foam plastic insulation more than 4 inches thick.** Foam plastic insulation installed at more than 4 inches (102 mm) in thickness shall have a flame spread index of not more than 75 and a *smoke-developed index* of not more than 450 where tested at a thickness of 4 inches (102 mm) in accordance with ASTM E84 or UL 723, provided that the end use is *approved* in accordance with Section R316.6 using the thickness and density intended for use.

**R316.4 Thermal barrier.** Unless otherwise allowed in Section R316.5, foam plastic shall be separated from the interior of a building by an *approved* thermal barrier of not less than  $\frac{1}{2}$ -inch (12.7 mm) gypsum wallboard,  $\frac{23}{32}$ -inch (18.2 mm) *wood structural panel* or a material that is tested in accordance with and meets the acceptance criteria of both the Temperature Transmission Fire Test and the Integrity Fire Test of NFPA 275.

**R316.5 Specific requirements.** The following requirements shall apply to these uses of foam plastic unless specifically *approved* in accordance with Section R316.6 or by other sections of the code or the requirements of Sections R316.2 through R316.4 have been met.

**R316.5.1 Masonry or concrete construction.** The thermal barrier specified in Section R316.4 is not required in a masonry or concrete wall, floor or roof where the foam plastic insulation is separated from the interior of the building by not less than a 1-inch (25 mm) thickness of masonry or concrete.

**R316.5.2 Roofing.** The thermal barrier specified in Section R316.4 is not required where the foam plastic is in a *roof assembly* or under a roof covering is installed in accordance with the code and the manufacturer's instructions and is separated from the interior of the building by tongue-and-groove wood planks or *wood structural panel* sheathing, in accordance with Section R803, that is not less than  $\frac{15}{32}$  inch (11.9 mm) thick bonded with exterior glue, identified as Exposure 1 and with edges supported by blocking or tongue-and-groove joints or an equivalent material. The *smoke-developed index* for roof applications shall not be limited.

**R316.5.3 Attics.** The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. *Attic* access is required by Section R807.1.

2. The space is entered only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
  - 3.1. 1½-inch-thick (38 mm) mineral fiber insulation.
  - 3.2. ¼-inch-thick (6.4 mm) *wood structural panels*.
  - 3.3. ⅜-inch (9.5 mm) particleboard.
  - 3.4. ¼-inch (6.4 mm) hardboard.
  - 3.5. ⅜-inch (9.5 mm) gypsum board.
  - 3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
  - 3.7. 1½-inch-thick (38 mm) cellulose insulation.
  - 3.8. ¼-inch (6.4 mm) fiber-cement panel, soffit or backer board.

The ignition barrier is not required where the foam plastic insulation has been tested in accordance with Section R316.6.

**R316.5.4 Crawl spaces.** The thermal barrier specified in Section R316.4 is not required where all of the following apply:

1. *Crawl space* access is required by Section R408.4.
2. Entry is made only for purposes of repairs or maintenance.
3. The foam plastic insulation has been tested in accordance with Section R316.6 or the foam plastic insulation is protected against ignition using one of the following ignition barrier materials:
  - 3.1. 1½-inch-thick (38 mm) mineral fiber insulation.
  - 3.2. ¼-inch-thick (6.4 mm) *wood structural panels*.
  - 3.3. ⅜-inch (9.5 mm) particleboard.
  - 3.4. ¼-inch (6.4 mm) hardboard.
  - 3.5. ⅜-inch (9.5 mm) gypsum board.
  - 3.6. Corrosion-resistant steel having a base metal thickness of 0.016 inch (0.406 mm).
  - 3.7. ¼-inch (6.4 mm) fiber-cement panel, soffit or backer board.

**R316.5.5 Foam-filled exterior doors.** Foam-filled exterior doors are exempt from the requirements of Sections R316.3 and R316.4.

**R316.5.6 Foam-filled garage doors.** Foam-filled garage doors in attached or detached garages are exempt from the requirements of Sections R316.3 and R316.4.

**R316.5.7 Foam backer board.** The thermal barrier specified in Section R316.4 is not required where siding backer board foam plastic insulation has a thickness of not more than 0.5 inch (12.7 mm) and a potential heat of

not more than 2000 Btu per square foot (22 720 kJ/m<sup>2</sup>) when tested in accordance with NFPA 259 and it complies with one or more of the following:

1. The foam plastic insulation is separated from the interior of the building by not less than 2 inches (51 mm) of mineral fiber insulation.
2. The foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding.
3. The foam plastic insulation has been tested in accordance with Section R316.6.

**R316.5.8 Re-siding.** The thermal barrier specified in Section R316.4 is not required where the foam plastic insulation is installed over existing exterior wall finish in conjunction with re-siding provided that the foam plastic has a thickness of not more than 0.5 inch (12.7 mm) and a potential heat of not more than 2000 Btu per square foot (22 720 kJ/m<sup>2</sup>) when tested in accordance with NFPA 259.

**R316.5.9 Interior trim.** The thermal barrier specified in Section R316.4 is not required for exposed foam plastic interior *trim*, provided that all of the following are met:

1. The density is not less than 20 pounds per cubic foot (320 kg/m<sup>3</sup>).
2. The thickness of the *trim* is not more than 0.5 inch (12.7 mm) and the width is not more than 8 inches (204 mm).
3. The interior *trim* shall not constitute more than 10 percent of the aggregate wall and ceiling area of any room or space.
4. The flame spread index does not exceed 75 when tested in accordance with ASTM E84 or UL 723. The *smoke-developed index* is not limited.

**R316.5.10 Interior finish.** Foam plastics used as interior finishes shall comply with Section R316.6 and shall meet the flame spread index and *smoke-developed index* requirements of Sections R302.9.1 and R302.9.2.

**R316.5.11 Sill plates and headers.** Foam plastic spray applied to sill plates and headers or installed in the perimeter joist space without the thermal barrier specified in Section R316.4 shall comply with all of the following:

1. The thickness of the foam plastic shall be not more than ¾ inches (83 mm).
2. The density of the foam plastic shall be in the range of 0.5 to 2.0 pounds per cubic foot (8 to 32 kg/m<sup>3</sup>).
3. The foam plastic shall have a flame spread index of 25 or less and an accompanying *smoke-developed index* of 450 or less when tested in accordance with ASTM E84 or UL 723.

**R316.5.12 Sheathing.** Foam plastic insulation used as sheathing shall comply with Section R316.3 and Section R316.4. Where the foam plastic sheathing is exposed to the *attic* space at a gable or kneewall, the provisions of Section R316.5.3 shall apply. Where foam plastic insula-



## BUILDING PLANNING

tion is used as exterior wall sheathing on framed wall assemblies, it shall comply with Section R316.8.

**R316.5.13 Floors.** The thermal barrier specified in Section R316.4 is not required to be installed on the walking surface of a structural floor system that contains foam plastic insulation where the foam plastic is covered by not less than a nominal  $\frac{1}{2}$ -inch-thick (12.7 mm) *wood structural panel* or equivalent. The thermal barrier specified in Section R316.4 is required on the underside of the structural floor system that contains foam plastic insulation where the underside of the structural floor system is exposed to the interior of the building.

**R316.6 Specific approval.** Foam plastic not meeting the requirements of Sections R316.3 through R316.5 shall be specifically *approved* on the basis of one of the following *approved* tests: NFPA 286 with the acceptance criteria of Section R302.9.4, FM 4880, UL 1040 or UL 1715, or fire tests related to actual end-use configurations. Approval shall be based on the actual end-use configuration and shall be performed on the finished foam plastic assembly in the maximum thickness intended for use. Assemblies tested shall include seams, joints and other typical details used in the installation of the assembly and shall be tested in the manner intended for use.

**R316.7 Termite damage.** The use of foam plastics in areas of “very heavy” termite infestation probability shall be in accordance with Section R318.4.

**R316.8 Wind resistance.** Foam plastic insulation complying with ASTM C578 and ASTM C1289 and used as exterior wall sheathing on framed wall assemblies shall comply with SBCA FS 100 for wind pressure resistance unless installed directly over a sheathing material that is separately capable of resisting the wind load or otherwise exempted from the scope of SBCA FS 100.

## SECTION R317 PROTECTION OF WOOD AND WOOD-BASED PRODUCTS AGAINST DECAY

**R317.1 Location required.** Protection of wood and wood-based products from decay shall be provided in the following locations by the use of *naturally durable wood* or wood that is preservative-treated in accordance with AWPA U1.

1. In crawl spaces or unexcavated areas located within the periphery of the building foundation, wood joists or the bottom of a wood structural floor where closer than 18 inches (457 mm) to exposed ground, wood girders where closer than 12 inches (305 mm) to exposed ground, and wood columns where closer than 8 inches (204 mm) to exposed ground.
2. Wood framing members, including columns, that rest directly on concrete or masonry exterior foundation walls and are less than 8 inches (203 mm) from the exposed ground.
3. Sills and sleepers on a concrete or masonry slab that is in direct contact with the ground unless separated from such slab by an impervious moisture barrier.

4. The ends of wood girders entering exterior masonry or concrete walls having clearances of less than  $\frac{1}{2}$  inch (12.7 mm) on tops, sides and ends.
  5. Wood siding, sheathing and wall framing on the exterior of a building having a clearance of less than 6 inches (152 mm) from the ground or less than 2 inches (51 mm) measured vertically from concrete steps, porch slabs, patio slabs and similar horizontal surfaces exposed to the weather.
  6. Wood structural members supporting moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, unless separated from such floors or roofs by an impervious moisture barrier.
  7. Wood furring strips or other wood framing members attached directly to the interior of exterior masonry walls or concrete walls below *grade* except where an *approved* vapor retarder is applied between the wall and the furring strips or framing members.
  8. Portions of wood structural members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances where those members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering that would prevent moisture or water accumulation on the surface or at joints between members.
- Exception:** Sawn lumber used in buildings located in a geographical region where experience has demonstrated that climatic conditions preclude the need to use naturally durable or preservative-treated wood where the structure is exposed to the weather.
9. Wood columns in contact with *basement* floor slabs unless supported by concrete piers or metal pedestals projecting not less than 1 inch (25 mm) above the concrete floor and separated from the concrete pier by an impervious moisture barrier.

**R317.1.1 Field treatment.** Field-cut ends, notches and drilled holes of preservative-treated wood shall be treated in the field in accordance with AWPA M4.

**R317.1.2 Ground contact.** All wood in contact with the ground, embedded in concrete in direct contact with the ground or embedded in concrete exposed to the weather that supports permanent structures intended for human occupancy shall be *approved* pressure-preservative-treated wood suitable for ground contact use, except that untreated wood used entirely below groundwater level or continuously submerged in fresh water shall not be required to be pressure-preservative treated.

**R317.2 Quality mark.** Lumber and plywood required to be pressure-preservative treated in accordance with Section R318.1 shall bear the quality *mark* of an *approved* inspection agency that maintains continuing supervision, testing and inspection over the quality of the product and that has been *approved* by an accreditation body that complies with the

requirements of the American Lumber Standard Committee treated wood program.

**R317.2.1 Required information.** The required quality *mark* on each piece of pressure-preservative-treated lumber or plywood shall contain the following information:

1. Identification of the treating plant.
2. Type of preservative.
3. The minimum preservative retention.
4. End use for which the product was treated.
5. Standard to which the product was treated.
6. Identity of the *approved* inspection agency.
7. The designation “Dry,” if applicable.

**Exception:** Quality *marks* on lumber less than 1 inch (25 mm) nominal thickness, or lumber less than nominal 1 inch by 5 inches (25 mm by 127 mm) or 2 inches by 4 inches (51 mm by 102 mm) or lumber 36 inches (914 mm) or less in length shall be applied by stamping the faces of exterior pieces or by end labeling not less than 25 percent of the pieces of a bundled unit.

**R317.3 Fasteners and connectors in contact with preservative-treated and fire-retardant-treated wood.**

Fasteners, including nuts and washers, and connectors in contact with preservative-treated wood and fire-retardant-treated wood shall be in accordance with this section. The coating weights for zinc-coated fasteners shall be in accordance with ASTM A153. Stainless steel driven fasteners shall be in accordance with the material requirements of ASTM F1667.

**R317.3.1 Fasteners for preservative-treated wood.**

Fasteners, including nuts and washers, for preservative-treated wood shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Staples shall be of stainless steel. Coating types and weights for connectors in contact with preservative-treated wood shall be in accordance with the connector manufacturer’s recommendations. In the absence of manufacturer’s recommendations, not less than ASTM A653 type G185 zinc-coated galvanized steel, or equivalent, shall be used.

**Exceptions:**

1. 1/2-inch-diameter (12.7 mm) or greater steel bolts.
2. Fasteners other than nails, staples and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum.
3. Plain carbon steel fasteners in SBX/DOT and zinc borate preservative-treated wood in an interior, dry environment shall be permitted.

**R317.3.2 Fastenings for wood foundations.** Fastenings, including nuts and washers, for wood foundations shall be as required in AWC PWF.

**R317.3.3 Fasteners for fire-retardant-treated wood used in exterior applications or wet or damp locations.**

Fasteners, including nuts and washers, for fire-retardant-treated wood used in exterior applications or wet or damp locations shall be of hot-dipped, zinc-coated galvanized steel, stainless steel, silicon bronze or copper. Fasteners other than nails, staples and timber rivets shall be permitted to be of mechanically deposited zinc-coated steel with coating weights in accordance with ASTM B695, Class 55 minimum.

**R317.3.4 Fasteners for fire-retardant-treated wood used in interior applications.**

Fasteners, including nuts and washers, for fire-retardant-treated wood used in interior locations shall be in accordance with the manufacturer’s recommendations. In the absence of the manufacturer’s recommendations, Section R317.3.3 shall apply.

**R317.4 Plastic composites.** *Plastic composite* exterior deck boards, stair treads, *guards* and *handrails* containing wood, cellulosic or other biodegradable materials shall comply with the requirements of Section R507.2.2.

## SECTION R318 PROTECTION AGAINST SUBTERRANEAN TERMITES

**R318.1 Subterranean termite control methods.** In areas subject to damage from termites as indicated by Table R301.2, protection shall be by one, or a combination, of the following methods:

1. Chemical termiticide treatment in accordance with Section R318.2.
2. Termite-baiting system installed and maintained in accordance with the *label*.
3. Pressure-preservative-treated wood in accordance with the provisions of Section R317.1.
4. Naturally durable termite-resistant wood.
5. Physical barriers in accordance with Section R318.3 and used in locations as specified in Section R317.1.
6. Cold-formed steel framing in accordance with Sections R505.2.1 and R603.2.1.

**R318.1.1 Quality mark.** Lumber and plywood required to be pressure-preservative treated in accordance with Section R318.1 shall bear the quality *mark* of an *approved* inspection agency that maintains continuing supervision, testing and inspection over the quality of the product and that has been *approved* by an accreditation body that complies with the requirements of the American Lumber Standard Committee treated wood program.

**R318.1.2 Field treatment.** Field-cut ends, notches and drilled holes of pressure-preservative-treated wood shall be retreated in the field in accordance with AWWA M4.

**R318.2 Chemical termiticide treatment.** Chemical termiticide treatment shall include soil treatment or field-applied wood treatment. The concentration, rate of application and method of treatment of the chemical termiticide shall be in strict accordance with the termiticide *label*.

## BUILDING PLANNING

**R318.3 Barriers.** *Approved* physical barriers, such as metal or plastic sheeting or collars specifically designed for termite prevention, shall be installed in a manner to prevent termites from entering the structure. Shields placed on top of an exterior foundation wall shall be used only if in combination with another method of protection.

**R318.4 Foam plastic protection.** In areas where the probability of termite infestation is “very heavy” as indicated in Figure R318.4, extruded and expanded polystyrene, polyisocyanurate and other foam plastics shall not be installed on the exterior face or under interior or exterior foundation walls or slab foundations located below *grade*. The clearance between foam plastics installed above *grade* and exposed earth shall be not less than 6 inches (152 mm).

**Exceptions:**

1. Buildings where the structural members of walls, floors, ceilings and roofs are entirely of *noncombustible materials* or pressure-preservative-treated wood.
2. Where in addition to the requirements of Section R318.1, an *approved* method of protecting the foam plastic and structure from subterranean termite damage is used.
3. On the interior side of basement *walls*.

### SECTION R319 SITE ADDRESS

**R319.1 Address identification.** Buildings shall be provided with *approved* address identification. The address identification shall be legible and placed in a position that is visible from the street or road fronting the property. Address identification characters shall contrast with their background. Address numbers shall be Arabic numbers or alphabetical letters. Numbers shall not be spelled out. Each character shall be not less than 4 inches (102 mm) in height with a stroke width of not less than 0.5 inch (12.7 mm). Where required by the fire code official, address identification shall be provided in additional *approved* locations to facilitate emergency response. Where access is by means of a private road and the building address cannot be viewed from the *public way*, a monument, pole or other sign or means shall be used to identify the structure. Address identification shall be maintained.

### SECTION R320 ACCESSIBILITY

**R320.1 Scope.** Where there are four or more *dwelling units* or *sleeping units* in a single structure, the provisions of Chapter 11 of the *International Building Code* for Group R-3 shall apply.

**Exception:** Owner-occupied *lodging houses* with five or fewer guestrooms are not required to be accessible.

**R320.2 Live/work units.** In *live/work units*, the nonresidential portion shall be accessible in accordance with Sections 508.5.9 and 508.5.11 of the *International Building Code*. In

a structure where there are four or more *live/work units*, the dwelling portion of the *live/work unit* shall comply with Section 1108.6.2.1 of the *International Building Code*.

### SECTION R321 ELEVATORS AND PLATFORM LIFTS

**R321.1 Elevators.** Where provided, passenger elevators, limited-use and limited-application elevators or private residence elevators shall comply with ASME A17.1/CSA B44.

**R321.2 Platform lifts.** Where provided, platform lifts shall comply with ASME A18.1.

**R321.3 Accessibility.** Elevators or platform lifts that are part of an accessible route required by Chapter 11 of the *International Building Code*, shall comply with ICC A117.1.

### SECTION R322 FLOOD-RESISTANT CONSTRUCTION

**R322.1 General.** Buildings and structures constructed in whole or in part in flood hazard areas, including A or V Zones and Coastal A Zones, as established in Table R301.2, and substantial improvement and *repair* of substantial damage of buildings and structures in flood hazard areas, shall be designed and constructed in accordance with the provisions contained in this section. Buildings and structures that are located in more than one flood hazard area shall comply with the provisions associated with the most restrictive flood hazard area. Buildings and structures located in whole or in part in identified floodways shall be designed and constructed in accordance with ASCE 24.

**R322.1.1 Alternative provisions.** As an alternative to the requirements in Section R322, ASCE 24 is permitted subject to the limitations of this code and the limitations therein.

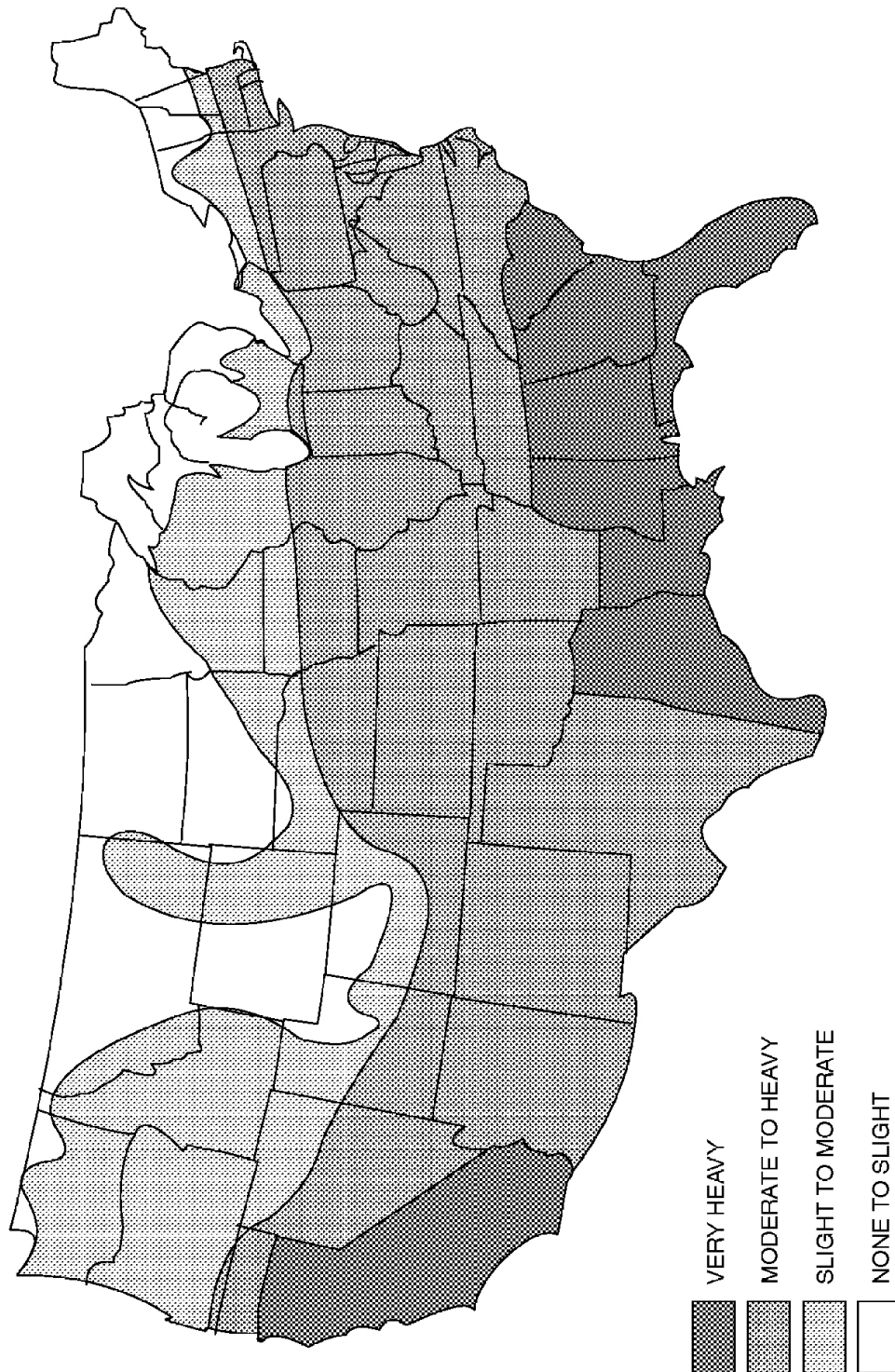
**R322.1.2 Structural systems.** Structural systems of buildings and structures shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses from flooding equal to the design flood elevation.

**R322.1.3 Flood-resistant construction.** Buildings and structures erected in areas prone to flooding shall be constructed by methods and practices that minimize flood damage.

**R322.1.4 Establishing the design flood elevation.** The design flood elevation shall be used to define flood hazard areas. At a minimum, the design flood elevation shall be the higher of the following:

1. The base flood elevation at the depth of peak elevation of flooding, including wave height, that has a 1-percent (100-year flood) or greater chance of being equaled or exceeded in any given year.
2. The elevation of the design flood associated with the area designated on a flood hazard map adopted by the community, or otherwise legally designated.





**Note:** Lines defining areas are approximate only. Local conditions may be more or less severe than indicated by the region classification.

**FIGURE R318.4**  
**TERMITE INFESTATION PROBABILITY MAP**



## BUILDING PLANNING

**R322.1.4.1 Determination of design flood elevations.** If design flood elevations are not specified, the *building official* is authorized to require the applicant to comply with either of the following:

1. Obtain and reasonably use data available from a federal, state or other source.
2. Determine the design flood elevation in accordance with accepted hydrologic and hydraulic engineering practices used to define special flood hazard areas. Determinations shall be undertaken by a *registered design professional* who shall document that the technical methods used reflect currently accepted engineering practice. Studies, analyses and computations shall be submitted in sufficient detail to allow thorough review and *approval*.

**R322.1.4.2 Determination of impacts.** In riverine flood hazard areas where design flood elevations are specified but floodways have not been designated, the applicant shall demonstrate that the effect of the proposed buildings and structures on design flood elevations, including fill, when combined with other existing and anticipated flood hazard area encroachments, will not increase the design flood elevation more than 1 foot (305 mm) at any point within the *jurisdiction*.

**R322.1.5 Lowest floor.** The lowest floor shall be the lowest floor of the lowest enclosed area, including *basement*, and excluding any unfinished flood-resistant enclosure that is useable solely for vehicle parking, building access or limited storage provided that such enclosure is not built so as to render the building or structure in violation of this section.

**R322.1.6 Protection of mechanical, plumbing and electrical systems.** Electrical systems, *equipment* and components; heating, ventilating, air-conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall be located at or above the elevation required in Section R322.2 or R322.3. If replaced as part of a substantial improvement, electrical systems, *equipment* and components; heating, ventilating, air-conditioning and plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* shall meet the requirements of this section. Systems, fixtures, and *equipment* and components shall not be mounted on or penetrate through walls intended to break away under flood loads.

**Exception:** Locating electrical systems, *equipment* and components; heating, ventilating, air-conditioning; plumbing *appliances* and plumbing fixtures; *duct systems*; and other service *equipment* is permitted below the elevation required in Section R322.2 or R322.3 provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the required elevation in accordance with ASCE 24. Elec-

trical wiring systems are permitted to be located below the required elevation provided that they conform to the provisions of the electrical part of this code for wet locations.

**R322.1.7 Protection of water supply and sanitary sewage systems.** New and replacement water supply systems shall be designed to minimize or eliminate infiltration of flood waters into the systems in accordance with the plumbing provisions of this code. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into systems and discharges from systems into floodwaters in accordance with the plumbing provisions of this code and Chapter 3 of the *International Private Sewage Disposal Code*.

**R322.1.8 Flood-resistant materials.** Building materials and installation methods used for flooring and interior and exterior walls and wall coverings below the elevation required in Section R322.2 or R322.3 shall be flood damage-resistant materials that conform to the provisions of FEMA TB-2.

**R322.1.9 Manufactured homes.** The bottom of the frame of new and replacement *manufactured homes* on foundations that conform to the requirements of Section R322.2 or R322.3, as applicable, shall be elevated to or above the elevations specified in Section R322.2 (flood hazard areas including A Zones) or R322.3 in coastal high-hazard areas (V Zones and Coastal A Zones). The anchor and tie-down requirements of the applicable state or federal requirements shall apply. The foundation and anchorage of *manufactured homes* to be located in identified floodways shall be designed and constructed in accordance with ASCE 24.

**R322.1.10 As-built elevation documentation.** A *registered design professional* shall prepare and seal documentation of the elevations specified in Section R322.2 or R322.3.

**R322.2 Flood hazard areas (including A Zones).** Areas that have been determined to be prone to flooding and that are not subject to high-velocity wave action shall be designated as flood hazard areas. Flood hazard areas that have been delineated as subject to wave heights between 1½ feet (457 mm) and 3 feet (914 mm) or otherwise designated by the *jurisdiction* shall be designated as Coastal A Zones and are subject to the requirements of Section R322.3. Buildings and structures constructed in whole or in part in flood hazard areas shall be designed and constructed in accordance with Sections R322.2.1 through R322.2.4.

#### R322.2.1 Elevation requirements.

1. Buildings and structures in flood hazard areas, not including flood hazard areas designated as Coastal A Zones, shall have the lowest floors elevated to or above the base flood elevation plus 1 foot (305 mm), or the design flood elevation, whichever is higher.
2. In areas of shallow flooding (AO Zones), buildings and structures shall have the lowest floor

(including *basement*) elevated to a height above the highest adjacent *grade* of not less than the depth number specified in feet (mm) on the FIRM plus 1 foot (305 mm), or not less than 3 feet (915 mm) if a depth number is not specified.

3. *Basement* floors that are below *grade* on all sides shall be elevated to or above base flood elevation plus 1 foot (305 mm), or the design flood elevation, whichever is higher.
4. Garage and carport floors shall comply with one of the following:
  - 4.1. They shall be elevated to or above the elevations required in Item 1 or Item 2, as applicable.
  - 4.2. They shall be at or above *grade* on not less than one side. Where a garage or carport is enclosed by walls, the garage or carport shall be used solely for parking, building access or storage.

**Exception:** Enclosed areas below the elevation required in this section, including *basements* with floors that are not below *grade* on all sides, shall meet the requirements of Section R322.2.2.

**R322.2.2 Enclosed area below required elevation.** Enclosed areas, including *crawl spaces*, that are below the elevation required in Section R322.2.1 shall:

1. Be used solely for parking of vehicles, building access or storage.
2. Be provided with flood openings that meet the following criteria and are installed in accordance with Section R322.2.2.1:
  - 2.1. The total net area of nonengineered openings shall be not less than 1 square inch (645 mm<sup>2</sup>) for each square foot (0.093 m<sup>2</sup>) of enclosed area where the enclosed area is measured on the exterior of the enclosure walls, or the openings shall be designed as engineered openings and the *construction documents* shall include a statement by a *registered design professional* that the design of the openings will provide for equalization of hydrostatic flood forces on exterior walls by allowing for the automatic entry and exit of floodwaters as specified in Section 2.7.2.2 of ASCE 24.
  - 2.2. Openings shall be not less than 3 inches (76 mm) in any direction in the plane of the wall.
  - 2.3. The presence of louvers, blades, screens and faceplates or other covers and devices shall allow the automatic flow of floodwater into and out of the enclosed areas and shall be accounted for in the determination of the net open area.

**R322.2.2.1 Installation of openings.** The walls of enclosed areas shall have openings installed such that:

1. There shall be not less than two openings on different sides of each enclosed area; if a building has more than one enclosed area, each area shall have openings.
2. The bottom of each opening shall be not more than 1 foot (305 mm) above the higher of the final interior grade or floor and the finished exterior grade immediately under each opening.
3. Openings shall be permitted to be installed in doors and windows; doors and windows without installed openings do not meet the requirements of this section.

**R322.2.3 Foundation design and construction.** Foundation walls for buildings and structures erected in flood hazard areas shall meet the requirements of Chapter 4.

**Exception:** Unless designed in accordance with Section R404:

1. The unsupported height of 6-inch (152 mm) plain masonry walls shall be not more than 3 feet (914 mm).
2. The unsupported height of 8-inch (203 mm) plain masonry walls shall be not more than 4 feet (1219 mm).
3. The unsupported height of 8-inch (203 mm) reinforced masonry walls shall be not more than 8 feet (2438 mm).

For the purpose of this exception, unsupported height is the distance from the finished *grade* of the under-floor space to the top of the wall.

**R322.2.4 Tanks.** Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.2.1 or shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood.

**R322.3 Coastal high-hazard areas (including V Zones and Coastal A Zones, where designated).** Areas that have been determined to be subject to wave heights in excess of 3 feet (914 mm) or subject to high-velocity wave action or wave-induced erosion shall be designated as coastal high-hazard areas. Flood hazard areas that have been designated as subject to wave heights between 1½ feet (457 mm) and 3 feet (914 mm) or otherwise designated by the *jurisdiction* shall be designated as Coastal A Zones. Buildings and structures constructed in whole or in part in coastal high-hazard areas and Coastal A Zones, where designated, shall be designed and constructed in accordance with Sections R322.3.1 through R322.3.10.

**R322.3.1 Location and site preparation.**

1. New buildings and buildings that are determined to be substantially improved pursuant to Section

## BUILDING PLANNING

R105.3.1.1 shall be located landward of the reach of mean high tide.

- For any alteration of sand dunes and mangrove stands, the *building official* shall require submission of an engineering analysis that demonstrates that the proposed alteration will not increase the potential for flood damage.

**R322.3.2 Elevation requirements.**

- Buildings and structures erected within coastal high-hazard areas and Coastal A Zones, shall be elevated so that the bottom of the lowest horizontal structural members supporting the lowest floor, with the exception of piling, pile caps, columns, grade beams and bracing, is elevated to or above the base flood elevation plus 1 foot (305 mm) or the design flood elevation, whichever is higher.
- Basement* floors that are below *grade* on all sides are prohibited.
- Garages used solely for parking, building access or storage, and carports shall comply with Item 1 or shall be at or above *grade* on not less than one side and, if enclosed with walls, such walls shall comply with Item 6.
- The use of fill for structural support is prohibited.
- Minor grading, and the placement of minor quantities of fill, shall be permitted for landscaping and for drainage purposes under and around buildings and for support of parking slabs, pool decks, patios and walkways.
- Walls and partitions enclosing areas below the elevation required in this section shall meet the requirements of Sections R322.3.5 and R322.3.6.

**R322.3.3 Foundations.** Buildings and structures erected in coastal high-hazard areas and Coastal A Zones shall be supported on pilings or columns and shall be adequately anchored to such pilings or columns and shall comply with the following:

- The space below the elevated building shall be either free of obstruction or, if enclosed with walls, the walls shall meet the requirements of Section R322.3.5.
- Pilings shall have adequate soil penetrations to resist the combined wave and wind loads (lateral and uplift) and pile embedment shall include consideration of decreased resistance capacity caused by scour of soil strata surrounding the piling.
- Columns and their supporting foundations shall be designed to resist combined wave and wind loads, lateral and uplift, and shall include consideration of decreased resistance capacity caused by scour of soil strata surrounding the columns. Spread footing, mat, raft or other foundations that support columns shall not be permitted where soil investigations that are required in accordance with Section R401.4 indicate that soil material under

the spread footing, mat, raft or other foundation is subject to scour or erosion from wave-velocity flow conditions. If permitted, spread footing, mat, raft or other foundations that support columns shall be designed in accordance with ASCE 24.

- Flood and wave loads shall be those associated with the design flood. Wind loads shall be those required by this code.
- Foundation designs and *construction documents* shall be prepared and sealed in accordance with Section R322.3.9.

**Exception:** In Coastal A Zones, stem wall foundations supporting a floor system above and backfilled with soil or gravel to the underside of the floor system shall be permitted provided that the foundations are designed to account for wave action, debris impact, erosion and local scour. Where soils are susceptible to erosion and local scour, stem wall foundations shall have deep footings to account for the loss of soil.

**R322.3.4 Concrete slabs.** Concrete slabs used for parking, floors of enclosures, landings, decks, walkways, patios and similar uses that are located beneath structures, or slabs that are located such that if undermined or displaced during base flood conditions could cause structural damage to the building foundation, shall be designed and constructed in accordance with one of the following:

- To be structurally independent of the foundation system of the structure, to not transfer flood loads to the main structure, and to be frangible and break away under flood conditions prior to base flood conditions. Slabs shall be a maximum of 4 inches (102 mm) thick, shall not have turned-down edges, shall not contain reinforcing, shall have isolation joints at pilings and columns, and shall have control or construction joints in both directions spaced not more than 4 feet (1219 mm) apart.
- To be self-supporting, structural slabs capable of remaining intact and functional under base flood conditions, including erosion and local scour, and the main structure shall be capable of resisting any added flood loads and effects of local scour caused by the presence of the slabs.

**R322.3.5 Walls below required elevation.** Walls and partitions are permitted below the elevation required in Section R322.3.2, provided that such walls and partitions are not part of the structural support of the building or structure and:

- Electrical, mechanical and plumbing system components are not to be mounted on or penetrate through walls that are designed to break away under flood loads; and
- Are constructed with insect screening or open lattice; or
- Are designed to break away or collapse without causing collapse, displacement or other structural damage to the elevated portion of the building or



supporting foundation system. Such walls, framing and connections shall have a resistance of not less than 10 (479 Pa) and not more than 20 pounds per square foot (958 Pa) as determined using allowable stress design; or

4. Where wind loading values of this code exceed 20 pounds per square foot (958 Pa), as determined using allowable stress design, the *construction documents* shall include documentation prepared and sealed by a *registered design professional* that:
  - 4.1. The walls and partitions below the required elevation have been designed to collapse from a water load less than that which would occur during the base flood.
  - 4.2. The elevated portion of the building and supporting foundation system have been designed to withstand the effects of wind and flood loads acting simultaneously on structural and nonstructural building components. Water-loading values used shall be those associated with the design flood. Wind-loading values shall be those required by this code.
5. Walls intended to break away under flood loads as specified in Item 3 or 4 have flood openings that meet the criteria in Section R322.2.2, Item 2.

**R322.3.6 Enclosed areas below required elevation.** Enclosed areas below the elevation required in Section R322.3.2 shall be used solely for parking of vehicles, building access or storage.

**R322.3.6.1 Protection of building envelope.** An exterior door that meets the requirements of Section R609 shall be installed at the top of stairs that provide access to the building and that are enclosed with walls designed to break away in accordance with Section R322.3.5.

**R322.3.7 Stairways and ramps.** *Stairways* and *ramps* that are located below the lowest floor elevations specified in Section R322.3.2 shall comply with one or more of the following:

1. Be designed and constructed with open or partially open *risers* and *guards*.
2. *Stairways* and *ramps* not part of the required means of egress shall be designed and constructed to break away during design flood conditions without causing damage to the building or structure, including foundation.
3. Be retractable, or able to be raised to or above the lowest floor elevation, provided that the ability to be retracted or raised prior to the onset of flooding is not contrary to the means of egress requirements of the code.
4. Be designed and constructed to resist flood loads and minimize transfer of flood loads to the building or structure, including foundation.

Areas below *stairways* and *ramps* shall not be enclosed with walls below the elevation required in Section R322.3.2 unless such walls are constructed in accordance with Section R322.3.5.

**R322.3.8 Decks and porches.** Attached decks and porches shall meet the elevation requirements of Section R322.3.2 and shall either meet the foundation requirements of this section or shall be cantilevered from or knee braced to the building or structure. Self-supporting decks and porches that are below the elevation required in Section R322.3.2 shall not be enclosed by solid, rigid walls, including walls designed to break away. Self-supporting decks and porches shall be designed and constructed to remain in place during base flood conditions or shall be frangible and break away under base flood conditions.

**R322.3.9 Construction documents.** The *construction documents* shall include documentation that is prepared and sealed by a *registered design professional* that the design and methods of construction to be used meet the applicable criteria of this section.

**R322.3.10 Tanks.** Underground tanks shall be anchored to prevent flotation, collapse and lateral movement under conditions of the base flood. Above-ground tanks shall be installed at or above the elevation required in Section R322.3.2. Where elevated on platforms, the platforms shall be cantilevered from or knee braced to the building or shall be supported on foundations that conform to the requirements of Section R322.3.

## SECTION R323 STORM SHELTERS

**R323.1 General.** This section applies to *storm shelters* where constructed as separate detached buildings or where constructed as safe rooms within buildings for the purpose of providing refuge from storms that produce high winds, such as tornados and hurricanes. In addition to other applicable requirements in this code, storm shelters shall be constructed in accordance with ICC 500.

**R323.1.1 Sealed documentation.** The *construction documents* for all structural components and *impact protective systems* of the *storm shelter* shall be prepared and sealed by a *registered design professional* indicating that the design meets the criteria of ICC 500.

**Exception:** *Storm shelters*, structural components and impact-protective systems that are *listed* and *labeled* to indicate compliance with ICC 500.

## SECTION R324 SOLAR ENERGY SYSTEMS

**R324.1 General.** Solar energy systems shall comply with the provisions of this section.

**R324.2 Solar thermal systems.** Solar thermal systems shall be designed and installed in accordance with Chapter 23.



## BUILDING PLANNING

**R324.3 Photovoltaic systems.** Photovoltaic (PV) systems shall be designed and installed in accordance with Sections R324.3.1 through R324.7.1 and the manufacturer's installation instructions. The electrical portion of solar PV systems shall be designed and installed in accordance with NFPA 70.

**R324.3.1 Equipment listings.** *Photovoltaic panels* and modules shall be *listed* and *labeled* in accordance with UL 1703 or with both UL 61730-1 and UL 61730-2. Inverters shall be *listed* and *labeled* in accordance with UL 1741. Systems connected to the utility grid shall use inverters *listed* for utility interaction. Mounting systems *listed* and *labeled* in accordance with UL 2703 shall be installed in accordance with the manufacturer's installation instructions and their listings.

**R324.4 Rooftop-mounted photovoltaic systems.** Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be designed and installed in accordance with this section.

**R324.4.1 Structural requirements.** Rooftop-mounted *photovoltaic panel systems* shall be designed to structurally support the system and withstand applicable gravity loads in accordance with Chapter 3. The roof on which these systems are installed shall be designed and constructed to support the loads imposed by such systems in accordance with Chapter 8.

**R324.4.1.1 Roof load.** Portions of roof structures not covered with *photovoltaic panel systems* shall be designed for dead loads and roof loads in accordance with Sections R301.4 and R301.6. Portions of roof structures covered with *photovoltaic panel systems* shall be designed for the following load cases:

1. Dead load (including *photovoltaic panel* weight) plus snow load in accordance with Table R301.2.
2. Dead load (excluding *photovoltaic panel* weight) plus roof *live load* or snow load, whichever is greater, in accordance with Section R301.6.

**R324.4.1.2 Wind load.** Rooftop-mounted *photovoltaic panel* or *module* systems and their supports shall be designed and installed to resist the component and cladding loads specified in Table R301.2.1(1), adjusted for height and exposure in accordance with Table R301.2.1(2).

**R324.4.2 Fire classification.** Rooftop-mounted *photovoltaic panel systems* shall have the same fire classification as the *roof assembly* required in Section R902.

**R324.4.3 Roof penetrations.** Roof penetrations shall be flashed and sealed in accordance with Chapter 9.

**R324.5 Building-integrated photovoltaic systems.** Building-integrated photovoltaic (BIPV) systems that serve as roof coverings shall be designed and installed in accordance with Section R905.

**R324.5.1 Photovoltaic shingles.** Photovoltaic shingles shall comply with Section R905.16.

**R324.5.2 Fire classification.** *Building-integrated photovoltaic systems* shall have a fire classification in accordance with Section R902.3.

**R324.5.3 BIPV roof panels.** BIPV roof panels shall comply with Section R905.17.

**R324.6 Roof access and pathways.** Roof access, pathways and setback requirements shall be provided in accordance with Sections R324.6.1 through R324.6.2.1. Access and minimum spacing shall be required to provide emergency access to the roof, to provide pathways to specific areas of the roof, provide for smoke ventilation opportunity areas, and to provide emergency egress from the roof.

#### Exceptions:

1. Detached, nonhabitable structures, including but not limited to detached garages, parking shade structures, carports, solar trellises and similar structures, shall not be required to provide roof access.
2. Roof access, pathways and setbacks need not be provided where the code official has determined that rooftop operations will not be employed.
3. These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal (17-percent slope) or less.
4. BIPV systems *listed* in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the BIPV system during fire-fighting operations has been determined to not expose a fire fighter to electrical shock hazards.

**R324.6.1 Pathways.** Not fewer than two pathways, on separate roof planes from lowest roof edge to ridge and not less than 36 inches (914 mm) wide, shall be provided on all buildings. Not fewer than one pathway shall be provided on the street or driveway side of the roof. For each roof plane with a photovoltaic array, a pathway not less than 36 inches wide (914 mm) shall be provided from the lowest roof edge to ridge on the same roof plane as the photovoltaic array, on an adjacent roof plane, or straddling the same and adjacent roof planes. Pathways shall be over areas capable of supporting fire fighters accessing the roof. Pathways shall be located in areas with minimal obstructions such as vent pipes, conduit, or mechanical equipment.

**R324.6.2 Setback at ridge.** For photovoltaic arrays occupying not more than 33 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge. For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.

**R324.6.2.1 Alternative setback at ridge.** Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D or Section P2904, setbacks at ridges shall comply with one of the following:

1. For photovoltaic arrays occupying not more than 66 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge.
2. For photovoltaic arrays occupying more than 66 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.

**R324.6.3 Emergency escape and rescue openings.** Panels and modules installed on dwellings shall not be placed on the portion of a roof that is below an *emergency escape and rescue opening*. A pathway not less than 36 inches (914 mm) wide shall be provided to the emergency escape and rescue opening.

**Exception:** BIPV systems *listed* in accordance with Section 690.12(B)(2) of NFPA 70, where the removal or cutting away of portions of the BIPV system during fire-fighting operations has been determined to not expose a fire fighter to electrical shock hazards.

**R324.7 Ground-mounted photovoltaic systems.** Ground-mounted photovoltaic systems shall be designed and installed in accordance with Section R301.

**R324.7.1 Fire separation distances.** Ground-mounted photovoltaic systems shall be subject to the *fire separation distance* requirements determined by the local *jurisdiction*.

## SECTION R325 MEZZANINES

**R325.1 General.** *Mezzanines* shall comply with Sections R325 through R325.5.

**R325.2 Mezzanines.** The clear height above and below *mezzanine* floor construction shall be not less than 7 feet (2134 mm).

**R325.3 Area limitation.** The aggregate area of a *mezzanine* or *mezzanines* shall be not greater than one-third of the floor area of the room or space in which they are located. The enclosed portion of a room shall not be included in a determination of the floor area of the room in which the *mezzanine* is located.

**Exception:** The aggregate area of a *mezzanine* located within a *dwelling unit* equipped with an automatic sprinkler system in accordance with NFPA 13D shall not be greater than one-half of the floor area of the room, provided that the *mezzanine* meets all of the following requirements:

1. Except for enclosed closets and bathrooms, the *mezzanine* is open to the room in which such *mezzanine* is located.

2. The opening to the room is unobstructed except for walls not more than 42 inches (1067 mm) in height, columns and posts.
3. The exceptions to Section R325.5 are not applied.

**R325.4 Means of egress.** The means of egress for *mezzanines* shall comply with the applicable provisions of Section R311.

**R325.5 Openness.** *Mezzanines* shall be open and unobstructed to the room in which they are located except for walls not more than 36 inches (914 mm) in height, columns and posts.

### Exceptions:

1. *Mezzanines* or portions thereof are not required to be open to the room in which they are located, provided that the aggregate floor area of the enclosed space is not greater than 10 percent of the *mezzanine* area.
2. In buildings that are not more than two stories above *grade plane* and equipped throughout with an automatic sprinkler system in accordance with Section R313, a *mezzanine* shall not be required to be open to the room in which the *mezzanine* is located.

## SECTION R326 HABITABLE ATTICS

**R326.1 General.** Habitable attics shall comply with Sections R326.2 and R326.3.

**R326.2 Minimum dimensions.** A habitable attic shall have a floor area in accordance with Section R304 and a ceiling height in accordance with Section R305.

**R326.3 Story above grade plane.** A habitable attic shall be considered a story above *grade plane*.

**Exceptions:** A habitable attic shall not be considered to be a story above *grade plane* provided that the habitable attic meets all the following:

1. The aggregate area of the habitable attic is either of the following:
  - 1.1. Not greater than one-third of the floor area of the story below.
  - 1.2. Not greater than one-half of the floor area of the story below where the habitable attic is located within a dwelling unit equipped with a fire sprinkler system in accordance with Section P2904.
2. The occupiable space is enclosed by the roof assembly above, knee walls, if applicable, on the sides and the floor-ceiling assembly below.
3. The floor of the habitable attic does not extend beyond the exterior walls of the story below.
4. Where a habitable attic is located above a third story, the dwelling unit or townhouse unit shall be equipped with a fire sprinkler system in accordance with Section P2904.

## BUILDING PLANNING

**R326.4 Means of egress.** The means of egress for habitable attics shall comply with the applicable provisions of Section R311.

### SECTION R327 SWIMMING POOLS, SPAS AND HOT TUBS

**R327.1 General.** The design and construction of pools and spas shall comply with the *International Swimming Pool and Spa Code*.

### SECTION R328 ENERGY STORAGE SYSTEMS

**R328.1 General.** *Energy storage systems (ESS)* shall comply with the provisions of this section.

**Exceptions:**

1. *ESS listed and labeled* in accordance with UL 9540 and marked "For use in residential dwelling units" where installed in accordance with the manufacturer's instructions and NFPA 70.
2. *ESS* less than 1 kWh (3.6 megajoules).

**R328.2 Equipment listings.** *Energy storage systems (ESS)* shall be *listed* and *labeled* in accordance with UL 9540.

**Exception:** Where *approved*, repurposed unlisted battery systems from electric vehicles are allowed to be installed outdoors or in detached sheds located not less than 5 feet (1524 mm) from exterior walls, property lines and public ways.

**R328.3 Installation.** *ESS* shall be installed in accordance with the manufacturer's instructions and their *listing*.

**R328.3.1 Spacing.** Individual units shall be separated from each other by not less than 3 feet (914 mm) except where smaller separation distances are documented to be adequate based on large-scale fire testing complying with Section 1207.1.5 of the *International Fire Code*.

**R328.4 Locations.** *ESS* shall be installed only in the following locations:

1. Detached garages and detached accessory structures.
2. Attached garages separated from the *dwelling unit* living space in accordance with Section R302.6.
3. Outdoors or on the exterior side of exterior walls located not less than 3 feet (914 mm) from doors and windows directly entering the *dwelling unit*.
4. Enclosed utility closets, basements, storage or utility spaces within *dwelling units* with finished or noncombustible walls and ceilings. Walls and ceilings of unfinished wood-framed construction shall be provided with not less than  $\frac{5}{8}$ -inch (15.9 mm) Type X gypsum wallboard.

*ESS* shall not be installed in sleeping rooms, or closets or spaces opening directly into sleeping rooms.

**R328.5 Energy ratings.** Individual *ESS* units shall have a maximum rating of 20 kWh. The aggregate rating of the *ESS* shall not exceed:

1. 40 kWh within utility closets, basements and storage or utility spaces.
2. 80 kWh in attached or detached garages and detached accessory structures.
3. 80 kWh on exterior walls.
4. 80 kWh outdoors on the ground.

*ESS* installations exceeding the permitted individual or aggregate ratings shall be installed in accordance with Section 1207 of the *International Fire Code*.

**R328.6 Electrical installation.** *ESS* shall be installed in accordance with NFPA 70. Inverters shall be *listed* and *labeled* in accordance with UL 1741 or provided as part of the UL 9540 listing. Systems connected to the utility grid shall use inverters *listed* for utility interaction.

**R328.7 Fire detection.** Rooms and areas within *dwelling units*, basements and attached garages in which *ESS* are installed shall be protected by smoke alarms in accordance with Section R314. A heat detector, *listed* and interconnected to the smoke alarms, shall be installed in locations within *dwelling units* and attached garages where smoke alarms cannot be installed based on their listing.

**R328.8 Protection from impact.** *ESS* installed in a location subject to vehicle damage shall be protected by *approved* barriers.

**R328.9 Ventilation.** Indoor installations of *ESS* that produce hydrogen or other flammable gases during charging shall be provided with mechanical *ventilation* in accordance with Section M1307.4.

**R328.10 Electric vehicle use.** The temporary use of an owner or occupant's electric-powered vehicle to power a *dwelling unit* while parked in an attached or detached garage or outdoors shall comply with the vehicle manufacturer's instructions and NFPA 70.

**R328.11 Documentation and labeling.** The following information shall be provided:

1. A copy of the manufacturer's installation, operation, maintenance and commissioning instructions shall be provided to the owner or placed in a conspicuous location near the *ESS* equipment.
2. A label on the installed system containing the contact information for the qualified maintenance and service providers.

### SECTION R329 STATIONARY ENGINE GENERATORS

**R329.1 General.** Stationary engine generators shall be *listed* and *labeled* in accordance with UL 2200 and shall comply with this section. The connection of stationary engine generators to the premise wiring system shall be by means of a *listed* transfer switch.

**R329.2 Installation.** The installation of stationary engine generators shall be in an *approved* location and in accordance with the listing, the manufacturer's installation instructions and Chapters 34 through 43.

## **SECTION R330 STATIONARY FUEL CELL POWER SYSTEMS**

**R330.1 General.** *Stationary fuel cell power systems* in new and existing buildings and structures shall comply with Section 1206 of the *International Fire Code*.





## CHAPTER 4

# FOUNDATIONS

### User note:

**About this chapter:** Chapter 4 provides requirements for constructing footings and walls for foundations of wood, masonry, concrete and precast concrete. In addition to a foundation's ability to support the required design loads, this chapter addresses several other factors that can affect foundation performance. These include controlling surface water and subsurface drainage, requiring soil tests where conditions warrant and evaluating proximity to slopes and minimum depth requirements. This chapter also provides requirements to minimize adverse effects of moisture, decay and pests in basements and crawl spaces.

### SECTION R401 GENERAL

**R401.1 Application.** The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for buildings. In addition to the provisions of this chapter, the design and construction of foundations in flood hazard areas as established by Table R301.2 shall meet the provisions of Section R322. Wood foundations shall be designed and installed in accordance with AWC PWF.

**Exception:** The provisions of this chapter shall be permitted to be used for wood foundations only in the following situations:

1. In buildings that have not more than two floors and a roof.
2. Where interior *basement* and foundation walls are constructed at intervals not exceeding 50 feet (15 240 mm).

Wood foundations in Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub> shall be designed in accordance with accepted engineering practice.

**R401.2 Requirements.** Foundation construction shall be capable of accommodating all loads in accordance with Section R301 and of transmitting the resulting loads to the supporting soil. Fill soils that support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice.

**R401.3 Drainage.** Surface drainage shall be diverted to a storm sewer conveyance or other *approved* point of collection that does not create a hazard. *Lots* shall be graded to drain surface water away from foundation walls. The *grade* shall fall not fewer than 6 inches (152 mm) within the first 10 feet (3048 mm).

**Exception:** Where *lot lines*, walls, slopes or other physical barriers prohibit 6 inches (152 mm) of fall within 10 feet (3048 mm), drains or swales shall be constructed to ensure drainage away from the structure. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped not less than 2 percent away from the building.

**R401.4 Soil tests.** Where quantifiable data created by accepted soil science methodologies indicate *expansive soils*, *compressible soils*, shifting soils or other questionable soil characteristics are likely to be present, the *building offi-*

*cial* shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an *approved agency* using an *approved method*.

**R401.4.1 Geotechnical evaluation.** In lieu of a complete geotechnical evaluation, the load-bearing values in Table R401.4.1 shall be assumed.

**TABLE R401.4.1**  
**PRESUMPTIVE LOAD-BEARING VALUES**  
**OF FOUNDATION MATERIALS<sup>a</sup>**

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (CL, ML, MH and CH)	1,500 <sup>b</sup>

For SI: 1 pound per square foot = 0.0479 kPa.

- a. Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.
- b. Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

**R401.4.2 Compressible or shifting soil.** Instead of a complete geotechnical evaluation, where top or subsoils are compressible or shifting, they shall be removed to a depth and width sufficient to ensure stable moisture content in each active zone and shall not be used as fill or stabilized within each active zone by chemical, dewatering or presaturation.

### SECTION R402 MATERIALS

**R402.1 Wood foundations.** Wood foundation systems shall be designed and installed in accordance with the provisions of this code.

## FOUNDATIONS

**R402.1.1 Fasteners.** Fasteners used below *grade* to attach plywood to the exterior side of exterior *basement* or crawl-space wall studs, or fasteners used in knee wall construction, shall be of Type 304 or 316 stainless steel. Fasteners used above *grade* to attach plywood and all lumber-to-lumber fasteners except those used in knee wall construction shall be of Type 304 or 316 stainless steel, silicon bronze, copper, hot-dipped galvanized (zinc coated) steel nails, or hot-tumbled galvanized (zinc coated) steel nails. Electro-galvanized steel nails and galvanized (zinc coated) steel staples shall not be permitted.

**R402.1.2 Wood treatment.** Lumber and plywood shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, Special Requirement 4.2), and shall bear the *label* of an accredited agency. Where lumber or plywood is cut or drilled after treatment, the treated surface shall be field treated with copper naphthenate, the concentration of which shall contain not less than 2-percent copper metal, by repeated brushing, dipping or soaking until the wood cannot absorb more preservative.

**R402.2 Concrete.** Concrete shall have a minimum specified compressive strength of  $f'_c$ , as shown in Table R402.2. Concrete subject to moderate or severe weathering as indicated in Table R301.2 shall be air entrained as specified in Table R402.2. The maximum weight of fly ash, other pozzolans, silica fume, slag or blended cements that is included in concrete mixtures for garage floor slabs and for exterior porches, carport slabs and steps that will be exposed to deicing chemicals shall not exceed the percentages of the total weight of cementitious materials specified in Section 19.3.3.4 of ACI 318. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in Chapters 19 and 20 of ACI 318 or ACI 332.

**R402.2.1 Materials for concrete.** Materials for concrete shall comply with the requirements of Section R608.5.1.

**R402.3 Precast concrete.** *Precast concrete* foundations shall be designed in accordance with Section R404.5 and shall be installed in accordance with the provisions of this code and the manufacturer's instructions.

**R402.3.1 Precast concrete foundation materials.** Materials used to produce *precast concrete* foundations shall meet the following requirements:

1. All concrete used in the manufacture of *precast concrete* foundations shall have a minimum compressive strength of 5,000 psi (34 470 kPa) at 28 days. Concrete exposed to a freezing and thawing environment shall be air entrained with a minimum total air content of 5 percent.
2. Structural reinforcing steel shall meet the requirements of ASTM A615, A706M or A996M. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). Steel reinforcement for *precast concrete foundation walls* shall have a minimum concrete cover of  $\frac{3}{4}$  inch (19.1 mm).

**TABLE R402.2**  
**MINIMUM SPECIFIED COMPRESSIVE**  
**STRENGTH OF CONCRETE**

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH <sup>a</sup> ( $f'_c$ )		
	Weathering Potential <sup>b</sup>		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500 <sup>c</sup>
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500 <sup>c</sup>
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000 <sup>d</sup>	3,000 <sup>d</sup>
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000 <sup>d, e, f</sup>	3,500 <sup>d, e, f</sup>

For SI: 1 pound per square inch = 6.895 kPa.

- a. Strength at 28 days psi.
- b. See Table R301.2 for weathering potential.
- c. Concrete in these locations that is subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Note d.
- d. Concrete shall be air-entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.
- e. See Section R402.2 for maximum cementitious materials content.
- f. For garage floors with a steel-troweled finish, reduction of the total air content (percent by volume of concrete) to not less than 3 percent is permitted if the specified compressive strength of the concrete is increased to not less than 4,000 psi.

3. Panel-to-panel connections shall be made with Grade II steel fasteners.
4. The use of nonstructural fibers shall conform to ASTM C1116.
5. Grout used for bedding precast foundations placed on concrete footings shall meet ASTM C1107.

**R402.4 Masonry.** Masonry systems shall be designed and installed in accordance with this chapter and shall have a minimum specified compressive strength of 1,500 psi (10.3 MPa).

## SECTION R403

### FOOTINGS

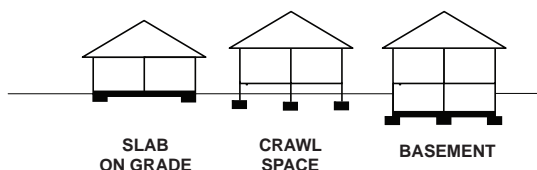
**R403.1 General.** All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other *approved* structural systems that shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on undisturbed natural soils or engineered fill. Concrete footing shall be designed and constructed in accordance with the provisions of Section R403 or in accordance with ACI 332.

**TABLE R403.1(1)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION (inches)<sup>a, b, c, d</sup>**

GROUND SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH LIGHT FRAME	LOAD-BEARING VALUE OF SOIL (psf)					
		1,500	2,000	2,500	3,000	3,500	4,000
20 psf roof live load or 25 psf ground snow load	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
30 psf	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	16 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
50 psf	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	18 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	15 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	21 × 7	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	18 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	24 × 8	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
70 psf	1 story—slab-on-grade	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	17 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	22 × 7	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	24 × 8	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Linear interpolation of footing width is permitted between the soil bearing pressures in the table. Extrapolation is not permitted.
- The table is based on the following conditions and loads: building width, 32 feet; wall height, 9 feet; basement wall height, 8 feet; dead loads, 15 psf roof and ceiling assembly, 10 psf floor assembly, 12 psf wall assembly; live loads, roof and ground snow loads as listed, 40 psf first floor, 30 psf second and third floors. Footing sizes are calculated assuming a clear span roof/ceiling assembly and an interior bearing wall or beam at each floor.
- Where the building width perpendicular to the wall footing is greater than 32 feet, the footing width shall be increased by 2 inches and footing depth shall be increased by 1 inch for every 4 feet of increase in building width.
- Where the building width perpendicular to the wall footing is less than 32 feet, a 2-inch decrease in footing width and 1-inch decrease in footing depth is permitted for every 4 feet of decrease in building width provided that the minimum width is 12 inches and minimum depth is 6 inches.





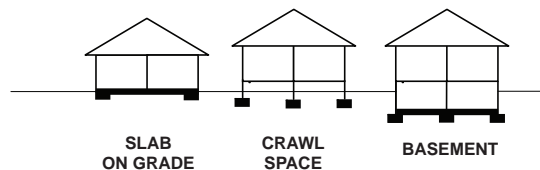
## FOUNDATIONS

**TABLE R403.1(2)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME**  
**CONSTRUCTION WITH BRICK VENEER OR LATH AND PLASTER (inches)<sup>a, b, c, d</sup>**

GROUND SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH BRICK VENEER	LOAD-BEARING VALUE OF SOIL (psf)					
		1,500	2,000	2,500	3,000	3,500	4,000
20 psf roof live load or 25 psf ground snow load	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	18 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	23 × 8	17 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	23 × 8	17 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	25 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—plus basement	29 × 11	21 × 7	17 × 6	14 × 6	12 × 6	12 × 6
30 psf	1 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	24 × 8	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	23 × 8	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	26 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—plus basement	29 × 11	22 × 7	17 × 6	14 × 6	12 × 6	12 × 6
50 psf	1 story—slab-on-grade	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	22 × 7	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	25 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	25 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—with crawl space	27 × 10	21 × 7	16 × 6	14 × 6	12 × 6	12 × 6
	3 story—plus basement	31 × 12	23 × 8	18 × 6	15 × 6	13 × 6	12 × 6
70 psf	1 story—slab-on-grade	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	17 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on grade	21 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	24 × 8	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	27 × 10	20 × 6	16 × 6	13 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	27 × 10	20 × 6	16 × 6	13 × 6	12 × 6	12 × 6
	3 story—with crawl space	29 × 11	22 × 7	17 × 6	15 × 6	12 × 6	12 × 6
	3 story—plus basement	32 × 12	24 × 8	19 × 6	16 × 6	14 × 6	12 × 6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Linear interpolation of footing width is permitted between the soil bearing pressures in the table. Extrapolation is not permitted.
- The table is based on the following conditions and loads: building width, 32 feet; wall height, 9 feet; basement wall height, 8 feet; dead loads, 15 psf roof and ceiling assembly, 10 psf floor assembly, 12 psf wall assembly; live loads, roof and ground snow loads as listed, 40 psf first floor, 30 psf second and third floors. Footing sizes are calculated assuming a clear span roof/ceiling assembly and an interior bearing wall or beam at each floor.
- Where the building width perpendicular to the wall footing is greater than 32 feet, the footing width shall be increased by 2 inches and footing depth shall be increased by 1 inch for every 4 feet of increase in building width.
- Where the building width perpendicular to the wall footing is less than 32 feet, a 2-inch decrease in footing width and 1-inch decrease in footing depth is permitted for every 4 feet of decrease in building width provided that the minimum width is 12 inches and minimum depth is 6 inches.

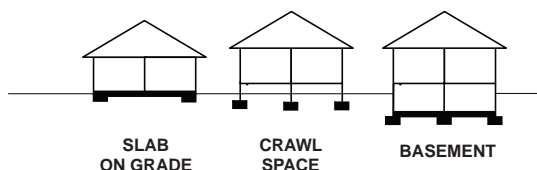


**TABLE R403.1(3)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS WITH CAST-IN-PLACE**  
**CONCRETE OR PARTIALLY GROUTED MASONRY WALL CONSTRUCTION (inches)<sup>a, b, c, d</sup>**

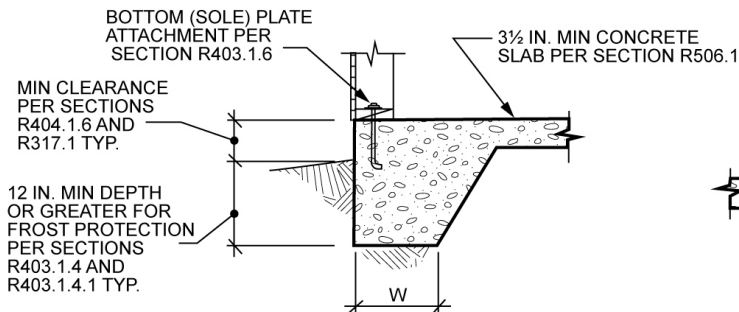
GROUND SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH CMU OR CONCRETE	LOAD-BEARING VALUE OF SOIL (psf)					
		1,500	2,000	2,500	3,000	3,500	4,000
20 psf roof live load or 25 psf ground snow load	1 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	25 × 9	19 × 6	15 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	25 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—with crawl space	28 × 10	21 × 7	17 × 6	14 × 6	12 × 6	12 × 6
	3 story—plus basement	31 × 12	23 × 8	18 × 6	15 × 6	13 × 6	12 × 6
30 psf	1 story—slab-on-grade	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	19 × 7	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	19 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	22 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	25 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	26 × 9	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
	3 story—with crawl space	28 × 10	21 × 7	17 × 6	14 × 6	12 × 6	12 × 6
	3 story—plus basement	31 × 12	23 × 8	19 × 6	16 × 6	13 × 6	12 × 6
50 psf	1 story—slab-on-grade	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	18 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	21 × 7	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	21 × 7	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	24 × 8	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	27 × 10	20 × 6	16 × 6	13 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	27 × 10	20 × 6	16 × 6	14 × 6	12 × 6	12 × 6
	3 story—with crawl space	30 × 11	22 × 7	18 × 6	15 × 6	13 × 6	12 × 6
	3 story—plus basement	33 × 13	25 × 9	20 × 6	16 × 6	14 × 6	12 × 6
70 psf	1 story—slab-on-grade	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	22 × 7	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	23 × 8	17 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	25 × 9	19 × 6	15 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	28 × 10	21 × 7	17 × 6	14 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	29 × 11	22 × 7	17 × 6	14 × 6	12 × 6	12 × 6
	3 story—with crawl space	31 × 12	23 × 8	19 × 6	16 × 6	13 × 6	12 × 6
	3 story—plus basement	34 × 13	26 × 9	21 × 7	17 × 6	15 × 6	13 × 6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Linear interpolation of footing width is permitted between the soil bearing pressures in the table. Extrapolation is not permitted.
- The table is based on the following conditions and loads: building width, 32 feet; wall height, 9 feet; basement wall height, 8 feet; dead loads, 15 psf roof and ceiling assembly, 10 psf floor assembly, 12 psf wall assembly; live loads, roof and ground snow loads as listed, 40 psf first floor, 30 psf second and third floors. Footing sizes are calculated assuming a clear span roof/ceiling assembly and an interior bearing wall or beam at each floor.
- Where the building width perpendicular to the wall footing is greater than 32 feet, the footing width shall be increased by 2 inches and footing depth shall be increased by 1 inch for every 4 feet of increase in building width.
- Where the building width perpendicular to the wall footing is less than 32 feet, a 2-inch decrease in footing width and 1-inch decrease in footing depth is permitted for every 4 feet of decrease in building width provided that the minimum width is 12 inches and minimum depth is 6 inches.

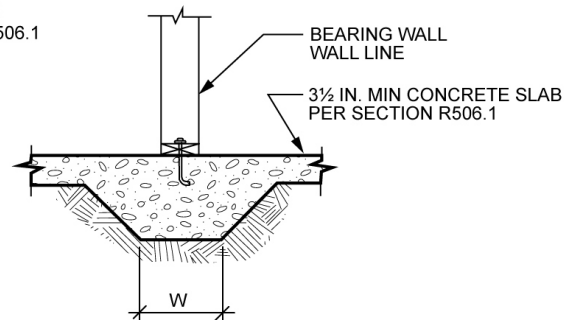


## FOUNDATIONS



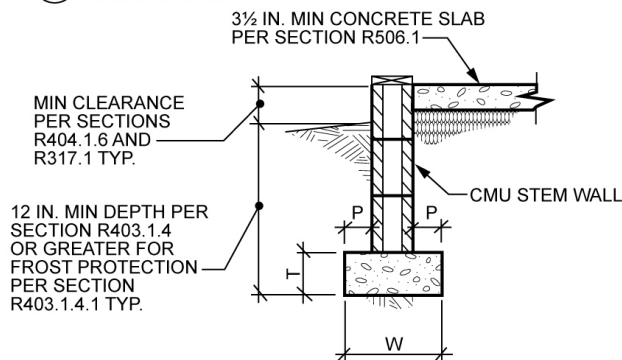
**1** MONOLITHIC SLAB-ON-GROUND WITH TURNED-DOWN FOOTING

SCALE: NOT TO SCALE



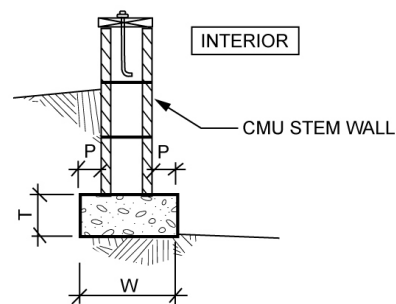
**2** THICKENED SLAB-ON-GROUND FOOTING AT BEARING WALLS OR BRACED WALL LINES

SCALE: NOT TO SCALE



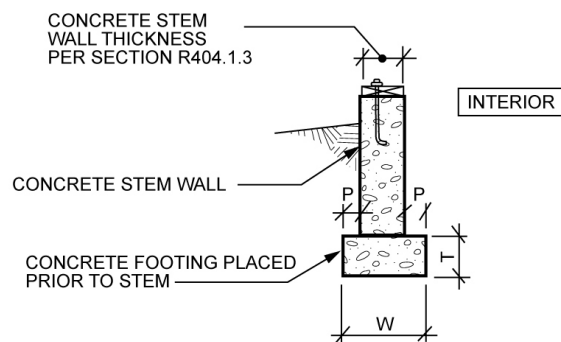
**3** SLAB-ON-GROUND WITH MASONRY STEM WALL AND SPREAD FOOTING

SCALE: NOT TO SCALE



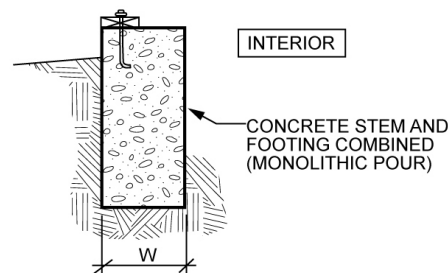
**4** BASEMENT OR CRAWL SPACE WITH MASONRY WALL AND SPREAD FOOTING

SCALE: NOT TO SCALE



**5** BASEMENT OR CRAWL SPACE WITH CONCRETE WALL AND SPREAD FOOTING

SCALE: NOT TO SCALE



**6** BASEMENT OR CRAWL SPACE WITH FOUNDATION WALL BEARING DIRECTLY ON SOIL

SCALE: NOT TO SCALE

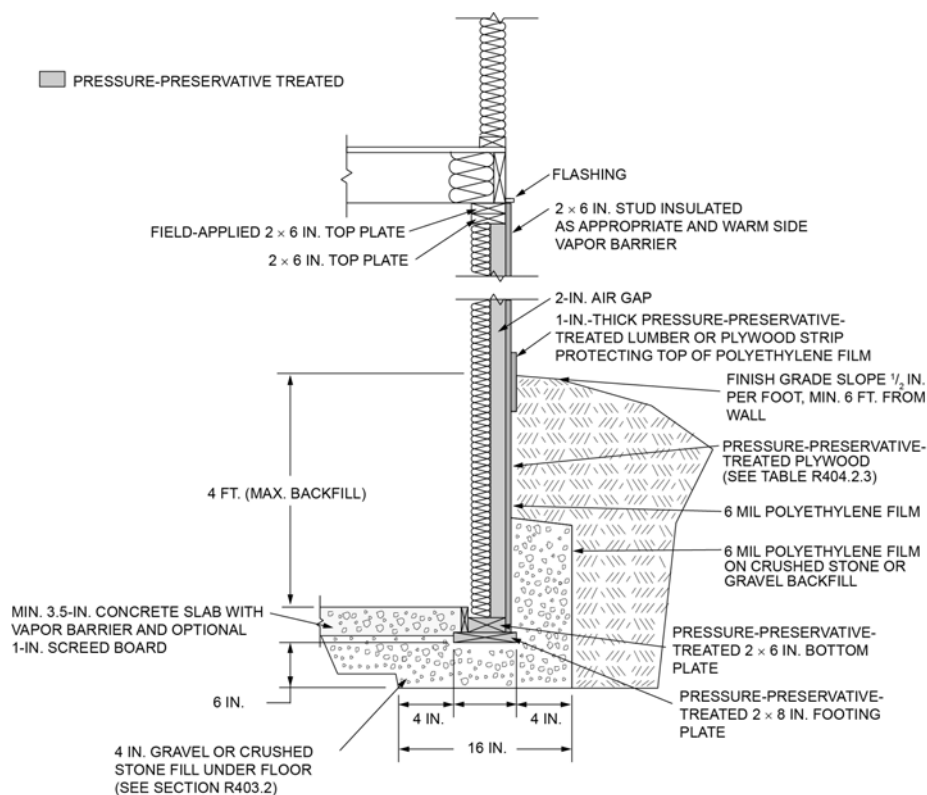
For SI: 1 inch = 25.4 mm.

W = Width of footing, T = Thickness of footing and P = Projection per Section R403.1.1.

### NOTES:

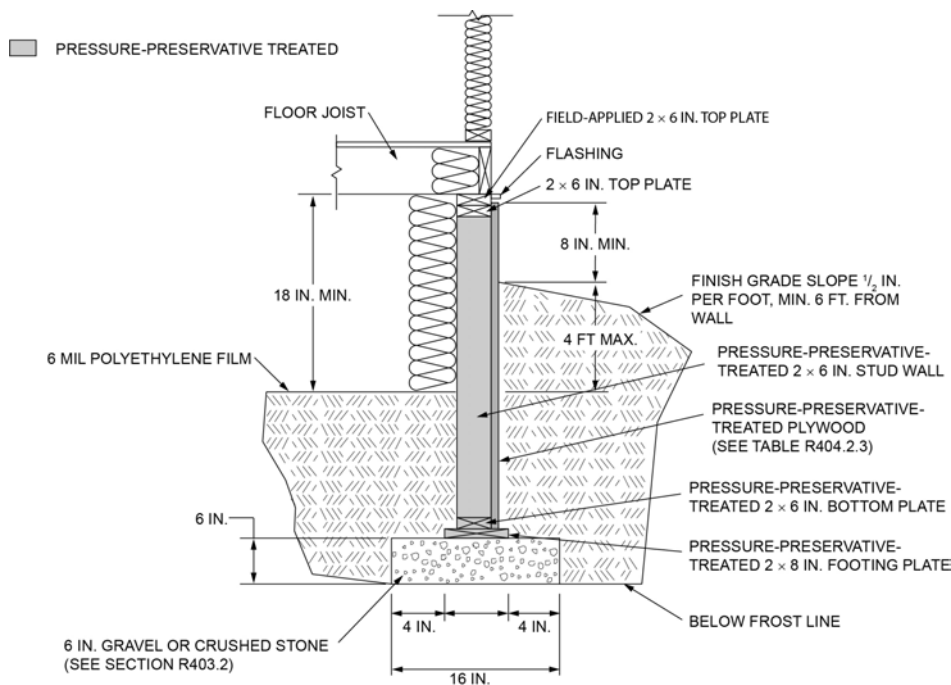
- See Section R404.3 for sill requirements.
- See Section R403.1.6 for sill attachment.
- See Section R506.2.3 for vapor barrier requirements.
- See Section R403.1 for base.
- See Figure R403.1.3 for additional footing requirements for structures in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$  and townhouses in Seismic Design Category C.
- See Section R408 for under-floor ventilation and access requirements.

**FIGURE R403.1(1)**  
**PLAIN CONCRETE FOOTINGS WITH MASONRY AND CONCRETE STEM WALLS IN SEISMIC DESIGN CATEGORIES A, B AND C<sup>a, b, c, d, e, f</sup>**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

**FIGURE R403.1(2)**  
**PERMANENT WOOD FOUNDATION BASEMENT WALL SECTION**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

**FIGURE R403.1(3)**  
**PERMANENT WOOD FOUNDATION CRAWL SPACE SECTION**



## FOUNDATIONS

**R403.1.1 Minimum size.** The minimum width,  $W$ , and thickness,  $T$ , for concrete footings shall be in accordance with Tables R403.1(1) through R403.1(3) and Figure R403.1(1) or R403.1.3, as applicable, but not less than 12 inches (305 mm) in width and 6 inches (152 mm) in depth. The footing width shall be based on the load-bearing value of the soil in accordance with Table R401.4.1. Footing projections,  $P$ , shall be not less than 2 inches (51 mm) and shall not exceed the thickness of the footing. Footing thickness and projection for fireplaces shall be in accordance with Section R1001.2. The size of footings supporting piers and columns shall be based on the tributary load and allowable soil pressure in accordance with Table R401.4.1. Footings for wood foundations shall be in accordance with the details set forth in Section R403.2, and Figures R403.1(2) and R403.1(3). Footings for precast foundations shall be in accordance with the details set forth in Section R403.4, Table R403.4, and Figures R403.4(1) and R403.4(2).

**R403.1.2 Continuous footing in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$ .** Exterior walls of buildings located in *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  shall be supported by continuous solid or fully grouted masonry or concrete footings. Other footing materials or systems shall be designed in accordance with accepted engineering practice. Required interior *braced wall panels* in buildings located in *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  with plan dimensions greater than 50 feet (15 240 mm) shall be supported by continuous solid or fully grouted masonry or concrete footings in accordance with Section R403.1.3.4, except for two-story buildings in Seismic Design Category  $D_2$ , in which all *braced wall panels*, interior and exterior, shall be supported on continuous foundations.

**Exception:** Two-story buildings shall be permitted to have interior *braced wall panels* supported on continuous foundations at intervals not exceeding 50 feet (15 240 mm) provided that:

1. The height of cripple walls does not exceed 4 feet (1219 mm).
2. First-floor *braced wall panels* are supported on doubled floor joists, continuous blocking or floor beams.
3. The distance between bracing lines does not exceed twice the building width measured parallel to the *braced wall line*.

**R403.1.3 Footing and stem wall reinforcing in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$ .** Concrete footings located in *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , as established in Table R301.2, shall have minimum reinforcement in accordance with this section and Figure R403.1.3. Reinforcement shall be installed with support and cover in accordance with Section R403.1.3.5.

**R403.1.3.1 Concrete stem walls with concrete footings.** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  where a construction joint is created between a

concrete footing and a concrete stem wall, not fewer than one No. 4 vertical bar shall be installed at not more than 4 feet (1219 mm) on center. The vertical bar shall have a standard hook and extend to the bottom of the footing and shall have support and cover as specified in Section R403.1.3.5.3 and extend not less than 14 inches (357 mm) into the stem wall. Standard hooks shall comply with Section R608.5.4.5. Not fewer than one No. 4 horizontal bar shall be installed within 12 inches (305 mm) of the top of the stem wall and one No. 4 horizontal bar shall be located 3 to 4 inches (76 mm to 102 mm) from the bottom of the footing.

**R403.1.3.2 Masonry stem walls with concrete footings.** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  where a masonry stem wall is supported on a concrete footing, not fewer than one No. 4 vertical bar shall be installed at not more than 4 feet (1219 mm) on center. The vertical bar shall have a standard hook and extend to the bottom of the footing and shall have support and cover as specified in Section R403.1.3.5.3 and extend not less than 14 inches (357 mm) into the stem wall. Standard hooks shall comply with Section R608.5.4.5. Not fewer than one No. 4 horizontal bar shall be installed within 12 inches (305 mm) of the top of the wall and one No. 4 horizontal bar shall be located 3 to 4 inches (76 mm to 102 mm) from the bottom of the footing. Masonry stem walls shall be solid grouted.

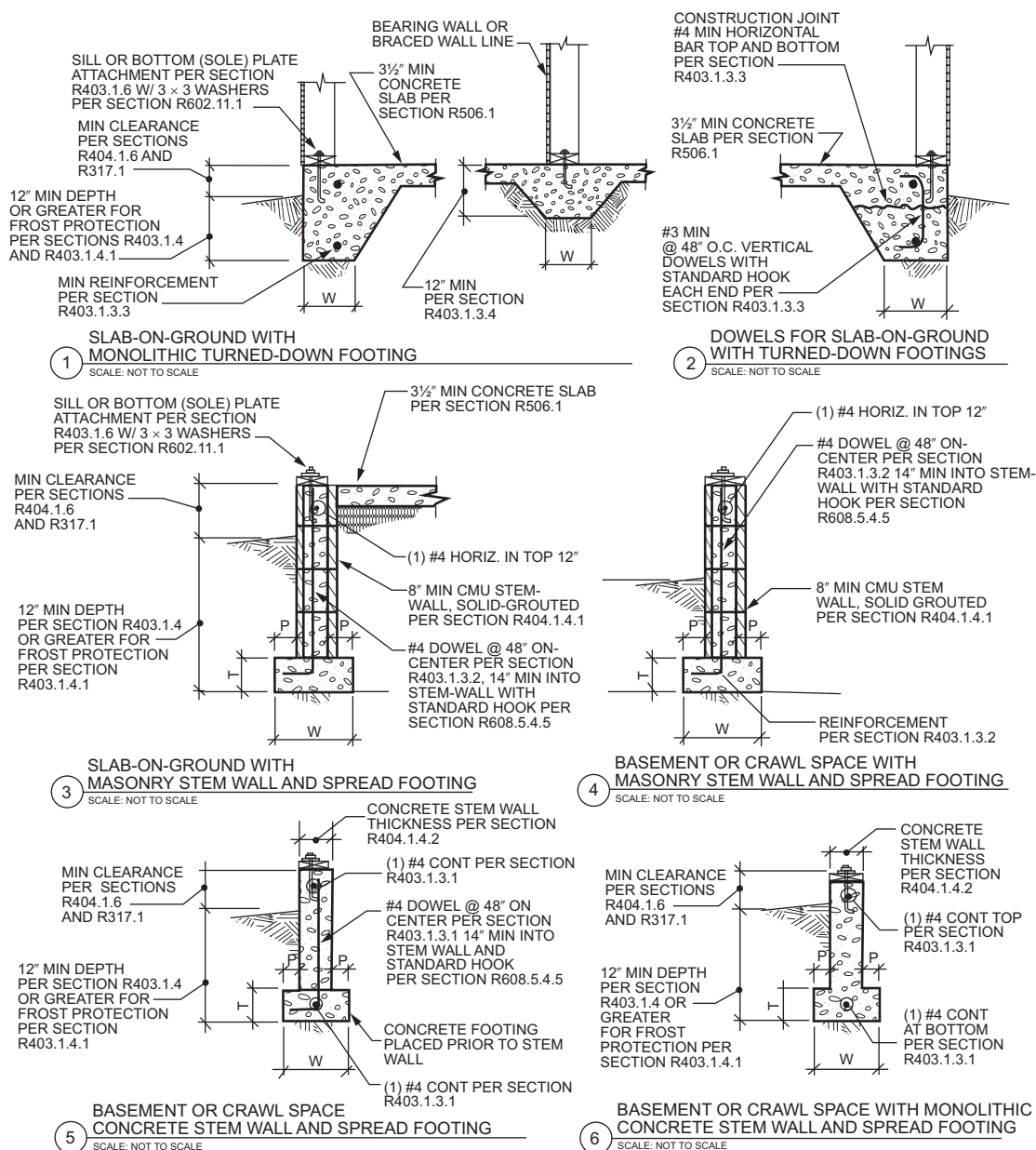
**R403.1.3.3 Slabs-on-ground with turned-down footings.** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , slabs-on-ground cast monolithically with turned-down footings shall have not fewer than one No. 4 bar at the top and the bottom of the footing or one No. 5 bar or two No. 4 bars in the middle third of the footing depth.

Where the slab is not cast monolithically with the footing, No. 3 or larger vertical dowels with standard hooks on each end shall be installed at not more than 4 feet (1219 mm) on center in accordance with Figure R403.1.3, Detail 2. Standard hooks shall comply with Section R608.5.4.5.

**R403.1.3.4 Interior bearing and braced wall panel footings in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$ .** In *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , interior footings supporting bearing walls or *braced wall panels*, and cast monolithically with a slab on *grade*, shall extend to a depth of not less than 12 inches (305 mm) below the top of the slab.

**R403.1.3.5 Reinforcement.** Footing and stem wall reinforcement shall comply with Sections R403.1.3.5.1 through R403.1.3.5.4.

**R403.1.3.5.1 Steel reinforcement.** Steel reinforcement shall comply with the requirements of ASTM A615, A706M or A996M. ASTM A996 bars produced from rail steel shall be Type R. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa).



For SI: 1 inch = 25.4 mm.

W = Width of footing, T = Thickness of footing and P = Projection per Section R403.1.1.

#### NOTES:

- See Section R404.3 for sill requirements.
- See Section R403.1.6 for sill attachment.
- See Section R506.2.3 for vapor barrier requirements.
- See Section R403.1 for base.
- See Section R408 for under-floor ventilation and access requirements.
- See Section R403.1.3.5 for reinforcement requirements.

**FIGURE R403.1.3**  
**REINFORCED CONCRETE FOOTINGS AND MASONRY AND CONCRETE STEM WALLS IN SDC D<sub>0</sub>, D<sub>1</sub> AND D<sub>2</sub><sup>a, b, c, d, e, f</sup>**

#### R403.1.3.5.2 Location of reinforcement in wall.

The center of vertical reinforcement in stem walls shall be located at the centerline of the wall. Horizontal and vertical reinforcement shall be located in footings and stem walls to provide the minimum cover required by Section R403.1.3.5.3.

#### R403.1.3.5.3 Support and cover. Reinforcement

shall be secured in the proper location in the forms with tie wire or other bar support system to prevent displacement during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches

## FOUNDATIONS

(75 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be  $1\frac{1}{2}$  inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be  $\frac{3}{4}$  inch (19 mm).

**R403.1.3.5.4 Lap splices.** Vertical and horizontal reinforcement shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splice shall be in accordance with Table R608.5.4(1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm) [see Figure R608.5.4(1)].

**R403.1.3.6 Isolated concrete footings.** In detached one- and two-family dwellings that are three *stories* or less in height and constructed with stud bearing walls, isolated plain concrete footings supporting columns or pedestals are permitted.

**R403.1.4 Minimum depth.** Exterior footings shall be placed not less than 12 inches (305 mm) below the undisturbed ground surface. Where applicable, the depth of footings shall also conform to Section R403.1.4.1. Deck footings shall be in accordance with Section R507.3.

**R403.1.4.1 Frost protection.** Except where otherwise protected from frost, foundation walls, piers and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extended below the frost line specified in Table R301.2.
2. Constructed in accordance with Section R403.3.
3. Constructed in accordance with ASCE 32.
4. Erected on solid rock.

Footings shall not bear on frozen soil unless the frozen condition is permanent.

### Exceptions:

1. Protection of free-standing *accessory structures* with an area of 600 square feet (56 m<sup>2</sup>) or less, of *light-frame construction*, with an eave height of 10 feet (3048 mm) or less shall not be required.
2. Protection of free-standing *accessory structures* with an area of 400 square feet (37 m<sup>2</sup>) or less, of other than *light-frame construction*, with an eave height of 10 feet (3048 mm) or less shall not be required.

**R403.1.5 Slope.** The top surface of footings shall be level. The bottom surface of footings shall not have a slope exceeding 1 unit vertical in 10 units horizontal (10-

percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footings will exceed 1 unit vertical in 10 units horizontal (10-percent slope).

**R403.1.6 Foundation anchorage.** Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

Cold-formed steel framing shall be anchored directly to the foundation or fastened to wood sill plates in accordance with Section R505.3.1 or R603.3.1, as applicable. Wood sill plates supporting cold-formed steel framing shall be anchored to the foundation in accordance with this section.

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of *braced wall panels* at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum  $\frac{1}{2}$ -inch-diameter (12.7 mm) anchor bolts spaced not greater than 6 feet (1829 mm) on center or *approved* anchors or anchor straps spaced as required to provide equivalent anchorage to  $\frac{1}{2}$ -inch-diameter (12.7 mm) anchor bolts. Bolts shall extend not less than 7 inches (178 mm) into concrete or grouted cells of *concrete masonry units*. The bolts shall be located in the middle third of the width of the plate. A nut and washer shall be tightened on each anchor bolt. There shall be not fewer than two bolts per plate section with one bolt located not more than 12 inches (305 mm) or less than seven bolt diameters from each end of the plate section. Interior bearing wall sole plates on monolithic slab foundation that are not part of a *braced wall panel* shall be positively anchored with *approved* fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections R317 and R318. Anchor bolts shall be permitted to be located while concrete is still plastic and before it has set. Where anchor bolts resist placement or the consolidation of concrete around anchor bolts is impeded, the concrete shall be vibrated to ensure full contact between the anchor bolts and concrete.

### Exceptions:

1. Walls 24 inches (610 mm) total length or shorter connecting offset *braced wall panels* shall be anchored to the foundation with not fewer than one anchor bolt located in the center third of the plate section and shall be attached to adjacent *braced wall panels* at corners as shown in Item 9 of Table R602.3(1).
2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset *braced wall panels* to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent *braced wall panels* at corners as shown in Item 9 of Table R602.3(1).

**R403.1.6.1 Foundation anchorage in Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** In addition to the requirements of Section R403.1.6, the following

requirements shall apply to wood light-frame structures in *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$  and wood light-frame *townhouses* in Seismic Design Category C.

1. Plate washers conforming to Section R602.11.1 shall be provided for all anchor bolts over the full length of required *braced wall lines* except where *approved* anchor straps are used. Properly sized cut washers shall be permitted for anchor bolts in wall lines not containing *braced wall panels*.
2. Interior braced wall plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section where supported on a continuous foundation.
3. Interior bearing wall sole plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section where supported on a continuous foundation.
4. The maximum anchor bolt spacing shall be 4 feet (1219 mm) for buildings over two *stories* in height.
5. Stepped cripple walls shall conform to Section R602.11.2.
6. Where continuous wood foundations in accordance with Section R404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section R602.11.1 or the *braced wall panel* shall be connected to the wood foundations in accordance with the *braced wall panel*-to-floor fastening requirements of Table R602.3(1).

**R403.1.7 Footings on or adjacent to slopes.** The placement of buildings and structures on or adjacent to slopes steeper than 1 unit vertical in 3 units horizontal (33.3-percent slope) shall conform to Sections R403.1.7.1 through R403.1.7.4.

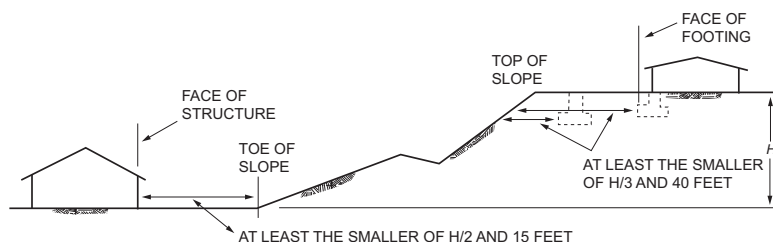
**R403.1.7.1 Building clearances from ascending slopes.** In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection

from slope drainage, erosion and shallow failures. Except as provided in Section R403.1.7.4 and Figure R403.1.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

**R403.1.7.2 Footing setback from descending slope surfaces.** Footings on or adjacent to slope surfaces shall be founded in material with an embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Except as provided for in Section R403.1.7.4 and Figure R403.1.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

**R403.1.7.3 Foundation elevation.** On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an *approved* drainage device not less than 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the *building official*, provided that it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

**R403.1.7.4 Alternate setbacks and clearances.** Alternate setbacks and clearances are permitted, subject to the approval of the *building official*. The *building official* is permitted to require an investigation and recommendation of a qualified engineer to demonstrate that the intent of this section has been satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.



For SI: 1 foot = 304.8 mm.

**FIGURE R403.1.7.1**  
**FOUNDATION CLEARANCE FROM SLOPES**



## FOUNDATIONS

**R403.1.8 Foundations on expansive soils.** Foundation and floor slabs for buildings located on *expansive soils* shall be designed in accordance with Section 1808.6 of the *International Building Code*.

**Exception:** Slab-on-ground and other foundation systems that have performed adequately in soil conditions similar to those encountered at the building site are permitted subject to the approval of the *building official*.

**R403.1.8.1 Expansive soils classifications.** Soils meeting all of the following provisions shall be considered to be expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

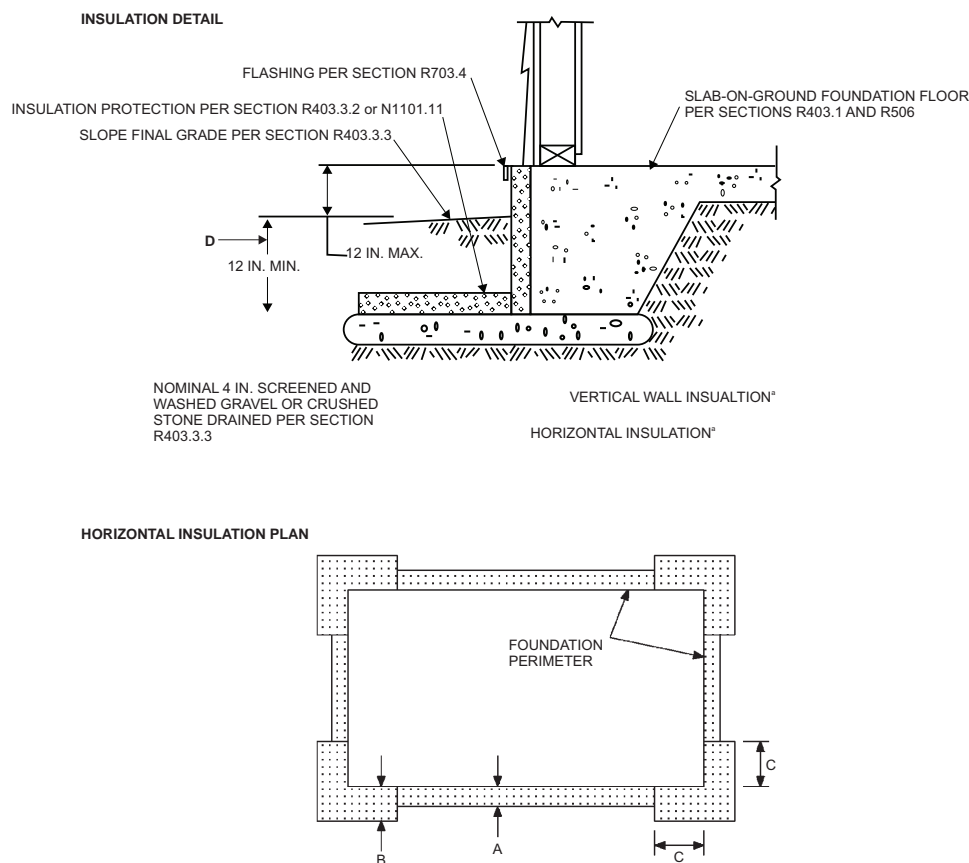
1. Plasticity Index (PI) of 15 or greater, determined in accordance with ASTM D4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75  $\mu\text{m}$ ), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.

4. Expansion Index greater than 20, determined in accordance with ASTM D4829.

**R403.2 Footings for wood foundations.** Footings for wood foundations shall be in accordance with Figures R403.1(2) and R403.1(3). Gravel shall be washed and well graded. The maximum size stone shall not exceed  $\frac{3}{4}$  inch (19.1 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than  $\frac{1}{16}$ -inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of  $\frac{1}{2}$  inch (12.7 mm).

**R403.3 Frost-protected shallow foundations.** For buildings where the monthly mean temperature of the building is maintained at not less than 64°F (18°C), footings are not required to extend below the frost line where protected from frost by insulation in accordance with Figure R403.3(1) and Table R403.3(1). Foundations protected from frost in accordance with Figure R403.3(1) and Table R403.3(1) shall not be used for unheated spaces such as porches, utility rooms, garages and carports, and shall not be attached to *basements* or *crawl spaces* that are not maintained at a minimum monthly mean temperature of 64°F (18°C).

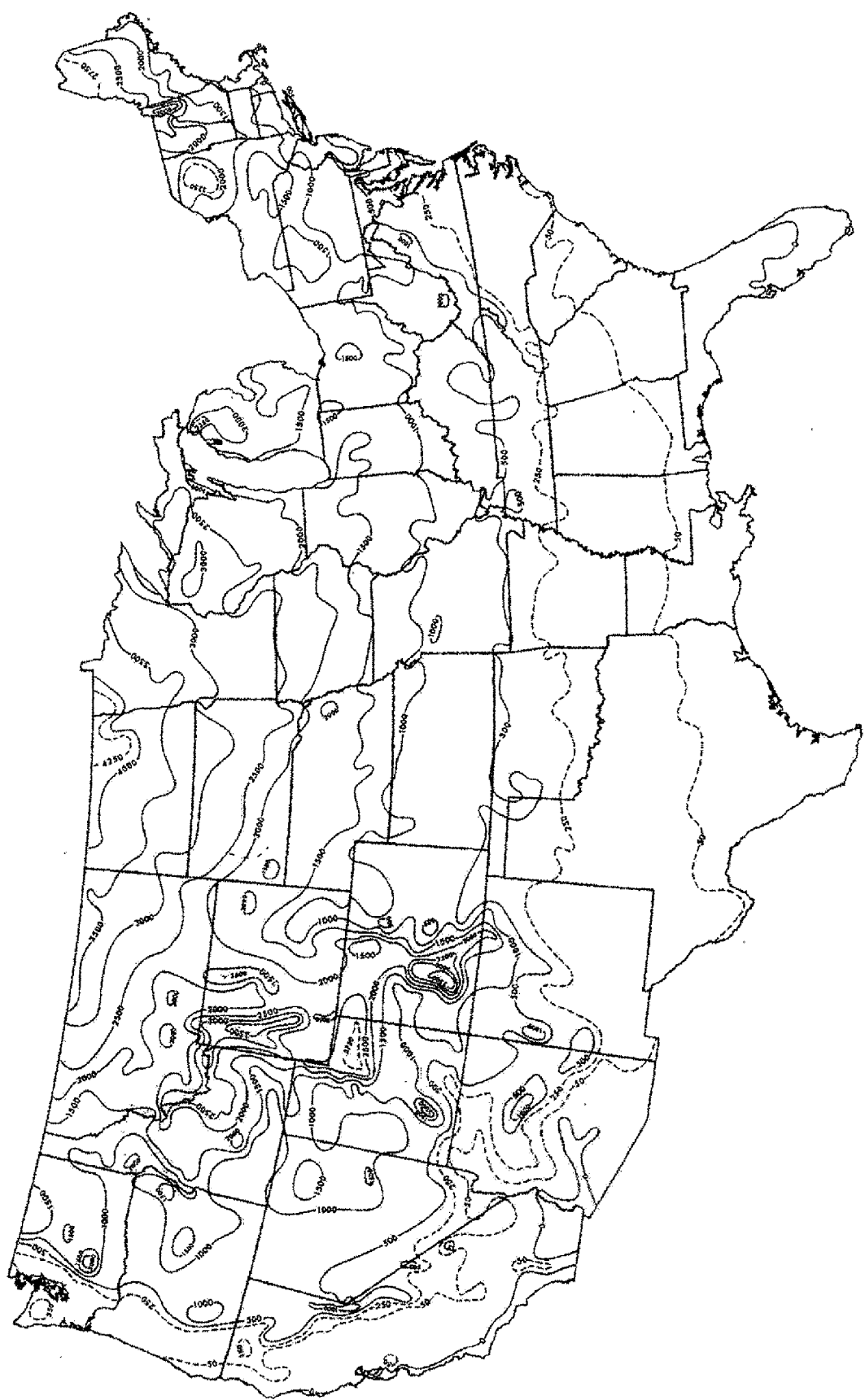
Materials used below *grade* for the purpose of insulating footings against frost shall be *labeled* as complying with ASTM C578.



For SI: 1 inch = 25.4 mm.

a. See Table R403.3(1) for required dimensions and *R*-values for vertical and horizontal insulation and minimum footing depth.

**FIGURE R403.3(1)**  
**INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS**



For SI:  $^{\circ}\text{C} = [(^{\circ}\text{F}) - 32]/1.8$ .

Note: The air-freezing index is defined as cumulative degree days below  $32^{\circ}\text{F}$ . It is used as a measure of the combined magnitude and duration of air temperature below freezing. The index was computed over a 12-month period (July–June) for each of the 3,044 stations used in the above analysis. Dates from the 1951–80 period were fitted to a Weibull probability distribution to produce an estimate of the 100-year return period.

FIGURE R403.3(2)  
AIR-FREEZING INDEX AN ESTIMATE OF THE 100-YEAR RETURN PERIOD

## FOUNDATIONS

**TABLE R403.3(1)**  
**MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS<sup>a</sup>**

AIR-FREEZING INDEX (°F days) <sup>b</sup>	MINIMUM FOOTING DEPTH, D (inches)	VERTICAL INSULATION R-VALUE <sup>c, d</sup>	HORIZONTAL INSULATION R-VALUE <sup>c, e</sup>		HORIZONTAL INSULATION DIMENSIONS PER Figure R403.3(1) (inches)		
			Along walls	At corners	A	B	C
1,500 or less	12	4.5	Not required	Not required	Not required	Not required	Not required
2,000	14	5.6	Not required	Not required	Not required	Not required	Not required
2,500	16	6.7	1.7	4.9	12	24	40
3,000	16	7.8	6.5	8.6	12	24	40
3,500	16	9.0	8.0	11.2	24	30	60
4,000	16	10.1	10.5	13.1	24	36	60

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

- a. Insulation requirements are for protection against frost damage in heated buildings. Greater values could be required to meet energy conservation standards.
- b. See Figure R403.3(2) or Table R403.3(2) for Air-Freezing Index values.
- c. Insulation materials shall provide the stated minimum R-values under long-term exposure to moist, below-ground conditions in freezing climates. The following R-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene (EPS)-3.2 R per inch for vertical insulation and 2.6 R per inch for horizontal insulation; Type IX expanded polystyrene (EPS)-3.4 R per inch for vertical insulation and 2.8 R per inch for horizontal insulation; Types IV, V, VI, VII, and X extruded polystyrene (XPS)-4.5 R per inch for vertical insulation and 4.0 R per inch for horizontal insulation.
- d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.
- e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.

**TABLE R403.3(2)**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Alabama	All counties	—	—	—	—	—
Alaska	Ketchikan Gateway, Prince of Wales-Outer Ketchikan (CA), Sitka, Wrangell-Petersburg (CA)	—	Aleutians West (CA), Haines, Juneau, Skagway-Hoonah-Angoon (CA), Yakutat	—	—	All counties not listed
Arizona	All counties	—	—	—	—	—
Arkansas	All counties	—	—	—	—	—
California	All counties not listed	Nevada, Sierra	—	—	—	—
Colorado	All counties not listed	Archuleta, Custer, Fremont, Huerfano, Las Animas, Ouray, Pitkin, San Miguel	Clear Creek, Conejos, Costilla, Dolores, Eagle, La Plata, Park, Routt, San Juan, Summit	Alamosa, Grand, Jackson, Larimer, Moffat, Rio Blanco, Rio Grande	Chaffee, Gunnison, Lake, Saguache	Hinsdale, Mineral
Connecticut	All counties not listed	Hartford, Litchfield	—	—	—	—
Delaware	All counties	—	—	—	—	—
District of Columbia	All counties	—	—	—	—	—
Florida	All counties	—	—	—	—	—
Georgia	All counties	—	—	—	—	—
Hawaii	All counties	—	—	—	—	—
Idaho	All counties not listed	Adams, Bannock, Blaine, Clearwater, Idaho, Lincoln, Oneida, Power, Valley, Washington	Bingham, Bonneville, Camas, Caribou, Elmore, Franklin, Jefferson, Madison, Teton	Bear Lake, Butte, Custer, Fremont, Lemhi	Clark	—

(continued)

**TABLE R403.3(2)—continued**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Illinois	All counties not listed	Boone, Bureau, Cook, Dekalb, DuPage, Fulton, Grundy, Henderson, Henry, Iroquois, Jo Daviess, Kane, Kankakee, Kendall, Knox, La Salle, Lake, Lee, Livingston, Marshall, Mason, McHenry, McLean, Mercer, Peoria, Putnam, Rock Island, Stark, Tazewell, Warren, Whiteside, Will, Woodford	Carroll, Ogle, Stephenson, Winnebago	—	—	—
Indiana	All counties not listed	Allen, Benton, Cass, Fountain, Fulton, Howard, Jasper, Kosciusko, La Porte, Lake, Marshall, Miami, Newton, Porter, Pulaski, Starke, Steuben, Tippecanoe, Tipton, Wabash, Warren, White	—	—	—	—
Iowa	Appanoose, Davis, Fremont, Lee, Van Buren	All counties not listed	Allamakee, Black Hawk, Boone, Bremer, Buchanan, Buena Vista, Butler, Calhoun, Cerro Gordo, Cherokee, Chickasaw, Clay, Clayton, Delaware, Dubuque, Fayette, Floyd, Franklin, Grundy, Hamilton, Hancock, Hardin, Humboldt, Ida, Jackson, Jasper, Jones, Linn, Marshall, Palo Alto, Plymouth, Pocahontas, Poweshiek, Sac, Sioux, Story, Tama, Webster, Winnebago, Woodbury, Worth, Wright	Dickinson, Emmet, Howard, Kossuth, Lyon, Mitchell, O'Brien, Osceola, Winneshiek	—	—
Kansas	All counties	—	—	—	—	—
Kentucky	All counties	—	—	—	—	—

(continued)



## FOUNDATIONS

**TABLE R403.3(2)—continued**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Louisiana	All counties	—	—	—	—	—
Maine	York	Knox, Lincoln, Sagadahoc	Androscoggin, Cumberland, Hancock, Kennebec, Waldo, Washington	Aroostook, Franklin, Oxford, Penobscot, Piscataquis, Somerset	—	—
Maryland	All counties	—	—	—	—	—
Massachusetts	All counties not listed	Berkshire, Franklin, Hampden, Worcester	—	—	—	—
Michigan	Berrien, Branch, Cass, Kalamazoo, Macomb, Ottawa, St. Clair, St. Joseph	All counties not listed	Alger, Charlevoix, Cheboygan, Chippewa, Crawford, Delta, Emmet, Iosco, Kalkaska, Lake, Luce, Mackinac, Menominee, Missaukee, Montmorency, Ogemaw, Osceola, Otsego, Roscommon, Schoolcraft, Wexford	Baraga, Dickinson, Iron, Keweenaw, Marquette	Gogebic, Houghton, Ontonagon	—
Minnesota	—	—	Houston, Winona	All counties not listed	Aitkin, Big Stone, Carlton, Crow Wing, Douglas, Itasca, Kanabec, Lake, Morrison, Pine, Pope, Stearns, Stevens, Swift, Todd, Wadena	Becker, Beltrami, Cass, Clay, Clearwater, Grant, Hubbard, Kittson, Koochiching, Lake of the Woods, Mahnomen, Marshall, Norman, Otter Tail, Pennington, Polk, Red Lake, Roseau, St. Louis, Traverse, Wilkin
Mississippi	All counties	—	—	—	—	—
Missouri	All counties not listed	Atchison, Mercer, Nodaway, Putnam	—	—	—	—
Montana	Mineral	Broadwater, Golden Valley, Granite, Lake, Lincoln, Missoula, Ravalli, Sanders, Sweet Grass	Big Horn, Carbon, Jefferson, Judith Basin, Lewis and Clark, Meagher, Musselshell, Powder River, Powell, Silver Bow, Stillwater, Westland	Carter, Cascade, Deer Lodge, Falcon, Fergus, Flathead, Gallatin, Glacier, Madison, Park, Petroleum, Ponder, Rosebud, Teton, Treasure, Yellowstone	Beaverhead, Blaine, Chouteau, Custer, Dawson, Garfield, Liberty, McCone, Prairie, Toole, Wibaux	Daniels, Hill, Phillips, Richland, Roosevelt, Sheridan, Valley

(continued)

**TABLE R403.3(2)—continued**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Nebraska	Adams, Banner, Chase, Cheyenne, Clay, Deuel, Dundy, Fillmore, Franklin, Frontier, Furnas, Gage, Garden, Gosper, Harlan, Hayes, Hitchcock, Jefferson, Kimball, Morrill, Nemaha, Nuckolls, Pawnee, Perkins, Phelps, Red Willow, Richardson, Saline, Scotts Bluff, Seward, Thayer, Webster	All counties not listed	Boyd, Burt, Cedar, Cuming, Dakota, Dixon, Dodge, Knox, Thurston	—	—	—
Nevada	All counties not listed	Elko, Eureka, Nye, Washoe, White Pine	—	—	—	—
New Hampshire	—	All counties not listed	—	—	—	Carroll, Coos, Grafton
New Jersey	All counties	—	—	—	—	—
New Mexico	All counties not listed	Rio Arriba	Colfax, Mora, Taos	—	—	—
New York	Albany, Bronx, Cayuga, Columbia, Cortland, Dutchess, Genessee, Kings, Livingston, Monroe, Nassau, New York, Niagara, Onondaga, Ontario, Orange, Orleans, Putnam, Queens, Richmond, Rockland, Seneca, Suffolk, Wayne, Westchester, Yates	All counties not listed	Clinton, Essex, Franklin, Hamilton, Herkimer, Jefferson, Lewis, St. Lawrence, Warren	—	—	—
North Carolina	All counties	—	—	—	—	—
North Dakota	—	—	—	Billings, Bowman	Adams, Dickey, Golden Valley, Hettinger, LaMoure, Oliver, Ransom, Sargent, Sioux, Slope, Stark	All counties not listed

*(continued)*

## FOUNDATIONS

**TABLE R403.3(2)—continued**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

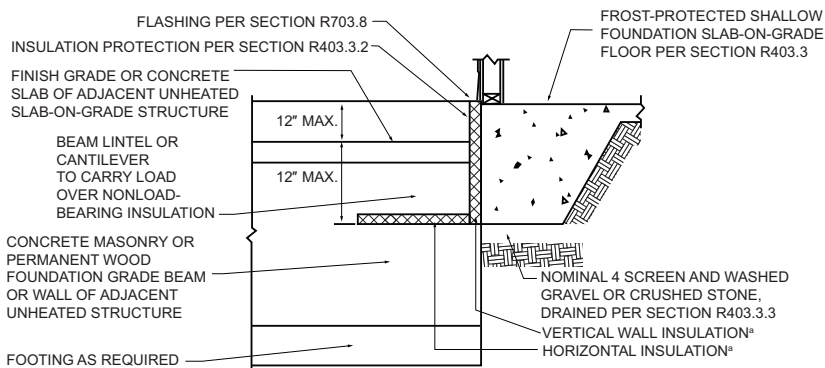
STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Ohio	All counties not listed	Ashland, Crawford, Defiance, Holmes, Huron, Knox, Licking, Morrow, Paulding, Putnam, Richland, Seneca, Williams	—	—	—	—
Oklahoma	All counties	—	—	—	—	—
Oregon	All counties not listed	Baker, Crook, Grant, Harney	—	—	—	—
Pennsylvania	All counties not listed	Berks, Blair, Bradford, Cambria, Cameron, Centre, Clarion, Clearfield, Clinton, Crawford, Elk, Forest, Huntingdon, Indiana, Jefferson, Lackawanna, Lycoming, McKean, Pike, Potter, Susquehanna, Tioga, Venango, Warren, Wayne, Wyoming	—	—	—	—
Rhode Island	All counties	—	—	—	—	—
South Carolina	All counties	—	—	—	—	—
South Dakota	—	Bennett, Custer, Fall River, Lawrence, Mellette, Shannon, Todd, Tripp	Bon Homme, Charles Mix, Davison, Douglas, Gregory, Jackson, Jones, Lyman	All counties not listed	Beadle, Brookings, Brown, Campbell, Codington, Corson, Day, Deuel, Edmunds, Faulk, Grant, Hamlin, Kingsbury, Marshall, McPherson, Perkins, Roberts, Spink, Walworth	—
Tennessee	All counties	—	—	—	—	—
Texas	All counties	—	—	—	—	—
Utah	All counties not listed	Box Elder, Morgan, Weber	Garfield, Salt Lake, Summit	Carbon, Daggett, Duchesne, Rich, Sanpete, Uintah, Wasatch	—	—
Vermont	—	Bennington, Grand Isle, Rutland, Windham	Addison, Chittenden, Franklin, Orange, Washington, Windsor	Caledonia, Essex, Lamoille, Orleans	—	—
Virginia	All counties	—	—	—	—	—

(continued)

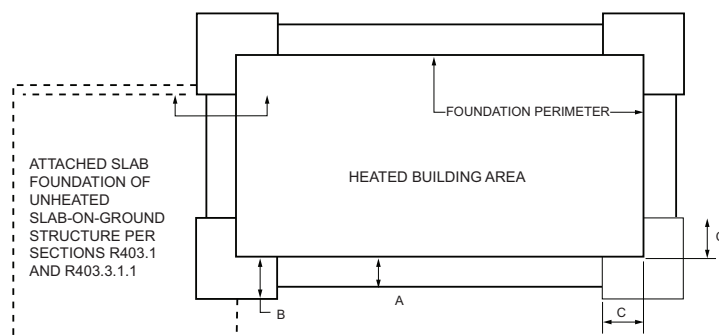
**TABLE R403.3(2)—continued**  
**AIR-FREEZING INDEX FOR US LOCATIONS BY COUNTY**

STATE	AIR-FREEZING INDEX					
	1,500 or less	2,000	2,500	3,000	3,500	4,000
Washington	All counties not listed	Chelan, Douglas, Ferry, Okanogan	—	—	—	—
West Virginia	All counties	—	—	—	—	—
Wisconsin	—	Kenosha, Kewaunee, Racine, Sheboygan, Walworth	All counties not listed	Ashland, Barron, Burnett, Chippewa, Clark, Dunn, Eau Claire, Florence, Forest, Iron, Jackson, La Crosse, Langlade, Marathon, Monroe, Pepin, Polk, Portage, Price, Rust, St. Croix, Taylor, Trempealeau, Vilas, Wood	Bayfield, Douglas, Lincoln, Oneida, Sawyer, Washburn	—
Wyoming	Goshen, Platte	Converse, Crook, Laramie, Niobrara	Campbell, Carbon, Hot Springs, Johnson, Natrona, Sheridan, Uinta, Weston	Albany, Big Horn, Park, Washakie	Fremont, Teton	Lincoln, Sublette, Sweetwater

#### INSULATION DETAIL



#### HORIZONTAL INSULATION PLAN



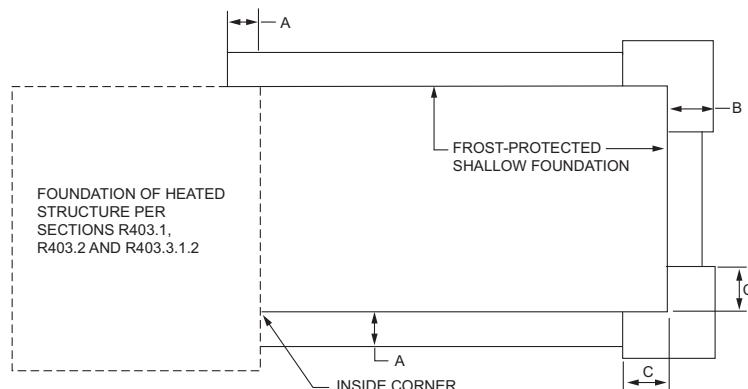
For SI: 1 inch = 25.4 mm.

a. See Table R403.3(1) for required dimensions and *R*-values for vertical and horizontal insulation.

**FIGURE R403.3(3)**  
**INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS ADJACENT TO UNHEATED SLAB-ON-GROUND STRUCTURE**



## FOUNDATIONS



**FIGURE R403.3(4)**  
**INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS ADJACENT TO HEATED STRUCTURE**

**R403.3.1 Foundations adjoining frost-protected shallow foundations.** Foundations that adjoin frost-protected shallow foundations shall be protected from frost in accordance with Section R403.1.4.

**R403.3.1.1 Attachment to unheated slab-on-ground structure.** Vertical wall insulation and horizontal insulation of frost-protected shallow foundations that adjoin a slab-on-ground foundation that does not have a monthly mean temperature maintained at not less than 64°F (18°C) shall be in accordance with Figure R403.3(3) and Table R403.3(1). Vertical wall insulation shall extend between the frost-protected shallow foundation and the adjoining slab foundation. Required horizontal insulation shall be continuous under the adjoining slab foundation and through any foundation walls adjoining the frost-protected shallow foundation. Where insulation passes through a foundation wall, it shall be either of a type complying with this section and having bearing capacity equal to or greater than the structural loads imposed by the building, or the building shall be designed and constructed using beams, lintels, cantilevers or other means of transferring building loads such that the structural loads of the building do not bear on the insulation.

**R403.3.1.2 Attachment to heated structure.** Where a frost-protected shallow foundation abuts a structure that has a monthly mean temperature maintained at not less than 64°F (18°C), horizontal insulation and vertical wall insulation shall not be required between the frost-protected shallow foundation and the adjoining structure. Where the frost-protected shallow foundation abuts the heated structure, the horizontal

insulation and vertical wall insulation shall extend along the adjoining foundation in accordance with Figure R403.3(4) a distance of not less than Dimension A in Table R403.3(1).

**Exception:** Where the frost-protected shallow foundation abuts the heated structure to form an inside corner, vertical insulation extending along the adjoining foundation is not required.

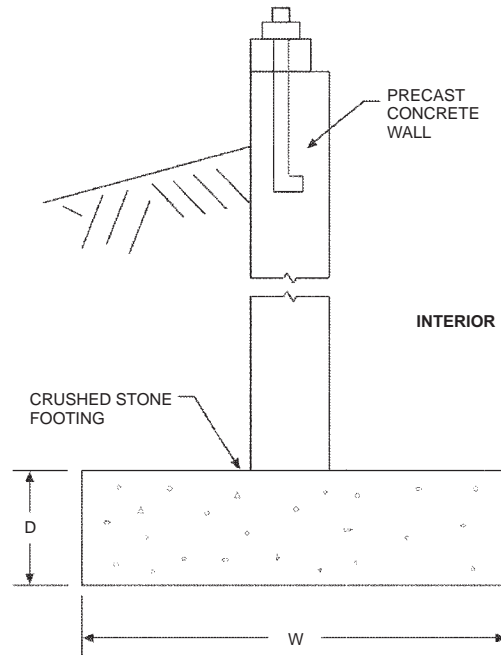
**R403.3.2 Protection of horizontal insulation below ground.** Horizontal insulation placed less than 12 inches (305 mm) below the ground surface or that portion of horizontal insulation extending outward more than 24 inches (610 mm) from the foundation edge shall be protected against damage by use of a concrete slab or asphalt paving on the ground surface directly above the insulation or by cementitious board, plywood rated for below-ground use, or other *approved* materials placed below ground, directly above the top surface of the insulation.

**R403.3.3 Drainage.** Final *grade* shall be sloped in accordance with Section R401.3. In other than Group I Soils, as detailed in Table R405.1, gravel or crushed stone beneath horizontal insulation below ground shall drain to daylight or into an *approved* sewer system.

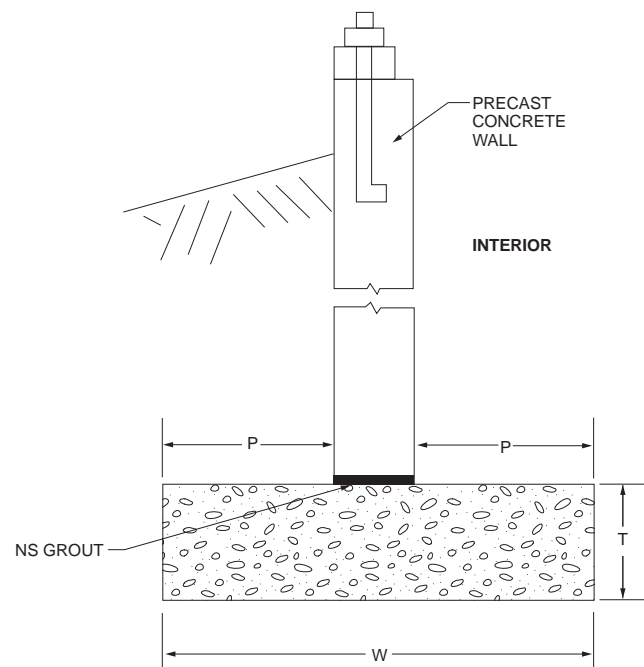
**R403.3.4 Termite protection.** The use of foam plastic in areas of “very heavy” termite infestation probability shall be in accordance with Section R318.4.

**R403.4 Footings for precast concrete foundations.** Footings for *precast concrete* foundations shall comply with Section R403.4.

## FOUNDATIONS



**FIGURE R403.4(1)**  
**BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL BEARING ON CRUSHED STONE**



**FIGURE R403.4(2)**  
**BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION WALL ON SPREAD FOOTING**

## FOUNDATIONS

**TABLE R403.4**  
**MINIMUM DEPTH (D) AND WIDTH (W) OF CRUSHED STONE FOOTINGS<sup>a,b</sup> (inches)**

NUMBER OF STORIES	UNIFORM WALL LOAD	DEPTH (D) AND WIDTH (W)	LOAD-BEARING VALUE OF SOIL (psf)																	
			1500			2000			2500			3000			3500			4000		
			MH, CH, CL, ML <sup>c</sup>			SC, GC, SM, GM, SP, SW <sup>c</sup>						GP, GW <sup>c</sup>								
			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)		
			8	10	12	8	10	12	8	10	12	8	10	12	8	10	12	8	10	12
Conventional light-frame construction																				
1-story	1,100 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	1,800 plf	D	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	15	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
3-story	2,900 plf	D	14	12	10	9	7	5	6	4	4	4	4	4	4	4	4	4	4	4
		W	25	24	24	19	19	18	15	15	17	13	15	17	13	15	17	13	15	17
4-inch brick veneer over light-frame or 8-inch hollow concrete masonry																				
1-story	1,500 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	2,700 plf	D	12	11	9	8	6	4	5	4	4	4	4	4	4	4	4	4	4	4
		W	22	23	23	18	17	17	14	15	17	13	15	17	13	15	17	13	15	17
3-story	4,000 plf	D	21	20	18	14	13	11	10	8	7	7	6	4	5	4	4	4	4	4
		W	33	34	33	25	26	25	20	20	21	17	17	17	14	15	17	13	15	17
8-inch solid or fully grouted masonry																				
1-story	2,000 plf	D	7	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	17	17	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	3,600 plf	D	19	17	15	12	11	9	9	7	5	6	4	4	4	4	4	4	4	4
		W	30	30	30	22	23	23	19	19	18	15	15	17	13	15	17	13	15	17
3-story	5,300 plf	D	30	29	27	21	19	18	16	14	12	12	10	8	9	8	6	7	6	4
		W	43	44	44	33	32	33	27	27	26	22	22	22	19	20	19	17	17	17

For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

a. Linear interpolation of stone depth between wall widths is permitted within each Load-Bearing Value of Soil (psf).

b. Crushed stone must be consolidated in 8-inch lifts with a plate vibrator.

c. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

**R403.4.1 Crushed stone footings.** Clean crushed stone shall be free from organic, clayey or silty soils. Crushed stone shall be angular in nature and meet ASTM C33, with the maximum size stone not to exceed  $\frac{1}{2}$  inch (12.7 mm) and the minimum stone size not to be smaller than  $\frac{1}{16}$  inch (1.6 mm). Crushed stone footings for precast foundations shall be installed in accordance with Figure R403.4(1) and Table R403.4. Crushed stone footings shall be consolidated using a vibratory plate in not greater than 8-inch (203 mm) lifts. Crushed stone footings shall be limited to *Seismic Design Categories A, B and C*.

**R403.4.2 Concrete footings.** Concrete footings shall be installed in accordance with Section R403.1 and Figure R403.4(2).

## SECTION R404 FOUNDATION AND RETAINING WALLS

**R404.1 Concrete and masonry foundation walls.** Concrete foundation walls shall be selected and constructed in accordance with the provisions of Section R404.1.3. Masonry foundation walls shall be selected and constructed in accordance with the provisions of Section R404.1.2.

**R404.1.1 Design required.** Concrete or masonry foundation walls shall be designed in accordance with accepted engineering practice where either of the following conditions exists:

1. Walls are subject to hydrostatic pressure from ground water.
2. Walls supporting more than 48 inches (1219 mm) of unbalanced backfill that do not have permanent lateral support at the top or bottom.

**TABLE R404.1.1(1)**  
**PLAIN MASONRY FOUNDATION WALLS<sup>f</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>c</sup> (feet)	PLAIN MASONRY <sup>a</sup> MINIMUM NOMINAL WALL THICKNESS (inches)		
		Soil classes <sup>b</sup>		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
5	4	6 solid <sup>d</sup> or 8	6 solid <sup>d</sup> or 8	6 solid <sup>d</sup> or 8
	5	6 solid <sup>d</sup> or 8	8	10
6	4	6 solid <sup>d</sup> or 8	6 solid <sup>d</sup> or 8	6 solid <sup>d</sup> or 8
	5	6 solid <sup>d</sup> or 8	8	10
	6	8	10	12
7	4	6 solid <sup>d</sup> or 8	8	8
	5	6 solid <sup>d</sup> or 8	10	10
	6	10	12	10 solid <sup>d</sup>
	7	12	10 solid <sup>d</sup>	12 solid <sup>d</sup>
8	4	6 solid <sup>d</sup> or 8	6 solid <sup>d</sup> or 8	8
	5	6 solid <sup>d</sup> or 8	10	12
	6	10	12	12 solid <sup>d</sup>
	7	12	12 solid <sup>d</sup>	Note e
	8	10 grout <sup>d</sup>	12 grout <sup>d</sup>	Note e
9	4	6 grout <sup>d</sup> or 8 solid <sup>d</sup> or 12	6 grout <sup>d</sup> or 8 solid <sup>d</sup>	8 grout <sup>d</sup> or 10 solid <sup>d</sup>
	5	6 grout <sup>d</sup> or 10 solid <sup>d</sup>	8 grout <sup>d</sup> or 12 solid <sup>d</sup>	8 grout <sup>d</sup>
	6	8 grout <sup>d</sup> or 12 solid <sup>d</sup>	10 grout <sup>d</sup>	10 grout <sup>d</sup>
	7	10 grout <sup>d</sup>	10 grout <sup>d</sup>	12 grout
	8	10 grout <sup>d</sup>	12 grout	Note e
	9	12 grout	Note e	Note e

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- Mortar shall be Type M or S and masonry shall be laid in running bond. UngROUTED hollow masonry units are permitted except where otherwise indicated.
- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.
- Solid indicates solid masonry unit; grout indicates grouted hollow units.
- Wall construction shall be in accordance with Table R404.1.1(2), R404.1.1(3) or R404.1.1(4), or a design shall be provided.
- The use of this table shall be prohibited for soil classifications not shown.



## FOUNDATIONS

**TABLE R404.1.1(2)**  
**8-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE  $d \geq 5$  INCHES<sup>a, c, f</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>e</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and lateral soil load <sup>d</sup> (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet 8 inches	#4 at 48	#5 at 48	#6 at 48
7 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet 4 inches	#5 at 48	#6 at 48	#6 at 40
8 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#5 at 48	#6 at 48	#6 at 32
8 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet 8 inches	#6 at 48	#6 at 32	#6 at 24
9 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#6 at 48	#6 at 40	#6 at 24
	9 feet 4 inches	#6 at 40	#6 at 24	#6 at 16
10 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 32
	8 feet	#6 at 48	#6 at 32	#6 at 24
	9 feet	#6 at 40	#6 at 24	#6 at 16
	10 feet	#6 at 32	#6 at 16	#6 at 16

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

- Mortar shall be Type M or S and masonry shall be laid in running bond.
- Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C, and 48 inches in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.
- Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 5 inches.
- Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.
- Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE R404.1.1(3)**  
**10-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE  $d \geq 6.75$  INCHES<sup>a, c, f</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>a</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and later soil load <sup>d</sup> (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet 8 inches	#4 at 56	#5 at 56	#5 at 56
7 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet 4 inches	#4 at 56	#5 at 56	#6 at 56
8 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 48
8 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet 8 inches	#5 at 56	#6 at 48	#6 at 32
9 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 40
	9 feet 4 inches	#6 at 56	#6 at 40	#6 at 24
10 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#5 at 56	#6 at 56	#6 at 48
	8 feet	#5 at 56	#6 at 48	#6 at 40
	9 feet	#6 at 56	#6 at 40	#6 at 24
	10 feet	#6 at 48	#6 at 32	#6 at 24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

- Mortar shall be Type M or S and masonry shall be laid in running bond.
- Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C, and 48 inches in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.
- Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 6.75 inches.
- Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.
- Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.
- The use of this table shall be prohibited for soil classifications not shown.

## FOUNDATIONS

**TABLE R404.1.1(4)**  
**12-INCH MASONRY FOUNDATION WALLS WITH REINFORCING WHERE  $d \geq 8.75$  INCHES<sup>a, c, f</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>e</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and lateral soil load <sup>d</sup> (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet 8 inches	#4 at 72	#4 at 72	#5 at 72
7 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet 4 inches	#4 at 72	#5 at 72	#6 at 72
8 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 64
8 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet 8 inches	#5 at 72	#7 at 72	#6 at 48
9 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 56
	9 feet 4 inches	#6 at 72	#6 at 48	#6 at 40
10 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#6 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 48
	9 feet	#6 at 72	#6 at 56	#6 at 40
	10 feet	#6 at 64	#6 at 40	#6 at 32

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

a. Mortar shall be Type M or S and masonry shall be laid in running bond.

b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches in Seismic Design Categories A, B and C, and 48 inches in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.

c. Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 8.75 inches.

d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.

e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground levels. Where an interior concrete slab-on-grade is provided and in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height is permitted to be measured from the exterior finish ground level to the top of the interior concrete slab is permitted.

f. The use of this table shall be prohibited for soil classifications not shown.

**R404.1.2 Design of masonry foundation walls.**

Masonry foundation walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of TMS 402. Where TMS 402 or the provisions of this section are used to design masonry foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the jurisdiction having authority.

**TABLE R404.1.2(1)**  
**MINIMUM HORIZONTAL REINFORCEMENT**  
**FOR CONCRETE BASEMENT WALLS<sup>a, b</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	LOCATION OF HORIZONTAL REINFORCEMENT
≤ 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near mid-height of the wall story.
> 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near third points in the wall story.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa.

a. Horizontal reinforcement requirements are for reinforcing bars with a minimum yield strength of 40,000 psi and concrete with a minimum concrete compressive strength of 2,500 psi.

b. See Section R404.1.3.2 for minimum reinforcement required for foundation walls supporting above-grade concrete walls.

**TABLE R404.1.2(2)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS<sup>b, c, d, e, g, h, i, j, k</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	6 @ 39	6 @ 48
	6	5 @ 39	6 @ 48	6 @ 35
	7	6 @ 48	6 @ 34	6 @ 25
	8	6 @ 39	6 @ 25	6 @ 18
9	4	NR	NR	NR
	5	NR	5 @ 37	6 @ 48
	6	5 @ 36	6 @ 44	6 @ 32
	7	6 @ 47	6 @ 30	6 @ 22
	8	6 @ 34	6 @ 22	6 @ 16
10	9	6 @ 27	6 @ 17	DR
	4	NR	NR	NR
	5	NR	5 @ 35	6 @ 48
	6	6 @ 48	6 @ 41	6 @ 30
	7	6 @ 43	6 @ 28	6 @ 20
	8	6 @ 31	6 @ 20	DR
	9	6 @ 24	6 @ 15	DR
	10	6 @ 19	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

a. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

b. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.

c. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).

d. Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.

e. Interpolation is not permitted.

f. Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.

g. NR indicates vertical wall reinforcement is not required, except for 6-inch-nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.

h. See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.

i. See Table R608.3 for tolerance from nominal thickness permitted for flat walls.

j. DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.

k. The use of this table shall be prohibited for soil classifications not shown.



## FOUNDATIONS

**TABLE R404.1.2(3)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH (203 mm) NOMINAL FLAT CONCRETE BASEMENT WALLS<sup>b, c, d, e, f, h, i, j</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 37
	7	NR	6 @ 36	6 @ 35
	8	6 @ 41	6 @ 35	6 @ 26
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 32
	8	6 @ 36	6 @ 32	6 @ 23
	9	6 @ 35	6 @ 25	6 @ 18
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 29
	8	6 @ 35	6 @ 29	6 @ 21
	9	6 @ 34	6 @ 22	6 @ 16
	10	6 @ 27	6 @ 17	6 @ 13

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE R404.1.2(4)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 10-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS<sup>b, c, d, e, f, h, i, j</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	NR
	8	6 @ 48	6 @ 35	6 @ 28
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 31
	8	NR	6 @ 31	6 @ 28
	9	6 @ 37	6 @ 28	6 @ 24
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 28
	8	NR	6 @ 28	6 @ 28
	9	6 @ 33	6 @ 28	6 @ 21
	10	6 @ 28	6 @ 23	6 @ 17

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.

## FOUNDATIONS

**TABLE R404.1.2(5)**  
**MINIMUM VERTICAL WALL REINFORCEMENT FOR 6-INCH WAFFLE-GRID BASEMENT WALLS<sup>b, c, d, e, g, h, i, j</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 46	6 @ 39
	5	4 @ 45	5 @ 46	6 @ 47
	6	5 @ 45	6 @ 40	DR
	7	6 @ 44	DR	DR
	8	6 @ 32	DR	DR
9	4	4 @ 48	4 @ 46	4 @ 37
	5	4 @ 42	5 @ 43	6 @ 44
	6	5 @ 41	6 @ 37	DR
	7	6 @ 39	DR	DR
	> 8	DR <sup>i</sup>	DR	DR
10	4	4 @ 48	4 @ 46	4 @ 35
	5	4 @ 40	5 @ 40	6 @ 41
	6	5 @ 38	6 @ 34	DR
	7	6 @ 36	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table R608.3 for thicknesses and dimensions of waffle-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE R404.1.2(6)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH WAFFLE-GRID BASEMENT WALLS<sup>b, c, d, e, f, h, i, j, k</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	5 @ 48	5 @ 46
	6	5 @ 48	5 @ 43	6 @ 45
	7	5 @ 46	6 @ 43	6 @ 31
	8	6 @ 48	6 @ 32	6 @ 23
9	4	NR	NR	NR
	5	NR	5 @ 47	5 @ 46
	6	5 @ 46	5 @ 39	6 @ 41
	7	5 @ 42	6 @ 38	6 @ 28
	8	6 @ 44	6 @ 28	6 @ 20
	9	6 @ 34	6 @ 21	DR
10	4	NR	NR	NR
	5	NR	5 @ 46	5 @ 44
	6	5 @ 46	5 @ 37	6 @ 38
	7	5 @ 38	6 @ 35	6 @ 25
	8	6 @ 39	6 @ 25	DR
	9	6 @ 30	DR	DR
	10	6 @ 24	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 (420 MPa) and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation shall not be permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table R608.3 for thicknesses and dimensions of waffle-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.



## FOUNDATIONS

**TABLE R404.1.2(7)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH (152 mm) SCREEN-GRID BASEMENT WALLS<sup>b, c, d, e, g, h, i, j</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 48	5 @ 43
	5	4 @ 48	5 @ 48	5 @ 37
	6	5 @ 48	6 @ 45	6 @ 32
	7	6 @ 48	DR	DR
	8	6 @ 36	DR	DR
9	4	4 @ 48	4 @ 48	4 @ 41
	5	4 @ 48	5 @ 48	6 @ 48
	6	5 @ 45	6 @ 41	DR
	7	6 @ 43	DR	DR
	> 8	DR	DR	DR
10	4	4 @ 48	4 @ 48	4 @ 39
	5	4 @ 44	5 @ 44	6 @ 46
	6	5 @ 42	6 @ 38	DR
	7	6 @ 40	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section R404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Sections R404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table R608.3 for thicknesses and dimensions of screen-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE R404.1.2(8)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 6-, 8-, 10- AND 12-INCH NOMINAL FLAT BASEMENT WALLS<sup>b, c, d, e, f, h, i, k, n, o</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>9</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)											
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)											
		GW, GP, SW, SP 30				GM, GC, SM, SM-SC and ML 45				SC, ML-CL and inorganic CL 60			
		Minimum nominal wall thickness (inches)											
		6	8	10	12	6	8	10	12	6	8	10	12
5	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR <sup>1</sup>	NR	NR	4 @ 35	NR <sup>1</sup>	NR	NR
	6	NR	NR	NR	NR	5 @ 48	NR	NR	NR	5 @ 36	NR	NR	NR
7	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	5 @ 47	NR	NR	NR
	6	NR	NR	NR	NR	5 @ 42	NR	NR	NR	6 @ 43	5 @ 48	NR <sup>1</sup>	NR
	7	5 @ 46	NR	NR	NR	6 @ 42	5 @ 46	NR <sup>1</sup>	NR	6 @ 34	6 @ 48	NR	NR
8	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 38	NR <sup>1</sup>	NR	NR	5 @ 43	NR	NR	NR
	6	4 @ 37	NR <sup>1</sup>	NR	NR	5 @ 37	NR	NR	NR	6 @ 37	5 @ 43	NR <sup>1</sup>	NR
	7	5 @ 40	NR	NR	NR	6 @ 37	5 @ 41	NR <sup>1</sup>	NR	6 @ 34	6 @ 43	NR	NR
	8	6 @ 43	5 @ 47	NR <sup>1</sup>	NR	6 @ 34	6 @ 43	NR	NR	6 @ 27	6 @ 32	6 @ 44	NR
9	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 35	NR <sup>1</sup>	NR	NR	5 @ 40	NR	NR	NR
	6	4 @ 34	NR <sup>1</sup>	NR	NR	6 @ 48	NR	NR	NR	6 @ 36	6 @ 39	NR <sup>1</sup>	NR
	7	5 @ 36	NR	NR	NR	6 @ 34	5 @ 37	NR	NR	6 @ 33	6 @ 38	5 @ 37	NR <sup>1</sup>
	8	6 @ 38	5 @ 41	NR <sup>1</sup>	NR	6 @ 33	6 @ 38	5 @ 37	NR <sup>1</sup>	6 @ 24	6 @ 29	6 @ 39	4 @ 48 <sup>m</sup>
	9	6 @ 34	6 @ 46	NR	NR	6 @ 26	6 @ 30	6 @ 41	NR	6 @ 19	6 @ 23	6 @ 30	6 @ 39
10	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 33	NR <sup>1</sup>	NR	NR	5 @ 38	NR	NR	NR
	6	5 @ 48	NR <sup>1</sup>	NR	NR	6 @ 45	NR	NR	NR	6 @ 34	5 @ 37	NR	NR
	7	6 @ 47	NR	NR	NR	6 @ 34	6 @ 48	NR	NR	6 @ 30	6 @ 35	6 @ 48	NR <sup>1</sup>
	8	6 @ 34	5 @ 38	NR	NR	6 @ 30	6 @ 34	6 @ 47	NR <sup>1</sup>	6 @ 22	6 @ 26	6 @ 35	6 @ 45 <sup>m</sup>
	9	6 @ 34	6 @ 41	4 @ 48	NR <sup>1</sup>	6 @ 23	6 @ 27	6 @ 35	4 @ 48 <sup>m</sup>	DR	6 @ 22	6 @ 27	6 @ 34
	10	6 @ 28	6 @ 33	6 @ 45	NR	DR <sup>j</sup>	6 @ 23	6 @ 29	6 @ 38	DR	6 @ 22	6 @ 22	6 @ 28

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R404.1.3.3.7.6 and Table R404.1.2(9).
- NR indicates vertical wall reinforcement is not required, except for 6-inch nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.
- Allowable deflection criterion is  $L/240$ , where  $L$  is the unsupported height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- Vertical reinforcement shall be located to provide a cover of  $1\frac{1}{4}$  inches measured from the inside face of the wall shall be not less than  $\frac{3}{4}$  inch. The center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness or  $\frac{3}{8}$  inch.
- Concrete cover for reinforcement measured from the inside face of the wall shall be not less than  $\frac{3}{4}$  inch. Concrete cover for reinforcement measured from the outside face of the wall shall be not less than  $1\frac{1}{2}$  inches for No. 5 bars and smaller, and not less than 2 inches for larger bars.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- Concrete shall have a specified compressive strength,  $f'_c$ , of not less than 2,500 psi at 28 days, unless a higher strength is required by Note 1 or m.
- The minimum thickness is permitted to be reduced 2 inches, provided that the minimum specified compressive strength of concrete,  $f'_c$ , is 4,000 psi.
- A plain concrete wall with a minimum nominal thickness of 12 inches is permitted, provided that the minimum specified compressive strength of concrete,  $f'_c$ , is 3,500 psi.
- See Table R608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.

## FOUNDATIONS

**TABLE R404.1.2(9)**  
**MINIMUM SPACING FOR ALTERNATE BAR SIZE AND ALTERNATE GRADE OF STEEL<sup>a, b, c</sup>**

BAR SPACING FROM APPLICABLE TABLE IN SECTION R404.1.3.2 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION R404.1.3.2														
	#4					#5					#6				
	Alternate bar size and alternate grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternate bar size and alternate grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

For SI: 1 inch = 25.4 mm.

- a. This table is for use with tables in Section R404.1.3.2 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section R404.1.3.2 is based on Grade 60 steel reinforcement.
- b. Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.
- c. For Grade 50 steel bars (ASTM A996, Type R), use spacing for Grade 40 bars or interpolate between Grades 40 and 60.

**R404.1.2.1 Masonry foundation walls.** *Concrete masonry* and *clay masonry* foundation walls shall be constructed as set forth in Table R404.1.1(1), R404.1.1(2), R404.1.1(3) or R404.1.1(4) and shall comply with applicable provisions of Section R606. In buildings assigned to *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, *concrete masonry* and *clay masonry* foundation walls shall also comply with Section R404.1.4.1. Rubble stone masonry foundation walls shall be constructed in accordance with Sections R404.1.8 and R606.4.2. Rubble stone masonry walls shall not be used in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, or in *townhouses* in Seismic Design Category C.

**R404.1.3 Concrete foundation walls.** Concrete foundation walls that support light-frame walls shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are within the applicability limits of Section R608.2 shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are not within the applicability limits of Section R608.2 shall be designed and constructed in accordance with the provisions of ACI 318, ACI 332 or PCA 100. Where ACI 318, ACI 332, PCA 100 or the provisions of this section are used to design concrete foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

**R404.1.3.1 Concrete cross section.** Concrete walls constructed in accordance with this code shall comply with the shapes and minimum concrete cross-sectional dimensions required by Table R608.3. Other types of forming systems resulting in concrete walls not in compliance with this section and Table R608.3 shall be designed in accordance with ACI 318.

**R404.1.3.2 Reinforcement for foundation walls.** Concrete foundation walls shall be laterally supported at the top and bottom. Horizontal reinforcement shall be provided in accordance with Table R404.1.2(1). Vertical reinforcement shall be provided in accordance with Table R404.1.2(2), R404.1.2(3), R404.1.2(4), R404.1.2(5), R404.1.2(6), R404.1.2(7) or R404.1.2(8). Vertical reinforcement for flat *basement* walls retaining 4 feet (1219 mm) or more of unbalanced backfill is permitted to be determined in accordance with Table R404.1.2(9). For *basement* walls supporting above-grade concrete walls, vertical reinforcement shall be the greater of that required by Tables R404.1.2(2) through R404.1.2(8) or by Section R608.6 for the above-grade wall. In buildings assigned to Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, concrete foundation walls shall also comply with Section R404.1.4.2.

**R404.1.3.2.1 Concrete foundation stem walls supporting above-grade concrete walls.** Founda-

tion stem walls that support above-grade concrete walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground shall comply with this section. Where unbalanced backfill retained by the stem wall is less than or equal to 18 inches (457 mm), the stem wall and above-grade wall it supports shall be provided with vertical reinforcement in accordance with Section R608.6 and Table R608.6(1), R608.6(2) or R608.6(3) for above-grade walls. Where unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the stem wall and above-grade wall it supports shall be provided with vertical reinforcement in accordance with Section R608.6 and Table R608.6(1).
2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be vertically reinforced in accordance with Section R608.6 and Table R608.6(1), R608.6(2) or R608.6(3) for above-grade walls. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall shall be designed in accordance with PCA 100 or with accepted engineering practice. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the minimum nominal thickness of the wall shall be 6 inches (152 mm).

**R404.1.3.2.2 Concrete foundation stem walls supporting light-frame above-grade walls.** Concrete foundation stem walls that support light-frame above-grade walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground and retain 48 inches (1219 mm) or less of unbalanced fill, measured from the top of the wall, shall be constructed in accordance with Section R404.1.3. Foundation stem walls that retain more than 48 inches (1219 mm) of unbalanced fill, measured from the top of the wall, shall be designed in accordance with Sections R404.1.1 and R404.4.



## FOUNDATIONS

2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be constructed in accordance with Section R404.1.3. Where the unbalanced backfill retained by the stem wall is greater than 48 inches (1219 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall, shall be designed in accordance with PCA 100 or in accordance with accepted engineering practice.

**R404.1.3.3 Concrete, materials for concrete, and forms.** Materials used in concrete, the concrete itself and forms shall conform to requirements of this section or ACI 318.

**R404.1.3.3.1 Compressive strength.** The minimum specified compressive strength of concrete,  $f'_c$ , shall comply with Section R402.2 and shall be not less than 2,500 psi (17.2 MPa) at 28 days in buildings assigned to Seismic Design Category A, B or C and 3,000 psi (20.5 MPa) in buildings assigned to Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>.

**R404.1.3.3.2 Concrete mixing and delivery.** Mixing and delivery of concrete shall comply with ASTM C94 or ASTM C685.

**R404.1.3.3.3 Maximum aggregate size.** The nominal maximum size of coarse aggregate shall not exceed one-fifth the narrowest distance between sides of forms, or three-fourths the clear spacing between reinforcing bars or between a bar and the side of the form.

**Exception:** Where *approved*, these limitations shall not apply where removable forms are used and workability and methods of consolidation permit concrete to be placed without honeycombs or voids.

**R404.1.3.3.4 Proportioning and slump of concrete.** Proportions of materials for concrete shall be established to provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding. Slump of concrete placed in removable forms shall not exceed 6 inches (152 mm).

**Exception:** Where *approved*, the slump is permitted to exceed 6 inches (152 mm) for concrete mixtures that are resistant to segregation, and are in accordance with the form manufacturer's recommendations.

Slump of concrete placed in stay-in-place forms shall exceed 6 inches (152 mm). Slump of concrete shall be determined in accordance with ASTM C143.

**R404.1.3.3.5 Consolidation of concrete.** Concrete shall be consolidated by suitable means during placement and shall be worked around embedded items and reinforcement and into corners of forms. Where stay-in-place forms are used, concrete shall be consolidated by internal vibration.

**Exception:** Where *approved* for concrete to be placed in stay-in-place forms, self-consolidating concrete mixtures with slumps equal to or greater than 8 inches (203 mm) that are specifically designed for placement without internal vibration need not be internally vibrated.

**R404.1.3.3.6 Form materials and form ties.** Forms shall be made of wood, steel, aluminum, plastic, a composite of cement and foam insulation, a composite of cement and wood chips, or other *approved* material suitable for supporting and containing concrete. Forms shall be accurately positioned and secured before placing concrete and shall provide sufficient strength to contain concrete during the concrete placement operation.

Form ties shall be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the forces created by fluid pressure of fresh concrete.

**R404.1.3.3.6.1 Stay-in-place forms.** Stay-in-place concrete forms shall comply with this section.

1. Surface burning characteristics. The flame-spread index and *smoke-developed index* of forming material, other than foam plastic, left exposed on the interior shall comply with Section R302. The surface burning characteristics of foam plastic used in *insulating concrete forms* shall comply with Section R316.3.
2. Interior covering. Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Section R316. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives in addition to mechanical fasteners is permitted.
3. Exterior wall covering. Stay-in-place forms constructed of rigid foam plastics shall be protected from sunlight and physical damage by the application of an *approved* exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.
4. Termite protection. In areas where the probability of termite infestation is "very heavy" as indicated by Table R301.2 or

Figure R301.2.1, foam plastic insulation shall be permitted below grade on foundation walls in accordance with Section R318.4.

5. Flat ICF wall system forms shall conform to ASTM E2634.

#### **R404.1.3.3.7 Reinforcement.**

**R404.1.3.3.7.1 Steel reinforcement.** Steel reinforcement shall comply with the requirements of ASTM A615, A706M or A996. ASTM A996 bars produced from rail steel shall be Type R. In buildings assigned to Seismic Design Category A, B or C, the minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). In buildings assigned to Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, the minimum yield strength shall be 60,000 psi (Grade 60) (414 MPa).

**R404.1.3.3.7.2 Location of reinforcement in wall.** The center of vertical reinforcement in *basement* walls determined from Tables R404.1.2(2) through R404.1.2(7) shall be located at the centerline of the wall. Vertical reinforcement in *basement* walls determined from Table R404.1.2(8) shall be located to provide a maximum cover of 1<sup>1</sup>/<sub>4</sub> inches (32 mm) measured from the inside face of the wall. Regardless of the table used to determine vertical wall reinforcement, the center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness and 3<sup>1</sup>/<sub>8</sub> inch (10 mm). Horizontal and vertical reinforcement shall be located in foundation walls to provide the minimum cover required by Section R404.1.3.3.7.4.

**R404.1.3.3.7.3 Wall openings.** Vertical wall reinforcement required by Section R404.1.3.2 that is interrupted by wall openings shall have additional vertical reinforcement of the same size placed within 12 inches (305 mm) of each side of the opening.

**R404.1.3.3.7.4 Support and cover.** Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system to prevent displacement during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (75 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be 1<sup>1</sup>/<sub>2</sub> inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be 3<sup>1</sup>/<sub>4</sub> inch (19 mm). The minus tolerance for cover shall not

exceed the smaller of one-third the required cover or 3<sup>1</sup>/<sub>8</sub> inch (10 mm).

**R404.1.3.3.7.5 Lap splices.** Vertical and horizontal wall reinforcement shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splice shall be in accordance with Table R608.5.4(1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm) [See Figure R608.5.4(1)].

**R404.1.3.3.7.6 Alternate grade of reinforcement and spacing.** Where tables in Section R404.1.3.2 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (414 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided that an equivalent area of steel per linear foot of wall is provided. Use of Table R404.1.2(9) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables or bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

**R404.1.3.3.7.7 Standard hooks.** Where reinforcement is required by this code to terminate with a standard hook, the hook shall comply with Section R608.5.4.5 and Figure R608.5.4(3).

**R404.1.3.3.7.8 Construction joint reinforcement.** Construction joints in foundation walls shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Sections R404.1.3.2 and R404.1.4.2, shall be located at points of lateral support, and not fewer than one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have not less than 12 inches (305 mm) embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

**Exception:** Use of vertical wall reinforcement required by this code is permitted in lieu of construction joint reinforcement provided that the spacing does not exceed 24 inches (610 mm), or the combination of wall reinforcement and No. 4 bars described in this section does not exceed 24 inches (610 mm).

**R404.1.3.3.8 Exterior wall coverings.** Requirements for installation of masonry veneer, stucco and

## FOUNDATIONS

other wall coverings on the exterior of concrete walls and other construction details not covered in this section shall comply with the requirements of this code.

**R404.1.3.4 Requirements for Seismic Design Category C.** Concrete foundation walls supporting above-grade concrete walls in *townhouses* assigned to Seismic Design Category C shall comply with ACI 318, ACI 332 or PCA 100 (see Section R404.1.3).

### R404.1.4 Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>.

**R404.1.4.1 Masonry foundation walls.** In buildings assigned to Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, as established in Table R301.2, masonry foundation walls shall comply with this section. In addition to the requirements of Table R404.1.1(1), plain masonry foundation walls shall comply with the following:

1. Wall height shall not exceed 8 feet (2438 mm).
2. Unbalanced backfill height shall not exceed 4 feet (1219 mm).
3. Minimum nominal thickness for plain masonry foundation walls shall be 8 inches (203 mm).
4. Masonry stem walls shall have a minimum vertical reinforcement of one No. 4 (No. 13) bar located not greater than 4 feet (1219 mm) on center in grouted cells. Vertical reinforcement shall be tied to the horizontal reinforcement in the footings.

Foundation walls, supporting more than 4 feet (1219 mm) of unbalanced backfill or exceeding 8 feet (2438 mm) in height shall be constructed in accordance with Table R404.1.1(2), R404.1.1(3) or R404.1.1(4). Masonry foundation walls shall have two No. 4 (No. 13) horizontal bars located in the upper 12 inches (305 mm) of the wall.

**R404.1.4.2 Concrete foundation walls.** In buildings assigned to Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, as established in Table R301.2, concrete foundation walls that support light-frame walls shall comply with this section, and concrete foundation walls that support above-grade concrete walls shall comply with ACI 318, ACI 332 or PCA 100 (see Section R404.1.3). In addition to the horizontal reinforcement required by Table R404.1.2(1), plain concrete walls supporting light-frame walls shall comply with the following:

1. Wall height shall not exceed 8 feet (2438 mm).
2. Unbalanced backfill height shall not exceed 4 feet (1219 mm).
3. Minimum thickness for plain concrete foundation walls shall be 7.5 inches (191 mm) except that 6 inches (152 mm) is permitted where the maximum wall height is 4 feet 6 inches (1372 mm).

Foundation walls less than 7.5 inches (191 mm) in thickness, supporting more than 4 feet (1219 mm) of unbalanced backfill or exceeding 8 feet (2438 mm) in height shall be provided with horizontal reinforcement

in accordance with Table R404.1.2(1), and vertical reinforcement in accordance with Table R404.1.2(2), R404.1.2(3), R404.1.2(4), R404.1.2(5), R404.1.2(6), R404.1.2(7) or R404.1.2(8). Where Tables R404.1.2(2) through R404.1.2(8) permit plain concrete walls, not less than No. 4 (No. 13) vertical bars at a spacing not exceeding 48 inches (1219 mm) shall be provided.

**R404.1.5 Foundation wall thickness based on walls supported.** The thickness of masonry or concrete foundation walls shall be not less than that required by Section R404.1.5.1 or R404.1.5.2, respectively.

**R404.1.5.1 Masonry wall thickness.** Masonry foundation walls shall be not less than the thickness of the wall supported, except that masonry foundation walls of not less than 8-inch (203 mm) nominal thickness shall be permitted under brick veneered frame walls and under 10-inch-wide (254 mm) cavity walls where the total height of the wall supported, including gables, is not more than 20 feet (6096 mm), provided that the requirements of Section R404.1.1 are met.

**R404.1.5.2 Concrete wall thickness.** The thickness of concrete foundation walls shall be equal to or greater than the thickness of the wall in the story above. Concrete foundation walls with corbels, brackets or other projections built into the wall for support of masonry veneer or other purposes are not within the scope of the tables in this section.

Where a concrete foundation wall is reduced in thickness to provide a shelf for the support of masonry veneer, the reduced thickness shall be equal to or greater than the thickness of the wall in the story above. Vertical reinforcement for the foundation wall shall be based on Table R404.1.2(8) and located in the wall as required by Section R404.1.3.3.7.2 where that table is used. Vertical reinforcement shall be based on the thickness of the thinner portion of the wall.

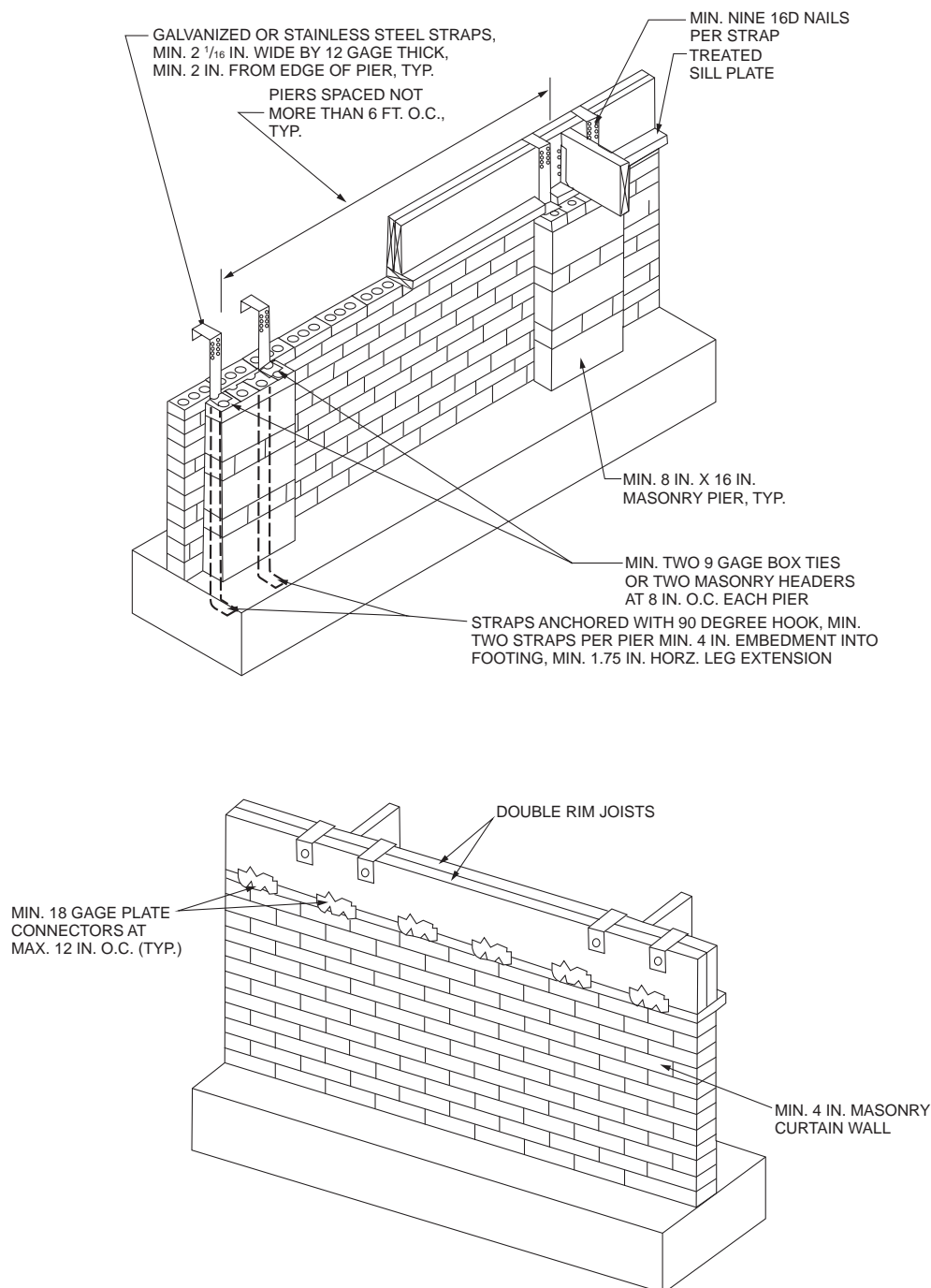
**Exception:** Where the height of the reduced thickness portion measured to the underside of the floor assembly or sill plate above is less than or equal to 24 inches (610 mm) and the reduction in thickness does not exceed 4 inches (102 mm), the vertical reinforcement is permitted to be based on the thicker portion of the wall.

**R404.1.5.3 Pier and curtain wall foundations.** Use of pier and curtain wall foundations shall be permitted to support *light-frame construction* not more than two *stories* in height, provided that the following requirements are met:

1. All *load-bearing walls* shall be placed on continuous concrete footings placed integrally with the exterior wall footings.
2. The minimum actual thickness of a load-bearing masonry wall shall be not less than 4 inches (102 mm) nominal or  $3\frac{3}{8}$  inches (92 mm) actual thickness, and shall be bonded integrally

## FOUNDATIONS

- with piers spaced in accordance with Section R606.6.4.
3. Piers shall be constructed in accordance with Sections R606.7 and R606.7.1, and shall be bonded into the load-bearing masonry wall in accordance with Section R606.13.1 or R606.13.1.1.
  4. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood-frame walls and floors shall be not more than 4 feet (1219 mm).
  5. Anchorage shall be in accordance with Section R403.1.6, Figure R404.1.5.3, or as specified by engineered design accepted by the *building official*.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

**FIGURE R404.1.5.3**  
**FOUNDATION WALL CLAY MASONRY CURTAIN WALL WITH CONCRETE MASONRY PIERS**



## FOUNDATIONS

6. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for *solid masonry* or 12 inches (305 mm) for *hollow masonry*.
7. In *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, prescriptive reinforcement shall be provided in the horizontal and vertical direction. Provide minimum horizontal joint reinforcement of two No. 9 gage wires spaced not less than 6 inches (152 mm) or one 1/4-inch-diameter (6.4 mm) wire at 10 inches (254 mm) on center vertically. Provide minimum vertical reinforcement of one No. 4 bar at 48 inches (1220 mm) on center horizontally grouted in place.

**R404.1.6 Height above finished grade.** Concrete and masonry foundation walls shall extend above the finished *grade* adjacent to the foundation at all points not less than 4 inches (102 mm) where masonry veneer is used and not less than 6 inches (152 mm) elsewhere.

**R404.1.7 Backfill placement.** Backfill shall not be placed against the wall until the wall has sufficient strength and has been anchored to the floor above, or has been sufficiently braced to prevent damage by the backfill.

**Exception:** Bracing is not required for walls supporting less than 4 feet (1219 mm) of unbalanced backfill.

**R404.1.8 Rubble stone masonry.** Rubble stone masonry foundation walls shall have a minimum thickness of 16 inches (406 mm), shall not support an unbalanced backfill exceeding 8 feet (2438 mm) in height, shall not support a soil pressure greater than 30 pounds per square foot per foot (4.71 kPa/m), and shall not be constructed in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub>, D<sub>2</sub> or *townhouses* in Seismic Design Category C, as established in Figure R301.2(2).

**R404.1.9 Isolated masonry piers.** Isolated masonry piers shall be constructed in accordance with this section and the general masonry construction requirements of Section R606. *Hollow masonry* piers shall have a minimum nominal thickness of 8 inches (203 mm), with a nominal height not exceeding four times the nominal thickness and a nominal length not exceeding three times the nominal thickness. Where *hollow masonry units* are solidly filled with concrete or grout, piers shall be permitted to have a nominal height not exceeding ten times the nominal thickness. Footings for isolated masonry piers shall be sized in accordance with Section R403.1.1.

**R404.1.9.1 Pier cap.** *Hollow masonry* piers shall be capped with 4 inches (102 mm) of *solid masonry* or concrete, a masonry cap block, or shall have cavities of the top course filled with concrete or grout. Where required, termite protection for the pier cap shall be provided in accordance with Section R318.

**R404.1.9.2 Masonry piers supporting floor girders.** Masonry piers supporting wood girders sized in accordance with Tables R602.7(1) and R602.7(2) shall be permitted in accordance with this section. Piers supporting girders for interior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm)

and a maximum height of 10 feet (3048 mm) from top of footing to bottom of sill plate or girder. Piers supporting girders for exterior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 4 feet (1220 mm) from top of footing to bottom of sill plate or girder. Girders and sill plates shall be anchored to the pier or footing in accordance with Section R403.1.6 or Figure R404.1.5.3. Floor girder bearing shall be in accordance with Section R502.6.

**R404.1.9.3 Masonry piers supporting braced wall panels.** Masonry piers supporting *braced wall panels* shall be designed in accordance with accepted engineering practice.

**R404.1.9.4 Seismic design of masonry piers.** Masonry piers in *dwelling*s located in Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, and *townhouses* in Seismic Design Category C, shall be designed in accordance with accepted engineering practice.

**R404.1.9.5 Masonry piers in flood hazard areas.** Masonry piers for *dwelling*s in flood hazard areas shall be designed in accordance with Section R322.

**R404.2 Wood foundation walls.** Wood foundation walls shall be constructed in accordance with the provisions of Sections R404.2.1 through R404.2.6 and with the details shown in Figures R403.1(2) and R403.1(3).

**R404.2.1 Identification.** Load-bearing lumber shall be identified by the grade *mark* of a lumber grading or inspection agency that has been *approved* by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted. *Wood structural panels* shall conform to DOC PS 1 or DOC PS 2 and shall be identified by a grade *mark* or certificate of inspection issued by an *approved agency*.

**R404.2.2 Stud size.** The studs used in foundation walls shall be 2-inch by 6-inch (51 mm by 152 mm) members. Where spaced 16 inches (406 mm) on center, a wood species with an  $F_b$  value of not less than 1,250 pounds per square inch (8619 kPa) as *listed* in ANSI AWC NDS shall be used. Where spaced 12 inches (305 mm) on center, an  $F_b$  of not less than 875 psi (6033 kPa) shall be required.

**R404.2.3 Height of backfill.** For wood foundations that are not designed and installed in accordance with AWC PWF, the height of backfill against a foundation wall shall not exceed 4 feet (1219 mm). Where the height of fill is more than 12 inches (305 mm) above the interior grade of a *crawl space* or floor of a *basement*, the thickness of the plywood sheathing shall meet the requirements of Table R404.2.3.

**R404.2.4 Backfilling.** Wood foundation walls shall not be backfilled until the *basement* floor and first floor have been constructed or the walls have been braced. For *crawl space* construction, backfill or bracing shall be installed on the interior of the walls prior to placing backfill on the exterior.

**TABLE R404.2.3**  
**PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION (30 pcf equivalent-fluid weight soil pressure)**

HEIGHT OF FILL (inches)	STUD SPACING (inches)	FACE GRAIN ACROSS STUDS			FACE GRAIN PARALLEL TO STUDS		
		Grade <sup>a</sup>	Minimum thickness (inches)	Span rating	Grade <sup>a</sup>	Minimum thickness (inches) <sup>b, c</sup>	Span rating
24	12	B	$\frac{15}{32}$	32/16	A	$\frac{15}{32}$	32/16
					B	$\frac{15}{32}^c$	32/16
	16	B	$\frac{15}{32}$	32/16	A	$\frac{15}{32}^c$	32/16
					B	$\frac{19}{32}^c$ (4, 5 ply)	40/20
36	12	B	$\frac{15}{32}$	32/16	A	$\frac{15}{32}$	32/16
					B	$\frac{15}{32}^c$ (4, 5 ply)	32/16
					B	$\frac{19}{32}^c$ (4, 5 ply)	40/20
	16	B	$\frac{15}{32}^c$	32/16	A	$\frac{19}{32}$	40/20
					B	$\frac{23}{32}$	48/24
48	12	B	$\frac{15}{32}$	32/16	A	$\frac{15}{32}^c$	32/16
					B	$\frac{19}{32}^c$ (4, 5 ply)	40/20
	16	B	$\frac{19}{32}$	40/20	A	$\frac{19}{32}^c$	40/20
					A	$\frac{23}{32}$	48/24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Plywood shall be of the following minimum grades in accordance with DOC PS 1 or DOC PS 2:

1. DOC PS 1 Plywood grades marked:
  - 1.1. Structural I C-D (Exposure 1).
  - 1.2. C-D (Exposure 1).

2. DOC PS 2 Plywood grades marked:
  - 2.1. Structural I Sheathing (Exposure 1).
  - 2.2. Sheathing (Exposure 1).

3. Where a major portion of the wall is exposed above ground and a better appearance is desired, the following plywood grades marked exterior are suitable:

- 3.1. Structural I A-C, Structural I B-C or Structural I C-C (Plugged) in accordance with DOC PS 1.
- 3.2. A-C Group 1, B-C Group 1, C-C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS 1.
- 3.3. Single Floor in accordance with DOC PS 1 or DOC PS 2.

b. Minimum thickness  $\frac{15}{32}$  inch, except crawl space sheathing shall have not less than  $\frac{3}{8}$  inch for face grain across studs 16 inches on center and maximum 2-foot depth of unequal fill.

c. For this fill height, thickness and grade combination, panels that are continuous over less than three spans (across less than three stud spacings) require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through studs with two 16d corrosion-resistant nails at each end.

**R404.2.5 Drainage and dampproofing.** Wood foundation *basements* shall be drained and dampproofed in accordance with Sections R405 and R406, respectively.

**R404.2.6 Fastening.** Wood structural panel foundation wall sheathing shall be attached to framing in accordance with Table R602.3(1) and Section R402.1.1.

**R404.3 Wood sill plates.** Wood sill plates shall be not less than 2-inch by 4-inch (51 mm by 102 mm) nominal lumber. Sill plate anchorage shall be in accordance with Sections R403.1.6 and R602.1.1.

**R404.4 Retaining walls.** Retaining walls that are not laterally supported at the top and that retain in excess of 48 inches (1219 mm) of unbalanced fill, or retaining walls exceeding 24 inches (610 mm) in height that resist lateral loads in addition to soil, shall be designed in accordance with accepted engineering practice to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning. This

section shall not apply to foundation walls supporting buildings.

#### **R404.5 Precast concrete foundation walls.**

**R404.5.1 Design.** Precast concrete foundation walls shall be designed in accordance with accepted engineering practice. The design and manufacture of *precast concrete* foundation wall panels shall comply with the materials requirements of Section R402.3 or ACI 318. The panel design drawings shall be prepared by a *registered design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1.

**R404.5.2 Precast concrete foundation design drawings.** Precast concrete foundation wall design drawings shall be submitted to the *building official* and *approved* prior to installation. Drawings shall include, at a minimum, the following information:

1. Design loading as applicable.
2. Footing design and material.

## FOUNDATIONS

3. Concentrated loads and their points of application.
4. Soil bearing capacity.
5. Maximum allowable total uniform load.
6. Seismic design category.
7. Basic wind speed.

**R404.5.3 Identification.** *Precast concrete* foundation wall panels shall be identified by a certificate of inspection *label* issued by an *approved* third-party inspection agency.

### SECTION R405 FOUNDATION DRAINAGE

**R405.1 Concrete or masonry foundations.** Drains shall be provided around concrete or masonry foundations that retain earth and enclose habitable or usable spaces located below *grade*. Drainage tiles, gravel or crushed stone drains, perforated pipe or other *approved* systems or materials shall be installed at or below the top of the footing or below the bottom of the slab and shall discharge by gravity or mechanical means into an *approved* drainage system. Gravel or

crushed stone drains shall extend not less than 1 foot (305 mm) beyond the outside edge of the footing and 6 inches (152 mm) above the top of the footing and be covered with an *approved* filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper. Except where otherwise recommended by the drain manufacturer, perforated drains shall be surrounded with an *approved* filter membrane or the filter membrane shall cover the washed gravel or crushed rock covering the drain. Drainage tiles or perforated pipe shall be placed on not less than 2 inches (51 mm) of washed gravel or crushed rock not less than one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches (152 mm) of the same material.

**Exception:** A drainage system is not required where the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I soils, as detailed in Table R405.1.

**R405.1.1 Precast concrete foundation.** *Precast concrete* walls that retain earth and enclose habitable or useable space located below-*grade* that rest on crushed stone

TABLE R405.1  
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS <sup>a</sup>	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION <sup>b</sup>
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

- a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.
- b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

footings shall have a perforated drainage pipe installed below the base of the wall on either the interior or exterior side of the wall, not less than 1 foot (305 mm) beyond the edge of the wall. If the exterior drainage pipe is used, an *approved* filter membrane material shall cover the pipe. The drainage system shall discharge into an *approved* sewer system or to daylight.

**R405.2 Wood foundations.** Wood foundations enclosing habitable or usable spaces located below *grade* shall be adequately drained in accordance with Sections R405.2.1 through R405.2.3.

**R405.2.1 Base.** A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of 4 inches (102 mm) under the *basement* floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

**R405.2.2 Vapor retarder.** A 6-mil-thick (0.15 mm) polyethylene vapor retarder shall be applied over the porous layer with the *basement* floor constructed over the polyethylene.

**R405.2.3 Drainage system.** In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be not less than 24 inches (610 mm) in diameter or 20 inches square (0.0129 m<sup>2</sup>), shall extend not less than 24 inches (610 mm) below the bottom of the *basement* floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. The drainage system shall discharge into an *approved* sewer system or to daylight.

## SECTION R406 FOUNDATION WATERPROOFING AND DAMPPOOFING

**R406.1 Concrete and masonry foundation dampproofing.** Except where required by Section R406.2 to be waterproofed, foundation walls that retain earth and enclose interior spaces and floors below *grade* shall be dampproofed from the finished grade to the higher of the top of the footing or 6 inches (152 mm) below the top of the basement floor. Masonry walls shall have not less than  $\frac{3}{8}$ -inch (9.5 mm) Portland cement parging applied to the exterior of the wall. The parging shall be dampproofed in accordance with one of the following:

1. Bituminous coating.
2. Three pounds per square yard (1.63 kg/m<sup>2</sup>) of acrylic modified cement.
3. One-eighth-inch (3.2 mm) coat of surface-bonding cement complying with ASTM C887.
4. Any material permitted for waterproofing in Section R406.2.
5. Other *approved* methods or materials.

**Exception:** Parging of unit masonry walls is not required where a material is *approved* for direct application to the masonry.

Concrete walls shall be dampproofed by applying any one of the listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.

**R406.2 Concrete and masonry foundation waterproofing.** In areas where a high water table or other severe soil-water conditions are known to exist, exterior foundation walls that retain earth and enclose interior spaces and floors below *grade* shall be waterproofed from the finished *grade* to the higher of the top of the footing or 6 inches (152 mm) below the top of the basement floor. Walls shall be waterproofed in accordance with one of the following:

1. Two-ply hot-mopped felts.
2. Fifty-five-pound (25 kg) roll roofing.
3. Forty-mil (1 mm) polymer-modified asphalt.
4. Sixty-mil (1.5 mm) flexible polymer cement.
5. One-eighth-inch (3 mm) cement-based, fiber-reinforced, waterproof coating.
6. Sixty-mil (1.5 mm) solvent-free liquid-applied synthetic rubber.

All joints in membrane waterproofing shall be lapped and sealed with an adhesive compatible with the membrane.

**Exception:** Organic-solvent-based products such as hydrocarbons, chlorinated hydrocarbons, ketones and esters shall not be used for ICF walls with expanded polystyrene form material. Use of plastic roofing cements, acrylic coatings, latex coatings, mortars and pargings to seal ICF walls is permitted. Cold-setting asphalt or hot asphalt shall conform to Type C of ASTM D449. Hot asphalt shall be applied at a temperature of less than 200°F (93°C).

**R406.3 Dampproofing for wood foundations.** Wood foundations enclosing habitable or usable spaces located below *grade* shall be dampproofed in accordance with Sections R406.3.1 through R406.3.4.

**R406.3.1 Panel joint sealed.** Plywood panel joints in the foundation walls shall be sealed full length with a caulking compound capable of producing a moistureproof seal under the conditions of temperature and moisture content at which it will be applied and used.

**R406.3.2 Below-grade moisture barrier.** A 6-mil-thick (0.15 mm) polyethylene film shall be applied over the below-*grade* portion of exterior foundation walls prior to backfilling. Joints in the polyethylene film shall be lapped 6 inches (152 mm) and sealed with adhesive. The top edge of the polyethylene film shall be bonded to the sheathing to form a seal. Film areas at *grade* level shall be protected from mechanical damage and exposure by a pressure-preservative treated lumber or plywood strip attached to the wall several inches above finished *grade* level and extending approximately 9 inches (229 mm) below *grade*. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Where *approved*, other coverings appropriate to the architectural treatment shall be permitted to be used. The polyethylene film shall extend down to the bottom of



## FOUNDATIONS

the wood footing plate but shall not overlap or extend into the gravel or crushed stone footing.

**R406.3.3 Porous fill.** The space between the excavation and the foundation wall shall be backfilled with the same material used for footings, up to a height of 1 foot (305 mm) above the footing for well-drained sites, or one-half the total backfill height for poorly drained sites. The porous fill shall be covered with strips of 30-pound (13.6 kg) asphalt paper or 6-mil (0.15 mm) polyethylene to permit water seepage while avoiding infiltration of fine soils.

**R406.3.4 Backfill.** The remainder of the excavated area shall be backfilled with the same type of soil as was removed during the excavation.

**R406.4 Precast concrete foundation system dampproofing.** Except where required by Section R406.2 to be waterproofed, *precast concrete* foundation walls enclosing habitable or useable spaces located below *grade* shall be dampproofed in accordance with Section R406.1.

**R406.4.1 Panel joints sealed.** *Precast concrete* foundation panel joints shall be sealed full height with a sealant meeting ASTM C920, Type S or M, Grade NS, Class 25, Use NT, M or A. Joint sealant shall be installed in accordance with the manufacturer's instructions.

## SECTION R407 COLUMNS

**R407.1 Wood column protection.** Wood columns shall be protected against decay as set forth in Section R317.

**R407.2 Steel column protection.** All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

**R407.3 Structural requirements.** The columns shall be restrained to prevent lateral displacement at the bottom end. Wood columns shall be not less in nominal size than 4 inches by 4 inches (102 mm by 102 mm). Steel columns shall be not less than 3-inch-diameter (76 mm) Schedule 40 pipe manufactured in accordance with ASTM A53/A53M Grade B or *approved* equivalent.

**Exception:** In *Seismic Design Categories A, B and C*, columns not more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within under-floor areas enclosed by a continuous foundation.

## SECTION R408 UNDER-FLOOR SPACE

**R408.1 Moisture control.** The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a *basement*) shall comply with Section R408.2 or R408.3.

**R408.2 Openings for under-floor ventilation.** Ventilation openings through foundation or exterior walls surrounding the under-floor space shall be provided in accordance with

this section. The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m<sup>2</sup>) for each 150 square feet (14 m<sup>2</sup>) of under-floor area. One ventilation opening shall be within 3 feet (915 mm) of each external corner of the under-floor space. Ventilation openings shall be covered for their height and width with any of the following materials provided that the least dimension of the covering shall not exceed 1/4 inch (6.4 mm), and operational louvers are permitted:

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grill or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant wire mesh, with the least dimension being 1/8 inch (3.2 mm) thick.

### Exceptions:

1. The total area of ventilation openings shall be permitted to be reduced to 1/1,500 of the under-floor area where the ground surface is covered with an *approved* Class I vapor retarder material.
2. Where the ground surface is covered with an *approved* Class I vapor retarder material, ventilation openings are not required to be within 3 feet (915 mm) of each external corner of the under-floor space provided that the openings are placed to provide cross ventilation of the space.

**R408.3 Unvented crawl space.** For unvented under-floor spaces, the following items shall be provided:

1. Exposed earth shall be covered with a continuous Class I vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.
2. The unvented crawl space is provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.02 cfm per square foot (0.00001 m<sup>3</sup>/s × m<sup>2</sup>) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent; alternatively, for crawl spaces, the mechanical exhaust shall be automatically controlled to operate when the absolute moisture content of the outside air is less than or equal to the moisture content in the served space but shall not operate when the outside temperature is below 32°F (0°C).

**R408.3.1 Supply air.** The use of a crawl space for a supply air plenum is prohibited.

**R408.4 Access.** Access shall be provided to all under-floor spaces. Access openings through the floor shall be not

smaller than 18 inches by 24 inches (457 mm by 610 mm). Openings through a perimeter wall shall be not less than 16 inches by 24 inches (407 mm by 610 mm). Where any portion of the through-wall access is below *grade*, an area-way not less than 16 inches by 24 inches (407 mm by 610 mm) shall be provided. The bottom of the areaway shall be below the threshold of the access opening. Through wall access openings shall not be located under a door to the residence. See Section M1305.1.3 for access requirements where mechanical *equipment* is located under floors.

**R408.5 Removal of debris.** The under-floor *grade* shall be cleaned of all vegetation and organic material. Wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. Construction materials shall be removed before a building is occupied or used for any purpose.

**R408.6 Finished grade.** The finished *grade* of under-floor surface shall be permitted to be located at the bottom of the footings; however, where there is evidence that the ground-water table can rise to within 6 inches (152 mm) of the finished floor at the building perimeter or where there is evidence that the surface water does not readily drain from the building site, the *grade* in the under-floor space shall be as high as the outside finished *grade*, unless an *approved* drainage system is provided.

**R408.7 Flood resistance.** For buildings located in flood hazard areas as established in Table R301.2:

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R322.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level on at least one side.

**Exception:** Under-floor spaces that meet the requirements of FEMA TB 11-1.

**R408.8 Under-floor vapor retarder.** In Climate Zones 1A, 2A and 3A below the warm-humid line, a continuous Class I or II vapor retarder shall be provided on the exposed face of air-permeable insulation installed between the floor joists and exposed to the grade in the under-floor space. The vapor retarder shall have a maximum water vapor permeance of 1.5 perms when tested in accordance with Procedure B of ASTM E96.

**Exception:** The vapor retarder shall not be required in unvented *crawl spaces* constructed in accordance with Section R408.3.



## CHAPTER 5

# FLOORS

### User note:

**About this chapter:** Chapter 5 provides the requirements for the design and construction of floor systems that will be capable of supporting minimum required design loads. This chapter covers wood floor framing, wood floors on the ground, cold-formed steel floor framing and concrete slabs on the ground. Allowable span tables are provided that greatly simplify the determination of joist, girder and sheathing sizes for raised floor systems of wood framing and cold-formed steel framing. This chapter also contains prescriptive requirements for wood-framed exterior decks and their attachment to the main building.

### SECTION R501 GENERAL

**R501.1 Application.** The provisions of this chapter shall control the design and construction of the floors for buildings, including the floors of attic spaces used to house mechanical or plumbing fixtures and *equipment*.

**R501.2 Requirements.** Floor construction shall be capable of accommodating all loads in accordance with Section R301 and of transmitting the resulting loads to the supporting structural elements.

### SECTION R502 WOOD FLOOR FRAMING

**R502.1 General.** Wood and wood-based products used for load-supporting purposes shall conform to the applicable provisions of this section.

**R502.1.1 Sawn lumber.** Sawn lumber shall be identified by a grade *mark* of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

**R502.1.1.1 Preservative-treated lumber.** Preservative treated dimension lumber shall be identified as required by Section R317.2.

**R502.1.1.2 End-jointed lumber.** *Approved* end-jointed lumber identified by a grade *mark* conforming to Section R502.1.1 shall be permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required elsewhere in this code to have a fire-resistance rating shall have the designation “Heat-Resistant Adhesive” or “HRA” included in its grade *mark*.

**R502.1.2 Prefabricated wood I-joists.** Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D5055.

**R502.1.3 Structural glued laminated timbers.** Glued laminated timbers shall be manufactured and identified as required in ANSI A190.1, ANSI 117 and ASTM D3737.

**R502.1.4 Structural log members.** Structural log members shall comply with the provisions of ICC 400.

**R502.1.5 Structural composite lumber.** Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

**R502.1.6 Cross-laminated timber.** Cross-laminated timber shall be manufactured and identified as required by ANSI/APA PRG 320.

**R502.1.7 Engineered wood rim board.** Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

**R502.2 Design and construction.** Floors shall be designed and constructed in accordance with the provisions of this chapter, Figure R502.2 and Sections R317 and R318 or in accordance with ANSI AWC NDS.

**R502.2.1 Framing at braced wall lines.** A load path for lateral forces shall be provided between floor framing and *braced wall panels* located above or below a floor, as specified in Section R602.10.8.

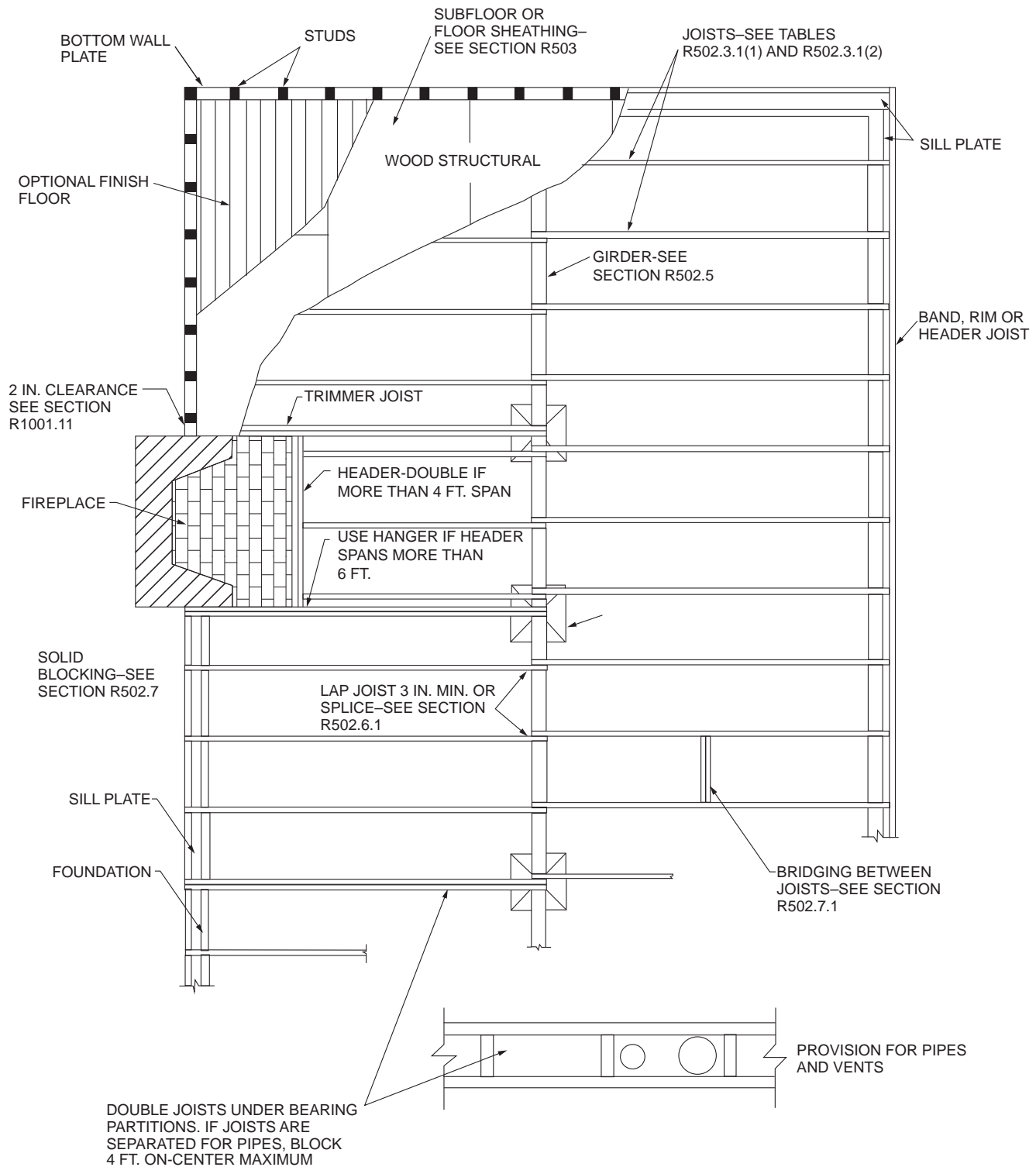
**R502.2.2 Blocking and subflooring.** Blocking for fastening panel edges or fixtures shall be not less than utility grade lumber. Subflooring shall be not less than utility grade lumber, No. 4 common grade boards or *wood structural panels* as specified in Section R503.2. Fire-blocking shall be of any grade lumber.

**R502.3 Allowable joist spans.** Spans for floor joists shall be in accordance with Tables R502.3.1(1) and R502.3.1(2). For other grades and species and for other loading conditions, refer to the AWC STJR.

**R502.3.1 Sleeping areas and attic joists.** Table R502.3.1(1) shall be used to determine the maximum allowable span of floor joists that support sleeping areas and *attics* that are accessed by means of a fixed *stairway* in accordance with Section R311.7 provided that the design *live load* does not exceed 30 pounds per square foot (1.44 kPa) and the design dead load does not exceed 20 pounds per square foot (0.96 kPa). The allowable span of ceiling joists that support *attics* used for limited storage or no storage shall be determined in accordance with Section R802.5.



## FLOORS



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R502.2**  
**FLOOR CONSTRUCTION**

## FLOORS

**TABLE R502.3.1(1)**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/Δ = 360)<sup>a</sup>**

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
12	Douglas fir-larch	SS	12-6	16-6	21-0	25-7	12-6	16-6	21-0	25-7
	Douglas fir-larch	#1	12-0	15-10	20-3	24-8	12-0	15-7	19-0	22-0
	Douglas fir-larch	#2	11-10	15-7	19-10	23-4	11-8	14-9	18-0	20-11
	Douglas fir-larch	#3	9-11	12-7	15-5	17-10	8-11	11-3	13-9	16-0
	Hem-fir	SS	11-10	15-7	19-10	24-2	11-10	15-7	19-10	24-2
	Hem-fir	#1	11-7	15-3	19-5	23-7	11-7	15-3	18-9	21-9
	Hem-fir	#2	11-0	14-6	18-6	22-6	11-0	14-4	17-6	20-4
	Hem-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Southern pine	SS	12-3	16-2	20-8	25-1	12-3	16-2	20-8	25-1
	Southern pine	#1	11-10	15-7	19-10	24-2	11-10	15-7	18-7	22-0
	Southern pine	#2	11-3	14-11	18-1	21-4	10-9	13-8	16-2	19-1
	Southern pine	#3	9-2	11-6	14-0	16-6	8-2	10-3	12-6	14-9
	Spruce-pine-fir	SS	11-7	15-3	19-5	23-7	11-7	15-3	19-5	23-7
	Spruce-pine-fir	#1	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#2	11-3	14-11	19-0	23-0	11-3	14-7	17-9	20-7
	Spruce-pine-fir	#3	9-8	12-4	15-0	17-5	8-8	11-0	13-5	15-7
16	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	21-4	10-8	13-6	16-5	19-1
	Douglas fir-larch	#2	10-9	14-2	17-5	20-3	10-1	12-9	15-7	18-1
	Douglas fir-larch	#3	8-7	10-11	13-4	15-5	7-8	9-9	11-11	13-10
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-1	10-6	13-4	16-3	18-10
	Hem-fir	#2	10-0	13-2	16-10	19-8	9-10	12-5	15-2	17-7
	Hem-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-4	10-9	13-9	16-1	19-1
	Southern pine	#2	10-3	13-3	15-8	18-6	9-4	11-10	14-0	16-6
	Southern pine	#3	7-11	10-0	11-1	14-4	7-1	8-11	10-10	12-10
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-4
	Spruce-pine-fir	#1	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#2	10-3	13-6	17-2	19-11	9-11	12-7	15-5	17-10
	Spruce-pine-fir	#3	8-5	10-8	13-0	15-1	7-6	9-6	11-8	13-6

(continued)

## FLOORS

**TABLE R502.3.1(1)—continued**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential sleeping areas, live load = 30 psf, L/Δ = 360)<sup>a</sup>**

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
19.2	Douglas fir-larch	SS	10-8	14-1	18-0	21-10	10-8	14-1	18-0	21-4
	Douglas fir-larch	#1	10-4	13-7	16-9	19-6	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	10-1	13-0	15-11	18-6	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-10	10-0	12-2	14-1	7-0	8-11	10-11	12-7
	Hem-fir	SS	10-1	13-4	17-0	20-8	10-1	13-4	17-0	20-7
	Hem-fir	#1	9-10	13-0	16-7	19-3	9-7	12-2	14-10	17-2
	Hem-fir	#2	9-5	12-5	15-6	17-1	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
	Southern pine	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Southern pine	#1	10-1	13-4	16-5	19-6	9-11	12-7	14-8	17-5
	Southern pine	#2	9-6	12-1	14-4	16-10	8-6	10-10	12-10	15-1
	Southern pine	#3	7-3	9-1	11-0	13-1	6-5	8-2	9-10	11-8
	Spruce-pine-fir	SS	9-10	13-0	16-7	20-2	9-10	13-0	16-7	19-6
	Spruce-pine-fir	#1	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#2	9-8	12-9	15-8	18-3	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-8	9-9	11-10	13-9	6-10	8-8	10-7	12-4
24	Douglas fir-larch	SS	9-11	13-1	16-8	20-3	9-11	13-1	16-5	19-1
	Douglas fir-larch	#1	9-7	12-4	15-0	17-5	8-8	11-0	13-5	15-7
	Douglas fir-larch	#2	9-3	11-8	14-3	16-6	8-3	10-5	12-9	14-9
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-3	8-0	9-9	11-3
	Hem-fir	SS	9-4	12-4	15-9	19-2	9-4	12-4	15-9	18-5
	Hem-fir	#1	9-2	12-1	14-10	17-2	8-7	10-10	13-3	15-5
	Hem-fir	#2	8-9	11-4	13-10	16-1	8-0	10-2	12-5	14-4
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0
	Southern pine	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-8
	Southern pine	#1	9-4	12-4	14-8	17-5	8-10	11-3	13-1	15-7
	Southern pine	#2	8-6	10-10	12-10	15-1	7-7	9-8	11-5	13-6
	Southern pine	#3	6-5	8-2	9-10	11-8	5-9	7-3	8-10	10-5
	Spruce-pine-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-0	17-5
	Spruce-pine-fir	#1	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#2	8-11	11-6	14-1	16-3	8-1	10-3	12-7	14-7
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-2	7-9	9-6	11-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

**Note:** Check sources for availability of lumber in lengths greater than 20 feet.

a. Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> shall be determined in accordance with Section R301.2.2.2.

## FLOORS

**TABLE R502.3.1(2)**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential living areas, live load = 40 psf, L/Δ = 360)<sup>b</sup>**

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
12	Douglas fir-larch	SS	11-4	15-0	19-1	23-3	11-4	15-0	19-1	23-3
	Douglas fir-larch	#1	10-11	14-5	18-5	22-0	10-11	14-2	17-4	20-1
	Douglas fir-larch	#2	10-9	14-2	18-0	20-11	10-8	13-6	16-5	19-1
	Douglas fir-larch	#3	8-11	11-3	13-9	16-0	8-1	10-3	12-7	14-7
	Hem-fir	SS	10-9	14-2	18-0	21-11	10-9	14-2	18-0	21-11
	Hem-fir	#1	10-6	13-10	17-8	21-6	10-6	13-10	17-1	19-10
	Hem-fir	#2	10-0	13-2	16-10	20-4	10-0	13-1	16-0	18-6
	Hem-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Southern pine	SS	11-2	14-8	18-9	22-10	11-2	14-8	18-9	22-10
	Southern pine	#1	10-9	14-2	18-0	21-11	10-9	14-2	16-11	20-1
	Southern pine	#2	10-3	13-6	16-2	19-1	9-10	12-6	14-9	17-5
	Southern pine	#3	8-2	10-3	12-6	14-9	7-5	9-5	11-5	13-6
	Spruce-pine-fir	SS	10-6	13-10	17-8	21-6	10-6	13-10	17-8	21-6
	Spruce-pine-fir	#1	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#2	10-3	13-6	17-3	20-7	10-3	13-3	16-3	18-10
	Spruce-pine-fir	#3	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
16	Douglas fir-larch	SS	10-4	13-7	17-4	21-1	10-4	13-7	17-4	21-1
	Douglas fir-larch	#1	9-11	13-1	16-5	19-1	9-8	12-4	15-0	17-5
	Douglas fir-larch	#2	9-9	12-9	15-7	18-1	9-3	11-8	14-3	16-6
	Douglas fir-larch	#3	7-8	9-9	11-11	13-10	7-0	8-11	10-11	12-7
	Hem-fir	SS	9-9	12-10	16-5	19-11	9-9	12-10	16-5	19-11
	Hem-fir	#1	9-6	12-7	16-0	18-10	9-6	12-2	14-10	17-2
	Hem-fir	#2	9-1	12-0	15-2	17-7	8-11	11-4	13-10	16-1
	Hem-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4
	Southern pine	SS	10-2	13-4	17-0	20-9	10-2	13-4	17-0	20-9
	Southern pine	#1	9-9	12-10	16-1	19-1	9-9	12-7	14-8	17-5
	Southern pine	#2	9-4	11-10	14-0	16-6	8-6	10-10	12-10	15-1
	Southern pine	#3	7-1	8-11	10-10	12-10	6-5	8-2	9-10	11-8
	Spruce-pine-fir	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Spruce-pine-fir	#1	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#2	9-4	12-3	15-5	17-10	9-1	11-6	14-1	16-3
	Spruce-pine-fir	#3	7-6	9-6	11-8	13-6	6-10	8-8	10-7	12-4

(continued)



## FLOORS

**TABLE R502.3.1(2)—continued**  
**FLOOR JOIST SPANS FOR COMMON LUMBER SPECIES (Residential living areas, live load = 40 psf, L/Δ = 360)<sup>b</sup>**

JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf				DEAD LOAD = 20 psf			
			2 × 6	2 × 8	2 × 10	2 × 12	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum floor joist spans							
			(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)	(ft-in)
19.2	Douglas fir-larch	SS	9-8	12-10	16-4	19-10	9-8	12-10	16-4	19-6
	Douglas fir-larch	#1	9-4	12-4	15-0	17-5	8-10	11-3	13-8	15-11
	Douglas fir-larch	#2	9-2	11-8	14-3	16-6	8-5	10-8	13-0	15-1
	Douglas fir-larch	#3	7-0	8-11	10-11	12-7	6-5	8-2	9-11	11-6
	Hem-fir	SS	9-2	12-1	15-5	18-9	9-2	12-1	15-5	18-9
	Hem-fir	#1	9-0	11-10	14-10	17-2	8-9	11-1	13-6	15-8
	Hem-fir	#2	8-7	11-3	13-10	16-1	8-2	10-4	12-8	14-8
	Hem-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
	Southern pine	SS	9-6	12-7	16-0	19-6	9-6	12-7	16-0	19-6
	Southern pine	#1	9-2	12-1	14-8	17-5	9-0	11-5	13-5	15-11
	Southern pine	#2	8-6	10-10	12-10	15-1	7-9	9-10	11-8	13-9
	Southern pine	#3	6-5	8-2	9-10	11-8	5-11	7-5	9-0	10-8
	Spruce-pine-fir	SS	9-0	11-10	15-1	18-4	9-0	11-10	15-1	17-9
	Spruce-pine-fir	#1	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#2	8-9	11-6	14-1	16-3	8-3	10-6	12-10	14-10
	Spruce-pine-fir	#3	6-10	8-8	10-7	12-4	6-3	7-11	9-8	11-3
24	Douglas fir-larch	SS	9-0	11-11	15-2	18-5	9-0	11-11	15-0	17-5
	Douglas fir-larch	#1	8-8	11-0	13-5	15-7	7-11	10-0	12-3	14-3
	Douglas fir-larch	#2	8-3	10-5	12-9	14-9	7-6	9-6	11-8	13-6
	Douglas fir-larch	#3	6-3	8-0	9-9	11-3	5-9	7-3	8-11	10-4
	Hem-fir	SS	8-6	11-3	14-4	17-5	8-6	11-3	14-4	16-10 <sup>a</sup>
	Hem-fir	#1	8-4	10-10	13-3	15-5	7-10	9-11	12-1	14-0
	Hem-fir	#2	7-11	10-2	12-5	14-4	7-4	9-3	11-4	13-1
	Hem-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1
	Southern pine	SS	8-10	11-8	14-11	18-1	8-10	11-8	14-11	18-0
	Southern pine	#1	8-6	11-3	13-1	15-7	8-1	10-3	12-0	14-3
	Southern pine	#2	7-7	9-8	11-5	13-6	7-0	8-10	10-5	12-4
	Southern pine	#3	5-9	7-3	8-10	10-5	5-3	6-8	8-1	9-6
	Spruce-pine-fir	SS	8-4	11-0	14-0	17-0	8-4	11-0	13-8	15-11
	Spruce-pine-fir	#1	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#2	8-1	10-3	12-7	14-7	7-5	9-5	11-6	13-4
	Spruce-pine-fir	#3	6-2	7-9	9-6	11-0	5-7	7-1	8-8	10-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

**Note:** Check sources for availability of lumber in lengths greater than 20 feet.

a. End bearing length shall be increased to 2 inches.

b. Dead load limits for townhouses in Seismic Design Category C and all structures in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub>, and D<sub>2</sub> shall be determined in accordance with Section R301.2.2.2.

**R502.3.2 Other floor joists.** Table R502.3.1(2) shall be used to determine the maximum allowable span of floor joists that support other areas of the building, other than sleeping areas and *attics*, provided that the design *live load* does not exceed 40 pounds per square foot (1.92 kPa) and the design dead load does not exceed 20 pounds per square foot (0.96 kPa).

**R502.3.3 Floor cantilevers.** Floor cantilever spans shall not exceed the nominal depth of the wood floor joist. Floor cantilevers constructed in accordance with Table R502.3.3(1) shall be permitted where supporting a light-frame bearing wall and roof only. Floor cantilevers supporting an exterior balcony are permitted to be constructed in accordance with Table R502.3.3(2).

**R502.4 Joists under bearing partitions.** Joists under parallel bearing partitions shall be of adequate size to support the load. Double joists, sized to adequately support the load, that are separated to permit the installation of piping or vents shall be full-depth solid blocked with lumber not less than 2 inches (51 mm) in nominal thickness spaced not more than 4 feet (1219 mm) on center. Bearing partitions perpendicular to joists shall not be offset from supporting girders, walls or partitions more than the joist depth unless such joists are of sufficient size to carry the additional load.

**R502.5 Allowable girder and header spans.** The allowable spans of girders and headers fabricated of dimension lumber shall not exceed the values set forth in Tables R602.7(1), R602.7(2) and R602.7(3).

**R502.6 Bearing.** The ends of each joist, beam or girder shall have not less than 1½ inches (38 mm) of bearing on wood or metal, have not less than 3 inches of bearing (76 mm) on masonry or concrete or be supported by *approved* joist hangers. Alternatively, the ends of joists shall be supported on a 1-inch by 4-inch (25 mm by 102 mm) ribbon strip and shall be nailed to the adjacent stud. The bearing on masonry or concrete shall be direct, or a sill plate of 2-inch-minimum (51 mm) nominal thickness shall be provided under the joist, beam or girder. The sill plate shall provide a minimum nominal bearing area of 48 square inches (30 865 mm²).

**R502.6.1 Floor systems.** Joists framing from opposite sides over a bearing support shall lap not less than 3 inches (76 mm) and shall be nailed together with a minimum three 10d face nails. A wood or metal splice with strength equal to or greater than that provided by the nailed lap is permitted.

**R502.6.2 Joist framing.** Joists framing into the side of a wood girder shall be supported by *approved* framing anchors or on ledger strips not less than nominal 2 inches by 2 inches (51 mm by 51 mm).

**TABLE R502.3.3(1)**  
**CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING LIGHT-FRAME EXTERIOR BEARING WALL AND ROOF ONLY<sup>a, b, c, f, g, h</sup>**  
(Floor live load ≤ 40 psf, roof live load ≤ 20 psf)

MEMBER & SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lb) <sup>d, e</sup>											
	Ground Snow Load											
	≤ 20 psf			30 psf			50 psf			70 psf		
	Roof Width			Roof Width			Roof Width			Roof Width		
	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft	24 ft	32 ft	40 ft
2 × 8 @ 12"	20" (177)	15" (227)	—	18" (209)	—	—	—	—	—	—	—	—
2 × 10 @ 16"	29" (228)	21" (297)	16" (364)	26" (271)	18" (354)	—	20" (375)	—	—	—	—	—
2 × 10 @ 12"	36" (166)	26" (219)	20" (270)	34" (198)	22" (263)	16" (324)	26" (277)	—	—	19" (356)	—	—
2 × 12 @ 16"	—	32" (287)	25" (356)	36" (263)	29" (345)	21" (428)	29" (367)	20" (484)	—	23" (471)	—	—
2 × 12 @ 12"	—	42" (209)	31" (263)	—	37" (253)	27" (317)	36" (271)	27" (358)	17" (447)	31" (348)	19" (462)	—
2 × 12 @ 8"	—	48" (136)	45" (169)	—	48" (164)	38" (206)	—	40" (233)	26" (294)	36" (230)	29" (304)	18" (379)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Tabulated values are for clear-span roof supported solely by exterior bearing walls.

b. Spans are based on No. 2 Grade lumber of Douglas fir-larch, Southern pine, hem-fir and spruce-pine-fir for repetitive (three or more) members.

c. Ratio of backspan to cantilever span shall be not less than 3:1.

d. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.

e. Uplift force is for a backspan to cantilever span ratio of 3:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 3 divided by the actual backspan ratio provided (3/backspan ratio).

f. See Section R301.2.2.6, Item 1, for additional limitations on cantilevered floor joists for detached one- and two-family dwellings in Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub> and townhouses in Seismic Design Category C, D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>.

g. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less and the building is assigned to Seismic Design Category A, B or C, solid blocking at the support for the cantilever shall not be required.

h. Linear interpolation shall be permitted for building widths and ground snow loads other than shown.

## FLOORS

**TABLE R502.3.3(2)**  
**CANTILEVER SPANS FOR FLOOR JOISTS SUPPORTING EXTERIOR BALCONY<sup>a, b, e, f</sup>**

MEMBER SIZE	SPACING	MAXIMUM CANTILEVER SPAN (uplift force at backspan support in lb) <sup>c, d</sup>		
		Ground Snow Load		
		≤ 30 psf	50 psf	70 psf
2 × 8	12"	42" (139)	39" (156)	34" (165)
2 × 8	16"	36" (151)	34" (171)	29" (180)
2 × 10	12"	61" (164)	57" (189)	49" (201)
2 × 10	16"	53" (180)	49" (208)	42" (220)
2 × 10	24"	43" (212)	40" (241)	34" (255)
2 × 12	16"	72" (228)	67" (260)	57" (268)
2 × 12	24"	58" (279)	54" (319)	47" (330)

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Spans are based on No. 2 Grade lumber of Douglas fir-larch, Southern pine, hem-fir, and spruce-pine-fir for repetitive (three or more) members.

b. Ratio of backspan to cantilever span shall be not less than 2:1.

c. Connections capable of resisting the indicated uplift force shall be provided at the backspan support.

d. Uplift force is for a backspan to cantilever span ratio of 2:1. Tabulated uplift values are permitted to be reduced by multiplying by a factor equal to 2 divided by the actual backspan ratio provided (2/backspan ratio).

e. A full-depth rim joist shall be provided at the unsupported end of the cantilever joists. Solid blocking shall be provided at the supported end. Where the cantilever length is 24 inches or less and the building is assigned to Seismic Design Category A, B or C, solid blocking at the support for the cantilever shall not be required.

f. Linear interpolation shall be permitted for ground snow loads other than shown.

**R502.7 Lateral restraint at supports.** Joists shall be supported laterally at the ends by full-depth solid blocking not less than 2 inches (51 mm) nominal in thickness; or by attachment to a full-depth header, band or rim joist, or to an adjoining stud or shall be otherwise provided with lateral support to prevent rotation.

**Exceptions:**

1. Trusses, *structural composite lumber*, structural glued-laminated members and I-joists shall be supported laterally as required by the manufacturer's recommendations.
2. In *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, lateral restraint shall be provided at each intermediate support.

**R502.7.1 Bridging.** Joists exceeding a nominal 2 inches by 12 inches (51 mm by 305 mm) shall be supported laterally by solid blocking, diagonal bridging (wood or metal), or a continuous 1-inch by 3-inch (25 mm by 76 mm) strip nailed across the bottom of joists perpendicular to joists at intervals not exceeding 8 feet (2438 mm).

**Exception:** Trusses, *structural composite lumber*, structural glued-laminated members and I-joists shall be supported laterally as required by the manufacturer's recommendations.

**R502.8 Cutting, drilling and notching.** Structural floor members shall not be cut, bored or notched in excess of the limitations specified in this section. See Figure R502.8.

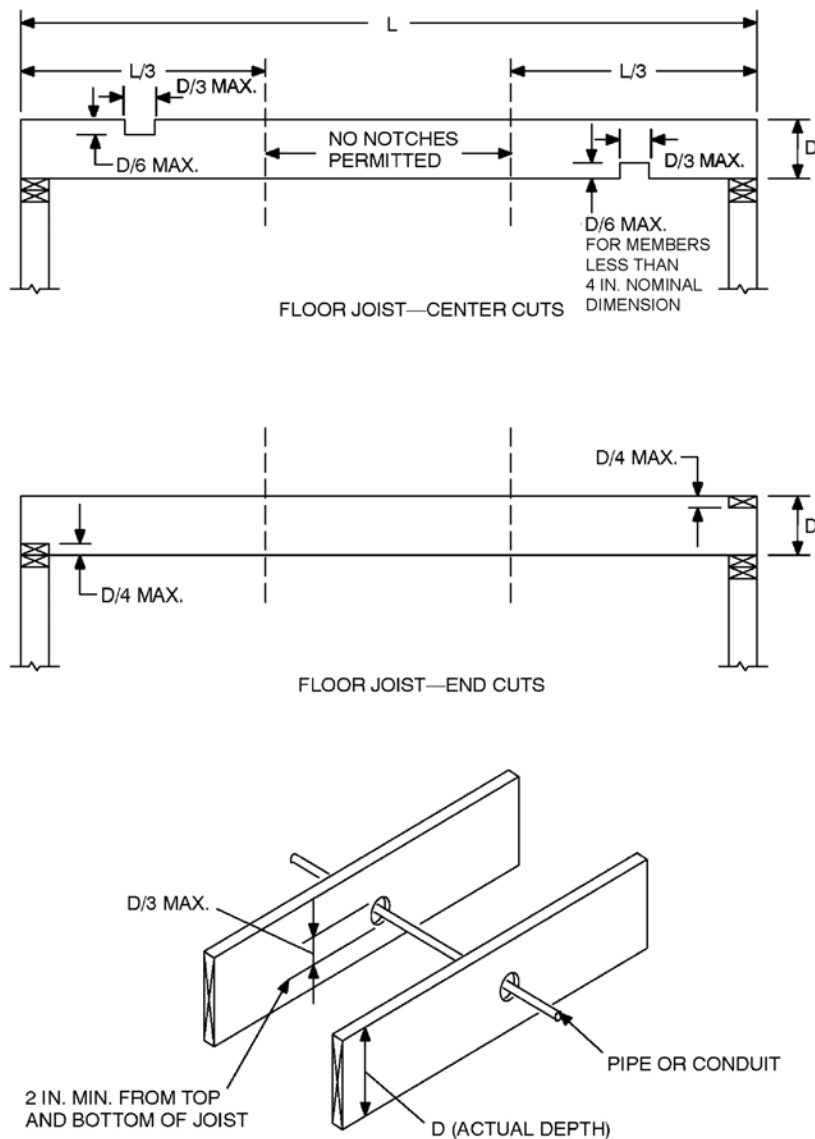
**R502.8.1 Sawn lumber.** Notches in solid lumber joists, rafters and beams shall not exceed one-sixth of the depth of the member, shall not be longer than one-third of the depth of the member and shall not be located in the middle one-third of the span. Notches at the ends of the

member shall not exceed one-fourth the depth of the member. The tension side of members 4 inches (102 mm) or greater in nominal thickness shall not be notched except at the ends of the members. The diameter of holes bored or cut into members shall not exceed one-third the depth of the member. Holes shall not be closer than 2 inches (51 mm) to the top or bottom of the member, or to any other hole located in the member. Where the member is notched, the hole shall not be closer than 2 inches (51 mm) to the notch.

**R502.8.2 Engineered wood products.** Cuts, notches and holes bored in trusses, *structural composite lumber*, structural glue-laminated members, cross-laminated timber members or I-joists are prohibited except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a *registered design professional*.

**R502.9 Fastening.** Floor framing shall be nailed in accordance with Table R602.3(1). Where posts and beam or girder construction is used to support floor framing, positive connections shall be provided to ensure against uplift and lateral displacement.

**R502.10 Framing of openings.** Openings in floor framing shall be framed with header and trimmer joists. Where the header joist span does not exceed 4 feet (1219 mm), the header joist shall be a single member the same size as the floor joist. Single trimmer joists shall be used to carry a single header joist that is located within 3 feet (914 mm) of the trimmer joist bearing. Where the header joist span exceeds 4 feet (1219 mm), the trimmer joists and the header joist shall be doubled and of sufficient cross section to support the floor joists framing into the header.



For SI: 1 inch = 25.4 mm.

**FIGURE R502.8**  
**CUTTING, NOTCHING AND DRILLING**

### **R502.11 Wood trusses.**

**R502.11.1 Design.** Wood trusses shall be designed in accordance with *approved* engineering practice. The design and manufacture of metal-plate-connected wood trusses shall comply with ANSI/TPI 1. The *truss design drawings* shall be prepared by a *registered design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1.

**R502.11.2 Bracing.** Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the *construction documents* for the building and on the individual *truss design draw-*

*ings*. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the SBCA *Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses*.

**R502.11.3 Alterations to trusses.** Truss members and components shall not be cut, notched, spliced or otherwise altered in any way without the approval of a *registered design professional*. *Alterations* resulting in the addition of load that exceeds the design load for the truss, shall not be permitted without verification that the truss is capable of supporting the additional loading.



## FLOORS

**R502.11.4 Truss design drawings.** *Truss design drawings*, prepared in compliance with Section R502.11.1, shall be submitted to the *building official* and *approved* prior to installation. *Truss design drawings* shall be provided with the shipment of trusses delivered to the job site. *Truss design drawings* shall include, at a minimum, the information specified as follows:

1. Slope or depth, span and spacing.
2. Location of all joints.
3. Required bearing widths.
4. Design loads as applicable:
  - 4.1. Top chord *live load*.
  - 4.2. Top chord dead load.
  - 4.3. Bottom chord *live load*.
  - 4.4. Bottom chord dead load.
  - 4.5. Concentrated loads and their points of application.
  - 4.6. Controlling wind and earthquake loads.
5. Adjustments to lumber and joint connector design values for conditions of use.
6. Each reaction force and direction.
7. Joint connector type and description, such as size, thickness or gage, and the dimensioned location of each joint connector except where symmetrically located relative to the joint interface.
8. Lumber size, species and grade for each member.
9. Connection requirements for:
  - 9.1. Truss-to-girder-truss.
  - 9.2. Truss ply-to-ply.
  - 9.3. Field splices.
10. Calculated deflection ratio, maximum description for live and total load, or both.
11. Maximum axial compression forces in the truss members to enable the building designer to design the size, connections and anchorage of the permanent continuous lateral bracing. Forces shall be shown on the truss drawing or on supplemental documents.
12. Required permanent truss member bracing location.

**R502.12 Draftstopping required.** Draftstopping shall be provided in accordance with Section R302.12.

**R502.13 Fireblocking required.** Fireblocking shall be provided in accordance with Section R302.11.

## SECTION R503 FLOOR SHEATHING

**R503.1 Lumber sheathing.** Maximum allowable spans for lumber used as floor sheathing shall conform to Tables R503.1, R503.2.1.1(1) and R503.2.1.1(2).

**TABLE R503.1  
MINIMUM THICKNESS OF LUMBER FLOOR SHEATHING**

JOIST OR BEAM SPACING (inches)	MINIMUM NET THICKNESS	
	Perpendicular to joist	Diagonal to joist
24	$\frac{11}{16}$	$\frac{3}{4}$
16	$\frac{5}{8}$	$\frac{5}{8}$
48 <sup>a</sup>	$1\frac{1}{2}$ T & G	N/A
54 <sup>b</sup>		
60 <sup>c</sup>		

For SI: 1 inch = 25.4 mm, 1 pound per square inch = 6.895 kPa.

N/A = Not Applicable.

- a. For this support spacing, lumber sheathing shall have a minimum  $F_b$  of 675 and minimum E of 1,100,000 (see ANSI AWC NDS).
- b. For this support spacing, lumber sheathing shall have a minimum  $F_b$  of 765 and minimum E of 1,400,000 (see ANSI AWC NDS).
- c. For this support spacing, lumber sheathing shall have a minimum  $F_b$  of 855 and minimum E of 1,700,000 (see ANSI AWC NDS).

**R503.1.1 End joints.** End joints in lumber used as subflooring shall occur over supports unless end-matched lumber is used, in which case each piece shall bear on not less than two joists. Subflooring shall be permitted to be omitted where joist spacing does not exceed 16 inches (406 mm) and a 1-inch (25 mm) nominal tongue-and-groove wood strip flooring is applied perpendicular to the joists.

### R503.2 Wood structural panel sheathing.

**R503.2.1 Identification and grade.** *Wood structural panel* sheathing used for structural purposes shall conform to CSA O325, CSA O437 DOC PS 1 or DOC PS 2. Panels shall be identified for grade, bond classification and Performance Category by a grade *mark* or certificate of inspection issued by an *approved* agency. The Performance Category value shall be used as the “nominal *panel thickness*” or “*panel thickness*” wherever referenced in this code.

**R503.2.1.1 Subfloor and combined subfloor underlayment.** Where used as subflooring or combination subfloor underlayment, *wood structural panels* shall be of one of the grades specified in Table R503.2.1.1(1). Where sanded plywood is used as combination subfloor underlayment, the grade, bond classification, and Performance Category shall be as specified in Table R503.2.1.1(2).

## FLOORS

**TABLE R503.2.1.1(1)**  
**ALLOWABLE SPANS AND LOADS FOR WOOD STRUCTURAL PANELS FOR ROOF AND**  
**SUBFLOOR SHEATHING AND COMBINATION SUBFLOOR UNDERLAYMENT<sup>a, b, c</sup>**

SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inch)	ALLOWABLE LIVE LOAD (psf) <sup>h, i</sup>		MAXIMUM SPAN (inches)		LOAD (pounds per square foot, at maximum span)		MAXIMUM SPAN (inches)
		SPAN @ 16" o.c.	SPAN @ 24" o.c.	With edge support <sup>d</sup>	Without edge support	Total load	Live load	
Sheathing <sup>e</sup>				Roof <sup>f</sup>				Subfloor <sup>j</sup>
16/0	<sup>3</sup> / <sub>8</sub>	30	—	16	16	40	30	0
20/0	<sup>3</sup> / <sub>8</sub>	50	—	20	20	40	30	0
24/0	<sup>3</sup> / <sub>8</sub>	100	30	24	20 <sup>g</sup>	40	30	0
24/16	<sup>7</sup> / <sub>16</sub>	100	40	24	24	50	40	16
32/16	<sup>15</sup> / <sub>32</sub> , <sup>1</sup> / <sub>2</sub>	180	70	32	28	40	30	16 <sup>h</sup>
40/20	<sup>19</sup> / <sub>32</sub> , <sup>5</sup> / <sub>8</sub>	305	130	40	32	40	30	20 <sup>h, i</sup>
48/24	<sup>23</sup> / <sub>32</sub> , <sup>3</sup> / <sub>4</sub>	—	175	48	36	45	35	24
60/32	<sup>7</sup> / <sub>8</sub>	—	305	60	48	45	35	32
Underlayment, C-C plugged, single floor <sup>e</sup>				Roof <sup>f</sup>				Combination subfloor underlayment <sup>k</sup>
16 o.c.	<sup>19</sup> / <sub>32</sub> , <sup>5</sup> / <sub>8</sub>	100	40	24	24	50	40	16 <sup>i</sup>
20 o.c.	<sup>19</sup> / <sub>32</sub> , <sup>5</sup> / <sub>8</sub>	150	60	32	32	40	30	20 <sup>i, j</sup>
24 o.c.	<sup>23</sup> / <sub>32</sub> , <sup>3</sup> / <sub>4</sub>	240	100	48	36	35	25	24
32 o.c.	<sup>7</sup> / <sub>8</sub>	—	185	48	40	50	40	32
48 o.c.	<sup>13</sup> / <sub>32</sub> , <sup>1</sup> / <sub>8</sub>	—	290	60	48	50	40	48

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- The allowable total loads were determined using a dead load of 10 psf. If the dead load exceeds 10 psf, then the live load shall be reduced accordingly.
- Panels continuous over two or more spans with long dimension (strength axis) perpendicular to supports. Spans shall be limited to values shown because of possible effect of concentrated loads.
- Applies to panels 24 inches or wider.
- Lumber blocking, panel edge clips (one midway between each support, except two equally spaced between supports where span is 48 inches), tongue-and-groove panel edges, or other approved type of edge support.
- Includes Structural I panels in these grades.
- Uniform load deflection limitation:  $\frac{1}{180}$  of span under live load plus dead load,  $\frac{1}{240}$  of span under live load only.
- Maximum span 24 inches for  $\frac{15}{32}$ - and  $\frac{1}{2}$ -inch panels.
- Maximum span 24 inches where  $\frac{3}{4}$ -inch wood finish flooring is installed at right angles to joists.
- Maximum span 24 inches where 1.5 inches of lightweight concrete or approved cellular concrete is placed over the subfloor.
- Unsupported edges shall have tongue-and-groove joints or shall be supported with blocking unless minimum nominal  $\frac{1}{4}$ -inch-thick wood panel-type underlayment, fiber-cement underlayment with end and edge joints offset not less than 2 inches or  $\frac{1}{2}$  inches of lightweight concrete or approved cellular concrete is placed over the subfloor, or  $\frac{3}{4}$ -inch wood finish flooring is installed at right angles to the supports. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span, based on deflection of  $\frac{1}{360}$  of span, is 100 psf.
- Unsupported edges shall have tongue-and-groove joints or shall be supported by blocking unless nominal  $\frac{1}{4}$ -inch-thick wood panel-type underlayment, fiber-cement underlayment with end and edge joints offset not less than 2 inches or  $\frac{3}{4}$ -inch wood finish flooring is installed at right angles to the supports. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span, based on deflection of  $\frac{1}{360}$  of span, is 100 psf, except panels with a span rating of 48 on center are limited to 65 psf total uniform load at maximum span.
- Allowable live load values at spans of 16 inches on center and 24 inches on center taken from referenced standard APA E30, *APA Engineered Wood Construction Guide*. Refer to referenced standard for allowable spans not listed in the table.

**TABLE R503.2.1.1(2)**  
**ALLOWABLE SPANS FOR SANDED**  
**PLYWOOD COMBINATION SUBFLOOR UNDERLAYMENT<sup>a</sup>**

IDENTIFICATION	SPACING OF JOISTS (inches)		
	16	20	24
Species group <sup>b</sup>	—	—	—
1	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$
2, 3	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$
4	$\frac{3}{4}$	$\frac{7}{8}$	1

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- Plywood continuous over two or more spans and face grain perpendicular to supports. Unsupported edges shall be tongue-and-groove or blocked except where nominal  $\frac{1}{4}$ -inch-thick wood panel-type underlayment, fiber-cement underlayment or  $\frac{3}{4}$ -inch wood finish floor is used. Fiber-cement underlayment shall comply with ASTM C1288 or ISO 8336 Category C. Allowable uniform live load at maximum span based on deflection of  $\frac{1}{360}$  of span is 100 psf.
- Applicable to all grades of sanded exterior-type plywood.

**R503.2.2 Allowable spans.** The maximum allowable span for *wood structural panels* used as subfloor or combination subfloor underlayment shall be as set forth in Table R503.2.1.1(1), or APA E30. The maximum span for sanded plywood combination subfloor underlayment shall be as set forth in Table R503.2.1.1(2).

**R503.2.3 Installation.** *Wood structural panels* used as subfloor or combination subfloor underlayment shall be attached to wood framing in accordance with Table R602.3(1) and shall be attached to cold-formed steel framing in accordance with Table R505.3.1(2).

### R503.3 Particleboard.

**R503.3.1 Identification and grade.** Particleboard shall conform to ANSI A208.1 and shall be so identified by a grade *mark* or certificate of inspection issued by an *approved agency*.

## FLOORS

**R503.3.2 Floor underlayment.** Particleboard floor underlayment shall conform to Type PBU and shall be not less than  $\frac{1}{4}$  inch (6.4 mm) in thickness.

**R503.3.3 Installation.** Particleboard underlayment shall be installed in accordance with the recommendations of the manufacturer and attached to framing in accordance with Table R602.3(1).

### SECTION R504 PRESSURE PRESERVATIVE-TREATED WOOD FLOORS (ON GROUND)

**R504.1 General.** Pressure preservative-treated wood *basement* floors and floors on ground shall be designed to withstand axial forces and bending moments resulting from lateral soil pressures at the base of the exterior walls and floor live and dead loads. Floor framing shall be designed to meet joist deflection requirements in accordance with Section R301.

**R504.1.1 Unbalanced soil loads.** Unless special provision is made to resist sliding caused by unbalanced lateral soil loads, wood *basement* floors shall be limited to applications where the differential depth of fill on opposite exterior foundation walls is 2 feet (610 mm) or less.

**R504.1.2 Construction.** Joists in wood *basement* floors shall bear tightly against the narrow face of studs in the foundation wall or directly against a band joist that bears on the studs. Plywood subfloor shall be continuous over lapped joists or over butt joints between in-line joists. Sufficient blocking shall be provided between joists to transfer lateral forces at the base of the end walls into the floor system.

**R504.1.3 Uplift and buckling.** Where required, resistance to uplift or restraint against buckling shall be provided by interior bearing walls or properly designed stub walls anchored in the supporting soil below.

**R504.2 Site preparation.** The area within the foundation walls shall have all vegetation, topsoil and foreign material removed, and any fill material that is added shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the pressure preservative-treated wood floor sleepers.

**R504.2.1 Base.** A minimum 4-inch-thick (102 mm) granular base of gravel having a maximum size of  $\frac{3}{4}$  inch (19.1 mm) or crushed stone having a maximum size of  $\frac{1}{2}$  inch (12.7 mm) shall be placed over the compacted earth.

**R504.2.2 Moisture barrier.** Polyethylene sheeting of minimum 6-mil (0.15 mm) thickness shall be placed over the granular base. Joints shall be lapped 6 inches (152 mm) and left unsealed. The polyethylene membrane shall be placed over the pressure preservative-treated wood sleepers and shall not extend beneath the footing plates of the exterior walls.

**R504.3 Materials.** Framing materials, including sleepers, joists, blocking and plywood subflooring, shall be pressure-

preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, Special Requirement 4.2), and shall bear the *label* of an accredited agency.

### SECTION R505 COLD-FORMED STEEL FLOOR FRAMING

**R505.1 Cold-formed steel floor framing.** Elements shall be straight and free of any defects that would significantly affect structural performance. Cold-formed steel floor framing members shall be in accordance with the requirements of this section.

**R505.1.1 Applicability limits.** The provisions of this section shall control the construction of cold-formed steel floor framing for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist span, not greater than 40 feet (12 192 mm) in width parallel to the joist span and less than or equal to three *stories* above *grade plane*. Cold-formed steel floor framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 140 miles per hour (63 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3.35 kPa).

**R505.1.1.1 Alternate applications.** Cold-formed steel floor framing for buildings exceeding the applicability limits of Section R505.1.1 is permitted to be designed and constructed in accordance with AISI S230, subject to the limits therein.

**R505.1.2 In-line framing.** Where supported by cold-formed steel-framed walls in accordance with Section R603, cold-formed steel floor framing shall be constructed with floor joists located in-line with load-bearing studs located below the joists in accordance with the tolerances specified in AISI S240, Section B1.2.3.

**R505.1.3 Floor trusses.** Cold-formed steel trusses shall be designed, braced and installed in accordance with AISI S230, Section D8. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the SBCA *Cold-Formed Steel Building Component Safety Information (CFSBCSI), Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses*. Truss members shall not be notched, cut or altered in any manner without an *approved* design.

**R505.2 Structural framing.** Load-bearing cold-formed steel floor framing members shall be in accordance with this section.

**R505.2.1 Material.** Load-bearing cold-formed steel framing members shall be cold formed to shape from structural quality sheet steel complying with the requirements of AISI S240, Section A3.

**R505.2.2 Corrosion protection.** Load-bearing cold-formed steel framing shall have a metallic coating complying with AISI S240, Section A4.

**R505.2.3 Dimension, thickness and material grade.** Load-bearing cold-formed steel floor framing members shall comply with AISI S230, Section A4.3 and material grade requirements as specified in AISI S230, Section A4.4.

**R505.2.4 Identification.** Load-bearing cold-formed steel framing members shall meet the product identification requirements of AISI S240, Section A5.5.

**R505.2.5 Fastening.** Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of  $\frac{1}{2}$  inch (12.7 mm), shall be self-drilling tapping, and shall conform to ASTM C1513. Floor sheathing shall be attached to cold-formed steel joists with minimum No. 8 self-drilling tapping screws that conform to ASTM C1513. Screws attaching floor sheathing to cold-formed steel joists shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a minimum edge distance of  $\frac{3}{8}$  inch (9.5 mm). Gypsum board ceilings shall be attached to cold-formed steel joists with minimum No. 6 screws conforming to ASTM C954 or ASTM C1513 with a bugle-head style and shall be installed in accordance with Section R702. For all connections, screws shall extend through the steel not fewer than three exposed threads. Fasteners shall have a rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

**R505.2.6 Web holes, web hole reinforcing and web hole patching.** Web holes in floor framing members shall comply with the conditions as prescribed in AISI S230, Section A4.5. Web holes not in compliance with the conditions as prescribed in AISI S230, Section A4.5 shall be reinforced in accordance with the provisions of AISI S230, Section A4.6 or patched in accordance with the provisions of AISI S230, Section A4.7.

**R505.3 Floor construction.** Cold-formed steel floors shall be constructed in accordance with this section.

**R505.3.1 Floor-to-foundation or load-bearing wall connections.** Cold-formed steel-framed floors shall be anchored to foundations, wood sills or *load-bearing walls* in accordance with Table R505.3.1(1) and Figure R505.3.1(1), R505.3.1(2), R505.3.1(3), R505.3.1(4), R505.3.1(5) or R505.3.1(6). Anchor bolts shall be located not more than 12 inches (305 mm) from corners or the termination of bottom tracks. Continuous cold-formed steel joists supported by interior *load-bearing walls* shall be constructed in accordance with Figure R505.3.1(7). Lapped cold-formed steel joists shall be constructed in accordance with Figure R505.3.1(8). End floor joists constructed on foundation walls parallel to the joist span shall be doubled unless a C-shaped bearing stiffener, sized in accordance with Section R505.3.4, is installed web-to-web with the floor joist beneath each supported wall stud, as shown in Figure R505.3.1(9). Fastening of cold-formed steel joists to other framing members shall be in accordance with Section R505.2.5 and Table R505.3.1(2).

**TABLE R505.3.1(1)**  
**FLOOR-TO-FOUNDATION OR BEARING WALL CONNECTION REQUIREMENTS<sup>a, b</sup>**

FRAMING CONDITION	BASIC ULTIMATE WIND SPEED (mph) AND EXPOSURE	
	110 mph Exposure Category C or less than 139 mph Exposure Category B	Less than 139 mph Exposure Category C
Floor joist to wall track of exterior wall in accordance with Figure R505.3.1(1)	2-No. 8 screws	3-No. 8 screws
Rim track or end joist to load-bearing wall top track in accordance with Figure R505.3.1(1)	1-No. 8 screw at 24 inches o.c.	1-No. 8 screw at 24 inches o.c.
Rim track or end joist to wood sill in accordance with Figure R505.3.1(2)	Steel plate spaced at 4 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 2 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails
Rim track or end joist to foundation in accordance with Figure R505.3.1(3)	$\frac{1}{2}$ -inch minimum diameter anchor bolt and clip angle spaced at 6 feet o.c. with 8-No. 8 screws	$\frac{1}{2}$ -inch minimum diameter anchor bolt and clip angle spaced at 4 feet o.c. with 8-No. 8 screws
Cantilevered joist to foundation in accordance with Figure R505.3.1(4)	$\frac{1}{2}$ -inch minimum diameter anchor bolt and clip angle spaced at 6 feet o.c. with 8-No. 8 screws	$\frac{1}{2}$ -inch minimum diameter anchor bolt and clip angle spaced at 4 feet o.c. with 8-No. 8 screws
Cantilevered joist to wood sill in accordance with Figure R505.3.1(5)	Steel plate spaced at 4 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 2 feet o.c. with 4-No. 8 screws and 4-10d or 6-8d common nails
Cantilevered joist to exterior load-bearing wall track in accordance with Figure R505.3.1(6)	2-No. 8 screws	3-No. 8 screws

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.

- Anchor bolts are to be located not more than 12 inches from corners or the termination of bottom tracks such as at door openings or corners. Bolts extend not less than 15 inches into masonry or 7 inches into concrete. Anchor bolts connecting cold-formed steel framing to the foundation structure are to be installed so that the distance from the center of the bolt hole to the edge of the connected member is not less than one and one-half bolt diameters.
- All screw sizes shown are minimum.

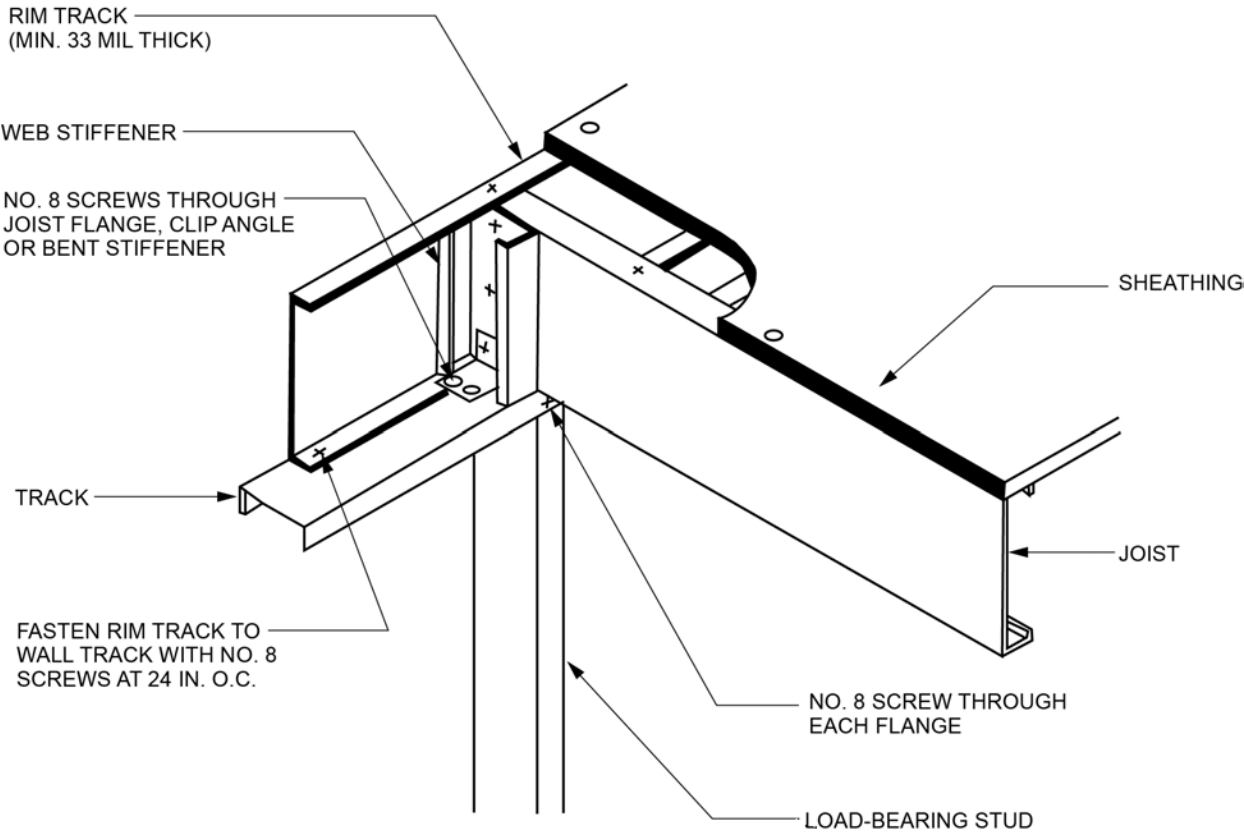


FLOORS

TABLE R505.3.1(2)  
FLOOR FASTENING SCHEDULE<sup>a</sup>

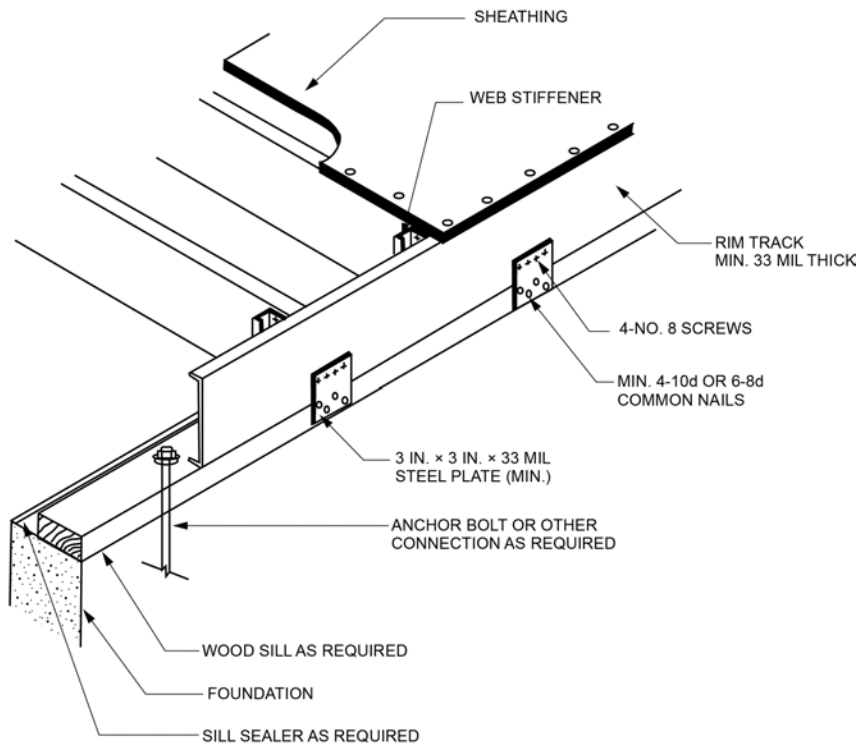
DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND SIZE OF FASTENERS	SPACING OF FASTENERS
Floor joist to track of an interior load-bearing wall in accordance with Figures R505.3.1(7) and R505.3.1(8)	2-No. 8 screws	Each joist
Floor joist to track at end of joist	2-No. 8 screws	One per flange or two per bearing stiffener
Subfloor to floor joists	No. 8 screws	6 in. o.c. on edges and 12 in. o.c. at intermediate supports

For SI: 1 inch = 25.4 mm.  
a. All screw sizes shown are minimum.



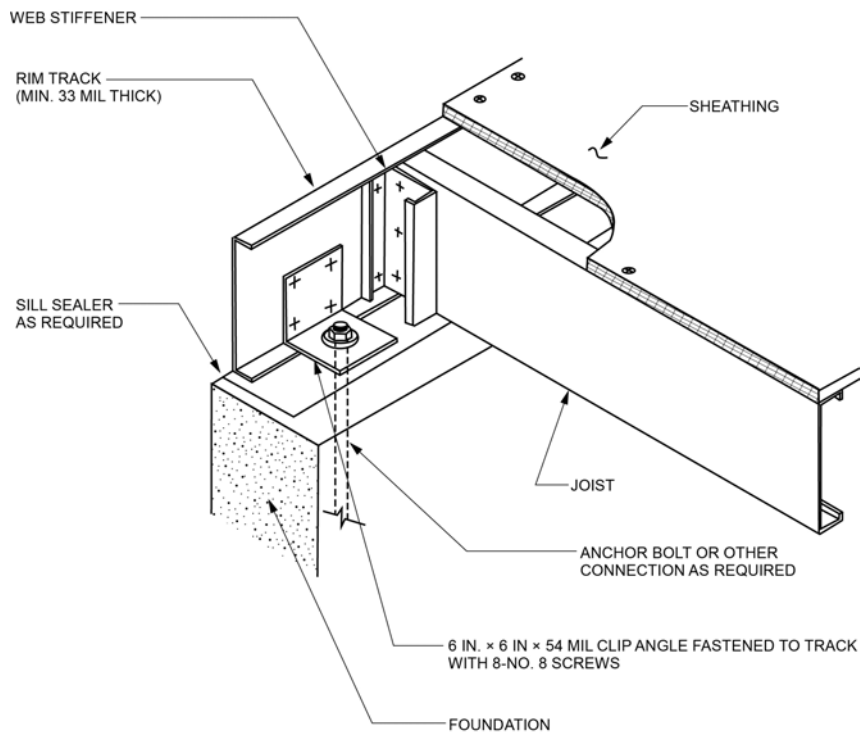
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

FIGURE R505.3.1(1)  
FLOOR-TO-EXTERIOR LOAD-BEARING WALL STUD CONNECTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

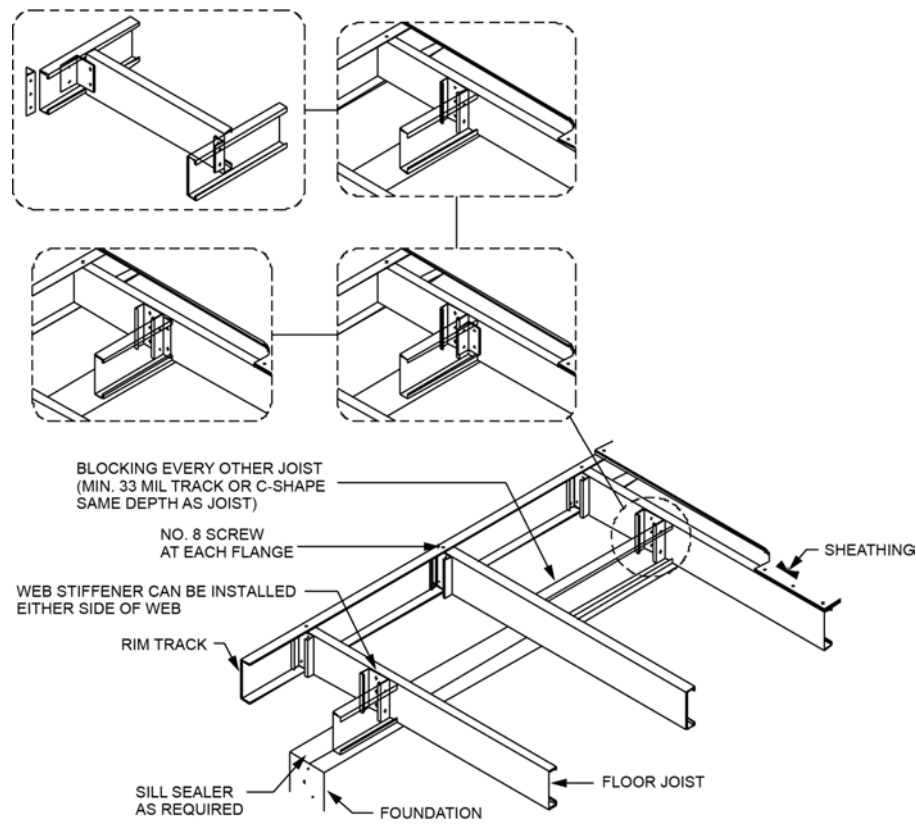
FIGURE R505.3.1(2)  
FLOOR-TO-WOOD-SILL CONNECTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

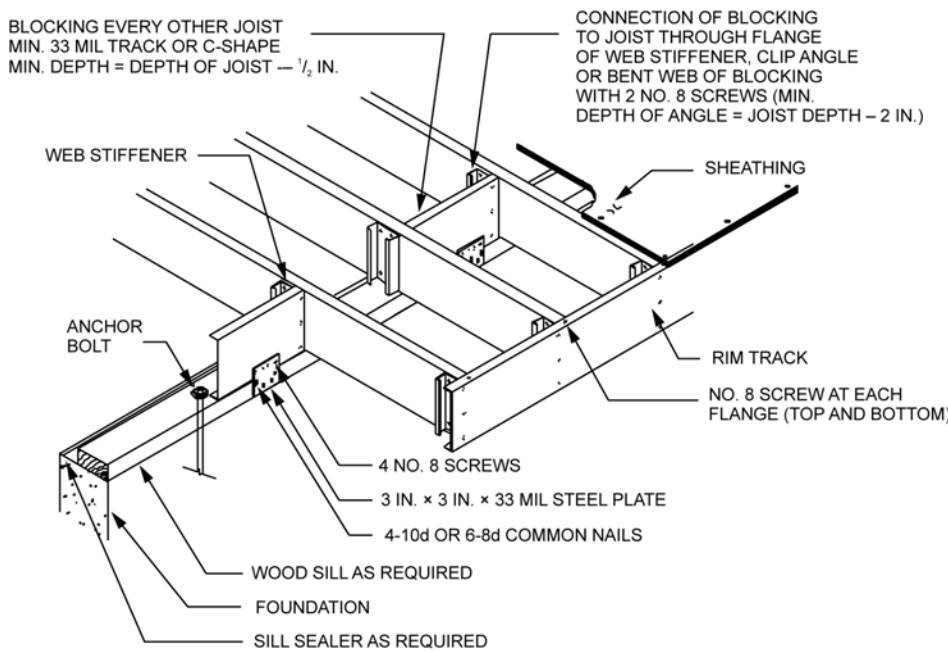
FIGURE R505.3.1(3)  
FLOOR-TO-FOUNDATION CONNECTION

# FLOORS



For SI: 1 mil = 0.0254 mm.

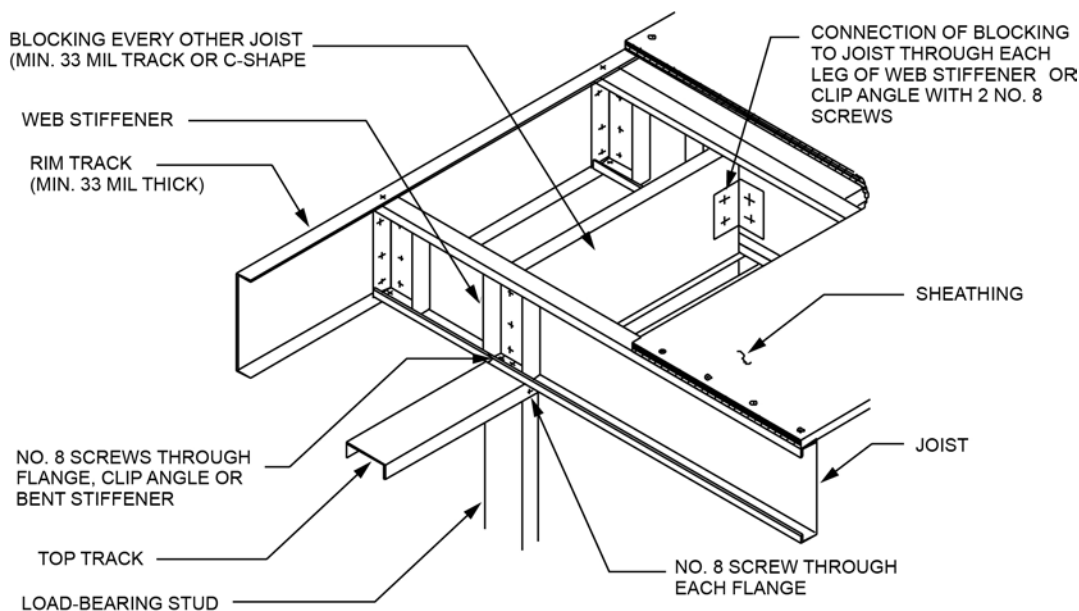
**FIGURE R505.3.1(4)**  
**CANTILEVERED FLOOR-TO-FOUNDATION CONNECTION**



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

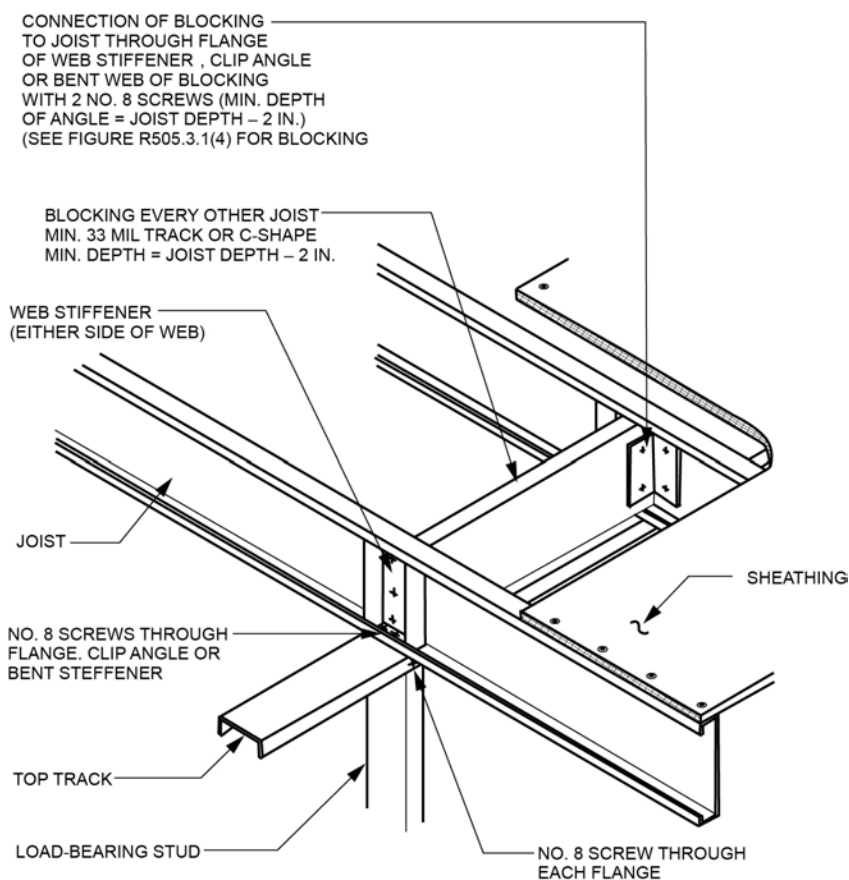
**FIGURE R505.3.1(5)**  
**CANTILEVERED FLOOR-TO-WOOD-SILL CONNECTION**

## FLOORS



For SI: 1 mil = 0.0254 mm.

**FIGURE R505.3.1(6)**  
**CANTILEVERED FLOOR TO EXTERIOR LOAD-BEARING WALL CONNECTION**

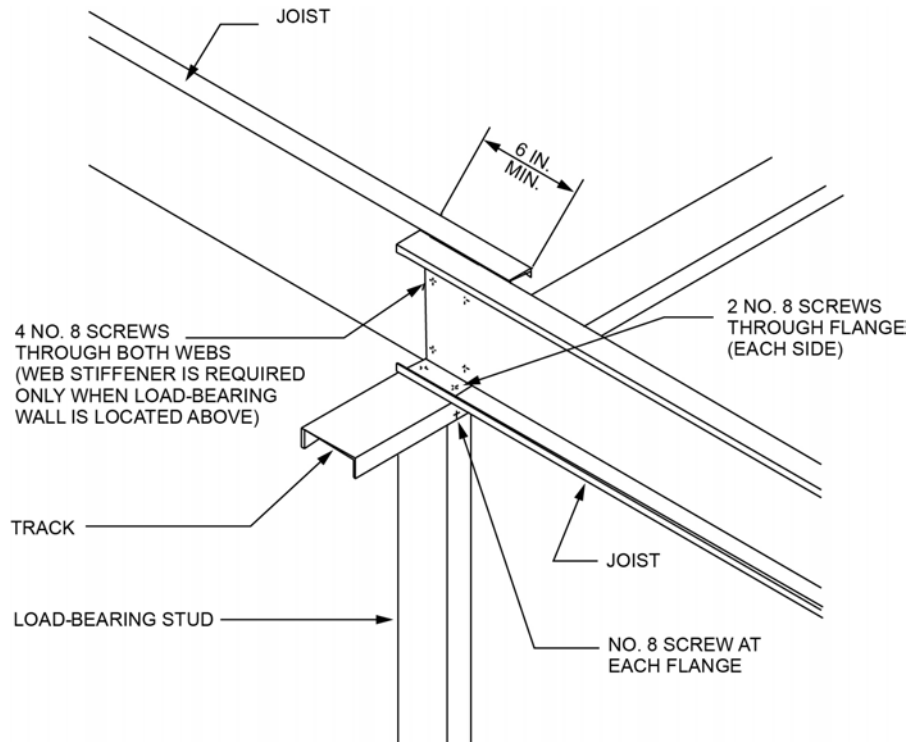


For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

**FIGURE R505.3.1(7)**  
**CONTINUOUS SPAN JOIST SUPPORTED ON INTERIOR LOAD-BEARING WALL**

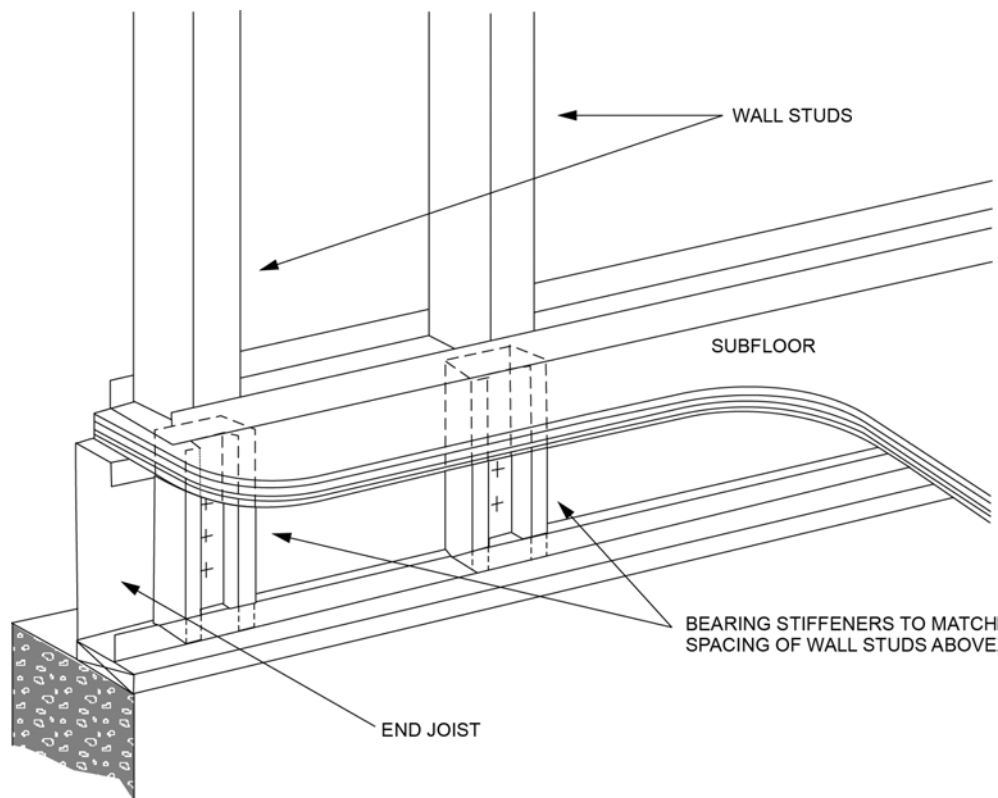


FLOORS



For SI: 1 inch = 25.4 mm.

**FIGURE R505.3.1(8)**  
**LAPPED JOISTS SUPPORTED ON INTERIOR LOAD-BEARING WALL**



**FIGURE R505.3.1(9)**  
**BEARING STIFFENERS FOR END JOISTS**

**R505.3.2 Minimum floor joist sizes.** Floor joist size and thickness shall be determined in accordance with the limits set forth in Table R505.3.2 for single or continuous spans. Where continuous joist members are used, the interior bearing supports shall be located within 2 feet (610 mm) of midspan of the cold-formed steel joists, and the individual spans shall not exceed the spans in Table R505.3.2. Floor joists shall have a bearing support length of not less than 1½ inches (38 mm) for exterior wall supports and 3½ inches (89 mm) for interior wall supports. Tracks shall be not less than 33 mils (0.84 mm) thick except where used as part of a floor header or trimmer in accordance with Section R505.3.8. Bearing stiffeners shall be installed in accordance with Section R505.3.4.

**R505.3.3 Joist bracing and blocking.** Joist bracing and blocking shall be in accordance with this section.

**R505.3.3.1 Joist top flange bracing.** The top flanges of cold-formed steel joists shall be laterally braced by the application of floor sheathing fastened to the joists in accordance with Section R505.2.5 and Table R505.3.1(2).

**R505.3.3.2 Joist bottom flange bracing/blocking.** Floor joists with spans that exceed 12 feet (3658 mm) shall have the bottom flanges laterally braced in accordance with one of the following:

1. Gypsum board installed with minimum No. 6 screws in accordance with Section R702.
2. Continuous steel straps installed in accordance with Figure R505.3.3.2(1). Steel straps shall be spaced at not greater than 12 feet (3658 mm)

on center and shall be not less than 1½ inches (38 mm) in width and 33 mils (0.84 mm) in thickness. Straps shall be fastened to the bottom flange of each joist with one No. 8 screw, fastened to blocking with two No. 8 screws, and fastened at each end (of strap) with two No. 8 screws. Blocking in accordance with Figure R505.3.3.2(1) or R505.3.3.2(2) shall be installed between joists at each end of the continuous strapping and at a maximum spacing of 12 feet (3658 mm) measured along the continuous strapping (perpendicular to the joist run). Blocking shall also be located at the termination of all straps. As an alternative to blocking at the ends, anchoring the strap to a stable building component with two No. 8 screws shall be permitted.

**R505.3.3.3 Blocking at interior bearing supports.** Blocking is not required for continuous back-to-back floor joists at bearing supports. Blocking shall be installed between every other joist for single continuous floor joists across bearing supports in accordance with Figure R505.3.1(7). Blocking shall consist of C-shaped or track section with a minimum thickness of 33 mils (0.84 mm). Blocking shall be fastened to each adjacent joist through a 33-mil (0.84 mm) clip angle, bent web of blocking or flanges of web stiffeners with two No. 8 screws on each side. The minimum depth of the blocking shall be equal to the depth of the joist minus 2 inches (51 mm). The minimum length of the angle shall be equal to the depth of the joist minus 2 inches (51 mm).

**TABLE R505.3.2**  
**ALLOWABLE SPANS FOR COLD-FORMED STEEL JOISTS—SINGLE OR CONTINUOUS SPANS<sup>a, b, c, d, e, f</sup>**

JOIST DESIGNATION	30 PSF LIVE LOAD				40 PSF LIVE LOAD			
	Spacing (inches)				Spacing (inches)			
	12	16	19.2	24	12	16	19.2	24
550S162-33	11'-8"	10'-4"	9'-5"	8'-5"	10'-7"	9'-2"	8'-5"	7'-6"
550S162-43	12'-8"	11'-6"	10'-8"	10'-5"	11'-6"	10'-4"	9'-10"	9'-3"
550S162-54	13'-7"	12'-4"	11'-7"	10'-9"	12'-4"	11'-3"	10'-7"	9'-10"
550S162-68	14'-7"	13'-3"	12'-6"	11'-7"	13'-3"	12'-0"	11'-4"	10'-6"
800S162-33	14'-6"	12'-6"	11'-5"	10'-3"	12'-10"	11'-1"	10'-2"	9'-1"
800S162-43	17'-0"	15'-1"	13'-9"	12'-4"	15'-5"	13'-5"	12'-3"	10'-11"
800S162-54	18'-3"	16'-7"	15'-8"	14'-6"	16'-7"	15'-1"	14'-2"	13'-2"
800S162-68	19'-9"	17'-11"	16'-11"	15'-8"	17'-11"	16'-3"	15'-4"	14'-3"
1000S162-43	19'-4"	16'-9"	15'-3"	13'-8"	17'-2"	14'-10"	13'-7"	12'-2"
1000S162-54	21'-9"	19'-9"	18'-7"	17'-3"	19'-9"	18'-0"	16'-11"	15'-8"
1000S162-68	23'-7"	21'-5"	20'-2"	18'-9"	21'-5"	19'-6"	18'-4"	17'-0"
1200S162-54	25'-1"	22'-10"	21'-6"	19'-9"	22'-10"	20'-9"	19'-6"	17'-6"
1200S162-68	27'-3"	24'-9"	23'-4"	21'-8"	24'-9"	22'-6"	21'-2"	19'-8"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mil = 0.0254 mm.

a. Deflection criteria: L/480 for live loads, L/240 for total loads.

b. Floor dead load = 10 psf.

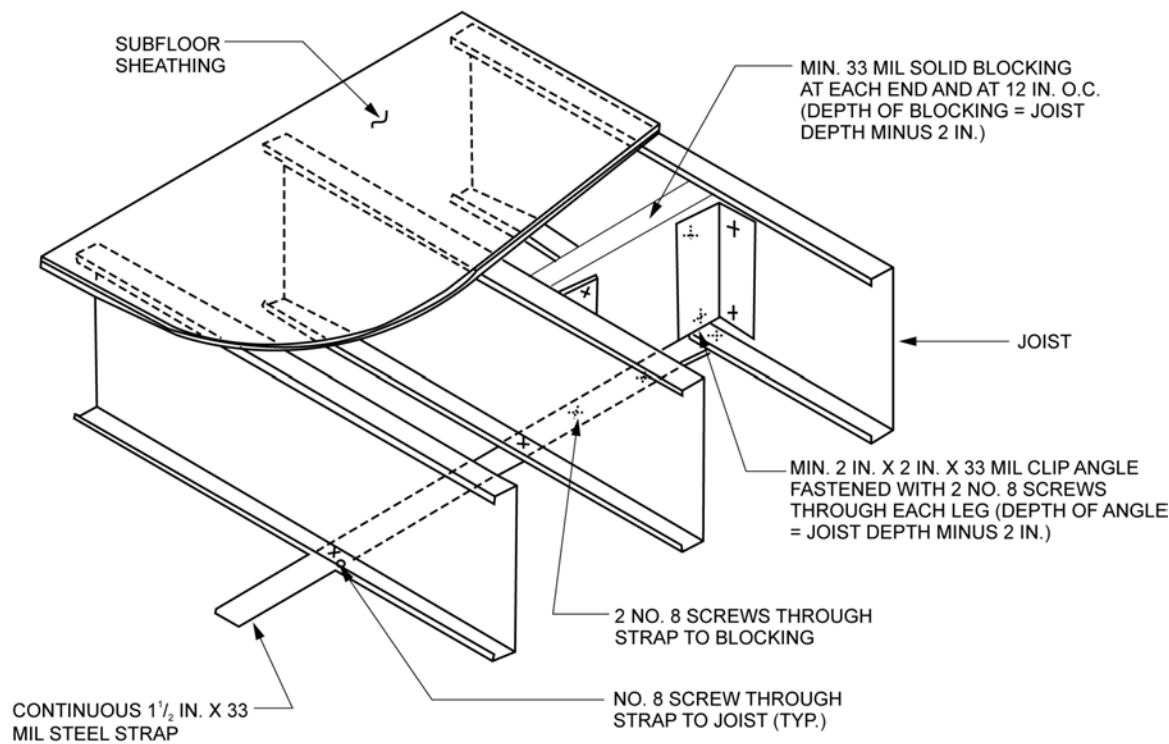
c. Table provides the maximum clear span in feet and inches.

d. Bearing stiffeners are to be installed at all support points and concentrated loads.

e. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thickness. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thickness.

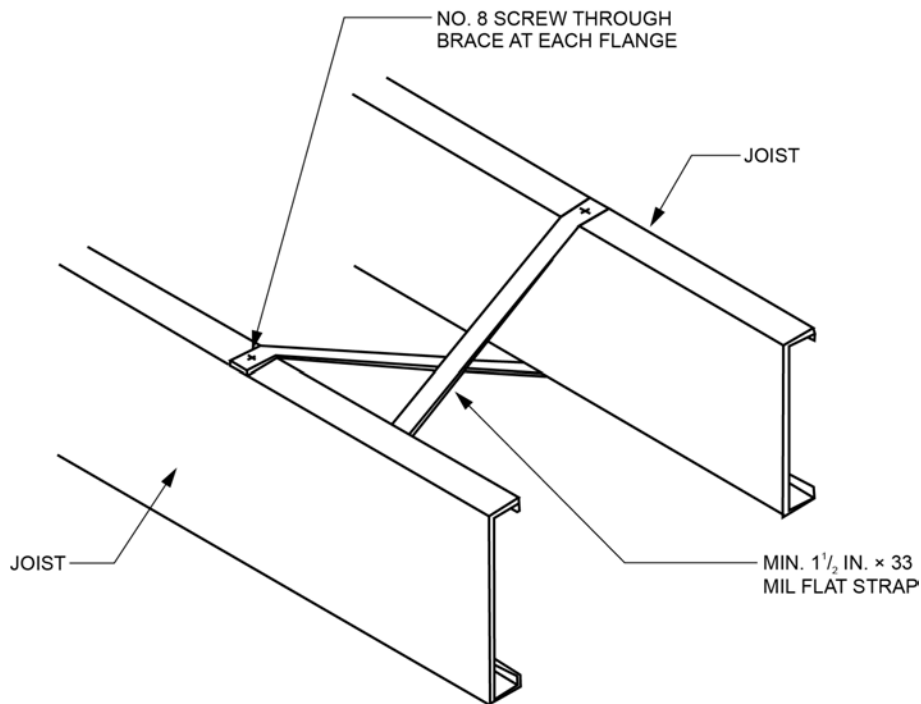
f. Table R505.3.2 is not applicable for 800S162-33 and 1000S162-43 continuous joist members.

FLOORS



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

FIGURE R505.3.3.2(1)  
JOIST BLOCKING (SOLID)



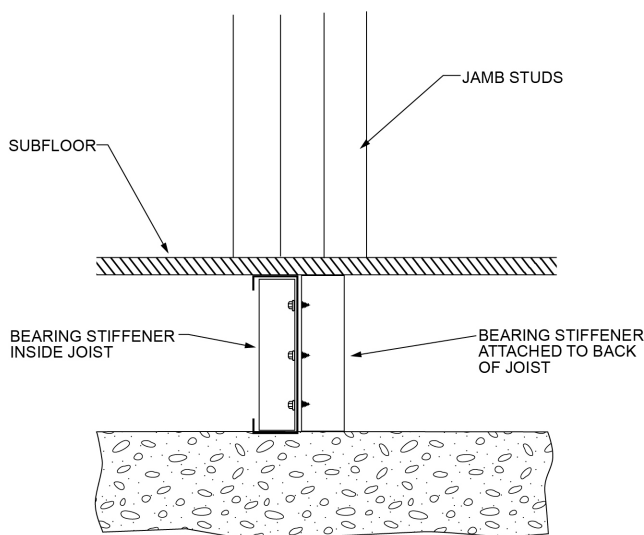
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

FIGURE R505.3.3.2(2)  
JOIST BLOCKING (STRAP)

**R505.3.3.4 Blocking at cantilevers.** Blocking shall be installed between every other joist over cantilever bearing supports in accordance with Figure R505.3.1(4), R505.3.1(5) or R505.3.1(6). Blocking shall consist of C-shaped or track section with minimum thickness of 33 mils (0.84 mm). Blocking shall be fastened to each adjacent joist through bent web of blocking, 33 mil clip angle or flange of web stiffener with two No. 8 screws at each end. The depth of the blocking shall be equal to the depth of the joist. The minimum length of the angle shall be equal to the depth of the joist minus 2 inches (51 mm). Blocking shall be fastened through the floor sheathing and to the support with three No. 8 screws (top and bottom).

**R505.3.4 Bearing stiffeners.** Bearing stiffeners shall be installed at each joist bearing location in accordance with this section, except for joists lapped over an interior support not carrying a *load-bearing wall* above. Floor joists supporting jamb studs with multiple members shall have two bearing stiffeners in accordance with Figure R505.3.4(1). Bearing stiffeners shall be fabricated from a C-shaped, track or clip angle member in accordance with one of the following:

1. C-shaped bearing stiffeners:
  - 1.1. Where the joist is not carrying a *load-bearing wall* above, the bearing stiffener shall be a minimum 33 mil (0.84 mm) thickness.
  - 1.2. Where the joist is carrying a *load-bearing wall* above, the bearing stiffener shall be not less than the same designation thickness as the wall stud above.
2. Track bearing stiffeners:
  - 2.1. Where the joist is not carrying a *load-bearing wall* above, the bearing stiffener shall be a minimum 43 mil (1.09 mm) thickness.



**FIGURE R505.3.4(1)**  
**BEARING STIFFENERS UNDER JAMB STUDS**

- 2.2. Where the joist is carrying a *load-bearing wall* above, the bearing stiffener shall be not less than one designation thickness greater than the wall stud above.

The minimum length of a bearing stiffener shall be the depth of member being stiffened minus  $\frac{3}{8}$  inch (9.5 mm). Each bearing stiffener shall be fastened to the web of the member it is stiffening as shown in Figure R505.3.4(2).

**R505.3.5 Cutting and notching.** Flanges and lips of load-bearing cold-formed steel floor framing members shall not be cut or notched.

**R505.3.6 Floor cantilevers.** Floor cantilevers for the top floor of a two- or three-story building or the first floor of a one-story building shall not exceed 24 inches (610 mm). Cantilevers, not exceeding 24 inches (610 mm) and supporting two stories and roof (first floor of a two-story building), shall be permitted provided that all cantilevered joists are doubled (nested or back-to-back). The doubled cantilevered joists shall extend not less than 6 feet (1829 mm) toward the inside and shall be fastened with not less than two No. 8 screws spaced at 24 inches (610 mm) on center through the webs (for back-to-back) or flanges (for nested joists).

**R505.3.7 Splicing.** Joists and other structural members shall not be spliced without an *approved* design. Splicing of tracks shall conform to Figure R505.3.7.

**R505.3.8 Framing of floor openings.** Openings in floors shall be framed with header and trimmer joists. Header joist spans shall not exceed 6 feet (1829 mm) or 8 feet (2438 mm) in length in accordance with Figure R505.3.8(1) or R505.3.8(2), respectively. Header and trimmer joists shall be fabricated from joist and track members, having a minimum size and thickness at least equivalent to the adjacent floor joists, and shall be installed in accordance with Figures R505.3.8(1), R505.3.8(2), R505.3.8(3) and R505.3.8(4). Each header joist shall be connected to trimmer joists with four 2-inch by 2-inch (51-mm by 51-mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four No. 8 screws, evenly spaced, through each leg of the clip angle. The clip angles shall have a thickness not less than that of the floor joist. Each track section for a built-up header or trimmer joist shall extend the full length of the joist (continuous).

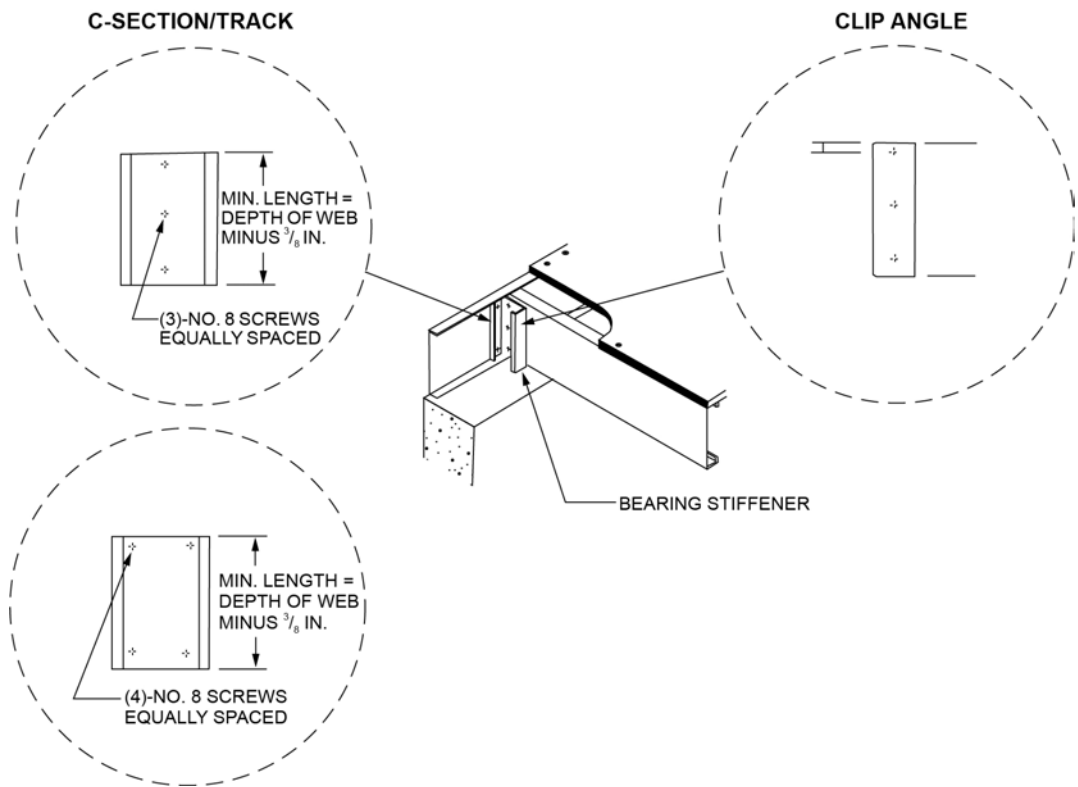
## **SECTION R506** **CONCRETE FLOORS (ON GROUND)**

**R506.1 General.** Concrete slab-on-ground floors shall be designed and constructed in accordance with the provisions of this section or ACI 332. Floors shall be a minimum  $3\frac{1}{2}$  inches (89 mm) thick (for *expansive soils*, see Section R403.1.8). The specified compressive strength of concrete shall be as set forth in Section R402.2.

**R506.2 Site preparation.** The area within the foundation walls shall have all vegetation, top soil and foreign material removed.

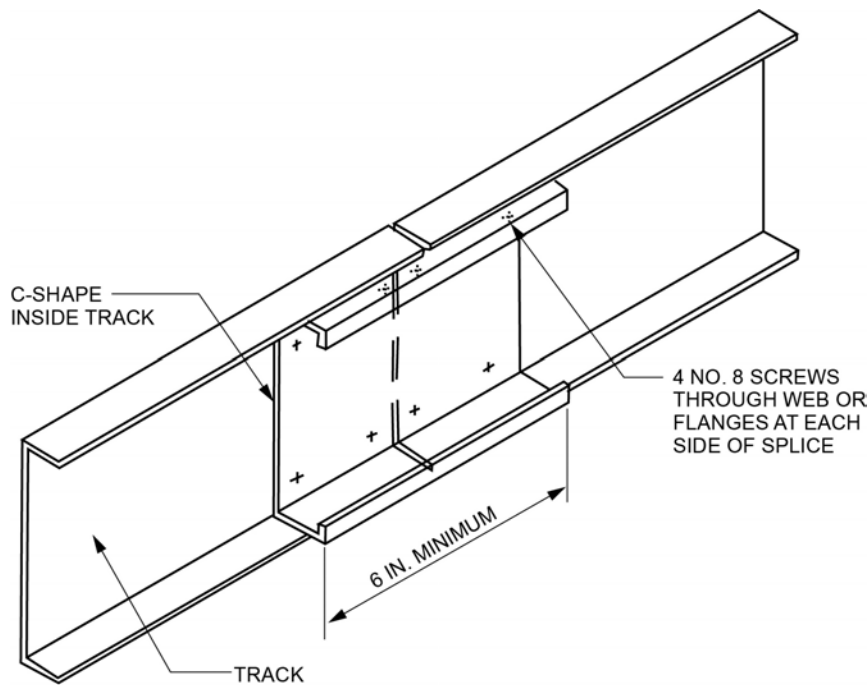


FLOORS



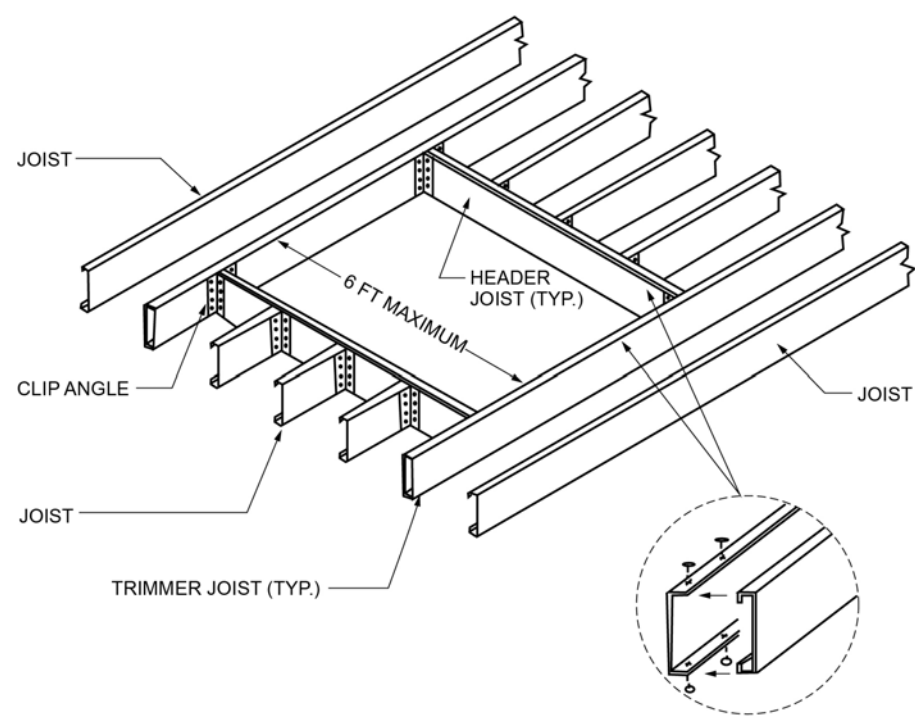
For SI: 1 inch = 25.4 mm.

FIGURE R505.3.4(2)  
BEARING STIFFENER



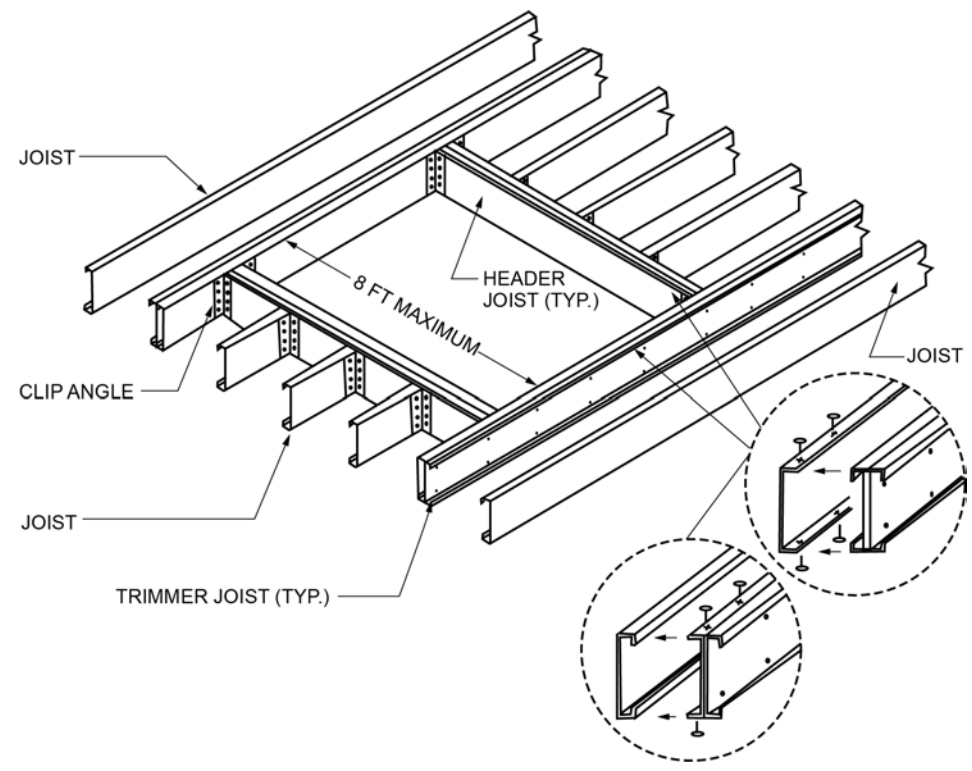
For SI: 1 inch = 25.4 mm.

FIGURE R505.3.7  
TRACK SPLICE



For SI: 1 foot = 304.8 mm.

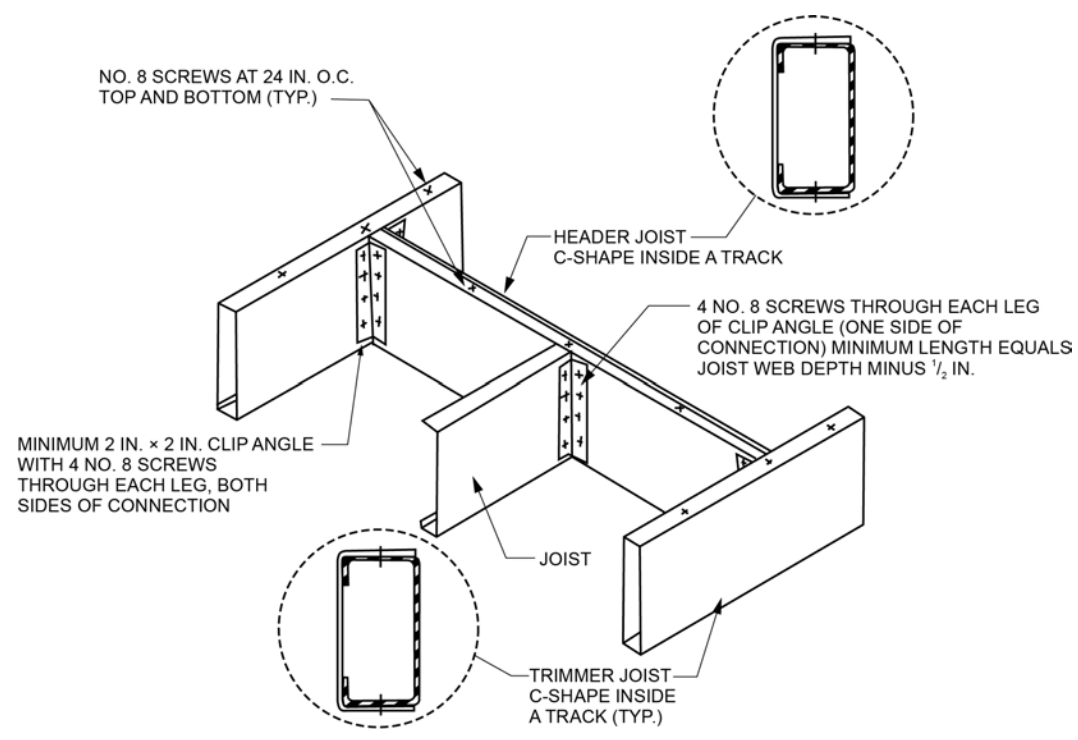
**FIGURE R505.3.8(1)**  
**COLD-FORMED STEEL FLOOR CONSTRUCTION—6-FOOT FLOOR OPENING**



For SI: 1 foot = 304.8 mm.

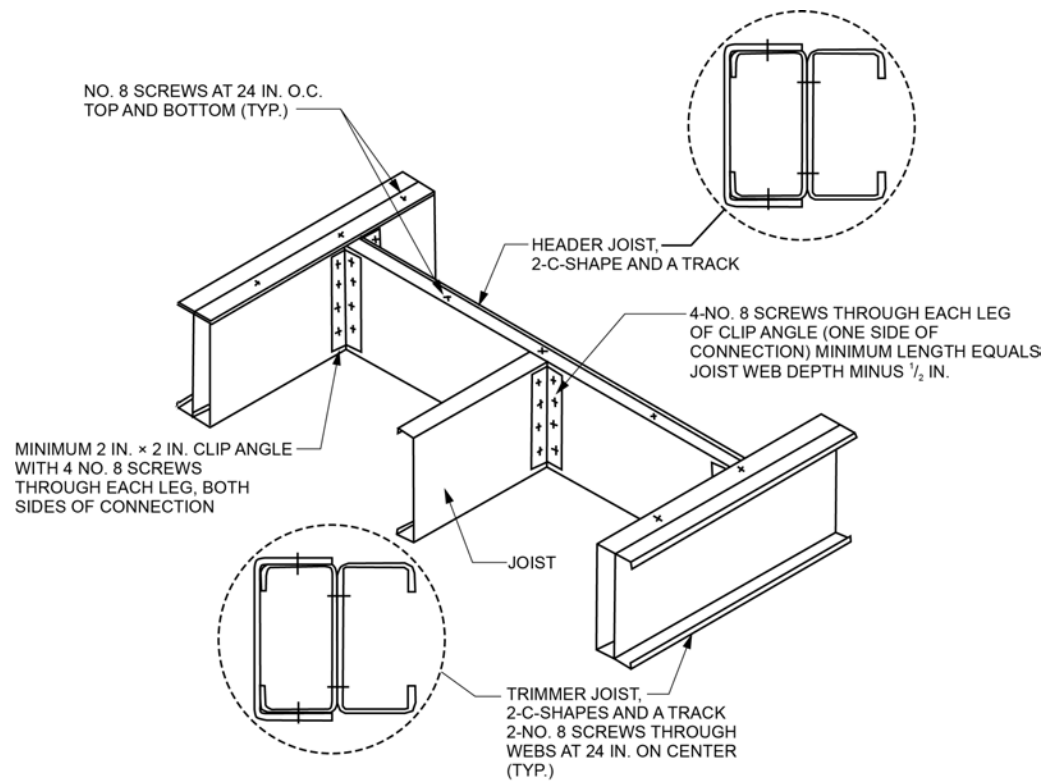
**FIGURE R505.3.8(2)**  
**COLD-FORMED STEEL FLOOR CONSTRUCTION—8-FOOT FLOOR OPENING**

FLOORS



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R505.3.8(3)**  
**COLD-FORMED STEEL FLOOR CONSTRUCTION: FLOOR HEADER TO TRIMMER CONNECTION—6-FOOT OPENING**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R505.3.8(4)**  
**COLD-FORMED STEEL FLOOR CONSTRUCTION: FLOOR HEADER TO TRIMMER CONNECTION—8-FOOT OPENING**

**R506.2.1 Fill.** Fill material shall be free of vegetation and foreign material. The fill shall be compacted to ensure uniform support of the slab, and except where *approved*, the fill depths shall not exceed 24 inches (610 mm) for clean sand or gravel and 8 inches (203 mm) for earth.

**R506.2.2 Base.** A 4-inch-thick (102 mm) base course consisting of clean graded sand, gravel, crushed stone, crushed concrete or crushed blast-furnace slag passing a 2-inch (51 mm) sieve shall be placed on the prepared subgrade where the slab is below *grade*.

**Exception:** A base course is not required where the concrete slab is installed on well-drained or sand-gravel mixture soils classified as Group I according to the United Soil Classification System in accordance with Table R405.1.

**R506.2.3 Vapor retarder.** A minimum 10-mil (0.010 inch; 0.254 mm) vapor retarder conforming to ASTM E1745 Class A requirements with joints lapped not less than 6 inches (152 mm) shall be placed between the concrete floor slab and the base course or the prepared subgrade where a base course does not exist.

**Exception:** The vapor retarder is not required for the following:

1. Garages, utility buildings and other unheated *accessory structures*.
2. For unheated storage rooms having an area of less than 70 square feet (6.5 m<sup>2</sup>) and carports.
3. Driveways, walks, patios and other flatwork not likely to be enclosed and heated at a later date.
4. Where *approved* by the *building official*, based on local site conditions.

**R506.2.4 Reinforcement support.** Where provided in slabs-on-ground, reinforcement shall be supported to remain in place from the center to upper one-third of the slab for the duration of the concrete placement.

## SECTION R507 EXTERIOR DECKS

**R507.1 Decks.** Wood-framed decks shall be in accordance with this section. Decks shall be designed for the *live load* required in Section R301.5 or the ground snow load indicated in Table R301.2, whichever is greater. For decks using materials and conditions not prescribed in this section, refer to Section R301.

**R507.2 Materials.** Materials used for the construction of decks shall comply with this section.

**R507.2.1 Wood materials.** Wood materials shall be No. 2 grade or better lumber, preservative-treated in accordance with Section R317, or *approved*, naturally durable lumber, and termite protected where required in accordance with Section R318. Where design in accordance with Section R301 is provided, wood structural members

shall be designed using the wet service factor defined in AWC NDS. Cuts, notches and drilled holes of preservative-treated wood members shall be treated in accordance with Section R317.1.1. All preservative-treated wood products in contact with the ground shall be *labeled* for such usage.

**R507.2.1.1 Engineered wood products.** Engineered wood products shall be in accordance with Section R502.

**R507.2.2 Plastic composite deck boards, stair treads, guards or handrails.** *Plastic composite* exterior deck boards, stair treads, *guards* and *handrails* shall comply with the requirements of ASTM D7032 and this section.

**R507.2.2.1 Labeling.** *Plastic composite* deck boards and stair treads, or their packaging, shall bear a *label* that indicates compliance with ASTM D7032 and includes the allowable load and maximum allowable span determined in accordance with ASTM D7032. *Plastic* or composite *handrails* and *guards*, or their packaging, shall bear a *label* that indicates compliance with ASTM D7032 and includes the maximum allowable span determined in accordance with ASTM D7032.

**R507.2.2.2 Flame spread index.** *Plastic composite* deck boards, stair treads, *guards*, and *handrails* shall exhibit a flame spread index not exceeding 200 when tested in accordance with ASTM E84 or UL 723 with the test specimen remaining in place during the test.

**Exception:** *Plastic composites* determined to be noncombustible.

**R507.2.2.3 Decay resistance.** *Plastic composite* deck boards, stair treads, *guards* and *handrails* containing wood, cellulosic or other biodegradable materials shall be decay resistant in accordance with ASTM D7032.

**R507.2.2.4 Termite resistance.** Where required by Section 318, *plastic composite* deck boards, stair treads, *guards* and *handrails* containing wood, cellulosic or other biodegradable materials shall be termite resistant in accordance with ASTM D7032.

**R507.2.2.5 Installation of plastic composites.** *Plastic composite* deck boards, stair treads, *guards* and *handrails* shall be installed in accordance with this code and the manufacturer's instructions.

**R507.2.3 Fasteners and connectors.** Metal fasteners and connectors used for all decks shall be in accordance with Section R317.3 and Table R507.2.3.

**R507.2.4 Flashing.** Flashing shall be corrosion-resistant metal of nominal thickness not less than 0.019 inch (0.48 mm) or *approved* nonmetallic material that is compatible with the substrate of the structure and the decking materials.

**R507.2.5 Alternate materials.** Alternative materials, including glass and metals, shall be permitted.



## FLOORS

**TABLE R507.2.3**  
**FASTENER AND CONNECTOR SPECIFICATIONS FOR DECKS<sup>a, b</sup>**

ITEM	MATERIAL	MINIMUM FINISH/COATING	ALTERNATE FINISH/COATING <sup>c</sup>
Nails and glulam rivets	In accordance with ASTM F1667	Hot-dipped galvanized per ASTM A153, Class D for $\frac{3}{8}$ -inch diameter and less	Stainless steel, silicon bronze or copper
Bolts <sup>c</sup>	In accordance with ASTM A307 (bolts), ASTM A563 (nuts), ASTM F844 (washers)	Hot-dipped galvanized per ASTM A153, Class C (Class D for $\frac{3}{8}$ -inch diameter and less) or mechanically galvanized per ASTM B695, Class 55 or 410 stainless steel	Stainless steel, silicon bronze or copper
Lag screws <sup>d</sup> (including nuts and washers)			
Metal connectors	Per manufacturer's specification	ASTM A653 type G185 zinc-coated galvanized steel or post hot-dipped galvanized per ASTM A123 providing a minimum average coating weight of 2.0 oz./ft <sup>2</sup> (total both sides)	Stainless steel

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Equivalent materials, coatings and finishes shall be permitted.

b. Fasteners and connectors exposed to salt water or located within 300 feet of a salt water shoreline shall be stainless steel.

c. Holes for bolts shall be drilled a minimum  $\frac{1}{32}$  inch and a maximum  $\frac{1}{16}$  inch larger than the bolt.

d. Lag screws  $\frac{1}{2}$  inch and larger shall be predrilled to avoid wood splitting per the *National Design Specification (NDS) for Wood Construction*.

e. Stainless-steel-driven fasteners shall be in accordance with ASTM F1667.

**R507.3 Footings.** Decks shall be supported on concrete footings or other *approved* structural systems designed to accommodate all loads in accordance with Section R301. Deck footings shall be sized to carry the imposed loads from the deck structure to the ground as shown in Figure R507.3.

**Exceptions:**

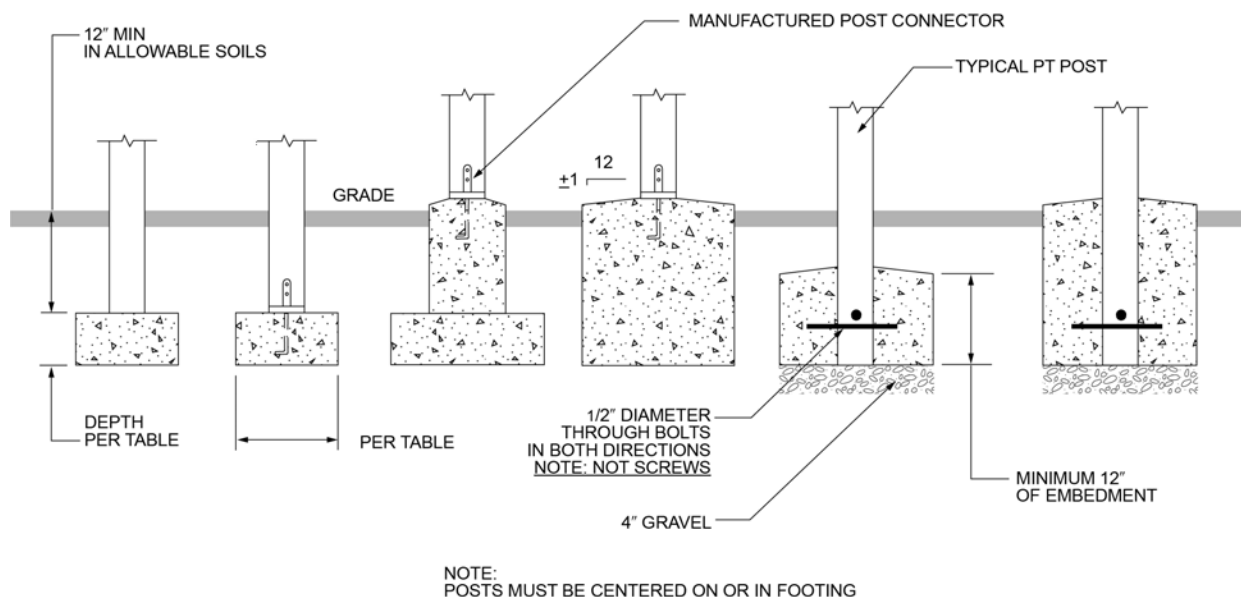
- Footings shall not be required for free-standing decks consisting of joists directly supported on grade over their entire length.
- Footings shall not be required for free-standing decks that meet all of the following criteria:
  - The joists bear directly on *precast concrete* pier blocks at grade without support by beams or posts.

2.2. The area of the deck does not exceed 200 square feet (18.6 m<sup>2</sup>).

2.3. The walking surface is not more than 20 inches (508 mm) above grade at any point within 36 inches (914 mm) measured horizontally from the edge.

**R507.3.1 Minimum size.** The minimum size of concrete footings shall be in accordance with Table R507.3.1, based on the tributary area and allowable soil-bearing pressure in accordance with Table R401.4.1.

**R507.3.2 Minimum depth.** Deck footings shall be placed not less than 12 inches (305 mm) below the undisturbed ground surface.



For SI: 1 inch = 25.4 mm.

**FIGURE R507.3**  
**DECK POSTS TO DECK FOOTING CONNECTION**

**TABLE R507.3.1**  
**MINIMUM FOOTING SIZE FOR DECKS**

LIVE OR GROUND SNOW LOAD <sup>b</sup> (psf)	TRIBUTARY AREA (ft <sup>2</sup> )	LOAD-BEARING VALUE OF SOILS <sup>a, c, d</sup> (psf)								
		1,500 <sup>e</sup>			2,000 <sup>e</sup>			≥ 3,000 <sup>e</sup>		
		Side of a square footing (inches)	Diameter of a round footing (inches)	Thickness (inches) <sup>f</sup>	Side of a square footing (inches)	Diameter of a round footing (inches)	Thickness (inches) <sup>f</sup>	Side of a square footing (inches)	Diameter of a round footing (inches)	Thickness (inches) <sup>f</sup>
40	5	7	8	6	7	8	6	7	8	6
	20	10	12	6	9	9	6	7	8	6
	40	14	16	6	12	14	6	10	12	6
	60	17	19	6	15	17	6	12	14	6
	80	20	22	7	17	19	6	14	16	6
	100	22	25	8	19	21	6	15	17	6
	120	24	27	9	21	23	7	17	19	6
	140	26	29	10	22	25	8	18	21	6
	160	28	31	11	24	27	9	20	22	7
50	5	7	8	6	7	8	6	7	8	6
	20	11	13	6	10	11	6	8	9	6
	40	15	17	6	13	15	6	11	13	6
	60	19	21	6	16	18	6	13	15	6
	80	21	24	8	19	21	6	15	17	6
	100	24	27	9	21	23	7	17	19	6
	120	26	30	10	23	26	8	19	21	6
	140	28	32	11	25	28	9	20	23	7
	160	30	34	12	26	30	10	21	24	8
60	5	7	8	6	7	8	6	7	8	6
	20	12	14	6	11	12	6	9	10	6
	40	16	19	6	14	16	8	12	14	6
	60	20	23	7	17	20	6	14	16	6
	80	23	26	9	20	23	7	16	19	6
	100	26	29	10	22	25	8	18	21	6
	120	28	32	11	25	28	9	20	23	7
	140	31	35	12	27	30	10	22	24	8
	160	33	37	13	28	32	11	23	26	9
70	5	7	8	6	7	8	6	7	8	6
	20	12	14	6	11	13	6	9	10	6
	40	18	20	6	15	17	6	12	14	6
	60	21	24	8	19	21	6	15	17	6
	80	25	28	9	21	24	8	18	20	6
	100	28	31	11	24	27	9	20	22	7
	120	30	34	12	26	30	10	21	24	8
	140	33	37	13	28	32	11	23	26	9
	160	35	40	15	30	34	12	25	28	9

For SI: 1 inch = 25.4 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square foot = 0.0479 kPa.

a. Interpolation permitted, extrapolation not permitted.

b. Based on highest load case: Dead + Live or Dead + Snow.

c. Footing dimensions shall allow complete bearing of the post.

d. If the support is a brick or CMU pier, the footing shall have a minimum 2-inch projection on all sides.

e. Area, in square feet, of deck surface supported by post and footings.

f. Minimum thickness shall only apply to plain concrete footings.

## FLOORS

**R507.3.3 Frost protection.** Where decks are attached to a frost-protected structure, deck footings shall be protected from frost by one or more of the following methods:

1. Extending below the frost line specified in Table R301.2.

2. Erecting on solid rock.

3. Other *approved* methods of frost protection.

**R507.4 Deck posts.** For single-level decks, wood post size shall be in accordance with Table R507.4.

**TABLE R507.4  
DECK POST HEIGHT**

LOADS (psf) <sup>b</sup>	POST SPECIES <sup>c</sup>	POST SIZE <sup>d</sup>	TRIBUTARY AREA (ft <sup>2</sup> ) <sup>g, h</sup>							
			20	40	60	80	100	120	140	160
			MAXIMUM DECK POST HEIGHT <sup>a</sup> (feet-inches)							
40 live load	Southern pine	4 × 4	14-0	13-8	11-0	9-5	8-4	7-5	6-9	6-2
		4 × 6	14-0	14-0	13-11	12-0	10-8	9-8	8-10	8-2
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	4 × 4	14-0	13-6	10-10	9-3	8-0	7-0	6-2	5-3
		4 × 6	14-0	14-0	13-10	11-10	10-6	9-5	8-7	7-10
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	4 × 4	14-0	13-2	10-3	8-1	5-8	NP	NP	NP
		4 × 6	14-0	14-0	13-6	11-4	9-9	8-4	6-9	4-7
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	13-7	9-7
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
50 ground snow load	Southern pine	4 × 4	14-0	12-2	9-10	8-5	7-5	6-7	5-11	5-4
		4 × 6	14-0	14-0	12-6	10-9	9-6	8-7	7-10	7-3
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	13-4
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	4 × 4	14-0	12-1	9-8	8-2	7-1	6-2	5-3	4-2
		4 × 6	14-0	14-0	12-4	10-7	9-4	8-4	7-7	6-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	12-10
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	4 × 4	14-0	11-8	9-0	6-10	3-7	NP	NP	NP
		4 × 6	14-0	14-0	12-0	10-0	8-6	7-0	5-3	NP
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	10-8	2-4
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
60 ground snow load	Southern pine	4 × 4	14-0	11-1	8-11	7-7	6-7	5-10	5-2	4-6
		4 × 6	14-0	14-0	11-4	9-9	8-7	7-9	7-1	6-6
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	12-9	11-2
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	4 × 4	14-0	10-11	8-8	7-3	6-2	5-0	3-7	NP
		4 × 6	14-0	13-11	11-2	9-7	8-4	7-5	6-8	5-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	14-0	12-2	10-2
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	4 × 4	14-0	10-6	7-9	4-7	NP	NP	NP	NP
		4 × 6	14-0	13-7	10-9	8-9	7-0	4-9	NP	NP
		6 × 6	14-0	14-0	14-0	14-0	14-0	9-9	NP	NP
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0

(continued)

**TABLE R507.4—continued**  
**DECK POST HEIGHT**

LOADS (psf) <sup>b</sup>	POST SPECIES <sup>c</sup>	POST SIZE <sup>d</sup>	TRIBUTARY AREA (ft <sup>2</sup> ) <sup>g,h</sup>							
			20	40	60	80	100	120	140	160
			MAXIMUM DECK POST HEIGHT <sup>a</sup> (feet-inches)							
70 ground snow load	Southern pine	4 × 4	14-0	10-2	8-2	6-11	5-11	5-2	4-4	3-4
		4 × 6	14-0	12-11	10-5	8-11	7-10	7-1	6-5	5-10
		6 × 6	14-0	14-0	14-0	14-0	14-0	12-9	10-11	8-7
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas fir <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	4 × 4	14-0	10-1	7-11	6-6	5-3	3-7	NP	NP
		4 × 6	14-0	12-10	10-3	8-9	7-7	6-8	5-10	4-11
		6 × 6	14-0	14-0	14-0	14-0	14-0	12-2	9-9	5-9
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	4 × 4	14-0	9-5	6-5	NP	NP	NP	NP	NP
		4 × 6	14-0	12-6	9-8	7-7	5-3	NP	NP	NP
		6 × 6	14-0	14-0	14-0	14-0	10-8	NP	NP	NP
		8 × 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

NP = Not Permitted.

a. Measured from the underside of the beam to the top of footing or pier.

b. 10 psf dead load. Snow load not assumed to be concurrent with live load.

c. No. 2 grade, wet service factor included.

d. Notched deck posts shall be sized to accommodate beam size in accordance with Section R507.5.2.

e. Includes incising factor.

f. Incising factor not included.

g. Area, in square feet, of deck surface supported by post and footings.

h. Interpolation permitted. Extrapolation not permitted.

**R507.4.1 Deck post to deck footing connection.** Where posts bear on concrete footings in accordance with Section R403 and Figure R507.3, lateral restraint shall be provided by manufactured connectors or a minimum post embedment of 12 inches (305 mm) in surrounding soils or concrete piers. Other footing systems shall be permitted.

**Exception:** Where expansive, compressible, shifting or other questionable soils are present, surrounding soils shall not be relied on for lateral support.

**R507.5 Deck beams.** Maximum allowable spans for wood deck beams, as shown in Figure R507.5, shall be in accordance with Tables R507.5(1) through R507.5(4). Beam plies shall be fastened together with two rows of 10d (3-inch × 0.128-inch) nails minimum at 16 inches (406 mm) on center along each edge. Beams shall be permitted to cantilever at each end up to one-fourth of the actual beam span. Deck beams of other materials shall be permitted where designed in accordance with accepted engineering practices.

**R507.5.1 Deck beam bearing.** The ends of beams shall have not less than 1½ inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) of bearing on concrete or masonry for the entire width of the beam. Where multiple-span beams bear on intermediate posts, each ply must have full bearing on the post in accordance with Figures R507.5.1(1) and R507.5.1(2).

**R507.5.2 Deck beam connection to supports.** Deck beams shall be attached to supports in a manner capable of transferring vertical loads and resisting horizontal displacement. Deck beam connections to wood posts shall be in accordance with Figures R507.5.1(1) and R507.5.1(2). Manufactured post-to-beam connectors shall be sized for the post and beam sizes. Bolts shall have washers under the head and nut.

**R507.6 Deck joists.** Maximum allowable spans for wood deck joists, as shown in Figure R507.6, shall be in accordance with Table R507.6. The maximum joist spacing shall be limited by the decking materials in accordance with Table R507.7.

**R507.6.1 Deck joist bearing.** The ends of joists shall have not less than 1½ inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) of bearing on concrete or masonry over its entire width. Joists bearing on top of a multiple-ply beam or ledger shall be fastened in accordance with Table R602.3(1). Joists bearing on top of a single-ply beam or ledger shall be attached by a mechanical connector. Joist framing into the side of a beam or ledger board shall be supported by *approved* joist hangers.

**R507.6.2 Deck joist lateral restraint.** Joist ends and bearing locations shall be provided with lateral resistance to prevent rotation. Where lateral restraint is provided by joist hangers or blocking between joists, their depth shall



## FLOORS

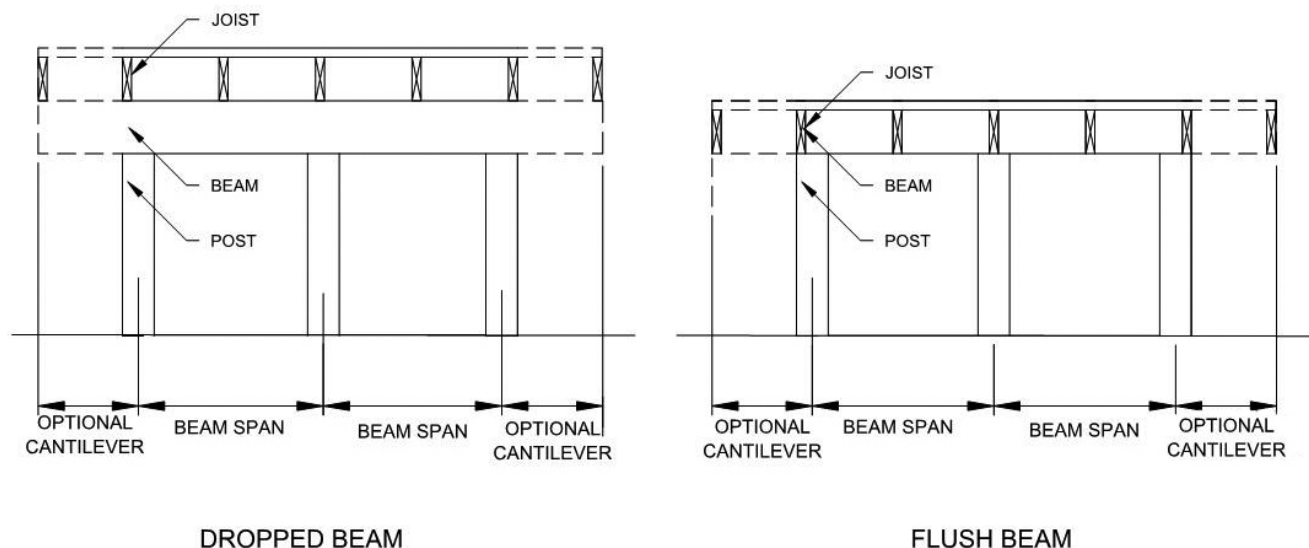


FIGURE R507.5  
TYPICAL DECK JOIST SPANS

equal not less than 60 percent of the joist depth. Where lateral restraint is provided by rim joists, they shall be secured to the end of each joist with not fewer than three 10d (3-inch by 0.128-inch) (76 mm by 3.3 mm) nails or three No. 10 x 3-inch-long (76 mm) wood screws.

**R507.7 Decking.** Maximum allowable spacing for joists supporting wood decking, excluding *stairways*, shall be in accordance with Table R507.7. Wood decking shall be attached to each supporting member with not less than two 8d threaded nails or two No. 8 wood screws. Maximum allowable spacing for joists supporting *plastic composite* decking shall be in accordance with Section R507.2. Other *approved* decking or fastener systems shall be installed in accordance with the manufacturer's installation requirements.

**R507.8 Vertical and lateral supports.** Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for both vertical and lateral loads. Such attachment shall not be accomplished by the use of toenails or nails subject to withdrawal. For decks with cantilevered framing members, connection to exterior walls or other framing members shall be designed and constructed to resist uplift resulting from the full *live load* specified in Table R301.5 acting on the cantilevered portion of the deck. Where positive connection to the

primary building structure cannot be verified during inspection, decks shall be self-supporting.

**R507.9 Vertical and lateral supports at band joist.** Vertical and lateral supports for decks shall comply with this section.

**R507.9.1 Vertical supports.** Vertical loads shall be transferred to band joists with ledgers in accordance with this section.

**R507.9.1.1 Ledger details.** Deck ledgers shall be a minimum 2-inch by 8-inch (51 mm by 203 mm) nominal, pressure-preservative-treated Southern pine, incised pressure-preservative-treated hem-fir, or *approved*, naturally durable, No. 2 grade or better lumber. Deck ledgers shall not support concentrated loads from beams or girders. Deck ledgers shall not be supported on stone or masonry veneer.

**R507.9.1.2 Band joist details.** Band joists supporting a ledger shall be a minimum 2-inch-nominal (51 mm), solid-sawn, spruce-pine-fir or better lumber or a minimum 1-inch (25 mm) nominal engineered wood rim boards in accordance with Section R502.1.7. Band joists shall bear fully on the primary structure capable of supporting all required loads.

**TABLE R507.5(1)**  
**MAXIMUM DECK BEAM SPAN—40 PSF LIVE LOAD<sup>c</sup>**

BEAM SPECIES <sup>d</sup>	BEAM SIZE <sup>e</sup>	EFFECTIVE DECK JOIST SPAN LENGTH <sup>a, i, j</sup> (feet)						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches) <sup>a, b, f</sup>						
Southern pine	1 – 2 × 6	4-7	4-0	3-7	3-3	3-0	2-10	2-8
	1 – 2 × 8	5-11	5-1	4-7	4-2	3-10	3-7	3-5
	1 – 2 × 10	7-0	6-0	5-5	4-11	4-7	4-3	4-0
	1 – 2 × 12	8-3	7-1	6-4	5-10	5-5	5-0	4-9
	2 – 2 × 6	6-11	5-11	5-4	4-10	4-6	4-3	4-0
	2 – 2 × 8	8-9	7-7	6-9	6-2	5-9	5-4	5-0
	2 – 2 × 10	10-4	9-0	8-0	7-4	6-9	6-4	6-0
	2 – 2 × 12	12-2	10-7	9-5	8-7	8-0	7-5	7-0
	3 – 2 × 6	8-6	7-5	6-8	6-1	5-8	5-3	4-11
	3 – 2 × 8	10-11	9-6	8-6	7-9	7-2	6-8	6-4
	3 – 2 × 10	13-0	11-2	10-0	9-2	8-6	7-11	7-6
	3 – 2 × 12	15-3	13-3	11-10	10-9	10-0	9-4	8-10
Douglas fir-larch <sup>g</sup> Hem-fir <sup>g</sup> Spruce-pine-fir	1 – 2 × 6	4-1	3-6	3-0	2-8	2-5	2-3	2-1
	1 – 2 × 8	5-6	4-8	4-0	3-6	3-2	2-11	2-9
	1 – 2 × 10	6-8	5-10	5-1	4-6	4-1	3-9	3-6
	1 – 2 × 12	7-9	6-9	6-0	5-6	5-0	3-9	3-6
	2 – 2 × 6	6-1	5-3	4-9	4-4	3-11	3-7	3-3
	2 – 2 × 8	8-2	7-1	6-4	5-9	5-2	4-8	4-4
	2 – 2 × 10	10-0	8-7	7-9	7-0	6-6	6-0	5-6
	2 – 2 × 12	11-7	10-0	8-11	8-2	7-7	7-1	6-8
	3 – 2 × 6	7-8	6-8	6-0	5-6	5-1	4-9	4-6
	3 – 2 × 8	10-3	8-10	7-11	7-3	6-8	6-3	5-11
	3 – 2 × 10	12-6	10-10	9-8	8-10	8-2	7-8	7-2
	3 – 2 × 12	14-6	12-7	11-3	10-3	9-6	8-11	8-5
Redwood <sup>h</sup> Western cedars <sup>h</sup> Ponderosa pine <sup>h</sup> Red pine <sup>h</sup>	1 – 2 × 6	4-2	3-7	3-1	2-9	2-6	2-3	2-2
	1 – 2 × 8	5-4	4-7	4-1	3-7	3-3	3-0	2-10
	1 – 2 × 10	6-6	5-7	5-0	4-7	4-2	3-10	3-7
	1 – 2 × 12	7-6	6-6	5-10	5-4	4-11	4-7	4-4
	2 – 2 × 6	6-2	5-4	4-10	4-5	4-0	3-8	3-4
	2 – 2 × 8	7-10	6-10	6-1	5-7	5-2	4-10	4-5
	2 – 2 × 10	9-7	8-4	7-5	6-9	6-3	5-10	5-6
	2 – 2 × 12	11-1	9-8	8-7	7-10	7-3	6-10	6-5
	3 – 2 × 6	7-8	6-9	6-0	5-6	5-1	4-9	4-6
	3 – 2 × 8	9-10	8-6	7-7	6-11	6-5	6-0	5-8
	3 – 2 × 10	12-0	10-5	9-4	8-6	7-10	7-4	6-11
	3 – 2 × 12	13-11	12-1	10-9	9-10	9-1	8-6	8-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Interpolation permitted. Extrapolation not permitted.

b. Beams supporting a single span of joists with or without cantilever.

c. Dead load = 10 psf,  $L/\Delta = 360$  at main span,  $L/\Delta = 180$  at cantilever. Snow load is not assumed to be concurrent with live load.

d. No. 2 grade, wet service factor included.

e. Beam depth shall be equal to or greater than the depth of intersecting joist for a flush beam connection.

f. Beam cantilevers are limited to the adjacent beam's span divided by 4.

g. Includes incising factor.

h. Incising factor not included.

i. Deck joist span as shown in Figure R507.5.

j. For calculation of effective deck joist span, the actual joist span length shall be multiplied by the joist span factor in accordance with Table R507.5(5).

## FLOORS

**TABLE R507.5(2)**  
**MAXIMUM DECK BEAM SPAN—50 PSF GROUND SNOW LOAD<sup>c</sup>**

BEAM SPECIES <sup>d</sup>	BEAM SIZE <sup>e</sup>	EFFECTIVE DECK JOIST SPAN LENGTH (feet) <sup>a, i, j</sup>						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches) <sup>a, b, f</sup>						
Southern pine	1 – 2 × 6	4-6	3-11	3-6	3-2	2-11	2-9	2-7
	1 – 2 × 8	5-9	4-11	4-5	4-0	3-9	3-6	3-3
	1 – 2 × 10	6-9	5-10	5-3	4-9	4-5	4-2	3-11
	1 – 2 × 12	8-0	6-11	6-2	5-8	5-3	4-11	4-7
	2 – 2 × 6	6-8	5-9	5-2	4-9	4-4	4-1	3-10
	2 – 2 × 8	8-6	7-4	6-7	6-0	5-7	5-2	4-11
	2 – 2 × 10	10-1	8-9	7-10	7-1	6-7	6-2	5-10
	2 – 2 × 12	11-11	10-3	9-2	8-5	7-9	7-3	6-10
	3 – 2 × 6	7-11	7-2	6-6	5-11	5-6	5-1	4-10
	3 – 2 × 8	10-5	9-3	8-3	7-6	6-11	6-6	6-2
	3 – 2 × 10	12-8	10-11	9-9	8-11	8-3	7-9	7-3
	3 – 2 × 12	14-11	12-11	11-6	10-6	9-9	9-1	8-7
Douglas fir-larch <sup>g</sup> Hem-fir <sup>g</sup> Spruce-pine-fir <sup>g</sup>	1 – 2 × 6	4-0	3-5	2-11	2-7	2-4	2-2	2-0
	1 – 2 × 8	5-4	4-7	3-11	3-5	3-1	2-10	2-8
	1 – 2 × 10	6-7	5-8	4-11	4-5	4-0	3-8	3-5
	1 – 2 × 12	7-7	6-7	5-11	5-4	4-10	4-6	4-2
	2 – 2 × 6	6-0	5-2	4-7	4-2	3-10	3-5	3-2
	2 – 2 × 8	8-0	6-11	6-2	5-8	5-0	4-7	4-2
	2 – 2 × 10	9-9	8-5	7-7	6-11	6-4	5-10	5-4
	2 – 2 × 12	11-4	9-10	8-9	8-0	7-5	6-11	6-6
	3 – 2 × 6	7-6	6-6	5-9	5-3	4-11	4-7	4-4
	3 – 2 × 8	10-0	8-8	7-9	7-1	6-6	6-1	5-8
	3 – 2 × 10	12-3	10-7	9-6	8-8	8-0	7-6	7-0
	3 – 2 × 12	14-3	12-4	11-0	10-1	9-4	8-9	8-3
Redwood <sup>h</sup> Western cedars <sup>h</sup> Ponderosa pine <sup>h</sup> Red pine <sup>h</sup>	1 – 2 × 6	4-1	3-6	3-0	2-8	2-5	2-3	2-1
	1 – 2 × 8	5-2	4-6	4-0	3-6	3-2	2-11	2-9
	1 – 2 × 10	6-4	5-6	4-11	4-6	4-1	3-9	3-6
	1 – 2 × 12	7-4	6-4	5-8	5-2	4-10	4-6	4-3
	2 – 2 × 6	6-1	5-3	4-8	4-4	3-11	3-6	3-3
	2 – 2 × 8	7-8	6-8	5-11	5-5	5-0	4-8	4-3
	2 – 2 × 10	9-5	8-2	7-3	6-8	6-2	5-9	5-5
	2 – 2 × 12	10-11	9-5	8-5	7-8	7-2	6-8	6-3
	3 – 2 × 6	7-1	6-5	5-11	5-5	5-0	4-8	4-5
	3 – 2 × 8	9-4	8-4	7-5	6-10	6-0	5-11	5-7
	3 – 2 × 10	11-9	10-2	9-1	8-4	7-8	7-2	6-9
	3 – 2 × 12	13-8	11-10	10-7	9-8	8-11	8-4	7-10

For SI: 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Interpolation allowed. Extrapolation is not allowed.

b. Beams supporting a single span of joists with or without cantilever.

c. Dead load = 10 psf,  $L/\Delta = 360$  at main span,  $L/\Delta = 180$  at cantilever. Snow load not assumed to be concurrent with live load.

d. No. 2 grade, wet service factor included.

e. Beam depth shall be equal to or greater than the depth of intersecting joist for a flush beam connection.

f. Beam cantilevers are limited to the adjacent beam's span divided by 4.

g. Includes incising factor.

h. Incising factor not included.

i. Deck joist span as shown in Figure R507.5.

j. For calculation of effective deck joist span, the actual joist span length shall be multiplied by the joist span factor in accordance with Table R507.5(5).

**TABLE R507.5(3)**  
**MAXIMUM DECK BEAM SPAN—60 PSF GROUND SNOW LOAD<sup>c</sup>**

BEAM SPECIES <sup>d</sup>	BEAM SIZE <sup>e</sup>	EFFECTIVE DECK JOIST SPAN LENGTH <sup>a,i,j</sup> (feet)						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches) <sup>a,b,f</sup>						
Southern pine	1 – 2 × 6	4-2	3-7	3-3	2-11	2-9	2-6	2-5
	1 – 2 × 8	5-3	4-7	4-1	3-9	3-5	3-3	3-0
	1 – 2 × 10	6-3	5-5	4-10	4-5	4-1	3-10	3-7
	1 – 2 × 12	7-5	6-5	5-9	5-3	4-10	4-6	4-3
	2 – 2 × 6	6-2	5-4	4-9	4-4	4-0	3-9	3-7
	2 – 2 × 8	7-10	6-10	6-1	5-7	5-2	4-10	4-6
	2 – 2 × 10	9-4	8-1	7-3	6-7	6-1	5-8	5-4
	2 – 2 × 12	11-0	9-6	8-6	7-9	7-2	6-9	6-4
	3 – 2 × 6	7-5	6-9	6-0	5-6	5-1	4-9	4-6
	3 – 2 × 8	9-9	8-6	7-8	6-11	6-5	6-0	5-8
	3 – 2 × 10	11-8	10-2	9-1	8-3	7-8	7-2	6-9
	3 – 2 × 12	13-9	11-11	10-8	9-9	9-0	8-5	7-11
Douglas fir-larch <sup>g</sup> Hem-fir <sup>g</sup> Spruce-pine-fir <sup>g</sup>	1 – 2 × 6	3-8	3-1	2-8	2-4	2-2	2-0	1-10
	1 – 2 × 8	5-0	4-1	3-6	3-1	2-10	2-7	2-5
	1 – 2 × 10	6-1	5-2	4-6	4-0	3-7	3-4	3-2
	1 – 2 × 12	7-1	6-1	5-5	4-10	4-5	4-1	3-10
	2 – 2 × 6	5-6	4-9	4-3	3-10	3-5	3-1	2-10
	2 – 2 × 8	7-5	6-5	5-9	5-0	4-6	4-1	3-9
	2 – 2 × 10	9-0	7-10	7-0	6-4	5-9	5-2	4-10
	2 – 2 × 12	10-6	9-1	8-1	7-5	6-10	6-4	5-10
	3 – 2 × 6	6-11	6-0	5-4	4-11	4-6	4-2	3-10
	3 – 2 × 8	9-3	8-0	7-2	6-6	6-1	5-6	5-0
	3 – 2 × 10	11-4	9-10	8-9	8-0	7-5	6-11	6-5
	3 – 2 × 12	13-2	11-5	10-2	9-4	8-7	8-1	7-7
Redwood <sup>h</sup> Western cedars <sup>h</sup> Ponderosa pine <sup>h</sup> Red pine <sup>h</sup>	1 – 2 × 6	3-9	3-2	2-9	2-5	2-2	2-0	1-11
	1 – 2 × 8	4-10	4-2	3-7	3-2	2-11	2-8	2-6
	1 – 2 × 10	5-10	5-1	4-6	4-1	3-8	3-5	3-3
	1 – 2 × 12	6-10	5-11	5-3	4-10	4-5	4-2	3-11
	2 – 2 × 6	5-7	4-10	4-4	3-11	3-6	3-2	2-11
	2 – 2 × 8	7-1	6-2	5-6	5-0	4-7	4-2	3-10
	2 – 2 × 10	8-8	7-6	6-9	6-2	5-8	5-4	4-11
	2 – 2 × 12	10-1	8-9	7-10	7-2	6-7	6-2	5-10
	3 – 2 × 6	6-8	6-1	5-5	5-0	4-7	4-3	3-11
	3 – 2 × 8	8-9	7-9	6-22	6-4	5-20	5-5	5-3
	3 – 2 × 10	10-11	9-5	8-5	7-8	7-3	6-8	6-3
	3 – 2 × 12	12-8	10-11	9-9	8-11	8-3	7-9	7-3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Interpolation allowed. Extrapolation is not allowed.

b. Beams supporting a single span of joists with or without cantilever.

c. Dead load = 10 psf,  $L/\Delta = 360$  at main span,  $L/\Delta = 180$  at cantilever. Snow load not assumed to be concurrent with live load.

d. No. 2 grade, wet service factor included.

e. Beam depth shall be equal to or greater than the depth of intersecting joist for a flush beam connection.

f. Beam cantilevers are limited to the adjacent beam's span divided by 4.

g. Includes incising factor.

h. Incising factor not included.

i. Deck joist span as shown in Figure R507.5.

j. For calculation of effective deck joist span, the actual joist span length shall be multiplied by the joist span factor in accordance with Table R507.5(5).



## FLOORS

**TABLE R507.5(4)**  
**MAXIMUM DECK BEAM SPAN—70 PSF GROUND SNOW LOAD<sup>c</sup>**

BEAM SPECIES <sup>d</sup>	BEAM SIZE <sup>e</sup>	EFFECTIVE DECK JOIST SPAN LENGTH (feet) <sup>a, i, j</sup>						
		6	8	10	12	14	16	18
		MAXIMUM DECK BEAM SPAN LENGTH (feet-inches) <sup>a, b, f</sup>						
Southern pine	1 – 2 × 6	3-11	3-4	3-0	2-9	2-6	2-4	2-3
	1 – 2 × 8	4-11	4-3	3-10	3-6	3-3	3-0	2-10
	1 – 2 × 10	5-10	5-1	4-6	4-2	3-10	3-7	3-4
	1 – 2 × 12	6-11	6-0	5-4	4-11	4-6	4-3	4-0
	2 – 2 × 6	5-9	5-0	4-6	4-1	3-9	3-6	3-4
	2 – 2 × 8	7-4	6-4	5-8	5-2	4-10	4-6	4-3
	2 – 2 × 10	8-9	7-7	6-9	6-2	5-8	5-4	5-0
	2 – 2 × 12	10-3	8-11	8-0	7-3	6-9	6-3	5-11
	3 – 2 × 6	7-0	6-3	5-7	5-1	4-9	4-5	4-2
	3 – 2 × 8	9-3	8-0	7-2	6-6	6-0	5-8	5-4
	3 – 2 × 10	10-11	9-6	8-6	7-9	7-2	6-8	6-4
	3 – 2 × 12	12-11	11-2	10-0	9-1	8-5	7-11	7-5
Douglas fir-larch <sup>g</sup> Hem-fir <sup>g</sup> Spruce-pine-fir <sup>g</sup>	1 – 2 × 6	3-5	2-10	2-5	2-2	2-0	1-10	1-9
	1 – 2 × 8	4-7	3-8	3-2	2-10	2-7	2-5	2-4
	1 – 2 × 10	5-8	4-9	4-1	3-8	3-4	3-1	2-11
	1 – 2 × 12	6-7	5-8	5-0	4-6	4-1	3-10	3-7
	2 – 2 × 6	5-2	4-6	4-0	3-5	3-1	2-10	2-7
	2 – 2 × 8	6-11	6-0	5-3	4-7	4-1	3-8	3-5
	2 – 2 × 10	8-5	7-4	6-6	5-10	5-2	4-9	4-5
	2 – 2 × 12	9-10	8-6	7-7	6-11	6-4	5-9	5-4
	3 – 2 × 6	6-6	5-7	5-0	4-7	4-2	3-9	3-5
	3 – 2 × 8	8-8	7-6	6-8	6-1	5-6	5-0	4-7
	3 – 2 × 10	10-7	9-2	8-2	7-6	6-11	6-4	5-10
	3 – 2 × 12	12-4	10-8	9-7	8-9	8-1	7-7	7-1
Redwood <sup>h</sup> Western cedars <sup>h</sup> Ponderosa pine <sup>h</sup> Red pine <sup>h</sup>	1 – 2 × 6	3-6	2-11	2-6	2-3	2-0	1-11	1-9
	1 – 2 × 8	4-6	3-10	3-3	2-11	2-8	2-6	2-4
	1 – 2 × 10	5-6	4-9	4-2	3-9	3-5	3-2	3-0
	1 – 2 × 12	6-4	5-6	4-11	4-6	4-2	3-11	3-8
	2 – 2 × 6	5-3	4-7	4-1	3-6	3-2	2-11	2-8
	2 – 2 × 8	6-8	5-9	5-2	4-8	4-2	3-10	3-6
	2 – 2 × 10	8-2	7-1	6-4	5-9	5-4	4-10	4-6
	2 – 2 × 12	9-5	8-2	7-4	6-8	6-2	5-9	5-5
	3 – 2 × 6	6-4	5-8	5-1	4-8	4-3	3-10	3-6
	3 – 2 × 8	8-4	7-3	6-5	5-11	5-5	5-1	4-8
	3 – 2 × 10	10-2	8-10	7-11	7-2	6-8	6-3	5-11
	3 – 2 × 12	11-10	10-3	9-2	8-4	7-9	7-3	6-10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

a. Interpolation allowed. Extrapolation is not allowed.

b. Beams supporting a single span of joists with or without cantilever.

c. Dead load = 10 psf,  $L/\Delta = 360$  at main span,  $L/\Delta = 180$  at cantilever. Snow load not assumed to be concurrent with live load.

d. No. 2 grade, wet service factor included.

e. Beam depth shall be equal to or greater than the depth of intersecting joist for a flush beam connection.

f. Beam cantilevers are limited to the adjacent beam's span divided by 4.

g. Includes incising factor.

h. Incising factor not included.

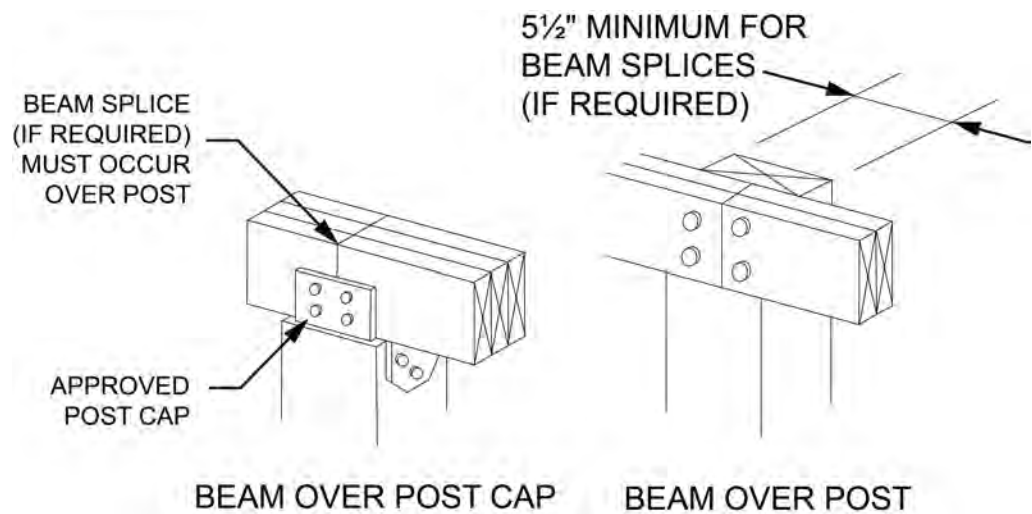
i. Deck joist span as shown in Figure R507.5.

j. For calculation of effective deck joist span, the actual joist span length shall be multiplied by the joist span factor in accordance with Table R507.5(5).

**TABLE R507.5(5)**  
**JOIST SPAN FACTORS FOR CALCULATING EFFECTIVE DECK JOIST SPAN**  
[for use with Note j in Tables R507.5(1), R507.5(2), R507.5(3) and R507.5(4)]

C/J <sup>a</sup>	JOIST SPAN FACTOR
0 (no cantilever)	0.66
1/12 (0.87)	0.72
1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

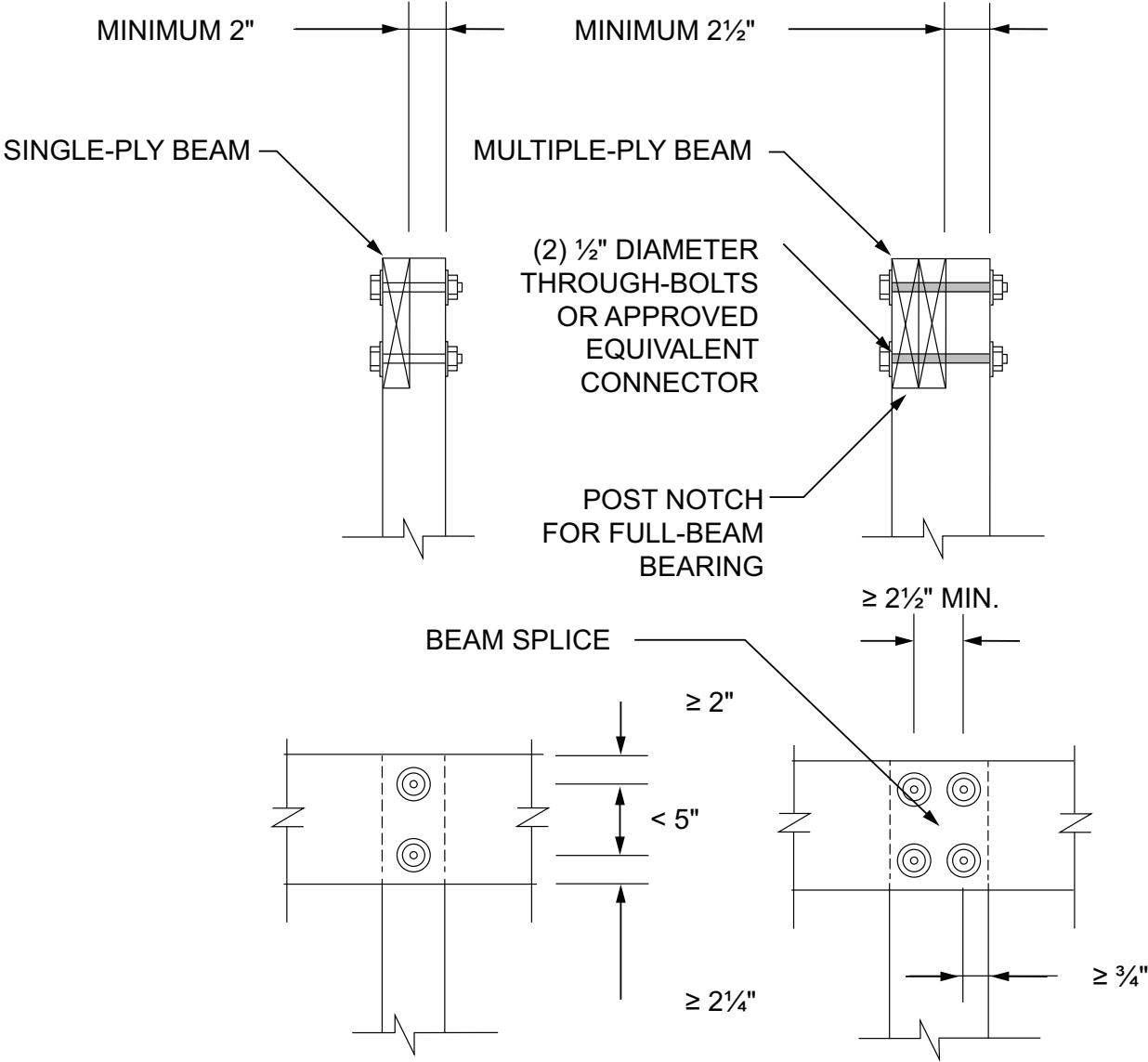
For SI: 1 foot = 304.8 mm.  
a. C = actual joist cantilever length (feet); J = actual joist span length (feet).



For SI: 1 inch = 25.4 mm.

**FIGURE R507.5.1(1)**  
**DECK BEAM TO DECK POST**

FLOORS



For SI: 1 inch = 25.4 mm.

**FIGURE R507.5.1(2)**  
**NOTCHED POST-TO-BEAM CONNECTION**

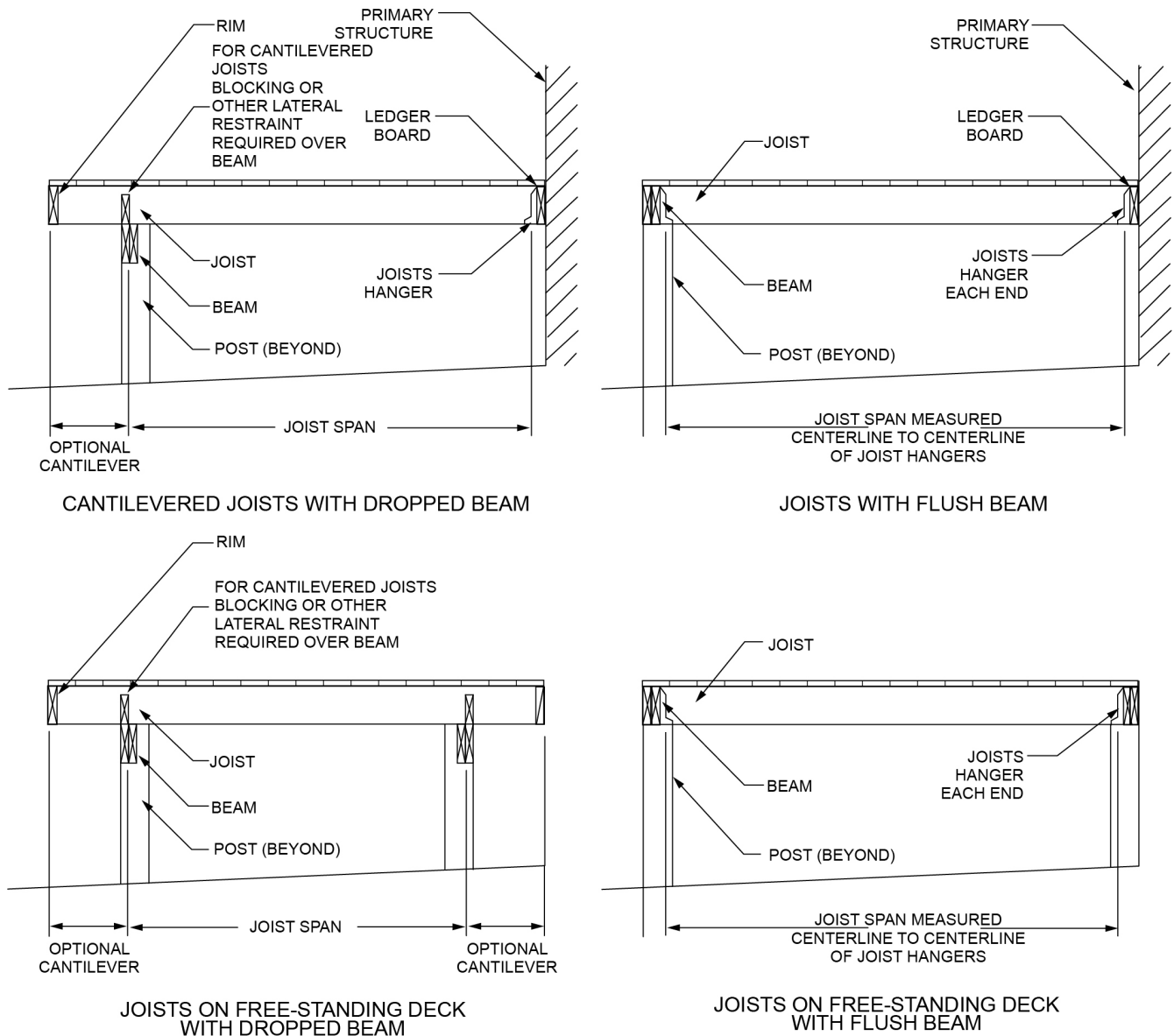


FIGURE R507.6  
TYPICAL DECK JOIST SPANS



## FLOORS

**TABLE R507.6**  
**MAXIMUM DECK JOIST SPANS**

LOAD <sup>a</sup> (psf)	JOIST SPECIES <sup>b</sup>	JOIST SIZE	ALLOWABLE JOIST SPAN <sup>b, c</sup> (feet-inches)			MAXIMUM CANTILEVER <sup>d, f</sup> (feet-inches)							
			Joist spacing (inches)			Joist back span <sup>g</sup> (feet)							
			12	16	24	4	6	8	10	12	14	16	18
40 live load	Southern pine	2 × 6	9-11	9-0	7-7	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	13-1	11-10	9-8	1-0	1-6	2-0	2-6	2-3	NP	NP	NP
		2 × 10	16-2	14-0	11-5	1-0	1-6	2-0	2-6	3-0	3-4	3-4	NP
		2 × 12	18-0	16-6	13-6	1-0	1-6	2-0	2-6	3-0	3-6	4-0	4-1
	Douglas fir-larch <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	2 × 6	9-6	8-4	6-10	1-0	1-6	1-4	NP	NP	NP	NP	NP
		2 × 8	12-6	11-1	9-1	1-0	1-6	2-0	2-3	2-0	NP	NP	NP
		2 × 10	15-8	13-7	11-1	1-0	1-6	2-0	2-6	3-0	3-3	NP	NP
		2 × 12	18-0	15-9	12-10	1-0	1-6	2-0	2-6	3-0	3-6	3-11	3-11
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	2 × 6	8-10	8-0	6-10	1-0	1-4	1-1	NP	NP	NP	NP	NP
		2 × 8	11-8	10-7	8-8	1-0	1-6	2-0	1-11	NP	NP	NP	NP
		2 × 10	14-11	13-0	10-7	1-0	1-6	2-0	2-6	3-0	2-9	NP	NP
		2 × 12	17-5	15-1	12-4	1-0	1-6	2-0	2-6	3-0	3-6	3-8	NP
50 ground snow load	Southern pine	2 × 6	9-2	8-4	7-4	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	12-1	11-0	9-5	1-0	1-6	2-0	2-5	2-3	NP	NP	NP
		2 × 10	15-5	13-9	11-3	1-0	1-6	2-0	2-6	3-0	3-1	NP	NP
		2 × 12	18-0	16-2	13-2	1-0	1-6	2-0	2-6	3-0	3-6	3-10	3-10
	Douglas fir-larch <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	2 × 6	8-10	8-0	6-8	1-0	1-6	1-4	NP	NP	NP	NP	NP
		2 × 8	11-7	10-7	8-11	1-0	1-6	2-0	2-3	NP	NP	NP	NP
		2 × 10	14-10	13-3	10-10	1-0	1-6	2-0	2-6	3-0	3-0	NP	NP
		2 × 12	17-9	15-5	12-7	1-0	1-6	2-0	2-6	3-0	3-6	3-8	NP
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	2 × 6	8-3	7-6	6-6	1-0	1-4	1-1	NP	NP	NP	NP	NP
		2 × 8	10-10	9-10	8-6	1-0	1-6	2-0	1-11	NP	NP	NP	NP
		2 × 10	13-10	12-7	10-5	1-0	1-6	2-0	2-6	2-9	NP	NP	NP
		2 × 12	16-10	14-9	12-1	1-0	1-6	2-0	2-6	3-0	3-5	3-5	NP
60 ground snow load	Southern pine	2 × 6	8-8	7-10	6-10	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	11-5	10-4	8-9	1-0	1-6	2-0	2-4	NP	NP	NP	NP
		2 × 10	14-7	12-9	10-5	1-0	1-6	2-0	2-6	2-11	2-11	NP	NP
		2 × 12	17-3	15-0	12-3	1-0	1-6	2-0	2-6	3-0	3-6	3-7	NP
	Douglas fir-larch <sup>e</sup> Hem-fir <sup>e</sup> Spruce-pine-fir <sup>e</sup>	2 × 6	8-4	7-6	6-2	1-0	1-6	1-4	NP	NP	NP	NP	NP
		2 × 8	10-11	9-11	8-3	1-0	1-6	2-0	2-2	NP	NP	NP	NP
		2 × 10	13-11	12-4	10-0	1-0	1-6	2-0	2-6	2-10	NP	NP	NP
		2 × 12	16-6	14-3	11-8	1-0	1-6	2-0	2-6	3-0	3-5	3-5	NP
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	2 × 6	7-9	7-0	6-2	1-0	1-4	NP	NP	NP	NP	NP	NP
		2 × 8	10-2	9-3	7-11	1-0	1-6	2-0	1-11	NP	NP	NP	NP
		2 × 10	13-0	11-9	9-7	1-0	1-6	2-0	2-6	2-7	NP	NP	NP
		2 × 12	15-9	13-8	11-2	1-0	1-6	2-0	2-6	3-0	3-2	NP	NP

(continued)

**TABLE R507.6—continued**  
**MAXIMUM DECK JOIST SPANS**

LOAD <sup>a</sup> (psf)	JOIST SPECIES <sup>b</sup>	JOIST SIZE	ALLOWABLE JOIST SPAN <sup>b, c</sup> (feet-inches)			MAXIMUM CANTILEVER <sup>d, f</sup> (feet-inches)							
			Joist spacing (inches)			Joist back span <sup>g</sup> (feet)							
			12	16	24	4	6	8	10	12	14	16	18
70 ground snow load	Southern pine	2 × 6	8-3	7-6	6-5	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2 × 8	10-10	9-10	8-2	1-0	1-6	2-0	2-2	NP	NP	NP	NP
		2 × 10	13-9	11-11	9-9	1-0	1-6	2-0	2-6	2-9	NP	NP	NP
		2 × 12	16-2	14-0	11-5	1-0	1-6	2-0	2-6	3-0	3-5	3-5	NP
	Douglas fir-larch <sup>c</sup> Hem-fir <sup>c</sup> Spruce-pine-fir <sup>c</sup>	2 × 6	7-11	7-1	5-9	1-0	1-6	NP	NP	NP	NP	NP	NP
		2 × 8	10-5	9-5	7-8	1-0	1-6	2-0	2-1	NP	NP	NP	NP
		2 × 10	13-3	11-6	9-5	1-0	1-6	2-0	2-6	2-8	NP	NP	NP
		2 × 12	15-5	13-4	10-11	1-0	1-6	2-0	2-6	3-0	3-3	NP	NP
	Redwood <sup>f</sup> Western cedars <sup>f</sup> Ponderosa pine <sup>f</sup> Red pine <sup>f</sup>	2 × 6	7-4	6-8	5-10	1-0	1-4	NP	NP	NP	NP	NP	NP
		2 × 8	9-8	8-10	7-4	1-0	1-6	1-11	NP	NP	NP	NP	NP
		2 × 10	12-4	11-0	9-0	1-0	1-6	2-0	2-6	2-6	NP	NP	NP
		2 × 12	14-9	12-9	10-5	1-0	1-6	2-0	2-6	3-0	3-0	NP	NP

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound = 0.454 kg.

NP = Not Permitted.

a. Dead load = 10 psf. Snow load not assumed to be concurrent with live load.

b. No. 2 grade, wet service factor included.

c.  $L/\Delta = 360$  at main span.

d.  $L/\Delta = 180$  at cantilever with a 220-pound point load applied to end.

e. Includes incising factor.

f. Incising factor not included.

g. Interpolation allowed. Extrapolation is not allowed.

**TABLE R507.7**  
**MAXIMUM JOIST SPACING FOR WOOD DECKING**

DECKING MATERIAL TYPE AND NOMINAL SIZE	DECKING PERPENDICULAR TO JOIST		DECKING DIAGONAL TO JOIST <sup>a</sup>	
	Single span <sup>c</sup>	Multiple span <sup>c</sup>	Single span <sup>c</sup>	Multiple span <sup>c</sup>
	Maximum on-center joist spacing (inches)			
1 <sup>1</sup> / <sub>4</sub> -inch-thick wood <sup>b</sup>	12	16	8	12
2-inch-thick wood	24	24	18	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.01745 rad.

a. Maximum angle of 45 degrees from perpendicular for wood deck boards.

b. Other maximum span provided by an accredited lumber grading or inspection agency also allowed.

c. Individual wood deck boards supported by two joists shall be considered single span and three or more joists shall be considered multiple span.

## FLOORS

**R507.9.1.3 Ledger to band joist details.** Fasteners used in deck ledger connections in accordance with Table R507.9.1.3(1) shall be hot-dipped galvanized or stainless steel and shall be installed in accordance with Table R507.9.1.3(2) and Figures R507.9.1.3(1) and R507.9.1.3(2).

**R507.9.1.4 Alternate ledger details.** Alternate framing configurations supporting a ledger constructed to meet the load requirements of Section R301.5 shall be permitted.

**TABLE R507.9.1.3(1)**  
**DECK LEDGER CONNECTION TO BAND JOIST**

LOAD <sup>c</sup> (psf)	JOIST SPAN <sup>a</sup> (feet)	ON-CENTER SPACING OF FASTENERS <sup>b</sup> (inches)		
		<sup>1</sup> / <sub>2</sub> -inch diameter lag screw with <sup>1</sup> / <sub>2</sub> -inch maximum sheathing <sup>d,e</sup>	<sup>1</sup> / <sub>2</sub> -inch diameter bolt with <sup>1</sup> / <sub>2</sub> -inch maximum sheathing <sup>e</sup>	<sup>1</sup> / <sub>2</sub> -inch diameter bolt with 1-inch maximum sheathing <sup>f</sup>
40 live load	6	30	36	36
	8	23	36	36
	10	18	34	29
	12	15	29	24
	14	13	24	21
	16	11	21	18
	18	10	19	16
50 ground snow load	6	29	36	36
	8	22	36	35
	10	17	33	28
	12	14	27	23
	14	12	23	20
	16	11	20	17
	18	9	18	15
60 ground snow load	6	25	36	36
	8	18	35	30
	10	15	28	24
	12	12	23	20
	14	10	20	17
	16	9	17	15
	18	8	15	13
70 ground snow load	6	22	36	35
	8	16	31	26
	10	13	25	21
	12	11	20	17
	14	9	17	15
	16	8	15	13
	18	7	13	11

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Interpolation permitted. Extrapolation is not permitted.

b. Ledgers shall be flashed in accordance with Section R703.4 to prevent water from contacting the house band joist.

c. Dead Load = 10 psf. Snow load shall not be assumed to act concurrently with live load.

d. The tip of the lag screw shall fully extend beyond the inside face of the band joist.

e. Sheathing shall be wood structural panel or solid sawn lumber.

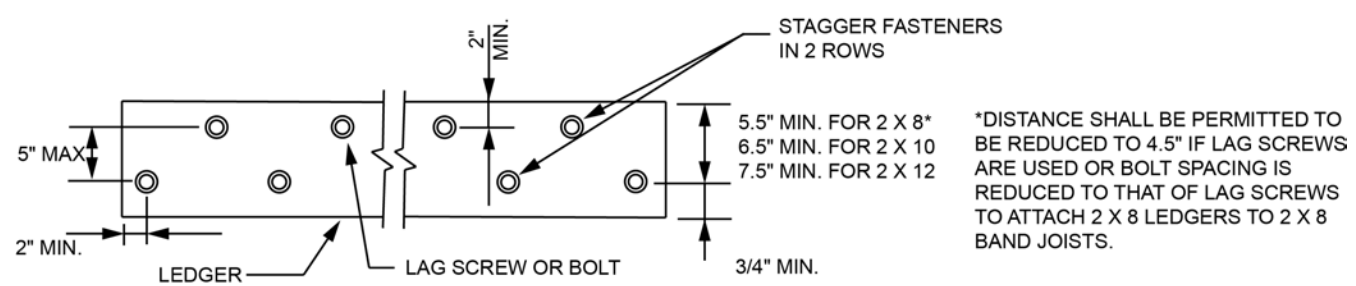
f. Sheathing shall be permitted to be wood structural panel, gypsum board, fiberboard, lumber or foam sheathing. Up to <sup>1</sup>/<sub>2</sub>-inch thickness of stacked washers shall be permitted to substitute for up to <sup>1</sup>/<sub>2</sub> inch of allowable sheathing thickness where combined with wood structural panel or lumber sheathing.

TABLE R507.9.1.3(2)  
PLACEMENT OF LAG SCREWS AND BOLTS IN DECK LEDGERS AND BAND JOISTS

MINIMUM END AND EDGE DISTANCES AND SPACING BETWEEN ROWS				
	TOP EDGE	BOTTOM EDGE	ENDS	ROW SPACING
Ledger <sup>a</sup>	2 inches <sup>d</sup>	<sup>3</sup> / <sub>4</sub> inch	2 inches <sup>b</sup>	1 <sup>5</sup> / <sub>8</sub> inches <sup>b</sup>
Band Joist <sup>c</sup>	<sup>3</sup> / <sub>4</sub> inch	2 inches	2 inches <sup>b</sup>	1 <sup>5</sup> / <sub>8</sub> inches <sup>b</sup>

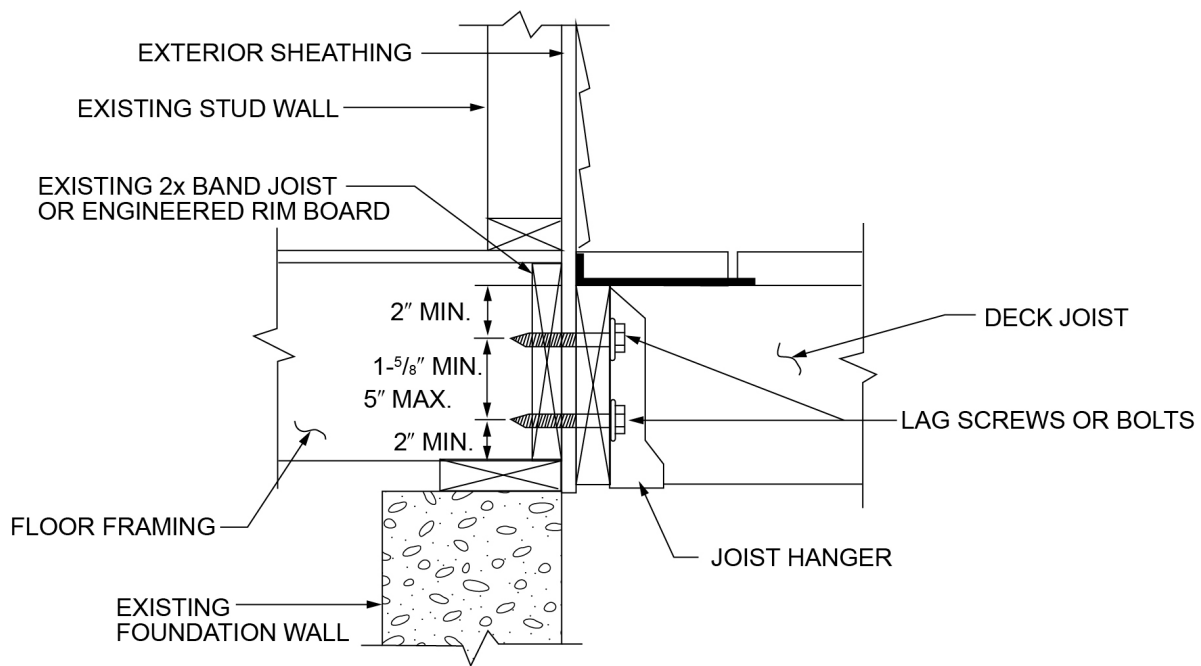
For SI: 1 inch = 25.4 mm.

- a. Lag screws or bolts shall be staggered from the top to the bottom along the horizontal run of the deck ledger in accordance with Figure R507.9.1.3(1).
- b. Maximum 5 inches.
- c. For engineered rim joists, the manufacturer's recommendations shall govern.
- d. The minimum distance from bottom row of lag screws or bolts to the top edge of the ledger shall be in accordance with Figure R507.9.1.3(1).



For SI: 1 inch = 25.4 mm.

FIGURE R507.9.1.3(1)  
PLACEMENT OF LAG SCREWS AND BOLTS IN LEDGERS



For SI: 1 inch = 25.4 mm.

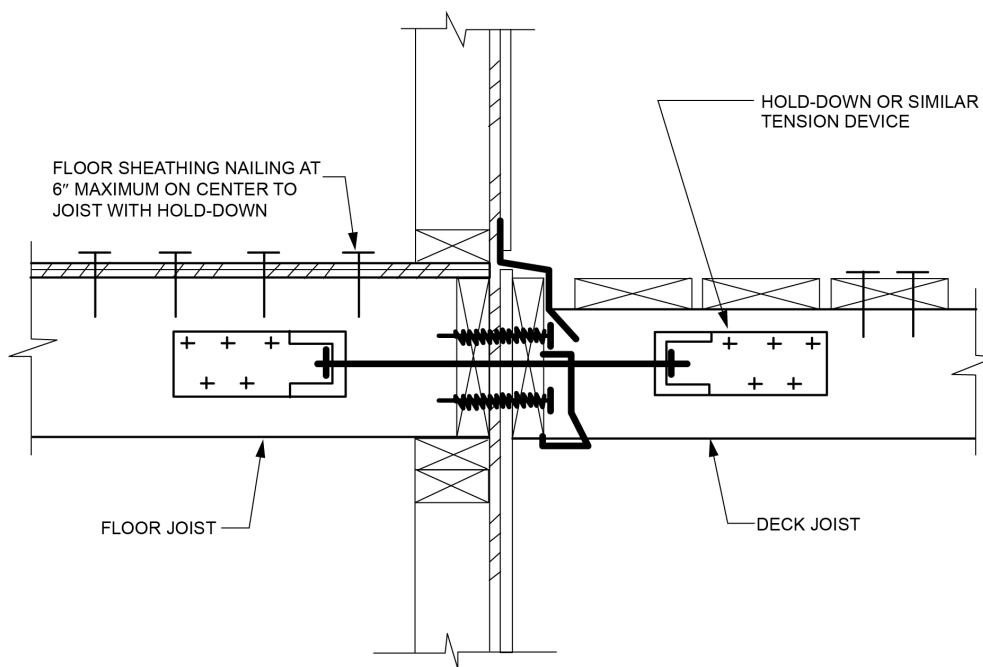
FIGURE R507.9.1.3(2)  
PLACEMENT OF LAG SCREWS AND BOLTS IN BAND JOISTS



## FLOORS

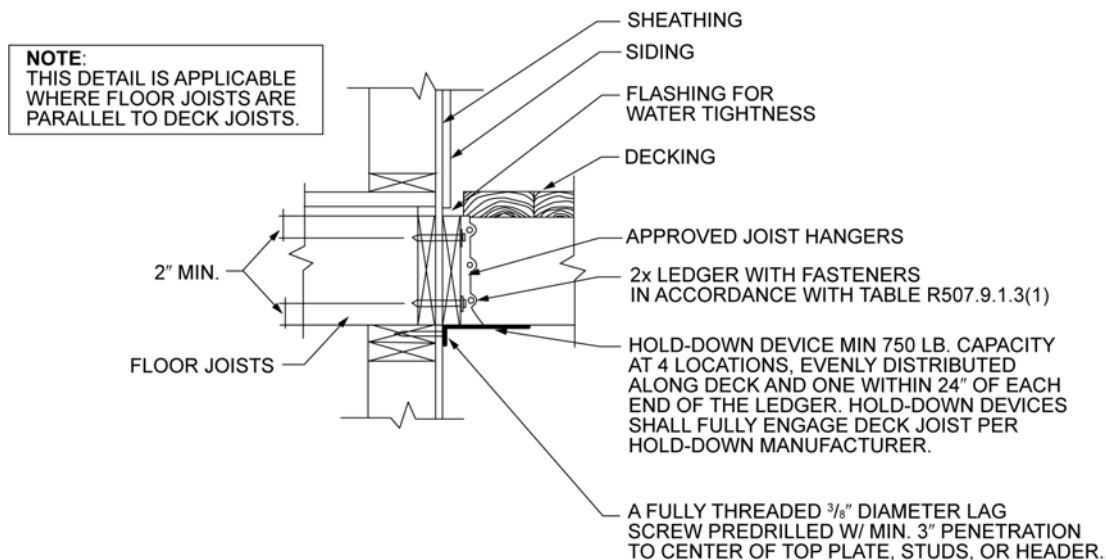
**R507.9.2 Lateral connection.** Lateral loads shall be transferred to the ground or to a structure capable of transmitting them to the ground. Where the lateral load connection is provided in accordance with Figure R507.9.2(1), hold-down tension devices shall be installed in not less than two locations per deck, within 24 inches (610 mm) of each end of the deck. Each device shall have

an allowable stress design capacity of not less than 1,500 pounds (6672 N). Where the lateral load connections are provided in accordance with Figure R507.9.2(2), the hold-down tension devices shall be installed in not less than four locations per deck, and each device shall have an allowable stress design capacity of not less than 750 pounds (3336 N).



For SI: 1 inch = 25.4 mm.

**FIGURE R507.9.2(1)**  
**DECK ATTACHMENT FOR LATERAL LOADS**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R507.9.2(2)**  
**DECK ATTACHMENT FOR LATERAL LOADS**

**R507.10 Exterior guards.** *Guards* shall be constructed to meet the requirements of Sections R301.5 and R312, and this section.

**R507.10.1 Support of guards.** Where *guards* are supported on deck framing, *guard* loads shall be transferred to the deck framing with a continuous load path to the deck joists.

**R507.10.1.1 Guards supported by side of deck framing.** Where *guards* are connected to the interior or exterior side of a deck joist or beam, the joist or beam shall be connected to the adjacent joists to prevent rotation of the joist or beam. Connections relying only on fasteners in end grain withdrawal are not permitted.

**R507.10.1.2 Guards supported on top of deck framing.** Where *guards* are mounted on top of the decking, the *guards* shall be connected to the deck framing or blocking and installed in accordance with manufacturer's instructions to transfer the *guard* loads to the adjacent joists.

**R507.10.2 Wood posts at deck guards.** Where 4-inch by 4-inch (102 mm by 102 mm) wood posts support guard loads applied to the top of the guard, such posts shall not be notched at the connection to the supporting structure.

**R507.10.3 Plastic composite guards.** *Plastic composite guards* shall comply with the provisions of Section R507.2.2.

**R507.10.4 Other guards.** Other *guards* shall be in accordance with either manufacturer's instructions or accepted engineering principles.



## CHAPTER 6

# WALL CONSTRUCTION

### User note:

**About this chapter:** Chapter 6 contains prescriptive provisions for the design and construction of walls. The wall construction covered in Chapter 6 consists of five different types: wood framed, cold-formed steel framed, masonry, concrete and structural insulated panel (SIP). The primary concern of this chapter is the structural integrity of wall construction and transfer of all imposed loads to the supporting structure.

### SECTION R601 GENERAL

**R601.1 Application.** The provisions of this chapter shall control the design and construction of walls and partitions for buildings.

**R601.2 Requirements.** Wall construction shall be capable of accommodating all loads imposed in accordance with Section R301 and of transmitting the resulting loads to the supporting structural elements.

**R601.2.1 Compressible floor-covering materials.** Compressible floor-covering materials that compress more than  $\frac{1}{32}$  inch (0.8 mm) when subjected to 50 pounds (23 kg) applied over 1 inch square (645 mm) of material and are greater than  $\frac{1}{8}$  inch (3.2 mm) in thickness in the uncompressed state shall not extend beneath walls, partitions or columns, which are fastened to the floor.

### SECTION R602 WOOD WALL FRAMING

**R602.1 General.** Wood and wood-based products used for load-supporting purposes shall conform to the applicable provisions of this section.

**R602.1.1 Sawn lumber.** Sawn lumber shall be identified by a grade *mark* of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade *mark*, a certification of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

**R602.1.2 End-jointed lumber.** *Approved* end-jointed lumber identified by a grade *mark* conforming to Section R602.1 shall be permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required elsewhere in this code to have a fire-resistance rating shall have the designation "Heat Resistant Adhesive" or "HRA" included in its grade *mark*.

**R602.1.3 Structural glued-laminated timbers.** Glued-laminated timbers shall be manufactured and identified as required in ANSI A190.1, ANSI 117 and ASTM D3737.

**R602.1.4 Structural log members.** Structural log members shall comply with the provisions of ICC 400.

**R602.1.5 Structural composite lumber.** Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

**R602.1.6 Cross-laminated timber.** Cross-laminated timber shall be manufactured and identified as required by ANSI/APA PRG 320.

**R602.1.7 Engineered wood rim board.** Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with either ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

**R602.1.8 Wood structural panels.** *Wood structural panel* sheathing shall conform to DOC PS 1, DOC PS 2 or, when manufactured in Canada, CSA O325 or CSA O437. Panels shall be identified for grade, bond classification, and performance category by a grade *mark* or certificate of inspection issued by an *approved* agency.

**R602.1.9 Particleboard.** Particleboard shall conform to ANSI A208.1. Particleboard shall be identified by the grade *mark* or certificate of inspection issued by an *approved* agency.

**R602.1.10 Fiberboard.** Fiberboard shall conform to ASTM C208. Fiberboard sheathing, where used structurally, shall be identified by an *approved* agency as conforming to ASTM C208.

**R602.1.11 Structural insulated panels.** *Structural insulated panels* shall be manufactured and identified in accordance with ANSI/APA PRS 610.1.

**R602.2 Grade.** Studs shall be a minimum No. 3, standard or stud grade lumber.

**Exception:** Bearing studs not supporting floors and nonbearing studs shall be permitted to be utility grade lumber, provided that the studs are spaced in accordance with Table R602.3(5).

**R602.3 Design and construction.** Exterior walls of wood-frame construction shall be designed and constructed in accordance with the provisions of this chapter and Figures R602.3(1) and R602.3(2), or in accordance with AWC NDS. Components of exterior walls shall be fastened in accordance with Tables R602.3(1) through R602.3(4). Wall sheathing



## WALL CONSTRUCTION

shall be fastened directly to framing members and, where placed on the exterior side of an exterior wall, shall be capable of resisting the wind pressures listed in Table R301.2.1(1) adjusted for height and exposure using Table R301.2.1(2) and shall conform to the requirements of Table R602.3(3). Wall sheathing used only for exterior wall covering purposes shall comply with Section R703.

Studs shall be continuous from support at the sole plate to a support at the top plate to resist loads perpendicular to the wall. The support shall be a foundation or floor, ceiling or roof *diaphragm* or shall be designed in accordance with accepted engineering practice.

**Exception:** Jack studs, trimmer studs and cripple studs at openings in walls that comply with Tables R602.7(1) and R602.7(2).

**R602.3.1 Stud size, height and spacing.** The size, height and spacing of studs shall be in accordance with Table R602.3(5).

### Exceptions:

1. Utility grade studs shall not be spaced more than 16 inches (406 mm) on center, shall not support more than a roof and ceiling, and shall not exceed 8 feet (2438 mm) in height for exterior walls and *load-bearing walls* or 10 feet (3048 mm) for interior nonload-bearing walls.
2. Where ground snow loads are less than or equal to 25 pounds per square foot (1.2 kPa), and the ultimate design wind speed is less than or equal to 130 mph (58.1 m/s), 2-inch by 6-inch (38 mm by 140 mm) studs supporting a roof load with not more than 6 feet (1829 mm) of tributary length shall have a maximum height of 18 feet (5486 mm) where spaced at 16 inches (406 mm) on center, or 20 feet (6096 mm) where spaced at 12 inches (305 mm) on center. Studs shall be No. 2 grade lumber or better.
3. Exterior load-bearing studs not exceeding 12 feet (3658 mm) in height provided in accordance with Table R602.3(6). The minimum number of full-height studs adjacent to openings shall be in accordance with Section R602.7.5. The building shall be located in Exposure B, the roof *live load* shall not exceed 20 psf (0.96 kPa), and the ground snow load shall not exceed 30 psf (1.4 kPa). Studs and plates shall be No. 2 grade lumber or better.

**R602.3.2 Top plate.** Wood stud walls shall be capped with a double top plate installed to provide overlapping at corners and intersections with bearing partitions. End joints in top plates shall be offset not less than 24 inches (610 mm). Joints in plates need not occur over studs. Plates shall be not less than 2-inches (51 mm) nominal thickness and have a width not less than the width of the studs.

**Exception:** A single top plate used as an alternative to a double top plate shall comply with the following:

1. The single top plate shall be tied at corners, intersecting walls, and at in-line splices in

straight wall lines in accordance with Table R602.3.2.

2. The rafters or joists shall be centered over the studs with a tolerance of not more than 1 inch (25 mm).
3. Omission of the top plate is permitted over headers where the headers are adequately tied to adjacent wall sections in accordance with Table R602.3.2.

**R602.3.3 Bearing studs.** Where joists, trusses or rafters are spaced more than 16 inches (406 mm) on center and the bearing studs below are spaced 24 inches (610 mm) on center, such members shall bear within 5 inches (127 mm) of the studs beneath.

### Exceptions:

1. The top plates are two 2-inch by 6-inch (38 mm by 140 mm) or two 3-inch by 4-inch (64 mm by 89 mm) members.
2. A third top plate is installed.
3. Solid blocking equal in size to the studs is installed to reinforce the double top plate.

**R602.3.4 Bottom (sole) plate.** Studs shall have full bearing on a nominal 2-by (51 mm) or larger plate or sill having a width not less than to the width of the studs.

**R602.3.5 Braced wall panel uplift load path.** Braced wall panels located at exterior walls that support roof rafters or trusses (including stories below top story) shall have the framing members connected in accordance with one of the following:

1. Fastening in accordance with Table R602.3(1) where:
  - 1.1. The ultimate design wind speed does not exceed 115 mph (51 m/s), the wind exposure category is B, the roof pitch is 5:12 or greater, and the roof span is 32 feet (9754 mm) or less.
  - 1.2. The net uplift value at the top of a wall does not exceed 100 plf (146 N/mm). The net uplift value shall be determined in accordance with Section R802.11 and shall be permitted to be reduced by 60 plf (86 N/mm) for each full wall above.
2. Where the net uplift value at the top of a wall exceeds 100 plf (146 N/mm), installing *approved* uplift framing connectors to provide a continuous load path from the top of the wall to the foundation or to a point where the uplift force is 100 plf (146 N/mm) or less. The net uplift value shall be as determined in Item 1.2.
3. Wall sheathing and fasteners designed to resist combined uplift and shear forces in accordance with accepted engineering practice.

**R602.4 Interior load-bearing walls.** Interior *load-bearing walls* shall be constructed, framed and fireblocked as specified for exterior walls.

## WALL CONSTRUCTION

**TABLE R602.3(1)**  
**FASTENING SCHEDULE**

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a, b, c</sup>	SPACING AND LOCATION
Roof			
1	Blocking between ceiling joists, rafters or trusses to top plate or other framing below	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Toe nail
	Blocking between rafters or truss not at the wall top plates, to rafter or truss	2-8d common (2½" × 0.131"); or 2-3" × 0.131" nails	Each end toe nail
		2-16d common (3½" × 0.162"); or 3-3" × 0.131" nails	End nail
	Flat blocking to truss and web filler	16d common (3½" × 0.162"); or 3" × 0.131" nails	6" o.c. face nail
2	Ceiling joists to top plate	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions [see Section R802.5.2 and Table R802.5.2(1)]	4-10d box (3" × 0.128"); or 3-16d common (3½" × 0.162"); or 4-3" × 0.131" nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) [see Section R802.5.2 and Table R802.5.2(1)]	Table R802.5.2(1)	Face nail
5	Collar tie to rafter, face nail	4-10d box (3" × 0.128"); or 3-10d common (3" × 0.148"); or 4-3" × 0.131" nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box (3½" × 0.135"); or 3-10d common (3" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss <sup>i</sup>
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2" ridge beam	4-16d box (3½" × 0.135"); or 3-10d common (3" × 0.148"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	Toe nail
		3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	End nail
Wall			
8	Stud to stud (not at braced wall panels)	16d common (3½" × 0.162")	24" o.c. face nail
		10d box (3" × 0.128"); or 3" × 0.131" nails	16" o.c. face nail
9	Stud to stud and abutting studs at intersecting wall corners (at braced wall panels)	16d box (3½" × 0.135"); or 3" × 0.131" nails	12" o.c. face nail
		16d common (3½" × 0.162")	16" o.c. face nail
10	Built-up header (2" to 2" header with ½" spacer)	16d common (3½" × 0.162")	16" o.c. each edge face nail
		16d box (3½" × 0.135")	12" o.c. each edge face nail
11	Continuous header to stud	5-8d box (2½" × 0.113"); or 4-8d common (2½" × 0.131"); or 4-10d box (3" × 0.128")	Toe nail

(continued)

## WALL CONSTRUCTION

TABLE R602.3(1)—continued  
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a, b, c</sup>	SPACING AND LOCATION
Wall			
12	Adjacent full-height stud to end of header	4-16d box (3½"× 0.135"); or 3-16d common (3½" × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	End nail
13	Top plate to top plate	16d common (3½" × 0.162")	16" o.c. face nail
		10d box (3" × 0.128"); or 3" × 0.131" nails	12" o.c. face nail
14	Double top plate splice	8-16d common (3½" × 0.162"); or 12-16d box (3½" × 0.135"); or 12-10d box (3" × 0.128"); or 12-3" × 0.131" nails	Face nail on each side of end joint (minimum 24" lap splice length each side of end joint)
15	Bottom plate to joist, rim joist, band joist or blocking (not at braced wall panels)	16d common (3½" × 0.162")	16" o.c. face nail
		16d box (3½" × 0.135"); or 3" × 0.131" nails	12" o.c. face nail
Roof			
16	Bottom plate to joist, rim joist, band joist or blocking (at braced wall panel)	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162"); or 4-3" × 0.131" nails	16" o.c. face nail
17	Top or bottom plate to stud	4-8d box (2½" × 0.113"); or 3-16d box (3½" × 0.135"); or 4-8d common (2½" × 0.131"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails	Toe nail
		3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails	End nail
18	Top plates, laps at corners and intersections	3-10d box (3" × 0.128"); or 2-16d common (3½" × 0.162"); or 3-3" × 0.131" nails	Face nail
19	1" brace to each stud and plate	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 2-(3" × 0.131"); or 2-10d box (3" × 0.128")	Face nail
20	1" × 6" sheathing to each bearing	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 2-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., 1¾" long	Face nail
21	1" × 8" and wider sheathing to each bearing	3-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3 staples, 1" crown, 16 ga., 1¾" long	Face nail
		Wider than 1" × 8" 4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 4 staples, 1" crown, 16 ga., 1¾" long	

(continued)

## WALL CONSTRUCTION

**TABLE R602.3(1)—continued  
FASTENING SCHEDULE**

FASTENING SCHEDULE					
ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a, b, c</sup>		SPACING AND LOCATION	
Floor					
22	Joist to sill, top plate or girder	4-8d box (2½" × 0.113"); or 3-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails		Toe nail	
23	Rim joist, band joist or blocking to sill or top plate (roof applications also)	8d box (2½" × 0.113")		4" o.c. toe nail	
		8d common (2½" × 0.131"); or 10d box (3" × 0.128"); or 3" × 0.131" nails		6" o.c. toe nail	
24	1" × 6" subfloor or less to each joist	3-8d box (2½" × 0.113"); or 2-8d common (2½" × 0.131"); or 3-10d box (3" × 0.128"); or 2 staples, 1" crown, 16 ga., 1¾" long		Face nail	
25	2" subfloor to joist or girder	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")		Blind and face nail	
26	2" planks (plank & beam—floor & roof)	3-16d box (3½" × 0.135"); or 2-16d common (3½" × 0.162")		At each bearing, face nail	
27	Band or rim joist to joist	3-16d common (3½" × 0.162"); or 4-10 box (3" × 0.128"); or 4-3" × 0.131" nails; or 4-3" × 14 ga. staples, 7/16" crown		End nail	
28	Built-up girders and beams, 2-inch lumber layers	20d common (4" × 0.192"); or		Nail each layer as follows: 32" o.c. at top and bottom and staggered.	
		10d box (3" × 0.128"); or 3" × 0.131" nails		24" o.c. face nail at top and bottom staggered on opposite sides	
		And: 2-20d common (4" × 0.192"); or 3-10d box (3" × 0.128"); or 3-3" × 0.131" nails		Face nail at ends and at each splice	
29	Ledger strip supporting joists or rafters	4-16d box (3½" × 0.135"); or 3-16d common (3½" × 0.162"); or 4-10d box (3" × 0.128"); or 4-3" × 0.131" nails		At each joist or rafter, face nail	
30	Bridging or blocking to joist, rafter or truss	2-10d box (3" × 0.128"); or 2-8d common (2½" × 0.131"); or 3" × 0.131" nails		Each end, toe nail	
ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a, b, c</sup>	SPACING OF FASTENERS		
			Edges <sup>h</sup> (inches)		Intermediate supports <sup>c, e</sup> (inches)
Wood structural panels, subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing [see Table R602.3(3) for wood structural panel exterior wall sheathing to wall framing]					
31	3/8" – 1/2"	6d common or deformed (2" × 0.113" × 0.266" head); or 2¾" × 0.113" × 0.266" head nail (subfloor, wall) <sup>i</sup>		6	6 <sup>f</sup>
		8d common (2½" × 0.131") nail (roof); or RSRS-01 (2¾" × 0.113") nail (roof) <sup>b</sup>		6	6 <sup>f</sup>
32	19/32" – 3/4"	8d common (2-2½" × 0.131") nail (subfloor, wall)		6	12
		8d common (2½" × 0.131") nail (roof); or RSRS-01; (2¾" × 0.113") nail (roof) <sup>b</sup>		6	6 <sup>f</sup>
		Deformed 2¾" × 0.113" × 0.266" head (wall or subfloor)		6	12
33	7/8" – 1¼"	10d common (3" × 0.148") nail; or (2½" × 0.131 × 0.281" head) deformed nail		6	12

(continued)



## WALL CONSTRUCTION

TABLE R602.3(1)—continued  
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER <sup>a, b, c</sup>	SPACING AND LOCATION	
Other wall sheathing <sup>g</sup>				
34	$\frac{1}{2}$ " structural cellulosic fiberboard sheathing	$1\frac{1}{2}$ " $\times$ 0.120" galvanized roofing nail, $\frac{7}{16}$ " head diameter; or $1\frac{1}{4}$ " long 16 ga. staple with $\frac{7}{16}$ " or 1" crown	3	6
35	$\frac{25}{32}$ " structural cellulosic fiberboard sheathing	$1\frac{3}{4}$ " $\times$ 0.120" galvanized roofing nail, $\frac{7}{16}$ " head diameter; or $1\frac{1}{4}$ " long 16 ga. staple with $\frac{7}{16}$ " or 1" crown	3	6
36	$\frac{1}{2}$ " gypsum sheathing <sup>d</sup>	$1\frac{1}{2}$ " $\times$ 0.120" galvanized roofing nail, $\frac{7}{16}$ " head diameter, or $1\frac{1}{4}$ " long 16 ga.; staple galvanized, $1\frac{1}{2}$ " long; $\frac{7}{16}$ " or 1" crown or $1\frac{1}{4}$ " screws, Type W or S	7	7
37	$\frac{5}{8}$ " gypsum sheathing <sup>d</sup>	$1\frac{3}{4}$ " $\times$ 0.120" galvanized roofing nail, $\frac{7}{16}$ " head diameter, or $1\frac{1}{4}$ " long 16 ga.; staple galvanized, $1\frac{1}{2}$ " long; $\frac{7}{16}$ " or 1" crown or $1\frac{1}{4}$ " screws, Type W or S	7	7
Wood structural panels, combination subfloor underlayment to framing				
38	$\frac{3}{4}$ " and less	Deformed (2" $\times$ 0.113") or Deformed (2" $\times$ 0.120") nail; or 8d common (2 $\frac{1}{2}$ " $\times$ 0.131") nail	6	12
39	$\frac{7}{8}$ " – 1"	8d common (2 $\frac{1}{2}$ " $\times$ 0.131") nail; or Deformed (2 $\frac{1}{2}$ " $\times$ 0.131"); or Deformed (2 $\frac{1}{2}$ " $\times$ 0.120") nail	6	12
40	$1\frac{1}{8}$ " – 1 $\frac{1}{4}$ "	10d common (3" $\times$ 0.148") nail; or Deformed (2 $\frac{1}{2}$ " $\times$ 0.131"); or Deformed (2 $\frac{1}{2}$ " $\times$ 0.120") nail	6	12

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s; 1 ksi = 6.895 MPa.

- Nails are smooth-common, box or deformed shanks except where otherwise stated. Nails used for framing and sheathing connections are carbon steel and shall have minimum average bending yield strengths as shown: 80 ksi for shank diameter of 0.192 inch (20d common nail), 90 ksi for shank diameters larger than 0.142 inch but not larger than 0.177 inch, and 100 ksi for shank diameters of 0.142 inch or less. Connections using nails and staples of other materials, such as stainless steel, shall be designed by accepted engineering practice or approved under Section R104.11.
- RSRS-01 is a Roof Sheathing Ring Shank nail meeting the specifications in ASTM F1667.
- Nails shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater.
- Four-foot by 8-foot or 4-foot by 9-foot panels shall be applied vertically.
- Spacing of fasteners not included in this table shall be based on Table R602.3(2).
- For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48 inches of roof edges and ridges, nails shall be spaced at 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 110 mph in Exposure C.
- Gypsum sheathing shall conform to ASTM C1396 and shall be installed in accordance with ASTM C1280 or GA 253. Fiberboard sheathing shall conform to ASTM C208.
- Spacing of fasteners on floor sheathing panel edges applies to panel edges supported by framing members and required blocking and at floor perimeters only. Spacing of fasteners on roof sheathing panel edges applies to panel edges supported by framing members and required blocking. Blocking of roof or floor sheathing panel edges perpendicular to the framing members need not be provided except as required by other provisions of this code. Floor perimeter shall be supported by framing members or solid blocking.
- Where a rafter is fastened to an adjacent parallel ceiling joist in accordance with this schedule, provide two toe nails on one side of the rafter and toe nails from the ceiling joist to top plate in accordance with this schedule. The toe nail on the opposite side of the rafter shall not be required.

## WALL CONSTRUCTION

**TABLE R602.3(2)**  
**ALTERNATE ATTACHMENTS TO TABLE R602.3(1)**

NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION <sup>a, b</sup> OF FASTENER AND LENGTH (inches)	SPACING <sup>c</sup> OF FASTENERS	
		Edges (inches)	Intermediate supports (inches)
Wood structural panels subfloor, roof <sup>a</sup> and wall sheathing to framing and particleboard wall sheathing to framing <sup>f</sup>			
Up to 1/2	Staple 15 ga. 1 <sup>3</sup> / <sub>4</sub>	4	8
	0.097–0.099 Nail 2 <sup>1</sup> / <sub>4</sub>	3	6
	Staple 16 ga. 1 <sup>3</sup> / <sub>4</sub>	3	6
19/32 and 5/8	0.113 Nail 2	3	6
	Staple 15 and 16 ga. 2	4	8
	0.097–0.099 Nail 2 <sup>1</sup> / <sub>4</sub>	4	8
23/32 and 3/4	Staple 14 ga. 2	4	8
	Staple 15 ga. 1 <sup>3</sup> / <sub>4</sub>	3	6
	0.097–0.099 Nail 2 <sup>1</sup> / <sub>4</sub>	4	8
	Staple 16 ga. 2	4	8
1	Staple 14 ga. 2 <sup>1</sup> / <sub>4</sub>	4	8
	0.113 Nail 2 <sup>1</sup> / <sub>4</sub>	3	6
	Staple 15 ga. 2 <sup>1</sup> / <sub>4</sub>	4	8
	0.097–0.099 Nail 2 <sup>1</sup> / <sub>2</sub>	4	8
NOMINAL MATERIAL THICKNESS (inches)	DESCRIPTION <sup>a, b</sup> OF FASTENER AND LENGTH (inches)	SPACING <sup>c</sup> OF FASTENERS	
		Edges (inches)	Body of panel <sup>d</sup> (inches)
Floor underlayment; plywood-hardboard-particleboard <sup>f</sup> -fiber-cement <sup>h</sup>			
Fiber-cement			
1/4	1 <sup>1</sup> / <sub>4</sub> long × 0.099" corrosion-resistant, ring shank nails (finished flooring other than tile)	3	6
	Staple 18 ga., 7/8 long, 1/4 crown (finished flooring other than tile)	3	6
	1 <sup>1</sup> / <sub>4</sub> long × .121 shank × .375 head diameter corrosion-resistant (galvanized or stainless steel) roofing nails (for tile finish)	8	8
	1 <sup>1</sup> / <sub>4</sub> long, No. 8 × .375 head diameter, ribbed wafer-head screws (for tile finish)	8	8
Plywood			
1/4 and 5/16	1 <sup>1</sup> / <sub>4</sub> ring or screw shank nail-minimum 12 <sup>1</sup> / <sub>2</sub> ga. (0.099") shank diameter	3	6
	Staple 18 ga., 7/8, 3/16 crown width	2	5
11/32, 3/8, 15/32 and 1/2	1 <sup>1</sup> / <sub>4</sub> ring or screw shank nail-minimum 12 <sup>1</sup> / <sub>2</sub> ga. (0.099") shank diameter	6	8 <sup>e</sup>
19/32, 5/8, 23/32 and 3/4	1 <sup>1</sup> / <sub>2</sub> ring or screw shank nail-minimum 12 <sup>1</sup> / <sub>2</sub> ga. (0.099") shank diameter	6	8
	Staple 16 ga. 1 <sup>1</sup> / <sub>2</sub>	6	8
Hardboard <sup>f</sup>			
0.200	1 <sup>1</sup> / <sub>2</sub> long × 0.080" ring-grooved shank underlayment nail	6	6
	1 <sup>3</sup> / <sub>8</sub> long × 0.080" polymer cement-coated sinker nail	6	6
	Staple 18 ga., 7/8 long (plastic coated)	3	6
Particleboard			
1/4	1 <sup>1</sup> / <sub>2</sub> long × 0.099" ring-grooved shank underlayment nail	3	6
	Staple 18 ga., 7/8 long, 3/16 crown	3	6
3/8	2 long × 0.120" ring-grooved shank underlayment nail	6	10
	Staple 16 ga., 1 <sup>1</sup> / <sub>8</sub> long, 3/8 crown	3	6
1/2, 5/8	2 long × 0.120" ring-grooved shank underlayment nail	6	10
	Staple 16 ga., 1 <sup>5</sup> / <sub>8</sub> long, 3/8 crown	3	6

(continued)

## WALL CONSTRUCTION

**TABLE R602.3(2)—continued**  
**ALTERNATE ATTACHMENTS TO TABLE R602.3(1)**

For SI: 1 inch = 25.4 mm.

- Nail is a general description and shall be permitted to be T-head, modified round head or round head.
- Staples shall have a minimum crown width of  $\frac{7}{16}$ -inch except as noted.
- Nails or staples shall be spaced at not more than 6 inches on center at all supports where spans are 48 inches or greater. Nails or staples shall be spaced at not more than 12 inches on center at intermediate supports for floors.
- Fasteners shall be placed in a grid pattern throughout the body of the panel.
- For 5-ply panels, intermediate nails shall be spaced not more than 12 inches on center each way.
- Hardboard underlayment shall conform to CPA/ANSI A135.4.
- Alternate fastening is only permitted for roof sheathing where the ultimate design wind speed is less than or equal to 110 mph, and where fasteners are installed 3 inches on center at all supports.
- Fiber-cement underlayment shall conform to ASTM C1288 or ISO 8336, Category C.

**TABLE R602.3(3)**  
**REQUIREMENTS FOR WOOD STRUCTURAL PANEL WALL SHEATHING USED TO RESIST WIND PRESSURES<sup>a, b, c</sup>**

MINIMUM NAIL		MINIMUM WOOD STRUCTURAL PANEL SPAN RATING	MINIMUM NOMINAL PANEL THICKNESS (inches)	MAXIMUM WALL STUD SPACING (inches)	PANEL NAIL SPACING		ULTIMATE DESIGN WIND SPEED V <sub>ult</sub> (mph)		
Size	Penetration (inches)				Edges (inches o.c.)	Field (inches o.c.)	Wind exposure category		
							B	C	D
6d Common (2.0" × 0.113")	1.5	24/0	<sup>3</sup> / <sub>8</sub>	16	6	12	140	115	110
8d Common (2.5" × 0.131")	1.75	24/16	<sup>7</sup> / <sub>16</sub>	16	6	12	170	140	135
				24	6	12	140	115	110

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- Panel strength axis parallel or perpendicular to supports. Three-ply plywood sheathing with studs spaced more than 16 inches on center shall be applied with panel strength axis perpendicular to supports.
- Table is based on wind pressures acting toward and away from building surfaces in accordance with Section R301.2. Lateral bracing requirements shall be in accordance with Section R602.10.
- Wood structural panels with span ratings of Wall-16 or Wall-24 shall be permitted as an alternate to panels with a 24/0 span rating. Plywood siding rated 16 o.c. or 24 o.c. shall be permitted as an alternate to panels with a 24/16 span rating. Wall-16 and Plywood siding 16 o.c. shall be used with studs spaced not more than 16 inches on center.

**TABLE R602.3(4)**  
**ALLOWABLE SPANS FOR PARTICLEBOARD WALL SHEATHING<sup>a</sup>**

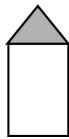
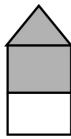
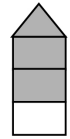

THICKNESS (inch)	GRADE	STUD SPACING (inches)	
		Where siding is nailed to studs	Where siding is nailed to sheathing
$\frac{3}{8}$	M-1 Exterior glue	16	—
$\frac{1}{2}$	M-2 Exterior glue	16	16

For SI: 1 inch = 25.4 mm.

- Wall sheathing not exposed to the weather. If the panels are applied horizontally, the end joints of the panel shall be offset so that four panel corners will not meet. Panel edges must be supported. Leave a  $\frac{1}{16}$ -inch gap between panels and nail not less than  $\frac{3}{8}$  inch from panel edges.

## WALL CONSTRUCTION

**TABLE R602.3(5)**  
**SIZE, HEIGHT AND SPACING OF WOOD STUDS<sup>a</sup>**

STUD SIZE (inches)	BEARING WALLS					NONBEARING WALLS	
	Laterally unsupported stud height <sup>a</sup> (feet)	Maximum spacing where supporting a roof-ceiling attic assembly, only (inches)	Maximum spacing where supporting one floor, plus a roof-ceiling attic assembly (inches)	Maximum spacing where supporting two floors, plus a roof-ceiling attic assembly (inches)	Maximum spacing where supporting one floor height <sup>a</sup> (inches)	Laterally unsupported stud height <sup>a</sup> (feet)	Maximum spacing (inches)
							
2 × 3 <sup>b</sup>	—	—	—	—	—	10	16
2 × 4	10	24 <sup>c</sup>	16 <sup>c</sup>	—	24	14	24
3 × 4	10	24	24	16	24	14	24
2 × 5	10	24	24	—	24	16	24
2 × 6	10	24	24	16	24	20	24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Listed heights are distances between points of lateral support placed perpendicular to the plane of the wall. Bearing walls shall be sheathed on not less than one side or bridging shall be installed not greater than 4 feet apart measured vertically from either end of the stud. Increases in unsupported height are permitted where in compliance with Exception 2 of Section R602.3.1 or designed in accordance with accepted engineering practice.
- b. Shall not be used in exterior walls.
- c. A habitable attic assembly supported by 2 × 4 studs is limited to a roof span of 32 feet. Where the roof span exceeds 32 feet, the wall studs shall be increased to 2 × 6 or the studs shall be designed in accordance with accepted engineering practice.

**TABLE R602.3(6)**  
**ALTERNATE WOOD BEARING WALL STUD SIZE, HEIGHT AND SPACING**

STUD HEIGHT	SUPPORTING	STUD SPACING <sup>a</sup>	ULTIMATE DESIGN WIND SPEED					
			115 mph		130 mph <sup>b</sup>		140 mph <sup>b</sup>	
			Maximum roof/floor span <sup>c</sup>		Maximum roof/floor span <sup>c</sup>		Maximum roof/floor span <sup>c</sup>	
			12 ft	24 ft	12 ft	24 ft	12 ft	24 ft
11 ft	Roof only	12 in	2 × 4	2 × 4	2 × 4	2 × 4	2 × 4	2 × 4
		16 in	2 × 4	2 × 4	2 × 4	2 × 6	2 × 4	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
	Roof and one floor	12 in	2 × 4	2 × 6	2 × 4	2 × 6	2 × 4	2 × 6
		16 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
12 ft	Roof only	12 in	2 × 4	2 × 4	2 × 4	2 × 6	2 × 4	2 × 6
		16 in	2 × 4	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
	Roof and one floor	12 in	2 × 4	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		16 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6
		24 in	2 × 6	2 × 6	2 × 6	2 × 6	2 × 6	DR

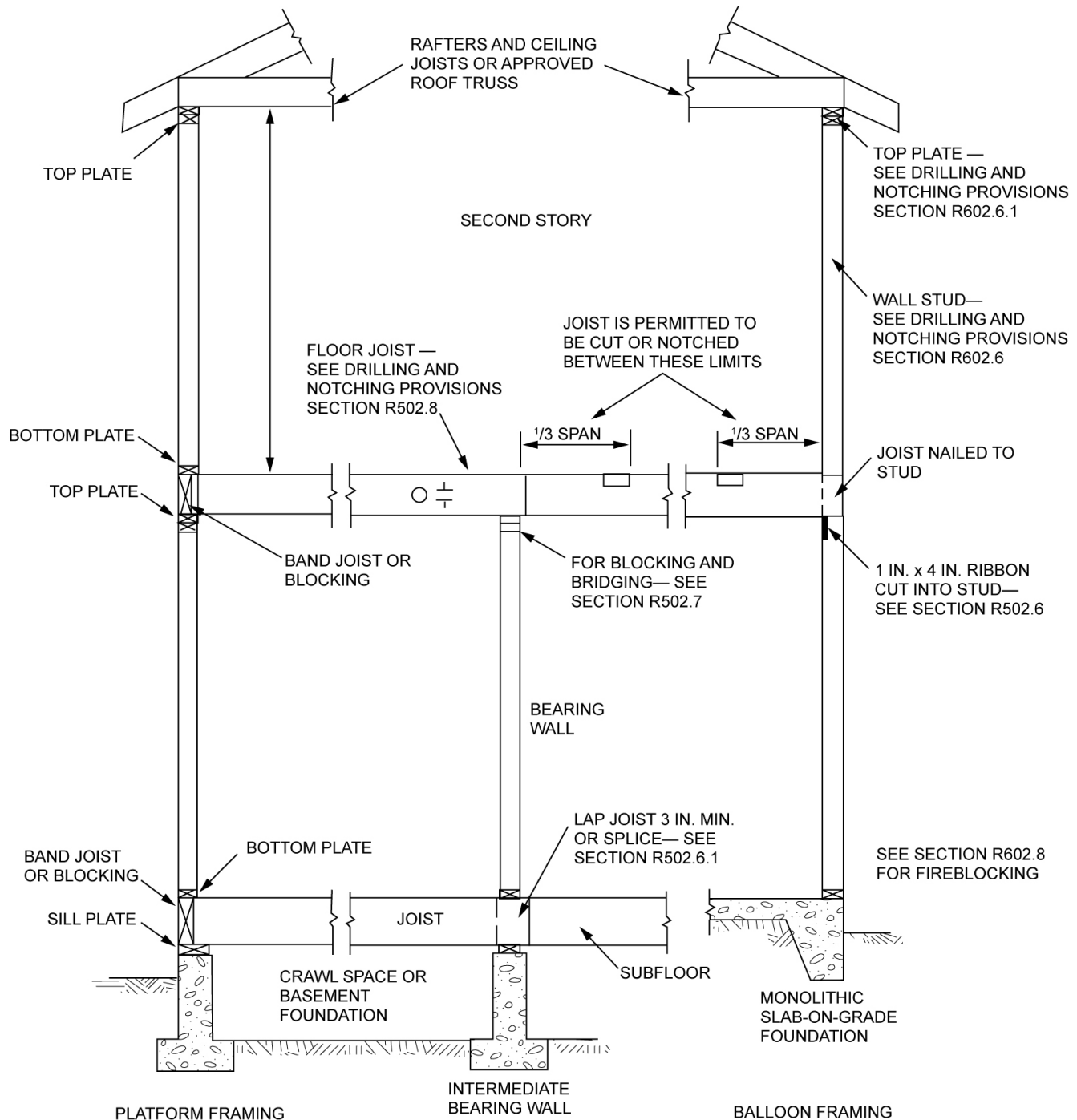
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mph = 0.447 m/s, 1 pound = 4.448 N.

DR = Design Required.

- a. Wall studs not exceeding 16 inches on center shall be sheathed with minimum 1/2-inch gypsum board on the interior and 3/8-inch wood structural panel sheathing on the exterior. Wood structural panel sheathing shall be attached with 8d (2.5" × 0.131") nails not greater than 6 inches on center along panel edges and 12 inches on center at intermediate supports, and all panel joints shall occur over studs or blocking.
- b. Where the ultimate design wind speed exceeds 115 mph, studs shall be attached to top and bottom plates with connectors having a minimum 300-pound lateral capacity.
- c. The maximum span is applicable to both single- and multiple-span roof and floor conditions. The *roof assembly* shall not contain a habitable attic.



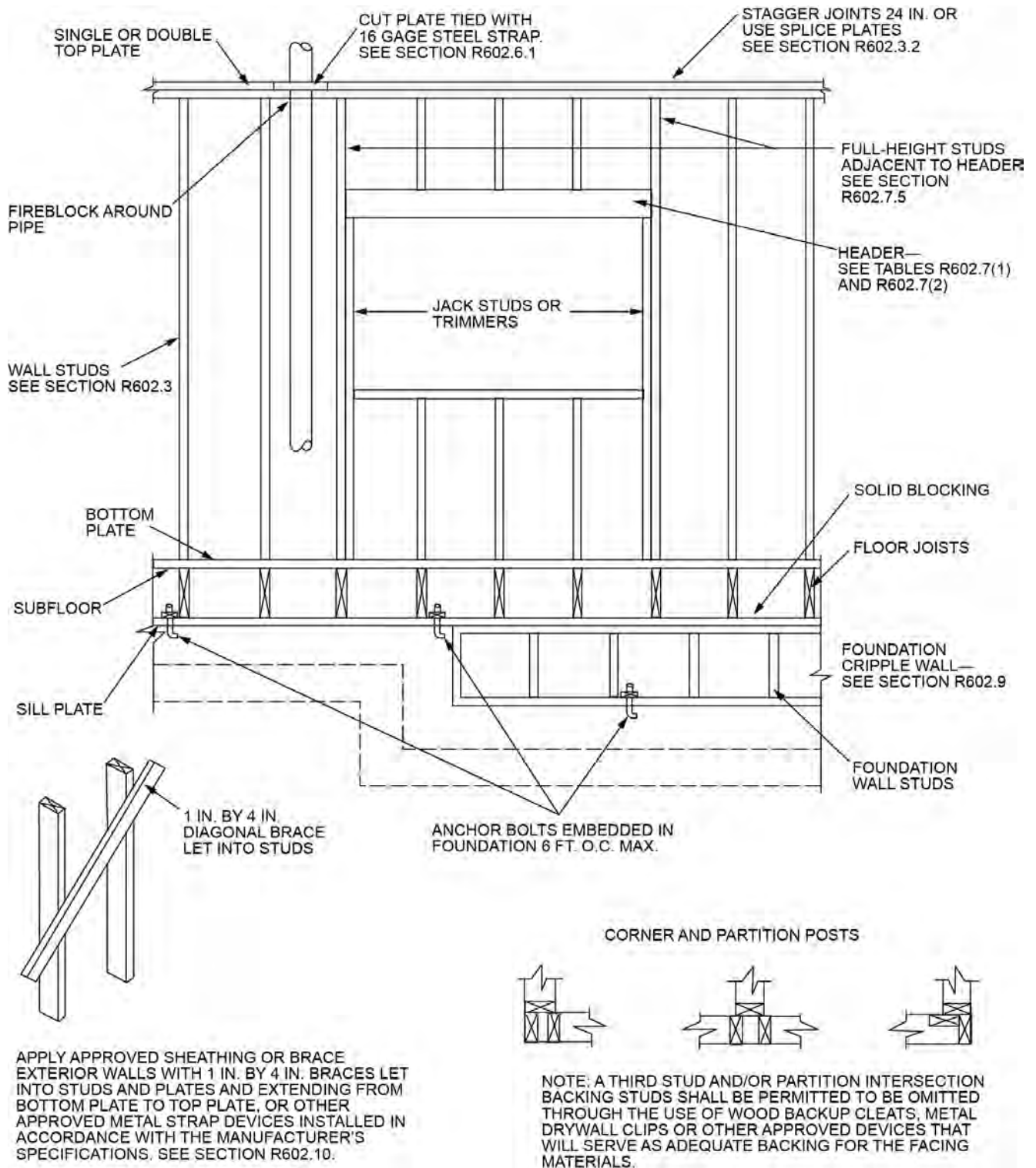
## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**FIGURE R602.3(1)**  
**TYPICAL WALL, FLOOR AND ROOF FRAMING**

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R602.3(2)**  
**FRAMING DETAILS**

## WALL CONSTRUCTION

**TABLE R602.3.2**  
**SINGLE TOP-PLATE SPLICE CONNECTION DETAILS**

CONDITION	TOP-PLATE SPLICE LOCATION			
	Corners and intersecting walls		Butt joints in straight walls	
	Splice plate size	Minimum nails each side of joint	Splice plate size	Minimum nails each side of joint
Structures in SDC A-C; and in SDC D <sub>0</sub> , D <sub>1</sub> and D <sub>2</sub> with braced wall line spacing less than 25 feet	3" × 6" × 0.036" galvanized steel plate or equivalent	(6) 8d box (2½" × 0.113") nails	3" × 12" × 0.036" galvanized steel plate or equivalent	(12) 8d box (2½" × 0.113") nails
Structures in SDC D <sub>0</sub> , D <sub>1</sub> and D <sub>2</sub> , with braced wall line spacing greater than or equal to 25 feet	3" × 8" × 0.036" galvanized steel plate or equivalent	(9) 8d box (2½" × 0.113") nails	3" × 16" × 0.036" galvanized steel plate or equivalent	(18) 8d box (2½" × 0.113") nails

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**R602.5 Interior nonbearing walls.** Interior *nonbearing walls* shall be permitted to be constructed with 2-inch by 3-inch (51 mm by 76 mm) studs spaced 24 inches (610 mm) on center or, where not part of a *braced wall line*, 2-inch by 4-inch (51 mm by 102 mm) flat studs spaced at 16 inches (406 mm) on center. Interior *nonbearing walls* shall be capped with not less than a single top plate. Interior *nonbearing walls* shall be fireblocked in accordance with Section R602.8.

**R602.6 Drilling and notching of studs.** Drilling and notching of studs shall be in accordance with the following:

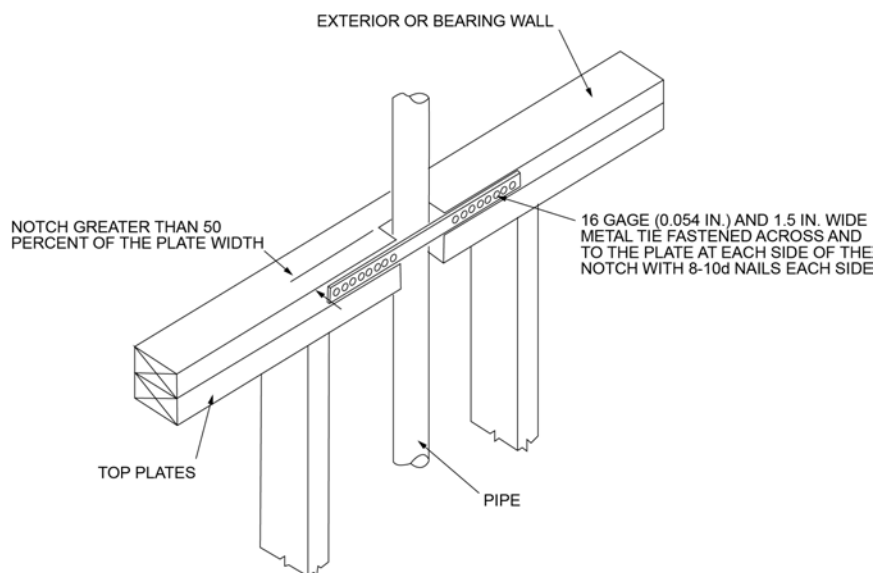
1. Notching. A stud in an exterior wall or bearing partition shall not be cut or notched to a depth exceeding 25 percent of its depth. Studs in nonbearing partitions shall not be notched to a depth exceeding 40 percent of a single stud depth.
2. Boring. The diameter of bored holes in studs shall not exceed 60 percent of the stud depth, the edge of the hole shall not be less than ⅝ inch (16 mm) from the edge of the stud, and the hole shall not be located in the same section as a cut or notch. Where the diameter of a bored hole in a stud located in exterior

walls or bearing partitions is over 40 percent, such stud shall be doubled and not more than two successive doubled studs shall be so bored. See Figures R602.6(1) and R602.6(2).

**Exception:** Where approved, stud shoes are installed in accordance with the manufacturer's instructions.

**R602.6.1 Drilling and notching of top plate.** Where piping or ductwork is placed in or partly in an exterior wall or interior *load-bearing wall*, necessitating cutting, drilling or notching of the top plate by more than 50 percent of its width, a galvanized metal tie not less than 0.054 inch thick (1.37 mm) (16 ga) and 1½ inches (38 mm) wide shall be fastened across and to the plate at each side of the opening with not less than eight 10d (0.148 inch diameter) nails having a minimum length of 1½ inches (38 mm) at each side or equivalent. The metal tie must extend not less than 6 inches past the opening. See Figure R602.6.1.

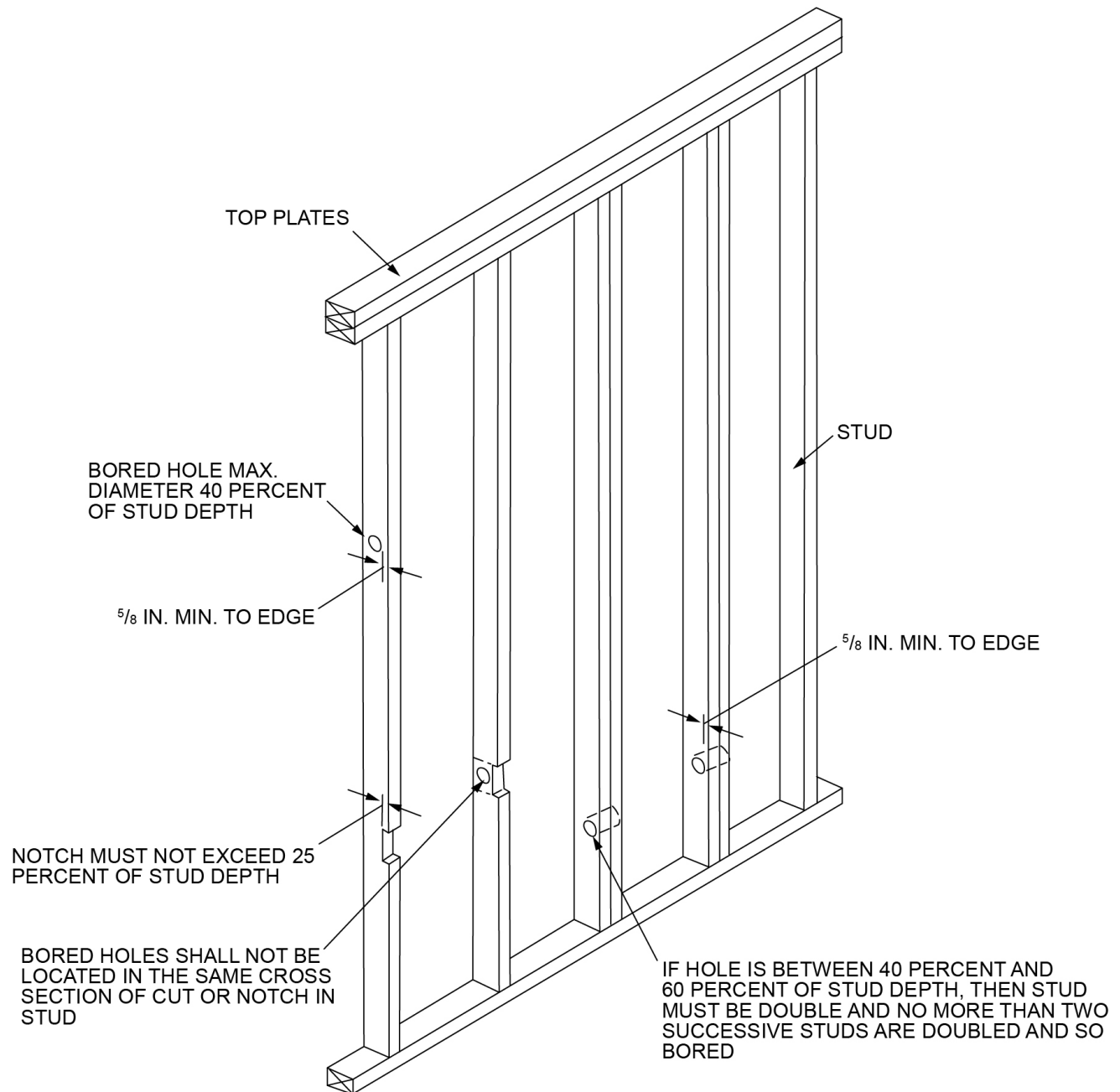
**Exception:** Where the entire side of the wall with the notch or cut is covered by wood structural panel sheathing.



For SI: 1 inch = 25.4 mm.

**FIGURE R602.6.1**  
**TOP PLATE FRAMING TO ACCOMMODATE PIPING**

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**Note:** Condition for exterior and bearing walls.

**FIGURE R602.6(1)**  
**NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS**



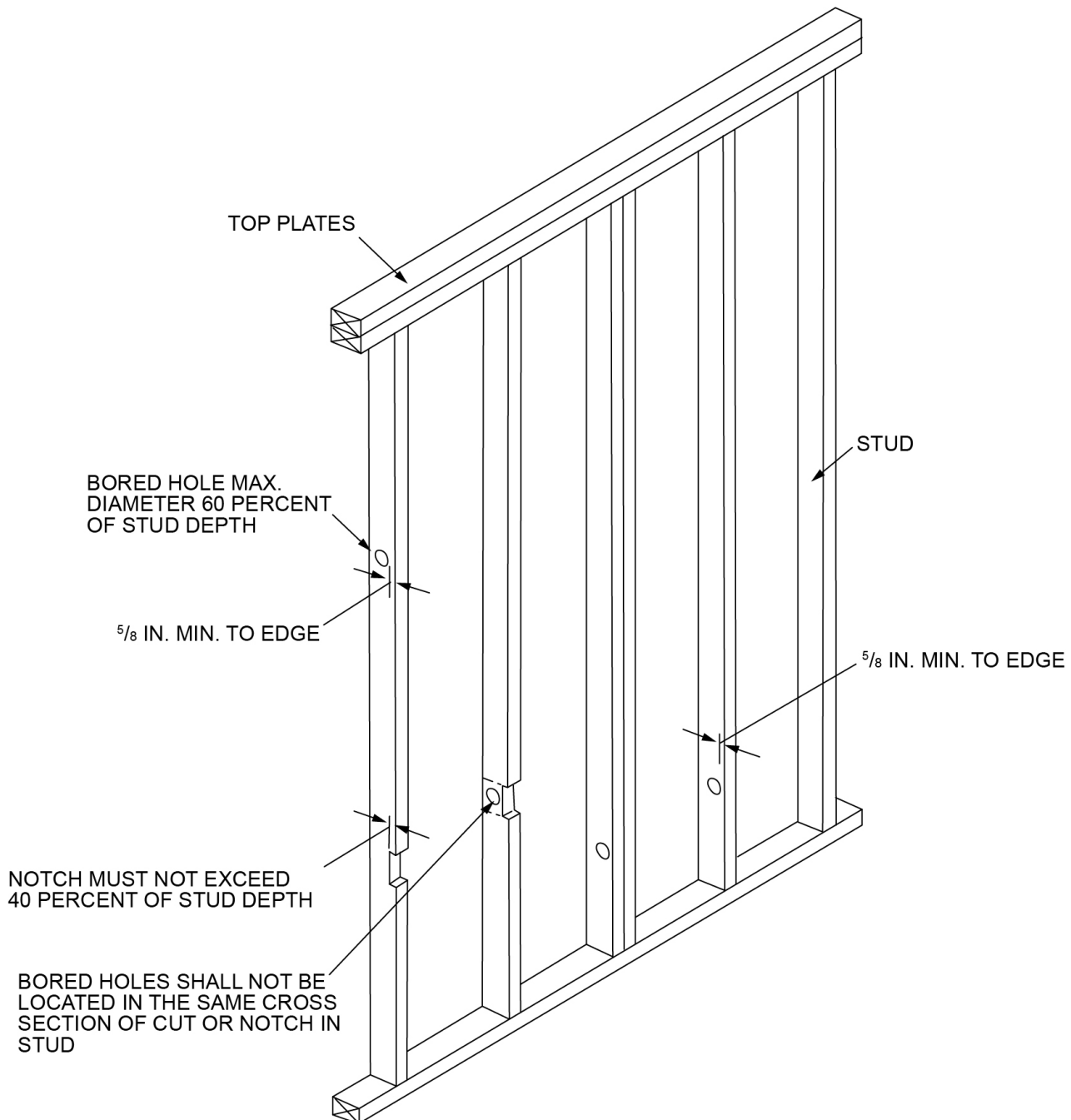
## WALL CONSTRUCTION

**R602.7 Headers.** For header spans, see Tables R602.7(1), R602.7(2) and R602.7(3).

**R602.7.1 Single member headers.** Single headers shall be framed with a single flat 2-inch-nominal (51 mm) member or wall plate not less in width than the wall studs on the top and bottom of the header in accordance with Figures R602.7.1(1) and R602.7.1(2) and face nailed to

the top and bottom of the header with 10d box nails (3 inches  $\times$  0.128 inches) spaced 12 inches on center.

**R602.7.2 Rim board headers.** Rim board header size, material and span shall be in accordance with Table R602.7(1). Rim board headers shall be constructed in accordance with Figure R602.7.2 and shall be supported at each end by full-height studs. The number of full-



For SI: 1 inch = 25.4 mm.

**FIGURE R602.6(2)**  
**NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR NONBEARING WALLS**

height studs at each end shall be not less than the number of studs displaced by half of the header span based on the maximum stud spacing in accordance with Table R602.3(5). Rim board headers supporting concentrated loads shall be designed in accordance with accepted engineering practice.

**R602.7.3 Wood structural panel box headers.** Wood structural panel box headers shall be constructed in accordance with Figure R602.7.3 and Table R602.7.3.

**R602.7.4 Nonbearing walls.** Load-bearing headers are not required in interior or exterior *nonbearing walls*. A single flat 2-inch by 4-inch (51 mm by 102 mm) member shall be permitted to be used as a header in interior or exterior *nonbearing walls* for openings up to 8 feet (2438 mm) in width if the vertical distance to the parallel nailing surface above is not more than 24 inches (610 mm). For such nonbearing headers, cripples or blocking are not required above the header.

**R602.7.5 Supports for headers.** Headers shall be supported on each end with one or more jack studs or with *approved* framing anchors in accordance with Table R602.7(1) or R602.7(2). The full-height stud adjacent to each end of the header shall be end nailed to each end of the header in accordance with Table R602.3(1). The minimum number of full-height studs at each end of a header shall be in accordance with Table R602.7.5.

**TABLE R602.7.5**  
**MINIMUM NUMBER OF FULL-HEIGHT STUDS**  
**AT EACH END OF HEADERS IN EXTERIOR WALLS<sup>a</sup>**

MAXIMUM HEADER SPAN (feet)	ULTIMATE DESIGN WIND SPEED AND EXPOSURE CATEGORY	
	< 140 mph, Exposure B or < 130 mph, Exposure C	≤ 115 mph, Exposure B <sup>b</sup>
4	1	1
6	2	1
8	2	1
10	3	2
12	3	2
14	3	2
16	4	2
18	4	2

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

- For header spans between those given, use the minimum number of full-height studs associated with the larger header span.
- The tabulated minimum number of full-height studs is applicable where jack studs are provided to support the header at each end in accordance with Table R602.7(1). Where a framing anchor is used to support the header in lieu of a jack stud in accordance with Note d of Table R602.7(1), the minimum number of full-height studs at each end of a header shall be in accordance with requirements for wind speed < 140 mph, Exposure B.

**R602.8 Fireblocking required.** Fireblocking shall be provided in accordance with Section R302.11.

**R602.9 Cripple walls.** Foundation cripple walls shall be framed of studs not smaller than the studding above. Where exceeding 4 feet (1219 mm) in height, such walls shall be framed of studs having the size required for an additional story.

Exterior cripple walls with a stud height less than 14 inches (356 mm) shall be continuously sheathed on one side with wood structural panels fastened to both the top and bottom plates in accordance with Table R602.3(1), or the cripple walls shall be constructed of solid blocking.

Cripple walls shall be supported on continuous foundations.

**R602.10 Wall bracing.** Buildings shall be braced in accordance with this section or, when applicable, Section R602.12. Where a building, or portion thereof, does not comply with one or more of the bracing requirements in this section, those portions shall be designed and constructed in accordance with Section R301.1.

**R602.10.1 Braced wall lines.** For the purpose of determining the amount and location of bracing required in each story level of a building, *braced wall lines* shall be designated as straight lines in the building plan placed in accordance with this section.

**R602.10.1.1 Length of a braced wall line.** The length of a *braced wall line* shall be the distance between its ends. The end of a *braced wall line* shall be the intersection with a perpendicular *braced wall line*, an angled *braced wall line* as permitted in Section R602.10.1.4 or an exterior wall as shown in Figure R602.10.1.1.



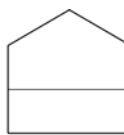
**R602.10.1.2 Location of braced wall lines and permitted offsets.** Each *braced wall line* shall be located such that no more than two-thirds of the required *braced wall panel* length is located to one side of the *braced wall line*. Braced wall panels shall be permitted to be offset up to 4 feet (1219 mm) from the designated *braced wall line*. Braced wall panels parallel to a *braced wall line* shall be offset not more than 4 feet (1219 mm) from the designated *braced wall line* location as shown in Figure R602.10.1.1.

Exterior walls parallel to a *braced wall line* shall be offset not more than 4 feet (1219 mm) from the designated *braced wall line* location as shown in Figure R602.10.1.1.

Interior walls used as bracing shall be offset not more than 4 feet (1219 mm) from a *braced wall line* through the interior of the building as shown in Figure R602.10.1.1.

## WALL CONSTRUCTION



**TABLE R602.7(1)**  
**GIRDER SPANS<sup>a</sup> AND HEADER SPANS<sup>a</sup> FOR EXTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir<sup>b</sup> and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING		SIZE	GROUND SNOW LOAD (psf) <sup>c</sup>																	
			30						50						70					
			Building width <sup>c</sup> (feet)																	
			12		24		36		12		24		36		12		24		36	
			Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>
<div>Roof and ceiling</div>  <div>ROOF AND CEILING</div>	1-2 × 6	4-0	1	3-1	2	2-7	2	3-5	1	2-8	2	2-3	2	3-0	2	2-4	2	2-0	2	
	1-2 × 8	5-1	2	3-11	2	3-3	2	4-4	2	3-4	2	2-10	2	3-10	2	3-0	2	2-6	3	
	1-2 × 10	6-0	2	4-8	2	3-11	2	5-2	2	4-0	2	3-4	3	4-7	2	3-6	3	3-0	3	
	1-2 × 12	7-1	2	5-5	2	4-7	3	6-1	2	4-8	3	3-11	3	5-5	2	4-2	3	3-6	3	
	2-2 × 4	4-0	1	3-1	1	2-7	1	3-5	1	2-7	1	2-2	1	3-0	1	2-4	1	2-0	1	
	2-2 × 6	6-0	1	4-7	1	3-10	1	5-1	1	3-11	1	3-3	2	4-6	1	3-6	2	2-11	2	
	2-2 × 8	7-7	1	5-9	1	4-10	2	6-5	1	5-0	2	4-2	2	5-9	1	4-5	2	3-9	2	
	2-2 × 10	9-0	1	6-10	2	5-9	2	7-8	2	5-11	2	4-11	2	6-9	2	5-3	2	4-5	2	
	2-2 × 12	10-7	2	8-1	2	6-10	2	9-0	2	6-11	2	5-10	2	8-0	2	6-2	2	5-2	3	
	3-2 × 8	9-5	1	7-3	1	6-1	1	8-1	1	6-3	1	5-3	2	7-2	1	5-6	2	4-8	2	
	3-2 × 10	11-3	1	8-7	1	7-3	2	9-7	1	7-4	2	6-2	2	8-6	1	6-7	2	5-6	2	
	3-2 × 12	13-2	1	10-1	2	8-6	2	11-3	2	8-8	2	7-4	2	10-0	2	7-9	2	6-6	2	
	4-2 × 8	10-11	1	8-4	1	7-0	1	9-4	1	7-2	1	6-0	1	8-3	1	6-4	1	5-4	2	
	4-2 × 10	12-11	1	9-11	1	8-4	1	11-1	1	8-6	1	7-2	2	9-10	1	7-7	2	6-4	2	
4-2 × 12	15-3	1	11-8	1	9-10	2	13-0	1	10-0	2	8-5	2	11-7	1	8-11	2	7-6	2		
<div>Roof, ceiling and one center- bearing floor</div>  <div>ROOF, CEILING AND ONE FLOOR (CENTER BEARING)</div>	1-2 × 6	3-3	1	2-7	2	2-2	2	3-0	2	2-4	2	2-0	2	2-9	2	2-2	2	1-10	2	
	1-2 × 8	4-1	2	3-3	2	2-9	2	3-9	2	3-0	2	2-6	3	3-6	2	2-9	2	2-4	3	
	1-2 × 10	4-11	2	3-10	2	3-3	3	4-6	2	3-6	3	3-0	3	4-1	2	3-3	3	2-9	3	
	1-2 × 12	5-9	2	4-6	3	3-10	3	5-3	2	4-2	3	3-6	3	4-10	3	3-10	3	3-3	4	
	2-2 × 4	3-3	1	2-6	1	2-2	1	3-0	1	2-4	1	2-0	1	2-8	1	2-2	1	1-10	1	
	2-2 × 6	4-10	1	3-9	1	3-3	2	4-5	1	3-6	2	3-0	2	4-1	1	3-3	2	2-9	2	
	2-2 × 8	6-1	1	4-10	2	4-1	2	5-7	2	4-5	2	3-9	2	5-2	2	4-1	2	3-6	2	
	2-2 × 10	7-3	2	5-8	2	4-10	2	6-8	2	5-3	2	4-5	2	6-1	2	4-10	2	4-1	2	
	2-2 × 12	8-6	2	6-8	2	5-8	2	7-10	2	6-2	2	5-3	3	7-2	2	5-8	2	4-10	3	
	3-2 × 8	7-8	1	6-0	1	5-1	2	7-0	1	5-6	2	4-8	2	6-5	1	5-1	2	4-4	2	
	3-2 × 10	9-1	1	7-2	2	6-1	2	8-4	1	6-7	2	5-7	2	7-8	2	6-1	2	5-2	2	
	3-2 × 12	10-8	2	8-5	2	7-2	2	9-10	2	7-8	2	6-7	2	9-0	2	7-1	2	6-1	2	
	4-2 × 8	8-10	1	6-11	1	5-11	1	8-1	1	6-4	1	5-5	2	7-5	1	5-11	1	5-0	2	
	4-2 × 10	10-6	1	8-3	2	7-0	2	9-8	1	7-7	2	6-5	2	8-10	1	7-0	2	6-0	2	
4-2 × 12	12-4	1	9-8	2	8-3	2	11-4	2	8-11	2	7-7	2	10-4	2	8-3	2	7-0	2		
<div>Roof, ceiling and one clear- span floor</div>  <div>ROOF, CEILING AND ONE FLOOR (CLEAR SPAN)</div>	1-2 × 6	2-11	2	2-3	2	1-11	2	2-9	2	2-1	2	1-9	2	2-7	2	2-0	2	1-8	2	
	1-2 × 8	3-9	2	2-10	2	2-5	3	3-6	2	2-8	2	2-3	3	3-3	2	2-6	3	2-2	3	
	1-2 × 10	4-5	2	3-5	3	2-10	3	4-2	2	3-2	3	2-8	3	3-11	2	3-0	3	2-6	3	
	1-2 × 12	5-2	2	4-0	3	3-4	3	4-10	3	3-9	3	3-2	4	4-7	3	3-6	3	3-0	4	
	2-2 × 4	2-11	1	2-3	1	1-10	1	2-9	1	2-1	1	1-9	1	2-7	1	2-0	1	1-8	1	
	2-2 × 6	4-4	1	3-4	2	2-10	2	4-1	1	3-2	2	2-8	2	3-10	1	3-0	2	2-6	2	
	2-2 × 8	5-6	2	4-3	2	3-7	2	5-2	2	4-0	2	3-4	2	4-10	2	3-9	2	3-2	2	
	2-2 × 10	6-7	2	5-0	2	4-2	2	6-1	2	4-9	2	4-0	2	5-9	2	4-5	2	3-9	3	
	2-2 × 12	7-9	2	5-11	2	4-11	3	7-2	2	5-7	2	4-8	3	6-9	2	5-3	3	4-5	3	
	3-2 × 8	6-11	1	5-3	2	4-5	2	6-5	1	5-0	2	4-2	2	6-1	1	4-8	2	4-0	2	
	3-2 × 10	8-3	2	6-3	2	5-3	2	7-8	2	5-11	2	5-0	2	7-3	2	5-7	2	4-8	2	
	3-2 × 12	9-8	2	7-5	2	6-2	2	9-0	2	7-0	2	5-10	2	8-6	2	6-7	2	5-6	3	
	4-2 × 8	8-0	1	6-1	1	5-1	2	7-5	1	5-9	2	4-10	2	7-0	1	5-5	2	4-7	2	
	4-2 × 10	9-6	1	7-3	2	6-1	2	8-10	1	6-10	2	5-9	2	8-4	1	6-5	2	5-5	2	
4-2 × 12	11-2	2	8-6	2	7-2	2	10-5	2	8-0	2	6-9	2	9-10	2	7-7	2	6-5	2		

(continued)

## WALL CONSTRUCTION

**TABLE R602.7(1)—continued**  
**GIRDER SPANS<sup>a</sup> AND HEADER SPANS<sup>a</sup> FOR EXTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir<sup>b</sup> and required number of jack studs)

GIRDERS AND HEADERS SUPPORTING	SIZE	GROUND SNOW LOAD (psf) <sup>e</sup>																	
		30						50						70					
		Building width <sup>c</sup> (feet)																	
		12		24		36		12		24		36		12		24		36	
		Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>	Span <sup>f</sup>	NJ <sup>d</sup>
Roof, ceiling and two center- bearing floors   ROOF, CEILING AND TWO FLOORS (CENTER BEARING)	1-2 × 6	2-8	2	2-1	2	1-10	2	2-7	2	2-0	2	1-9	2	2-5	2	1-11	2	1-8	2
	1-2 × 8	3-5	2	2-8	2	2-4	3	3-3	2	2-7	2	2-2	3	3-1	2	2-5	3	2-1	3
	1-2 × 10	4-0	2	3-2	3	2-9	3	3-10	2	3-1	3	2-7	3	3-8	2	2-11	3	2-5	3
	1-2 × 12	4-9	3	3-9	3	3-2	4	4-6	3	3-7	3	3-1	4	4-3	3	3-5	3	2-11	4
	2-2 × 4	2-8	1	2-1	1	1-9	1	2-6	1	2-0	1	1-8	1	2-5	1	1-11	1	1-7	1
	2-2 × 6	4-0	1	3-2	2	2-8	2	3-9	1	3-0	2	2-7	2	3-7	1	2-10	2	2-5	2
	2-2 × 8	5-0	2	4-0	2	3-5	2	4-10	2	3-10	2	3-3	2	4-7	2	3-7	2	3-1	2
	2-2 × 10	6-0	2	4-9	2	4-0	2	5-8	2	4-6	2	3-10	3	5-5	2	4-3	2	3-8	3
	2-2 × 12	7-0	2	5-7	2	4-9	3	6-8	2	5-4	3	4-6	3	6-4	2	5-0	3	4-3	3
	3-2 × 8	6-4	1	5-0	2	4-3	2	6-0	1	4-9	2	4-1	2	5-8	2	4-6	2	3-10	2
	3-2 × 10	7-6	2	5-11	2	5-1	2	7-1	2	5-8	2	4-10	2	6-9	2	5-4	2	4-7	2
	3-2 × 12	8-10	2	7-0	2	5-11	2	8-5	2	6-8	2	5-8	3	8-0	2	6-4	2	5-4	3
	4-2 × 8	7-3	1	5-9	1	4-11	2	6-11	1	5-6	2	4-8	2	6-7	1	5-2	2	4-5	2
	4-2 × 10	8-8	1	6-10	2	5-10	2	8-3	2	6-6	2	5-7	2	7-10	2	6-2	2	5-3	2
	4-2 × 12	10-2	2	8-1	2	6-10	2	9-8	2	7-8	2	6-7	2	9-2	2	7-3	2	6-2	2
Roof, ceiling, and two clear- span floors   ROOF, CEILING AND TWO FLOORS (CLEAR SPAN)	1-2 × 6	2-3	2	1-9	2	1-5	2	2-3	2	1-9	2	1-5	3	2-2	2	1-8	2	1-5	3
	1-2 × 8	2-10	2	2-2	3	1-10	3	2-10	2	2-2	3	1-10	3	2-9	2	2-1	3	1-10	3
	1-2 × 10	3-4	2	2-7	3	2-2	3	3-4	3	2-7	3	2-2	4	3-3	3	2-6	3	2-2	4
	1-2 × 12	4-0	3	3-0	3	2-7	4	4-0	3	3-0	4	2-7	4	3-10	3	3-0	4	2-6	4
	2-2 × 4	2-3	1	1-8	1	1-4	1	2-3	1	1-8	1	1-4	1	2-2	1	1-8	1	1-4	2
	2-2 × 6	3-4	1	2-6	2	2-2	2	3-4	2	2-6	2	2-2	2	3-3	2	2-6	2	2-1	2
	2-2 × 8	4-3	2	3-3	2	2-8	2	4-3	2	3-3	2	2-8	2	4-1	2	3-2	2	2-8	3
	2-2 × 10	5-0	2	3-10	2	3-2	3	5-0	2	3-10	2	3-2	3	4-10	2	3-9	3	3-2	3
	2-2 × 12	5-11	2	4-6	3	3-9	3	5-11	2	4-6	3	3-9	3	5-8	2	4-5	3	3-9	3
	3-2 × 8	5-3	1	4-0	2	3-5	2	5-3	2	4-0	2	3-5	2	5-1	2	3-11	2	3-4	2
	3-2 × 10	6-3	2	4-9	2	4-0	2	6-3	2	4-9	2	4-0	2	6-1	2	4-8	2	4-0	3
	3-2 × 12	7-5	2	5-8	2	4-9	3	7-5	2	5-8	2	4-9	3	7-2	2	5-6	3	4-8	3
	4-2 × 8	6-1	1	4-8	2	3-11	2	6-1	1	4-8	2	3-11	2	5-11	1	4-7	2	3-10	2
	4-2 × 10	7-3	2	5-6	2	4-8	2	7-3	2	5-6	2	4-8	2	7-0	2	5-5	2	4-7	2
	4-2 × 12	8-6	2	6-6	2	5-6	2	8-6	2	6-6	2	5-6	2	8-3	2	6-4	2	5-4	3

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- Spans are given in feet and inches.
- Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine, and spruce-pine-fir.
- Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
- NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing member attached to the full-height wall stud and to the header.
- Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.
- Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (for example, cripple studs bearing on the header), tabulated spans for headers consisting of 2 × 8, 2 × 10, or 2 × 12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.



## WALL CONSTRUCTION

**TABLE R602.7(2)**  
**GIRDER SPANS<sup>a</sup> AND HEADER SPANS<sup>a</sup> FOR INTERIOR BEARING WALLS**  
 (Maximum spans for Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir<sup>b</sup> and required number of jack studs)

HEADERS AND GIRDERS SUPPORTING	SIZE	BUILDING Width <sup>c</sup> (feet)					
		12		24		36	
		Span <sup>e</sup>	NJ <sup>d</sup>	Span <sup>e</sup>	NJ <sup>d</sup>	Span <sup>e</sup>	NJ <sup>d</sup>
One floor only	2-2 × 4	4-1	1	2-10	1	2-4	1
	2-2 × 6	6-1	1	4-4	1	3-6	1
	2-2 × 8	7-9	1	5-5	1	4-5	2
	2-2 × 10	9-2	1	6-6	2	5-3	2
	2-2 × 12	10-9	1	7-7	2	6-3	2
	3-2 × 8	9-8	1	6-10	1	5-7	1
	3-2 × 10	11-5	1	8-1	1	6-7	2
	3-2 × 12	13-6	1	9-6	2	7-9	2
	4-2 × 8	11-2	1	7-11	1	6-5	1
	4-2 × 10	13-3	1	9-4	1	7-8	1
	4-2 × 12	15-7	1	11-0	1	9-0	2
Two floors	2-2 × 4	2-7	1	1-11	1	1-7	1
	2-2 × 6	3-11	1	2-11	2	2-5	2
	2-2 × 8	5-0	1	3-8	2	3-1	2
	2-2 × 10	5-11	2	4-4	2	3-7	2
	2-2 × 12	6-11	2	5-2	2	4-3	3
	3-2 × 8	6-3	1	4-7	2	3-10	2
	3-2 × 10	7-5	1	5-6	2	4-6	2
	3-2 × 12	8-8	2	6-5	2	5-4	2
	4-2 × 8	7-2	1	5-4	1	4-5	2
	4-2 × 10	8-6	1	6-4	2	5-3	2
	4-2 × 12	10-1	1	7-5	2	6-2	2

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- Spans are given in feet and inches.
- Spans are based on minimum design properties for No. 2 grade lumber of Douglas fir-larch, hem-fir, Southern pine, and spruce-pine-fir.
- Building width is measured perpendicular to the ridge. For widths between those shown, spans are permitted to be interpolated.
- NJ = Number of jack studs required to support each end. Where the number of required jack studs equals one, the header is permitted to be supported by an approved framing anchor attached to the full-height wall stud and to the header.
- Spans are calculated assuming the top of the header or girder is laterally braced by perpendicular framing. Where the top of the header or girder is not laterally braced (for example, cripple studs bearing on the header), tabulated spans for headers consisting of 2 × 8, 2 × 10, or 2 × 12 sizes shall be multiplied by 0.70 or the header or girder shall be designed.

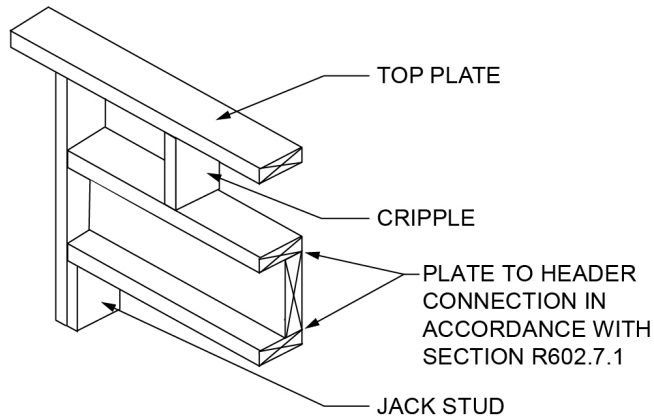
**TABLE R602.7(3)**  
**GIRDER AND HEADER SPANS<sup>a</sup> FOR OPEN PORCHES**  
 (Maximum span for Douglas fir-larch, hem-fir, Southern pine and spruce-pine-fir<sup>b</sup>)

SIZE	SUPPORTING ROOF						SUPPORTING FLOOR	
	Ground Snow Load (psf)							
	30		50		70			
	Depth of Porch <sup>c</sup> (feet)							
	8	14	8	14	8	14	8	14
2-2 × 6	7-6	5-8	6-2	4-8	5-4	4-0	6-4	4-9
2-2 × 8	10-1	7-7	8-3	6-2	7-1	5-4	8-5	6-4
2-2 × 10	12-4	9-4	10-1	7-7	8-9	6-7	10-4	7-9
2-2 × 12	14-4	10-10	11-8	8-10	10-1	7-8	11-11	9-0

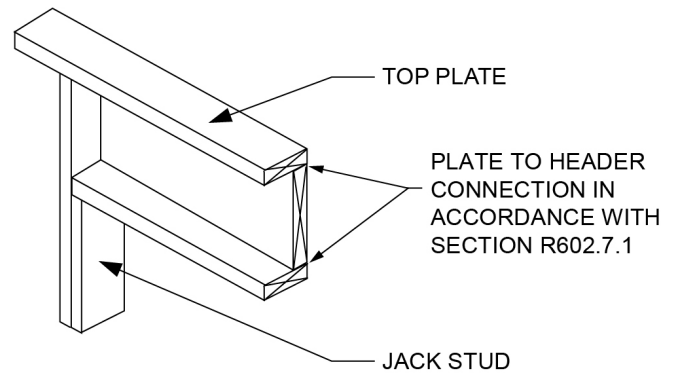
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- Spans are given in feet and inches.
- Tabulated values assume No. 2 grade lumber, wet service and incising for refractory species. Use 30 psf ground snow load for cases in which ground snow load is less than 30 psf and the roof live load is equal to or less than 20 psf.
- Porch depth is measured horizontally from building face to centerline of the header. For depths between those shown, spans are permitted to be interpolated.

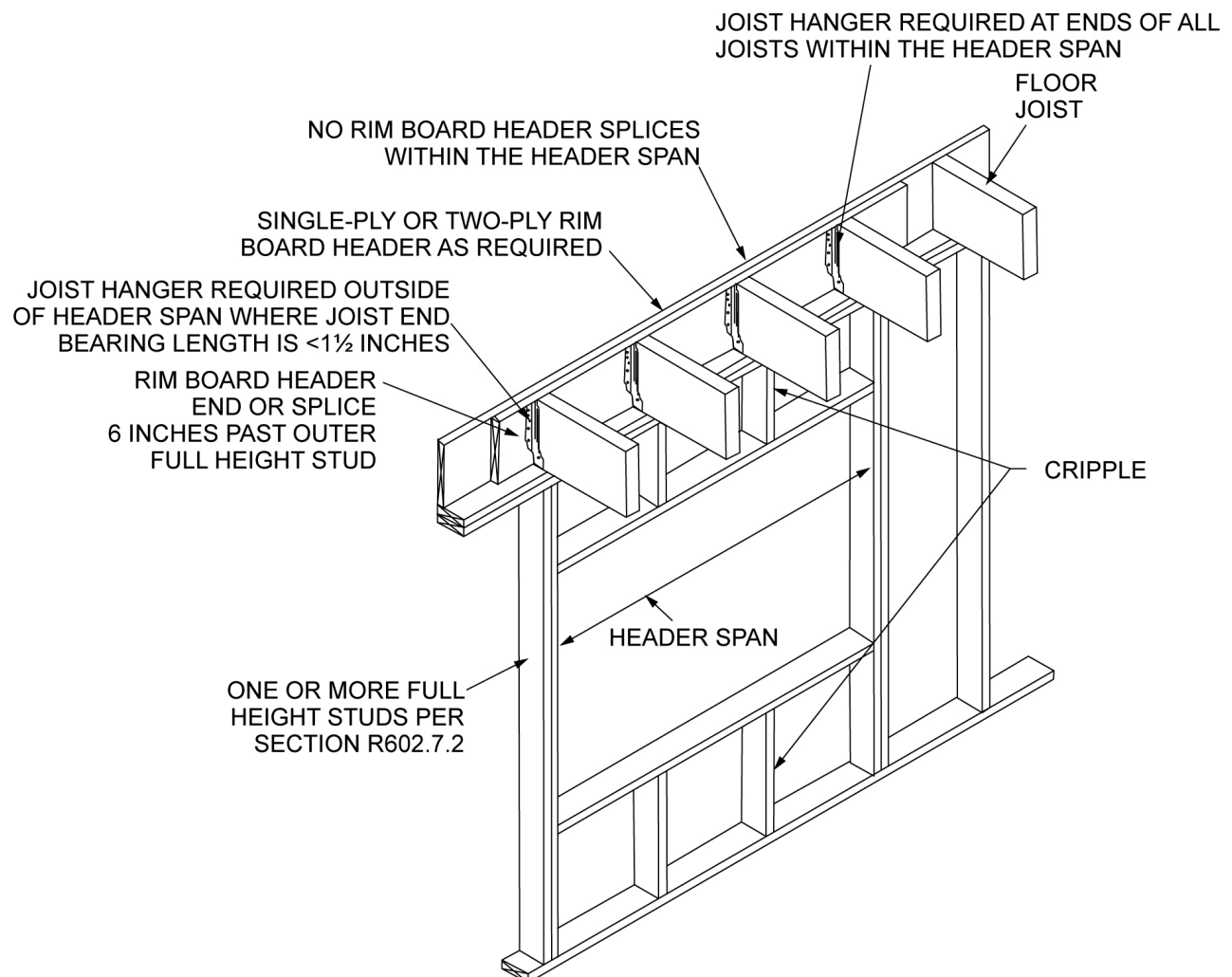
## WALL CONSTRUCTION



**FIGURE R602.7.1(1)**  
**SINGLE-MEMBER HEADER IN EXTERIOR BEARING WALL**



**FIGURE R602.7.1(2)**  
**ALTERNATIVE SINGLE-MEMBER  
HEADER WITHOUT CRIPPLE**



**FIGURE R602.7.2**  
**RIM BOARD HEADER CONSTRUCTION**

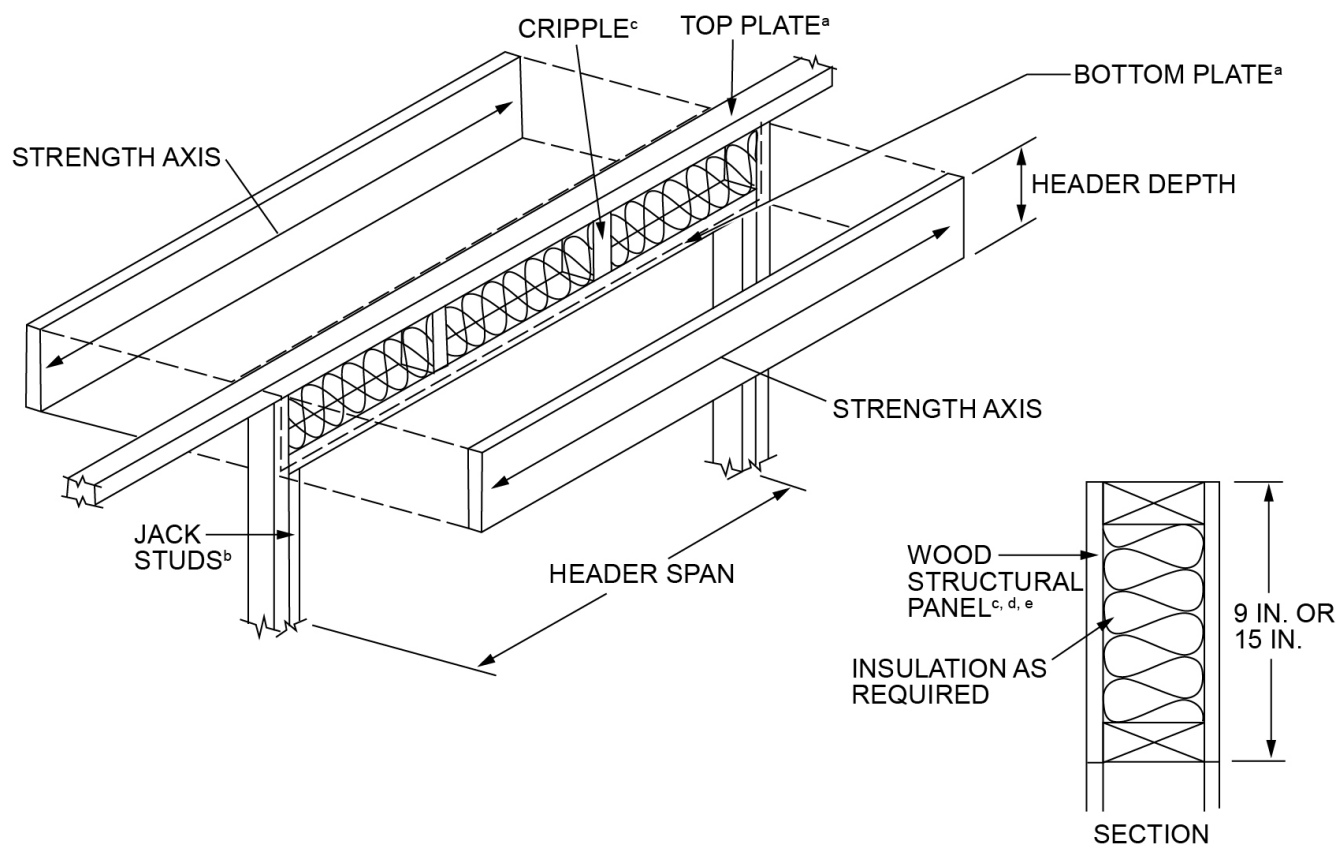
For SI: 25.4 mm = 1 inch.

WALL CONSTRUCTION

TABLE R602.7.3  
MAXIMUM SPANS FOR WOOD STRUCTURAL PANEL BOX HEADERS<sup>a</sup>

HEADER CONSTRUCTION <sup>b</sup>	HEADER DEPTH (inches)	HOUSE DEPTH (feet)				
		24	26	28	30	32
Wood structural panel—one side	9	4	4	3	3	—
	15	5	5	4	3	3
Wood structural panel—both sides	9	7	5	5	4	3
	15	8	8	7	7	6

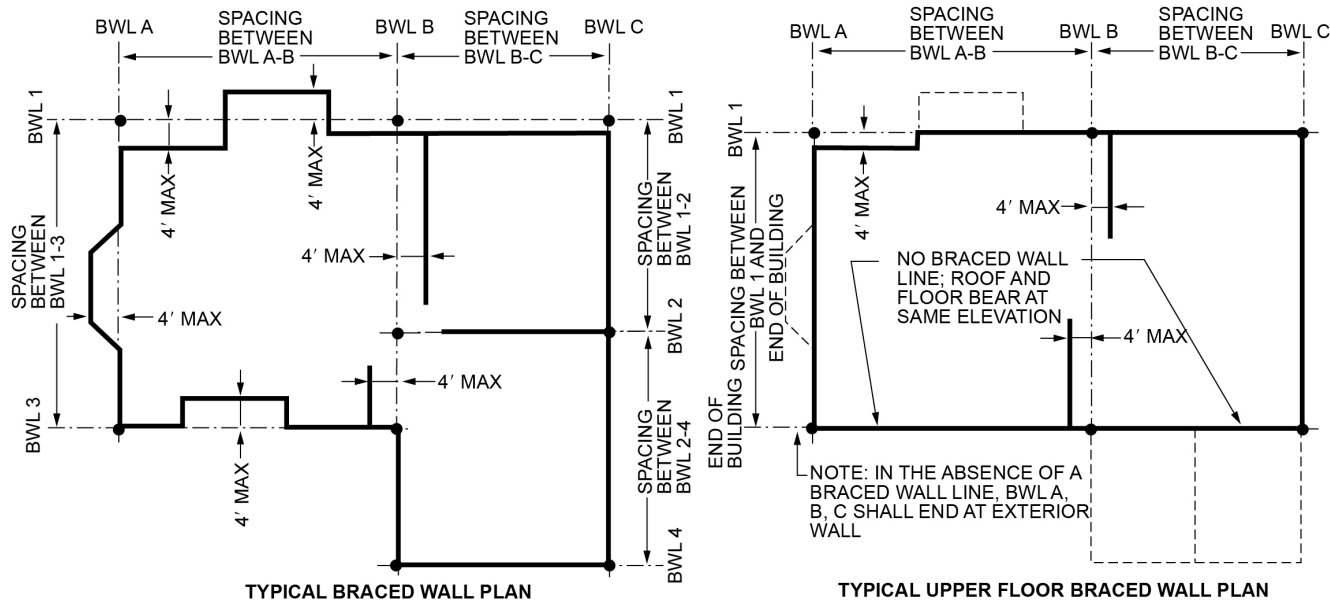
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.  
a. Spans are based on single story with clear-span trussed roof or two story with floor and roof supported by interior-bearing walls.  
b. See Figure R602.7.3 for construction details.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.  
**Notes:**  
a. The top and bottom plates shall be continuous at header location.  
b. Jack studs shall be used for spans over 4 feet.  
c. Cripple spacing shall be the same as for studs.  
d. Wood structural panel faces shall be single pieces of <sup>15</sup>/<sub>32</sub>-inch-thick Exposure 1 (exterior glue) or thicker, installed on the interior or exterior or both sides of the header.  
e. Wood structural panel faces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 3 inches on center, staggering alternate nails <sup>1</sup>/<sub>2</sub> inch. Galvanized nails shall be hot-dipped or tumbled.

FIGURE R602.7.3  
TYPICAL WOOD STRUCTURAL PANEL BOX HEADER CONSTRUCTION

## WALL CONSTRUCTION



For SI: 1 foot = 304.8 mm.

**FIGURE R602.10.1.1  
BRACED WALL LINES**

**R602.10.1.3 Spacing of braced wall lines.** The spacing between parallel *braced wall lines* shall be in accordance with Table R602.10.1.3. Intermediate *braced wall lines* through the interior of the building shall be permitted.

**R602.10.1.4 Angled walls.** Any portion of a wall along a *braced wall line* shall be permitted to angle out of plane for a maximum diagonal length of 8 feet (2438 mm). Where the angled wall occurs at a corner, the length of the *braced wall line* shall be measured from the projected corner as shown in Figure R602.10.1.4. Where the diagonal length is greater than 8 feet (2438 mm), it shall be considered to be a sepa-

rate *braced wall line* and shall be braced in accordance with Section R602.10.1.

**R602.10.2 Braced wall panels.** *Braced wall panels* shall be full-height sections of wall that shall not have vertical or horizontal offsets. *Braced wall panels* shall be constructed and placed along a *braced wall line* in accordance with this section and the bracing methods specified in Section R602.10.4.

**R602.10.2.1 Braced wall panel uplift load path.** The bracing lengths in Table R602.10.3(1) apply only when uplift loads are resisted in accordance with Section R602.3.5.

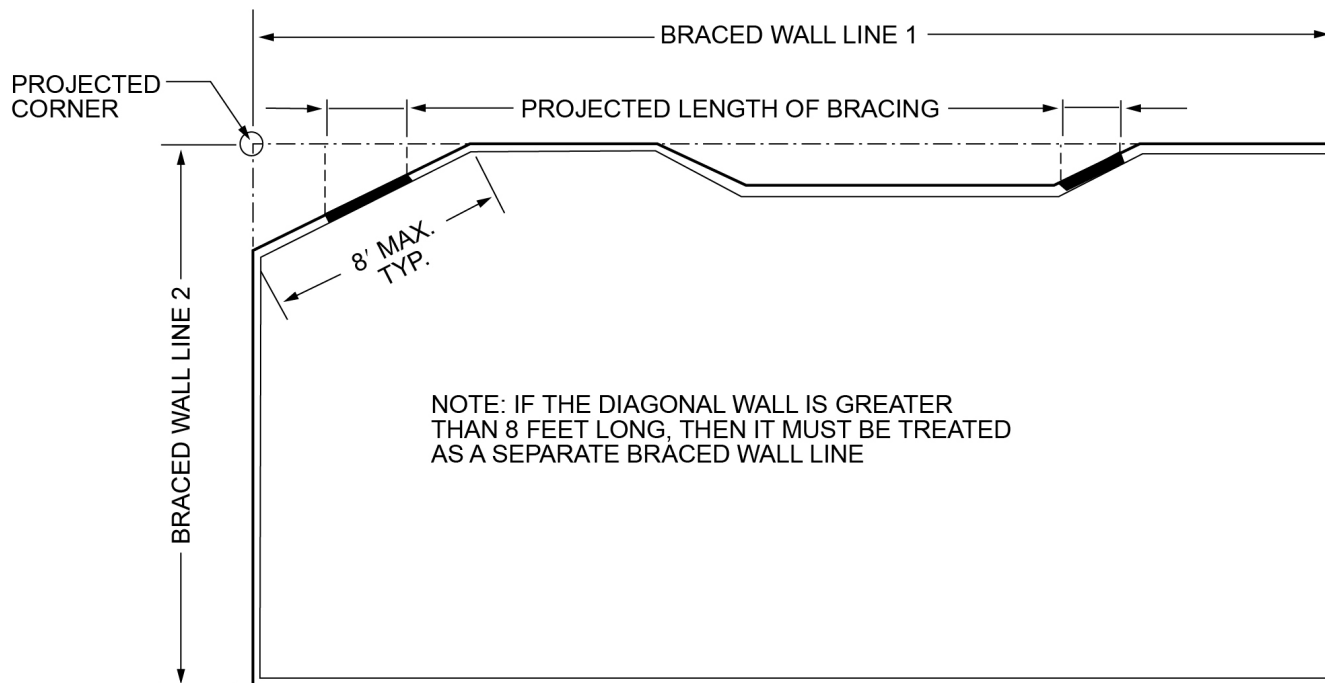
**TABLE R602.10.1.3  
BRACED WALL LINE SPACING**

APPLICATION	CONDITION	BUILDING TYPE	BRACED WALL LINE SPACING CRITERIA	
			Maximum Spacing	Exception to Maximum Spacing
Wind bracing	Ultimate design wind speed < 140 mph	Detached, townhouse	60 feet	None
Seismic bracing	SDC A – C	Detached	Use wind bracing	
	SDC A – B	Townhouse	Use wind bracing	
	SDC C	Townhouse	35 feet	Up to 50 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).
	SDC D <sub>0</sub> , D <sub>1</sub> , D <sub>2</sub>	Detached, townhouses, one- and two-story only	25 feet	Up to 35 feet to allow for a single room not to exceed 900 square feet. Spacing of all other braced wall lines shall not exceed 25 feet.
	SDC D <sub>0</sub> , D <sub>1</sub> , D <sub>2</sub>	Detached, townhouse	25 feet	Up to 35 feet when length of required bracing per Table R602.10.3(3) is adjusted in accordance with Table R602.10.3(4).

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 mile per hour = 0.447 m/s.



## WALL CONSTRUCTION



For SI: 1 foot = 304.8 mm.

**FIGURE R602.10.1.4  
ANGLED WALLS**

**R602.10.2.2 Locations of braced wall panels.** A *braced wall panel* shall begin within 10 feet (3810 mm) from each end of a *braced wall line* as determined in Section R602.10.1.1. The distance between adjacent edges of braced wall panels along a *braced wall line* shall be not greater than 20 feet (6096 mm) as shown in Figure R602.10.2.2.

**Exceptions:**

1. *Braced wall panels* in *Seismic Design Categories D<sub>0</sub>*, *D<sub>1</sub>* and *D<sub>2</sub>* shall comply with Section R602.10.2.2.1.
2. *Braced wall panels* with continuous sheathing in *Seismic Design Categories A*, *B* and *C* shall comply with Section R602.10.7.

**R602.10.2.2.1 Location of braced wall panels in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** Braced wall panels shall be located at each end of a *braced wall line*.

**Exceptions:**

1. Braced wall panels constructed of Method WSP or BV-WSP and continuous sheathing methods as specified in Section R602.10.4 shall be permitted to begin not more than 10 feet (3048 mm)

from each end of a *braced wall line* provided that each end complies with one of the following:

- 1.1. A minimum 24-inch-wide (610 mm) panel for Methods WSP, CS-WSP, CS-G and CS-PF is applied to each side of the building corner as shown in End Condition 4 of Figure R602.10.7.
- 1.2. The end of each *braced wall panel* closest to the end of the *braced wall line* shall have an 1,800-pound (8 kN) hold-down device fastened to the stud at the edge of the *braced wall panel* closest to the corner and to the foundation or framing below as shown in End Condition 5 of Figure R602.10.7.
2. Braced wall panels constructed of Method PFH or ABW, or of Method BV-WSP where a hold-down is provided in accordance with Table R602.10.6.5.4, shall be permitted to begin not more than 10 feet (3048 mm) from each end of a *braced wall line*.

**R602.10.2.3 Minimum number of braced wall panels.** *Braced wall lines* with a length of 16 feet (4877 mm) or less shall have not less than two *braced wall panels* of any length or one *braced wall panel* equal to 48 inches (1219 mm) or more. *Braced wall lines* greater than 16 feet (4877 mm) shall have not less than two *braced wall panels*.

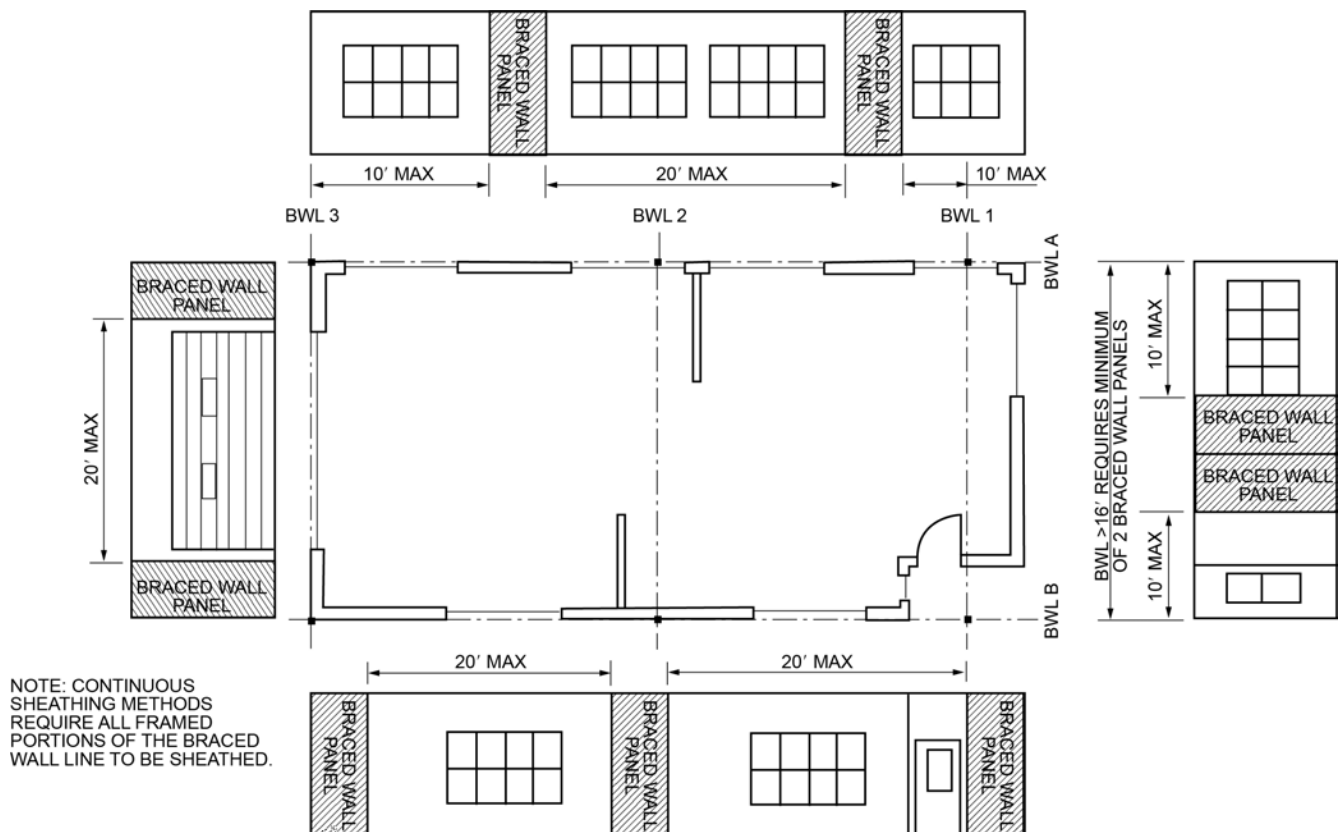
**R602.10.3 Required length of bracing.** The required length of bracing along each *braced wall line* shall be determined as follows:

1. All buildings in *Seismic Design Categories A* and *B* shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).
2. Detached buildings in *Seismic Design Category C* shall use Table R602.10.3(1) and the applicable adjustment factors in Table R602.10.3(2).
3. Townhouses in *Seismic Design Category C* shall use the greater value determined from Table R602.10.3(1) or R602.10.3(3) and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively.

4. All buildings in *Seismic Design Categories D<sub>0</sub>*, *D<sub>1</sub>* and *D<sub>2</sub>* shall use the greater value determined from Table R602.10.3(1) or R602.10.3(3) and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively.

Only *braced wall panels* parallel to the *braced wall line* shall contribute toward the required length of bracing of that *braced wall line*. *Braced wall panels* along an angled wall meeting the minimum length requirements of Tables R602.10.5 and R602.10.5.2 shall be permitted to contribute its projected length toward the minimum required length of bracing for the *braced wall line* as shown in Figure R602.10.1.4. Any *braced wall panel* on an angled wall at the end of a *braced wall line* shall contribute its projected length for only one of the *braced wall lines* at the projected corner.

**Exception:** The length of wall bracing for dwellings in *Seismic Design Categories D<sub>0</sub>*, *D<sub>1</sub>* and *D<sub>2</sub>* with stone or masonry veneer installed in accordance with Section R703.8 and exceeding the first-story height shall be in accordance with Section R602.10.6.5.



For SI: 1 foot = 304.8 mm.

**FIGURE R602.10.2.2**  
**LOCATION OF BRACED WALL PANELS**

## WALL CONSTRUCTION

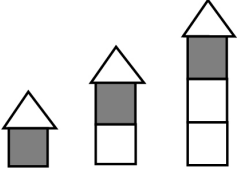
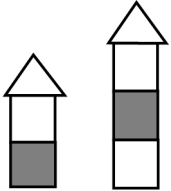


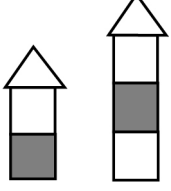
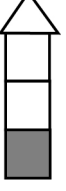
**TABLE R602.10.3(1)**  
**BRACING REQUIREMENTS BASED ON WIND SPEED**

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE <sup>a</sup>			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing <sup>c</sup> (feet)	Method LIB <sup>b</sup>	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFC, CS-SFB	Methods CS-WSP, CS-G, CS-PF
< 95 mph		10	2.5	2.5	1.5	1.5
		20	4.5	4.5	2.5	2.5
		30	6.5	6.5	4.0	3.5
		40	8.5	8.5	5.0	4.0
		50	10.5	10.5	6.0	5.0
		60	12.5	12.5	7.0	6.0
		10	5.0	5.0	3.0	2.5
		20	8.5	8.5	5.0	4.5
		30	12.5	12.5	7.0	6.0
		40	16.0	16.0	9.5	8.0
		50	20.0	20.0	11.5	10.0
		60	23.5	23.5	13.5	11.5
		10	NP	7.0	4.0	3.5
		20	NP	13.0	7.5	6.5
		30	NP	18.5	10.5	9.0
		40	NP	24.0	13.5	11.5
		50	NP	29.5	17.0	14.5
		60	NP	35.0	20.0	17.0
≤ 110		10	3.5	3.5	2.0	1.5
		20	6.0	6.0	3.5	3.0
		30	8.5	8.5	5.0	4.5
		40	11.5	11.5	6.5	5.5
		50	14.0	14.0	8.0	7.0
		60	16.5	16.5	9.5	8.0
		10	6.5	6.5	3.5	3.0
		20	11.5	11.5	6.5	5.5
		30	16.5	16.5	9.5	8.0
		40	21.5	21.5	12.5	10.5
		50	26.5	26.5	15.5	13.0
		60	31.5	31.5	18.0	15.5
		10	NP	9.5	5.5	4.5
		20	NP	17.0	10.0	8.5
		30	NP	24.5	14.0	12.0
		40	NP	32.0	18.5	15.5
		50	NP	39.5	22.5	19.0
		60	NP	46.5	26.5	23.0

(continued)

## WALL CONSTRUCTION

**TABLE R602.10.3(1)—continued**  
**BRACING REQUIREMENTS BASED ON WIND SPEED**

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE <sup>a</sup>			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing <sup>c</sup> (feet)	Method LIB <sup>b</sup>	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFC, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 115		10	3.5	3.5	2.0	2.0
		20	6.5	6.5	3.5	3.5
		30	9.5	9.5	5.5	4.5
		40	12.5	12.5	7.0	6.0
		50	15.0	15.0	9.0	7.5
		60	18.0	18.0	10.5	9.0
		10	7.0	7.0	4.0	3.5
		20	12.5	12.5	7.5	6.5
		30	18.0	18.0	10.5	9.0
		40	23.5	23.5	13.5	11.5
		50	29.0	29.0	16.5	14.0
		60	34.5	34.5	20.0	17.0
		10	NP	10.0	6.0	5.0
		20	NP	18.5	11.0	9.0
		30	NP	27.0	15.5	13.0
		40	NP	35.0	20.0	17.0
		50	NP	43.0	24.5	21.0
		60	NP	51.0	29.0	25.0
≤ 120		10	4.0	4.0	2.5	2.0
		20	7.0	7.0	4.0	3.5
		30	10.5	10.5	6.0	5.0
		40	13.5	13.5	8.0	6.5
		50	16.5	16.5	9.5	8.0
		60	19.5	19.5	11.5	9.5
		10	7.5	7.5	4.5	3.5
		20	14.0	14.0	8.0	7.0
		30	20.0	20.0	11.5	9.5
		40	25.5	25.5	15.0	12.5
		50	31.5	31.5	18.0	15.5
		60	37.5	37.5	21.5	18.5
		10	NP	11.0	6.5	5.5
		20	NP	20.5	11.5	10.0
		30	NP	29.0	17.0	14.5
		40	NP	38.0	22.0	18.5
		50	NP	47.0	27.0	23.0
		60	NP	55.5	32.0	27.0

(continued)

## WALL CONSTRUCTION

**TABLE R602.10.3(1)—continued**  
**BRACING REQUIREMENTS BASED ON WIND SPEED**

• EXPOSURE CATEGORY B • 30-FOOT MEAN ROOF HEIGHT • 10-FOOT WALL HEIGHT • 2 BRACED WALL LINES			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE <sup>a</sup>			
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line Spacing <sup>c</sup> (feet)	Method LIB <sup>b</sup>	Method GB	Methods DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP, ABW, PFH, PFC, CS-SFB	Methods CS-WSP, CS-G, CS-PF
≤ 130		10	4.5	4.5	2.5	2.5
		20	8.5	8.5	5.0	4.0
		30	12.0	12.0	7.0	6.0
		40	15.5	15.5	9.0	7.5
		50	19.5	19.5	11.0	9.5
		60	23.0	23.0	13.0	11.0
		10	8.5	8.5	5.0	4.5
		20	16.0	16.0	9.5	8.0
		30	23.0	23.0	13.5	11.5
		40	30.0	30.0	17.5	15.0
		50	37.0	37.0	21.5	18.0
		60	44.0	44.0	25.0	21.5
		10	NP	13.0	7.5	6.5
		20	NP	24.0	13.5	11.5
		30	NP	34.5	19.5	17.0
		40	NP	44.5	25.5	22.0
		50	NP	55.0	31.5	26.5
		60	NP	65.0	37.5	31.5
< 140		10	5.5	5.5	3.0	2.5
		20	10.0	10.0	5.5	5.0
		30	14.0	14.0	8.0	7.0
		40	18.0	18.0	10.5	9.0
		50	22.5	22.5	13.0	11.0
		60	26.5	26.5	15.0	13.0
		10	10.0	10.0	6.0	5.0
		20	18.5	18.5	11.0	9.0
		30	27.0	27.0	15.5	13.0
		40	35.0	35.0	20.0	17.0
		50	43.0	43.0	24.5	21.0
		60	51.0	51.0	29.0	25.0
		10	NP	15.0	8.5	7.5
		20	NP	27.5	16.0	13.5
		30	NP	39.5	23.0	19.5
		40	NP	51.5	29.5	25.0
		50	NP	63.5	36.5	31.0
		60	NP	75.5	43.0	36.5

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NP = Not Permitted.

- Linear interpolation shall be permitted.
- Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.
- Where three or more parallel braced wall lines are present and the distances between adjacent braced wall lines are different, the average dimension shall be permitted to be used for braced wall line spacing.



**TABLE R602.10.3(2)**  
**WIND ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING**

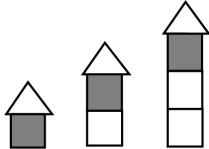
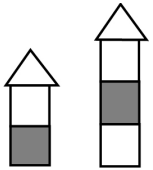
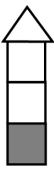
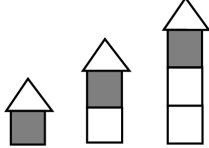
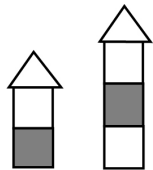
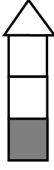
ITEM NUMBER	ADJUSTMENT BASED ON	STORY/SUPPORTING	CONDITION	ADJUSTMENT FACTOR <sup>a, b</sup> [multiply length from Table R602.10.3(1) by this factor]	APPLICABLE METHODS
1	Exposure category <sup>d</sup>	One-story structure	B	1.00	All methods
			C	1.20	
			D	1.50	
		Two-story structure	B	1.00	
			C	1.30	
			D	1.60	
		Three-story structure	B	1.00	
			C	1.40	
			D	1.70	
2	Roof eave-to-ridge height	Roof only	≤ 5 feet	0.70	All methods
			10 feet	1.00	
			15 feet	1.30	
			20 feet	1.60	
		Roof + 1 floor	≤ 5 feet	0.85	
			10 feet	1.00	
			15 feet	1.15	
			20 feet	1.30	
		Roof + 2 floors	≤ 5 feet	0.90	
			10 feet	1.00	
			15 feet	1.10	
			20 feet	Not permitted	
3	Story height (Section R301.3)	Any story	8 feet	0.90	
			9 feet	0.95	
			10 feet	1.00	
			11 feet	1.05	
			12 feet	1.10	
4	Number of braced wall lines (per plan direction) <sup>c</sup>	Any story	2	1.00	
			3	1.30	
			4	1.45	
			≥ 5	1.60	
5	Additional 800-pound hold-down device	Top story only	Fastened to the end studs of each braced wall panel and to the foundation or framing below	0.80	DWB, WSP, SFB, PBS, PCP, HPS
6	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.40	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
7	Gypsum board fastening	Any story	4 inches o.c. at panel edges, including top and bottom plates, and all horizontal joints blocked	0.7	GB
8	Horizontal blocking	Any story	Horizontal block is omitted	2.0	WSP, PBS, CS-WSP

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.48 N.

- Linear interpolation shall be permitted.
- The total adjustment factor is the product of all applicable adjustment factors.
- The adjustment factor is permitted to be 1.0 when determining bracing amounts for intermediate braced wall lines provided the bracing amounts on adjacent braced wall lines are based on a spacing and number that neglects the intermediate braced wall line.
- The same adjustment factor shall be applied to all braced wall lines on all floors of the structure, based on the worst-case exposure category.

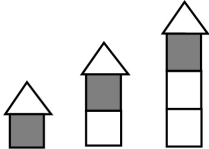
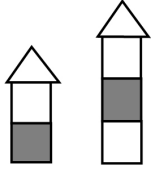
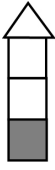
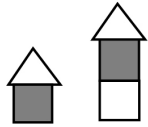

## WALL CONSTRUCTION

**TABLE R602.10.3(3)**  
**BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY**

• WALL HEIGHT = 10 FEET • 10 PSF FLOOR DEAD LOAD • 15 PSF ROOF/CEILING DEAD LOAD • BRACED WALL LINE SPACING ≤ 25 FEET			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE <sup>a, g</sup>				
Seismic Design Category <sup>b</sup>	Story Location	Braced Wall Line Length (feet) <sup>c</sup>	Method LIB <sup>d</sup>	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB <sup>e</sup>	Methods WSP, ABW <sup>f</sup> , PFH <sup>f</sup> and PFG <sup>g, f</sup>	Methods CS-WSP, CS-G, CS-PF
C (townhouses only)		10	2.5	2.5	2.5	1.6	1.4
		20	5.0	5.0	5.0	3.2	2.7
		30	7.5	7.5	7.5	4.8	4.1
		40	10.0	10.0	10.0	6.4	5.4
		50	12.5	12.5	12.5	8.0	6.8
		10	NP	4.5	4.5	3.0	2.6
		20	NP	9.0	9.0	6.0	5.1
		30	NP	13.5	13.5	9.0	7.7
		40	NP	18.0	18.0	12.0	10.2
		50	NP	22.5	22.5	15.0	12.8
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1
D <sub>0</sub>		10	NP	2.8	2.8	1.8	1.6
		20	NP	5.5	5.5	3.6	3.1
		30	NP	8.3	8.3	5.4	4.6
		40	NP	11.0	11.0	7.2	6.1
		50	NP	13.8	13.8	9.0	7.7
		10	NP	5.3	5.3	3.8	3.2
		20	NP	10.5	10.5	7.5	6.4
		30	NP	15.8	15.8	11.3	9.6
		40	NP	21.0	21.0	15.0	12.8
		50	NP	26.3	26.3	18.8	16.0
		10	NP	7.3	7.3	5.3	4.5
		20	NP	14.5	14.5	10.5	9.0
		30	NP	21.8	21.8	15.8	13.4
		40	NP	29.0	29.0	21.0	17.9
		50	NP	36.3	36.3	26.3	22.3

(continued)

**TABLE R602.10.3(3)—continued**  
**BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY**

• WALL HEIGHT = 10 FEET • 10 PSF FLOOR DEAD LOAD • 15 PSF ROOF/CEILING DEAD LOAD • BRACED WALL LINE SPACING ≤ 25 FEET			MINIMUM TOTAL LENGTH (FEET) OF BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE <sup>a, 9</sup>				
Seismic Design Category <sup>b</sup>	Story Location	Braced Wall Line Length (feet) <sup>c</sup>	Method LIB <sup>d</sup>	Method GB	Methods DWB, SFB, PBS, PCP, HPS, CS-SFB <sup>e</sup>	Methods WSP, ABW <sup>f</sup> , PFH <sup>f</sup> and PFG <sup>e, f</sup>	Methods CS-WSP, CS-G, CS-PF
D <sub>1</sub>		10	NP	3.0	3.0	2.0	1.7
		20	NP	6.0	6.0	4.0	3.4
		30	NP	9.0	9.0	6.0	5.1
		40	NP	12.0	12.0	8.0	6.8
		50	NP	15.0	15.0	10.0	8.5
		10	NP	6.0	6.0	4.5	3.8
		20	NP	12.0	12.0	9.0	7.7
		30	NP	18.0	18.0	13.5	11.5
		40	NP	24.0	24.0	18.0	15.3
		50	NP	30.0	30.0	22.5	19.1
		10	NP	8.5	8.5	6.0	5.1
		20	NP	17.0	17.0	12.0	10.2
		30	NP	25.5	25.5	18.0	15.3
		40	NP	34.0	34.0	24.0	20.4
		50	NP	42.5	42.5	30.0	25.5
D <sub>2</sub> <sup>h</sup>		10	NP	4.0	4.0	2.5	2.1
		20	NP	8.0	8.0	5.0	4.3
		30	NP	12.0	12.0	7.5	6.4
		40	NP	16.0	16.0	10.0	8.5
		50	NP	20.0	20.0	12.5	10.6
		10	NP	7.5	7.5	5.5	4.7
		20	NP	15.0	15.0	11.0	9.4
		30	NP	22.5	22.5	16.5	14.0
		40	NP	30.0	30.0	22.0	18.7
		50	NP	37.5	37.5	27.5	23.4
	Three-story dwelling	10	NP	NP	NP	NP	NP
		20	NP	NP	NP	NP	NP
		30	NP	NP	NP	NP	NP
		40	NP	NP	NP	NP	NP
		50	NP	NP	NP	NP	NP
	Cripple wall below one- or two-story dwelling	10	NP	NP	NP	7.5	6.4
		20	NP	NP	NP	15.0	12.8
		30	NP	NP	NP	22.5	19.1
		40	NP	NP	NP	30.0	25.5
		50	NP	NP	NP	37.5	31.9

(continued)

## WALL CONSTRUCTION

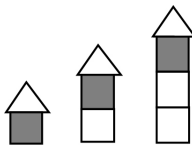
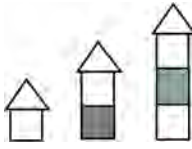
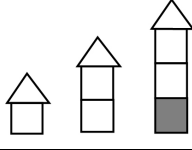
**TABLE R602.10.3(3)—continued**  
**BRACING REQUIREMENTS BASED ON SEISMIC DESIGN CATEGORY**

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

NP = Not Permitted.

- a. Linear interpolation shall be permitted.
- b. Interpolation of bracing length between the  $S_{ds}$  values associated with the seismic design categories shall be permitted when a site-specific  $S_{ds}$  value is determined in accordance with Section 1613.2 of the *International Building Code*.
- c. Where the braced wall line length is greater than 50 feet, braced wall lines shall be permitted to be divided into shorter segments having lengths of 50 feet or less, and the amount of bracing within each segment shall be in accordance with this table.
- d. Method LIB shall have gypsum board fastened to not less than one side with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum board. Spacing of fasteners at panel edges shall not exceed 8 inches.
- e. Methods PFG and CS-SFB do not apply in Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$ .
- f. Methods PFH, PFG and ABW are only permitted on a single story or a first of two stories.
- g. Where more than one bracing method is used, mixing methods shall be in accordance with Section R602.10.4.1.
- h. One- and two-family dwellings in Seismic Design Category  $D_2$  exceeding two stories shall be designed in accordance with accepted engineering practice.

**TABLE R602.10.3(4)**  
**SEISMIC ADJUSTMENT FACTORS TO THE REQUIRED LENGTH OF WALL BRACING**

ITEM NUMBER	ADJUSTMENT BASED ON	STORY <sup>a</sup>	CONDITION	ADJUSTMENT FACTOR <sup>a, b</sup> [Multiply length from Table R602.10.3(3) by this factor]	APPLICABLE METHODS
1	Story height (Section 301.3)	Any story	≤ 10 feet	1.0	All methods
			> 10 feet and ≤ 12 feet	1.2	
2	Braced wall line spacing, townhouses in SDC C	Any story	≤ 35 feet	1.0	
			> 35 feet and ≤ 50 feet	1.43	
3	Braced wall line spacing, in SDC D <sub>0</sub> , D <sub>1</sub> , D <sub>2</sub> <sup>c</sup>	Any story	> 25 feet and ≤ 30 feet	1.2	
			> 30 feet and ≤ 35 feet	1.4	
4	Wall dead load	Any story	> 8 psf and < 15 psf	1.0	
			< 8psf	0.85	
5	Roof/ceiling dead load for wall supporting	1-, 2- or 3-story building	≤15 psf	1.0	
		2- or 3-story building	> 15 psf and ≤ 25 psf	1.1	
		1-story building or top story	> 15 psf and ≤ 25 psf	1.2	
6	Walls with stone or masonry veneer, townhouses in SDC C <sup>d, e</sup>		1.0		
			1.5		
			1.5		
7	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D <sub>0</sub> – D <sub>2</sub> <sup>d, f</sup>	Any story	See Section R602.10.6.5.4		BV-WSP
8	Walls with stone or masonry veneer, detached one- and two-family dwellings in SDC D <sub>0</sub> – D <sub>2</sub> <sup>d, f</sup>	First and second story of two-story dwelling	Limited brick veneer on second story. See Section R602.10.6.5.3.	1.2	WSP, CS-WSP
9	Interior gypsum board finish (or equivalent)	Any story	Omitted from inside face of braced wall panels	1.5	DWB, WSP, SFB, PBS, PCP, HPS, CS-WSP, CS-G, CS-SFB
10	Horizontal blocking	Any story	Horizontal blocking omitted	2.0	WSP, PBS, CS-WSP

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- Linear interpolation shall be permitted.
- The total length of bracing required for a given wall line is the product of all applicable adjustment factors.
- The length-to-width ratio for the floor/roof diaphragm shall not exceed 3:1.
- Applies to stone or masonry veneer exceeding the first story height.
- The adjustment factor for stone or masonry veneer shall be applied to all exterior braced wall lines and all braced wall lines on the interior of the building, backing or perpendicular to and laterally supporting veneered walls.
- See Section R602.10.6.5 for requirements where stone or masonry veneer does not exceed the first-story height.
- One- and two-family dwellings in Seismic Design Category D<sub>2</sub> exceeding two stories shall be designed in accordance with accepted engineering practice.



## WALL CONSTRUCTION

**R602.10.4 Construction methods for braced wall panels.** Intermittent and continuously sheathed *braced wall panels* shall be constructed in accordance with this section and the methods listed in Table R602.10.4.

**R602.10.4.1 Mixing methods.** Mixing of bracing methods shall be permitted as follows:

1. Mixing intermittent bracing and continuous sheathing methods from story to story shall be permitted.
2. Mixing intermittent bracing methods from *braced wall line* to *braced wall line* within a story shall be permitted. In regions within *Seismic Design Categories A, B and C* where the ultimate design wind speed is less than or equal to 130 mph (58m/s), mixing of intermittent bracing and continuous sheathing methods from *braced wall line* to *braced wall line* within a story shall be permitted.
3. Mixing intermittent bracing methods along a *braced wall line* shall be permitted in *Seismic Design Categories A and B*, and detached dwellings in *Seismic Design Category C*, provided that the length of required bracing in accordance with Table R602.10.3(1) or R602.10.3(3) is the highest value of all intermittent bracing methods used.
4. Mixing of continuous sheathing methods CS-WSP, CS-G and CS-PF along a *braced wall line* shall be permitted. Intermittent methods ABW, PFH and PFG shall be permitted to be used along a *braced wall line* with continuous sheathed methods, provided that the length of required bracing for that *braced wall line* is determined in accordance with Table R602.10.3(1) or R602.10.3(3) using the highest value of the bracing methods used.
5. In *Seismic Design Categories A and B*, and for detached one- and two-family dwellings in *Seismic Design Category C*, mixing of intermittent bracing methods along the interior portion of a *braced wall line* with continuous sheathing methods CS-WSP, CS-G and CS-PF along the exterior portion of the same *braced wall line* shall be permitted. The length of required bracing shall be the highest value of all intermittent bracing methods used in accordance with Table R602.10.3(1) or R602.10.3(3) as adjusted by Tables R602.10.3(2) and R602.10.3(4), respectively. The requirements of Section R602.10.7 shall apply to each end of the continuously sheathed portion of the *braced wall line*.

**R602.10.4.2 Continuous sheathing methods.** Continuous sheathing methods require structural panel sheathing to be used on all sheathable surfaces on one side of a *braced wall line* including areas above and below openings and gable end walls and shall meet the requirements of Section R602.10.7.

**R602.10.4.3 Braced wall panel interior finish material.** *Braced wall panels* shall have gypsum wall board installed on the side of the wall opposite the bracing material. Gypsum wall board shall be not less than  $\frac{1}{2}$  inch (12.7 mm) in thickness and be fastened with nails or screws in accordance with Table R602.3(1) for exterior sheathing or Table R702.3.5 for interior gypsum wall board. Spacing of fasteners at panel edges for gypsum wall board opposite Method LIB bracing shall not exceed 8 inches (203 mm). Interior finish material shall not be glued in *Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*.

**Exceptions:**






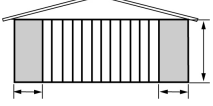
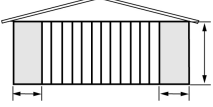
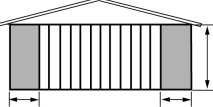
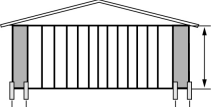
1. Interior finish material is not required opposite wall panels that are braced in accordance with Methods GB, BV-WSP, ABW, PFH, PFG and CS-PF, unless otherwise required by Section R302.6.
2. An *approved* interior finish material with an in-plane shear resistance equivalent to gypsum board shall be permitted to be substituted, unless otherwise required by Section R302.6.
3. Except for Method LIB, gypsum wall board is permitted to be omitted provided that the required length of bracing in Tables R602.10.3(1) and R602.10.3(3) is multiplied by the appropriate adjustment factor in Tables R602.10.3(2) and R602.10.3(4), respectively, unless otherwise required by Section R302.6.

**R602.10.4.4 Panel joints.** Vertical joints of panel sheathing shall occur over and be fastened to common studs. Horizontal joints of panel sheathing in *braced wall panels* shall occur over and be fastened to common blocking of a thickness of  $1\frac{1}{2}$  inches (38 mm) or greater.

**Exceptions:**

1. For methods WSP and CS-WSP, blocking of horizontal joints is permitted to be omitted when adjustment factor No. 8 of Table R602.10.3(2) or No. 9 of Table R602.10.3(4) is applied.
2. Vertical joints of panel sheathing shall be permitted to occur over double studs, where adjoining panel edges are attached to separate studs with the required panel edge fastening schedule, and the adjacent studs are attached together with two rows of 10d box nails [3 inches by 0.128 inch (76.2 mm by 3.25 mm)] at 10 inches o.c. (254 mm).
3. Blocking at horizontal joints shall not be required in wall segments that are not counted as *braced wall panels*.
4. Where Method GB panels are installed horizontally, blocking of horizontal joints is not required.

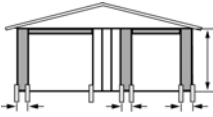
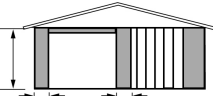
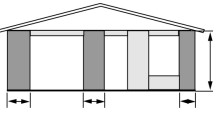
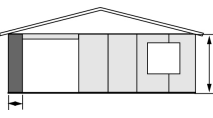
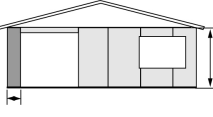
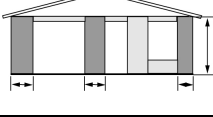
**TABLE R602.10.4  
BRACING METHODS**

METHODS, MATERIAL			MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA <sup>a</sup>	
					Fasteners	Spacing
Intermittent Bracing Methods	<b>LIB</b> Let-in-bracing	1 × 4 wood or approved metal straps at 45° to 60° angles for maximum 16" stud spacing		Wood: 2-8d common nails or 3-8d (2½" long × 0.113" dia.) nails  Metal strap: per manufacturer	Wood: per stud and top and bottom plates  Metal: per manufacturer	
	<b>DWB</b> Diagonal wood boards	¾" (1" nominal) for maximum 24" stud spacing		2-8d (2½" long × 0.113" dia.) nails or 2-1¾" long staples	Per stud	
	<b>WSP</b> Wood structural panel (See Section R604)	¾"		Exterior sheathing per Table R602.3(3)	6" edges 12" field	
				Interior sheathing per Table R602.3(1) or R602.3(2)	Varies by fastener	
	<b>BV-WSP<sup>e</sup></b> Wood structural panels with stone or masonry veneer (See Section R602.10.6.5)	7⁄₁₆"	See Figure R602.10.6.5.2	8d common (2½" × 0.131) nails	4" at panel edges 12" at intermediate supports 4" at braced wall panel end posts	
	<b>SFB</b> Structural fiberboard sheathing	½" or 25⁄₃₂" for maximum 16" stud spacing		1½" long × 0.12" dia. (for ½" thick sheathing) 1¾" long × 0.12" dia. (for 25⁄₃₂" thick sheathing) galvanized roofing nails	3" edges 6" field	
	<b>GB</b> Gypsum board	½"		Nails or screws per Table R602.3(1) for exterior locations	For all braced wall panel locations: 7" edges (including top and bottom plates) 7" field	
				Nails or screws per Table R702.3.5 for interior locations		
	<b>PBS</b> Particleboard sheathing (See Section R605)	3⁄₈" or ½" for maximum 16" stud spacing		For 3⁄₈", 6d common (2" long × 0.113" dia.) nails; For ½", 8d common (2½" long × 0.131" dia.) nails	3" edges 6" field	
	<b>PCP</b> Portland cement plaster	See Section R703.6 for maximum 16" stud spacing		1½" long, 11 gage, 0.120" dia., 7⁄₁₆" dia. head nails or 7⁄₈" long, 16 gage staples	6" o.c. on all framing members	
<b>HPS</b> Hardboard panel siding	7⁄₁₆" for maximum 16" stud spacing		0.092" dia., 0.225" dia. head nails with length to accommodate 1½" penetration into studs	4" edges 8" field		
<b>ABW</b> Alternate braced wall	3⁄₈"		See Section R602.10.6.1	See Section R602.10.6.1		

(continued)

## WALL CONSTRUCTION

TABLE R602.10.4—continued  
BRACING METHODS

METHODS, MATERIAL		MINIMUM THICKNESS	FIGURE	CONNECTION CRITERIA <sup>a</sup>	
				Fasteners	Spacing
Intermittent Bracing Methods	<b>PFH</b> Portal frame with hold-downs	$\frac{3}{8}$ "		See Section R602.10.6.2	See Section R602.10.6.2
	<b>PFG</b> Portal frame at garage	$\frac{7}{16}$ "		See Section R602.10.6.3	See Section R602.10.6.3
Continuous Sheathing Methods	<b>CS-WSP</b> Continuously sheathed wood structural panel	$\frac{3}{8}$ "		Exterior sheathing per Table R602.3(3)	6" edges 12" field
	<b>CS-G<sup>b,c</sup></b> Continuously sheathed wood structural panel adjacent to garage openings	$\frac{3}{8}$ "		See Method CS-WSP	See Method CS-WSP
	<b>CS-PF</b> Continuously sheathed portal frame	$\frac{7}{16}$ "		See Section R602.10.6.4	See Section R602.10.6.4
	<b>CS-SFB<sup>d</sup></b> Continuously sheathed structural fiberboard	$\frac{1}{2}$ " or $\frac{25}{32}$ " for maximum 16" stud spacing		$1\frac{1}{2}$ " long $\times$ 0.12" dia. (for $\frac{1}{2}$ " thick sheathing) $1\frac{3}{4}$ " long $\times$ 0.12" dia. (for $\frac{25}{32}$ " thick sheathing) galvanized roofing nails	3" edges 6" field

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad, 1 pound per square foot = 47.8 N/m<sup>2</sup>, 1 mile per hour = 0.447 m/s.

- Adhesive attachment of wall sheathing, including Method GB, shall not be permitted in Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.
- Applies to panels next to garage door opening where supporting gable end wall or roof load only. Shall only be used on one wall of the garage. In Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, roof covering dead load shall not exceed 3 psf.
- Garage openings adjacent to a Method CS-G panel shall be provided with a header in accordance with Table R602.7(1). A full-height clear opening shall not be permitted adjacent to a Method CS-G panel.
- Method CS-SFB does not apply in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.
- Method applies to detached one- and two-family dwellings in Seismic Design Categories D<sub>0</sub> through D<sub>2</sub> only.

**R602.10.5 Minimum length of a braced wall panel.**

The minimum length of a *braced wall panel* shall comply with Table R602.10.5. For Methods CS-WSP and CS-SFB, the minimum panel length shall be based on the adjacent clear opening height in accordance with Table R602.10.5 and Figure R602.10.5. Where a panel has an opening on either side of differing heights, the taller opening height shall be used to determine the panel length.

**R602.10.5.1 Contributing length.** For purposes of computing the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), the contributing length of each *braced wall panel* shall be as specified in Table R602.10.5.

**R602.10.5.2 Partial credit.** For Methods DWB, WSP, SFB, PBS, PCP and HPS in *Seismic Design Categories* A, B and C, panels between 36 inches and 48 inches (914 mm and 1219 mm) in length shall be considered a *braced wall panel* and shall be permitted to partially contribute toward the required length of bracing in Tables R602.10.3(1) and R602.10.3(3), and the contributing length shall be determined from Table R602.10.5.2.

**R602.10.6 Construction of Methods ABW, PFH, PFG, CS-PF and BV-WSP.** Methods ABW, PFH, PFG, CS-PF and BV-WSP shall be constructed as specified in Sections R602.10.6.1 through R602.10.6.5.

**R602.10.6.1 Method ABW: Alternate braced wall panels.** Method ABW *braced wall panels* shall be constructed in accordance with Figure R602.10.6.1. The hold-down force shall be in accordance with Table R602.10.6.1.

**R602.10.6.2 Method PFH: Portal frame with hold-downs.** Method PFH *braced wall panels* shall be constructed in accordance with Figure R602.10.6.2.

**R602.10.6.3 Method PFG: Portal frame at garage door openings in Seismic Design Categories A, B and C.** Where supporting a roof or one story and a roof, a Method PFG *braced wall panel* constructed in accordance with Figure R602.10.6.3 shall be permitted on either side of garage door openings.

**R602.10.6.4 Method CS-PF: Continuously sheathed portal frame.** Continuously sheathed portal frame *braced wall panels* shall be constructed in accordance with Figure R602.10.6.4 and Table R602.10.6.4.

**R602.10.6.5 Wall bracing for dwellings with stone and masonry veneer in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** Townhouses in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> with stone or masonry veneer exceeding the first-story height shall be designed in accordance with accepted engineering practice.

One- and two-family dwellings in *Seismic Design Category* D<sub>2</sub> exceeding two stories and having stone or masonry veneer shall be designed in accordance with accepted engineering practice.

Where stone and masonry veneer are installed in accordance with Section R703.8, wall bracing on exterior *braced wall lines* and *braced wall lines* on the interior of the building, backing or perpendicular to and laterally supporting veneered walls shall comply with this section.

**R602.10.6.5.1 Veneer on first story only.** Where dwellings in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> have stone or masonry veneer installed in accordance with Section R703.8 and the veneer does not exceed the first-story height, wall bracing shall be in accordance with Section R602.10, exclusive of Section R602.10.6.5.

**R602.10.6.5.2 Veneer exceeding first-story height.** Where detached one- or two-family dwellings in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> have stone or masonry veneer installed in accordance with Section R703.8, and the veneer exceeds the first-story height, wall bracing at exterior *braced wall lines* and *braced wall lines* on the interior of the building shall be constructed using Method BV-WSP in accordance with this section and Figure R602.10.6.5.2. Cripple walls shall not be permitted, and required interior *braced wall lines* shall be supported on continuous foundations.

**R602.10.6.5.3 Limited veneer exceeding first-story height.** Where detached one- or two-family dwellings in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> have exterior veneer installed in accordance with Section R703.8 and where brick veneer installed above the first-story height meets the following limitations, bracing in accordance with Method WSP or CS-WSP shall be permitted provided that the total length of *braced wall panels* specified by Table R602.10.3(3) is multiplied by 1.2 for each first- and second-story *braced wall line*.

1. The dwelling does not extend more than two stories above *grade plane*.
2. The veneer does not exceed 5 inches (127 mm) in thickness.
3. The height of veneer on gable-end walls does not extend more than 8 feet (2438 mm) above the bearing wall top plate elevation.
4. Where veneer is installed on multiple walls above the first story, the total area of the veneer on the second-story exterior walls shall not exceed 25 percent of the occupied second floor area.
5. Where the veneer is installed on one entire second-story exterior wall, including walls on bay windows and similar appurtenances, brick veneer shall not be installed on any of the other walls on that floor.

## WALL CONSTRUCTION

**TABLE R602.10.5**  
**MINIMUM LENGTH OF BRACED WALL PANELS**

METHOD (See Table R602.10.4)		MINIMUM LENGTH <sup>a</sup> (inches)					CONTRIBUTING LENGTH (inches)
		Wall Height					
		8 feet	9 feet	10 feet	11 feet	12 feet	
DWB, WSP, SFB, PBS, PCP, HPS, BV-WSP		48	48	48	53	58	Actual <sup>b</sup>
GB		48	48	48	53	58	Double sided = Actual Single sided = 0.5 × Actual
LIB		55	62	69	NP	NP	Actual <sup>b</sup>
ABW	SDC A, B and C, ultimate design wind speed < 140 mph	28	32	34	38	42	48
	SDC D <sub>0</sub> , D <sub>1</sub> and D <sub>2</sub> , ultimate design wind speed < 140 mph	32	32	34	NP	NP	
CS-G		24	27	30	33	36	Actual <sup>b</sup>
CS-WSP, CS-SFB	Adjacent clear opening height (inches)						Actual <sup>b</sup>
	≤ 64	24	27	30	33	36	
	68	26	27	30	33	36	
	72	27	27	30	33	36	
	76	30	29	30	33	36	
	80	32	30	30	33	36	
	84	35	32	32	33	36	
	88	38	35	33	33	36	
	92	43	37	35	35	36	
	96	48	41	38	36	36	
	100	—	44	40	38	38	
	104	—	49	43	40	39	
	108	—	54	46	43	41	
	112	—	—	50	45	43	
	116	—	—	55	48	45	
	120	—	—	60	52	48	
	124	—	—	—	56	51	
	128	—	—	—	61	54	
	132	—	—	—	66	58	
	136	—	—	—	—	62	
	140	—	—	—	—	66	
	144	—	—	—	—	72	
METHOD (See Table R602.10.4)		Portal header height					
		8 feet	9 feet	10 feet	11 feet	12 feet	
PFH	Supporting roof only	16	16	16	Note c	Note c	48
	Supporting one story and roof	24	24	24	Note c	Note c	
PFG		24	27	30	Note d	Note d	1.5 × Actual <sup>b</sup>
CS-PF	SDC A, B and C	16	18	20	Note e	Note e	1.5 × Actual <sup>b</sup>
	SDC D <sub>0</sub> , D <sub>1</sub> and D <sub>2</sub>	16	18	20	Note e	Note e	Actual <sup>b</sup>

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NP = Not Permitted.

a. Linear interpolation shall be permitted.

b. Use the actual length where it is greater than or equal to the minimum length.

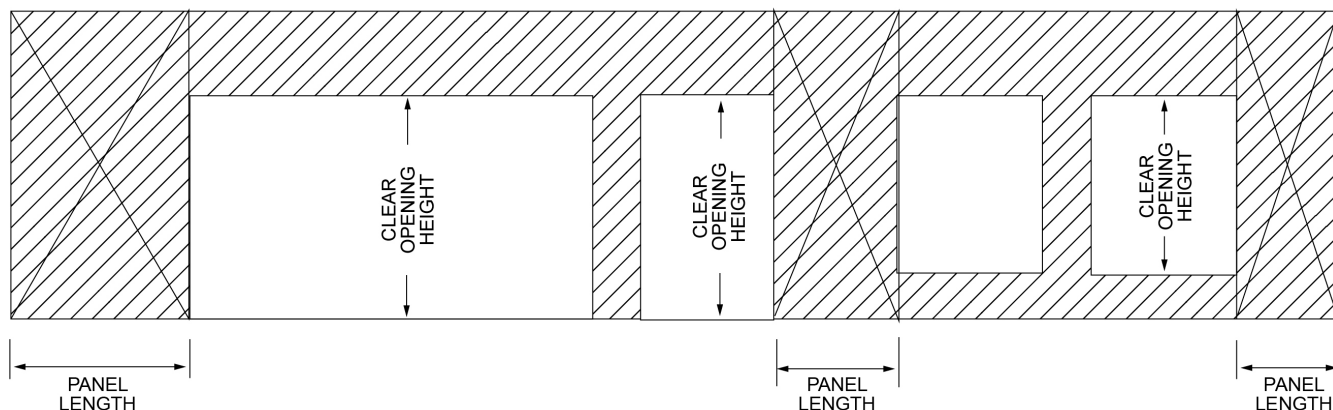
c. Maximum header height for PFH is 10 feet in accordance with Figure R602.10.6.2, but wall height shall be permitted to be increased to 12 feet with pony wall.

d. Maximum header height for PFG is 10 feet in accordance with Figure R602.10.6.3, but wall height shall be permitted to be increased to 12 feet with pony wall.

e. Maximum header height for CS-PF is 10 feet in accordance with Figure R602.10.6.4, but wall height shall be permitted to be increased to 12 feet with pony wall.



## WALL CONSTRUCTION



**FIGURE R602.10.5**  
**BRACED WALL PANELS WITH CONTINUOUS SHEATHING**

**TABLE R602.10.5.2**  
**PARTIAL CREDIT FOR BRACED WALL PANELS LESS THAN 48 INCHES IN ACTUAL LENGTH**

ACTUAL LENGTH OF BRACED WALL PANEL (inches)	CONTRIBUTING LENGTH OF BRACED WALL PANEL (inches) <sup>a</sup>	
	8-foot Wall Height	9-foot Wall Height
48	48	48
42	36	36
36	27	NA

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

NA = Not Applicable.

a. Linear interpolation shall be permitted.

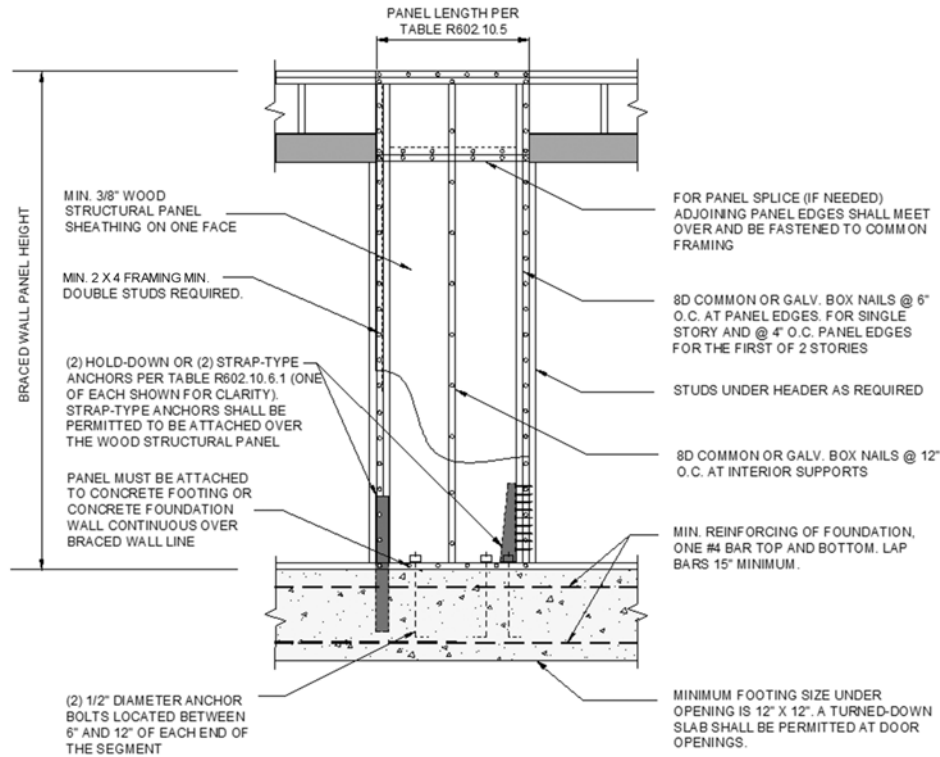
**TABLE R602.10.6.1**  
**MINIMUM HOLD-DOWN FORCES FOR METHOD ABW BRACED WALL PANELS**

SEISMIC DESIGN CATEGORY AND WIND SPEED	SUPPORTING/STORY	HOLD-DOWN FORCE (pounds)				
		Height of Braced Wall Panel				
		8 feet	9 feet	10 feet	11 feet	12 feet
SDC A, B and C Ultimate design wind speed < 140 mph	One story	1,800	1,800	1,800	2,000	2,200
	First of two stories	3,000	3,000	3,000	3,300	3,600
SDC D <sub>0</sub> , D <sub>1</sub> and D <sub>2</sub> Ultimate design wind speed < 140 mph	One story	1,800	1,800	1,800	NP	NP
	First of two stories	3,000	3,000	3,000	NP	NP

For SI: 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s.

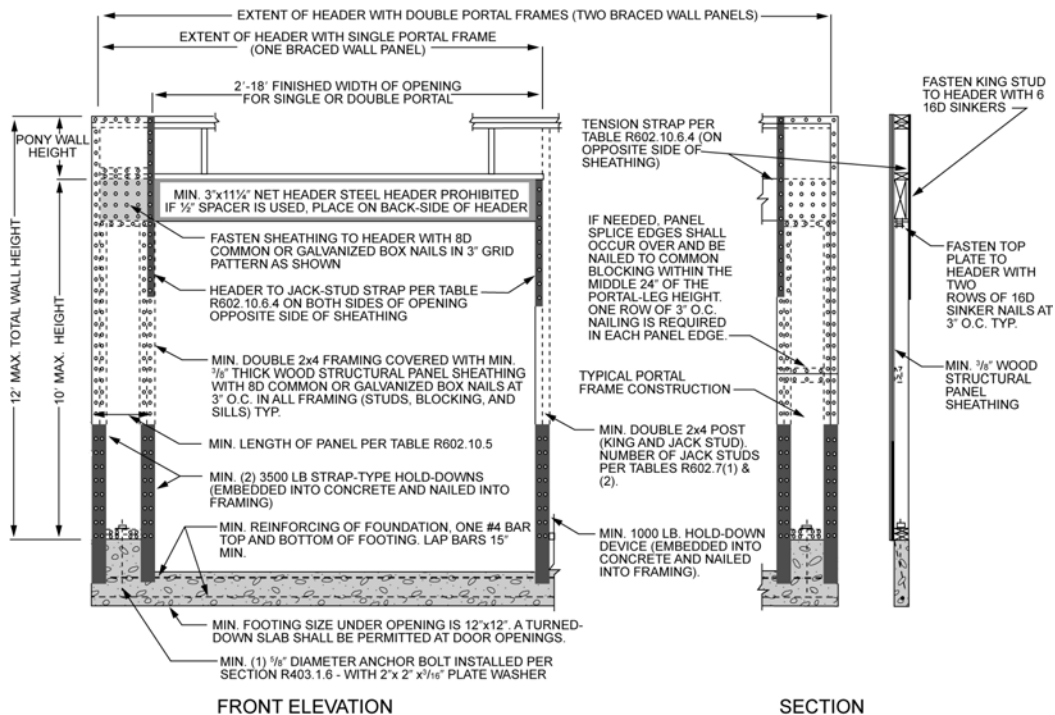
NP = Not Permitted.

# WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

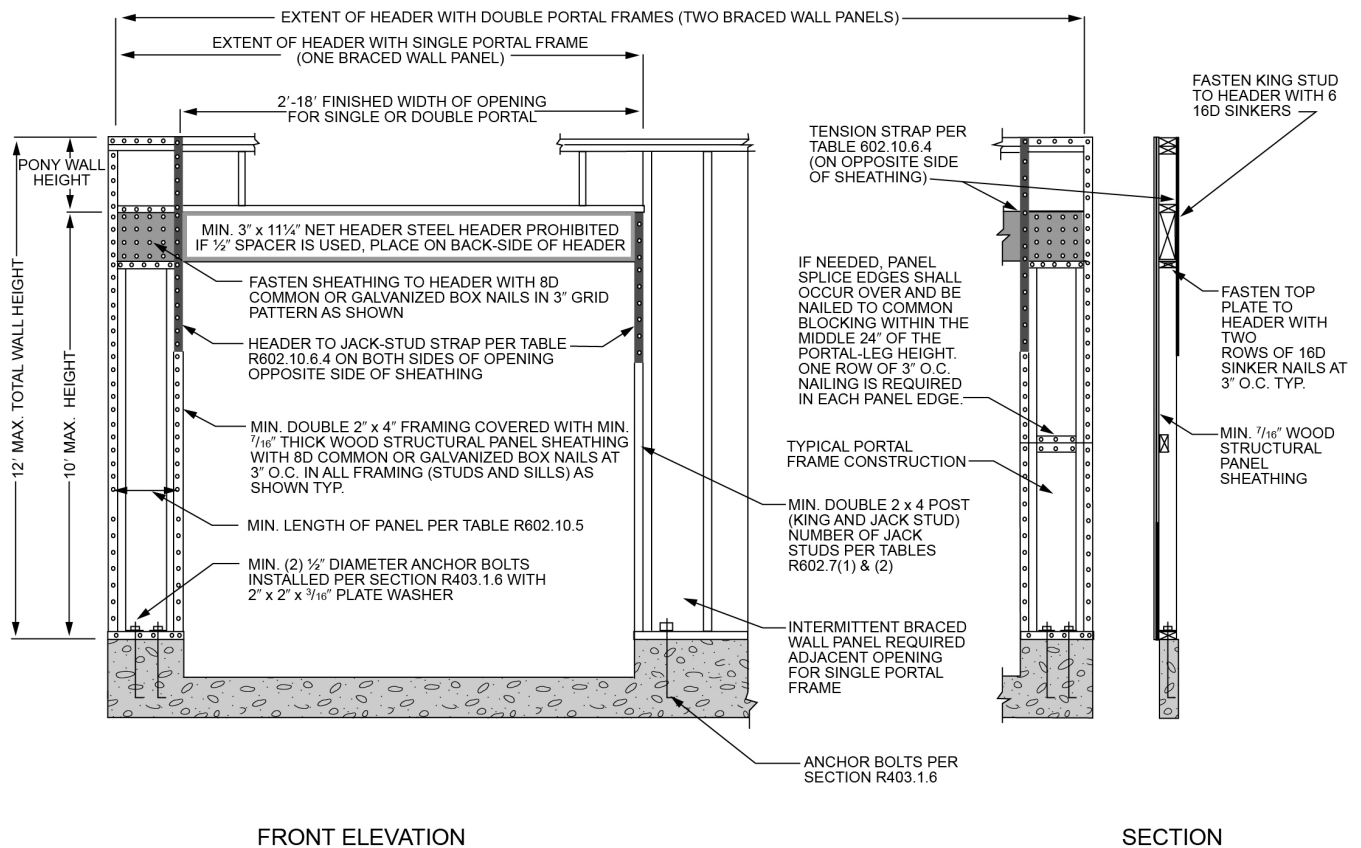
**FIGURE R602.10.6.1**  
**METHOD ABW—ALTERNATE BRACED WALL PANEL**



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R602.10.6.2**  
**METHOD PFH—PORTAL FRAME WITH HOLD-DOWNS**

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R602.10.6.3**  
**METHOD PFG—PORTAL FRAME AT GARAGE DOOR OPENINGS IN SEISMIC DESIGN CATEGORIES A, B AND C**

## WALL CONSTRUCTION

**TABLE R602.10.6.4**  
**TENSION STRAP CAPACITY FOR RESISTING WIND PRESSURES**  
**PERPENDICULAR TO METHODS PFH, PFG AND CS-PF BRACED WALL PANELS<sup>a</sup>**

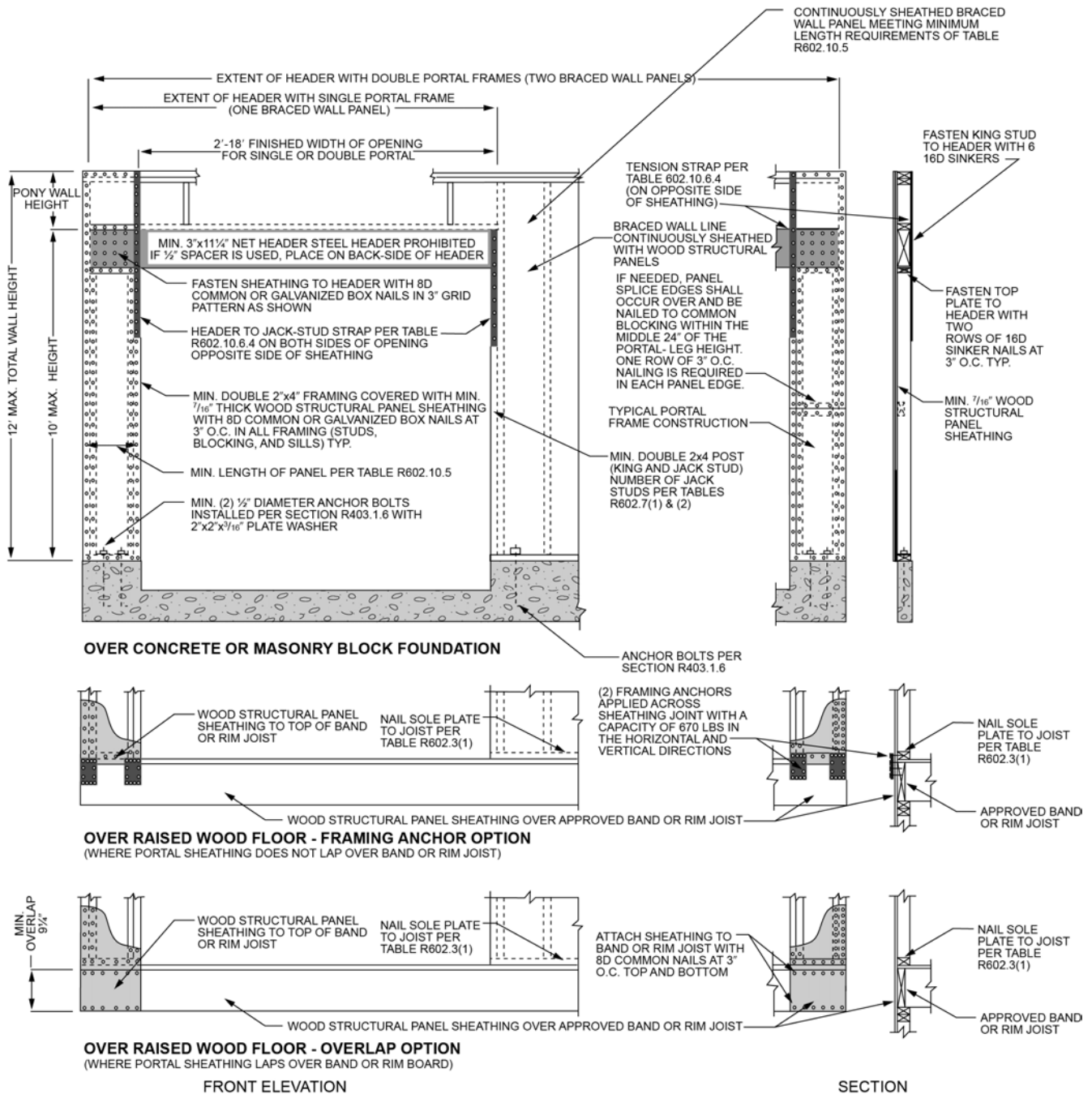
MINIMUM WALL STUD FRAMING NOMINAL SIZE AND GRADE	MAXIMUM PONY WALL HEIGHT (feet)	MAXIMUM TOTAL WALL HEIGHT (feet)	MAXIMUM OPENING WIDTH (feet)	TENSION STRAP CAPACITY REQUIRED (pounds) <sup>a</sup>					
				Ultimate Design Wind Speed $V_{ult}$ (mph)					
				≤ 110	115	130	≤ 110	115	130
				Exposure B			Exposure C		
2 × 4 No. 2 Grade	0	10	18	1,000	1,000	1,000	1,000	1,000	1,050
			9	1,000	1,000	1,000	1,000	1,000	1,750
	1	10	16	1,000	1,025	2,050	2,075	2,500	3,950
			18	1,000	1,275	2,375	2,400	2,850	DR
			9	1,000	1,000	1,475	1,500	1,875	3,125
	2	10	16	1,775	2,175	3,525	3,550	4,125	DR
			18	2,075	2,500	3,950	3,975	DR	DR
			9	1,150	1,500	2,650	2,675	3,175	DR
	2	12	16	2,875	3,375	DR	DR	DR	DR
			18	3,425	3,975	DR	DR	DR	DR
			9	2,275	2,750	DR	DR	DR	DR
	4	12	12	3,225	3,775	DR	DR	DR	DR
2 × 6 Stud Grade	2	12	9	1,000	1,000	1,700	1,700	2,025	3,050
			16	1,825	2,150	3,225	3,225	3,675	DR
			18	2,200	2,550	3,725	3,750	DR	DR
	4	12	9	1,450	1,750	2,700	2,725	3,125	DR
			16	2,050	2,400	DR	DR	DR	DR
			18	3,350	3,800	DR	DR	DR	DR

For SI: 1 foot = 304.8 mm, 1 pound = 4.45 N, 1 mile per hour = 0.447 m/s.

DR = Design Required.

a. Straps shall be installed in accordance with manufacturer's recommendations.

## WALL CONSTRUCTION

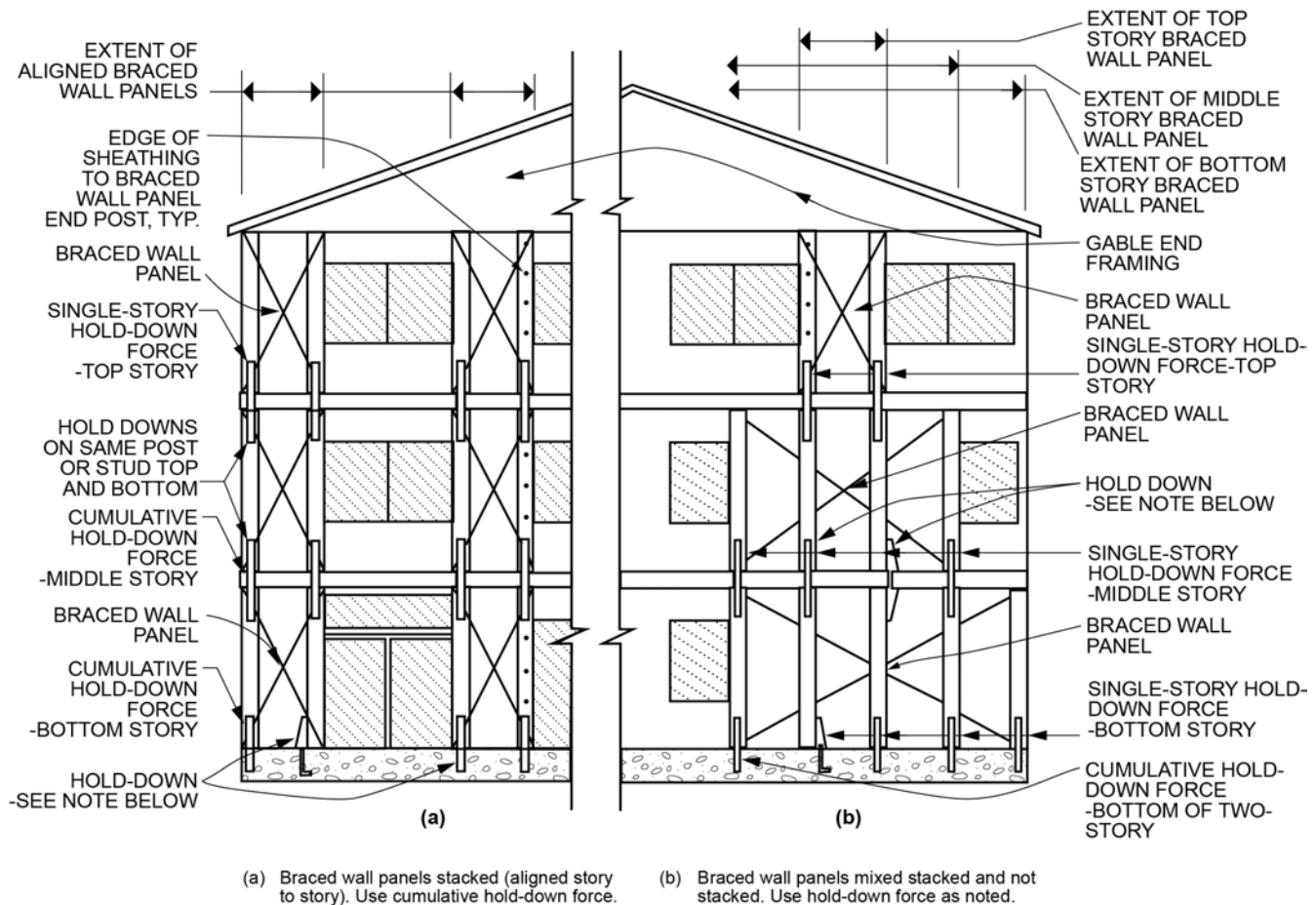


For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R602.10.6.4**  
**METHOD CS-PF—CONTINUOUSLY SHEATHED PORTAL FRAME PANEL CONSTRUCTION**



## WALL CONSTRUCTION



Note: Hold downs should be strap ties, tension ties, or other approved hold-down devices and shall be installed in accordance with the manufacturer's instructions.

**FIGURE R602.10.6.5.2**  
**METHOD BV-WSP—WALL BRACING FOR DWELLINGS WITH STONE AND MASONRY VENEER IN SEISMIC DESIGN CATEGORIES  $D_0$ ,  $D_1$  and  $D_2$**

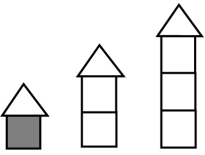
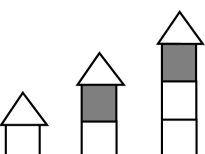
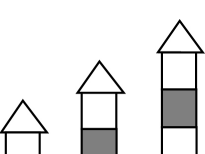

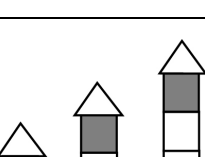
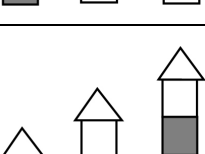
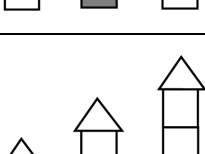
**R602.10.6.5.4 Length of bracing.** The length of bracing along each *braced wall line* shall be the greater of that required by the ultimate design wind speed and *braced wall line* spacing in accordance with Table R602.10.3(1) as adjusted by the factors in Table R602.10.3(2) or the seismic design category and *braced wall line* length in accordance either with Table R602.10.6.5.4 when using Method BV-WSP, or Table R602.10.3(3) as adjusted by the factors in Table R602.10.3(4) when using Method WSP or CS-WSP. Angled walls shall be permitted to be counted in accordance with Section R602.10.1.4, and *braced wall panel* location shall be in accordance with Section R602.10.2.2. Spacing between *braced wall lines* shall be in accordance

with Table R602.10.1.3. The seismic adjustment factors in Table R602.10.3(4) shall not be applied to the length of bracing determined using Table R602.10.6.5.4, except that the bracing amount increase for *braced wall line* spacing greater than 25 feet (7620 mm) in accordance with Table R602.10.1.3 shall be required. The minimum total length of bracing in a *braced wall line*, after all adjustments have been taken, shall be not less than 48 inches (1219 mm) total.

**R602.10.7 Ends of braced wall lines with continuous sheathing.** Each end of a *braced wall line* with continuous sheathing shall have one of the conditions shown in Figure R602.10.7.

## WALL CONSTRUCTION

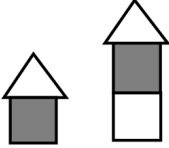
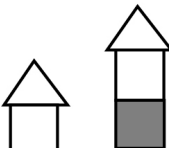
**TABLE R602.10.6.5.4  
METHOD BV-WSP WALL BRACING REQUIREMENTS<sup>d</sup>**

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (FEET)					SINGLE-STORY HOLD-DOWN FORCE (pounds) <sup>b</sup>	CUMULATIVE HOLD-DOWN FORCE (pounds) <sup>c</sup>
		10	20	30	40	50		
		Minimum Total Length (feet) of Braced Wall Panels Required Along each Braced Wall Line						
D <sub>0</sub>		4.0	7.0	10.5	14.0	17.5	NA	—
		4.0	7.0	10.5	14.0	17.5	1,900	—
		4.5	9.0	13.5	18.0	22.5	3,500	5,400
		6.0	12.0	18.0	24.0	30.0	3,500	8,900
D <sub>1</sub>		4.5	9.0	13.5	18.0	22.5	2,100	—
		4.5	9.0	13.5	18.0	22.5	3,700	5,800
		6.0	12.0	18.0	24.0	30.0	3,700	9,500

(continued)

## WALL CONSTRUCTION

**TABLE R602.10.6.5.4—continued**  
**METHOD BV-WSP WALL BRACING REQUIREMENTS<sup>d</sup>**

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (FEET)					SINGLE-STORY HOLD-DOWN FORCE (pounds) <sup>b</sup>	CUMULATIVE HOLD-DOWN FORCE (pounds) <sup>c</sup>
		10	20	30	40	50		
		Minimum Total Length (feet) of Braced Wall Panels Required Along each Braced Wall Line						
D <sub>2</sub> <sup>a</sup>		5.5	11.0	16.5	22.0	27.5	2,300	—
		5.5	11.0	16.5	22.0	27.5	3,900	6,200
	Three-story dwelling	NP	NP	NP	NP	NP	NA	NA

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa, 1 pound-force = 4.448 N.

NP = Not Permitted.

NA = Not Applicable.

- One- and two-family dwellings in Seismic Design Category D<sub>2</sub> exceeding two stories shall be designed in accordance with accepted engineering practices.
- Hold-down force is minimum allowable stress design load for connector providing uplift tie from wall framing at end of braced wall panel at the noted story to wall framing at end of braced wall panel at the story below, or to foundation or foundation wall. Use single-story hold-down force where edges of braced wall panels do not align; a continuous load path to the foundation shall be maintained.
- Where hold-down connectors from stories above align with stories below, use cumulative hold-down force to size middle- and bottom-story hold-down connectors.
- Interpolation between braced wall lengths is permitted.

**R602.10.8 Braced wall panel connections.** *Braced wall panels* shall be connected to floor framing or foundations as follows:

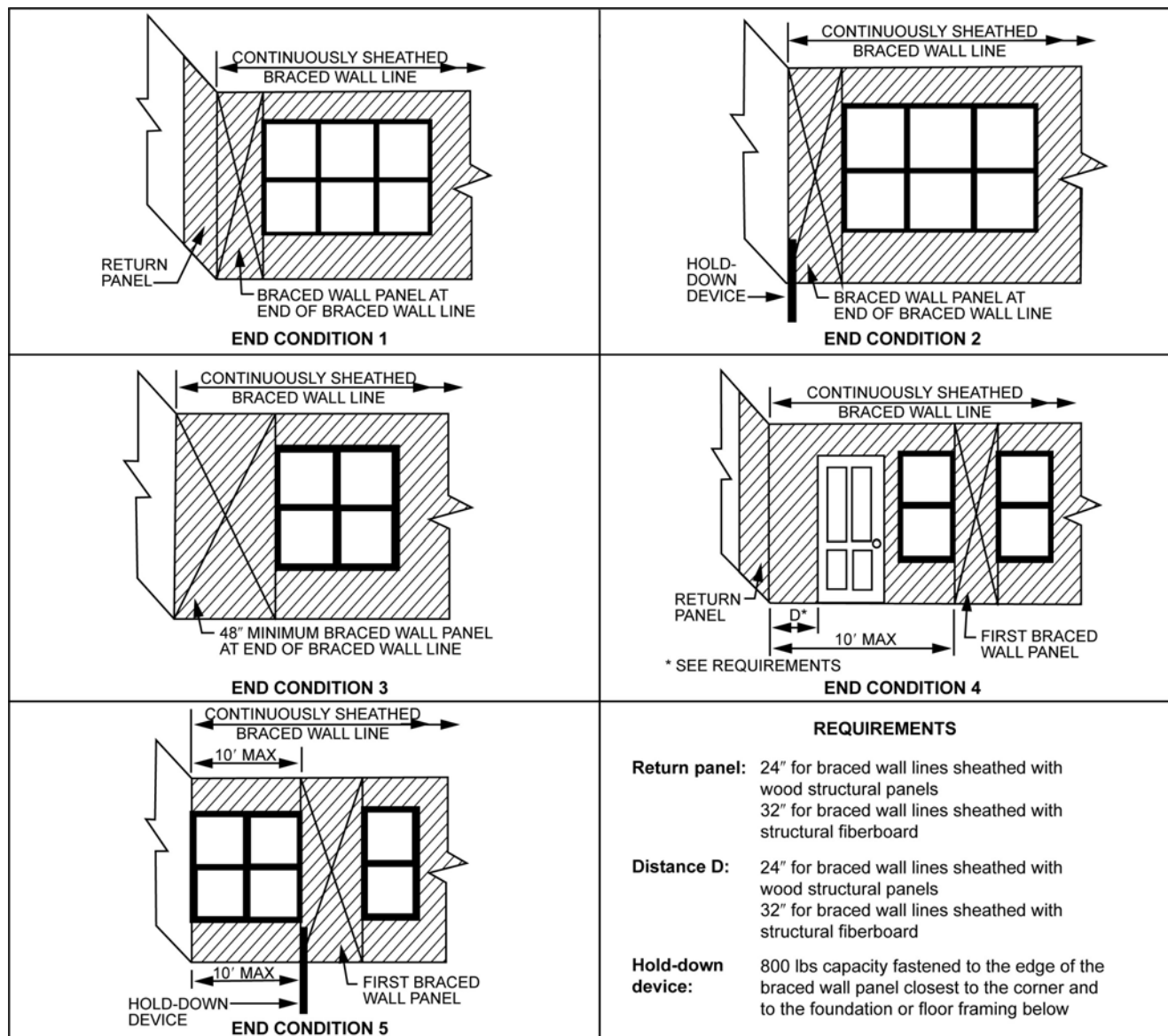
- Where joists are perpendicular to a *braced wall panel* above or below, a rim joist, band joist or blocking shall be provided along the entire length of the *braced wall panel* in accordance with Figure R602.10.8(1). Fastening of top and bottom wall plates to framing, rim joist, band joist or blocking shall be in accordance with Table R602.3(1).
- Where joists are parallel to a *braced wall panel* above or below, a rim joist, end joist or other parallel framing member shall be provided directly above and below the *braced wall panel* in accordance with Figure R602.10.8(2). Where a parallel framing member cannot be located directly above and below the panel, full-depth blocking at 16-inch (406 mm) spacing shall be provided between the parallel framing members to each side of the *braced wall panel* in accordance with Figure R602.10.8(2). Fastening of blocking and wall plates shall be in accordance with Table R602.3(1) and Figure R602.10.8(2).
- Connections of *braced wall panels* to concrete or masonry shall be in accordance with Section R403.1.6.

**R602.10.8.1 Braced wall panel connections for Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** *Braced wall panels* shall be fastened to required foundations in accordance with Section R602.11.1, and top plate lap splices shall be face-nailed with not less than eight 16d nails on each side of the splice.

**R602.10.8.2 Connections to roof framing.** Top plates of exterior *braced wall panels* shall be attached to rafters or roof trusses above in accordance with Table R602.3(1) and this section. Where required by this section, blocking between rafters or roof trusses shall be attached to top plates of *braced wall panels* and to rafters and roof trusses in accordance with Table R602.3(1). A continuous band, rim or header joist or roof truss parallel to the *braced wall panels* shall be permitted to replace the blocking required by this section. Blocking shall not be required over openings in continuously sheathed *braced wall lines*. In addition to the requirements of this section, lateral support shall be provided for rafters and ceiling joists in accordance with Section R802.8 and for trusses in accordance with Section R802.10.3. Roof *ventilation* shall be provided in accordance with Section R806.1.

- For *Seismic Design Categories A, B and C* where the distance from the top of the *braced wall panel* to the top of the rafters or roof trusses above is 9<sup>1</sup>/<sub>4</sub> inches (235 mm) or less,

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound = 4.45 N.

**FIGURE R602.10.7**  
**END CONDITIONS FOR BRACED WALL LINES WITH CONTINUOUS SHEATHING**

blocking between rafters or roof trusses shall not be required. Where the distance from the top of the *braced wall panel* to the top of the rafters or roof trusses above is between  $9\frac{1}{4}$  inches (235 mm) and  $15\frac{1}{4}$  inches (387 mm), blocking between rafters or roof trusses shall be provided above the *braced wall panel* in accordance with Figure R602.10.8.2(1).

**Exception:** Where the outside edge of truss vertical web members aligns with the outside face of the wall studs below, wood structural panel sheathing extending above

the top plate as shown in Figure R602.10.8.2(3) shall be permitted to be fastened to each truss web with three-8d nails ( $2\frac{1}{2}$  inches  $\times$  0.131 inch) and blocking between the trusses shall not be required.

- For *Seismic Design Categories*  $D_0$ ,  $D_1$  and  $D_2$ , where the distance from the top of the *braced wall panel* to the top of the rafters or roof trusses is  $15\frac{1}{4}$  inches (387 mm) or less, blocking between rafters or roof trusses shall be provided above the *braced wall panel* in accordance with Figure R602.10.8.2(1).

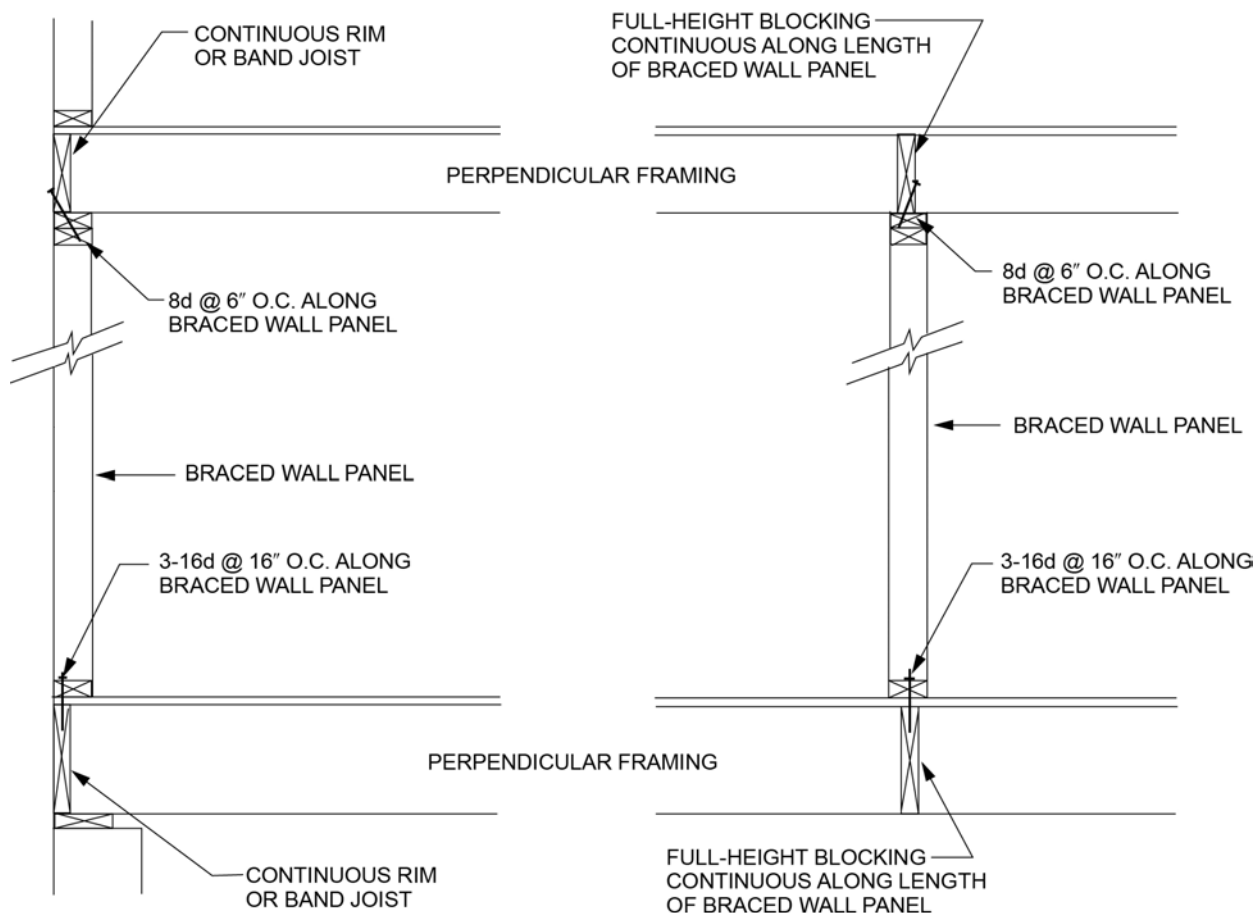
## WALL CONSTRUCTION

3. Where the distance from the top of the *braced wall panel* to the top of rafters or roof trusses exceeds  $15\frac{1}{4}$  inches (387 mm), the top plates of the *braced wall panel* shall be connected to perpendicular rafters or roof trusses above in accordance with one or more of the following methods:

- 3.1. Soffit blocking panels constructed in accordance with Figure R602.10.8.2(2).
- 3.2. Vertical blocking panels constructed in accordance with Figure R602.10.8.2(3).
- 3.3. Blocking panels provided by the roof truss manufacturer and designed in accordance with Section R802.
- 3.4. Blocking, blocking panels or other methods of lateral load transfer designed in accordance with the AWC WFCM or accepted engineering practice.

**R602.10.9 Braced wall panel support.** *Braced wall panel* support shall be provided as follows:

1. Cantilevered floor joists complying with Section R502.3.3 shall be permitted to support *braced wall panels*.
2. Raised floor system post or pier foundations supporting *braced wall panels* shall be designed in accordance with accepted engineering practice.
3. Masonry stem walls with a length of 48 inches (1219 mm) or less supporting *braced wall panels* shall be reinforced in accordance with Figure R602.10.9. Masonry stem walls with a length greater than 48 inches (1219 mm) supporting *braced wall panels* shall be constructed in accordance with Section R403.1 Methods ABW and PFH shall not be permitted to attach to masonry stem walls.
4. Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall have reinforcement sized and located in accordance with Figure R602.10.9.

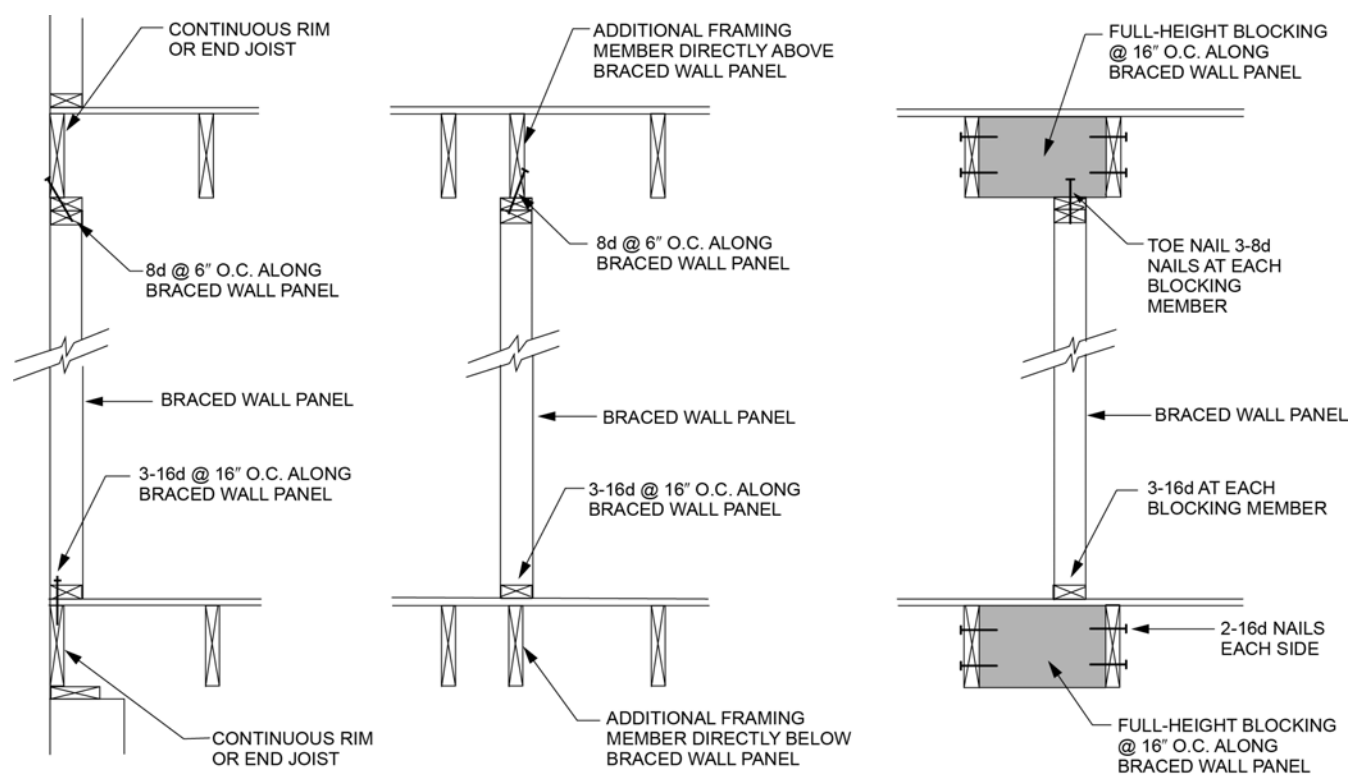


For SI: 1 inch = 25.4 mm.

**FIGURE R602.10.8(1)**  
**BRACED WALL PANEL CONNECTION WHEN PERPENDICULAR TO FLOOR/CEILING FRAMING**

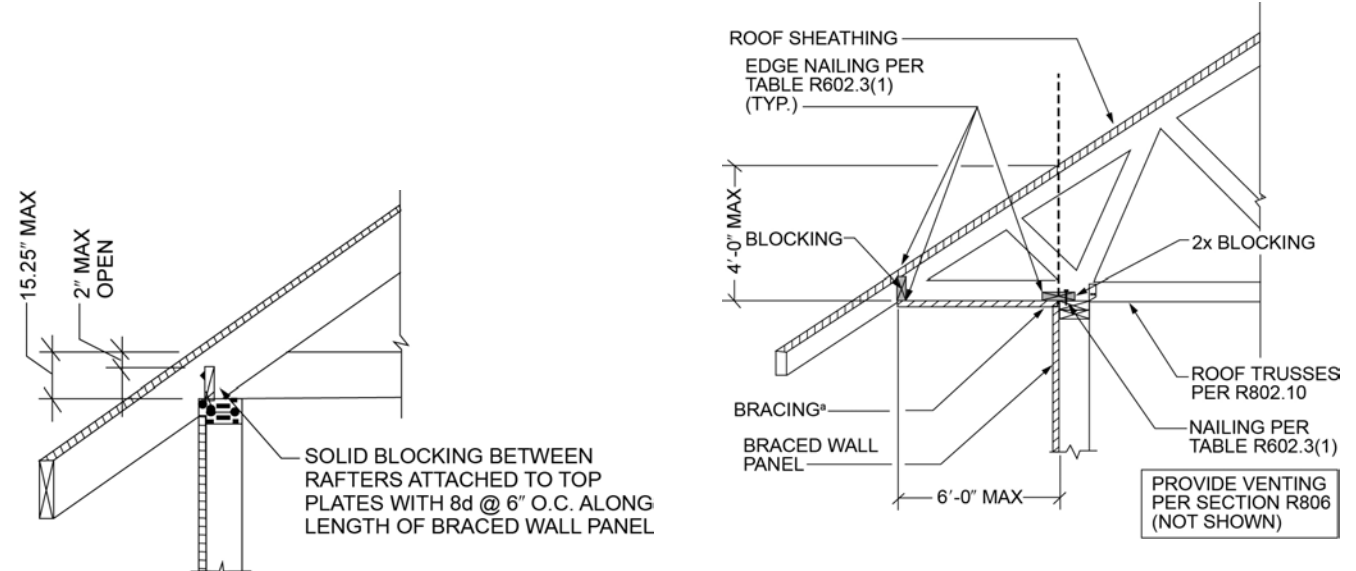


WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

FIGURE R602.10.8(2)  
BRACED WALL PANEL CONNECTION WHEN PARALLEL TO FLOOR/CEILING FRAMING



For SI: 1 inch = 25.4 mm.

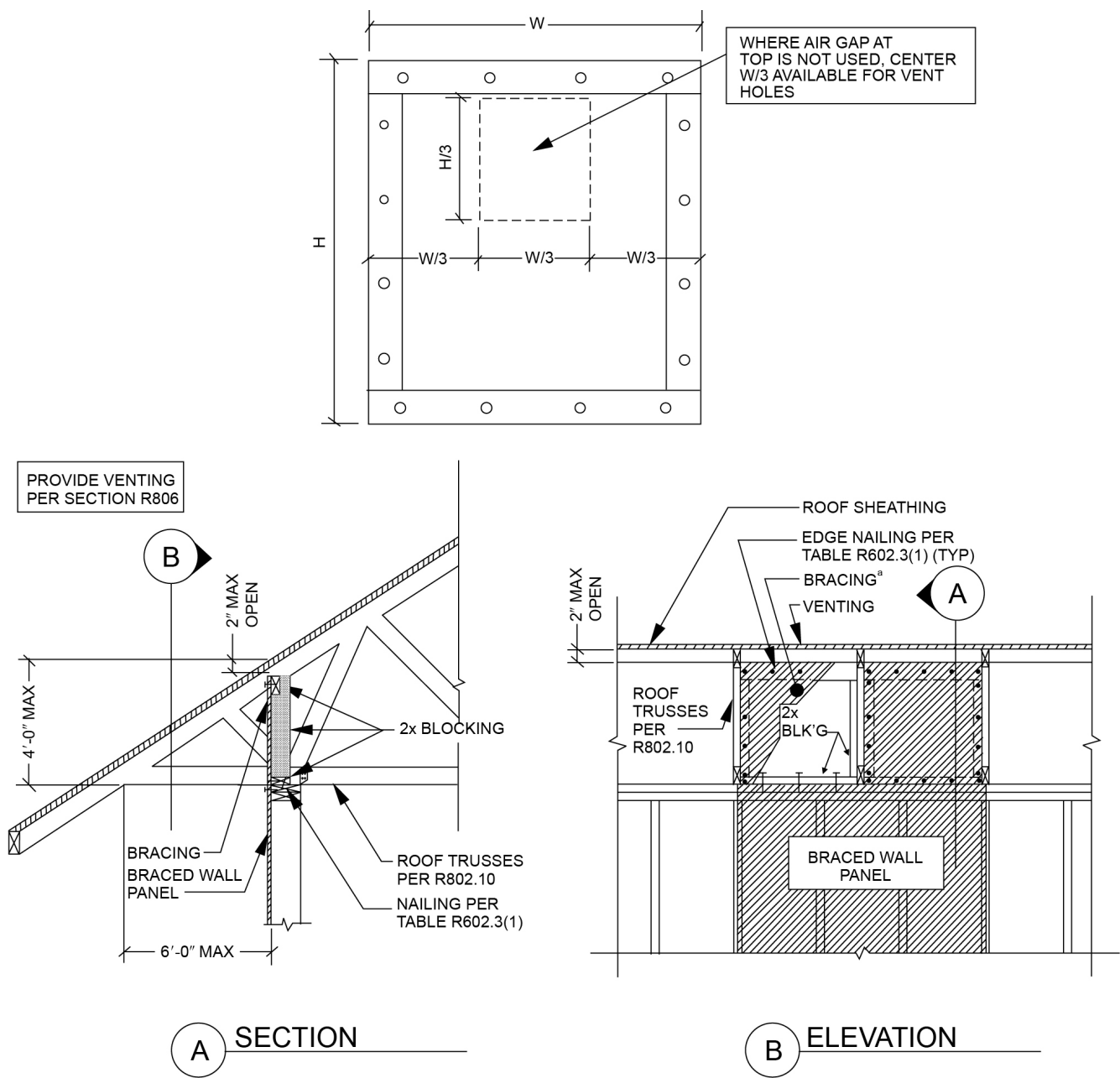
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Methods of bracing shall be as described in Section R602.10.4.

FIGURE R602.10.8.2(1)  
BRACED WALL PANEL CONNECTION  
TO PERPENDICULAR RAFTERS

FIGURE R602.10.8.2(2)  
BRACED WALL PANEL CONNECTION OPTION TO  
PERPENDICULAR RAFTERS OR ROOF TRUSSES

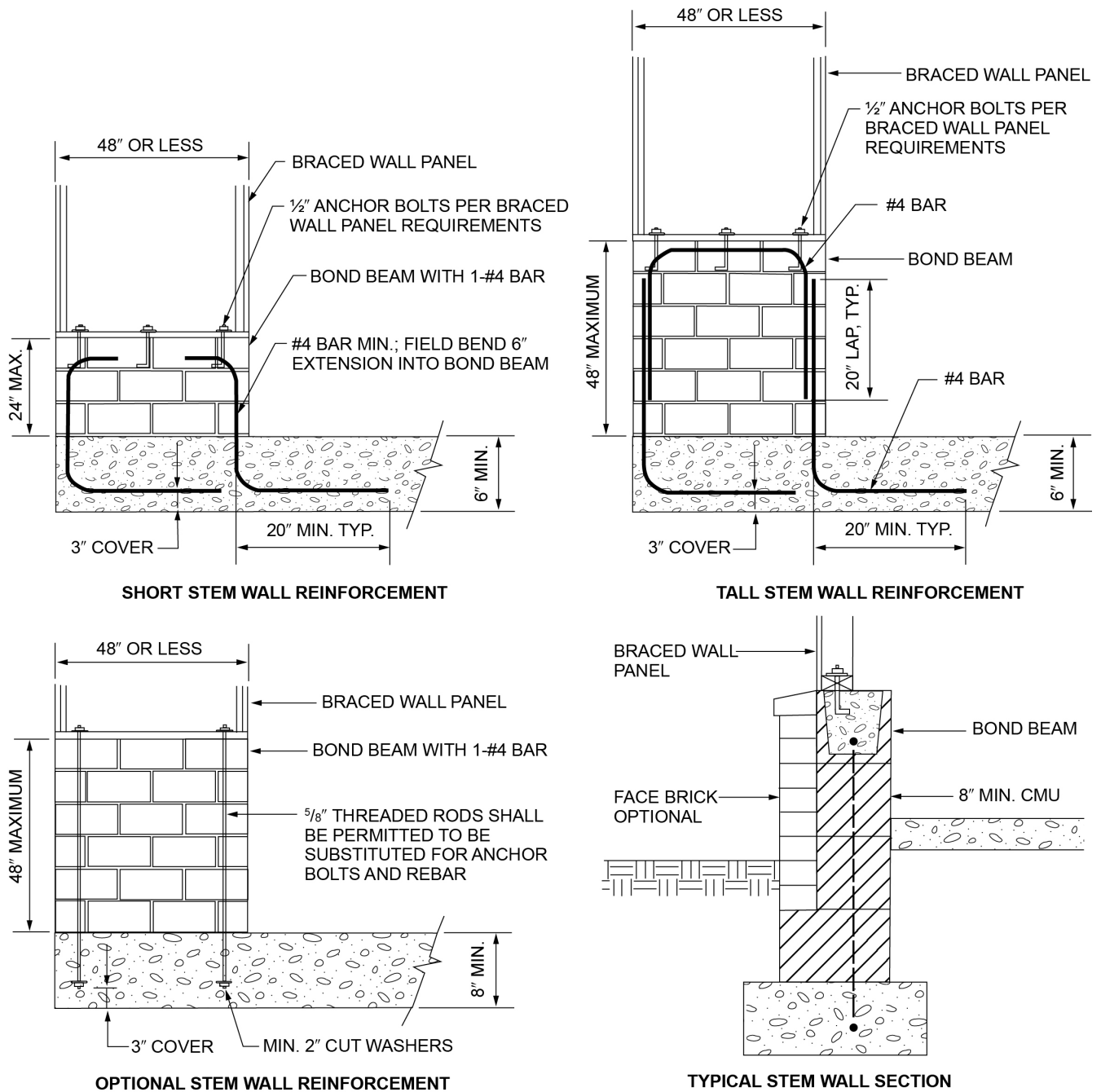
WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm  
a. Methods of bracing shall be as described in Section R602.10.4.

**FIGURE R602.10.8.2(3)**  
**BRACED WALL PANEL CONNECTION OPTION TO PERPENDICULAR RAFTERS OR ROOF TRUSSES**

## WALL CONSTRUCTION



NOTE: GROUT BOND BEAMS AND ALL CELLS THAT CONTAIN REBAR, THREADED RODS AND ANCHOR BOLTS.

For SI: 1 inch = 25.4 mm.

**FIGURE R602.10.9**  
**MASONRY STEM WALLS SUPPORTING BRACED WALL PANELS**

## WALL CONSTRUCTION

**R602.10.9.1 Braced wall panel support for Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** In *Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*, braced wall panel footings shall be as specified in Section R403.1.2.

**R602.10.10 Cripple wall bracing.** Cripple walls shall be constructed in accordance with Section R602.9 and braced in accordance with this section. Cripple walls shall be braced with the length and method of bracing used for the wall above in accordance with Tables R602.10.3(1) and R602.10.3(3), and the applicable adjustment factors in Table R602.10.3(2) or R602.10.3(4), respectively, except that the length of cripple wall bracing shall be multiplied by a factor of 1.15. Where gypsum wall board is not used on the inside of the cripple wall bracing, the length adjustments for the elimination of the gypsum wallboard, or equivalent, shall be applied as directed in Tables R602.10.3(2) and R602.10.3(4) to the length of cripple wall bracing required. This adjustment shall be taken in addition to the 1.15 increase.

**R602.10.10.1 Cripple wall bracing for Seismic Design Categories D<sub>0</sub> and D<sub>1</sub> and townhouses in Seismic Design Category C.** In addition to the requirements in Section R602.10.10, cripple wall bracing shall be limited to methods WSP and CS-WSP, and the distance between adjacent edges of braced wall panels for cripple walls along a braced wall line shall be 14 feet (4267 mm) maximum.

Where braced wall lines at interior walls are not supported on a continuous foundation below, the adjacent parallel cripple walls, where provided, shall be braced with Method WSP or Method CS-WSP in accordance with Section R602.10.4. The length of bracing required in accordance with Table R602.10.3(3) for the cripple walls shall be multiplied by 1.5. Where the cripple walls do not have sufficient length to provide the required bracing, the spacing of panel edge fasteners shall be reduced to 4 inches (102 mm) on center and the required bracing length adjusted by 0.7. If the required length can still not be provided, the cripple wall shall be designed in accordance with accepted engineering practice.

**R602.10.10.2 Cripple wall bracing for Seismic Design Category D<sub>2</sub>.** In *Seismic Design Category D<sub>2</sub>*, cripple walls shall be braced in accordance with Tables R602.10.3(3) and R602.10.3(4).

**R602.10.10.3 Redesignation of cripple walls.** Where all cripple wall segments along a braced wall line do not exceed 48 inches (1219 mm) in height, the cripple walls shall be permitted to be redesignated as a first-story wall for purposes of determining wall bracing requirements. Where any cripple wall segment in a braced wall line exceeds 48 inches (1219 mm) in height, the entire cripple wall shall be counted as an additional story. If the cripple walls are redesignated, the stories above the redesignated story shall be counted as the second and third stories, respectively.

**R602.11 Wall anchorage.** Braced wall line sills shall be anchored to concrete or masonry foundations in accordance with Sections R403.1.6 and R602.11.1.

**R602.11.1 Wall anchorage for all buildings in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> and townhouses in Seismic Design Category C.** Plate washers, not less than 0.229 inch by 3 inches by 3 inches (5.8 mm by 76 mm by 76 mm) in size, shall be provided between the foundation sill plate and the nut except where approved anchor straps are used. The hole in the plate washer is permitted to be diagonally slotted with a width of up to  $\frac{3}{16}$  inch (5 mm) larger than the bolt diameter and a slot length not to exceed  $1\frac{3}{4}$  inches (44 mm), provided a standard cut washer is placed between the plate washer and the nut.

**R602.11.2 Stepped foundations in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** In all buildings located in *Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>*, where the height of a required braced wall line that extends from foundation to floor above varies more than 4 feet (1219 mm), the braced wall line shall be constructed in accordance with the following:

1. Where the lowest floor framing rests directly on a sill bolted to a foundation not less than 8 feet (2440 mm) in length along a line of bracing, the line shall be considered as braced. The double plate of the cripple stud wall beyond the segment of footing that extends to the lowest framed floor shall be spliced by extending the upper top plate not less than 4 feet (1219 mm) along the foundation. Anchor bolts shall be located not more than 1 foot and 3 feet (305 and 914 mm) from the step in the foundation. See Figure R602.11.2.
2. Where cripple walls occur between the top of the foundation and the lowest floor framing, the bracing requirements of Sections R602.10.10, R602.10.10.1 and R602.10.10.2 shall apply.
3. Where only the bottom of the foundation is stepped and the lowest floor framing rests directly on a sill bolted to the foundations, the requirements of Sections R403.1.6 and R602.11.1 shall apply.

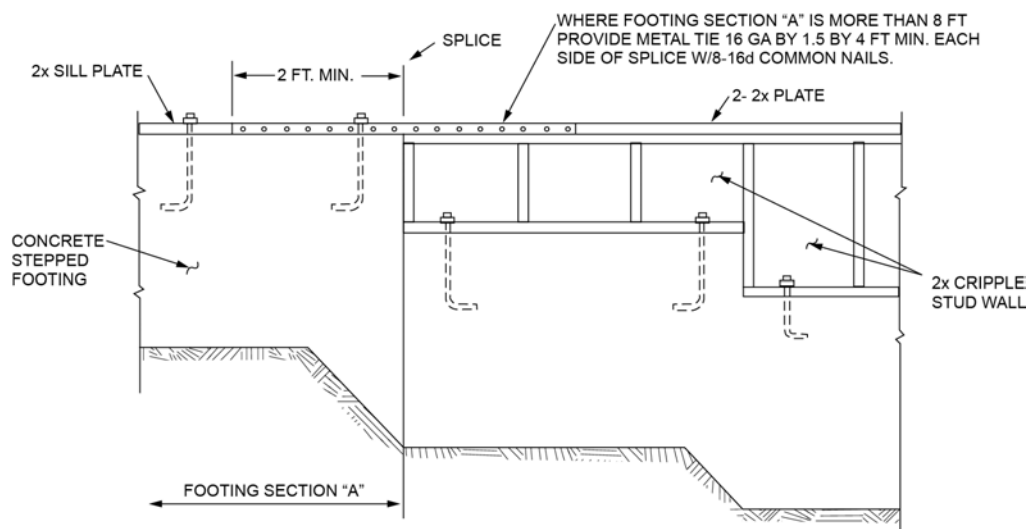
**R602.12 Simplified wall bracing.** Buildings meeting all of the following conditions shall be permitted to be braced in accordance with this section as an alternative to the requirements of Section R602.10. The entire building shall be braced in accordance with this section; the use of other bracing provisions of Section R602.10, except as specified herein, shall not be permitted.

1. There shall be not more than three stories above the top of a concrete or masonry foundation or basement wall. Permanent wood foundations shall not be permitted.
2. Floors shall not cantilever more than 24 inches (607 mm) beyond the foundation or bearing wall below.
3. Wall height shall not be greater than 10 feet (3048 mm).

## WALL CONSTRUCTION

4. The building shall have a roof eave-to-ridge height of 15 feet (4572 mm) or less.
5. Exterior walls shall have gypsum board with a minimum thickness of  $\frac{1}{2}$  inch (12.7 mm) installed on the interior side fastened in accordance with Table R702.3.5.
6. The structure shall be located where the ultimate design wind speed is less than or equal to 130 mph (58 m/s), and the exposure category is B or C.
7. The structure shall be located in *Seismic Design Category A, B or C* for detached one- and two-family dwellings or *Seismic Design Category A or B* for townhouses.
8. Cripple walls shall not be permitted in three-story buildings.

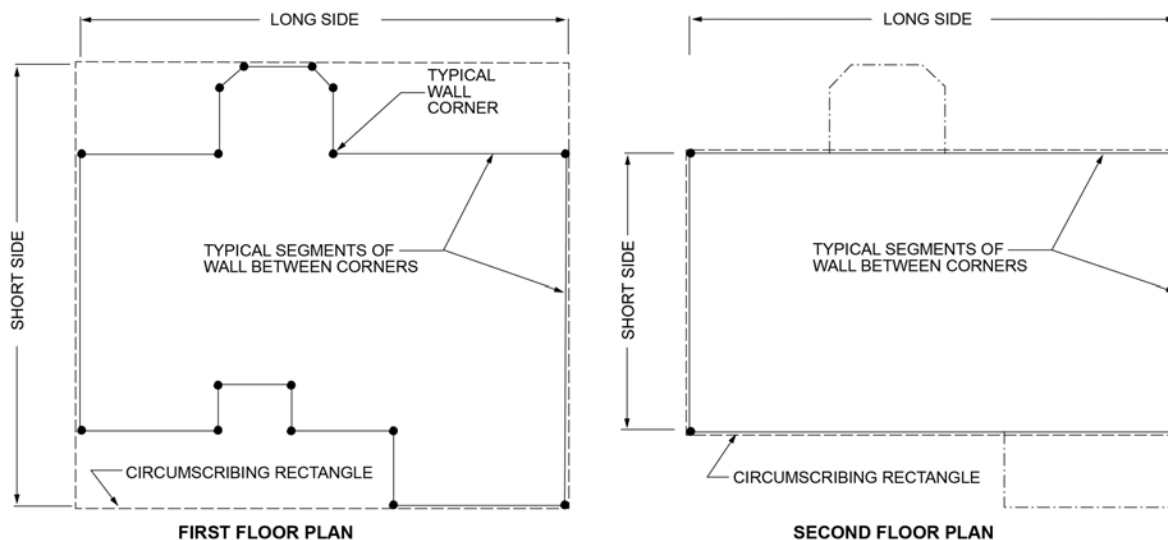
**R602.12.1 Circumscribed rectangle.** The bracing required for each building shall be determined by circumscribing a rectangle around the entire building on each floor as shown in Figure R602.12.1. The rectangle shall surround all enclosed offsets and projections such as *sunrooms* and attached garages. Open structures, such as carports and decks, shall be permitted to be excluded. The rectangle shall not have a side greater than 60 feet (18 288 mm), and the ratio between the long side and short side shall be not greater than 3:1.



For SI: 1 foot = 304.8 mm.

**Note:** Where footing Section "A" is less than 8 feet long in a 25-foot-long wall, install bracing at cripple stud wall.

**FIGURE R602.11.2**  
**STEPPED FOUNDATION CONSTRUCTION**



**FIGURE R602.12.1**  
**RECTANGLE CIRCUMSCRIBING AN ENCLOSED BUILDING**



## WALL CONSTRUCTION

**R602.12.2 Sheathing materials.** The following sheathing materials installed on the exterior side of exterior walls shall be used to construct a bracing unit as defined in Section R602.12.3. Mixing materials is prohibited.

1. Wood structural panels with a minimum thickness of  $\frac{3}{8}$  inch (9.5 mm) fastened in accordance with Table R602.3(3).
2. Structural fiberboard sheathing with a minimum thickness of  $\frac{1}{2}$  inch (12.7 mm) fastened in accordance with Table R602.3(1).

**R602.12.3 Bracing unit.** A bracing unit shall be a full-height sheathed segment of the exterior wall without openings or vertical or horizontal offsets and a minimum length as specified herein. Interior walls shall not contribute toward the amount of required bracing. Mixing of Items 1 and 2 is prohibited on the same story.

1. Where all framed portions of all exterior walls are sheathed in accordance with Section R602.12.2, including wall areas between bracing units, above and below openings and on gable end walls, the minimum length of a bracing unit shall be 3 feet (914 mm).
2. Where the exterior walls are braced with sheathing panels in accordance with Section R602.12.2 and areas between bracing units are covered with other materials, the minimum length of a bracing unit shall be 4 feet (1219 mm).

**R602.12.3.1 Multiple bracing units.** Segments of wall compliant with Section R602.12.3 and longer than the minimum bracing unit length shall be considered as multiple bracing units. The number of bracing units shall be determined by dividing the wall segment length by the minimum bracing unit length. Full-height sheathed segments of wall narrower than the minimum bracing unit length shall not contribute toward a bracing unit except as specified in Section R602.12.6.

**R602.12.4 Number of bracing units.** Each side of the circumscribed rectangle, as shown in Figure R602.12.1, shall have, at a minimum, the number of bracing units in accordance with Table R602.12.4 placed on the parallel

exterior walls facing the side of the rectangle. Bracing units shall then be placed using the distribution requirements specified in Section R602.12.5.

**R602.12.5 Distribution of bracing units.** The placement of bracing units on exterior walls shall meet all of the following requirements as shown in Figure R602.12.5.

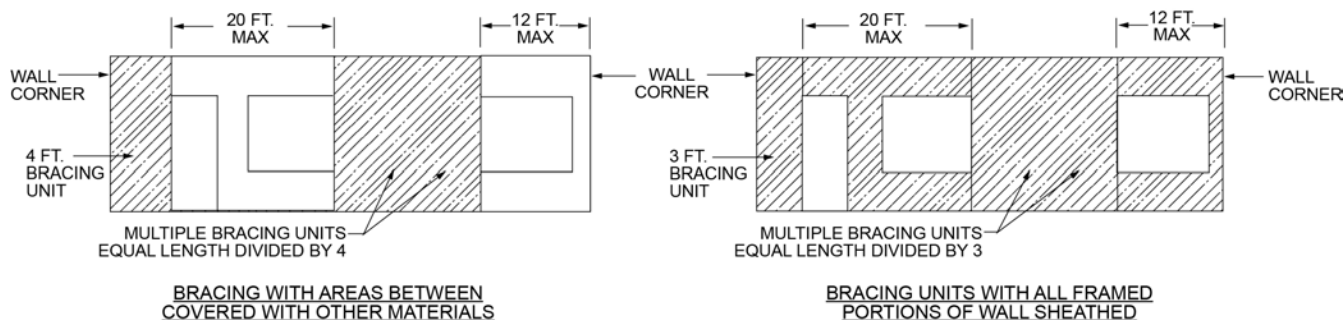
1. A bracing unit shall begin not more than 12 feet (3658 mm) from any wall corner.
2. The distance between adjacent edges of bracing units shall be not greater than 20 feet (6096 mm).
3. Segments of wall greater than 8 feet (2438 mm) in length shall have not less than one bracing unit.

**R602.12.6 Narrow panels.** The bracing methods referenced in Section R602.10 and specified in Sections R602.12.6.1 through R602.12.6.3 shall be permitted where using simplified wall bracing.

**R602.12.6.1 Method CS-G.** *Braced wall panels* constructed as Method CS-G in accordance with Tables R602.10.4 and R602.10.5 shall be permitted for one-story garages where all framed portions of all exterior walls are sheathed with *wood structural panels*. Each CS-G panel shall be equivalent to 0.5 of a bracing unit. Segments of wall that include a Method CS-G panel shall meet the requirements of Section R602.10.4.2.

**R602.12.6.2 Method CS-PF.** *Braced wall panels* constructed as Method CS-PF in accordance with Section R602.10.6.4 shall be permitted where all framed portions of all exterior walls are sheathed with *wood structural panels*. Each CS-PF panel shall equal 0.75 bracing units. Segments of wall that include a Method CS-PF panel shall meet the requirements of Section R602.10.4.2.

**R602.12.6.3 Methods ABW, PFH and PFG.** *Braced wall panels* constructed as Method ABW, PFH and PFG shall be permitted where bracing units are constructed using *wood structural panels* applied either continuously or intermittently. Each ABW and PFH panel shall equal one bracing unit and each PFG panel shall be equal to 0.75 bracing unit.















For SI: 1 foot = 304.8 mm.

FIGURE R602.12.5  
BRACING UNIT DISTRIBUTION

## WALL CONSTRUCTION

**TABLE R602.12.4**  
**MINIMUM NUMBER OF BRACING UNITS ON EACH SIDE OF THE CIRCUMSCRIBED RECTANGLE**

ULTIMATE DESIGN WIND SPEED (mph)	STORY LEVEL	EAVE-TO-RIDGE HEIGHT (feet)	MINIMUM NUMBER OF BRACING UNITS ON EACH LONG SIDE <sup>a, b, d</sup>						MINIMUM NUMBER OF BRACING UNITS ON EACH SHORT SIDE <sup>a, b, d</sup>					
			Length of short side (feet) <sup>c</sup>						Length of long side (feet) <sup>c</sup>					
			10	20	30	40	50	60	10	20	30	40	50	60
115		10	1	2	2	2	3	3	1	2	2	2	3	3
			2	3	3	4	5	6	2	3	3	4	5	6
			2	3	4	6	7	8	2	3	4	6	7	8
		15	1	2	3	3	4	4	1	2	3	3	4	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	6	7	9	2	4	5	6	7	9
130		10	1	2	2	3	3	4	1	2	2	3	3	4
			2	3	4	5	6	7	2	3	4	5	6	7
			2	4	5	7	8	10	2	4	5	7	8	10
		15	2	3	3	4	4	6	2	3	3	4	4	6
			3	4	6	7	8	10	3	4	6	7	8	10
			3	6	7	10	11	13	3	6	7	10	11	13

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447m/s.

- Interpolation shall not be permitted.
- Cripple walls or wood-framed basement walls in a walk-out condition shall be designated as the first story and the stories above shall be redesignated as the second and third stories, respectively, and shall be prohibited in a three-story structure.
- Actual lengths of the sides of the circumscribed rectangle shall be rounded to the next highest unit of 10 when using this table.
- For Exposure Category C, multiply bracing units by a factor of 1.20 for a one-story building, 1.30 for a two-story building and 1.40 for a three-story building.

## WALL CONSTRUCTION

**R602.12.7 Lateral support.** For bracing units located along the eaves, the vertical distance from the outside edge of the top wall plate to the roof sheathing above shall not exceed 9.25 inches (235 mm) at the location of a bracing unit unless lateral support is provided in accordance with Section R602.10.8.2.

**R602.12.8 Stem walls.** Masonry stem walls with a height and length of 48 inches (1219 mm) or less supporting a bracing unit or a Method CS-G, CS-PF or PFG *braced wall panel* shall be constructed in accordance with Figure R602.10.9. Concrete stem walls with a length of 48 inches (1219 mm) or less, greater than 12 inches (305 mm) tall and less than 6 inches (152 mm) thick shall be reinforced sized and located in accordance with Figure R602.10.9.

### SECTION R603 COLD-FORMED STEEL WALL FRAMING

**R603.1 General.** Elements shall be straight and free of any defects that would significantly affect structural performance. Cold-formed steel wall framing members shall be in accordance with the requirements of this section.

**R603.1.1 Applicability limits.** The provisions of this section shall control the construction of exterior cold-formed steel wall framing and interior load-bearing cold-formed steel wall framing for buildings not more than 60 feet (18 288 mm) long perpendicular to the joist or truss span, not more than 40 feet (12 192 mm) wide parallel to the joist or truss span, and less than or equal to three stories above *grade plane*. Exterior walls installed in accordance with the provisions of this section shall be considered as *load-bearing walls*. Cold-formed steel walls constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 140 miles per hour (63 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3.35 kPa).

**R603.1.1.1 Alternate applications.** Cold-formed steel wall framing for buildings exceeding the applicability limits of Section R603.1.1 are permitted to be designed and constructed in accordance with AISI S230, subject to the limits therein.

**R603.1.2 In-line framing.** Load-bearing cold-formed steel studs constructed in accordance with Section R603 shall be located in-line with joists, trusses and rafters in accordance with the tolerances specified in AISI S240, Section B1.2.3.

**R603.2 Structural framing.** Load-bearing cold-formed steel wall framing members shall be in accordance with this section.

**R603.2.1 Material.** Load-bearing cold-formed steel framing members shall be cold formed to shape from structural-quality sheet steel complying with the requirements of AISI 240, Section A3.

**R603.2.2 Corrosion protection.** Load-bearing cold-formed steel framing shall have a protective coating complying with AISI S240, Section A4.

**R603.2.3 Dimension, thickness and material grade.** Load-bearing cold-formed steel wall framing members shall comply with the dimensional and thickness requirements specified in AISI S230, Section A4.3 and material grade requirements as specified in AISI S230, Section A4.4.

**R603.2.4 Identification.** Load-bearing cold-formed steel framing members shall meet the product identification requirements of AISI S240, Section A5.5.

**R603.2.5 Fastening.** Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of  $\frac{1}{2}$  inch (12.7 mm), shall be self-drilling tapping and shall conform to ASTM C1513. Structural sheathing shall be attached to cold-formed steel studs with minimum No. 8 self-drilling tapping screws that conform to ASTM C1513. Screws for attaching structural sheathing to cold-formed steel wall framing shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a minimum edge distance of  $\frac{3}{8}$  inch (9.5 mm). Gypsum board shall be attached to cold-formed steel wall framing with minimum No. 6 screws conforming to ASTM C954 or ASTM C1513 with a bugle-head style and shall be installed in accordance with Section R702. For connections, screws shall extend through the steel not fewer than three exposed threads. Fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.

**R603.2.6 Web holes, web hole reinforcing and web hole patching.** Web holes in wall studs shall comply with the conditions as prescribed in AISI S230, Section A4.5. Web holes not in conformance to the conditions as prescribed in AISI S230, Section A4.5 shall be reinforced in accordance with the provisions of AISI S230, Section A4.6 or patched in accordance with the provisions of AISI S230, Section A4.7.

**R603.3 Wall construction.** Exterior cold-formed steel framed walls and interior load-bearing cold-formed steel framed walls shall be constructed in accordance with the provisions of this section.

**R603.3.1 Wall to foundation or floor connection.** Cold-formed steel framed walls shall be anchored to foundations or floors in accordance with Table R603.3.1 and Figure R603.3.1(1), R603.3.1(2), R603.3.1(3) or R603.3.1(4). Anchor bolts shall be located not more than 12 inches (305 mm) from corners or the termination of bottom tracks. Anchor bolts shall extend not less than 15 inches (381 mm) into masonry or 7 inches (178 mm) into concrete. Foundation anchor straps shall be permitted, in lieu of anchor bolts, if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.

## WALL CONSTRUCTION

**TABLE R603.3.1**  
**WALL TO FOUNDATION OR FLOOR CONNECTION REQUIREMENTS<sup>a, b</sup>**

FRAMING CONDITION			ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)					
			115 B	120 B	130 B or 115 C	< 140 B or 120 C	130 C	< 140 C
Wall bottom track to floor per Figure R603.3.1(1)			1-No. 8 screw at 12" o.c.	1-No. 8 screw at 8" o.c.	2-No. 8 screws at 8" o.c.	2-No. 8 screws at 6" o.c.	3-No. 8 screws at 8" o.c.	3-No. 8 screws at 6" o.c.
Wall bottom track to foundation per Figure R603.3.1(2) <sup>d</sup>			$\frac{1}{2}$ " minimum diameter anchor bolt at 6' o.c.	$\frac{1}{2}$ " minimum diameter anchor bolt at 6' o.c.	$\frac{1}{2}$ " minimum diameter anchor bolt at 4' o.c.	$\frac{1}{2}$ " minimum diameter anchor bolt at 4' o.c.	$\frac{1}{2}$ " minimum diameter anchor bolt at 3'-4" o.c.	$\frac{1}{2}$ " minimum diameter anchor bolt at 2'-8" o.c.
Wall bottom track to wood sill per Figure R603.3.1(3)			Steel plate spaced at 4' o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 4' o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 3' o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 3' o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 2' o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails	Steel plate spaced at 1'-4" o.c., with 4-No. 8 screws and 4-10d or 6-8d common nails
Wind uplift connector strength (lb) <sup>c, e</sup>	Stud Spacing (inches)	Roof Span (feet)						
	16	24	NR	NR	NR	NR	NR	NR
		28	NR	NR	NR	NR	NR	339
		32	NR	NR	NR	NR	NR	382
		36	NR	NR	NR	NR	333	426
		40	NR	NR	NR	NR	368	470
	24	24	NR	NR	NR	NR	343	443
		28	NR	NR	NR	NR	395	508
		32	NR	NR	NR	330	447	573
		36	NR	NR	NR	371	500	639
		40	NR	NR	345	411	552	704

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm, 1 pound = 4.45 N.

a. Anchor bolts are to be located not more than 12 inches from corners or the termination of bottom tracks, such as at door openings or corners. Bolts are to extend not less than 15 inches into masonry or 7 inches into concrete.

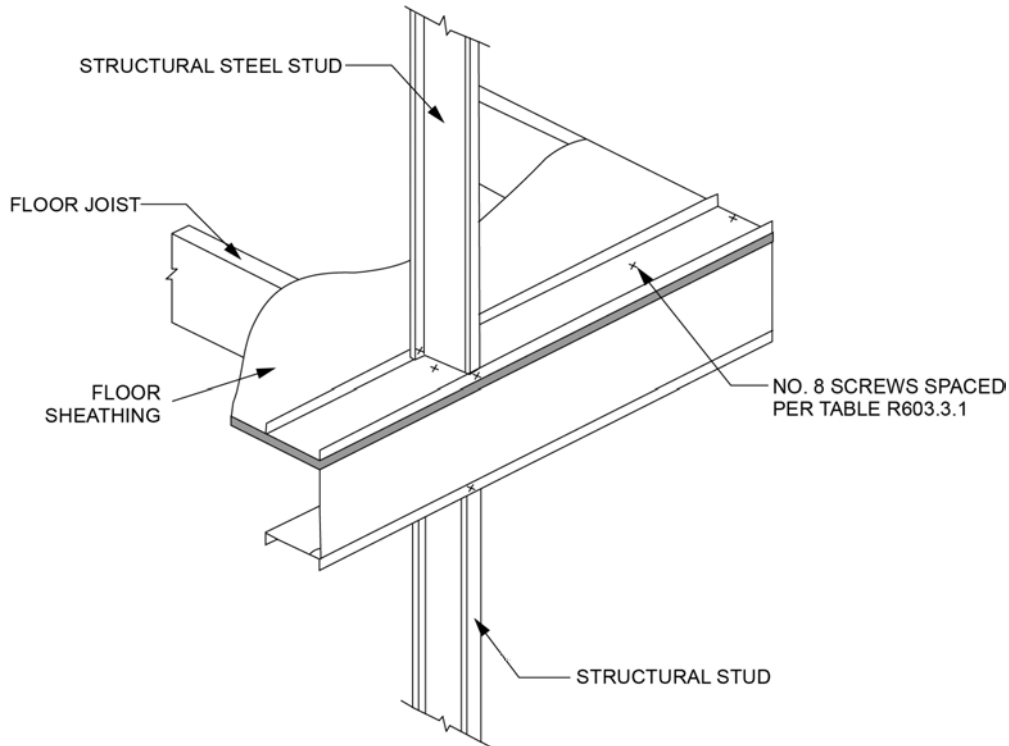
b. All screw sizes shown are minimum.

c. NR = Uplift connector not required.

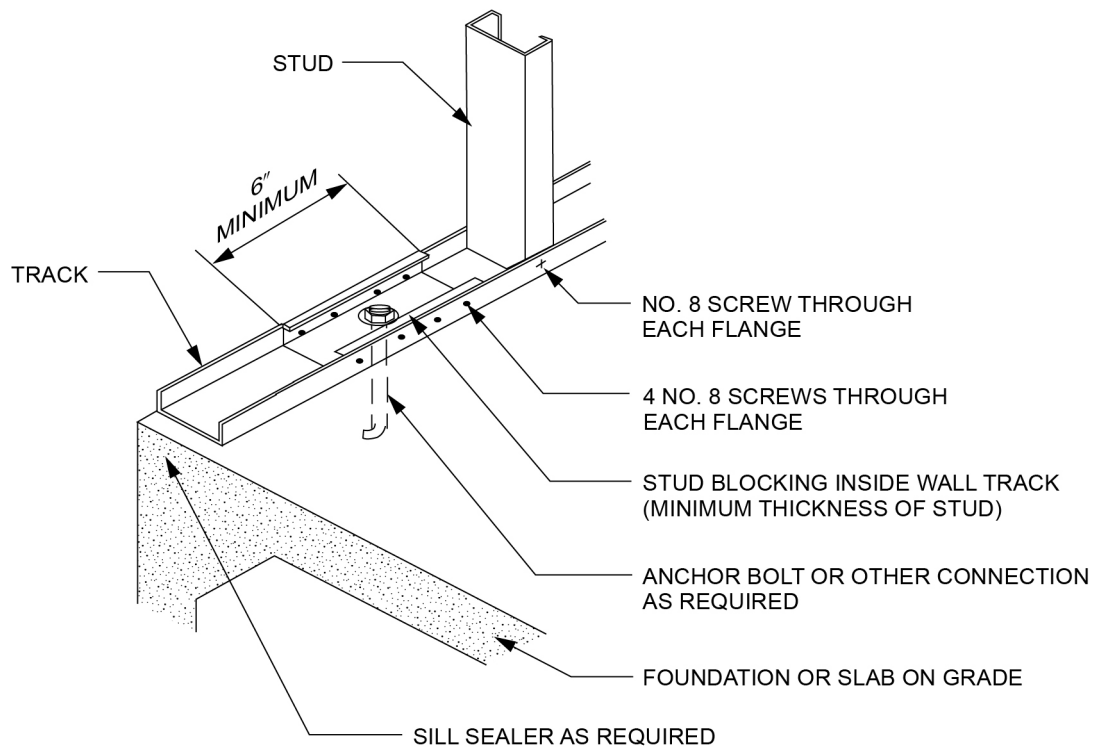
d. Foundation anchor straps are permitted in place of anchor bolts, if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.

e. See Figure R603.3.1(4) for details.

## WALL CONSTRUCTION



**FIGURE R603.3.1(1)**  
**WALL TO FLOOR CONNECTION**

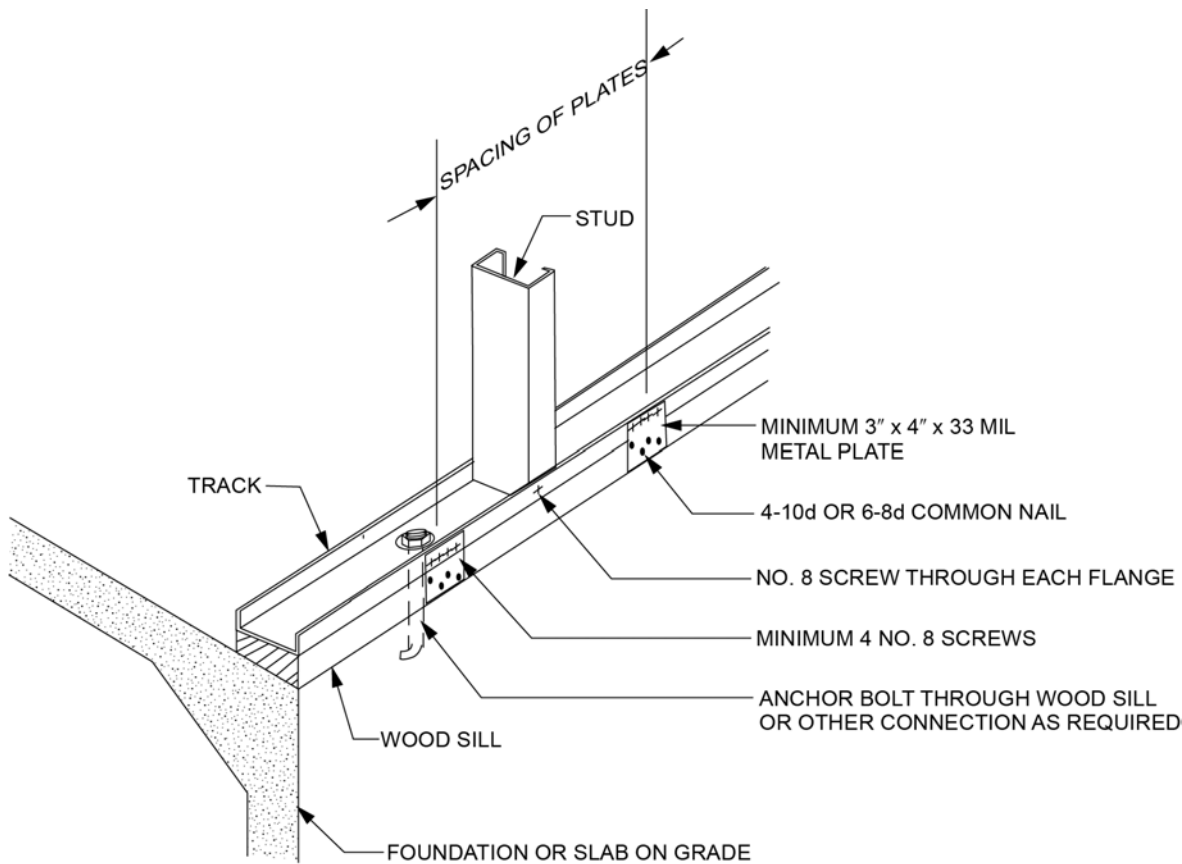


**FIGURE R603.3.1(2)**  
**WALL TO FOUNDATION CONNECTION**

For SI: 1 inch = 25.4 mm.

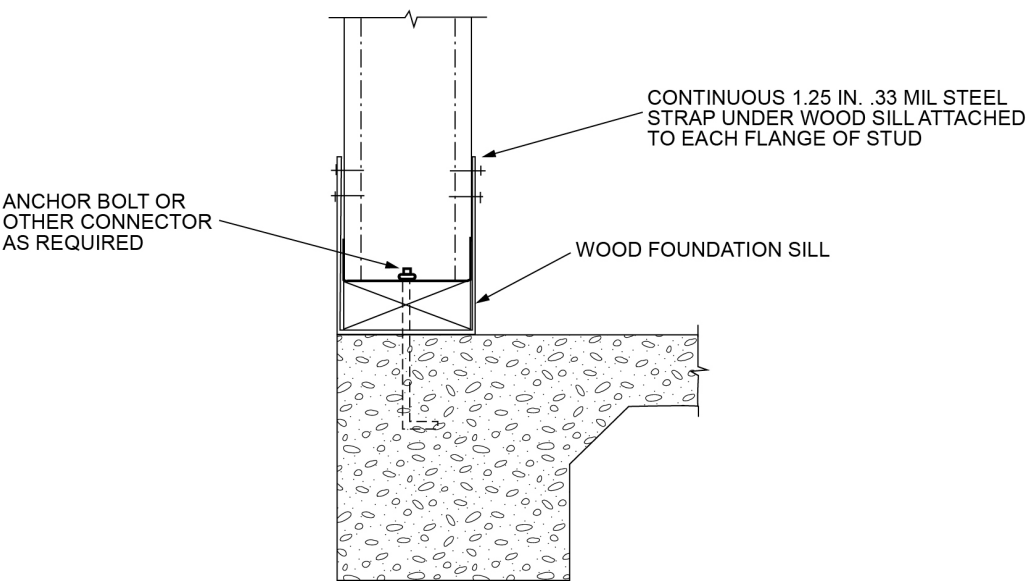


WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

FIGURE R603.3.1(3)  
WALL TO WOOD SILL CONNECTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm.

FIGURE R603.3.1(4)  
WIND UPLIFT CONNECTOR

## WALL CONSTRUCTION

**R603.3.1.1 Gable endwalls.** Gable endwalls with heights greater than 10 feet (3048 mm) shall be anchored to foundations or floors in accordance with Table R603.3.1.1(1) or R603.3.1.1(2).

**R603.3.2 Minimum stud sizes.** Cold-formed steel walls shall be constructed in accordance with Figure R603.3.1(1), R603.3.1(2) or R603.3.1(3), as applicable. Exterior wall stud size and thickness shall be determined in accordance with the limits set forth in Tables R603.3.2(2) through R603.3.2(16). Interior *load-bearing wall* stud size and thickness shall be determined in accordance with the limits set forth in Tables R603.3.2(2) through R603.3.2(16) based on an ultimate design wind speed of 115 miles per hour (51 m/s), Exposure Category B, and the building width, stud spacing and ground snow load, as appropriate. Fastening requirements shall be in accordance with Section R603.2.5 and Table R603.3.2(1). Top and bottom tracks shall have the same minimum thickness as the wall studs.

Exterior wall studs shall be permitted to be reduced to the next thinner size, as shown in Tables R603.3.2(2)

through R603.3.2(16), but not less than 33 mils (0.84 mm), where both of the following conditions exist:

1. Minimum of  $\frac{1}{2}$ -inch (12.7 mm) gypsum board is installed and fastened on the interior surface in accordance with Section R702.
2. Wood structural sheathing panels of minimum  $\frac{7}{16}$ -inch-thick (11.1 mm) oriented strand board or  $\frac{15}{32}$ -inch-thick (12 mm) plywood are installed and fastened in accordance with Section R603.9.1 and Table R603.3.2(1) on the outside surface.

Interior load-bearing walls shall be permitted to be reduced to the next thinner size, as shown in Tables R603.3.2(2) through R603.3.2(16), but not less than 33 mils (0.84 mm), where not less than  $\frac{1}{2}$ -inch (12.7 mm) gypsum board is installed and fastened in accordance with Section R702 on both sides of the wall. The tabulated stud thickness for *load-bearing walls* shall be used where the attic load is 10 pounds per square foot (480 Pa) or less. A limited attic storage load of 20 pounds per square foot (960 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(2) through R603.3.2(16).

**TABLE R603.3.1.1(1)**  
**GABLE ENDWALL TO FLOOR CONNECTION REQUIREMENTS<sup>a, b, c</sup>**

ULTIMATE WIND SPEED (mph)		WALL BOTTOM TRACK TO FLOOR JOIST OR TRACK CONNECTION		
Exposure Category		Stud height, <i>h</i> (feet)		
B	C	10 < <i>h</i> ≤ 14	14 < <i>h</i> ≤ 18	18 < <i>h</i> ≤ 22
115	—	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.
120	—	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.
130	115	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.	2-No. 8 screws @ 12" o.c.
< 140	120	1-No. 8 screw @ 12" o.c.	1-No. 8 screw @ 12" o.c.	2-No. 8 screws @ 12" o.c.
—	130	2-No. 8 screws @ 12" o.c.	1-No. 8 screw @ 8" o.c.	2-No. 8 screws @ 8" o.c.
—	< 140	2-No. 8 screws @ 12" o.c.	1-No. 8 screw @ 8" o.c.	2-No. 8 screws @ 8" o.c.

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.

a. Refer to Table R603.3.1.1(2) for gable endwall bottom track to foundation connections.

b. Where attachment is not given, special design is required.

c. Stud height, *h*, is measured from wall bottom track to wall top track or brace connection height.

**TABLE R603.3.1.1(2)**  
**GABLE ENDWALL BOTTOM TRACK TO FOUNDATION CONNECTION REQUIREMENTS<sup>a, b, c</sup>**

ULTIMATE WIND SPEED (mph)		MINIMUM SPACING FOR $\frac{1}{2}$ -INCH-DIAMETER ANCHOR BOLTS <sup>d</sup>		
Exposure Category		Stud height, <i>h</i> (feet)		
B	C	10 < <i>h</i> ≤ 14	14 < <i>h</i> ≤ 18	18 < <i>h</i> ≤ 22
115	—	6'- 0" o.c.	6'- 0" o.c.	6'- 0" o.c.
120	—	6'- 0" o.c.	5'- 7" o.c.	6'- 0" o.c.
130	115	5'- 0" o.c.	6'- 0" o.c.	6'- 0" o.c.
< 140	120	6'- 0" o.c.	5'- 6" o.c.	6'- 0" o.c.
—	130	5'- 3" o.c.	6'- 0" o.c.	6'- 0" o.c.
—	< 140	3'- 0" o.c.	3'- 0" o.c.	3'- 0" o.c.

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm.

a. Refer to Table R603.3.1.1(1) for gable endwall bottom track to floor joist or track connection connections.

b. Where attachment is not given, special design is required.

c. Stud height, *h*, is measured from wall bottom track to wall top track or brace connection height.

d. Foundation anchor straps are permitted in place of anchor bolts if spaced as required to provide equivalent anchorage to the required anchor bolts and installed in accordance with manufacturer's requirements.

## WALL CONSTRUCTION

For two-story buildings, the tabulated stud thickness for walls supporting one floor, roof and ceiling shall be used where the second-floor *live load* is 30 pounds per square foot (1440 Pa). Second-floor *live loads* of 40 psf (1920 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(2) through R603.3.2(11).

For three-story buildings, the tabulated stud thickness for walls supporting one or two floors, roof and ceiling shall be used where the third-floor *live load* is 30 pounds per square foot (1440 Pa). Third-floor *live loads* of 40 pounds per square foot (1920 Pa) shall be permitted provided that the next higher snow load column is used to select the stud size from Tables R603.3.2(12) through R603.3.2(16).

**TABLE R603.3.2(1)**  
**WALL FASTENING SCHEDULE<sup>a</sup>**

DESCRIPTION OF BUILDING ELEMENT	NUMBER AND SIZE OF FASTENERS <sup>a</sup>	SPACING OF FASTENERS
Wall stud to top or bottom track	2-No. 8 screws	Each end of stud, one per flange
Structural sheathing to wall studs	No. 8 screws <sup>b</sup>	6" o.c. on edges and 12" o.c. at intermediate supports
1/2" gypsum board to framing	No. 6 screws	12" o.c.

For SI: 1 inch = 25.4 mm.

a. All screw sizes shown are minimum.

b. Screws for attachment of structural sheathing panels are to be bugle-head, flat-head, or similar head styles with a minimum head diameter of 0.29 inch.

**TABLE R603.3.2(2)**  
**24-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	43	43	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	33	33	33	33	33	33	33	33	33	43
120	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	33	33	33	33	33	43
130	115	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	33	43
< 140	120	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	43	43	43	43	43	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	43	43	43	43	43
—	130	350S162	16	33	33	33	33	33	33	33	33	43	43	43	43	43
			24	43	43	43	43	54	54	54	54	54	54	54	54	54
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	43	43	43	43	43	43	43	43	43
—	< 140	350S162	16	33	33	33	33	43	43	43	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,

1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(3)**  
**28-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)													
				8-foot Studs				9-foot Studs				10-foot Studs					
				Ground Snow Load (psf)													
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70		
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	33	33	43	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	33	43	
120	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	43	43	43	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	33	33	33	43	33	33	33	33	43	
130	115	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43	
			24	33	33	43	54	43	43	43	54	43	43	43	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	33	33	33	43	33	33	33	33	43	
< 140	120	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43	
			24	33	33	43	54	43	43	43	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	33	33	33	43	43	43	43	43	43	
—	130	350S162	16	33	33	33	33	33	33	33	43	43	43	43	43	43	
			24	43	43	43	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	43	43	43	43	43	43	43	43	43	
—	< 140	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43	43	
			24	43	43	43	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(4)**  
**32-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	54	33	33	43	54	43	43	43	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	33	43
120	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43
			24	33	33	43	54	33	33	43	54	43	43	43	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	43	43	
130	115	350S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	33	33	43	54	43	43	43	54	43	43	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	33	43	33	33	43	43	
< 140	120	350S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	33	33	43	54	43	43	43	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	33	43	43	43	43	43	
—	130	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43	43
			24	43	43	43	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	43	43	43	43	43	43	43	43	43
—	< 140	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43	43
			24	43	43	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	43	43	43	43	43	43	43	43	43	43	43	43	43

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.



## WALL CONSTRUCTION

**TABLE R603.3.2(5)**  
**36-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	33	33	43	54	33	33	43	54	43	43	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43	
120	—	350S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	33	33	43	54	33	33	43	54	43	43	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	33	33	43	43	
130	115	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	33	43	43	54	43	43	43	54	43	43	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	33	33	43	43	
< 140	120	350S162	16	33	33	33	43	33	33	33	33	33	33	43	43	
			24	43	43	43	54	43	43	43	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	43	43	43	54	
—	130	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43	
			24	43	43	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	43	
			24	33	33	43	54	43	43	43	43	43	43	43	54	
—	< 140	350S162	16	33	33	33	43	43	43	43	43	43	43	43	54	
			24	43	43	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	43	
			24	43	43	43	54	43	43	43	43	43	43	43	54	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(6)**  
**40-FOOT-WIDE BUILDING SUPPORTING ROOF AND CEILING ONLY<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	33	33	43	54	33	43	43	54	43	43	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	33	33
			24	33	33	43	54	33	33	43	43	33	33	43	54	
120	—	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	33	43	43	54	33	43	43	54	43	43	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43	
			24	33	33	43	54	33	33	43	43	33	33	43	54	
130	115	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	43	43	54	54	43	43	54	54	43	54	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43	
			24	33	33	43	54	33	33	43	54	33	33	43	54	
< 140	120	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	43	43	54	54	43	43	54	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43	
			24	33	33	43	54	33	33	43	54	43	43	43	54	
—	130	350S162	16	33	33	43	43	33	33	43	43	43	43	43	54	
			24	43	43	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	33	33	43	54	43	43	43	54	43	43	43	54	
—	< 140	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54	
			24	43	43	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	43	43	43	54	43	43	43	54	43	43	43	54	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(7)**  
**24-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)													
				8-foot Studs				9-foot Studs				10-foot Studs					
				Ground Snow Load (psf)													
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70		
115	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43	
			24	33	33	43	43	43	43	43	43	43	43	43	43	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	33	43	33	33	33	43	33	33	33	33	43	
120	—	350S162	16	33	33	33	33	33	33	33	33	33	33	33	33	43	
			24	43	43	43	43	43	43	43	43	43	43	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	33	33	33	43	33	33	33	33	43	
130	115	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43	43	
			24	43	43	43	54	43	43	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	33	43	33	33	33	43	33	33	43	43		
< 140	120	350S162	16	33	33	33	43	33	33	43	43	43	43	43	43	43	
			24	43	43	43	54	43	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	33	43	43	43	43	43	43	
—	130	350S162	16	33	33	33	43	43	43	43	43	43	43	43	54		
			24	43	43	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	43	43	43	43	43	43	43	43	43	
—	< 140	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54		
			24	54	54	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33	
			24	43	43	43	43	43	43	43	43	43	43	43	43	43	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(8)**  
**28-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	43	43	43	54	43	43	43	54	43	43	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	33
			24	33	33	43	43	33	33	43	43	33	33	43	43	
120	—	350S162	16	33	33	33	43	33	33	33	43	33	33	43	43	
			24	43	43	43	54	43	43	43	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	33	33	43	43	
130	115	350S162	16	33	33	33	43	33	33	43	43	43	43	43	43	
			24	43	43	43	54	43	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	43	43	43	43	
< 140	120	350S162	16	33	33	33	43	43	43	43	43	43	43	43	43	
			24	43	43	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	33	
			24	33	33	43	43	33	33	43	43	43	43	43	43	
—	130	350S162	16	33	33	43	43	43	43	43	43	43	43	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	43	
			24	33	33	43	43	43	43	43	43	43	43	43	43	
—	< 140	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	33	33	33	33	33	33	33	33	43	
			24	43	43	43	43	43	43	43	43	43	43	43	54	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(9)**  
**32-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	33	43	33	33	33	43	33	43	43	43	
			24	43	43	43	54	43	43	43	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	33	43
			24	33	43	43	54	33	33	43	43	33	33	43	43	
120	—	350S162	16	33	33	33	43	33	33	33	43	43	43	43	43	
			24	43	43	43	54	43	43	43	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43	
			24	33	43	43	54	33	33	43	43	33	33	43	54	
130	115	350S162	16	33	33	43	43	43	43	43	43	43	43	43	43	
			24	43	43	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	33	33	33	33	43	
			24	33	43	43	54	33	33	43	43	43	43	43	54	
< 140	120	350S162	16	33	33	43	43	43	43	43	43	43	43	43	54	
			24	43	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	33	43	43	54	33	43	43	43	43	43	43	54	
—	130	350S162	16	43	43	43	43	43	43	43	43	43	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	43	43	43	54	43	43	43	54	43	43	43	54	
—	< 140	350S162	16	43	43	43	43	43	43	43	54	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	43	43	43	54	43	43	43	54	43	43	43	54	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.



## WALL CONSTRUCTION

**TABLE R603.3.2(10)**  
**36-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	43	43	33	33	43	43	43	43	43	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	43	54
120	—	350S162	16	33	33	43	43	33	33	43	43	43	43	43	43	43
			24	43	43	54	54	43	43	54	54	54	54	54	54	54
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	43	54
130	115	350S162	16	33	33	43	43	43	43	43	43	43	43	43	43	54
			24	43	54	54	54	54	54	54	54	54	54	54	68	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	43	54
< 140	120	350S162	16	43	43	43	43	43	43	43	43	43	43	43	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	43	54
—	130	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	33	43
			24	43	43	43	54	43	43	43	54	43	43	43	43	54
—	< 140	350S162	16	43	43	43	54	43	43	54	54	54	54	54	54	54
			24	54	54	54	54	54	54	54	54	54	54	54	68	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	43
			24	43	43	43	54	43	43	43	54	43	43	43	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(11)**  
**40-FOOT-WIDE BUILDING SUPPORTING ONE FLOOR, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	33	33	43	43	33	33	43	43	43	43	43	43	54
			24	43	43	54	54	43	43	54	54	54	54	54	68	
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	43	43	54	54	43	43	43	54	43	43	43	54	
120	—	350S162	16	33	33	43	43	33	33	43	43	43	43	43	54	
			24	43	43	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	33	43	33	33	33	43	33	33	33	43	
			24	43	43	54	54	43	43	43	54	43	43	43	54	
130	115	350S162	16	43	43	43	54	43	43	43	43	43	43	54	54	
			24	54	54	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	43	43	33	33	33	43	33	33	43	43	
			24	43	43	54	54	43	43	43	54	43	43	54	54	
< 140	120	350S162	16	43	43	43	54	43	43	43	54	43	43	54	54	
			24	54	54	54	54	54	54	54	54	54	54	68		
		550S162	16	33	33	43	43	33	33	33	43	33	33	43	43	
			24	43	43	54	54	43	43	43	54	43	43	54	54	
—	130	350S162	16	43	43	43	54	43	43	43	54	54	54	54	54	
			24	54	54	54	68	54	54	54	54	54	54	68	68	
		550S162	16	33	33	43	43	33	33	33	43	33	33	43	43	
			24	43	43	54	54	43	43	43	54	43	43	54	54	
—	< 140	350S162	16	43	43	43	54	43	43	54	54	54	54	54	54	
			24	54	54	54	68	54	54	54	68	54	54	68	68	
		550S162	16	33	33	43	43	33	33	43	43	33	43	43	43	
			24	43	43	54	54	43	43	43	54	43	43	54	54	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Second-floor dead load is 10 psf.

Second-floor live load is 30 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(12)**  
**24-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	43	43	43	43	33	33	33	43	43	43	43	43	
			24	54	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	
			24	43	43	54	54	43	43	43	43	43	43	43	54	
120	—	350S162	16	43	43	43	43	33	33	43	43	43	43	43	43	
			24	54	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	
			24	43	43	54	54	43	43	43	43	43	43	43	54	
130	115	350S162	16	43	43	43	43	43	43	43	43	43	43	43	54	
			24	54	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	
			24	43	43	54	54	43	43	43	43	43	43	43	54	
< 140	120	350S162	16	43	43	43	43	43	43	43	43	43	43	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54		
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	
			24	43	43	54	54	43	43	43	43	43	43	43	54	
—	130	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	68	68	
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	
			24	43	43	54	54	43	43	43	43	43	43	43	54	
—	< 140	350S162	16	43	43	43	43	43	43	54	54	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	68	68	
		550S162	16	33	33	43	43	33	33	33	33	33	33	33	43	43
			24	43	43	54	54	43	43	43	43	43	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Top- and middle-floor dead load is 10 psf.

Top-floor live load is 30 psf.

Middle-floor live load is 40 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(13)**  
**28-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)													
				8-foot Studs				9-foot Studs				10-foot Studs					
				Ground Snow Load (psf)													
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70		
115	—	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
120	—	350S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
130	115	350S162	16	43	43	43	43	43	43	43	43	43	43	43	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54	54	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
< 140	120	350S162	16	43	43	43	43	43	43	43	43	43	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	54	54	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
—	130	350S162	16	43	43	43	43	43	43	43	43	54	54	54	54	54	
			24	54	54	54	54	54	54	54	54	54	68	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
—	< 140	350S162	16	43	43	43	54	54	54	54	54	54	54	54	54	54	
			24	54	54	54	54	54	54	54	54	68	68	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Top- and middle-floor dead load is 10 psf.

Top-floor live load is 30 psf.

Middle-floor live load is 40 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(14)**  
**32-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)													
				8-foot Studs				9-foot Studs				10-foot Studs					
				Ground Snow Load (psf)													
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70		
115	—	350S162	16	43	43	43	54	43	43	43	43	43	43	43	43	54	
			24	54	54	54	68	54	54	54	54	54	54	54	54	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
120	—	350S162	16	43	43	43	54	43	43	43	43	43	43	43	43	54	
			24	54	54	54	68	54	54	54	54	54	54	54	54	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
130	115	350S162	16	43	43	43	54	43	43	43	43	43	54	54	54	54	
			24	54	54	54	68	54	54	54	54	54	54	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
< 140	120	350S162	16	43	43	43	54	43	43	43	43	54	54	54	54	54	
			24	54	54	54	68	54	54	54	54	54	68	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
—	130	350S162	16	43	43	43	54	43	54	54	54	54	54	54	54	54	
			24	54	54	54	68	54	54	54	68	68	68	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54
—	< 140	350S162	16	43	43	54	54	54	54	54	54	54	54	54	54	54	
			24	54	54	54	68	54	68	68	68	68	68	68	68	68	
		550S162	16	43	43	43	43	43	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Top- and middle-floor dead load is 10 psf.

Top-floor live load is 30 psf.

Middle-floor live load is 40 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.



## WALL CONSTRUCTION

**TABLE R603.3.2(15)**  
**36-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54	
			24	68	68	68	68	54	54	54	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54
120	—	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54	
			24	68	68	68	68	54	54	54	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54
130	115	350S162	16	54	54	54	54	43	43	43	54	54	54	54	54	
			24	68	68	68	68	54	54	54	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54
< 140	120	350S162	16	54	54	54	54	43	43	54	54	54	54	54	54	
			24	68	68	68	68	54	54	54	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54
—	130	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	
			24	68	68	68	68	54	54	68	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54
—	< 140	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	
			24	68	68	68	68	68	68	68	68	68	68	68	68	
		550S162	16	43	43	43	54	43	43	43	43	43	43	43	43	43
			24	54	54	54	54	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Top- and middle-floor dead load is 10 psf.

Top-floor live load is 30 psf.

Middle-floor live load is 40 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.3.2(16)**  
**40-FOOT-WIDE BUILDING SUPPORTING TWO FLOORS, ROOF AND CEILING<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)												
				8-foot Studs				9-foot Studs				10-foot Studs				
				Ground Snow Load (psf)												
Exp. B	Exp. C			20	30	50	70	20	30	50	70	20	30	50	70	
115	—	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54
120	—	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54
130	115	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54
< 140	120	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54
—	130	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54
—	< 140	350S162	16	54	54	54	54	54	54	54	54	54	54	54	54	54
			24	68	68	68	68	68	68	68	68	68	68	68	68	68
		550S162	16	54	54	54	54	43	43	54	54	43	43	54	54	54
			24	54	54	54	68	54	54	54	54	54	54	54	54	54

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion:  $L/240$ .

b. Design load assumptions:

Top- and middle-floor dead load is 10 psf.

Top-floor live load is 30 psf.

Middle-floor live load is 40 psf.

Roof/ceiling dead load is 12 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**R603.3.2.1 Gable endwalls.** The size and thickness of gable endwall studs with heights less than or equal to 10 feet (3048 mm) shall be permitted in accordance with the limits set forth in Table R603.3.2.1(1). The size and thickness of gable endwall studs with heights greater than 10 feet (3048 mm) shall be determined in accordance with the limits set forth in Table R603.3.2.1(2).

**R603.3.3 Stud bracing.** The flanges of cold-formed steel studs shall be laterally braced in accordance with one of the following:

1. Gypsum board on both sides, structural sheathing on both sides, or gypsum board on one side and

structural sheathing on the other side of *load-bearing walls* with gypsum board installed with minimum No. 6 screws in accordance with Section R702 and structural sheathing installed in accordance with Section R603.9 and Table R603.3.2(1).

2. Horizontal steel straps fastened in accordance with Figure R603.3.3(1) on both sides at mid-height for 8-foot (2438 mm) walls, and at one-third points for 9-foot and 10-foot (2743 mm and 3048 mm) walls. Horizontal steel straps shall be not less than 1½ inches in width and 33 mils in thickness (38 mm by 0.84 mm). Straps shall be

**TABLE R603.3.2.1(1)**  
**ALL BUILDING WIDTHS GABLE ENDWALLS 8, 9 OR 10 FEET IN HEIGHT<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)		
Exp. B	Exp. C			8-foot Studs	9-foot Studs	10-foot Studs
115	—	350S162	16	33	33	33
			24	33	33	33
		550S162	16	33	33	33
			24	33	33	33
120	—	350S162	16	33	33	33
			24	33	33	43
		550S162	16	33	33	33
			24	33	33	33
130	115	350S162	16	33	33	33
			24	33	43	43
		550S162	16	33	33	33
			24	33	33	33
< 140	120	350S162	16	33	33	43
			24	33	43	54
		550S162	16	33	33	33
			24	33	33	33
—	130	350S162	16	33	33	43
			24	43	43	54
		550S162	16	33	33	33
			24	33	43	43
—	< 140	350S162	16	33	43	43
			24	43	54	54
		550S162	16	33	33	33
			24	43	43	43

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion  $L/240$ .

b. Design load assumptions:

Ground snow load is 70 psf.

Roof/ceiling dead load is 12 psf.

Floor dead load is 10 psf.

Floor live load is 40 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

attached to the flanges of studs with one No. 8 screw. In-line blocking shall be installed between studs at the termination of straps and at 12-foot (3658 mm) intervals along the strap. Straps shall be fastened to the blocking with two No. 8 screws.

3. Sheathing on one side and strapping on the other side fastened in accordance with Figure R603.3.3(2). Sheathing shall be installed in accordance with Item 1. Steel straps shall be installed in accordance with Item 2.

**R603.3.4 Cutting and notching.** Flanges and lips of cold-formed steel studs and headers shall not be cut or notched.

**R603.3.5 Splicing.** Steel studs and other structural members shall not be spliced without an *approved* design. Tracks shall be spliced in accordance with Figure R603.3.5.

**R603.4 Corner framing.** In exterior walls, corner studs and the top tracks shall be installed in accordance with Figure R603.4.

**TABLE R603.3.2.1(2)**  
**ALL BUILDING WIDTHS GABLE ENDWALLS OVER 10 FEET IN HEIGHT<sup>a, b, c, d</sup>**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		MEMBER SIZE	STUD SPACING (inches)	MINIMUM STUD THICKNESS (mils)					
				Stud Height, <i>h</i> (feet)					
				10 < <i>h</i> ≤ 12	12 < <i>h</i> ≤ 14	14 < <i>h</i> ≤ 16	16 < <i>h</i> ≤ 18	18 < <i>h</i> ≤ 20	20 < <i>h</i> ≤ 22
115	—	350S162	16	33	43	68	97	—	—
			24	43	68	—	—	—	—
		550S162	16	33	33	33	43	43	54
			24	33	43	43	54	68	97
120	—	350S162	16	43	54	97	—	—	—
			24	54	97	—	—	—	—
		550S162	16	33	33	43	43	54	68
			24	33	43	54	54	68	97
130	115	350S162	16	43	54	97	—	—	—
			24	54	97	—	—	—	—
		550S162	16	33	33	43	54	54	97
			24	43	43	54	68	97	97
< 140	120	350S162	16	43	68	—	—	—	—
			24	68	—	—	—	—	—
		550S162	16	33	43	43	54	68	97
			24	43	54	54	68	97	—
—	130	350S162	16	54	97	—	—	—	—
			24	97	—	—	—	—	—
		550S162	16	33	43	54	68	97	—
			24	43	54	54	97	—	—
—	< 140	350S162	16	54	97	—	—	—	—
			24	97	—	—	—	—	—
		550S162	16	43	43	54	97	97	—
			24	54	54	68	—	—	—

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criterion  $L/240$ .

b. Design load assumptions:

Ground snow load is 70 psf.

Roof/ceiling dead load is 12 psf.

Floor dead load is 10 psf.

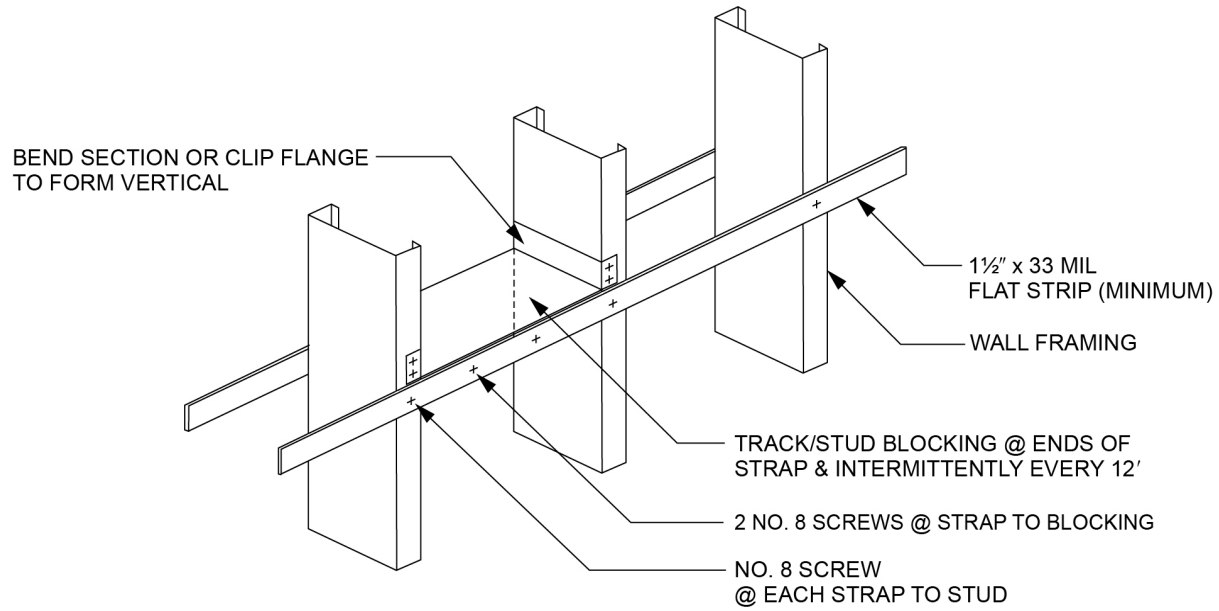
Floor live load is 40 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the wall studs.

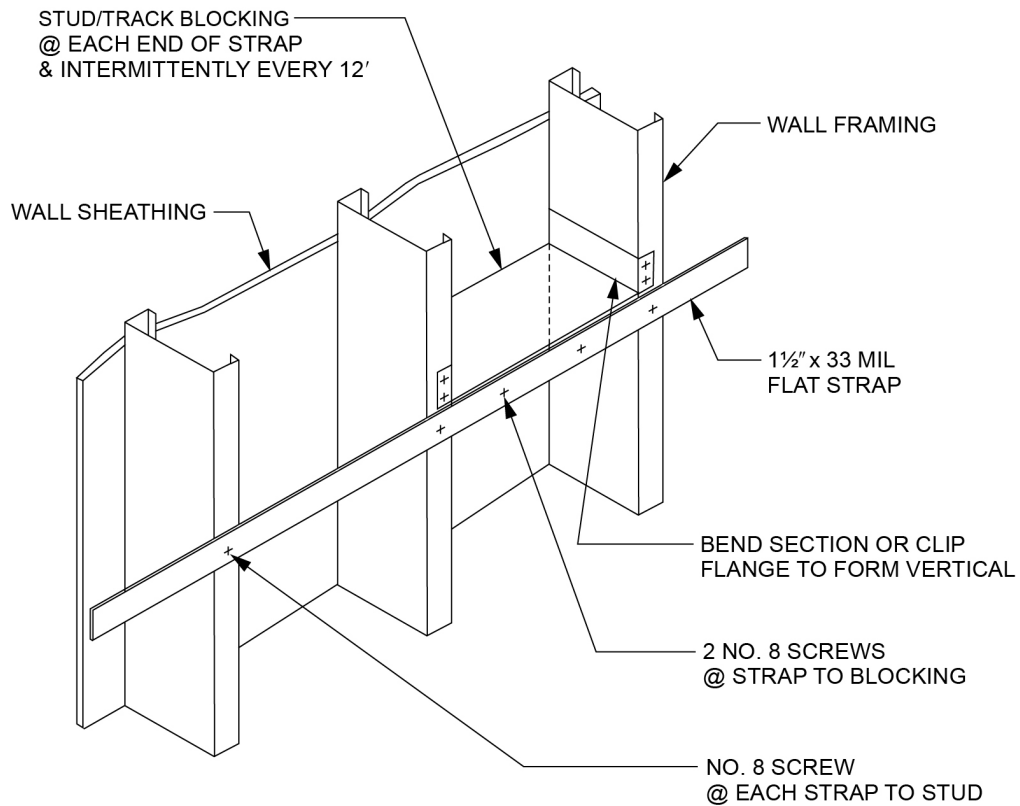
d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R603.3.3(1)**  
**STUD BRACING WITH STRAPPING ONLY**



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm.

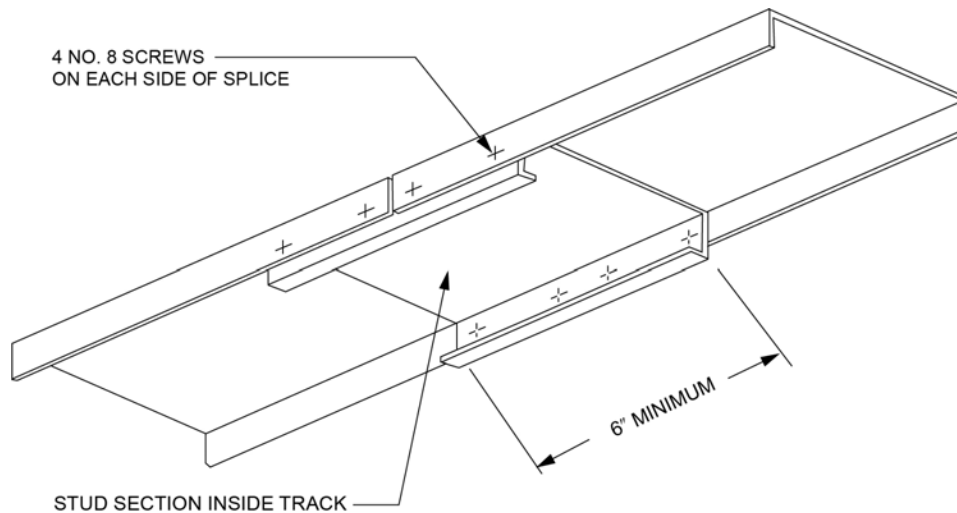
**FIGURE R603.3.3(2)**  
**STUD BRACING WITH STRAPPING AND SHEATHING MATERIAL**



## WALL CONSTRUCTION

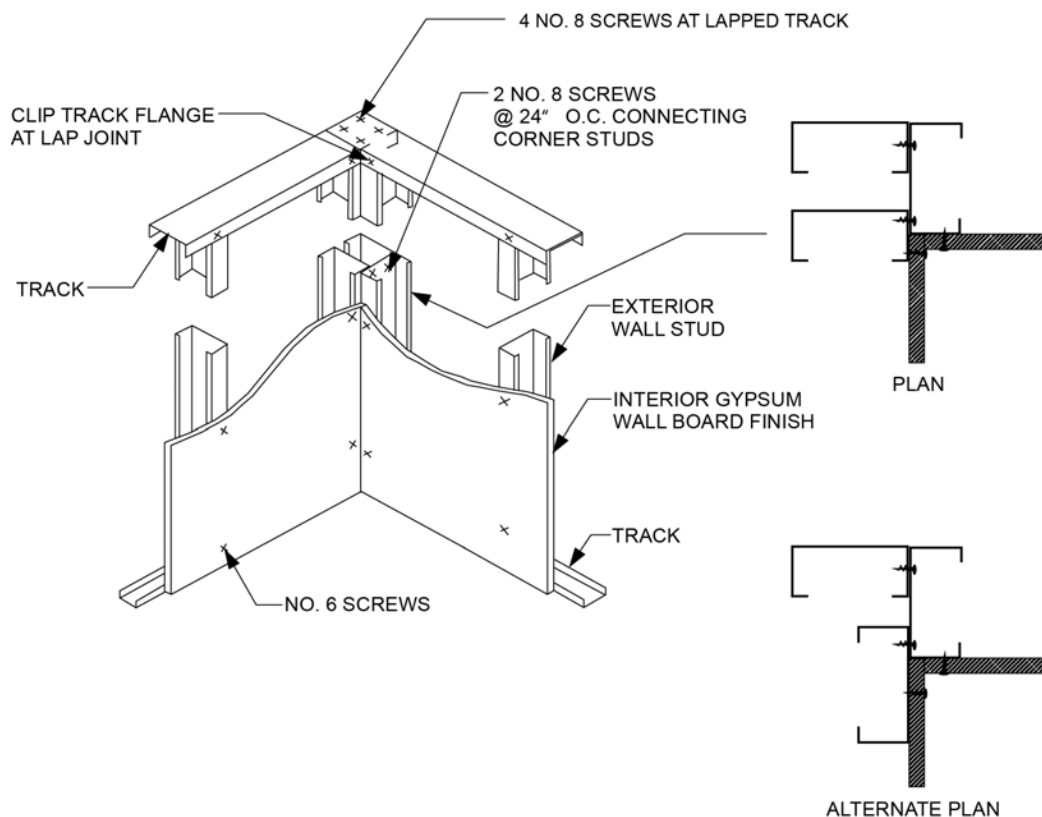
**R603.5 Exterior wall covering.** The method of attachment of exterior wall covering materials to cold-formed steel stud wall framing shall conform to the manufacturer's installation instructions.

**R603.6 Headers.** Headers shall be installed above all wall openings in exterior walls and interior *load-bearing walls*. Box beam headers and back-to-back headers each shall be



For SI: 1 inch = 25.4 mm.

**FIGURE R603.3.5  
TRACK SPLICE**



For SI: 1 inch = 25.4 mm.

**FIGURE R603.4  
CORNER FRAMING**

## WALL CONSTRUCTION

formed from two equal sized C-shaped members in accordance with Figures R603.6(1) and R603.6(2), respectively, and Tables R603.6(1) through R603.6(6). L-shaped headers shall be permitted to be constructed in accordance with AISI S230. Alternately, headers shall be permitted to be designed and constructed in accordance with AISI S240.

**R603.6.1 Headers in gable endwalls.** Box beam and back-to-back headers in gable endwalls shall be permitted to be constructed in accordance with Section R603.6 or with the header directly above the opening in accordance with Figures R603.6.1(1) and R603.6.1(2) and the following provisions:

1. Two 362S162-33 for openings less than or equal to 4 feet (1219 mm).
2. Two 600S162-43 for openings greater than 4 feet (1219 mm) but less than or equal to 6 feet (1829 mm).
3. Two 800S162-54 for openings greater than 6 feet (1829 mm) but less than or equal to 9 feet (2743 mm).

**R603.7 Jack and king studs.** The number of jack and king studs installed on each side of a header shall comply with

Table R603.7(1). King, jack and cripple studs shall be of the same dimension and thickness as the adjacent wall studs. Headers shall be connected to king studs in accordance with Table R603.7(2) and the following provisions:

1. For box beam headers, one-half of the total number of required screws shall be applied to the header and one-half to the king stud by use of C-shaped or track member in accordance with Figure R603.6(1). The track or C-shaped sections shall extend the depth of the header minus  $\frac{1}{2}$  inch (12.7 mm) and shall have a minimum thickness not less than that of the wall studs.
2. For back-to-back headers, one-half the total number of screws shall be applied to the header and one-half to the king stud by use of a minimum 2-inch by 2-inch (51 mm by 51 mm) clip angle in accordance with Figure R603.6(2). The clip angle shall extend the depth of the header minus  $\frac{1}{2}$  inch (12.7 mm) and shall have a minimum thickness not less than that of the wall studs. Jack and king studs shall be interconnected with structural sheathing in accordance with Figures R603.6(1) and R603.6(2).

**TABLE R603.6(1)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
Headers Supporting Roof and Ceiling Only<sup>a, b, d</sup>

MEMBER DESIGNATION	GROUND SNOW LOAD (20 psf)					GROUND SNOW LOAD (30 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	3'-3"	2'-8"	2'-2"	—	—	2'-8"	2'-2"	—	—	—
2-350S162-43	4'-2"	3'-9"	3'-4"	2'-11"	2'-7"	3'-9"	3'-4"	2'-11"	2'-7"	2'-2"
2-350S162-54	6'-2"	5'-10"	5'-8"	5'-3"	4'-10"	5'-11"	5'-8"	5'-2"	4'-10"	4'-6"
2-350S162-68	6'-7"	6'-3"	6'-0"	5'-10"	5'-8"	6'-4"	6'-1"	5'-10"	5'-8"	5'-6"
2-550S162-33	4'-8"	4'-0"	3'-6"	3'-0"	2'-6"	4'-1"	3'-6"	3'-0"	2'-6"	—
2-550S162-43	6'-0"	5'-4"	4'-10"	4'-4"	3'-11"	5'-5"	4'-10"	4'-4"	3'-10"	3'-5"
2-550S162-54	8'-9"	8'-5"	8'-1"	7'-9"	7'-3"	8'-6"	8'-1"	7'-8"	7'-2"	6'-8"
2-550S162-68	9'-5"	9'-0"	8'-8"	8'-4"	8'-1"	9'-1"	8'-8"	8'-4"	8'-1"	7'-10"
2-800S162-33	4'-5"	3'-11"	3'-5"	3'-1"	2'-10"	3'-11"	3'-6"	3'-1"	2'-9"	2'-3"
2-800S162-43	7'-3"	6'-7"	5'-11"	5'-4"	4'-10"	6'-7"	5'-11"	5'-4"	4'-9"	4'-3"
2-800S162-54	10'-10"	10'-2"	9'-7"	9'-0"	8'-5"	10'-2"	9'-7"	8'-11"	8'-4"	7'-9"
2-800S162-68	12'-8"	11'-10"	11'-2"	10'-7"	10'-1"	11'-11"	11'-2"	10'-7"	10'-0"	9'-6"
2-1000S162-43	7'-10"	6'-10"	6'-1"	5'-6"	5'-0"	6'-11"	6'-1"	5'-5"	4'-11"	4'-6"
2-1000S162-54	12'-3"	11'-5"	10'-9"	10'-2"	9'-6"	11'-6"	10'-9"	10'-1"	9'-5"	8'-9"
2-1000S162-68	14'-5"	13'-5"	12'-8"	12'-0"	11'-6"	13'-6"	12'-8"	12'-0"	11'-5"	10'-10"
2-1200S162-54	12'-11"	11'-3"	10'-0"	9'-0"	8'-2"	11'-5"	10'-0"	9'-0"	8'-1"	7'-4"
2-1200S162-68	15'-11"	14'-10"	14'-0"	13'-4"	12'-8"	15'-0"	14'-0"	13'-3"	12'-7"	11'-11"

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Roof/ceiling dead load is 12 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the header.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.6(2)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
**Headers Supporting Roof and Ceiling Only<sup>a, b, d</sup>**

MEMBER DESIGNATION	GROUND SNOW LOAD (50 psf)					GROUND SNOW LOAD (70 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	—	—	—	—	—	—	—	—	—	—
2-350S162-43	2'-4"	—	—	—	—	—	—	—	—	—
2-350S162-54	4'-8"	4'-2"	3'-9"	3'-5"	3'-1"	3'-7"	3'-2"	2'-9"	2'-5"	2'-0"
2-350S162-68	5'-7"	5'-2"	4'-9"	4'-4"	3'-11"	4'-7"	4'-1"	3'-7"	3'-2"	2'-10"
2-550S162-33	2'-2"	—	—	—	—	—	—	—	—	—
2-550S162-43	3'-8"	3'-1"	2'-6"	—	—	2'-3"	—	—	—	—
2-550S162-54	6'-11"	6'-3"	5'-9"	5'-3"	4'-9"	5'-6"	4'-11"	4'-5"	3'-11"	3'-5"
2-550S162-68	8'-0"	7'-6"	6'-11"	6'-5"	5'-11"	6'-9"	6'-1"	5'-6"	5'-0"	4'-7"
2-800S162-33	2'-7"	—	—	—	—	—	—	—	—	—
2-800S162-43	4'-6"	3'-9"	3'-1"	2'-5"	—	2'-10"	—	—	—	—
2-800S162-54	8'-0"	7'-3"	6'-8"	6'-1"	5'-7"	6'-5"	5'-9"	5'-1"	4'-7"	4'-0"
2-800S162-68	9'-9"	9'-0"	8'-3"	7'-8"	7'-1"	8'-0"	7'-3"	6'-7"	6'-0"	5'-6"
2-1000S162-43	4'-8"	4'-1"	3'-6"	2'-9"	—	3'-3"	2'-2"	—	—	—
2-1000S162-54	9'-1"	8'-2"	7'-3"	6'-7"	6'-0"	7'-0"	6'-2"	5'-6"	5'-0"	4'-6"
2-1000S162-68	11'-1"	10'-2"	9'-5"	8'-8"	8'-1"	9'-1"	8'-3"	7'-6"	6'-10"	6'-3"
2-1200S162-54	7'-8"	6'-9"	6'-1"	5'-6"	5'-0"	5'-10"	5'-1"	4'-7"	4'-1"	3'-9"
2-1200S162-68	12'-3"	11'-3"	10'-4"	9'-7"	8'-11"	10'-1"	9'-1"	8'-3"	7'-6"	6'-10"

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Roof/ceiling dead load is 12 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the header.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.6(3)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
**Headers Supporting One Floor, Roof and Ceiling<sup>a, b, d</sup>**

MEMBER DESIGNATION	GROUND SNOW LOAD (20 psf)					GROUND SNOW LOAD (30 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	—	—	—	—	—	—	—	—	—	—
2-350S162-43	2'-2"	—	—	—	—	2'-1"	—	—	—	—
2-350S162-54	4'-4"	3'-10"	3'-5"	3'-1"	2'-9"	4'-3"	2'-9"	3'-4"	3'-0"	2'-8"
2-350S162-68	5'-0"	4'-9"	4'-7"	4'-2"	3'-9"	4'-11"	4'-8"	4'-6"	4'-1"	3'-9"
2-550S162-33	—	—	—	—	—	—	—	—	—	—
2-550S162-43	3'-5"	2'-9"	2'-1"	—	—	3'-3"	2'-7"	—	—	—
2-550S162-54	6'-6"	5'-10"	5'-3"	4'-9"	4'-4"	6'-4"	5'-9"	5'-2"	4'-8"	4'-3"
2-550S162-68	7'-2"	6'-10"	6'-5"	5'-11"	5'-6"	7'-0"	6'-9"	6'-4"	5'-10"	5'-4"
2-800S162-33	2'-1"	—	—	—	—	—	—	—	—	—
2-800S162-43	4'-2"	3'-4"	2'-7"	—	—	4'-0"	3'-3"	2'-5"	—	—
2-800S162-54	7'-6"	6'-9"	6'-2"	5'-7"	5'-0"	7'-5"	6'-8"	6'-0"	5'-5"	4'-11"
2-800S162-68	9'-3"	8'-5"	7'-8"	7'-1"	6'-6"	9'-1"	8'-3"	7'-7"	7'-0"	6'-5"
2-1000S162-43	4'-4"	3'-9"	2'-11"	—	—	4'-3"	3'-8"	2'-9"	—	—
2-1000S162-54	8'-6"	7'-6"	6'-8"	6'-0"	5'-5"	8'-4"	7'-4"	6'-6"	5'-10"	5'-4"
2-1000S162-68	10'-6"	9'-7"	8'-9"	8'-0"	7'-5"	10'-4"	9'-5"	8'-7"	7'-11"	7'-3"
2-1200S162-54	7'-1"	6'-2"	5'-6"	5'-0"	4'-6"	6'-11"	6'-1"	5'-5"	4'-10"	4'-5"
2-1200S162-68	11'-7"	10'-7"	9'-8"	8'-11"	8'-2"	11'-5"	10'-5"	9'-6"	8'-9"	8'-0"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Second-floor dead load is 10 psf.

Roof/ceiling dead load is 12 psf.

Second-floor live load is 30 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the header.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.6(4)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
**Headers Supporting One Floor, Roof and Ceiling<sup>a, b, d</sup>**

MEMBER DESIGNATION	GROUND SNOW LOAD (50 psf)					GROUND SNOW LOAD (70 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	—	—	—	—	—	—	—	—	—	—
2-350S162-43	—	—	—	—	—	—	—	—	—	—
2-350S162-54	3'-5"	3'-0"	2'-7"	2'-2"	—	2'-8"	2'-2"	—	—	—
2-350S162-68	4'-6"	4'-1"	3'-8"	3'-3"	2'-11"	3'-9"	3'-3"	2'-10"	2'-5"	2'-1"
2-550S162-33	—	—	—	—	—	—	—	—	—	—
2-550S162-43	2'-0"	—	—	—	—	—	—	—	—	—
2-550S162-54	5'-3"	3'-8"	4'-1"	3'-8"	3'-2"	4'-3"	3'-8"	3'-1"	2'-7"	2'-0"
2-550S162-68	6'-5"	5'-10"	5'-3"	4'-9"	4'-4"	5'-5"	4'-9"	4'-3"	3'-9"	3'-4"
2-800S162-33	—	—	—	—	—	—	—	—	—	—
2-800S162-43	2'-6"	—	—	—	—	—	—	—	—	—
2-800S162-54	6'-1"	5'-5"	4'-10"	4'-3"	3'-9"	4'-11"	4'-3"	3'-8"	3'-0"	2'-5"
2-800S162-68	7'-8"	6'-11"	6'-3"	5'-9"	5'-2"	6'-5"	5'-9"	5'-1"	4'-6"	4'-0"
2-1000S162-43	2'-10"	—	—	—	—	—	—	—	—	—
2-1000S162-54	6'-7"	5'-10"	5'-3"	4'-9"	4'-3"	5'-4"	4'-9"	4'-1"	3'-5"	2'-9"
2-1000S162-68	8'-8"	7'-10"	7'-2"	6'-6"	5'-11"	7'-4"	6'-6"	5'-9"	5'-1"	4'-6"
2-1200S162-54	5'-6"	4'-10"	4'-4"	3'-11"	3'-7"	4'-5"	3'-11"	3'-6"	3'-2"	2'-11"
2-1200S162-68	9'-7"	8'-8"	7'-11"	7'-2"	6'-6"	8'-1"	7'-2"	6'-4"	5'-8"	5'-0"

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Second-floor dead load is 10 psf.

Roof/ceiling dead load is 12 psf.

Second-floor live load is 30 psf.

Attic dead load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the header.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.



## WALL CONSTRUCTION

**TABLE R603.6(5)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
**Headers Supporting Two Floors, Roof and Ceiling<sup>a, b, d</sup>**

MEMBER DESIGNATION	GROUND SNOW LOAD (20 psf)					GROUND SNOW LOAD (30 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	—	—	—	—	—	—	—	—	—	—
2-350S162-43	—	—	—	—	—	—	—	—	—	—
2-350S162-54	2'-5"	—	—	—	—	2'-4"	—	—	—	—
2-350S162-68	3'-6"	3'-0"	2'-6"	2'-1"	—	3'-5"	2'-11"	2'-6"	2'-0"	—
2-550S162-33	—	—	—	—	—	—	—	—	—	—
2-550S162-43	—	—	—	—	—	—	—	—	—	—
2-550S162-54	3'-11"	3'-3"	2'-8"	2'-0"	—	3'-10"	3'-3"	2'-7"	—	—
2-550S162-68	5'-1"	4'-5"	3'-10"	3'-3"	2'-9"	5'-0"	4'-4"	3'-9"	3'-3"	2'-9"
2-800S162-33	—	—	—	—	—	—	—	—	—	—
2-800S162-43	—	—	—	—	—	—	—	—	—	—
2-800S162-54	4'-7"	3'-10"	3'-1"	2'-5"	—	4'-6"	3'-9"	3'-0"	2'-4"	—
2-800S162-68	6'-0"	5'-3"	4'-7"	3'-11"	3'-4"	6'-0"	5'-2"	4'-6"	3'-11"	3'-3"
2-1000S162-43	—	—	—	—	—	—	—	—	—	—
2-1000S162-54	5'-0"	4'-4"	3'-6"	2'-9"	—	4'-11"	4'-3"	3'-5"	2'-7"	—
2-1000S162-68	6'-10"	6'-0"	5'-3"	4'-6"	3'-10"	6'-9"	5'-11"	5'-2"	4'-5"	3'-9"
2-1200S162-54	4'-2"	3'-7"	3'-3"	2'-11"	—	4'-1"	3'-7"	3'-2"	2'-10"	—
2-1200S162-68	7'-7"	6'-7"	5'-9"	5'-0"	4'-2"	7'-6"	6'-6"	5'-8"	4'-10"	4'-1"

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa, 1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Second-floor dead load is 10 psf.

Roof/ceiling dead load is 12 psf.

Second-floor live load is 40 psf.

Third floor live load is 30 psf.

Attic live load is 10 psf.

c. Building width is in the direction of horizontal framing members supported by the header.

d. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

## WALL CONSTRUCTION

**TABLE R603.6(6)**  
**BOX-BEAM AND BACK-TO-BACK HEADER SPANS**  
**Headers Supporting Two Floors, Roof and Ceiling<sup>a, b, d</sup>**

MEMBER DESIGNATION	GROUND SNOW LOAD (50 psf)					GROUND SNOW LOAD (70 psf)				
	Building width <sup>c</sup> (feet)					Building width <sup>c</sup> (feet)				
	24	28	32	36	40	24	28	32	36	40
2-350S162-33	—	—	—	—	—	—	—	—	—	—
2-350S162-43	—	—	—	—	—	—	—	—	—	—
2-350S162-54	2'-2"	—	—	—	—	—	—	—	—	—
2-350S162-68	3'-3"	2'-9"	2'-3"	—	—	2'-11"	2'-5"	—	—	—
2-550S162-33	—	—	—	—	—	—	—	—	—	—
2-550S162-43	—	—	—	—	—	—	—	—	—	—
2-550S162-54	3'-7"	2'-11"	2'-3"	—	—	3'-3"	2'-7"	—	—	—
2-550S162-68	4'-9"	2'-1"	3'-6"	3'-0"	2'-5"	4'-4"	3'-9"	3'-2"	2'-8"	2'-1"
2-800S162-33	—	—	—	—	—	—	—	—	—	—
2-800S162-43	—	—	—	—	—	—	—	—	—	—
2-800S162-54	4'-3"	3'-5"	2'-8"	—	—	3'-9"	3'-0"	2'-3"	—	—
2-800S162-68	5'-8"	4'-11"	4'-2"	3'-7"	2'-11"	5'-3"	4'-6"	3'-10"	3'-3"	2'-7"
2-1000S162-43	—	—	—	—	—	—	—	—	—	—
2-1000S162-54	4'-8"	3'-11"	3'-1"	2'-2"	—	4'-3"	3'-5"	2'-7"	—	—
2-1000S162-68	6'-5"	5'-7"	4'-9"	4'-1"	3'-4"	5'-11"	5'-1"	4'-5"	3'-8"	2'-11"
2-1200S162-54	3'-11"	3'-5"	3'-0"	2'-4"	—	3'-7"	3'-2"	2'-10"	—	—
2-1200S162-68	7'-1"	6'-2"	5'-3"	4'-6"	3'-8"	6'-6"	5'-8"	4'-10"	4'-0"	3'-3"

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa,  
1 ksi = 1,000 psi = 6.895 MPa.

a. Deflection criteria:  $L/360$  for live loads,  $L/240$  for total loads.

b. Design load assumptions:

Second-floor dead load is 10 psf.

Roof/ceiling dead load is 12 psf.

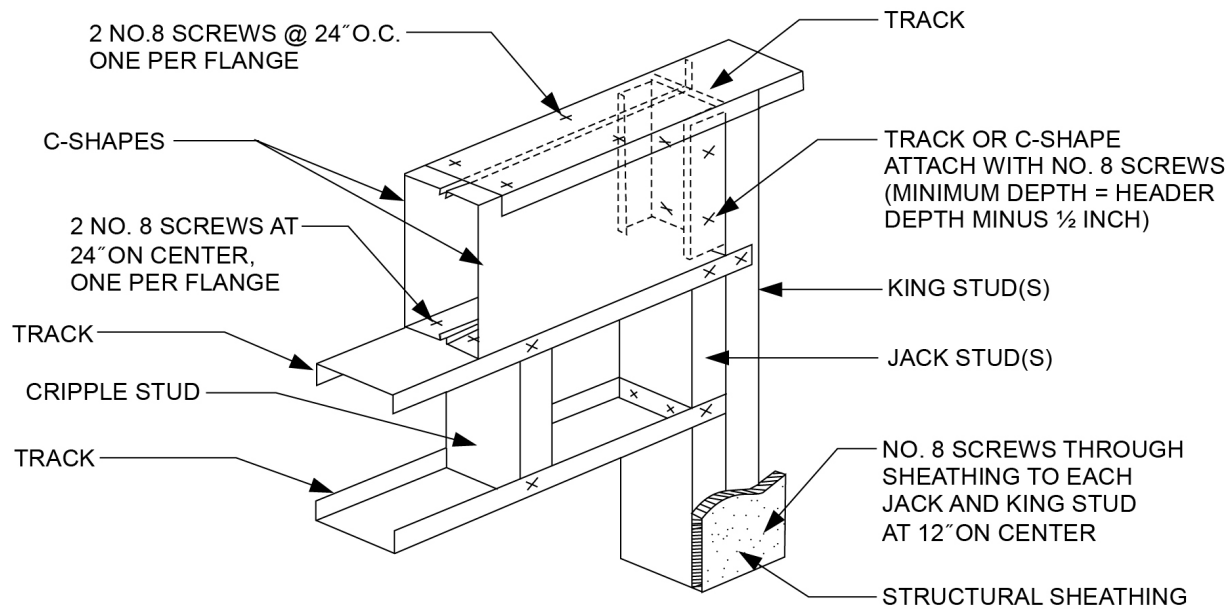
Second-floor live load is 40 psf.

Third floor live load is 30 psf.

Attic live load is 10 psf.

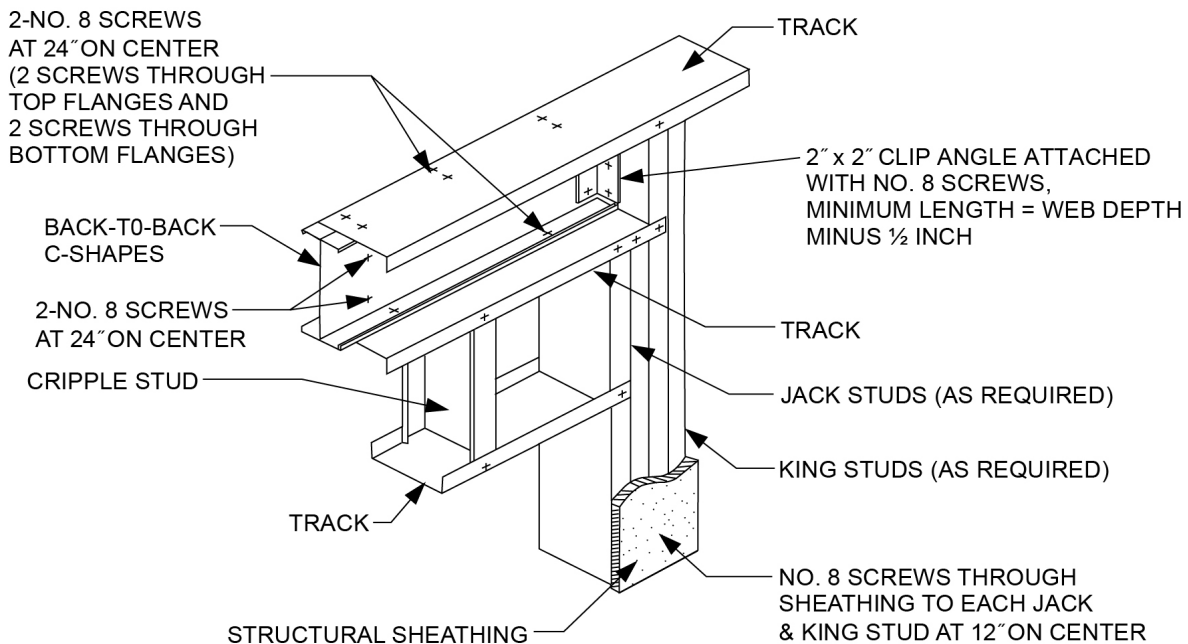
c. Building width is in the direction of horizontal framing members supported by the header.

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**FIGURE R603.6(1)**  
**BOX BEAM HEADER**



For SI: 1 inch = 25.4 mm.

**FIGURE R603.6(2)**  
**BACK-TO-BACK HEADER**

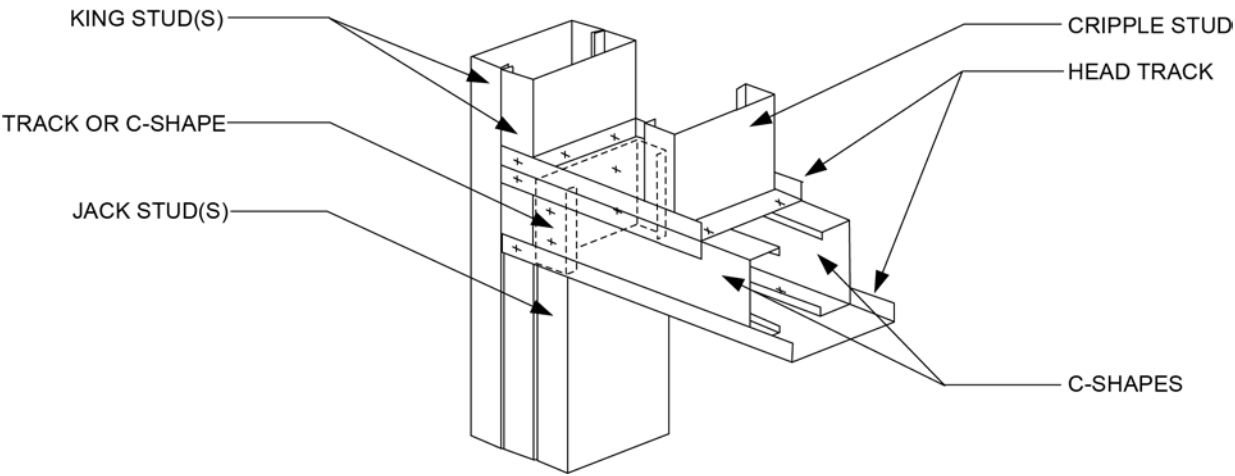
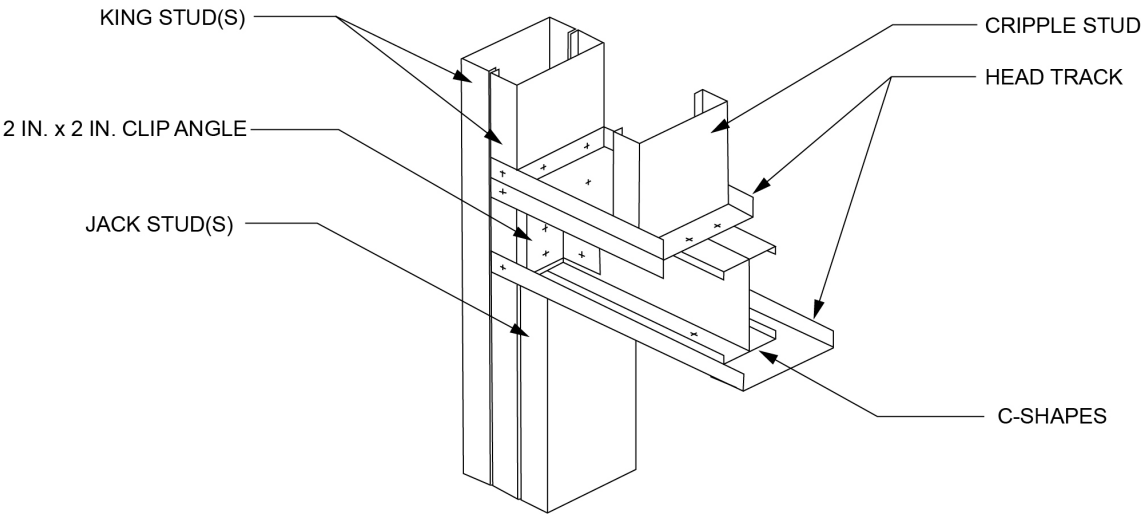


FIGURE R603.6.1(1)  
BOX BEAM HEADER IN GABLE ENDWALL



For SI: 1 inch = 25.4 mm.

FIGURE R603.6.1(2)  
BACK-TO-BACK HEADER IN GABLE ENDWALL

## WALL CONSTRUCTION

**R603.8 Head and sill track.** Head track spans above door and window openings and sill track spans beneath window openings shall comply with Table R603.8. For openings less than 4 feet (1219 mm) in height that have both a head track and a sill track, multiplying the spans by 1.75 shall be

permitted in Table R603.8. For openings less than or equal to 6 feet (1829 mm) in height that have both a head track and a sill track, multiplying the spans in Table R603.8 by 1.50 shall be permitted.

**TABLE R603.7(1)**  
**TOTAL NUMBER OF JACK AND KING STUDS REQUIRED AT EACH END OF AN OPENING**

SIZE OF OPENING (feet-inches)	24-INCH O.C. STUD SPACING		16-INCH O.C. STUD SPACING	
	No. of jack studs	No. of king studs	No. of jack studs	No. of king studs
Up to 3'-6"	1	1	1	1
> 3'-6" to 5'-0"	1	2	1	2
> 5'-0" to 5'-6"	1	2	2	2
> 5'-6" to 8'-0"	1	2	2	2
> 8'-0" to 10'-6"	2	2	2	3
> 10'-6" to 12'-0"	2	2	3	3
> 12'-0" to 13'-0"	2	3	3	3
> 13'-0" to 14'-0"	2	3	3	4
> 14'-0" to 16'-0"	2	3	3	4
> 16'-0" to 18'-0"	3	3	4	4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**TABLE R603.7(2)**  
**HEADER TO KING STUD CONNECTION REQUIREMENTS<sup>a, b, c, d</sup>**

HEADER SPAN (feet)	ULTIMATE WIND SPEED (mph), EXPOSURE CATEGORY					
	115 B	120 B	130 B	< 140 B	130 C	<140 C
			115 C	120 C		
≤ 4	4-No. 8 screws	4-No. 8 screws	4-No. 8 screws	4-No. 8 screws	6-No. 8 screws	6-No. 8 screws
> 4 to 8	4-No. 8 screws	4-No. 8 screws	4-No. 8 screws	6-No. 8 screws	8-No. 8 screws	8-No. 8 screws
> 8 to 12	4-No. 8 screws	6-No. 8 screws	6-No. 8 screws	8-No. 8 screws	10-No. 8 screws	12-No. 8 screws
> 12 to 16	4-No. 8 screws	6-No. 8 screws	8-No. 8 screws	10-No. 8 screws	12-No. 8 screws	14-No. 8 screws

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound = 4.448 N.

- All screw sizes shown are minimum.
- For headers located on the first floor of a two-story building or the first or second floor of a three-story building, the total number of screws is permitted to be reduced by 2 screws, but the total number of screws shall be not less than four.
- For roof slopes of 6:12 or greater, the required number of screws shall be permitted to be reduced by half, but the total number of screws shall be not less than four.
- Screws can be replaced by an uplift connector that has a capacity of the number of screws multiplied by 164 pounds.

**TABLE R603.8**  
**HEAD AND SILL TRACK SPAN**

ULTIMATE WIND SPEED AND EXPOSURE CATEGORY (mph)		ALLOWABLE HEAD AND SILL TRACK SPAN <sup>a, b, c</sup> (feet-inches)					
		TRACK DESIGNATION <sup>d</sup>					
B	C	350T125-33	350T125-43	350T125-54	550T125-33	550T125-43	550T125-54
115	—	5'-9"	6'-9"	9'-3"	7'-3"	9'-1"	12'-5"
120	—	5'-6"	6'-6"	8'-11"	7'-0"	8'-9"	11'-11"
130	115	4'-10"	5'-9"	7'-10"	6'-2"	7'-8"	10'-6"
< 140	120	4'-8"	5'-6"	7'-6"	5'-11"	7'-4"	10'-1"
—	130	4'-3"	5'-1"	6'-11"	5'-6"	6'-9"	9'-4"
—	< 140	4'-0"	4'-9"	6'-5"	5'-1"	6'-4"	8'-8"

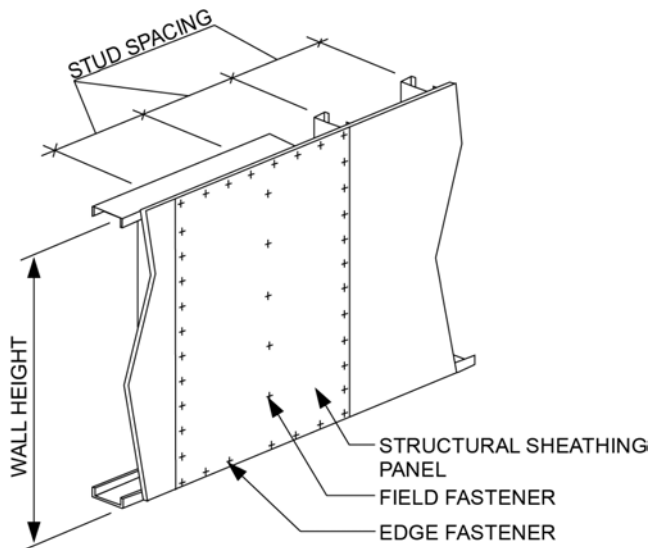
For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 ksi = 1,000 psi = 6.895 MPa.

- Deflection limit:  $L/240$ .
- Head and sill track spans are based on components and cladding wind pressures and 48-inch tributary span.
- For openings less than 4 feet in height that have both a head track and sill track, the spans are permitted to be multiplied by 1.75. For openings less than or equal to 6 feet in height that have both a head track and a sill track, the spans are permitted to be multiplied by a factor of 1.5.
- Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.



## WALL CONSTRUCTION

**R603.9 Structural sheathing.** Structural sheathing shall be installed in accordance with Figure R603.9 and this section on all sheathable exterior wall surfaces, including areas above and below openings.



**FIGURE R603.9**  
**STRUCTURAL SHEATHING FASTENING PATTERN**

**R603.9.1 Sheathing materials.** Structural sheathing panels shall consist of minimum  $\frac{7}{16}$ -inch-thick (11 mm) oriented strand board or  $\frac{15}{32}$ -inch-thick (12 mm) plywood.

**R603.9.2 Determination of minimum length of full-height sheathing.** The minimum length of full-height sheathing on each *braced wall line* shall be determined by multiplying the length of the *braced wall line* by the

percentage obtained from Table R603.9.2(1) and by the plan aspect-ratio adjustment factors obtained from Table R603.9.2(2). The minimum length of full-height sheathing shall be not less than 20 percent of the *braced wall line* length.

To be considered full-height sheathing, structural sheathing shall extend from the bottom to the top of the wall without interruption by openings. Only sheathed, full-height wall sections, uninterrupted by openings, which are not less than 48 inches (1219 mm) wide, shall be counted toward meeting the minimum percentages in Table R603.9.2(1). In addition, structural sheathing shall comply with all of the following requirements:

1. Be installed with the long dimension parallel to the stud framing and shall cover the full vertical height of wall from the bottom of the bottom track to the top of the top track of each *story*. Installing the long dimension perpendicular to the stud framing or using shorter segments shall be permitted provided that the horizontal joint is blocked as described in Item 2.
2. Be blocked where the long dimension is installed perpendicular to the stud framing. Blocking shall be not less than 33 mil (0.84 mm) thickness. Each horizontal structural sheathing panel shall be fastened with No. 8 screws spaced at 6 inches (152 mm) on center to the blocking at the joint.
3. Be applied to each end (corners) of each of the exterior walls with a minimum 48-inch-wide (1219 mm) panel.

**Exception:** Where stone or masonry veneer is installed, the required length of full-height sheathing and overturning anchorage required shall be determined in accordance with Section R603.9.5.

**TABLE R603.9.2(1)**  
**MINIMUM PERCENTAGE OF FULL-HEIGHT STRUCTURAL SHEATHING ON EXTERIOR WALLS<sup>a, b</sup>**

WALL SUPPORTING	ROOF SLOPE	ULTIMATE WIND SPEED AND EXPOSURE (mph)					
		115 B	120 B	130 B	< 140 B	< 130 C	< 140 C
				115 C	120 C		
Roof and ceiling only (one story or top floor of two- or three-story building)	3:12	9	11	11	13	17	20
	6:12	13	15	17	22	28	35
	9:12	23	27	29	33	53	59
	12:12	32	39	40	44	70	76
One story, roof and ceiling (first floor of a two-story building or second floor of a three-story building)	3:12	26	32	34	39	53	67
	6:12	27	33	34	44	61	75
	9:12	38	45	46	61	78	92
	12:12	43	53	57	72	106	116
Two stories, roof and ceiling (first floor of a three-story building)	3:12	43	53	57	64	89	113
	6:12	41	51	51	67	95	114
	9:12	53	63	63	89	104	126
	12:12	54	67	74	100	142	157

For SI: 1 mph = 0.447 m/s.

a. Linear interpolation is permitted.

b. For hip-roofed homes the minimum percentage of full-height sheathing, based on wind, is permitted to be multiplied by a factor of 0.95 for roof slopes not exceeding 7:12 and a factor of 0.9 for roof slopes greater than 7:12.

## WALL CONSTRUCTION

**TABLE R603.9.2(2)**  
**FULL-HEIGHT SHEATHING LENGTH ADJUSTMENT FACTORS**

PLAN ASPECT RATIO	LENGTH ADJUSTMENT FACTORS	
	Short wall	Long wall
1:1	1.0	1.0
1.5:1	1.5	0.67
2:1	2.0	0.50
3:1	3.0	0.33
4:1	4.0	0.25

**R603.9.2.1 Full-height sheathing.** The minimum percentage of full-height structural sheathing shall be multiplied by 1.10 for 9-foot-high (2743 mm) walls and multiplied by 1.20 for 10-foot-high (3048 mm) walls.

**R603.9.2.2 Full-height sheathing in lowest story.** In the lowest *story* of a *dwelling*, multiplying the percentage of full-height sheathing required in Table R603.9.2(1) by 0.6 shall be permitted where hold-down anchors are provided in accordance with Section R603.9.4.2.

**R603.9.3 Structural sheathing fastening.** Edges and interior areas of structural sheathing panels shall be fastened to framing members and tracks in accordance with Figure R603.9 and Table R603.3.2(1). Screws for attachment of structural sheathing panels shall be bugle-head, flat-head, or similar head style with a minimum head diameter of 0.29 inch (8 mm).

For continuously sheathed *braced wall lines* using *wood structural panels* installed with No. 8 screws spaced 4 inches (102 mm) on center at all panel edges and 12 inches (304.8 mm) on center on intermediate framing members, the following shall apply:

1. Multiplying the percentages of full-height sheathing in Table R603.9.2(1) by 0.72 shall be permitted.
2. For bottom track attached to foundations or framing below, the bottom track anchor or screw connection spacing in Tables R505.3.1(1) and R603.3.1 shall be multiplied by two-thirds.

**R603.9.4 Uplift connection requirements.** Uplift connections shall be provided in accordance with this section.

**R603.9.4.1 Ultimate design wind speeds greater than 130 mph.** Where ultimate design wind speeds exceed 130 miles per hour (58 m/s), Exposure Category C walls shall be provided with direct uplift connections in accordance with AISI S230, Section E13.3, and AISI S230, Section F8.2, as required for 140 miles per hour (63 m/s), Exposure Category C.

**R603.9.4.2 Hold-down anchor.** Where the percentage of full-height sheathing is adjusted in accordance with Section R603.9.2.2, a hold-down anchor, with a strength of 4,300 pounds (19 kN), shall be provided at

each end of each full-height sheathed wall section used to meet the minimum percent sheathing requirements of Section R603.9.2. Hold-down anchors shall be attached to back-to-back studs; structural sheathing panels shall have edge fastening to the studs, in accordance with Section R603.9.3 and AISI S230, Table E11-1.

A single hold-down anchor, installed in accordance with Figure R603.9.4.2, shall be permitted at the corners of buildings.

**R603.9.5 Structural sheathing for stone and masonry veneer.** Where stone and masonry veneer are installed in accordance with Section R703.8, the length of full-height sheathing for exterior and interior wall lines backing or perpendicular to and laterally supporting walls with veneer shall comply with this section.

**R603.9.5.1 Seismic Design Category C.** In *Seismic Design Category C*, the length of structural sheathing for walls supporting one *story*, roof and ceiling shall be the greater of the amounts required by Section R603.9.2, except Section R603.9.2.2 shall be permitted.

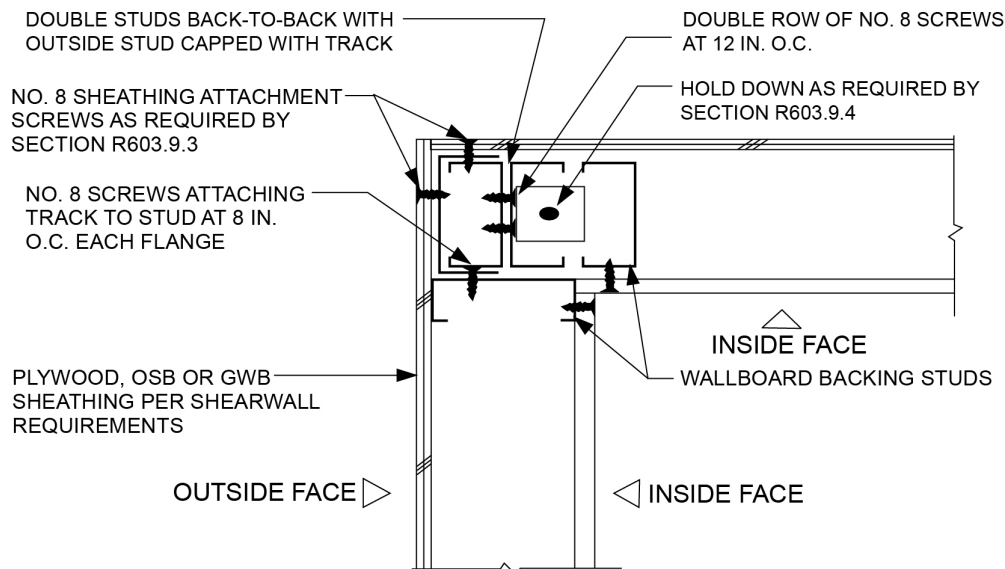
**R603.9.5.2 Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** In *Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*, the required length of structural sheathing and overturning anchorage shall be determined in accordance with Tables R603.9.5(1), R603.9.5(2), R603.9.5(3), and R603.9.5(4). Overturning anchorage shall be installed on the doubled studs at the end of each full-height wall segment.

## SECTION R604 WOOD STRUCTURAL PANELS

**R604.1 Identification and grade.** *Wood structural panels* shall conform to DOC PS 1, DOC PS 2, ANSI/APA PRP 210, CSA O325 or CSA O437. Panels shall be identified by a *grade mark* or certificate of inspection issued by an *approved* agency.

**R604.2 Allowable spans.** The maximum allowable spans for wood structural panel wall sheathing shall not exceed the values set forth in Table R602.3(3).

**R604.3 Installation.** Wood structural panel wall sheathing shall be attached to framing in accordance with Table R602.3(1) or R602.3(3).



For SI: 1 inch = 25.4 mm.

**FIGURE R603.9.4.2  
CORNER STUD HOLD-DOWN DETAIL**

## **SECTION R605 PARTICLEBOARD**

**R605.1 Identification and grade.** Particleboard shall conform to ANSI A208.1 and shall be so identified by a grade *mark* or certificate of inspection issued by an *approved* agency. Particleboard shall comply with the grades specified in Table R602.3(4).

## **SECTION R606 GENERAL MASONRY CONSTRUCTION**

**R606.1 General.** Masonry construction shall be designed and constructed in accordance with the provisions of this section, TMS 402, TMS 403 or TMS 404.

**R606.1.1 Professional registration not required.** Where the empirical design provisions of Appendix A of TMS 402, the provisions of TMS 403, or the provisions of this section are used to design masonry, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

### **R606.2 Masonry construction materials.**

**R606.2.1 Concrete masonry units.** *Concrete masonry units* shall conform to the following standards: ASTM C55 for concrete brick; ASTM C73 for calcium silicate face brick; ASTM C90 for load-bearing *concrete masonry units*; ASTM C744 for prefaced concrete and calcium silicate *masonry units*; or ASTM C1634 for concrete facing brick.

**R606.2.2 Clay or shale masonry units.** Clay or shale *masonry units* shall conform to the following standards: ASTM C34 for structural clay *load-bearing wall* tile; ASTM C56 for structural clay nonload-bearing wall tile; ASTM C62 for building brick (*solid masonry units* made from clay or shale); ASTM C126 for ceramic-glazed structural clay facing tile, facing brick and *solid masonry units*; ASTM C212 for structural clay facing tile; ASTM C216 for facing brick (*solid masonry units* made from clay or shale); ASTM C652 for hollow brick (*hollow masonry units* made from clay or shale); ASTM C1088 for solid units of thin veneer brick; or ASTM C1405 for glazed brick (single-fired solid brick units).

**Exception:** Structural clay tile for nonstructural use in fireproofing of structural members and in wall furring shall not be required to meet the compressive strength specifications. The fire-resistance rating shall be determined in accordance with ASTM E119 or UL 263 and shall comply with the requirements of Section R302.

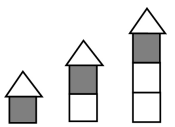


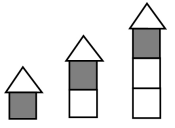
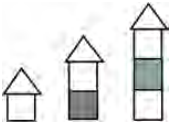
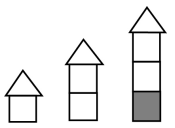

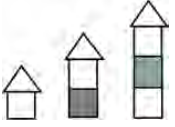
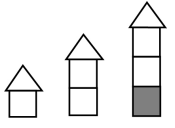
**R606.2.3 AAC masonry.** AAC *masonry units* shall conform to ASTM C1691 and ASTM C1693 for the strength class specified.

**R606.2.4 Stone masonry units.** Stone *masonry units* shall conform to the following standards: ASTM C503 for marble building stone (exterior); ASTM C568 for limestone building stone; ASTM C615 for granite building stone; ASTM C616 for sandstone building stone; or ASTM C629 for slate building stone.

**R606.2.5 Architectural cast stone.** Architectural cast stone shall conform to ASTM C1364.

## WALL CONSTRUCTION

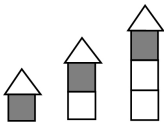
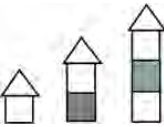
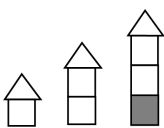
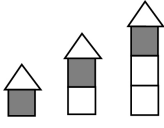

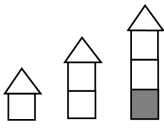
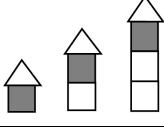

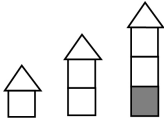
**TABLE R603.9.5(1)**  
**REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE**  
**FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 33-MIL COLD-FORMED**  
**STEEL FRAMING AND 6-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING**

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (feet)						SINGLE-STORY HOLD-DOWN FORCE (pounds)	CUMULATIVE HOLD-DOWN FORCE (pounds)
		10	20	30	40	50	60		
		Minimum total length of braced wall panels required along each braced wall line (feet)							
D <sub>0</sub>		3.3	4.7	6.1	7.4	8.8	10.2	3,360	—
		5.3	8.7	12.1	15.4	18.8	22.2	3,360	6,720
		7.3	12.7	18.0	23.4	28.8	34.2	3,360	10,080
D <sub>1</sub>		4.1	5.8	7.5	9.2	10.9	12.7	3,360	—
		6.6	10.7	14.9	19.1	23.3	27.5	3,360	6,720
		9.0	15.7	22.4	29.0	35.7	42.2	3,360	10,080
D <sub>2</sub>		5.7	8.2	10.6	13.0	15.4	17.8	3,360	—
		9.2	15.1	21.1	27.0	32.9	38.8	3,360	6,720
		12.7	22.1	31.5	40.9	50.3	59.7	3,360	10,080

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

## WALL CONSTRUCTION

**TABLE R603.9.5(2)**  
**REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE**  
**FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 43-MIL COLD-FORMED**  
**STEEL FRAMING AND 6-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING**

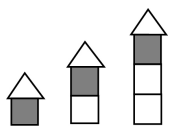


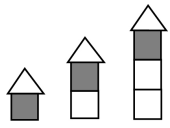
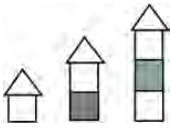
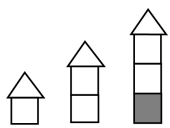
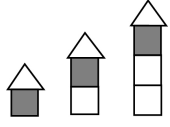

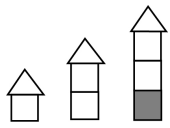
SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (feet)						SINGLE-STORY HOLD-DOWN FORCE (pounds)	CUMULATIVE HOLD-DOWN FORCE (pounds)
		10	20	30	40	50	60		
		Minimum total length of braced wall panels required along each braced wall line (feet)							
D <sub>0</sub>		2.8	4.0	5.1	6.3	7.5	8.7	3,960	—
		4.5	7.4	10.2	13.1	16.0	18.8	3,960	7,920
		6.2	10.7	15.3	19.9	24.4	29.0	3,960	11,880
D <sub>1</sub>		3.5	4.9	6.4	7.8	9.3	10.7	3,960	—
		5.6	9.1	12.7	16.2	19.8	23.3	3,960	7,920
		7.7	13.3	19.0	24.6	30.3	35.9	3,960	11,880
D <sub>2</sub>		4.9	6.9	9.0	11.0	13.1	15.1	3,960	—
		7.8	12.9	17.9	22.9	27.9	32.9	3,960	7,920
		10.8	18.8	26.7	34.7	42.7	50.7	3,960	11,880

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.



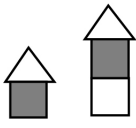
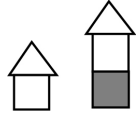
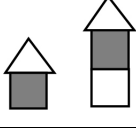
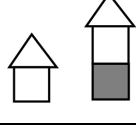
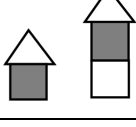
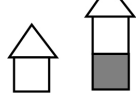
## WALL CONSTRUCTION

**TABLE R603.9.5(3)**  
**REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE FOR**  
**WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 33-MIL COLD-FORMED STEEL**  
**FRAMING AND 4-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING**

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (feet)						SINGLE-STORY HOLD-DOWN FORCE (pounds)	CUMULATIVE HOLD-DOWN FORCE (pounds)
		10	20	30	40	50	60		
		Minimum total length of braced wall panels required along each braced wall line (feet)							
D <sub>0</sub>		2.5	3.6	4.6	5.7	6.8	7.8	4,392	—
		4.0	6.6	9.2	11.8	14.4	17.0	4,392	8,784
		5.6	9.7	13.8	17.9	22.0	26.2	4,392	13,176
D <sub>1</sub>		3.1	4.4	5.7	7.1	8.4	9.7	4,392	—
		5.0	8.2	11.4	14.6	17.8	21.0	4,392	8,784
		6.9	12.0	17.1	22.2	27.3	32.4	4,392	13,176
D <sub>2</sub>		4.4	6.2	8.1	10.0	11.8	13.7	4,392	—
		7.1	11.6	16.1	20.6	25.1	29.7	4,392	8,784
		9.7	16.9	24.1	31.3	38.5	45.7	4,392	13,176

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

**TABLE R603.9.5(4)**  
**REQUIRED LENGTH OF FULL-HEIGHT SHEATHING AND ASSOCIATED OVERTURNING ANCHORAGE**  
**FOR WALLS SUPPORTING WALLS WITH STONE OR MASONRY VENEER AND USING 43-MIL COLD-FORMED STEEL**  
**FRAMING AND 4-INCH SCREW SPACING ON THE PERIMETER OF EACH PANEL OF STRUCTURAL SHEATHING**

SEISMIC DESIGN CATEGORY	STORY	BRACED WALL LINE LENGTH (feet)						SINGLE-STORY HOLD-DOWN FORCE (pounds)	CUMULATIVE HOLD-DOWN FORCE (pounds)
		10	20	30	40	50	60		
		Minimum total length of braced wall panels required along each braced wall line (feet)							
D <sub>0</sub>		1.9	2.7	3.4	4.2	5.0	5.8	5,928	—
		3.0	4.9	6.8	8.8	10.7	12.6	5,928	11,856
D <sub>1</sub>		2.3	3.3	4.3	5.2	6.2	7.2	5,928	—
		3.7	6.1	8.5	10.8	13.2	15.6	5,928	11,856
D <sub>2</sub>		3.3	4.6	6.0	7.4	8.7	10.1	5,928	—
		5.2	8.6	11.9	15.3	18.6	22.0	5,928	11,856

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

**R606.2.6 Adhered manufactured stone masonry veneer units.** Adhered manufactured stone masonry veneer units shall conform to ASTM C1670.

**R606.2.7 Second-hand units.** Second-hand *masonry units* shall not be reused unless they conform to the requirements of new units. The units shall be of whole, sound materials and free from cracks and other defects that will interfere with proper laying or use. Old mortar shall be cleaned from the unit before reuse.

**R606.2.8 Mortar.** Except for mortars listed in Sections R606.2.9, R606.2.10 and R606.2.11, mortar for use in masonry construction shall meet the proportion specifications of Table R606.2.8 or the property specifications of ASTM C270. The type of mortar shall be in accordance with Sections R606.2.8.1, R606.2.8.2 and R606.2.8.3.

**R606.2.8.1 Foundation walls.** Mortar for masonry foundation walls constructed as set forth in Tables R404.1.1(1) through R404.1.1(4) shall be Type M or S mortar.

**R606.2.8.2 Masonry in Seismic Design Categories A, B and C.** Mortar for masonry serving as the lateral force-resisting system in *Seismic Design Categories* A, B and C shall be Type M, S or N mortar.

**R606.2.8.3 Masonry in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** Mortar for masonry serving as the lateral force-resisting system in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> shall be Type M or S Portland cement-lime or mortar cement.

**R606.2.9 Surface-bonding mortar.** Surface-bonding mortar shall comply with ASTM C887. Surface bonding of *concrete masonry units* shall comply with ASTM C946.

**R606.2.10 Mortar for AAC masonry.** Thin-bed mortar for AAC masonry shall comply with Article 2.1 C.1 of TMS 602. Mortar used for the leveling courses of AAC masonry shall comply with Article 2.1 C.2 of TMS 602.

## WALL CONSTRUCTION

**R606.2.11 Mortar for adhered masonry veneer.** Mortar for use with adhered masonry veneer shall conform to ASTM C270 Type S or Type N or shall comply with ANSI A118.4 for latex-modified Portland cement mortar.

**R606.2.12 Grout.** Grout shall consist of cementitious material and aggregate in accordance with ASTM C476 or the proportion specifications of Table R606.2.12. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency shall be permitted to be used as grout.

**R606.2.13 Metal reinforcement and accessories.** Metal reinforcement and accessories shall conform to Article 2.4 of TMS 602.

**R606.3 Construction requirements.**

**R606.3.1 Bed and head joints.** Unless otherwise required or indicated on the project drawings, head and bed joints shall be  $\frac{3}{8}$  inch (9.5 mm) thick, except that the thickness of the bed joint of the starting course placed over foundations shall be not less than  $\frac{1}{4}$  inch (6.4 mm) and not more than  $\frac{3}{4}$  inch (19.1 mm). Mortar joint thick-

**TABLE R606.2.8**  
**MORTAR PROPORTIONS<sup>a, b</sup>**

MORTAR	TYPE	PROPORTIONS BY VOLUME (cementitious materials)							Aggregate ratio (measured in damp, loose conditions)	
		Portland cement or blended cement	Mortar cement			Masonry cement				Hydrated lime <sup>c</sup> or lime putty
			M	S	N	M	S	N		
Cement- lime	M	1	—	—	—	—	—	—	<sup>1</sup> / <sub>4</sub>	Not less than 2 <sup>1</sup> / <sub>4</sub> and not more than 3 times the sum of separate volumes of lime, if used, and cement
	S	1	—	—	—	—	—	—	over <sup>1</sup> / <sub>4</sub> to <sup>1</sup> / <sub>2</sub>	
	N	1	—	—	—	—	—	—	over <sup>1</sup> / <sub>2</sub> to 1 <sup>1</sup> / <sub>4</sub>	
	O	1	—	—	—	—	—	—	over 1 <sup>1</sup> / <sub>4</sub> to 2 <sup>1</sup> / <sub>2</sub>	
Mortar cement	M	1	—	—	1	—	—	—	—	
	M	—	1	—	—	—	—	—		
	S	<sup>1</sup> / <sub>2</sub>	—	—	1	—	—	—		
	S	—	—	1	—	—	—	—		
	N	—	—	—	1	—	—	—		
	O	—	—	—	1	—	—	—		
Masonry cement	M	1	—	—	—	—	—	1	—	
	M	—	—	—	—	1	—	—		
	S	<sup>1</sup> / <sub>2</sub>	—	—	—	—	—	1		
	S	—	—	—	—	—	1	—		
	N	—	—	—	—	—	—	1		
	O	—	—	—	—	—	—	1		

For SI: 1 cubic foot = 0.0283 m<sup>3</sup>, 1 pound = 0.454 kg.

a. For the purpose of these specifications, the weight of 1 cubic foot of the respective materials shall be considered to be as follows:

Hydrated lime = 40 pounds

Lime putty (Quicklime) = 80 pounds

Masonry cement = Weight printed on bag

Mortar cement = Weight printed on bag

Portland cement = 94 pounds

Sand, damp and loose = 80 pounds of dry sand

b. Two air-entraining materials shall not be combined in mortar.

c. Hydrated lime conforming to the requirements of ASTM C207.

**TABLE R606.2.12**  
**GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION**

TYPE	PORTLAND CEMENT OR BLENDED CEMENT SLAG CEMENT	HYDRATED LIME OR LIME PUTTY	AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION	
			Fine	Coarse
Fine	1	0 to 1/10	$2\frac{1}{4}$ to 3 times the sum of the volumes of the cementitious materials	—
Coarse	1	0 to 1/10	$2\frac{1}{4}$ to 3 times the sum of the volumes of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

ness for load-bearing masonry shall be within the following tolerances from the specified dimensions:

1. Bed joint:  $+\frac{1}{8}$  inch (3.2 mm).
2. Head joint:  $-\frac{1}{4}$  inch (6.4 mm),  $+\frac{3}{8}$  inch (9.5 mm).
3. Collar joints:  $-\frac{1}{4}$  inch (6.4 mm),  $+\frac{3}{8}$  inch (9.5 mm).

**R606.3.2 Masonry unit placement.** The mortar shall be sufficiently plastic and units shall be placed with sufficient pressure to extrude mortar from the joint and produce a tight joint. Deep furrowing of bed joints that produces voids shall not be permitted. Any units disturbed to the extent that initial bond is broken after initial placement shall be removed and relaid in fresh mortar. Surfaces to be in contact with mortar shall be clean and free of deleterious materials.

**R606.3.2.1 Solid masonry.** *Solid masonry* units shall be laid with full head and bed joints and all interior vertical joints that are designed to receive mortar shall be filled.

**R606.3.2.2 Hollow masonry.** For *hollow masonry units*, head and bed joints shall be filled solidly with mortar for a distance in from the face of the unit not less than the thickness of the face shell.

**R606.3.3 Installation of wall ties.** The installation of wall ties shall be as follows:

1. The ends of wall ties shall be embedded in mortar joints. Wall ties shall have not less than  $\frac{5}{8}$ -inch (15.9 mm) mortar coverage from the exposed face.
2. Wall ties shall not be bent after being embedded in grout or mortar.
3. For *solid masonry* units, solid grouted hollow units, or hollow units in anchored masonry veneer, wall ties shall be embedded in mortar bed not less than  $1\frac{1}{2}$  inches (38 mm).
4. For *hollow masonry units* in other than anchored masonry veneer, wall ties shall engage outer face shells by not less than  $\frac{1}{2}$  inch (13 mm).

**R606.3.4 Protection for reinforcement.** Bars shall be completely embedded in mortar or grout. Joint reinforcement embedded in horizontal mortar joints shall not have less than  $\frac{5}{8}$ -inch (15.9 mm) mortar coverage from the exposed face. Other reinforcement shall have a minimum coverage of one bar diameter over all bars, but not less than  $\frac{3}{4}$  inch (19 mm), except where exposed to weather

or soil, in which case the minimum coverage shall be 2 inches (51 mm).

**R606.3.4.1 Corrosion protection.** Minimum corrosion protection of joint reinforcement, anchor ties and wire fabric for use in masonry wall construction shall conform to Table R606.3.4.1.

### R606.3.5 Grouting requirements.

**R606.3.5.1 Grout placement.** Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an *approved* alternate method and shall be placed before any initial set occurs and not more than  $1\frac{1}{2}$  hours after water has been added. Grout shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost. Grout shall not be pumped through aluminum pipes.

Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to Table R606.3.5.1. Grout shall be poured in lifts with a maximum height of 8 feet (2438 mm). Where a total grout pour exceeds 8 feet (2438 mm) in height, the grout shall be placed in lifts not exceeding 64 inches (1626 mm) and special inspection during grouting shall be required. If the work is stopped for 1 hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout 1 inch (25 mm) below the top.

**R606.3.5.2 Cleanouts.** Provisions shall be made for cleaning the space to be grouted. Mortar that projects more than  $\frac{1}{2}$  inch (12.7 mm) into the grout space and any other foreign matter shall be removed from the grout space prior to inspection and grouting. Where required by the building official, cleanouts shall be provided in the bottom course of masonry for each grout pour where the grout pour height exceeds 64 inches (1626 mm). In solid grouted masonry, cleanouts shall be spaced horizontally not more than 32 inches (813 mm) on center. The cleanouts shall be sealed before grouting and after inspection.

**R606.3.5.3 Construction.** Requirements for grouted masonry construction shall be as follows:

1. Masonry shall be built to preserve the unobstructed vertical continuity of the cells or spaces to be filled. In partially grouted

TABLE R606.3.4.1  
MINIMUM CORROSION PROTECTION

MASONRY METAL ACCESSORY	STANDARD
Joint reinforcement, interior walls	ASTM A641, Class 1
Wire ties or anchors in exterior walls completely embedded in mortar or grout	ASTM A641, Class 3
Wire ties or anchors in exterior walls not completely embedded in mortar or grout	ASTM A153, Class B-2
Joint reinforcement in exterior walls or interior walls exposed to moist environment	ASTM A153, Class B-2
Sheet metal ties or anchors exposed to weather	ASTM A153, Class B-2
Sheet metal ties or anchors completely embedded in mortar or grout	ASTM A653, Coating Designation G60
Stainless steel hardware for any exposure	ASTM A167, Type 304

## WALL CONSTRUCTION

construction, cross webs forming cells to be filled shall be full-bedded in mortar to prevent leakage of grout. Head and end joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells.

2. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 200 diameters of the reinforcement.
3. Cells containing reinforcement shall be filled solidly with grout.
4. The thickness of grout or mortar between *masonry units* and reinforcement shall be not less than  $\frac{1}{4}$  inch (6.4 mm), except that  $\frac{1}{4}$ -inch (6.4 mm) bars shall be permitted to be laid in horizontal mortar joints not less than  $\frac{1}{2}$  inch (12.7 mm) thick, and steel wire reinforcement shall be permitted to be laid in horizontal mortar joints not less than twice the thickness of the wire diameter.

**R606.3.6 Grouted multiple-wythe masonry.** Grouted multiple-wythe masonry shall conform to all the requirements specified in Section R606.3.5 and the requirements of this section.

**R606.3.6.1 Bonding of backup wythe.** Where all interior vertical spaces are filled with grout in multiple-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with Section R606.13.2 to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with Section R606.13.2 where the backup wythe in multiple-wythe construction is fully grouted.

**R606.3.6.2 Grout barriers.** Vertical grout barriers or dams shall be built of *solid masonry* across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall be not more than 25 feet (7620 mm) apart. The grouting of

any section of a wall between control barriers shall be completed in one day without interruptions greater than 1 hour.

**R606.3.7 Masonry bonding pattern.** Masonry laid in running and *stack bond* shall conform to Sections R606.3.7.1 and R606.3.7.2.

**R606.3.7.1 Masonry laid in running bond.** In each wythe of masonry laid in *running bond*, head joints in successive courses shall be offset by not less than one-fourth the unit length, or the masonry walls shall be reinforced longitudinally as required in Section R606.3.7.2.

**R606.3.7.2 Masonry laid in stack bond.** Where unit masonry is laid with less head joint offset than in Section R606.3.7.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart shall be 0.0007 times the vertical cross-sectional area of the wall.

**R606.4 Thickness of masonry.** The nominal thickness of masonry walls shall conform to the requirements of Sections R606.4.1 through R606.4.4.

**R606.4.1 Minimum thickness.** The minimum thickness of masonry bearing walls more than one story high shall be 8 inches (203 mm). *Solid masonry* walls of one-story dwellings and garages shall be not less than 6 inches (152 mm) in thickness where not greater than 9 feet (2743 mm) in height, provided that where gable construction is used, an additional 6 feet (1829 mm) is permitted to the peak of the gable. Masonry walls shall be laterally supported in either the horizontal or vertical direction at intervals as required by Section R606.6.4.

**R606.4.2 Rubble stone masonry wall.** The minimum thickness of rough, random or coursed rubble stone masonry walls shall be 16 inches (406 mm).

**R606.4.3 Change in thickness.** Where walls of masonry of hollow units or masonry-bonded hollow walls are decreased in thickness, a course of *solid masonry* or

TABLE R606.3.5.1  
GROUT SPACE DIMENSIONS AND POUR HEIGHTS

GROUT TYPE	GROUT POUR MAXIMUM HEIGHT (feet)	MINIMUM WIDTH OF GROUT SPACES <sup>a, b</sup> (inches)	MINIMUM GROUT <sup>b, c</sup> SPACE DIMENSIONS FOR GROUTING CELLS OF HOLLOW UNITS (inches x inches)
Fine	1	0.75	1.5 × 2
	5	2	2 × 3
	12	2.5	2.5 × 3
	24	3	3 × 3
Coarse	1	1.5	1.5 × 3
	5	2	2.5 × 3
	12	2.5	3 × 3
	24	3	3 × 4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. For grouting between masonry wythes.

b. Grout space dimension is the clear dimension between any masonry protrusion and shall be increased by the horizontal projection of the diameters of the horizontal bars within the cross section of the grout space.

c. Area of vertical reinforcement shall not exceed 6 percent of the area of the grout space.



*masonry units* filled with mortar or grout shall be constructed between the wall below and the thinner wall above, or special units or construction shall be used to transmit the loads from face shells or wythes above to those below.

**R606.4.4 Parapet walls.** Unreinforced *solid masonry* parapet walls shall be not less than 8 inches (203 mm) thick and their height shall not exceed four times their thickness. Unreinforced hollow unit masonry parapet walls shall be not less than 8 inches (203 mm) thick, and their height shall not exceed three times their thickness. Masonry parapet walls in areas subject to wind loads of 30 pounds per square foot (1.44 kPa) located in *Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>*, or on townhouses in *Seismic Design Category C* shall be reinforced in accordance with Section R606.12.

**R606.5 Corbeled masonry.** Corbeled masonry shall be in accordance with Sections R606.5.1 through R606.5.3.

**R606.5.1 Units.** *Solid masonry* units or masonry units filled with mortar or grout shall be used for corbeling.

**R606.5.2 Corbel projection.** The maximum projection of one unit shall not exceed one-half the height of the unit or one-third the thickness at right angles to the wall. The maximum corbeled projection beyond the face of the wall shall not exceed:

1. One-half of the wall thickness for multiple-wythe walls bonded by mortar or grout and wall ties or masonry headers.
2. One-half the wythe thickness for single wythe walls, masonry-bonded hollow walls, multiple-wythe walls with open collar joints and veneer walls.

**R606.5.3 Corbeled masonry supporting floor or roof-framing members.** Where corbeled masonry is used to support floor or roof-framing members, the top course of the corbel shall be a header course or the top course bed joint shall have ties to the vertical wall.

**R606.6 Support conditions.** Bearing and support conditions shall be in accordance with Sections R606.6.1 through R606.6.4.

**R606.6.1 Bearing on support.** Each masonry wythe shall be supported by not less than two-thirds of the wythe thickness.

**R606.6.2 Support at foundation.** Cavity wall or masonry veneer construction shall be permitted to be supported on an 8-inch (203 mm) foundation wall, provided the 8-inch (203 mm) wall is corbeled to the width of the wall system above with masonry constructed of *solid masonry* units or masonry units filled with mortar or grout. The total horizontal projection of the corbel shall not exceed 2 inches (51 mm) with individual corbels projecting not more than one-third the thickness of the unit or one-half the height of the unit. The hollow space behind the corbeled masonry shall be filled with mortar or grout.

**R606.6.3 Beam supports.** Beams, girders or other concentrated loads supported by a wall or column shall have a bearing of not less than 3 inches (76 mm) in length measured parallel to the beam on *solid masonry* not less than 4 inches (102 mm) in thickness, or on a metal bearing plate of adequate design and dimensions to distribute the load safely, or on a continuous reinforced masonry member projecting not less than 4 inches (102 mm) from the face of the wall.

**R606.6.3.1 Joist bearing.** Joists shall have a bearing of not less than 1½ inches (38 mm), except as provided in Section R606.6.3, and shall be supported in accordance with Figure R606.11(1).

**R606.6.4 Lateral support.** Masonry walls shall be laterally supported in either the horizontal or the vertical direction. The maximum spacing between lateral supports shall not exceed the distances in Table R606.6.4. Lateral support shall be provided by cross walls, pilasters, buttresses or structural frame members where the limiting distance is taken horizontally, or by floors or roofs where the limiting distance is taken vertically.

**TABLE R606.6.4**  
**SPACING OF LATERAL SUPPORT FOR MASONRY WALLS**

CONSTRUCTION	MAXIMUM WALL LENGTH TO THICKNESS OR WALL HEIGHT TO THICKNESS <sup>a, b</sup>
Bearing walls:	
Solid or solid grouted	20
All other	18
Nonbearing walls:	
Exterior	18
Interior	36

For SI: 1 foot = 304.8 mm.

a. Except for cavity walls and cantilevered walls, the thickness of a wall shall be its nominal thickness measured perpendicular to the face of the wall. For cavity walls, the thickness shall be determined as the sum of the nominal thicknesses of the individual wythes. For cantilever walls, except for parapets, the ratio of height to nominal thickness shall not exceed 6 for solid masonry, or 4 for hollow masonry. For parapets, see Section R606.4.4.

b. An additional unsupported height of 6 feet is permitted for gable end walls.

**R606.6.4.1 Horizontal lateral support.** Lateral support in the horizontal direction provided by intersecting masonry walls shall be provided by one of the methods in Section R606.6.4.1.1 or R606.6.4.1.2.

**R606.6.4.1.1 Bonding pattern.** Fifty percent of the units at the intersection shall be laid in an overlapping masonry bonding pattern, with alternate units having a bearing of not less than 3 inches (76 mm) on the unit below.

**R606.6.4.1.2 Metal reinforcement.** Interior nonload-bearing walls shall be anchored at their intersections, at vertical intervals of not more than 16 inches (406 mm) with joint reinforcement of not less than 9 gage [0.148 inch (4 mm)], or ¼-inch (6

## WALL CONSTRUCTION

mm) galvanized mesh hardware cloth. Intersecting masonry walls, other than interior nonload-bearing walls, shall be anchored at vertical intervals of not more than 8 inches (203 mm) with joint reinforcement of not less than 9 gage (4 mm) and shall extend not less than 30 inches (762 mm) in each direction at the intersection. Other metal ties, joint reinforcement or anchors, if used, shall be spaced to provide equivalent area of anchorage to that required by this section.

**R606.6.4.2 Vertical lateral support.** Vertical lateral support of masonry walls in *Seismic Design Category A, B or C* shall be provided in accordance with one of the methods in Section R606.6.4.2.1 or R606.6.4.2.2.

**R606.6.4.2.1 Roof structures.** Masonry walls shall be anchored to roof structures with metal strap anchors spaced in accordance with the manufacturer's instructions,  $\frac{1}{2}$ -inch (13 mm) bolts spaced not more than 6 feet (1829 mm) on center, or other *approved* anchors. Anchors shall be embedded not less than 16 inches (406 mm) into the masonry, or be hooked or welded to bond beam reinforcement placed not less than 6 inches (152 mm) from the top of the wall.

**R606.6.4.2.2 Floor diaphragms.** Masonry walls shall be anchored to floor *diaphragm* framing by metal strap anchors spaced in accordance with the manufacturer's instructions,  $\frac{1}{2}$ -inch-diameter (13 mm) bolts spaced at intervals not to exceed 6 feet (1829 mm) and installed as shown in Figure R606.11(1), or by other *approved* methods.

**R606.7 Piers.** The unsupported height of masonry piers shall not exceed 10 times their least dimension. Where structural clay tile or hollow *concrete masonry units* are used for isolated piers to support beams and girders, the cellular spaces shall be filled solidly with grout or Type M or S mortar, except that unfilled hollow piers shall be permitted to be used if their unsupported height is not more than four times their least dimension. Where *hollow masonry units* are solidly filled with grout or Type M, S or N mortar, the allowable compressive stress shall be permitted to be increased as provided in Table R606.9.

**R606.7.1 Pier cap.** Hollow piers shall be capped with 4 inches (102 mm) of *solid masonry* or concrete, a masonry cap block, or shall have cavities of the top course filled with concrete or grout.

**R606.8 Chases.** Chases and recesses in masonry walls shall not be deeper than one-third the wall thickness. The maximum length of a horizontal chase or horizontal projection shall not exceed 4 feet (1219 mm) and shall have not less than 8 inches (203 mm) of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings. Chases and recesses in masonry walls shall be designed and constructed so as not to reduce the required strength or required fire resistance of the wall and shall not be permitted within the required area of a pier.

Masonry directly above chases or recesses wider than 12 inches (305 mm) shall be supported on noncombustible lintels.

**R606.9 Allowable stresses.** Allowable compressive stresses in masonry shall not exceed the values prescribed in Table R606.9. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account.

**R606.9.1 Combined units.** In walls or other structural members composed of different kinds or grades of units, materials or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the combination of units, materials and mortars of which the member is composed. The net thickness of any facing unit that is used to resist stress shall be not less than  $1\frac{1}{2}$  inches (38 mm).

**R606.10 Lintels.** Masonry over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or masonry arches, designed to support load imposed.

**R606.11 Anchorage.** Masonry walls shall be anchored to floor and roof systems in accordance with the details shown in Figure R606.11(1), R606.11(2) or R606.11(3). Footings shall be permitted to be considered as points of lateral support.

**R606.12 Seismic requirements.** The seismic requirements of this section shall apply to the design of masonry and the construction of masonry building elements located in *Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>*. Townhouses in *Seismic Design Category C* shall comply with the requirements of Section R606.12.2. These requirements shall not apply to glass unit masonry conforming to Section R607, anchored masonry veneer conforming to Section R703.8 or adhered masonry veneer conforming to Section R703.12.

**R606.12.1 General.** Masonry structures and masonry elements shall comply with the requirements of Sections R606.12.2 through R606.12.4 based on the seismic design category established in Table R301.2.1(1). Masonry structures and masonry elements shall comply with the requirements of Section R606.12 and Figures R606.11(1), R606.11(2) and R606.11(3) or shall be designed in accordance with TMS 402 or TMS 403.

**R606.12.1.1 Floor and roof diaphragm construction.** Floor and roof *diaphragms* shall be constructed of *wood structural panels* attached to wood framing in accordance with Table R602.3(1) or to cold-formed steel floor framing in accordance with Table R505.3.1(2) or to cold-formed steel roof framing in accordance with Table R804.3. Additionally, sheathing panel edges perpendicular to framing members shall be backed by blocking, and sheathing shall be connected to the blocking with fasteners at the edge spacing. For *Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>*, where the width-to-thickness dimension of the *diaphragm* exceeds 2-to-1, edge spacing of fasteners shall be 4 inches (102 mm) on center.

**TABLE R606.9**  
**ALLOWABLE COMPRESSIVE STRESSES**  
**FOR EMPIRICAL DESIGN OF MASONRY**

CONSTRUCTION; COMPRESSIVE STRENGTH OF UNIT, GROSS AREA	ALLOWABLE COMPRESSIVE STRESSES <sup>a</sup> GROSS CROSS-SECTIONAL AREA <sup>b</sup>	
	Type M or S mortar	Type N mortar
Solid masonry of brick and other solid units of clay or shale; sand-lime or concrete brick:		
8,000 + psi	350	300
4,500 psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Grouted <sup>c</sup> masonry, of clay or shale; sand-lime or concrete:		
4,500 + psi	225	200
2,500 psi	160	140
1,500 psi	115	100
Solid masonry of solid concrete masonry units:		
3,000 + psi	225	200
2,000 psi	160	140
1,200 psi	115	100
Masonry of hollow load-bearing units:		
2,000 + psi	140	120
1,500 psi	115	100
1,000 psi	75	70
700 psi	60	55
Hollow walls (cavity or masonry bonded <sup>d</sup> ) solid units:		
2,500 + psi	160	140
1,500 psi	115	100
Hollow units	75	70
Stone ashlar masonry:		
Granite	720	640
Limestone or marble	450	400
Sandstone or cast stone	360	320
Rubble stone masonry:		
Coarse, rough or random	120	100

For SI: 1 pound per square inch = 6.895 kPa.

- Linear interpolation shall be used for determining allowable stresses for masonry units having compressive strengths that are intermediate between those given in the table.
- Gross cross-sectional area shall be calculated on the actual rather than nominal dimensions.
- See Section R606.13.
- Where floor and roof loads are carried on one wythe, the gross cross-sectional area is that of the wythe under load; if both wythes are loaded, the gross cross-sectional area is that of the wall minus the area of the cavity between the wythes. Walls bonded with metal ties shall be considered as cavity walls unless the collar joints are filled with mortar or grout.

**R606.12.2 Seismic Design Category C.** Townhouses located in *Seismic Design Category C* shall comply with the requirements of this section.

**R606.12.2.1 Minimum length of wall without openings.** Table R606.12.2.1 shall be used to determine the minimum required solid wall length without openings at each masonry exterior wall. The provided percentage of solid wall length shall include only those wall segments that are 3 feet (914 mm) or longer. The maximum clear distance between wall segments included in determining the solid wall length shall not exceed 18 feet (5486 mm). *Shear wall* segments required to meet the minimum wall length shall be in accordance with Section R606.12.2.2.3.

**R606.12.2.2 Design of elements not part of the lateral force-resisting system.**

**R606.12.2.2.1 Load-bearing frames or columns.**

Elements not part of the lateral force-resisting system shall be analyzed to determine their effect on the response of the system. The frames or columns shall be adequate for vertical load-carrying capacity and induced moment caused by the design *story* drift.

**R606.12.2.2.2 Masonry partition walls.** Masonry partition walls, masonry screen walls and other masonry elements that are not designed to resist vertical or lateral loads, other than those induced by their own weight, shall be isolated from the structure so that vertical and lateral forces are not imparted to these elements. Isolation joints and connectors between these elements and the structure shall be designed to accommodate the design *story* drift.

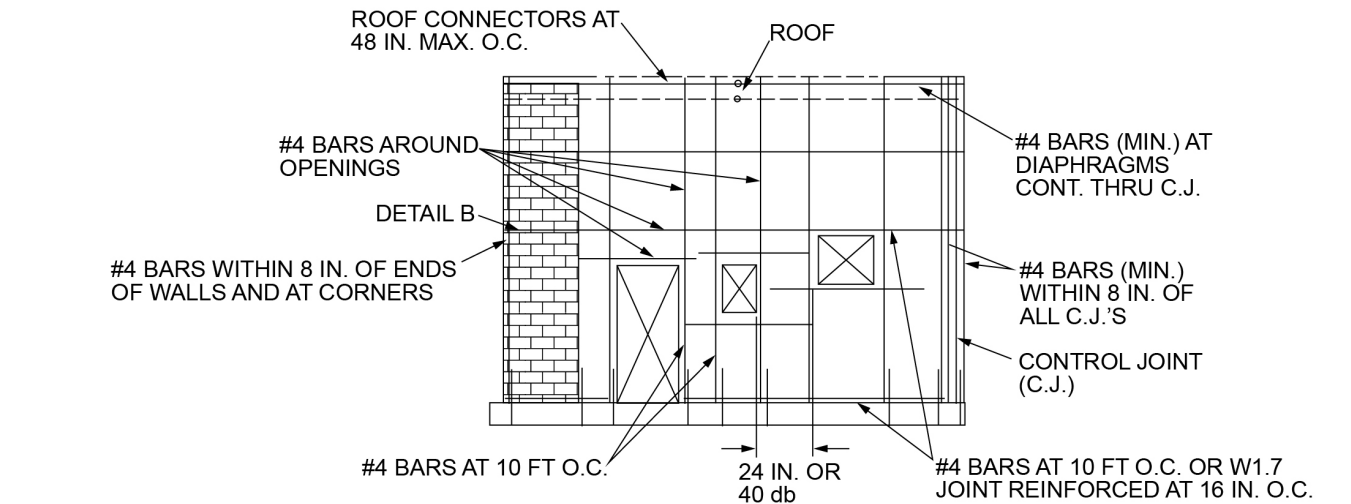
**R606.12.2.2.3 Reinforcement requirements for masonry elements.** Masonry elements listed in Section R606.12.2.2.2 shall be reinforced in either the horizontal or vertical direction as shown in Figure R606.11(2) and in accordance with the following:

- Horizontal reinforcement. Horizontal joint reinforcement shall consist of not less than two longitudinal W1.7 wires spaced not more than 16 inches (406 mm) for walls greater than 4 inches (102 mm) in width and not less than one longitudinal W1.7 wire spaced not more than 16 inches (406 mm) for walls not exceeding 4 inches (102 mm) in width; or not less than one No. 4 bar spaced not more than 48 inches (1219 mm). Where two longitudinal wires of joint reinforcement are used, the space between these wires shall be the widest that the mortar joint will accommodate. Horizontal reinforcement shall be provided within 16 inches (406 mm) of the top and bottom of these masonry elements.
- Vertical reinforcement. Vertical reinforcement shall consist of not less than one No. 4 bar spaced not more than 48 inches (1219 mm). Vertical reinforcement shall be located within 16 inches (406 mm) of the ends of masonry walls.

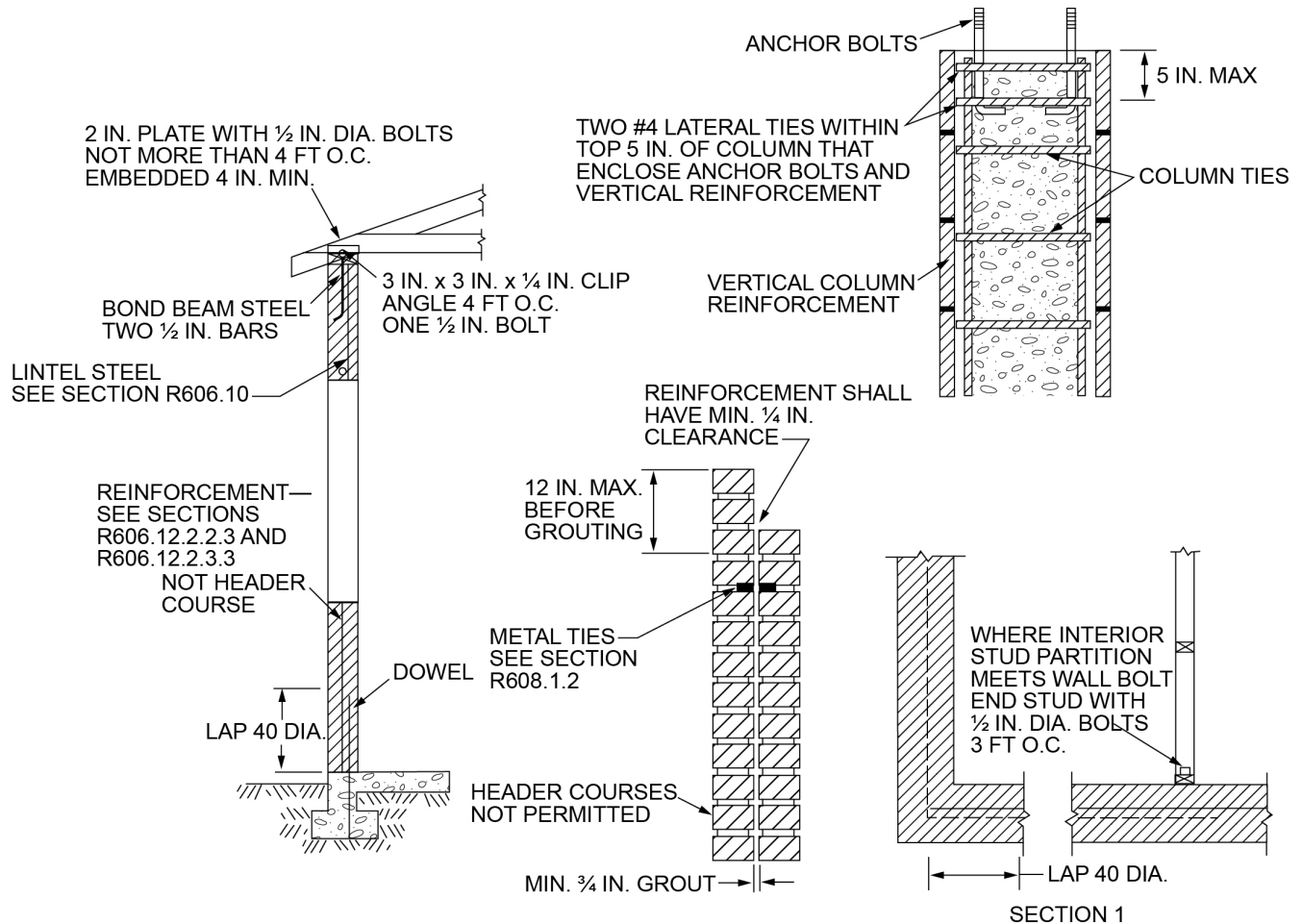




## WALL CONSTRUCTION



MINIMUM REINFORCEMENT FOR MASONRY WALLS

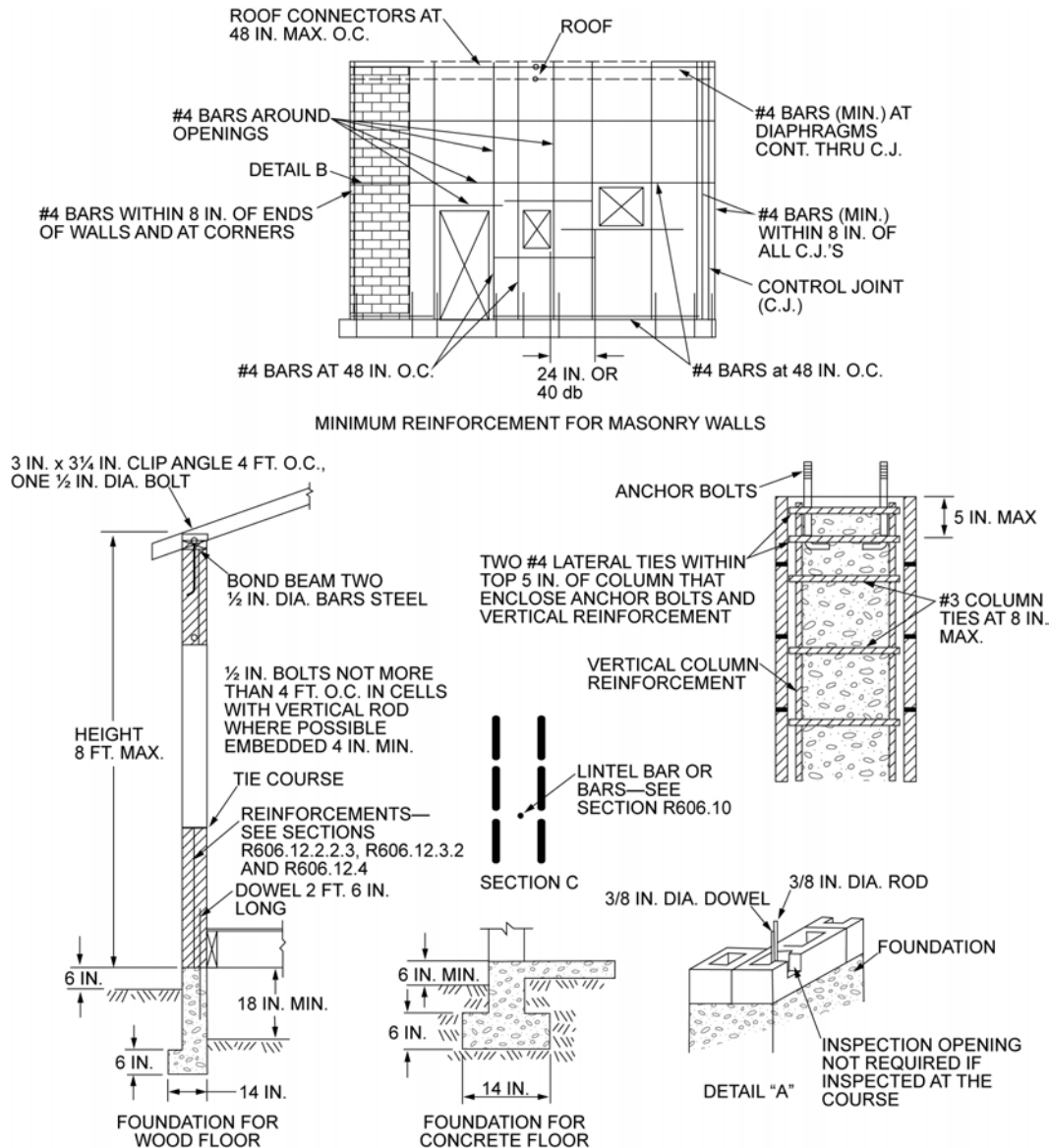


For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE R606.11(2)  
 REQUIREMENTS FOR REINFORCED GROUTED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY C



# WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**Note:** A full bed joint must be provided. Cells containing vertical bars are to be filled to the top of wall and provide inspection opening as shown on detail "A." Horizontal bars are to be laid as shown on detail "B." Lintel bars are to be laid as shown on Section C.

**FIGURE R606.11(3)**  
**REQUIREMENTS FOR REINFORCED MASONRY CONSTRUCTION IN SEISMIC DESIGN CATEGORY D<sub>0</sub>, D<sub>1</sub> OR D<sub>2</sub>**

**TABLE R606.12.2.1**  
**MINIMUM SOLID WALL LENGTH ALONG EXTERIOR WALL LINES**

SEISMIC DESIGN CATEGORY	MINIMUM SOLID WALL LENGTH (percent) <sup>a</sup>		
	One story or top story of two story	Wall supporting light-frame second story and roof	Wall supporting masonry second story and roof
Townhouses in C	20	25	35
D <sub>0</sub> or D <sub>1</sub>	25	NP	NP
D <sub>2</sub>	30	NP	NP

NP = Not Permitted, except with design in accordance with the *International Building Code*.

a. For all walls, the minimum required length of solid walls shall be based on the table percent multiplied by the dimension, parallel to the wall direction under consideration, of a rectangle inscribing the overall building plan.

### R606.12.2.3 Design of elements part of the lateral force-resisting system.

**R606.12.2.3.1 Connections to masonry shear walls.** Connectors shall be provided to transfer forces between masonry walls and horizontal elements in accordance with the requirements of Section 4.1.4 of TMS 402. Connectors shall be designed to transfer horizontal design forces acting either perpendicular or parallel to the wall, but not less than 200 pounds per linear foot (2919 N/m) of wall. The maximum spacing between connectors shall be 4 feet (1219 mm). Such anchorage mechanisms shall not induce tension stresses perpendicular to grain in ledgers or nailers.

**R606.12.2.3.2 Connections to masonry columns.** Connectors shall be provided to transfer forces between masonry columns and horizontal elements in accordance with the requirements of Section 4.1.4 of TMS 402. Where anchor bolts are used to connect horizontal elements to the tops of columns, the bolts shall be placed within lateral ties. Lateral ties shall enclose both the vertical bars in the column and the anchor bolts. There shall be not less than two No. 4 lateral ties provided in the top 5 inches (127 mm) of the column.

**R606.12.2.3.3 Minimum reinforcement requirements for masonry shear walls.** Vertical reinforcement of not less than one No. 4 bar shall be provided at corners, within 16 inches (406 mm) of each side of openings, within 8 inches (203 mm) of each side of movement joints, within 8 inches (203 mm) of the ends of walls, and at a maximum spacing of 10 feet (3048 mm).

Horizontal joint reinforcement shall consist of not less than two wires of W1.7 spaced not more than 16 inches (406 mm); or bond beam reinforcement of not less than one No. 4 bar spaced not more than 10 feet (3048 mm) shall be provided. Horizontal reinforcement shall be provided at the bottom and top of wall openings and shall extend not less than 24 inches (610 mm) nor less than 40 bar diameters past the opening; continuously at structurally connected roof and floor levels; and within 16 inches (406 mm) of the top of walls.

**R606.12.3 Seismic Design Category D<sub>0</sub> or D<sub>1</sub>.** Structures in *Seismic Design Category D<sub>0</sub>* or *D<sub>1</sub>* shall comply with the requirements of *Seismic Design Category C* and the additional requirements of this section. AAC masonry shall not be used for the design of masonry elements that are part of the lateral force-resisting system.

**R606.12.3.1 Design requirements.** Masonry elements other than those covered by Section R606.12.2.2.2 shall be designed in accordance with the requirements of Chapters 1 through 7 and Sections 8.1 and 8.3 of TMS 402 and shall meet the minimum reinforcement requirements contained in Sections R606.12.3.2 and R606.12.3.2.1. Otherwise, masonry shall be designed in accordance with TMS 403.

**Exception:** Masonry walls limited to one *story* in height and 9 feet (2743 mm) between lateral supports need not be designed provided they comply with the minimum reinforcement requirements of Sections R606.12.3.2 and R606.12.3.2.1.

**R606.12.3.2 Minimum reinforcement requirements for masonry walls.** Masonry walls other than those covered by Section R606.12.2.2.3 shall be reinforced in both the vertical and horizontal direction. The sum of the cross-sectional area of horizontal and vertical reinforcement shall be not less than 0.002 times the gross cross-sectional area of the wall, and the minimum cross-sectional area in each direction shall be not less than 0.0007 times the gross cross-sectional area of the wall. Reinforcement shall be uniformly distributed. Table R606.12.3.2 shows the minimum reinforcing bar sizes required for varying thicknesses of masonry walls. The maximum spacing of reinforcement shall be 48 inches (1219 mm) provided that the walls are solid grouted and constructed of hollow open-end units, hollow units laid with full head joints or two wythes of solid units. The maximum spacing of reinforcement shall be 24 inches (610 mm) for all other masonry.

**R606.12.3.2.1 Shear wall reinforcement requirements.** The maximum spacing of vertical and horizontal reinforcement shall be the smaller of one-third the length of the *shear wall*, one-third the height of the *shear wall*, or 48 inches (1219 mm). The minimum cross-sectional area of vertical reinforcement

TABLE R606.12.3.2  
MINIMUM DISTRIBUTED WALL REINFORCEMENT FOR BUILDINGS ASSIGNED TO SEISMIC DESIGN CATEGORY D<sub>0</sub> or D<sub>1</sub>

NOMINAL WALL THICKNESS (inches)	MINIMUM SUM OF THE VERTICAL AND HORIZONTAL REINFORCEMENT AREAS <sup>a</sup> (square inches per foot)	MINIMUM REINFORCEMENT AS DISTRIBUTED IN BOTH HORIZONTAL AND VERTICAL DIRECTIONS <sup>b</sup> (square inches per foot)	MINIMUM BAR SIZE FOR REINFORCEMENT SPACED AT 48 INCHES
6	0.135	0.047	#4
8	0.183	0.064	#5
10	0.231	0.081	#6
12	0.279	0.098	#6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch per foot = 2064 mm<sup>2</sup>/m.

a. Based on the minimum reinforcing ratio of 0.002 times the gross cross-sectional area of the wall.

b. Based on the minimum reinforcing ratio each direction of 0.0007 times the gross cross-sectional area of the wall.

## WALL CONSTRUCTION

shall be one-third of the required shear reinforcement. Shear reinforcement shall be anchored around vertical reinforcing bars with a standard hook.

**R606.12.3.3 Minimum reinforcement for masonry columns.** Lateral ties in masonry columns shall be spaced not more than 8 inches (203 mm) on center and shall be not less than  $\frac{3}{8}$ -inch (9.5 mm) diameter. Lateral ties shall be embedded in grout.

**R606.12.3.4 Material restrictions.** Type N mortar or masonry cement shall not be used as part of the lateral force-resisting system.

**R606.12.3.5 Lateral tie anchorage.** Standard hooks for lateral tie anchorage shall be either a 135-degree (2.4 rad) standard hook or a 180-degree (3.2 rad) standard hook.

**R606.12.4 Seismic Design Category D<sub>2</sub>.** Structures in *Seismic Design Category D<sub>2</sub>* shall comply with the requirements of *Seismic Design Category D<sub>1</sub>* and to the additional requirements of this section.

**R606.12.4.1 Design of elements not part of the lateral force-resisting system.** *Stack bond* masonry that is not part of the lateral force-resisting system shall have a horizontal cross-sectional area of reinforcement of not less than 0.0015 times the gross cross-sectional area of masonry. Table R606.12.4.1 shows minimum reinforcing bar sizes for masonry walls. The maximum spacing of horizontal reinforcement shall be 24 inches (610 mm). These elements shall be solidly grouted and shall be constructed of hollow open-end units or two wythes of solid units.

**TABLE R606.12.4.1**  
**MINIMUM REINFORCING FOR STACKED BONDED**  
**MASONRY WALLS IN SEISMIC DESIGN CATEGORY D<sub>2</sub>**

NOMINAL WALL THICKNESS (inches)	MINIMUM BAR SIZE SPACED AT 24 INCHES
6	#4
8	#5
10	#5
12	#6

For SI: 1 inch = 25.4 mm.

**R606.12.4.2 Design of elements part of the lateral force-resisting system.** *Stack bond* masonry that is part of the lateral force-resisting system shall have a horizontal cross-sectional area of reinforcement of not less than 0.0025 times the gross cross-sectional area of masonry. Table R606.12.4.2 shows minimum reinforcing bar sizes for masonry walls. The maximum spacing of horizontal reinforcement shall be 16 inches (406 mm). These elements shall be solidly grouted and shall be constructed of hollow open-end units or two wythes of solid units.

**TABLE R606.12.4.2**  
**MINIMUM REINFORCING FOR STACKED BONDED**  
**MASONRY WALLS IN SEISMIC DESIGN CATEGORY D<sub>2</sub>**

NOMINAL WALL THICKNESS (inches)	MINIMUM BAR SIZE SPACED AT 16 INCHES
6	#4
8	#5
10	#5
12	#6

For SI: 1 inch = 25.4 mm.

**R606.13 Multiple-wythe masonry.** The facing and backing of multiple-wythe masonry walls shall be bonded in accordance with Section R606.13.1, R606.13.2 or R606.13.3. In cavity walls, neither the facing nor the backing shall be less than 3 inches (76 mm) nominal in thickness and the cavity shall be not more than 4 inches (102 mm) nominal in width. The backing shall not be less than the thickness of the facing.

**Exception:** Cavities shall be permitted to exceed the 4-inch (102 mm) nominal dimension provided that tie size and tie spacing have been established by calculation.

**R606.13.1 Bonding with masonry headers.** Bonding with solid or *hollow masonry* headers shall comply with Sections R606.13.1.1 and R606.13.1.2.

**R606.13.1.1 Solid units.** Where the facing and backing (adjacent wythes) of *solid masonry* construction are bonded by means of masonry headers, not less than 4 percent of the wall surface of each face shall be composed of headers extending not less than 3 inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap not less than 3 inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below not less than 3 inches (76 mm).

**R606.13.1.2 Hollow units.** Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping not less than 3 inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units that are not less than 50 percent thicker than the units below.

**R606.13.2 Bonding with wall ties or joint reinforcement.** Bonding with wall ties or joint reinforcement shall comply with Section R606.13.2.3.

**R606.13.2.1 Bonding with wall ties.** Bonding with wall ties, except as required by Section R607, where the facing and backing (adjacent wythes) of masonry walls are bonded with  $\frac{3}{16}$ -inch-diameter (5 mm) wall

ties embedded in the horizontal mortar joints, there shall be not less than one metal tie for each  $4\frac{1}{2}$  square feet ( $0.418 \text{ m}^2$ ) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with *hollow masonry units* laid with the cells vertical. In other walls, the ends of ties shall be bent to 90-degree ( $0.79 \text{ rad}$ ) angles to provide hooks not less than 2 inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than 3 feet (914 mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

**R606.13.2.2 Bonding with adjustable wall ties.** Where the facing and backing (adjacent wythes) of masonry are bonded with adjustable wall ties, there shall be not less than one tie for each 2.67 square feet ( $0.248 \text{ m}^2$ ) of wall area. Neither the vertical nor the horizontal spacing of the adjustable wall ties shall exceed 24 inches (610 mm). The maximum vertical offset of bed joints from one wythe to the other shall be 1.25 inches (32 mm). The maximum clearance between connecting parts of the ties shall be  $\frac{1}{16}$  inch (2 mm). Where pintle legs are used, ties shall have not less than two  $\frac{3}{16}$ -inch-diameter (5 mm) legs.

**R606.13.2.3 Bonding with prefabricated joint reinforcement.** Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be not less than one cross wire serving as a tie for each 2.67 square feet ( $0.248 \text{ m}^2$ ) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406 mm). Cross wires on prefabricated joint reinforcement shall not be smaller than No. 9 gage. The longitudinal wires shall be embedded in the mortar.

**R606.13.3 Bonding with natural or cast stone.** Bonding with natural and cast stone shall conform to Sections R606.13.3.1 and R606.13.3.2.

**R606.13.3.1 Ashlar masonry.** In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10 percent of the wall area. Such bonder units shall extend not less than 4 inches (102 mm) into the backing wall.

**R606.13.3.2 Rubble stone masonry.** Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of 3 feet (914 mm) vertically and 3 feet (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each 6 square feet ( $0.557 \text{ m}^2$ ) of wall surface on both sides.

## **R606.14 Anchored and adhered masonry veneer.**

**R606.14.1 Anchored veneer.** Anchored masonry veneer installed over a backing of wood or cold-formed steel shall meet the requirements of Section R703.8.

**R606.14.2 Adhered veneer.** Adhered masonry veneer shall be installed in accordance with the requirements of Section R703.12.

## **SECTION R607 GLASS UNIT MASONRY**

**R607.1 General.** Panels of glass unit masonry located in load-bearing and nonload-bearing exterior and interior walls shall be constructed in accordance with this section.

**R607.2 Materials.** Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of  $\frac{3}{16}$  inch (5 mm). The surface of units in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. The use of reclaimed units is prohibited.

**R607.3 Units.** Hollow or solid glass block units shall be standard or thin units.

**R607.3.1 Standard units.** The specified thickness of standard units shall be not less than  $\frac{3}{8}$  inches (98 mm).

**R607.3.2 Thin units.** The specified thickness of thin units shall be not less than  $\frac{3}{8}$  inches (79 mm) for hollow units and not less than 3 inches (76 mm) for solid units.

**R607.4 Isolated panels.** Isolated panels of glass unit masonry shall conform to the requirements of this section.

**R607.4.1 Exterior standard-unit panels.** The maximum area of each individual standard-unit panel shall be 144 square feet ( $13.4 \text{ m}^2$ ) where the design wind pressure is 20 pounds per square foot (958 Pa). The maximum area of such panels subjected to design wind pressures other than 20 pounds per square foot (958 Pa) shall be in accordance with Figure R607.4.1. The maximum panel dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

**R607.4.2 Exterior thin-unit panels.** The maximum area of each individual thin-unit panel shall be 85 square feet ( $7.9 \text{ m}^2$ ). The maximum dimension between structural supports shall be 15 feet (4572 mm) in width or 10 feet (3048 mm) in height. Thin units shall not be used in applications where the design wind pressure as stated in Table R301.2.1(1) exceeds 20 pounds per square foot (958 Pa).

**R607.4.3 Interior panels.** The maximum area of each individual standard-unit panel shall be 250 square feet ( $23.2 \text{ m}^2$ ). The maximum area of each thin-unit panel shall be 150 square feet ( $13.9 \text{ m}^2$ ). The maximum dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

**R607.4.4 Curved panels.** The width of curved panels shall conform to the requirements of Sections R607.4.1, R607.4.2 and R607.4.3, except additional structural supports shall be provided at locations where a curved section joins a straight section, and at inflection points in multiple-curve walls.



## WALL CONSTRUCTION

**R607.5 Panel support.** Glass unit masonry panels shall conform to the support requirements of this section.

**R607.5.1 Deflection.** The maximum total deflection of structural members that support glass unit masonry shall not exceed  $\frac{1}{600}$ .

**R607.5.2 Lateral support.** Glass unit masonry panels shall be laterally supported along the top and sides of the panel. Lateral supports for glass unit masonry panels shall be designed to resist not less than 200 pounds per lineal foot (2918 N/m) of panel, or the actual applied loads, whichever is greater. Except for single-unit panels, lateral support shall be provided by panel anchors along the top and sides spaced not greater than 16 inches (406 mm) on center or by channel-type restraints. Single-unit panels shall be supported by channel-type restraints.

### Exceptions:

1. Lateral support is not required at the top of panels that are one unit wide.
2. Lateral support is not required at the sides of panels that are one unit high.

**R607.5.2.1 Panel anchor restraints.** Panel anchors shall be spaced not greater than 16 inches (406 mm) on center in both jambs and across the head. Panel anchors shall be embedded not less than 12 inches (305 mm) and shall be provided with two fasteners so as to resist the loads specified in Section R607.5.2.

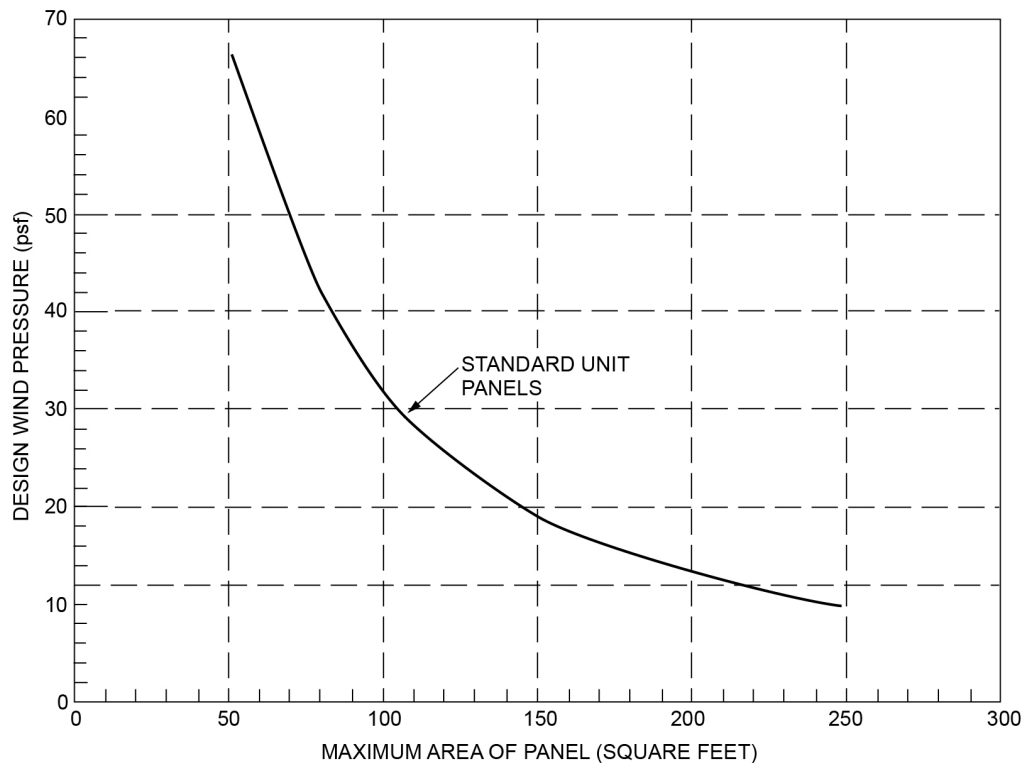
**R607.5.2.2 Channel-type restraints.** Glass unit masonry panels shall be recessed not less than 1 inch (25 mm) within channels and chases. Channel-type restraints shall be oversized to accommodate expansion material in the opening, packing and sealant between the framing restraints, and the glass unit masonry perimeter units.

**R607.6 Sills.** Before the bedding of glass units, the sill area shall be covered with a water-base asphaltic emulsion coating. The coating shall be not less than  $\frac{1}{8}$  inch (3 mm) thick.

**R607.7 Expansion joints.** Glass unit masonry panels shall be provided with expansion joints along the top and sides at all structural supports. Expansion joints shall be not less than  $\frac{3}{8}$  inch (10 mm) in thickness and shall have sufficient thickness to accommodate displacements of the supporting structure. Expansion joints shall be entirely free of mortar and other debris and shall be filled with resilient material.

**R607.8 Mortar.** Glass unit masonry shall be laid with Type S or N mortar. Mortar shall not be retempered after initial set. Mortar unused within  $1\frac{1}{2}$  hours after initial mixing shall be discarded.

**R607.9 Reinforcement.** Glass unit masonry panels shall have horizontal joint reinforcement spaced not greater than 16 inches (406 mm) on center located in the mortar bed joint. Horizontal joint reinforcement shall extend the entire length of the panel but shall not extend across expansion joints.



For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 pound per square foot = 0.0479 kPa.

**FIGURE R607.4.1**  
**GLASS UNIT MASONRY DESIGN WIND LOAD RESISTANCE**



Longitudinal wires shall be lapped not less than 6 inches (152 mm) at splices. Joint reinforcement shall be placed in the bed joint immediately below and above openings in the panel. The reinforcement shall have not less than two parallel longitudinal wires of size W1.7 or greater, and have welded cross wires of size W1.7 or greater.

**R607.10 Placement.** Glass units shall be placed so head and bed joints are filled solidly. Mortar shall not be furrowed. Head and bed joints of glass unit masonry shall be  $\frac{1}{4}$  inch (6.4 mm) thick, except that vertical joint thickness of radial panels shall be not less than  $\frac{1}{8}$  inch (3 mm) or greater than  $\frac{5}{8}$  inch (16 mm). The bed joint thickness tolerance shall be minus  $\frac{1}{16}$  inch (1.6 mm) and plus  $\frac{1}{8}$  inch (3 mm). The head joint thickness tolerance shall be plus or minus  $\frac{1}{8}$  inch (3 mm).

## SECTION R608 EXTERIOR CONCRETE WALL CONSTRUCTION

**R608.1 General.** Exterior concrete walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of PCA 100, ACI 318 or ACI 332. Where PCA 100, ACI 318, ACI 332 or the provisions of this section are used to design concrete walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

**R608.1.1 Interior construction.** These provisions are based on the assumption that interior walls and partitions, both load-bearing and nonload-bearing, floors and roof/ceiling assemblies are constructed of *light-frame construction* complying with the limitations of this code and the additional limitations of Section R608.2. Design and construction of light-frame assemblies shall be in accordance with the applicable provisions of this code. Where second-story exterior walls are of *light-frame construction*, they shall be designed and constructed as required by this code.

Aspects of concrete construction not specifically addressed by this code, including interior concrete walls, shall comply with ACI 318.

**R608.1.2 Other concrete walls.** Exterior concrete walls constructed in accordance with this code shall comply with the shapes and minimum concrete cross-sectional dimensions of Table R608.3. Other types of forming systems resulting in concrete walls not in compliance with this section shall be designed in accordance with ACI 318.

**R608.2 Applicability limits.** The provisions of this section shall apply to the construction of exterior concrete walls for buildings not greater than 60 feet (18 288 mm) in plan dimensions, floors with clear spans not greater than 32 feet (9754 mm) and roofs with clear spans not greater than 40 feet (12 192 mm). Buildings shall not exceed 35 feet (10 668 mm) in mean roof height or two stories in height above grade. Floor/ceiling dead loads shall not exceed 10 pounds

per square foot (479 Pa), roof/ceiling dead loads shall not exceed 15 pounds per square foot (718 Pa) and attic live loads shall not exceed 20 pounds per square foot (958 Pa). Roof overhangs shall not exceed 2 feet (610 mm) of horizontal projection beyond the exterior wall and the dead load of the overhangs shall not exceed 8 pounds per square foot (383 Pa).

Walls constructed in accordance with the provisions of this section shall be limited to buildings subjected to a maximum design wind speed of 160 mph (72 m/s) Exposure B, 136 mph (61 m/s) Exposure C and 125 mph (56 m/s) Exposure D. Walls constructed in accordance with the provisions of this section shall be limited to detached one- and two-family *dwellings* and townhouses assigned to *Seismic Design Category A* or *B*, and detached one- and two-family *dwellings* assigned to *Seismic Design Category C*.

Buildings that are not within the scope of this section shall be designed in accordance with PCA 100 or ACI 318.

**R608.3 Concrete wall systems.** Concrete walls constructed in accordance with these provisions shall comply with the shapes and minimum concrete cross-sectional dimensions of Table R608.3.

**R608.3.1 Flat wall systems.** Flat concrete wall systems shall comply with Table R608.3 and Figure R608.3(1) and have a minimum nominal thickness of 4 inches (102 mm).

**R608.3.2 Waffle-grid wall systems.** Waffle-grid wall systems shall comply with Table R608.3 and Figure R608.3(2) and shall have a minimum nominal thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The core and web dimensions shall comply with Table R608.3. The maximum weight of waffle-grid walls shall comply with Table R608.3.

**R608.3.3 Screen-grid wall systems.** Screen-grid wall systems shall comply with Table R608.3 and Figure R608.3(3) and shall have a minimum nominal thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The core dimensions shall comply with Table R608.3. The maximum weight of screen-grid walls shall comply with Table R608.3.

**R608.4 Stay-in-place forms.** Stay-in-place concrete forms shall comply with this section.

**R608.4.1 Surface burning characteristics.** The flame spread index and *smoke-developed index* of forming material, other than foam plastic, left exposed on the interior shall comply with Section R302.9. The surface burning characteristics of foam plastic used in *insulating concrete forms* shall comply with Section R316.3.

**R608.4.2 Interior covering.** Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Sections R316.4 and R702.3.4. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives is permitted in addition to mechanical fasteners.

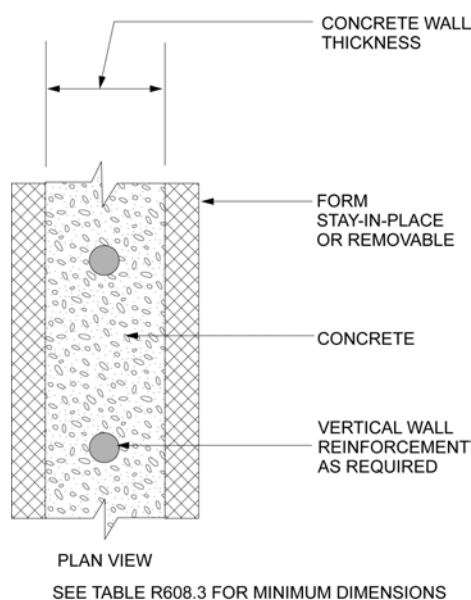
## WALL CONSTRUCTION

**TABLE R608.3**  
**DIMENSIONAL REQUIREMENTS FOR WALLS<sup>a</sup>**

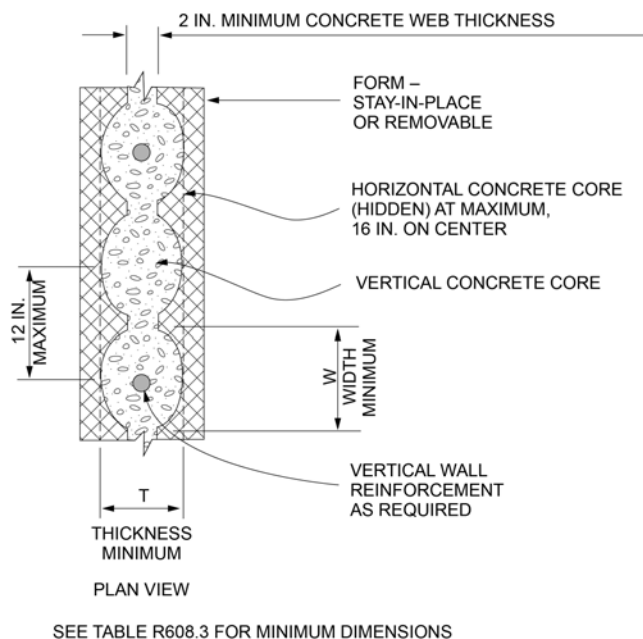
WALL TYPE AND NOMINAL THICKNESS	MAXIMUM WALL WEIGHT <sup>b</sup> (psf)	MINIMUM WIDTH, W, OF VERTICAL CORES (inches)	MINIMUM THICKNESS, T, OF VERTICAL CORES (inches)	MAXIMUM SPACING OF VERTICAL CORES (inches)	MAXIMUM SPACING OF HORIZONTAL CORES (inches)	MINIMUM WEB THICKNESS (inches)
4" Flat <sup>c</sup>	50	NA	NA	NA	NA	NA
6" Flat <sup>c</sup>	75	NA	NA	NA	NA	NA
8" Flat <sup>c</sup>	100	NA	NA	NA	NA	NA
10" Flat <sup>c</sup>	125	NA	NA	NA	NA	NA
6" Waffle-grid	56	8 <sup>d</sup>	5.5 <sup>d</sup>	12	16	2
8" Waffle-grid	76	8 <sup>e</sup>	8 <sup>e</sup>	12	16	2
6" Screen-grid	53	6.25 <sup>f</sup>	6.25 <sup>f</sup>	12	12	NA

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per cubic foot = 2402.77 kg/m<sup>3</sup>, 1 square inch = 645.16 mm<sup>2</sup>, 1 inch<sup>4</sup> = 42 cm<sup>4</sup>.  
NA = Not Applicable.

- Width "W," thickness "T," spacing and web thickness, refer to Figures R608.3(2) and R608.3(3).
- Wall weight is based on a unit weight of concrete of 150 pcf. For flat walls the weight is based on the nominal thickness. The tabulated values do not include any allowance for interior and exterior finishes.
- Nominal wall thickness. The actual as-built thickness of a flat wall shall not be more than  $\frac{1}{2}$  inch less or more than  $\frac{1}{4}$  inch more than the nominal dimension indicated.
- Vertical core is assumed to be elliptical-shaped. Another shape of core is permitted provided the minimum thickness is 5 inches, the moment of inertia,  $I$ , about the centerline of the wall (ignoring the web) is not less than 65 inch<sup>4</sup>, and the area,  $A$ , is not less than 31.25 square inches. The width used to calculate  $A$  and  $I$  shall not exceed 8 inches.
- Vertical core is assumed to be circular. Another shape of core is permitted provided the minimum thickness is 7 inches, the moment of inertia,  $I$ , about the centerline of the wall (ignoring the web) is not less than 200 inch<sup>4</sup>, and the area,  $A$ , is not less than 49 square inches. The width used to calculate  $A$  and  $I$  shall not exceed 8 inches.
- Vertical core is assumed to be circular. Another shape of core is permitted provided the minimum thickness is 5.5 inches, the moment of inertia,  $I$ , about the centerline of the wall is not less than 76 inch<sup>4</sup>, and the area,  $A$ , is not less than 30.25 square inches. The width used to calculate  $A$  and  $I$  shall not exceed 6.25 inches.

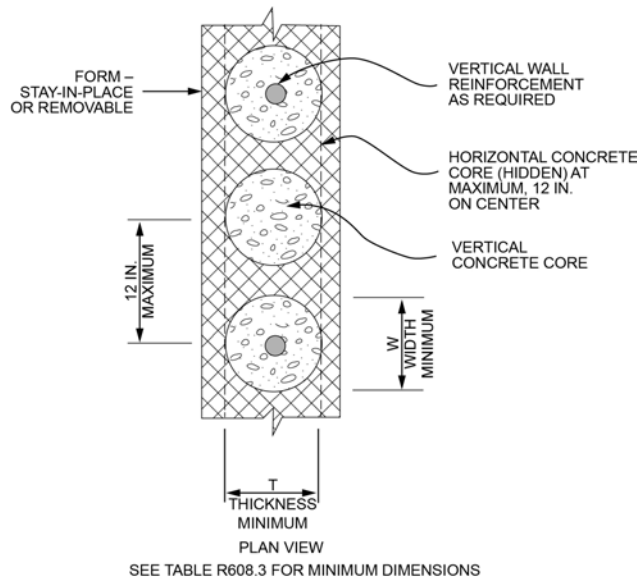


**FIGURE R608.3(1)**  
**FLAT WALL SYSTEM**



**FIGURE R608.3(2)**  
**WAFFLE-GRID WALL SYSTEM**

For SI: 1 inch = 25.4 mm.



For SI: 1 inch = 25.4 mm.

**FIGURE R608.3(3)**  
**SCREEN-GRID WALL SYSTEM**

**R608.4.3 Exterior wall covering.** Stay-in-place forms constructed of rigid foam plastics shall be protected from sunlight and physical damage by the application of an *approved* exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.

Requirements for installation of masonry veneer, stucco and other finishes on the exterior of concrete walls and other construction details not covered in this section shall comply with the requirements of this code.

**R608.4.4 Flat ICF wall systems.** Flat ICF wall system forms shall conform to ASTM E2634.

**R608.5 Materials.** Materials used in the construction of concrete walls shall comply with this section.

**R608.5.1 Concrete and materials for concrete.** Materials used in concrete, and the concrete itself, shall conform to requirements of this section, PCA 100, ACI 318 or ACI 332.

**R608.5.1.1 Cements.** The following standards as referenced in Chapter 44 shall be permitted to be used:

1. ASTM C150
2. ASTM C595
3. ASTM C1157

**R608.5.1.2 Concrete mixing and delivery.** Mixing and delivery of concrete shall comply with ASTM C94 or ASTM C685.

**R608.5.1.3 Maximum aggregate size.** The nominal maximum size of coarse aggregate shall not exceed

one-fifth the narrowest distance between sides of forms, or three-fourths the clear spacing between reinforcing bars or between a bar and the side of the form.

**Exception:** When *approved*, these limitations shall not apply where removable forms are used and workability and methods of consolidation permit concrete to be placed without honeycombs or voids.

**R608.5.1.4 Proportioning and slump of concrete.** Proportions of materials for concrete shall be established to provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding. Slump of concrete placed in removable forms shall not exceed 6 inches (152 mm).

**Exception:** When *approved*, the slump is permitted to exceed 6 inches (152 mm) for concrete mixtures that are resistant to segregation, and are in accordance with the form manufacturer's recommendations.

Slump of concrete placed in stay-in-place forms shall exceed 6 inches (152 mm). Slump of concrete shall be determined in accordance with ASTM C143.

**R608.5.1.5 Compressive strength.** The minimum specified compressive strength of concrete,  $f'_c$ , shall comply with Section R402.2 and shall be not less than 2,500 pounds per square inch (17.2 MPa) at 28 days.

**R608.5.1.6 Consolidation of concrete.** Concrete shall be consolidated by suitable means during placement and shall be worked around embedded items and reinforcement and into corners of forms. Where stay-in-place forms are used, concrete shall be consolidated by internal vibration.

**Exception:** When *approved*, self-consolidating concrete mixtures with slumps equal to or greater than 8 inches (203 mm) that are specifically designed for placement without internal vibration need not be internally vibrated.

## **R608.5.2 Steel reinforcement and anchor bolts.**

**R608.5.2.1 Steel reinforcement.** Steel reinforcement shall comply with ASTM A615, ASTM A706, or ASTM A996. ASTM A996 bars produced from rail steel shall be Type R.

**R608.5.2.2 Anchor bolts.** Anchor bolts for use with connection details in accordance with Figures R608.9(1) through R608.9(12) shall be bolts with heads complying with ASTM A307 or ASTM F1554. ASTM A307 bolts shall be Grade A with heads. ASTM F1554 bolts shall be Grade 36 minimum. Instead of bolts with heads, it is permissible to use rods with threads on both ends fabricated from steel complying with ASTM A36. The threaded end of the rod to be embedded in the concrete shall be provided with a hex or square nut.

**R608.5.2.3 Sheet steel angles and tension tie straps.** Angles and tension tie straps for use with connection

## WALL CONSTRUCTION

details in accordance with Figures R608.9(1) through R608.9(12) shall be fabricated from sheet steel complying with ASTM A653 SS, ASTM A792 SS, or ASTM A875 SS. The steel shall be minimum Grade 33 unless a higher grade is required by the applicable figure.

**R608.5.3 Form materials and form ties.** Forms shall be made of wood, steel, aluminum, plastic, a composite of cement and foam insulation, a composite of cement and wood chips, or other *approved* material suitable for supporting and containing concrete. Forms shall provide sufficient strength to contain concrete during the concrete placement operation.

Form ties shall be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the forces created by fluid pressure of fresh concrete.

### R608.5.4 Reinforcement installation details.

**R608.5.4.1 Support and cover.** Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system such that displacement will not occur during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (76 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be 1½ inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be ¾ inch (19 mm). The minus tolerance for

cover shall not exceed the smaller of one-third the required cover and ¾ inch (10 mm). See Section R608.5.4.4 for cover requirements for hooks of bars developed in tension.

**R608.5.4.2 Location of reinforcement in walls.** For location of reinforcement in foundation walls and above-grade walls, see Sections R404.1.3.3.7.2 and R608.6.5, respectively.

**R608.5.4.3 Lap splices.** Vertical and horizontal wall reinforcement required by Sections R608.6 and R608.7 shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splices shall be in accordance with Table R608.5.4(1) and Figure R608.5.4(1). The maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm). See Figure R608.5.4(1).

**R608.5.4.4 Development of bars in tension.** Where bars are required to be developed in tension by other provisions of this code, development lengths and cover for hooks and bar extensions shall comply with Table R608.5.4(1) and Figure R608.5.4(2). The development lengths shown in Table R608.5.4(1) shall apply to bundled bars in lintels installed in accordance with Section R608.8.2.2.

**R608.5.4.5 Standard hooks.** Where reinforcement is required by this code to terminate with a standard hook, the hook shall comply with Figure R608.5.4(3).

**R608.5.4.6 Webs of waffle-grid walls.** Reinforcement, including stirrups, shall not be placed in webs of waffle-grid walls, including lintels. Webs are permitted to have form ties.

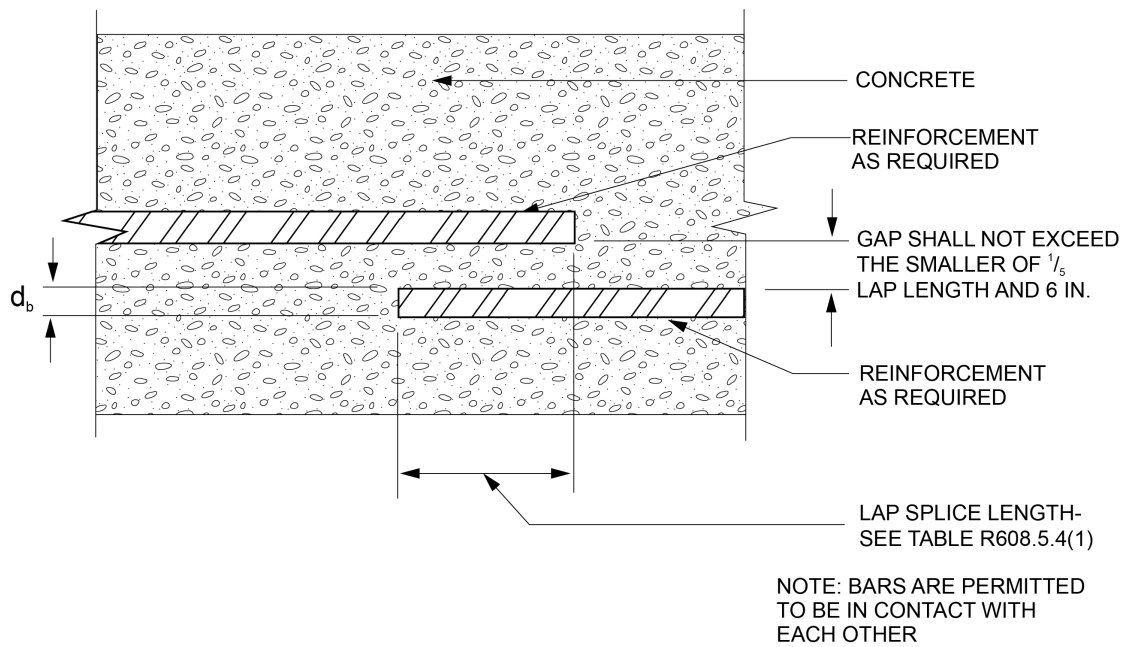
**TABLE R608.5.4(1)**  
**LAP SPLICE AND TENSION DEVELOPMENT LENGTHS**

	BAR SIZE NO.	YIELD STRENGTH OF STEEL, $f_y$ psi (MPa)	
		40,000 (280)	60,000 (420)
		Splice length or tension development length (inches)	
Lap splice length-tension	4	20	30
	5	25	38
	6	30	45
Tension development length for straight bar	4	15	23
	5	19	28
	6	23	34
Tension development length for: a. 90-degree and 180-degree standard hooks with not less than 2½ inches of side cover perpendicular to plane of hook. b. 90-degree standard hooks with not less than 2 inches of cover on the bar extension beyond the hook.	4	6	9
	5	7	11
	6	8	13
Tension development length for bar with 90-degree or 180-degree standard hook having less cover than required in Items a and b.	4	8	12
	5	10	15
	6	12	18

For SI: 1 inch = 25.4 mm, 1 degree = 0.0175 rad, 1 pound per square inch = 6.895 kPa.

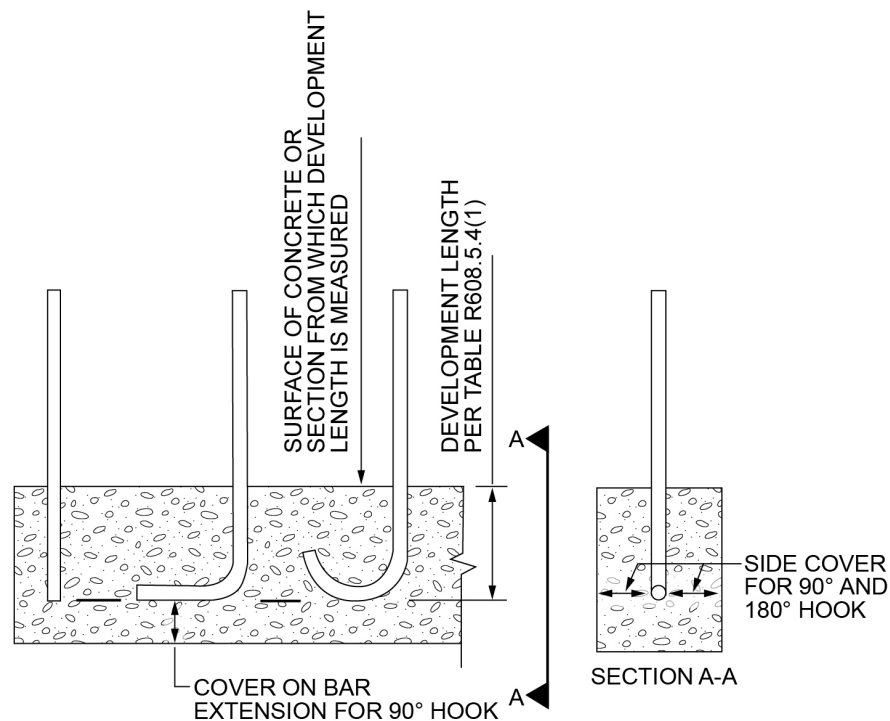


## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**FIGURE R608.5.4(1)**  
**LAP SPLICES**

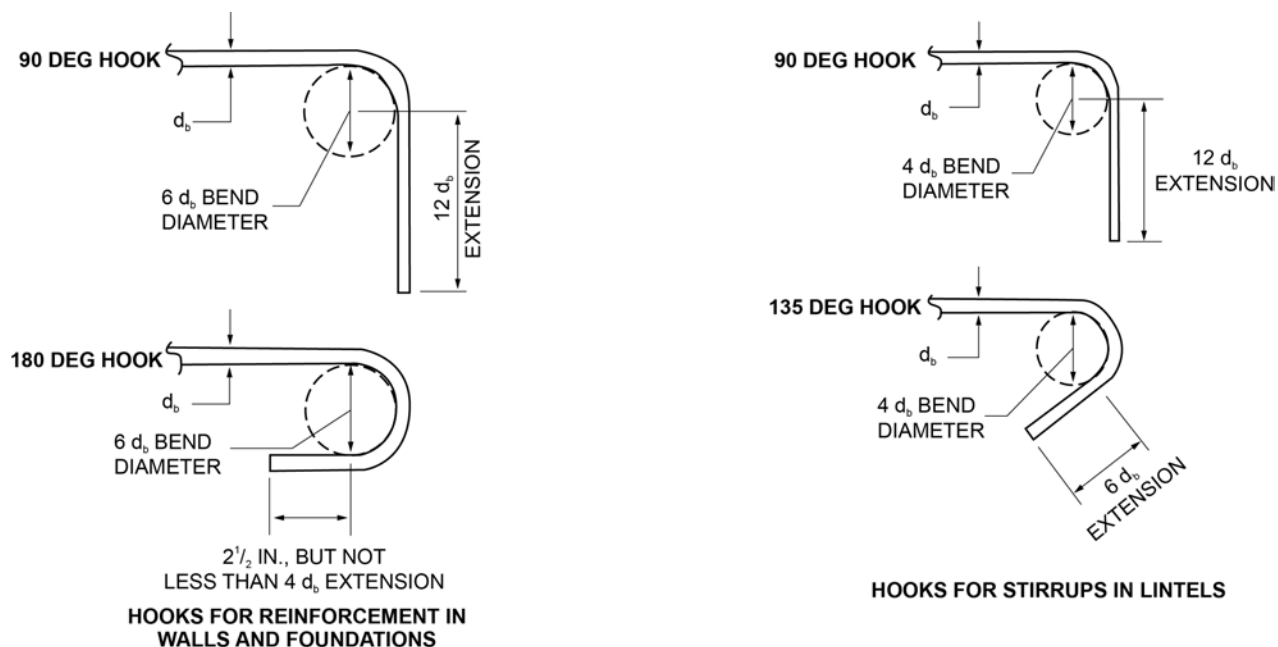


For SI: 1 degree = 0.0175 rad.

**FIGURE R608.5.4(2)**  
**DEVELOPMENT LENGTH AND COVER FOR HOOKS AND BAR EXTENSION**



## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm, 1 degree = 0.0175 rad.

**FIGURE R608.5.4(3)**  
**STANDARD HOOKS**

**R608.5.4.7 Alternate grade of reinforcement and spacing.** Where tables in Sections R404.1.3 and R608.6 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (420 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided an equivalent area of steel per linear foot of wall is provided. Use of Table R608.5.4(2) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables and bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

**R608.5.5 Construction joints in walls.** Construction joints shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Section R608.6, shall be located at points of lateral support, and not less than one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have not less than 12 inches (305 mm) of embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

**Exception:** Vertical wall reinforcement required by this code is permitted to be used in lieu of construction joint reinforcement, provided the spacing does not

exceed 24 inches (610 mm), or the combination of wall reinforcement and No. 4 bars described in Section R608.5.5 does not exceed 24 inches (610 mm).

#### **R608.6 Above-grade wall requirements.**

**R608.6.1 General.** The minimum thickness of load-bearing and nonload-bearing above-grade walls and reinforcement shall be as set forth in the appropriate table in this section based on the type of wall form to be used. The wall shall be designed in accordance with ACI 318 where the wall or building is not within the limitations of Section R608.2, where design is required by the tables in this section or where the wall is not within the scope of the tables in this section.

Above-grade concrete walls shall be constructed in accordance with this section and Figure R608.6(1), R608.6(2), R608.6(3) or R608.6(4). Above-grade concrete walls that are continuous with stem walls and not laterally supported by the slab-on-ground shall be designed and constructed in accordance with this section. Concrete walls shall be supported on continuous foundation walls or slabs-on-ground that are monolithic with the footing in accordance with Section R403. The minimum length of solid wall without openings shall be in accordance with Section R608.7. Reinforcement around openings, including lintels, shall be in accordance with Section R608.8. Lateral support for above-grade walls in the out-of-plane direction shall be provided by connections to the floor framing system, if applicable, and to ceiling and roof framing systems in accordance with Section R608.9. The wall thickness shall be equal to or greater than the thickness of the wall in the story above.

## WALL CONSTRUCTION

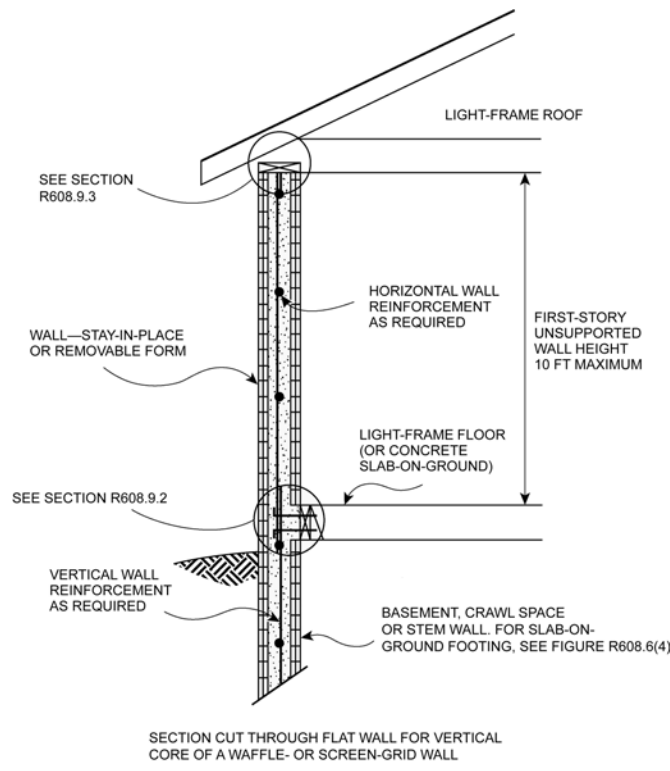
**TABLE R608.5.4(2)**  
**MAXIMUM SPACING FOR ALTERNATIVE BAR SIZE AND ALTERNATIVE GRADE OF STEEL<sup>a, b, c</sup>**

BAR SPACING FROM APPLICABLE TABLE IN SECTION R608.6 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION R608.6														
	#4					#5					#6				
	Alternative bar size and alternative grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternative bar size and alternative grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

For SI: 1 inch = 25.4 mm.

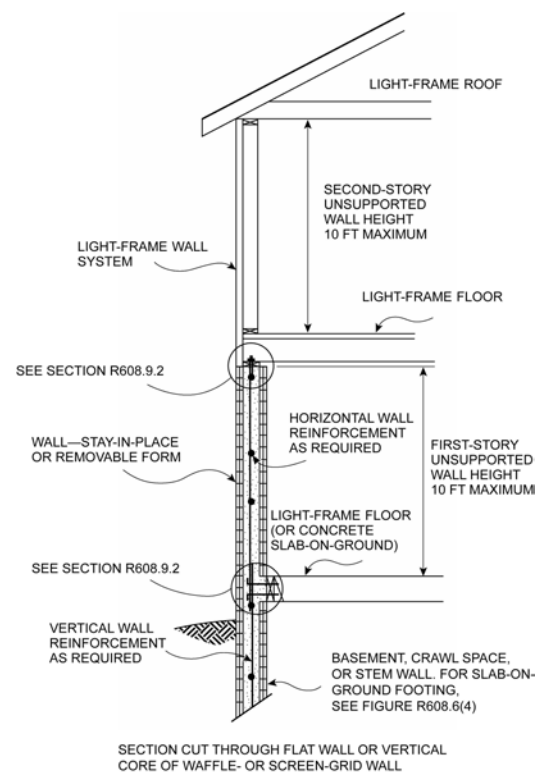
- This table is for use with tables in Section R608.6 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section R608.6 is based on Grade 60 (420 MPa) steel reinforcement.
- Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.
- For Grade 50 (350 MPa) steel bars (ASTM A996, Type R), use spacing for Grade 40 (280 MPa) bars or interpolate between Grade 40 (280 MPa) and Grade 60 (420 MPa).

WALL CONSTRUCTION



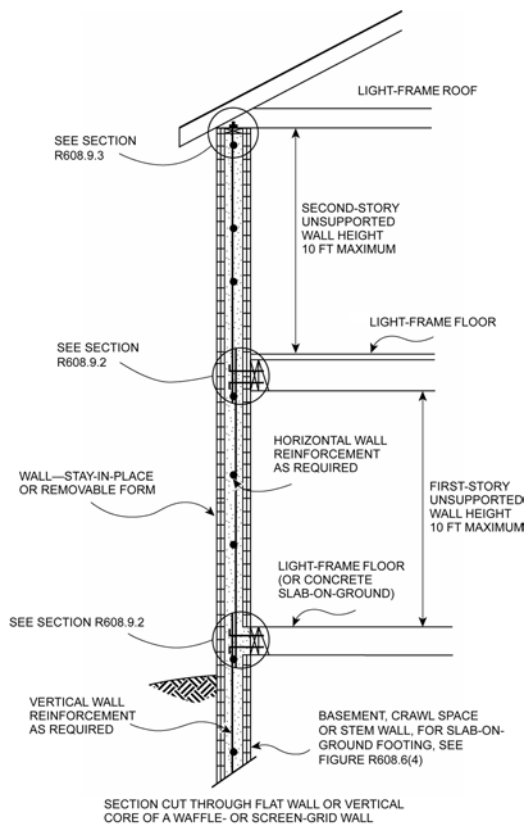
For SI: 1 foot = 304.8 mm.

FIGURE R608.6(1)  
ABOVE-GRADE CONCRETE WALL CONSTRUCTION ONE STORY



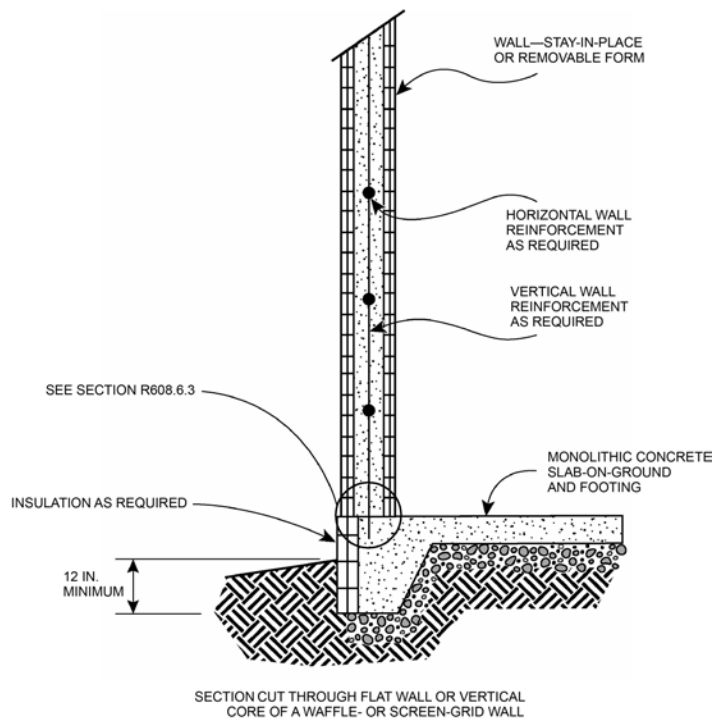
For SI: 1 foot = 304.8 mm.

FIGURE R608.6(2)  
ABOVE-GRADE CONCRETE WALL CONSTRUCTION CONCRETE FIRST STORY AND LIGHT-FRAME SECOND STORY



For SI: 1 foot = 304.8 mm.

**FIGURE R608.6(3)**  
**ABOVE-GRADE CONCRETE WALL CONSTRUCTION TWO-STORY**



For SI: 1 foot = 304.8 mm.

**FIGURE R608.6(4)**  
**ABOVE-GRADE CONCRETE WALL SUPPORTED ON MONOLITHIC SLAB-ON-GROUND FOOTING**

## WALL CONSTRUCTION

**TABLE R608.6(1)**  
**MINIMUM VERTICAL REINFORCEMENT FOR FLAT ABOVE-GRADE WALLS<sup>a, b, c, d, e</sup>**

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) <sup>f, g</sup>								
				Nominal <sup>h</sup> wall thickness (inches)								
Exposure Category				4		6		8		10		
				Top <sup>i</sup>	Side <sup>i</sup>	Top <sup>i</sup>	Side <sup>i</sup>	Top <sup>i</sup>	Side <sup>i</sup>	Top <sup>i</sup>	Side <sup>i</sup>	
115	—	—	8	4@48	4@48	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@48	4@39	4@48	4@48	4@48	4@48	4@48	4@48	
			10	4@41	4@34	4@48	4@48	4@48	4@48	4@48	4@48	
120	—	—	8	4@48	4@43	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@48	4@36	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48	4@48
130	110	—	8	4@48	4@38	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@39	4@34	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48	4@48
140	119	110	8	4@43	4@34	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@34	4@31	4@48	4@48	4@48	4@48	4@48	4@48	4@48
150	127	117	8	4@37	4@34	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@34	4@33	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@31	4@27	4@48	4@48	4@48	4@48	4@48	4@48	4@48
160	136	125	8	4@34	4@34	4@48	4@48	4@48	4@48	4@48	4@48	
			9	4@34	4@29	4@48	4@48	4@48	4@48	4@48	4@48	4@48
			10	4@27	4@24	4@48	4@48	4@48	4@48	4@48	4@48	4@48

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 1.895 kPa, 1 square foot = 0.0929 m<sup>2</sup>.

- Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor,  $K_z$ , equal to 1.0, and Risk Category II.
- Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
- See Section R608.6.5 for location of reinforcement in wall.
- Deflection criterion is  $L/240$ , where  $L$  is the unsupported height of the wall in inches.
- Interpolation is not permitted.
- Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
- Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
- See Table R608.3 for tolerances on nominal thicknesses.
- “Top” means gravity load from roof or floor construction bears on top of wall. “Side” means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing walls where floor framing members span parallel to the wall, use of the “Top” bearing condition is permitted.



**TABLE R608.6(2)**  
**MINIMUM VERTICAL REINFORCEMENT FOR WAFFLE-GRID ABOVE-GRADE WALLS<sup>a, b, c, d, e</sup>**

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) <sup>f, g</sup>			
				Nominal <sup>h</sup> wall thickness (inches)			
Exposure Category				6		8	
				Top <sup>i</sup>	Side <sup>i</sup>	Top <sup>i</sup>	Side <sup>i</sup>
115	—	—	8	4@48	4@48	4@48	4@48
			9	4@48	5@43	4@48	4@48
			10	5@47	5@37	4@48	4@48
120	—	—	8	4@48	5@48	4@48	4@48
			9	4@48	5@40	4@48	4@48
			10	5@43	5@37	4@48	4@48
130	110	—	8	4@48	5@42	4@48	4@48
			9	5@45	5@37	4@48	4@48
			10	5@37	5@37	4@48	4@48
140	119	110	8	4@48	5@38	4@48	4@48
			9	5@39	5@37	4@48	4@48
			10	5@37	5@35	4@48	4@48
150	127	117	8	5@43	5@37	4@48	4@48
			9	5@37	5@37	4@48	4@48
			10	5@36	6@44	4@48	4@48
160	136	125	8	5@38	5@37	4@48	4@48
			9	5@37	6@47	4@48	4@48
			10	6@45	6@39	4@48	6@46

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m<sup>2</sup>.

- Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor,  $K_{zt}$ , equal to 1.0, and Risk Category II.
- Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
- See Section R608.6.5 for location of reinforcement in wall.
- Deflection criterion is  $L/240$ , where  $L$  is the unsupported height of the wall in inches.
- Interpolation is not permitted.
- Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
- Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
- See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.
- “Top” means gravity load from roof or floor construction bears on top of wall. “Side” means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing walls and where floor framing members span parallel to the wall, the “top” bearing condition is permitted to be used.

## WALL CONSTRUCTION

**TABLE R608.6(3)**  
**MINIMUM VERTICAL REINFORCEMENT FOR 6-INCH SCREEN-GRID ABOVE-GRADE WALLS<sup>a, b, c, d, e</sup>**

MAXIMUM WIND SPEED (mph)			MAXIMUM UNSUPPORTED WALL HEIGHT PER STORY (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) <sup>f, g</sup>	
				Nominal <sup>h</sup> wall thickness (inches)	
Exposure Category				6	
B	C	D		Top <sup>i</sup>	Side <sup>i</sup>
115	—	—	8	4@48	4@48
			9	4@48	5@41
			10	4@48	6@48
120	—	—	8	4@48	4@48
			9	4@48	5@38
			10	5@42	6@48
130	110	—	8	4@48	5@41
			9	5@44	6@48
			10	5@35	6@48
140	119	110	8	4@48	5@36
			9	5@38	6@48
			10	6@48	6@48
150	127	117	8	5@42	6@48
			9	6@48	6@48
			10	6@48	6@42
160	136	125	8	5@37	6@48
			9	6@48	6@45
			10	6@44	6@38

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m<sup>2</sup>.

- Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor,  $K_z$ , equal to 1.0, and Risk Category II.
- Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
- See Section R608.6.5 for location of reinforcement in wall.
- Deflection criterion is  $L/240$ , where  $L$  is the unsupported height of the wall in inches.
- Interpolation is not permitted.
- Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
- Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi or bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
- See Table R608.3 for minimum core dimensions and maximum spacing of horizontal and vertical cores.
- "Top" means gravity load from roof or floor construction bears on top of wall. "Side" means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. For nonload-bearing wall and where floor framing members span parallel to the wall, use of the "Top" bearing condition is permitted.

## WALL CONSTRUCTION

**TABLE R608.6(4)**  
**MINIMUM VERTICAL REINFORCEMENT FOR FLAT, WAFFLE- AND SCREEN-GRID**  
**ABOVE-GRADE WALLS DESIGNED CONTINUOUS WITH FOUNDATION STEM WALLS<sup>a, b, c, d, e, k</sup>**

MAXIMUM WIND SPEED (mph)			HEIGHT OF STEM WALL <sup>h, i</sup> (feet)	MAXIMUM DESIGN LATERAL SOIL LOAD (psf/ft)	MAXIMUM UNSUP- PORTED HEIGHT OF ABOVE-GRADE WALL (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches) <sup>f, g</sup>						
						Wall type and nominal thickness <sup>j</sup> (inches)						
						Flat				Waffle		Screen
B	C	D				4	6	8	10	6	8	6
115	—	—	3	30	8	4@30	4@48	4@48	4@48	4@22	4@26	4@21
					10	4@23	5@43	4@48	4@48	4@17	4@20	4@16
				60	10	4@19	5@37	4@48	4@48	4@14	4@17	4@14
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
120	—	—	3	30	8	4@28	4@48	4@48	4@48	4@21	4@48	4@20
					10	4@22	5@41	4@48	4@48	4@16	4@19	4@15
				60	10	4@18	5@35	4@48	4@48	4@14	4@17	4@13
			6	30	10	DR	5@21	6@35	4@48	DR	4@10	DR
				60	10	DR	5@12	6@25	6@28	DR	DR	DR
130	110	—	3	30	8	4@25	4@48	4@48	4@48	4@18	4@22	4@18
					10	4@19	5@36	4@48	4@48	4@14	4@17	4@13
				60	10	4@16	5@34	4@48	4@48	4@12	4@17	4@12
			6	30	10	DR	5@19	6@35	4@48	DR	4@9	DR
				60	10	DR	5@12	6@24	6@28	DR	DR	DR
140	119	110	3	30	8	4@22	5@42	4@48	4@48	4@16	4@20	4@16
					10	4@17	5@34	4@48	4@48	4@21	4@17	4@12
				60	10	4@15	5@34	4@48	4@48	4@11	4@17	4@10
			6	30	10	DR	5@18	6@35	6@35	DR	4@48	DR
				60	10	DR	5@11	6@23	6@28	DR	DR	DR
150	127	117	3	30	8	4@20	5@37	4@48	4@48	4@15	4@18	4@14
					10	4@15	5@34	4@48	4@48	4@11	4@17	4@11
				60	10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
			6	30	10	DR	5@17	6@33	6@32	DR	4@8	DR
				60	10	DR	DR	6@22	6@28	DR	DR	DR
160	136	125	3	30	8	4@18	5@34	4@48	4@48	4@13	4@17	4@13
					10	4@13	5@34	4@48	4@48	4@10	4@16	4@9
				60	10	4@11	5@31	6@45	4@48	4@9	4@14	4@8
			6	30	10	DR	5@15	6@31	6@30	DR	4@7	DR
				60	10	DR	DR	6@21	6@27	DR	DR	DR

(continued)

## WALL CONSTRUCTION

**TABLE R608.6(4)—continued**  
**MINIMUM VERTICAL REINFORCEMENT FOR FLAT, WAFFLE- AND SCREEN-GRID**  
**ABOVE-GRADE WALLS DESIGNED CONTINUOUS WITH FOUNDATION STEM WALLS<sup>a, b, c, d, e, k</sup>**

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound per square inch = 6.895 kPa, 1 square foot = 0.0929 m<sup>2</sup>.

DR = Design Required.

- a. Table is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 feet, interior wall area 4, an effective wind area of 10 square feet, topographic factor,  $K_{zt}$ , equal to 1.0, and Risk Category II.
- b. Table is based on concrete with a minimum specified compressive strength of 2,500 psi.
- c. See Section R608.6.5 for location of reinforcement in wall.
- d. Deflection criterion is  $L/240$ , where  $L$  is the height of the wall in inches from the exterior finish ground level to the top of the above-grade wall.
- e. Interpolation is not permitted. For intermediate values of basic wind speed, heights of stem wall and above-grade wall, and design lateral soil load, use next higher value.
- f. Where No. 4 reinforcing bars at a spacing of 48 inches are specified in the table as indicated by shaded cells, use of bars with a minimum yield strength of 40,000 psi or 60,000 psi is permitted.
- g. Other than for No. 4 bars spaced at 48 inches on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi. Maximum spacings shown are the values calculated for the specified bar size. In waffle and screen-grid walls where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches such as, 12, 24, 36 and 48, that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section R608.5.4.7 and Table R608.5.4(2).
- h. Height of stem wall is the distance from the exterior finish ground level to the top of the slab-on-ground.
- i. Where the distance from the exterior finish ground level to the top of the slab-on-ground is equal to or greater than 4 feet, the stem wall shall be laterally supported at the top and bottom before backfilling. Where the wall is designed and constructed to be continuous with the above-grade wall, temporary supports bracing the top of the stem wall shall remain in place until the above-grade wall is laterally supported at the top by floor or roof construction.
- j. See Table R608.3 for tolerances on nominal thicknesses, and minimum core dimensions and maximum spacing of horizontal and vertical cores for waffle- and screen-grid walls.
- k. Tabulated values are applicable to construction where gravity loads bear on top of wall, and conditions where gravity loads from floor construction are transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall. See Tables R608.6(1), R608.6(2) and R608.6(3).

**R608.6.2 Wall reinforcement for wind.** Vertical wall reinforcement for resistance to out-of-plane wind forces shall be determined from Table R608.6(1), R608.6(2), R608.6(3) or R608.6(4). For the design of nonload-bearing walls, in Tables R608.6(1), R608.6(2) and R608.6(3) use the appropriate column labeled “Top.” (see Sections R608.7.2.2.2 and R608.7.2.2.3). There shall be a vertical bar at corners of exterior walls. Unless more horizontal reinforcement is required by Section R608.7.2.2.1, the minimum horizontal reinforcement shall be four No. 4 bars [Grade 40 (280 MPa)] placed as follows: top bar within 12 inches (305 mm) of the top of the wall, bottom bar within 12 inches (305 mm) of the finish floor and one bar each at approximately one-third and two-thirds of the wall height.

**R608.6.3 Continuity of wall reinforcement between stories.** Vertical reinforcement required by this section shall be continuous between elements providing lateral support for the wall. Reinforcement in the wall of the *story* above shall be continuous with the reinforcement in the wall of the *story* below, or the foundation wall, if applicable. Lap splices, where required, shall comply with Section R608.5.4.3 and Figure R608.5.4(1). Where the above-grade wall is supported by a monolithic slab-on-ground and footing, dowel bars with a size and spacing to match the vertical above-grade concrete wall reinforcement shall be embedded in the monolithic slab-on-ground and footing the distance required to develop the dowel bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2) and lap-spliced with the above-grade wall reinforcement in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

Where a construction joint in the wall is located below the level of the floor and less than the distance required to develop the bar in tension, the distance required to

develop the bar in tension shall be measured from the top of the concrete below the joint. See Section R608.5.5.

**Exception:** Where reinforcement in the wall above cannot be made continuous with the reinforcement in the wall below, the bottom of the reinforcement in the wall above shall be terminated in accordance with one of the following:

1. Extend below the top of the floor the distance required to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2).
2. Lap-spliced in accordance with Section R608.5.4.3 and Figure R608.5.4(1) with a dowel bar that extends into the wall below the distance required to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2).

**R608.6.4 Termination of reinforcement.** Where indicated in Items 1 through 3, vertical wall reinforcement in the top-most *story* with concrete walls shall be terminated with a 90-degree (1.57 rad) standard hook complying with Section R608.5.4.5 and Figure R608.5.4(3).

1. Vertical bars adjacent to door and window openings required by Section R608.8.1.2.
2. Vertical bars at the ends of required solid wall segments (see Section R608.7.2.2.2).
3. Vertical bars (other than end bars, see Item 2) used as shear reinforcement in required solid wall segments where the reduction factor for design strength,  $R_3$ , used is based on the wall having horizontal and vertical shear reinforcement (see Section R608.7.2.2.3).

The bar extension of the hook shall be oriented parallel to the horizontal wall reinforcement and be within 4 inches (102 mm) of the top of the wall.

Horizontal reinforcement shall be continuous around the building corners by bending one of the bars and lap-splicing it with the bar in the other wall in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

In required solid wall segments where the reduction factor for design strength,  $R_3$ , is based on the wall having horizontal and vertical shear reinforcement in accordance with Section R608.7.2.2.1, horizontal wall reinforcement shall be terminated with a standard hook complying with Section R608.5.4.5 and Figure R608.5.4(3) or in a lap-splice, except at corners where the reinforcement shall be continuous as required.

**Exception:** In lieu of bending horizontal reinforcement at corners, separate bent reinforcing bars shall be permitted provided that the bent bar is lap-spliced with the horizontal reinforcement in both walls in accordance with Section R608.5.4.3 and Figure R608.5.4(1).

**R608.6.5 Location of reinforcement in wall.** Except for vertical reinforcement at the ends of required solid wall segments, which shall be located as required by Section R608.7.2.2.2, the location of the vertical reinforcement shall not vary from the center of the wall by more than the greater of 10 percent of the wall thickness and  $\frac{3}{8}$ -inch (10 mm). Horizontal and vertical reinforcement shall be located to provide not less than the minimum cover required by Section R608.5.4.1.

## R608.7 Solid walls for resistance to lateral forces.

**R608.7.1 Length of solid wall.** Each exterior wall line in each *story* shall have a total length of solid wall required by Section R608.7.1.1. A solid wall is a section of flat, waffle-grid or screen-grid wall, extending the full *story height* without openings or penetrations, except those permitted by Section R608.7.2. Solid wall segments that contribute to the total length of solid wall shall comply with Section R608.7.2.

**R608.7.1.1 Length of solid wall for wind.** Buildings shall have solid walls in each exterior endwall line (the side of a building that is parallel to the span of the roof or floor framing) and sidewall line (the side of a building that is perpendicular to the span of the roof or floor framing) to resist lateral in-plane wind forces. The site-appropriate basic wind speed and exposure category shall be used in Tables R608.7.1.1(1) through (3) to determine the unreduced total length,  $UR$ , of solid wall required in each exterior endwall line and sidewall line. For buildings with a mean roof height of less than 35 feet (10 668 mm), the unreduced values determined from Tables R608.7.1.1(1) through (3) are permitted to be reduced by multiplying by the applicable factor,  $R_1$ , from Table R608.7.1.1(4); however,

reduced values shall be not less than the minimum values in Tables R608.7.1.1(1) through (3). Where the floor-to-ceiling height of a *story* is less than 10 feet (3048 mm), the unreduced values determined from Tables R608.7.1.1(1) through (3), including minimum values, are permitted to be reduced by multiplying by the applicable factor,  $R_2$ , from Table R608.7.1.1(5). To account for different design strengths than assumed in determining the values in Tables R608.7.1.1(1) through (3), the unreduced lengths determined from Tables R608.7.1.1(1) through (3), including minimum values, are permitted to be reduced by multiplying by the applicable factor,  $R_3$ , from Table R608.7.1.1(6). The reductions permitted by Tables R608.7.1.1(4), R608.7.1.1(5) and R608.7.1.1(6) are cumulative.

The total length of solid wall segments,  $TL$ , in a wall line that comply with the minimum length requirements of Section R608.7.2.1 [see Figure R608.7.1.1(1)] shall be equal to or greater than the product of the unreduced length of solid wall from Tables R608.7.1.1(1) through (3),  $UR$  and the applicable reduction factors, if any, from Tables R608.7.1.1(4), R608.7.1.1(5) and R608.7.1.1(6) as indicated by Equation R6-1.

$$TL \geq R_1 \times R_2 \times R_3 \times UR \quad (\text{Equation R6-1})$$

where:

$TL$  = Total length of solid wall segments in a wall line that comply with Section R608.7.2.1 [see Figure R608.7.1.1(1)].

$R_1$  = 1.0 or reduction factor for mean roof height from Table R608.7.1.1(4).

$R_2$  = 1.0 or reduction factor for floor-to-ceiling wall height from Table R608.7.1.1(5).

$R_3$  = 1.0 or reduction factor for design strength from Table R608.7.1.1(6).

$UR$  = Unreduced length of solid wall from Tables R608.7.1.1(1) through (3).

The total length of solid wall in a wall line,  $TL$ , shall be not less than that provided by two solid wall segments complying with the minimum length requirements of Section R608.7.2.1.

To facilitate determining the required wall thickness, wall type, number and *grade* of vertical bars at each end of each solid wall segment, and whether shear reinforcement is required, use of Equation R6-2 is permitted.

$$R_3 \leq \frac{TL}{R_1 \times R_2 \times UR} \quad (\text{Equation R6-2})$$

After determining the maximum permitted value of the reduction factor for design strength,  $R_3$ , in accordance with Equation R6-2, select a wall type from Table R608.7.1.1(6) with  $R_3$  less than or equal to the value calculated.



## WALL CONSTRUCTION

**TABLE R608.7.1.1(1)**  
**UNREDUCED LENGTH,  $U_R$ , OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL**  
**FOR WIND PERPENDICULAR TO RIDGE ONE STORY OR TOP STORY OF TWO STORY<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, $U_R$ , OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum <sup>b</sup>
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
15	15	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	0.92
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.15
		7:12	2.00	2.18	2.56	2.97	3.41	3.88	1.25
		12:12	3.20	3.48	4.09	4.74	5.44	6.19	1.54
	30	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	0.98
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.43
		7:12	2.78	3.03	3.56	4.13	4.74	5.39	1.64
		12:12	5.17	5.63	6.61	7.67	8.80	10.01	2.21
	45	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	1.04
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	1.72
		7:12	3.57	3.88	4.56	5.28	6.07	6.90	2.03
		12:12	7.15	7.78	9.13	10.59	12.16	13.84	2.89
	60	< 1:12	1.03	1.12	1.32	1.53	1.76	2.00	1.09
		5:12	1.43	1.56	1.83	2.12	2.43	2.77	2.01
		7:12	4.35	4.73	5.55	6.44	7.39	8.41	2.42
		12:12	9.12	9.93	11.66	13.52	15.52	17.66	3.57
30	15	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	1.82
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	2.23
		7:12	3.61	3.93	4.61	5.34	6.13	6.98	2.42
		12:12	5.61	6.10	7.16	8.31	9.54	10.85	2.93
	30	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	1.93
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	2.75
		7:12	4.92	5.35	6.28	7.29	8.37	9.52	3.12
		12:12	8.92	9.71	11.39	13.22	15.17	17.26	4.14
	45	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	2.03
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	3.26
		7:12	6.23	6.78	7.96	9.23	10.60	12.06	3.82
		12:12	12.23	13.31	15.63	18.12	20.80	23.67	5.36
	60	< 1:12	1.84	2.01	2.35	2.73	3.13	3.57	2.14
		5:12	2.56	2.78	3.27	3.79	4.35	4.95	3.78
		7:12	7.54	8.21	9.64	11.17	12.83	14.60	4.52
		12:12	15.54	16.92	19.86	23.03	26.44	30.08	6.57

(continued)

**TABLE R608.7.1.1(1)—continued**  
**UNREDUCED LENGTH,  $U_R$ , OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL**  
**FOR WIND PERPENDICULAR TO RIDGE ONE STORY OR TOP STORY OF TWO STORY<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, $U_R$ , OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum <sup>b</sup>
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
60	15	< 1:12	3.42	3.72	4.36	5.06	5.81	6.61	3.63
		5:12	4.75	5.17	6.06	7.03	8.07	9.19	4.40
		7:12	6.76	7.36	8.64	10.02	11.51	13.09	4.75
		12:12	10.35	11.27	13.23	15.34	17.61	20.04	5.71
	30	< 1:12	3.42	3.72	4.36	5.06	5.81	6.61	3.83
		5:12	4.75	5.17	6.06	7.03	8.07	9.19	5.37
		7:12	9.12	9.93	11.66	13.52	15.52	17.66	6.07
		12:12	16.30	17.75	20.83	24.16	27.73	31.55	8.00
	45	< 1:12	3.55	3.87	4.54	5.27	6.05	6.88	4.03
		5:12	4.94	5.37	6.31	7.31	8.40	9.55	6.34
		7:12	11.71	12.75	14.97	17.36	19.93	22.67	7.39
		12:12	22.70	24.71	29.00	33.64	38.62	43.94	10.29
	60	< 1:12	3.68	4.01	4.71	5.46	6.27	7.13	4.23
		5:12	5.11	5.57	6.54	7.58	8.70	9.90	7.31
		7:12	14.38	15.66	18.37	21.31	24.46	27.83	8.71
		12:12	29.30	31.90	37.44	43.42	49.85	56.72	12.57

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound-force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

- Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor,  $K_{zt}$ , equal to 1.0, and Risk Category II. For wind perpendicular to the ridge, the effects of a 2-foot overhang on each endwall are included. The design pressures were used to calculate forces to be resisted by solid wall segments in each. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length,  $U_R$ , of solid wall length required in each endwall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.
- Tabulated lengths in the “minimum” column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 16 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the “minimum” value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.
- For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor,  $R_1$ , from Table R608.7.1.1(4). The reduced length shall be not less than the “minimum” value shown in the table.
- Tabulated lengths for “one story or top story of two story” are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for “first story of two story” are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.1.1(2) or (3), or multiply the value in the table by the reduction factor,  $R_2$ , from Table R608.7.1.1(5).
- Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength,  $R_3$ , from Table R608.7.1.1(6).
- The reduction factors,  $R_1$ ,  $R_2$  and  $R_3$ , in Tables R608.7.1.1(4), R608.7.1.1(5), and R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid wall segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.
- For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

## WALL CONSTRUCTION

**TABLE R608.7.1.1(2)**  
**UNREDUCED LENGTH, *U<sub>R</sub>*, OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL**  
**FOR WIND PERPENDICULAR TO RIDGE FIRST STORY OF TWO STORY<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, <i>U<sub>R</sub></i> , OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum <sup>b</sup>
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
15	15	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.54
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	2.76
		7:12	4.31	4.70	5.51	6.39	7.34	8.35	2.87
		12:12	5.51	6.00	7.04	8.16	9.37	10.66	3.15
	30	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.59
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.05
		7:12	5.09	5.55	6.51	7.55	8.67	9.86	3.26
		12:12	7.48	8.15	9.56	11.09	12.73	14.49	3.83
	45	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.65
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.34
		7:12	5.88	6.40	7.51	8.71	10.00	11.37	3.65
		12:12	9.46	10.30	12.09	14.02	16.09	18.31	4.51
	60	< 1:12	2.98	3.25	3.81	4.42	5.07	5.77	2.71
		5:12	4.13	4.50	5.28	6.12	7.03	8.00	3.63
		7:12	6.66	7.25	8.51	9.87	11.32	12.89	4.04
		12:12	11.43	12.45	14.61	16.94	19.45	22.13	5.19
30	15	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.06
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	5.47
		7:12	7.94	8.65	10.15	11.77	13.51	15.37	5.65
		12:12	9.94	10.82	12.70	14.73	16.91	19.24	6.17
	30	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.16
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	5.98
		7:12	9.25	10.07	11.82	13.71	15.74	17.91	6.35
		12:12	13.25	14.43	16.93	19.64	22.54	25.65	7.38
	45	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.27
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	6.50
		7:12	10.56	11.50	13.50	15.65	17.97	20.45	7.06
		12:12	16.56	18.03	21.16	24.55	28.18	32.06	8.60
	60	< 1:12	5.32	5.79	6.80	7.89	9.05	10.30	5.38
		5:12	7.39	8.04	9.44	10.95	12.57	14.30	7.01
		7:12	11.87	12.93	15.17	17.60	20.20	22.98	7.76
		12:12	19.87	21.64	25.40	29.45	33.81	38.47	9.81

(continued)

**TABLE R608.7.1.1(2)—continued**  
**UNREDUCED LENGTH,  $U_R$ , OF SOLID WALL REQUIRED IN EACH EXTERIOR ENDWALL**  
**FOR WIND PERPENDICULAR TO RIDGE FIRST STORY OF TWO STORY<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, $U_R$ , OF SOLID WALL REQUIRED IN ENDWALLS FOR WIND PERPENDICULAR TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						
			115B	120B	130B	140B	150B	160B	Minimum <sup>b</sup>
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
60	15	< 1:12	9.87	10.74	12.61	14.62	16.79	19.10	10.10
		5:12	13.71	14.93	17.52	20.32	23.33	26.54	10.87
		7:12	15.08	16.42	19.27	22.35	25.66	29.20	11.22
		12:12	18.67	20.33	23.86	27.67	31.77	36.14	12.19
	30	< 1:12	9.87	10.74	12.61	14.62	16.79	19.10	10.30
		5:12	13.71	14.93	17.52	20.32	23.33	26.54	11.85
		7:12	17.44	18.99	22.29	25.85	29.67	33.76	12.54
		12:12	24.62	26.81	31.46	36.49	41.89	47.66	14.48
	45	< 1:12	10.27	11.18	13.12	15.21	17.47	19.87	10.50
		5:12	14.26	15.52	18.22	21.13	24.26	27.60	12.82
		7:12	20.21	22.01	25.83	29.95	34.39	39.12	13.86
		12:12	31.20	33.97	39.87	46.23	53.07	60.39	16.76
	60	< 1:12	10.64	11.59	13.60	15.77	18.11	20.60	10.70
		5:12	14.77	16.09	18.88	21.90	25.14	28.60	13.79
		7:12	23.05	25.09	29.45	34.15	39.21	44.61	15.18
		12:12	37.97	41.34	48.52	56.27	64.60	73.49	19.05

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

- Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor,  $K_{zt}$ , equal to 1.0, and Risk Category II. For wind perpendicular to the ridge, the effects of a 2-foot overhang on each endwall are included. The design pressures were used to calculate forces to be resisted by solid wall segments in each endwall. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length,  $U_R$ , of solid wall length required in each endwall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.
- Tabulated lengths in the “minimum” column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 1016 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the “minimum” value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.
- For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor,  $R_1$ , from Table R608.7.1.1(4). The reduced length shall be not less than the “minimum” value shown in the table.
- Tabulated lengths for “one story or top story of two story” are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for “first story of two story” are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.7.1.1(1) or R608.7.1.1(3), or multiply the value in the table by the reduction factor,  $R_2$ , from Table R608.7.1.1(5).
- Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength,  $R_3$ , from Table R608.7.1.1(6).
- The reduction factors,  $R_1$ ,  $R_2$  and  $R_3$ , in Tables R608.7.1.1(4), R608.7.1.1(5), and R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid wall segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.
- For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

## WALL CONSTRUCTION

**TABLE R608.7.1.1(3)**  
**UNREDUCED LENGTH, *U<sub>R</sub>*, OF SOLID WALL REQUIRED IN EACH EXTERIOR SIDEWALL FOR WIND PARALLEL TO RIDGE<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, <i>U<sub>R</sub></i> , OF SOLID WALL REQUIRED IN SIDEWALLS FOR WIND PARALLEL TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						Minimum <sup>b</sup>
			115B	120B	130B	140B	150B	160B	
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
One story or top story of two story									
< 30	15	< 1:12	1.08	1.18	1.39	1.61	1.84	2.10	0.90
		5:12	1.29	1.40	1.65	1.91	2.19	2.49	1.08
		7:12	1.38	1.50	1.76	2.04	2.35	2.67	1.17
		12:12	1.63	1.78	2.09	2.42	2.78	3.16	1.39
	30	< 1:12	2.02	2.20	2.59	3.00	3.44	3.92	1.90
		5:12	2.73	2.97	3.48	4.04	4.64	5.28	2.62
		7:12	3.05	3.32	3.89	4.51	5.18	5.89	2.95
		12:12	3.93	4.27	5.02	5.82	6.68	7.60	3.86
	45	< 1:12	3.03	3.30	3.87	4.49	5.15	5.86	2.99
		5:12	4.55	4.96	5.82	6.75	7.74	8.81	4.62
		7:12	5.24	5.71	6.70	7.77	8.92	10.15	5.36
		12:12	7.16	7.79	9.14	10.61	12.17	13.85	7.39
	60	< 1:12	4.11	4.47	5.25	6.09	6.99	7.96	4.18
		5:12	6.78	7.39	8.67	10.05	11.54	13.13	7.07
		7:12	8.00	8.71	10.22	11.85	13.61	15.48	8.38
		12:12	11.35	12.36	14.51	16.82	19.31	21.97	12.00
60	45	< 1:12	3.17	3.46	4.06	4.70	5.40	6.14	2.99
		5:12	4.75	5.18	6.07	7.04	8.09	9.20	4.62
		7:12	5.47	5.96	6.99	8.11	9.31	10.59	5.36
		12:12	7.45	8.11	9.52	11.04	12.68	14.43	7.39
	60	< 1:12	4.41	4.81	5.64	6.54	7.51	8.54	4.18
		5:12	7.22	7.86	9.23	10.70	12.29	13.98	7.07
		7:12	8.50	9.25	10.86	12.59	14.46	16.45	8.38
		12:12	12.02	13.09	15.36	17.81	20.45	23.27	12.00

(continued)



**TABLE R608.7.1.1(3)—continued**  
**UNREDUCED LENGTH,  $UR$ , OF SOLID WALL REQUIRED IN EACH EXTERIOR SIDEWALL FOR WIND PARALLEL TO RIDGE<sup>a, c, d, e, f, g</sup>**

SIDEWALL LENGTH (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	UNREDUCED LENGTH, $UR$ , OF SOLID WALL REQUIRED IN SIDEWALLS FOR WIND PARALLEL TO RIDGE (feet)						
			Basic Wind Speed (mph) Exposure						Minimum <sup>b</sup>
			115B	120B	130B	140B	150B	160B	
			—	—	110C	119C	127C	136C	
			—	—	—	110D	117D	125D	
			One story or top story of two story						
< 30	15	< 1:12	3.03	3.30	3.88	4.49	5.16	5.87	2.52
		5:12	3.24	3.52	4.14	4.80	5.51	6.26	2.70
		7:12	3.33	3.62	4.25	4.93	5.66	6.44	2.79
		12:12	3.58	3.90	4.58	5.31	6.10	6.94	3.01
	30	< 1:12	5.50	5.99	7.03	8.16	9.36	10.65	5.14
		5:12	6.21	6.76	7.93	9.20	10.56	12.01	5.86
		7:12	6.52	7.10	8.34	9.67	11.10	12.63	6.19
		12:12	7.41	8.06	9.46	10.97	12.60	14.33	7.10
	45	< 1:12	8.00	8.71	10.22	11.85	13.61	15.48	7.85
		5:12	9.52	10.37	12.17	14.11	16.20	18.43	9.48
		7:12	10.21	11.12	13.05	15.14	17.38	19.77	10.21
		12:12	12.13	13.20	15.50	17.97	20.63	23.47	12.25
	60	< 1:12	10.56	11.50	13.50	15.65	17.97	20.44	10.65
		5:12	13.24	14.41	16.91	19.62	22.52	25.62	13.54
		7:12	14.45	15.73	18.46	21.41	24.58	27.97	14.85
		12:12	17.80	19.38	22.75	26.38	30.29	34.46	18.48
60	45	< 1:12	8.39	9.14	10.72	12.44	14.28	16.25	7.85
		5:12	9.97	10.86	12.74	14.78	16.97	19.30	9.48
		7:12	10.69	11.64	13.66	15.84	18.19	20.69	10.21
		12:12	12.67	13.80	16.19	18.78	21.56	24.53	12.25
	60	< 1:12	11.37	12.38	14.53	16.85	19.35	22.01	10.65
		5:12	14.18	15.44	18.12	21.02	24.13	27.45	13.54
		7:12	15.46	16.83	19.75	22.91	26.29	29.92	14.85
		12:12	18.98	20.66	24.25	28.13	32.29	36.74	18.48

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound force per linear foot = 0.146 kN/m, 1 pound per square foot = 47.88 Pa.

- Tabulated lengths were derived by calculating design wind pressures in accordance with Figure 28.4-1 of ASCE 7 for a building with a mean roof height of 35 feet, topographic factor,  $K_{zt}$ , equal to 1.0, and Risk Category II. The design pressures were used to calculate forces to be resisted by solid wall segments in each sidewall. The forces to be resisted by each wall line were then divided by the default design strength of 840 pounds per linear foot of length to determine the unreduced length,  $UR$ , of solid wall length required in each sidewall. The actual mean roof height of the building shall not exceed the least horizontal dimension of the building.
- Tabulated lengths in the “minimum” column are based on the requirement of Section 28.4.4 of ASCE 7 that the main windforce-resisting system be designed for a minimum pressure of 16 psf multiplied by the wall area of the building and 8 psf multiplied by the roof area of the building projected onto a vertical plane normal to the assumed wind direction. Tabulated lengths in shaded cells are less than the “minimum” value. Where the minimum controls, it is permitted to be reduced in accordance with Notes c, d and e. See Section R608.7.1.1.
- For buildings with a mean roof height of less than 35 feet, tabulated lengths are permitted to be reduced by multiplying by the appropriate factor,  $R_1$ , from Table R608.7.1.1(4). The reduced length shall be not less than the “minimum” value shown in the table.
- Tabulated lengths for “one story or top story of two story” are based on a floor-to-ceiling height of 10 feet. Tabulated lengths for “first story of two story” are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor-to-ceiling heights less than assumed, use the lengths in this table or Table R608.7.1.1(1) or Table R608.7.1.1(2), or multiply the value in the table by the reduction factor,  $R_2$ , from Table R608.7.1.1(5).
- Tabulated lengths are based on the default design shear strength of 840 pounds per linear foot of solid wall segment. The tabulated lengths are permitted to be reduced by multiplying by the applicable reduction factor for design strength,  $R_3$ , from Table R608.7.1.1(6).
- The reduction factors,  $R_1$ ,  $R_2$  and  $R_3$ , in Table R608.7.1.1(4), Table R608.7.1.1(5), and Table R608.7.1.1(6), respectively, are permitted to be compounded, subject to the limitations of Note b. However, the minimum number and minimum length of solid walls segments in each wall line shall comply with Sections R608.7.1 and R608.7.2.1, respectively.
- For intermediate values of sidewall length, endwall length, roof slope and basic wind speed, use the next higher value, or determine by interpolation.

## WALL CONSTRUCTION

**TABLE R608.7.1.1(4)**  
**REDUCTION FACTOR,  $R_1$ , FOR BUILDINGS WITH MEAN ROOF HEIGHT LESS THAN 35 FEET<sup>a</sup>**

MEAN ROOF HEIGHT <sup>b, c</sup> (feet)	REDUCTION FACTOR $R_1$ , FOR MEAN ROOF HEIGHT		
	Exposure category		
	B	C	D
< 15	0.96	0.84	0.87
20	0.96	0.89	0.91
25	0.96	0.93	0.94
30	0.96	0.97	0.98
35	1.00	1.00	1.00

For SI: 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

- a. See Section R608.7.1.1 and Note c to Table R608.7.1.1(1) for application of reduction factors in this table. This reduction is not permitted for “minimum” values.
- b. For intermediate values of mean roof height, use the factor for the next greater height, or determine by interpolation.
- c. Mean roof height is the average of the roof eave height and height of the highest point on the roof surface, except that for roof slopes of less than or equal to  $2\frac{1}{8}$ :12 (10 degrees), the mean roof height is permitted to be taken as the roof eave height.

## WALL CONSTRUCTION

**TABLE R608.7.1.1(5)**  
**REDUCTION FACTOR,  $R_2$ , FOR FLOOR-TO-CEILING WALL HEIGHTS LESS THAN 10 FEET<sup>a, b</sup>**

STORY UNDER CONSIDERATION	FLOOR-TO-CEILING HEIGHT <sup>c</sup> (feet)	ENDWALL LENGTH (feet)	ROOF SLOPE	REDUCTION FACTOR, $R_2$
Endwalls—for wind perpendicular to ridge				
One story or top story of two story	8	15	< 5:12	0.83
			7:12	0.90
			12:12	0.94
		60	< 5:12	0.83
			7:12	0.95
			12:12	0.98
First story of two story	16 combined first and second story	15	< 5:12	0.83
			7:12	0.86
			12:12	0.89
		60	< 5:12	0.83
			7:12	0.91
			12:12	0.95
Sidewalls—for wind parallel to ridge				
One story or top story of two story	8	15	< 1:12	0.84
			5:12	0.87
			7:12	0.88
			12:12	0.89
		60	< 1:12	0.86
			5:12	0.92
			7:12	0.93
			12:12	0.95
First story of two story	16 combined first and second story	15	< 1:12	0.83
			5:12	0.84
			7:12	0.85
			12:12	0.86
		60	< 1:12	0.84
			5:12	0.87
			7:12	0.88
			12:12	0.90

For SI: 1 foot = 304.8 mm.

- a. See Section R608.7.1.1 and Note d to Table R608.7.1.1(1) for application of reduction factors in this table.
- b. For intermediate values of endwall length and roof slope, use the next higher value or determine by interpolation.
- c. Tabulated values in Tables R608.7.1.1(1) and R608.7.1.1(3) for “one story or top story of two story” are based on a floor-to-ceiling height of 10 feet. Tabulated values in Tables R608.7.1.1(2) and R608.7.1.1(3) for “first story of two story” are based on floor-to-ceiling heights of 10 feet each for the first and second story. For floor to ceiling heights between those shown in this table and those assumed in Table R608.7.1.1(1), R608.7.1.1(2) or R608.7.1.1(3), use the solid wall lengths in Table R608.7.1.1(1), R608.7.1.1(2) or R608.7.1.1(3), or determine the reduction factor by interpolating between 1.0 and the factor shown in this table.

## WALL CONSTRUCTION

**TABLE R608.7.1.1(6)**  
**REDUCTION FACTOR FOR DESIGN STRENGTH,  $R_3$ , FOR FLAT, WAFFLE- AND SCREEN-GRID WALLS<sup>a, c</sup>**

NOMINAL THICKNESS OF WALL (inches)	VERTICAL BARS AT EACH END OF SOLID WALL SEGMENT		VERTICAL REINFORCEMENT LAYOUT DETAIL [see Figure R608.7.1.1(2)]	REDUCTION FACTOR, $R_3$ , FOR LENGTH OF SOLID WALL			
				Horizontal and vertical shear reinforcement provided			
	Number of bars	Bar size		No		Yes <sup>d</sup>	
				40,000 <sup>b</sup>	60,000 <sup>b</sup>	40,000 <sup>b</sup>	60,000 <sup>b</sup>
Flat walls							
4	2	4	1	0.74	0.61	0.74	0.50
	3	4	2	0.61	0.61	0.52	0.27
	2	5	1	0.61	0.61	0.48	0.25
	3	5	2	0.61	0.61	0.26	0.18
6	2	4	3	0.70	0.48	0.70	0.48
	3	4	4	0.49	0.38	0.49	0.33
	2	5	3	0.46	0.38	0.46	0.31
	3	5	4	0.38	0.38	0.32	0.16
8	2	4	3	0.70	0.47	0.70	0.47
	3	4	5	0.47	0.32	0.47	0.32
	2	5	3	0.45	0.31	0.45	0.31
	4	4	6	0.36	0.28	0.36	0.25
	3	5	5	0.31	0.28	0.31	0.16
	4	5	6	0.28	0.28	0.24	0.12
10	2	4	3	0.70	0.47	0.70	0.47
	2	5	3	0.45	0.30	0.45	0.30
	4	4	7	0.36	0.25	0.36	0.25
	6	4	8	0.25	0.22	0.25	0.13
	4	5	7	0.24	0.22	0.24	0.12
	6	5	8	0.22	0.22	0.12	0.08
Waffle-grid walls <sup>e</sup>							
6	2	4	3	0.78	0.78	0.70	0.48
	3	4	4	0.78	0.78	0.49	0.25
	2	5	3	0.78	0.78	0.46	0.23
	3	5	4	0.78	0.78	0.24	0.16
8	2	4	3	0.78	0.78	0.70	0.47
	3	4	5	0.78	0.78	0.47	0.24
	2	5	3	0.78	0.78	0.45	0.23
	4	4	6	0.78	0.78	0.36	0.18
	3	5	5	0.78	0.78	0.23	0.16
	4	5	6	0.78	0.78	0.18	0.13
Screen-grid walls <sup>e</sup>							
6	2	4	3	0.93	0.93	0.70	0.48
	3	4	4	0.93	0.93	0.49	0.25
	2	5	3	0.93	0.93	0.46	0.23
	3	5	4	0.93	0.93	0.24	0.16

For SI: 1 inch = 25.4 mm, 1,000 pounds per square inch = 6.895 MPa.

a. See Note e to Table R608.7.1.1(1) for application of adjustment factors in this table.

b. Yield strength in pounds per square inch of vertical wall reinforcement at ends of solid wall segments.

c. Values are based on concrete with a specified compressive strength,  $f'_c$ , of 2,500 psi. Where concrete with  $f'_c$  of not less than 3,000 psi is used, values in shaded cells are permitted to be decreased by multiplying by 0.91.

d. Horizontal and vertical shear reinforcement shall be provided in accordance with Section R608.7.2.2.

e. Each end of each solid wall segment shall have rectangular flanges. In the through-the-wall dimension, the flange shall be not less than 5½ inches for 6-inch-nominal waffle- and screen-grid walls, and not less than 7½ inches for 8-inch-nominal waffle-grid walls. In the in-plane dimension, flanges shall be long enough to accommodate the vertical reinforcement required by the layout detail selected from Figure R608.7.1.1(2) and provide the cover required by Section R608.5.4.1. If necessary to achieve the required dimensions, form material shall be removed or use of flat wall forms is permitted.

## WALL CONSTRUCTION

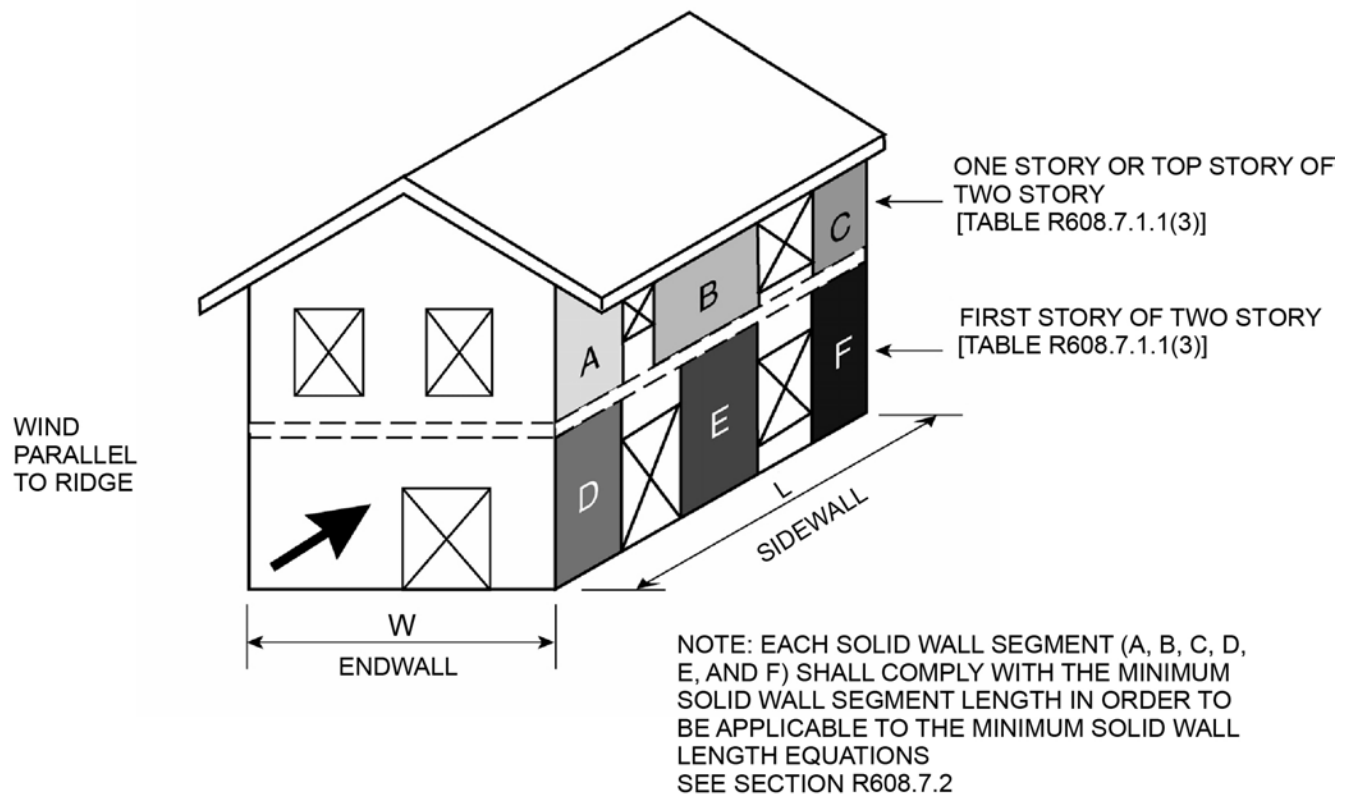
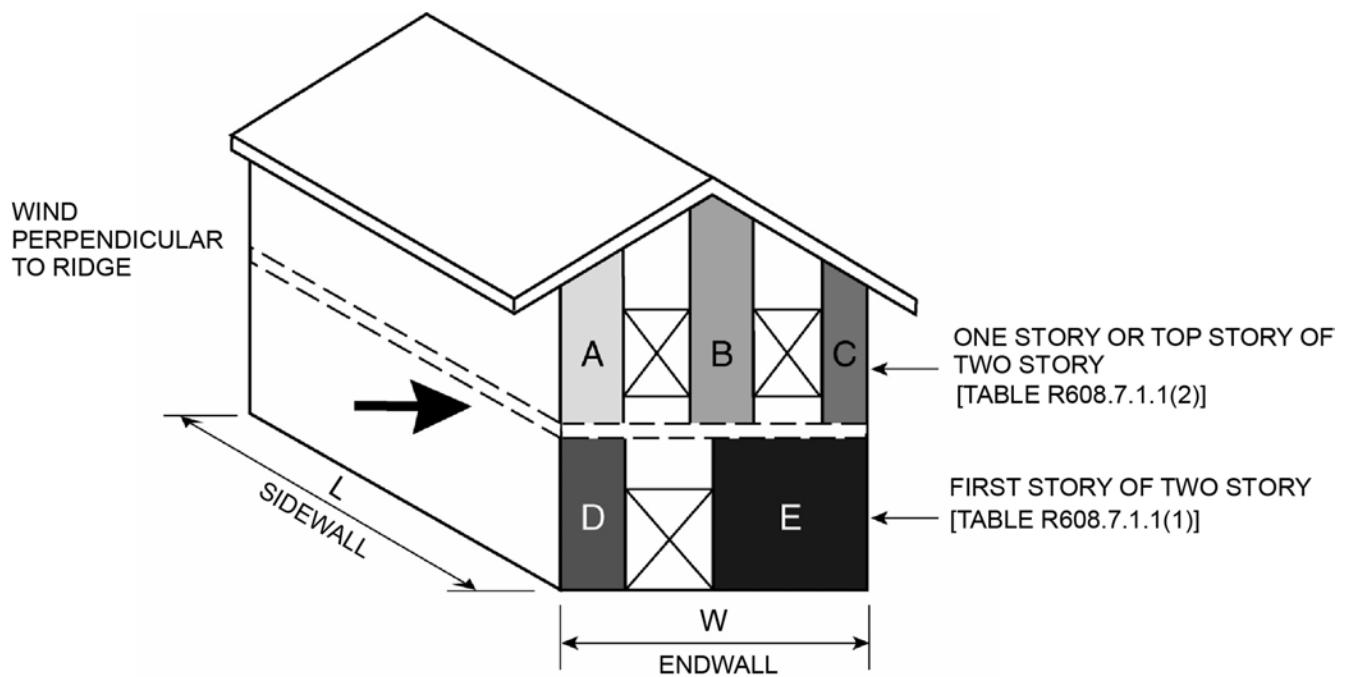
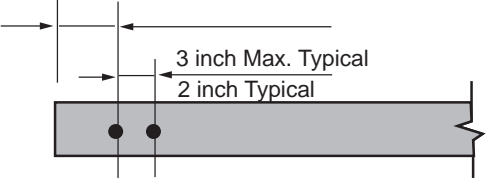



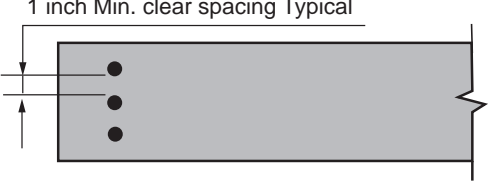


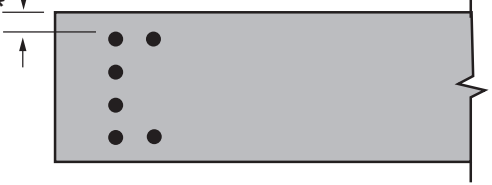


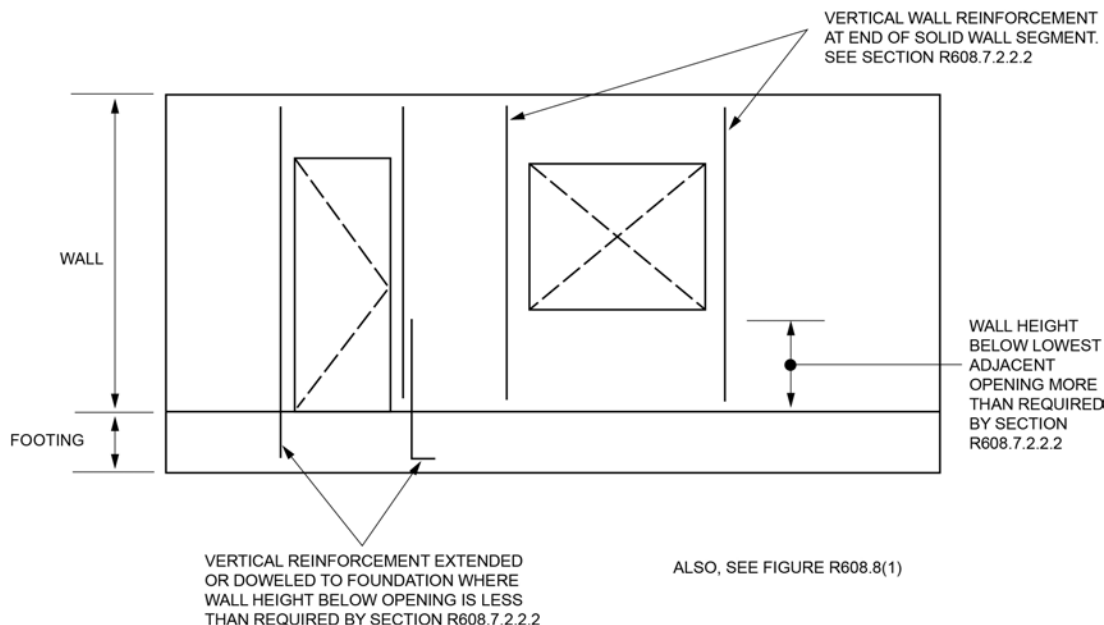
FIGURE R608.7.1.1(1)  
MINIMUM SOLID WALL LENGTH



## WALL CONSTRUCTION

DETAIL NO.	NOM. WALL THICKNESS, IN.	REINFORCEMENT LAYOUT AT ENDS OF SOLID WALL SEGMENTS	NOTES
1	4		For SI: 1 inch = 25.4 mm. 1. See Table R608.7.1.1(6) for use of details.
2	4		2. Minimum length of solid wall segment and size and grade of reinforcement in each end of each solid wall segment shall be determined from Table R608.7.1.1(6).
3	6 8 10		3. For minimum cover requirements, see Section R608.5.4.1.
4	6		4. For details 3 - 8 where two or more bars are in the same row parallel to the end of the segment, place bars so that corner bars are as close to the sides of the wall segments as minimum cover requirements of Section R608.5.4.1 will permit.
5	8		5. For waffle- and screen-grid walls, each end of each solid wall segment shall have rectangular flanges. In the through-the-wall dimension, the flange shall be not less than 5½ inches for 6-inch nominal waffle- and screen-grid forms, and not less than 7½ inches for 8-inch nominal waffle-grid forms. In the in-plane dimension, flanges shall be long enough to accommodate the vertical reinforcement required by the layout detail selected and provide the cover required by Section R608.5.4.1. If necessary to achieve the required dimensions, form material shall be removed or flat wall forms are permitted. See Table R608.7.1.1(6), Note e.
6	8		
7	10		
8	10	 * For minimum cover see Section R608.5.4.1	

**FIGURE R608.7.1.1(2)**  
**VERTICAL REINFORCEMENT LAYOUT DETAIL**



**FIGURE R608.7.1.1(3)**  
**VERTICAL WALL REINFORCEMENT ADJACENT TO WALL OPENINGS**

**R608.7.2 Solid wall segments.** Solid wall segments that contribute to the required length of solid wall shall comply with this section. Reinforcement shall be provided in accordance with Section R608.7.2.2 and Table R608.7.1.1(6). Solid wall segments shall extend the full story-height without openings, other than openings for the utilities and other building services passing through the wall. In flat walls and waffle-grid walls, such openings shall have an area of less than 30 square inches (19 355 mm<sup>2</sup>) without any dimension exceeding 6<sup>1</sup>/<sub>4</sub> inches (159 mm), and shall not be located within 6 inches (152 mm) of the side edges of the solid wall segment. In screen-grid walls, such openings shall be located in the portion of the solid wall segment between horizontal and vertical cores of concrete and opening size and location are not restricted provided there is not any concrete removed.

**R608.7.2.1 Minimum length of solid wall segment and maximum spacing.** Only solid wall segments equal to or greater than 24 inches (610 mm) in length shall be included in the total length of solid wall required by Section R608.7.1. In addition, not more than two solid wall segments equal to or greater than 24 inches (610 mm) in length and less than 48 inches (1219 mm) in length shall be included in the required total length of solid wall. The maximum clear opening width shall be 18 feet (5486 mm). See Figure R608.7.1.1(1).

**R608.7.2.2 Reinforcement in solid wall segments.**

**R608.7.2.2.1 Horizontal shear reinforcement.**

Where reduction factors for design strength,  $R_3$ , from Table R608.7.1.1(6) based on horizontal and vertical shear reinforcement being provided are used, solid wall segments shall have horizontal reinforcement consisting of minimum No. 4 bars.

Horizontal shear reinforcement shall be the same grade of steel required for the vertical reinforcement at the ends of solid wall segments by Section R608.7.2.2.2.

The spacing of horizontal reinforcement shall not exceed the smaller of one-half the length of the solid wall segment, minus 2 inches (51 mm), and 18 inches (457 mm). Horizontal shear reinforcement shall terminate in accordance with Section R608.6.4.

**R608.7.2.2.2 Vertical reinforcement.** Vertical reinforcement applicable to the reduction factor(s) for design strength,  $R_3$ , from Table R608.7.1.1(6) that is used, shall be located at each end of each solid wall segment in accordance with the applicable detail in Figure R608.7.1.1(2). The No. 4 vertical bar required on each side of an opening by Section R608.8.1.2 is permitted to be used as reinforcement at the ends of solid wall segments where installed in accordance with the applicable detail in Figure R608.7.1.1(2). There shall be not less than two No. 4 bars at each end of solid wall segments located as required by the applicable detail in Figure R608.7.1.1(2). One of the bars at each end of solid wall segments shall be deemed to meet the requirements for vertical wall reinforcement required by Section R608.6.

The vertical wall reinforcement at each end of each solid wall segment shall be developed below the bottom of the adjacent wall opening [see Figure R608.7.1.1(3)] by one of the following methods:

1. Where the wall height below the bottom of the adjacent opening is equal to or greater than 22 inches (559 mm) for No. 4 or 28

## WALL CONSTRUCTION

inches (711 mm) for No. 5 vertical wall reinforcement, reinforcement around openings in accordance with Section R608.8.1 shall be sufficient.

2. Where the wall height below the bottom of the adjacent opening is less than required by Item 1, the vertical wall reinforcement adjacent to the opening shall extend into the footing far enough to develop the bar in tension in accordance with Section R608.5.4.4 and Figure R608.5.4(2), or shall be lap-spliced with a dowel that is embedded in the footing far enough to develop the dowel-bar in tension.

### R608.7.2.2.3 Vertical shear reinforcement.

Where reduction factors for design strength,  $R_3$ , from Table R608.7.1.1(6) based on horizontal and vertical shear reinforcement being provided are used, solid wall segments shall have vertical reinforcement consisting of minimum No. 4 bars. Vertical shear reinforcement shall be the same grade of steel required by Section R608.7.2.2.2 for the vertical reinforcement at the ends of solid wall segments. The spacing of vertical reinforcement throughout the length of the segment shall not exceed the smaller of one third the length of the segment, and 18 inches (457 mm). Vertical shear reinforcement shall be continuous between stories in accordance with Section R608.6.3, and shall terminate in accordance with Section R608.6.4. Vertical shear reinforcement required by this section is permitted to be used for vertical reinforcement required by Table R608.6(1), R608.6(2), R608.6(3) or R608.6(4), whichever is applicable.

**R608.7.2.3 Solid wall segments at corners.** At all interior and exterior corners of exterior walls, a solid wall segment shall extend the full height of each wall story. The segment shall have the length required to develop the horizontal reinforcement above and below the adjacent opening in tension in accordance with Section R608.5.4.4. For an exterior corner, the limiting dimension is measured on the outside of the wall, and for an interior corner the limiting dimension is measured on the inside of the wall. See Section R608.8.1. The length of a segment contributing to the required length of solid wall shall comply with Section R608.7.2.1.

The end of a solid wall segment complying with the minimum length requirements of Section R608.7.2.1 shall be located not more than 6 feet (1829 mm) from each corner.

## R608.8 Requirements for lintels and reinforcement around openings.

**R608.8.1 Reinforcement around openings.** Reinforcement shall be provided around openings in walls equal to or greater than 2 feet (610 mm) in width in accordance with this section and Figure R608.8(1), in addition to the minimum wall reinforcement required by Sections R404.1.3, R608.6 and R608.7. Vertical wall reinforcement

required by this section is permitted to be used as reinforcement at the ends of solid wall segments required by Section R608.7.2.2.2 provided it is located in accordance with Section R608.8.1.2. Wall openings shall have a minimum depth of concrete over the width of the opening of 8 inches (203 mm) in flat walls and waffle-grid walls, and 12 inches (305 mm) in screen-grid walls. Wall openings in waffle-grid and screen-grid walls shall be located such that not less than one-half of a vertical core occurs along each side of the opening.

**R608.8.1.1 Horizontal reinforcement.** Lintels complying with Section R608.8.2 shall be provided above wall openings equal to or greater than 2 feet (610 mm) in width.

Openings equal to or greater than 2 feet (610 mm) in width shall have not less than one No. 4 bar placed within 12 inches (305 mm) of the bottom of the opening. See Figure R608.8(1).

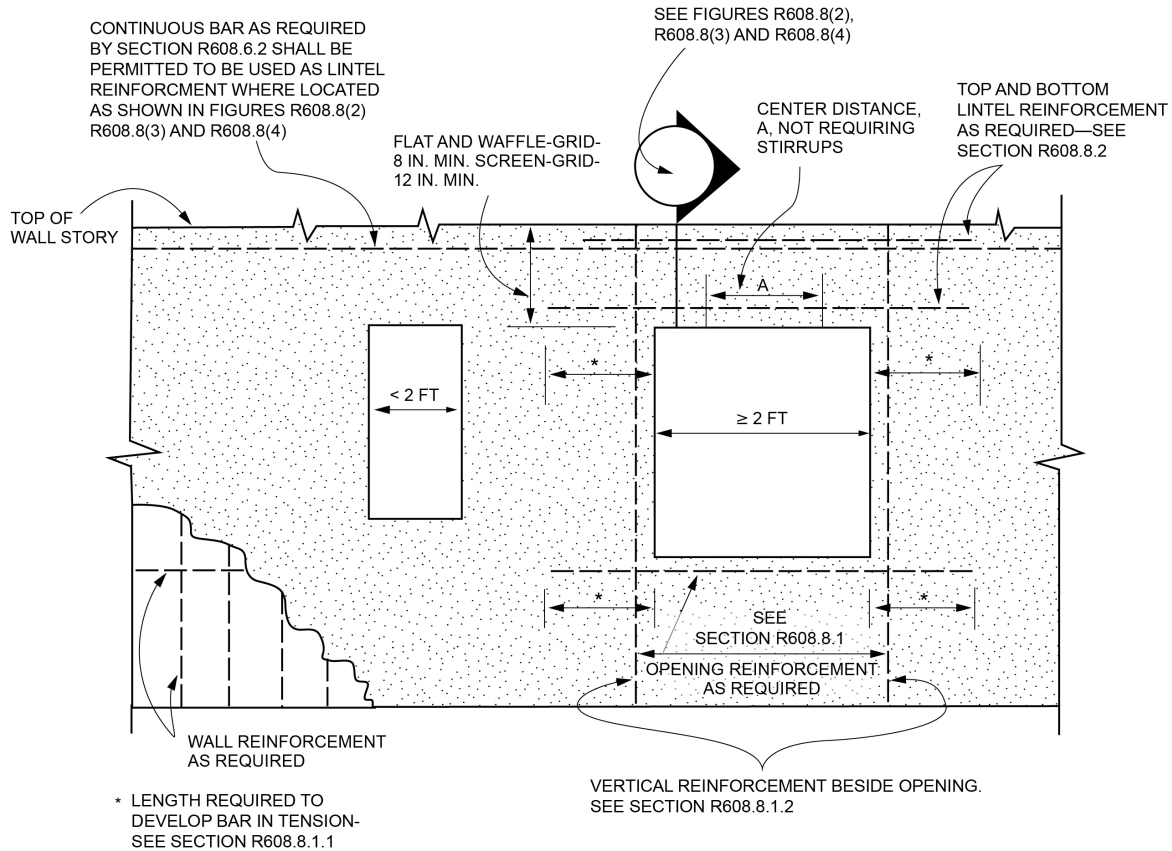
Horizontal reinforcement placed above and below an opening shall extend beyond the edges of the opening the dimension required to develop the bar in tension in accordance with Section R608.5.4.4.

**Exception:** Continuous horizontal wall reinforcement placed within 12 inches (305 mm) of the top of the wall story as required in Sections R404.1.3.2 and R608.6.2 is permitted in lieu of top or bottom lintel reinforcement required by Section R608.8.2 provided that the continuous horizontal wall reinforcement meets the location requirements specified in Figures R608.8(2), R608.8(3), and R608.8(4) and the size requirements specified in Tables R608.8(2) through R608.8(10).

**R608.8.1.2 Vertical reinforcement.** Not less than one No. 4 bar [Grade 40 (280 MPa)] shall be provided on each side of openings equal to or greater than 2 feet (610 mm) in width. The vertical reinforcement required by this section shall extend the full height of the wall story and shall be located within 12 inches (305 mm) of each side of the opening. The vertical reinforcement required on each side of an opening by this section is permitted to serve as reinforcement at the ends of solid wall segments in accordance with Section R608.7.2.2.2, provided it is located as required by the applicable detail in Figure R608.7.1.1(2). Where the vertical reinforcement required by this section is used to satisfy the requirements of Section R608.7.2.2.2 in waffle- and screen-grid walls, a concrete flange shall be created at the ends of the solid wall segments in accordance with Table R608.7.1.1(6), Note e. In the top-most story, the reinforcement shall terminate in accordance with Section R608.6.4.

**R608.8.2 Lintels.** Lintels shall be provided over all openings equal to or greater than 2 feet (610 mm) in width. Lintels with uniform loading shall conform to Sections R608.8.2.1 and R608.8.2.2, or Section R608.8.2.3. Lintels supporting concentrated loads, such as from roof or floor beams or girders, shall be designed in accordance with ACI 318.

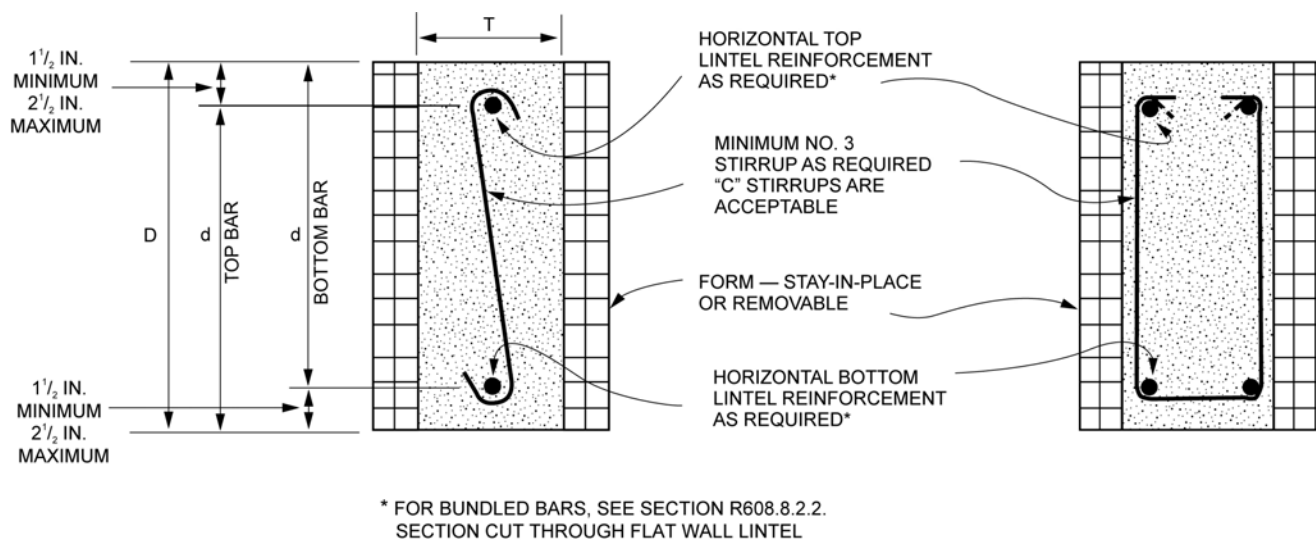
## WALL CONSTRUCTION



ELEVATION OF WALL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R608.8(1)  
REINFORCEMENT OF OPENINGS**

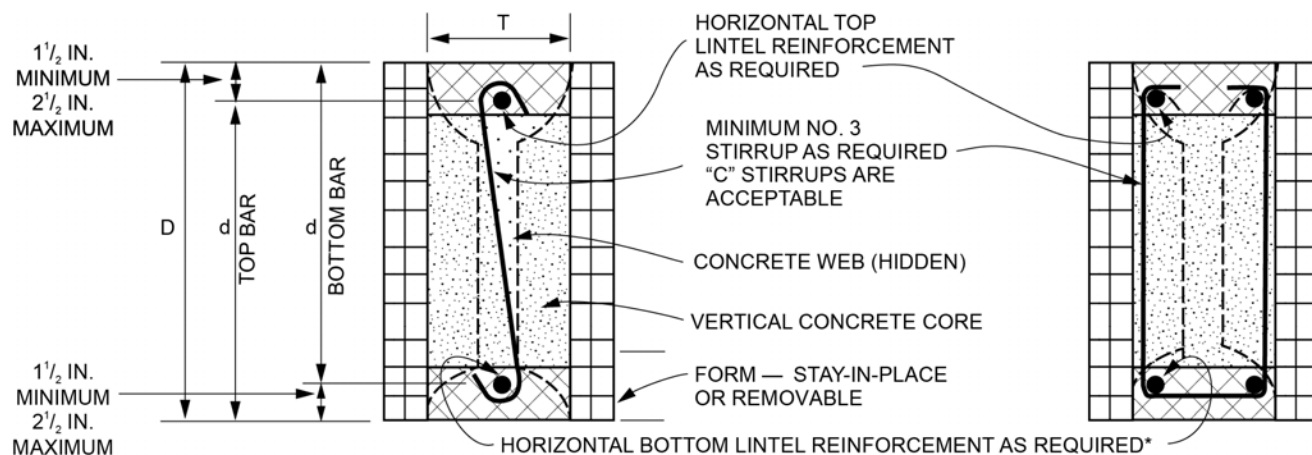


For SI: 1 inch = 25.4 mm.

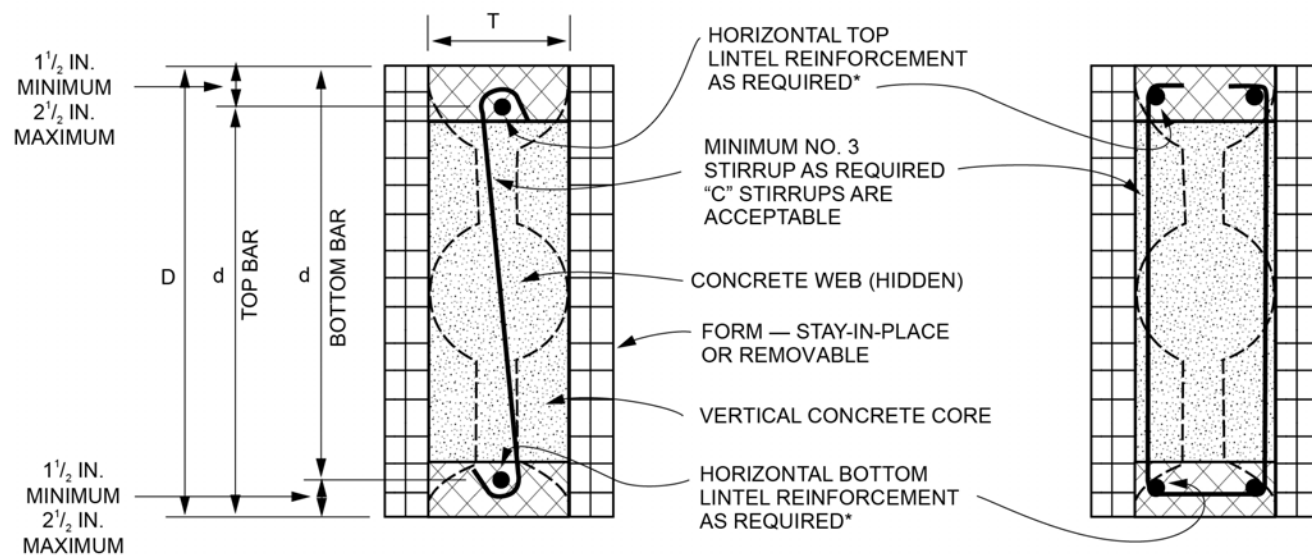
**FIGURE R608.8(2)  
LINTEL FOR FLAT WALLS**



## WALL CONSTRUCTION



(a) SINGLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A WAFFLE-GRID LINTEL



(b) DOUBLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A WAFFLE-GRID LINTEL

\*FOR BUNDLED BARS, SEE SECTION R608.8.2.2.

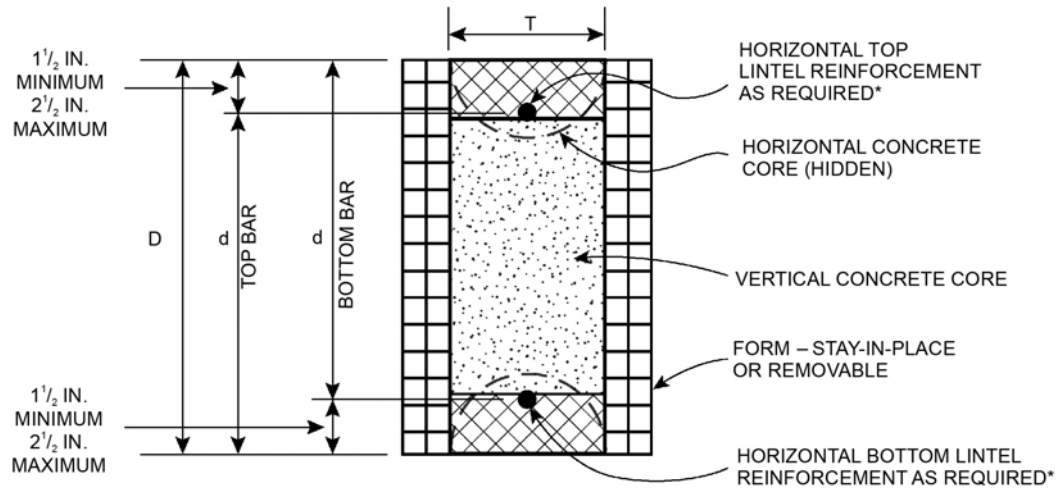
NOTE: CROSS HATCHING REPRESENTS THE AREA IN WHICH FORM MATERIAL SHALL BE REMOVED, IF NECESSARY, TO CREATE FLANGES CONTINUOUS THE LENGTH OF THE LINTEL. FLANGES SHALL HAVE A MINIMUM THICKNESS OF 3 IN., AND A MINIMUM WIDTH OF 5 IN. AND 7 IN. IN 6 IN. NOMINAL AND 8 IN. NOMINAL WAFFLE-GRID WALLS, RESPECTIVELY. SEE NOTE a TO TABLES R608.8(6) AND R608.8(10).

For SI: 1 inch = 25.4 mm.

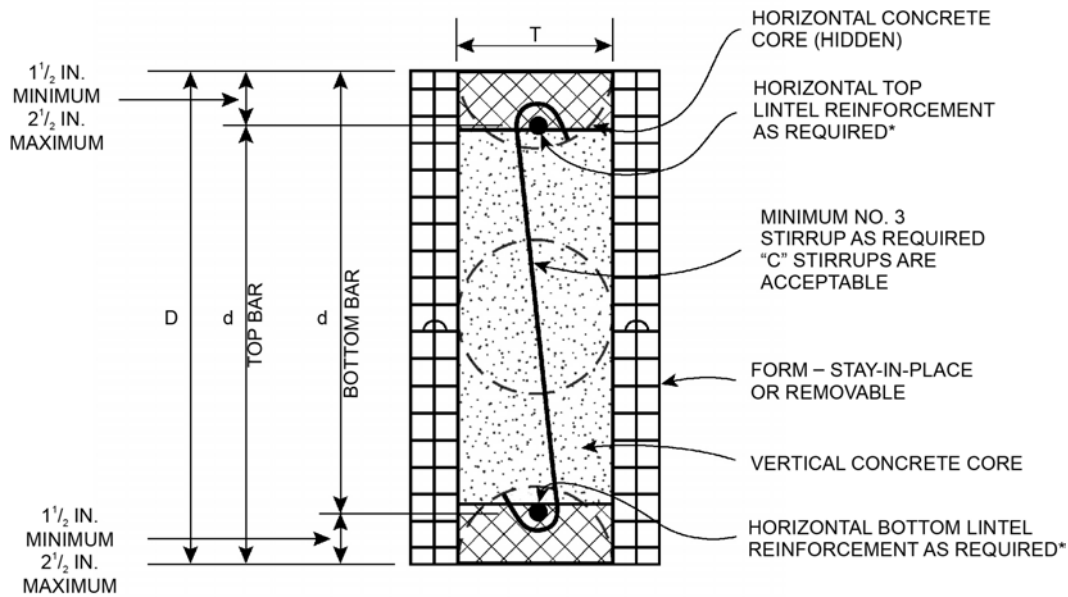
**FIGURE R608.8(3)**  
**LINTELS FOR WAFFLE-GRID WALLS**



## WALL CONSTRUCTION



(a) SINGLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A SCREEN-GRID LINTEL



(b) DOUBLE FORM HEIGHT SECTION CUT THROUGH VERTICAL CORE OF A SCREEN-GRID LINTEL

\*FOR BUNDLED BARS, SEE SECTION R608.8.2.2

NOTE: CROSS HATCHING REPRESENTS THE AREA IN WHICH FORM MATERIAL SHALL BE REMOVED, IF NECESSARY, TO CREATE FLANGES CONTINUOUS THE LENGTH OF THE LINTEL. FLANGES SHALL HAVE A MINIMUM THICKNESS OF 2.5 IN. AND A MINIMUM WIDTH OF 5 IN. SEE NOTE a TO TABLES R608.8(8) AND R608.8(10).

For SI: 1 inch = 25.4 mm.

FIGURE R608.8(4)  
LINTELS FOR SCREEN-GRID WALLS

## WALL CONSTRUCTION

**TABLE R608.8(1)**  
**LINTEL DESIGN LOADING CONDITIONS<sup>a, b, d</sup>**

DESCRIPTION OF LOADS AND OPENINGS ABOVE INFLUENCING DESIGN OF LINTEL			DESIGN LOAD CONDITION <sup>c</sup>
Opening in wall of top story of two-story building, or first story of one-story building			
Wall supporting loads from roof, including attic floor, if applicable, and	Top of lintel equal to or less than W/2 below top of wall		2
	Top of lintel greater than W/2 below top of wall		NLB
Wall not supporting loads from roof or attic floor			NLB
Opening in wall of first story of two-story building where wall immediately above is of concrete construction, or opening in basement wall of one-story building where wall immediately above is of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, and	Top of lintel greater than W/2 below bottom of opening in story above		1
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	1
		Opening is partially within the footprint of the opening in the story above	4
LB ledger board mounted to side of wall with bottom of ledger more than W/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, or no ledger board, and	Top of lintel greater than W/2 below bottom of opening in story above		NLB
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	NLB
		Opening is partially within the footprint of the opening in the story above	1
Opening in basement wall of two-story building where walls of two stories above are of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, and	Top of lintel greater than W/2 below bottom of opening in story above		1
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	1
		Opening is partially within the footprint of the opening in the story above	5
LB ledger board mounted to side of wall with bottom of ledger more than W/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to W/2 above top of lintel, or no ledger board, and	Top of lintel greater than W/2 below bottom of opening in story above		NLB
	Top of lintel less than or equal to W/2 below bottom of opening in story above, and	Opening is entirely within the footprint of the opening in the story above	NLB
		Opening is partially within the footprint of the opening in the story above	1
Opening in wall of first story of two-story building where wall immediately above is of light-frame construction, or opening in basement wall of one-story building where wall immediately above is of light-frame construction			
Wall supporting loads from roof, second floor and top-story wall of light-frame construction, and	Top of lintel equal to or less than W/2 below top of wall		3
	Top of lintel greater than W/2 below top of wall		NLB
Wall not supporting loads from roof or second floor			NLB

a. LB means load bearing, NLB means nonload bearing, and W means width of opening.

b. Footprint is the area of the wall below an opening in the story above, bounded by the bottom of the opening and vertical lines extending downward from the edges of the opening.

c. For design loading condition "NLB" see Tables R608.8(9) and R608.8(10). For all other design loading conditions, see Tables R608.8(2) through R608.8(8).

d. An NLB ledger board is a ledger attached to a wall that is parallel to the span of the floor, roof or ceiling framing that supports the edge of the floor, ceiling or roof.

## WALL CONSTRUCTION

**TABLE R608.8(2)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 4-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^9$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups <sup>i,j</sup>		3-2	3-4	2-4	2-6	2-2	2-1	2-0	2-0	2-0
	1-#4	40,000	5-2	5-5	4-1	4-3	3-10	3-7	3-4	2-9	2-9
		60,000	6-2	6-5	4-11	5-1	4-6	4-2	3-8	2-11	2-10
	1-#5	40,000	6-3	6-7	5-0	5-2	4-6	4-2	3-8	2-11	2-10
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,l}$		1-1	1-2	0-8	0-9	0-7	0-6	0-5	0-4	0-4	
12	Span without stirrups <sup>i,j</sup>		3-4	3-7	2-9	2-11	2-8	2-6	2-5	2-2	2-2
	1-#4	40,000	6-7	7-0	5-4	5-7	5-0	4-9	4-4	3-8	3-7
		60,000	7-11	8-6	6-6	6-9	6-0	5-9	5-3	4-5	4-4
	1-#5	40,000	8-1	8-8	6-7	6-10	6-2	5-10	5-4	4-6	4-5
		60,000	9-8	10-4	7-11	8-2	7-4	6-11	6-2	4-10	4-8
	2-#4 1-#6	40,000	9-1	9-8	7-4	7-8	6-10	6-6	6-0	4-10	4-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance $A^{k,l}$		1-8	1-11	1-1	1-3	1-0	0-11	0-9	0-6	0-6
16	Span without stirrups <sup>i,j</sup>		4-7	5-0	3-11	4-0	3-8	3-7	3-4	3-1	3-0
	1-#4	40,000	6-8	7-3	5-6	5-9	5-2	4-11	4-6	3-10	3-8
		60,000	9-3	10-1	7-9	8-0	7-2	6-10	6-3	5-4	5-2
	1-#4	40,000	9-6	10-4	7-10	8-2	7-4	6-11	6-5	5-5	5-3
		60,000	11-5	12-5	9-6	9-10	8-10	8-4	7-9	6-6	6-4
	2-#4 1-#6	40,000	10-7	11-7	8-10	9-2	8-3	7-9	7-2	6-1	5-11
		60,000	12-9	13-10	10-7	11-0	9-10	9-4	8-7	6-9	6-6
	2-#5	40,000	13-0	14-1	10-9	11-2	9-11	9-2	8-2	6-6	6-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,l}$		2-3	2-8	1-7	1-8	1-4	1-3	1-0	0-9	0-8	
20	Span without stirrups $A^{i,j}$		5-9	6-5	5-0	5-2	4-9	4-7	4-4	3-11	3-11
	1-#4	40,000	7-5	8-2	6-3	6-6	5-10	5-7	5-1	4-4	4-2
		60,000	9-0	10-0	7-8	7-11	7-1	6-9	6-3	5-3	5-1
	1-#5	40,000	9-2	10-2	7-9	8-1	7-3	6-11	6-4	5-4	5-2
		60,000	12-9	14-2	10-10	11-3	10-1	9-7	8-10	7-5	7-3
	2-#4 1-#6	40,000	11-10	13-2	10-1	10-5	9-4	8-11	8-2	6-11	6-9
		60,000	14-4	15-10	12-1	12-7	11-3	10-9	9-11	8-4	8-1
	2-#5	40,000	14-7	16-2	12-4	12-9	11-4	10-6	9-5	7-7	7-3
		60,000	17-5	19-2	14-9	15-3	13-5	12-4	11-0	8-8	8-4
	2-#6	40,000	16-4	18-11	12-7	13-3	11-4	10-6	9-5	7-7	7-3
60,000		DR	DR	DR	DR	DR	DR	DR	DR	DR	
Center distance $A^{k,l}$		2-9	3-5	2-0	2-2	1-9	1-7	1-4	0-11	0-11	

(continued)

## WALL CONSTRUCTION

**TABLE R608.8(2)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 4-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24	Span without stirrups <sup>i, j</sup>		6-11	7-9	6-1	6-3	5-9	5-7	5-3	4-9	4-8
	1-#4	40,000	8-0	9-0	6-11	7-2	6-5	6-2	5-8	4-9	4-8
		60,000	9-9	11-0	8-5	8-9	7-10	7-6	6-11	5-10	5-8
	1-#5	40,000	10-0	11-3	8-7	8-11	8-0	7-7	7-0	5-11	5-9
		60,000	13-11	15-8	12-0	12-5	11-2	10-7	9-10	8-3	8-0
	2-#4 1-#6	40,000	12-11	14-6	11-2	11-6	10-5	9-10	9-1	7-8	7-5
		60,000	15-7	17-7	13-6	13-11	12-7	11-11	11-0	9-3	9-0
	2-#5	40,000	15-11	17-11	13-7	14-3	12-8	11-9	10-8	8-7	8-4
		60,000	19-1	21-6	16-5	17-1	15-1	14-0	12-6	9-11	9-7
	2-#6	40,000	17-7	21-1	14-1	14-10	12-8	11-9	10-8	8-7	8-4
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance $A^{k, l}$		3-3	4-1	2-5	2-7	2-1	1-11	1-7	1-2	1-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- See Table R608.3 for tolerances permitted from nominal thickness.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.
- Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$ -inch, whichever is less.
- Linear interpolation is permitted between ground snow loads and between lintel depths.
- DR indicates design required.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

## WALL CONSTRUCTION

**TABLE R608.8(3)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups <sup>i,j</sup>		4-2	4-8	3-1	3-3	2-10	2-6	2-3	2-0	2-0
	1-#4	40,000	5-1	5-5	4-2	4-3	3-10	3-6	3-3	2-8	2-7
		60,000	6-2	6-7	5-0	5-2	4-8	4-2	3-11	3-3	3-2
	1-#5	40,000	6-3	6-8	5-1	5-3	4-9	4-3	4-0	3-3	3-2
		60,000	7-6	8-0	6-1	6-4	5-8	5-1	4-9	3-8	3-6
	2-#4 1-#6	40,000	7-0	7-6	5-8	5-11	5-3	4-9	4-5	3-8	3-6
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,1}$		1-7	1-10	1-1	1-2	0-11	0-9	0-8	0-5	0-5	
12	Span without stirrups <sup>i,j</sup>		4-2	4-8	3-5	3-6	3-2	2-11	2-9	2-5	2-4
	1-#4	40,000	5-7	6-1	4-8	4-10	4-4	3-11	3-8	3-0	2-11
		60,000	7-9	8-6	6-6	6-9	6-1	5-6	5-1	4-3	4-1
	1-#5	40,000	7-11	8-8	6-8	6-11	6-2	5-7	5-2	4-4	4-2
		60,000	9-7	10-6	8-0	8-4	7-6	6-9	6-3	5-2	5-1
	2-#4 1-#6	40,000	8-11	9-9	7-6	7-9	6-11	6-3	5-10	4-10	4-8
		60,000	10-8	11-9	8-12	9-4	8-4	7-6	7-0	5-10	5-8
	2-#5	40,000	10-11	12-0	9-2	9-6	8-6	7-8	7-2	5-6	5-3
		60,000	12-11	14-3	10-10	11-3	10-1	9-0	8-1	6-1	5-10
	2-#6	40,000	12-9	14-0	10-8	11-1	9-7	8-1	7-3	5-6	5-3
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,1}$		2-6	3-0	1-9	1-10	1-6	1-3	1-1	0-9	0-8	
16	Span without stirrups <sup>i,j</sup>		5-7	6-5	4-9	4-11	4-5	4-0	3-10	3-4	3-4
	1-#4	40,000	6-5	7-2	5-6	5-9	5-2	4-8	4-4	3-7	3-6
		60,000	7-10	8-9	6-9	7-0	6-3	5-8	5-3	4-4	4-3
	1-#5	40,000	7-11	8-11	6-10	7-1	6-5	5-9	5-4	4-5	4-4
		60,000	11-1	12-6	9-7	9-11	8-11	8-0	7-6	6-2	6-0
	2-#4 1-#6	40,000	10-3	11-7	8-10	9-2	8-3	7-6	6-11	5-9	5-7
		60,000	12-5	14-0	10-9	11-1	10-0	9-0	8-5	7-0	6-9
	2-#5	40,000	12-8	14-3	10-11	11-4	10-2	9-2	8-7	6-9	6-6
		60,000	15-2	17-1	13-1	13-7	12-3	11-0	10-3	7-11	7-7
	2-#6	40,000	14-11	16-9	12-8	13-4	11-4	9-8	8-8	6-9	6-6
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,1}$		3-3	4-1	2-5	2-7	2-1	1-9	1-6	1-0	1-0	

(continued)



## WALL CONSTRUCTION

**TABLE R608.8(3)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups <sup>i,j</sup>		6-11	8-2	6-1	6-3	5-8	5-2	4-11	4-4	4-3
	1-#5	40,000	8-9	10-1	7-9	8-0	7-3	6-6	6-1	5-1	4-11
		60,000	10-8	12-3	9-5	9-9	8-10	8-0	7-5	6-2	6-0
	2-#4	40,000	9-11	11-4	8-9	9-1	8-2	7-4	6-10	5-8	5-7
		60,000	13-9	15-10	12-2	12-8	11-5	10-3	9-7	7-11	7-9
	2-#5	40,000	14-0	16-2	12-5	12-11	11-7	10-6	9-9	7-11	7-8
		60,000	16-11	19-6	15-0	15-6	14-0	12-7	11-9	9-1	8-9
	2-#6	40,000	16-7	19-1	14-7	15-3	13-1	11-3	10-2	7-11	7-8
		60,000	19-11	22-10	17-4	18-3	15-6	13-2	11-10	9-1	8-9
Center distance $A^{k,l}$		3-11	5-2	3-1	3-3	2-8	2-2	1-11	1-4	1-3	
24	Span without stirrups <sup>i,j</sup>		8-2	9-10	7-4	7-8	6-11	6-4	5-11	5-3	5-2
	1-#5	40,000	9-5	11-1	8-7	8-10	8-0	7-3	6-9	5-7	5-5
		60,000	11-6	13-6	10-5	10-9	9-9	8-9	8-2	6-10	6-8
	2-#4	40,000	10-8	12-6	9-8	10-0	9-0	8-2	7-7	6-4	6-2
		60,000	12-11	15-2	11-9	12-2	11-0	9-11	9-3	7-8	7-6
	2-#5	40,000	15-2	17-9	13-9	14-3	12-10	11-7	10-10	9-0	8-9
		60,000	18-4	21-6	16-7	17-3	15-6	14-0	13-1	10-4	10-0
	2-#6	40,000	18-0	21-1	16-4	16-11	14-10	12-9	11-8	9-2	8-11
		60,000	21-7	25-4	19-2	20-4	17-2	14-9	13-4	10-4	10-0
	Center distance $A^{k,l}$		4-6	6-2	3-8	4-0	3-3	2-8	2-3	1-7	1-6

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- See Table R608.3 for tolerances permitted from nominal thickness.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.
- Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads and between lintel depths.
- DR indicates design required.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
  - Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

## WALL CONSTRUCTION

**TABLE R608.8(4)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^B$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups <sup>i,j</sup>		4-4	4-9	3-7	3-9	3-4	2-10	2-7	2-1	2-0
	1-#4	40,000	4-4	4-9	3-7	3-9	3-4	2-11	2-9	2-3	2-2
		60,000	6-1	6-7	5-0	5-3	4-8	4-0	3-9	3-1	3-0
	1-#5	40,000	6-2	6-9	5-2	5-4	4-9	4-1	3-10	3-2	3-1
		60,000	7-5	8-1	6-2	6-5	5-9	4-11	4-7	3-9	3-8
	2-#4	40,000	6-11	7-6	5-9	6-0	5-4	4-7	4-4	3-6	3-5
		60,000	8-3	9-0	6-11	7-2	6-5	5-6	5-2	4-2	4-1
	2-#5	40,000	8-5	9-2	7-0	7-3	6-6	5-7	5-3	4-2	4-0
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,1}$		2-1	2-6	1-5	1-6	1-3	0-11	0-10	0-6	0-6	
12	Span without stirrups <sup>i,j</sup>		4-10	5-8	4-0	4-2	3-9	3-2	3-0	2-7	2-6
	1-#4	40,000	5-5	6-1	4-8	4-10	4-4	3-9	3-6	2-10	2-10
		60,000	6-7	7-5	5-8	5-11	5-4	4-7	4-3	3-6	3-5
	1-#5	40,000	6-9	7-7	5-9	6-0	5-5	4-8	4-4	3-7	3-6
		60,000	9-4	10-6	8-1	8-4	7-6	6-6	6-1	5-0	4-10
	2-#4	40,000	8-8	9-9	7-6	7-9	7-0	6-0	5-8	4-7	4-6
		60,000	10-6	11-9	9-1	9-5	8-5	7-3	6-10	5-7	5-5
	2-#5	40,000	10-8	12-0	9-3	9-7	8-7	7-5	6-11	5-6	5-4
		60,000	12-10	14-5	11-1	11-6	10-4	8-11	8-4	6-7	6-4
	2-#6	40,000	12-7	14-2	10-10	11-3	10-2	8-3	7-6	5-6	5-4
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{k,1}$		3-2	4-0	2-4	2-6	2-0	1-6	1-4	0-11	0-10	
16	Span without stirrups <sup>i,j</sup>		6-5	7-9	5-7	5-10	5-2	4-5	4-2	3-7	3-6
	1-#4	40,000	6-2	7-1	5-6	5-8	5-1	4-5	4-2	3-5	3-4
		60,000	7-6	8-8	6-8	6-11	6-3	5-5	5-1	4-2	4-0
	1-#5	40,000	7-8	8-10	6-10	7-1	6-4	5-6	5-2	4-3	4-1
		60,000	9-4	10-9	8-4	8-7	7-9	6-8	6-3	5-2	5-0
	2-#4	40,000	8-8	10-0	7-8	8-0	7-2	6-2	5-10	4-9	4-8
		60,000	12-0	13-11	10-9	11-2	10-0	8-8	8-1	6-8	6-6
	2-#5	40,000	12-3	14-2	11-0	11-4	10-3	8-10	8-3	6-9	6-7
		60,000	14-10	17-2	13-3	13-8	12-4	10-8	10-0	7-11	7-8
	2-#6	40,000	14-6	16-10	13-0	13-5	12-1	10-1	9-2	6-11	6-8
		60,000	17-5	20-2	15-7	16-1	14-6	11-10	10-8	7-11	7-8
Center distance $A^{k,1}$		4-1	5-5	3-3	3-6	2-10	2-1	1-10	1-3	1-2	

(continued)

## WALL CONSTRUCTION

**TABLE R608.8(4)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups <sup>i,j</sup>		7-10	9-10	7-1	7-5	6-7	5-8	5-4	4-7	4-6
	1-#5	40,000	8-4	9-11	7-8	8-0	7-2	6-3	5-10	4-9	4-8
		60,000	10-2	12-1	9-5	9-9	8-9	7-7	7-1	5-10	5-8
	2-#4	40,000	9-5	11-3	8-8	9-0	8-1	7-0	6-7	5-5	5-3
		1-#6	60,000	11-6	13-8	10-7	11-0	9-11	8-7	8-0	6-7
	2-#5	40,000	11-9	13-11	10-10	11-2	10-1	8-9	8-2	6-8	6-7
		60,000	16-4	19-5	15-0	15-7	14-0	12-2	11-4	9-3	9-0
	2-#6	40,000	16-0	19-0	14-9	15-3	13-9	11-10	10-10	8-3	8-0
		60,000	19-3	22-11	17-9	18-5	16-7	13-7	12-4	9-3	9-0
	Center distance $A^{k,l}$		4-10	6-10	4-1	4-5	3-7	2-8	2-4	1-7	1-6
24	Span without stirrups <sup>i,j</sup>		9-2	11-9	8-7	8-11	8-0	6-11	6-6	5-7	5-6
	1-#5	40,000	8-11	10-10	8-6	8-9	7-11	6-10	6-5	5-3	5-2
		60,000	10-11	13-3	10-4	10-8	9-8	8-4	7-10	6-5	6-3
	2-#4	40,000	10-1	12-3	9-7	9-11	8-11	7-9	7-3	6-0	5-10
		1-#6	60,000	12-3	15-0	11-8	12-1	10-11	9-5	8-10	7-3
	2-#5	40,000	12-6	15-3	11-11	12-4	11-1	9-7	9-0	7-5	7-3
		60,000	17-6	21-3	16-7	17-2	15-6	13-5	12-7	10-4	10-1
	2-#6	40,000	17-2	20-11	16-3	16-10	15-3	13-2	12-4	9-7	9-4
		60,000	20-9	25-3	19-8	20-4	18-5	15-4	14-0	10-7	10-3
	Center distance $A^{k,l}$		5-6	8-1	4-11	5-3	4-4	3-3	2-10	1-11	1-10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

**Note:** Top and bottom reinforcement for lintels without stirrups, as shown in shaded cells, shall be equal to or greater than that required for lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups.

- See Table R608.3 for tolerances permitted from nominal thickness.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.
- Table values are based on uniform loading. See Section R608.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads and between lintel depths.
- DR indicates design required.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.

## WALL CONSTRUCTION

**TABLE R608.8(5)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 10-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8	Span without stirrups <sup>i,j</sup>		6-0	7-2	4-7	4-10	4-1	3-1	2-11	2-3	2-2
	1-#4	40,000	4-3	4-9	3-7	3-9	3-4	2-9	2-7	2-1	2-1
		60,000	5-11	6-7	5-0	5-3	4-8	3-10	3-8	2-11	2-11
	1-#5	40,000	6-1	6-9	5-2	5-4	4-9	3-11	3-9	3-0	2-11
		60,000	7-4	8-1	6-3	6-5	5-9	4-9	4-6	3-7	3-7
	2-#4 1-#6	40,000	6-10	7-6	5-9	6-0	5-5	4-5	4-2	3-4	3-4
		60,000	8-2	9-1	6-11	7-2	6-6	5-4	5-0	4-1	4-0
	2-#5	40,000	8-4	9-3	7-1	7-4	6-7	5-5	5-1	4-1	4-0
		60,000	9-11	11-0	8-5	8-9	7-10	6-6	6-1	4-8	4-6
	2-#6	40,000	9-9	10-10	8-3	8-7	7-9	6-4	5-10	4-1	4-0
60,000		DR	DR	DR	DR	DR	DR	DR	DR	DR	
Center distance $A^{k,l}$		2-6	3-1	1-10	1-11	1-7	1-1	0-11	0-7	0-7	
12	Span without stirrups <sup>i,j</sup>		5-5	6-7	4-7	4-10	4-3	3-5	3-3	2-8	2-8
	1-#4	40,000	5-3	6-0	4-8	4-10	4-4	3-7	3-4	2-9	2-8
		60,000	6-5	7-4	5-8	5-10	5-3	4-4	4-1	3-4	3-3
	1-#5	40,000	6-6	7-6	5-9	6-0	5-5	4-5	4-2	3-5	3-4
		60,000	7-11	9-1	7-0	7-3	6-7	5-5	5-1	4-2	4-0
	2-#4 1-#6	40,000	7-4	8-5	6-6	6-9	6-1	5-0	4-9	3-10	3-9
		60,000	10-3	11-9	9-1	9-5	8-6	7-0	6-7	5-4	5-3
	2-#5	40,000	10-5	12-0	9-3	9-7	8-8	7-2	6-9	5-5	5-4
		60,000	12-7	14-5	11-2	11-6	10-5	8-7	8-1	6-6	6-4
	2-#6	40,000	12-4	14-2	10-11	11-4	10-2	8-5	7-8	5-7	5-5
60,000		14-9	17-0	13-1	13-6	12-2	10-0	9-1	6-6	6-4	
Center distance $A^{k,l}$		3-9	4-11	2-11	3-2	2-7	1-9	1-7	1-0	1-0	
16	Span without stirrups <sup>i,j</sup>		7-1	9-0	6-4	6-8	5-10	4-9	4-6	3-9	3-8
	1-#4	40,000	5-11	7-0	5-5	5-8	5-1	4-3	4-0	3-3	3-2
		60,000	7-3	8-7	6-8	6-11	6-3	5-2	4-10	3-11	3-10
	1-#5	40,000	7-4	8-9	6-9	7-0	6-4	5-3	4-11	4-0	3-11
		60,000	9-0	10-8	8-3	8-7	7-9	6-5	6-0	4-11	4-9
	2-#4 1-#6	40,000	8-4	9-11	7-8	7-11	7-2	5-11	5-7	4-6	4-5
		60,000	10-2	12-0	9-4	9-8	8-9	7-3	6-10	5-6	5-5
	2-#5	40,000	10-4	12-3	9-6	9-10	8-11	7-4	6-11	5-8	5-6
		60,000	14-4	17-1	13-3	13-8	12-4	10-3	9-8	7-10	7-8
	2-#6	40,000	14-1	16-9	13-0	13-5	12-2	10-1	9-6	7-0	6-10
60,000		17-0	20-2	15-8	16-2	14-7	12-0	10-11	8-0	7-9	
Center distance $A^{k,l}$		4-9	6-8	4-0	4-4	3-6	2-5	2-2	1-5	1-4	

(continued)

## WALL CONSTRUCTION

**TABLE R608.8(5)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 10-INCH-NOMINAL THICK FLAT LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, m</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^a$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>b</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
20	Span without stirrups <sup>i,j</sup>		8-7	11-4	8-1	8-5	7-5	6-1	5-9	4-10	4-9
	1-#4	40,000	6-5	7-10	6-2	6-4	5-9	4-9	4-6	3-8	3-7
		60,000	7-10	9-7	7-6	7-9	7-0	5-10	5-6	4-5	4-4
	1-#5	40,000	8-0	9-9	7-8	7-11	7-2	5-11	5-7	4-6	4-5
		60,000	9-9	11-11	9-4	9-8	8-9	7-3	6-10	5-6	5-5
	2-#4	40,000	9-0	11-1	8-8	8-11	8-1	6-9	6-4	5-2	5-0
		1-#6	60,000	11-0	13-6	10-6	10-11	9-10	8-2	7-9	6-3
	2-#5	40,000	11-3	13-9	10-9	11-1	10-0	8-4	7-10	6-5	6-3
		60,000	15-8	19-2	15-0	15-6	14-0	11-8	11-0	8-11	8-9
	2-#6	40,000	15-5	18-10	14-8	15-2	13-9	11-5	10-9	8-6	8-3
		60,000	18-7	22-9	17-9	18-5	16-7	13-10	12-9	9-5	9-2
	Center distance $A^{k,1}$		5-7	8-4	5-1	5-5	4-5	3-1	2-9	1-10	1-9
24	Span without stirrups <sup>i,j</sup>		9-11	13-7	9-9	10-2	9-0	7-5	7-0	5-10	5-9
	1-#5	40,000	8-6	10-8	8-5	8-8	7-10	6-6	6-2	5-0	4-11
		60,000	10-5	13-0	10-3	10-7	9-7	8-0	7-6	6-1	6-0
	2-#4	40,000	9-7	12-1	9-6	9-9	8-10	7-5	7-0	5-8	5-6
		1-#6	60,000	11-9	14-9	11-7	11-11	10-10	9-0	8-6	6-11
	2-#5	40,000	12-0	15-0	11-9	12-2	11-0	9-2	8-8	7-1	6-11
		60,000	14-7	18-3	14-4	14-10	13-5	11-2	10-7	8-7	8-5
	2-#6	40,000	14-3	17-11	14-1	14-7	13-2	11-0	10-4	8-5	8-3
		60,000	19-11	25-0	19-7	20-3	18-4	15-3	14-5	10-10	10-7
	Center distance $A^{k,1}$		6-3	9-11	6-1	6-6	5-4	3-9	3-4	2-2	2-1

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

**Note:** Top and bottom reinforcement for lintels without stirrups, as shown in shaded cells, shall be equal to or greater than that required for lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups.

- See Table R608.3 for tolerances permitted from nominal thickness.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note j.
- Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads and between lintel depths.
- DR indicates design required.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the clear span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
  - Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel clear spans in the table greater than 18 feet are shown for interpolation and information only.



## WALL CONSTRUCTION

**TABLE R608.8(6)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, o</sup>**  
**MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR SPAN 32 FEET**

LINTEL DEPTH, $D^d$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>b, f</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8 <sup>i</sup>	Span without stirrups <sup>k, l</sup>		2-7	2-9	2-0	2-1	2-0	2-0	2-0	2-0	2-0
	1-#4	40,000	5-2	5-5	4-0	4-3	3-7	3-3	2-11	2-4	2-3
		60,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
	1-#5	40,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
		60,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
	2-#4	40,000	5-9	6-3	4-0	4-3	3-7	3-3	2-11	2-4	2-3
	1-#6	60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{m, n}$			0-9	0-10	0-6	0-6	0-5	0-5	0-4	STL	STL
12 <sup>i</sup>	Span without stirrups <sup>k, l</sup>		2-11	3-1	2-6	2-7	2-5	2-4	2-3	2-1	2-0
	1-#4	40,000	5-9	6-2	4-8	4-10	4-4	4-1	3-9	3-2	3-1
		60,000	8-0	8-7	6-6	6-9	6-0	5-5	4-11	3-11	3-10
	1-#5	40,000	8-1	8-9	6-8	6-11	6-0	5-5	4-11	3-11	3-10
		60,000	9-1	10-3	6-8	7-0	6-0	5-5	4-11	3-11	3-10
	2-#4 1-#6	40,000	9-1	9-9	6-8	7-0	6-0	5-5	4-11	3-11	3-10
	Center distance $A^{m, n}$			1-3	1-5	0-10	0-11	0-9	0-8	0-6	STL
Span without stirrups <sup>k, l</sup>			4-0	4-4	3-6	3-7	3-4	3-3	3-1	2-10	2-10
16 <sup>i</sup>	1-#4	40,000	6-7	7-3	5-6	5-9	5-2	4-10	4-6	3-9	3-8
		60,000	8-0	8-10	6-9	7-0	6-3	5-11	5-5	4-7	4-5
	1-#5	40,000	8-2	9-0	6-11	7-2	6-5	6-0	5-7	4-8	4-6
		60,000	11-5	12-6	9-3	9-9	8-4	7-7	6-10	5-6	5-4
	2-#4 1-#6	40,000	10-7	11-7	8-11	9-3	8-3	7-7	6-10	5-6	5-4
		60,000	12-2	14-0	9-3	9-9	8-4	7-7	6-10	5-6	5-4
	2-#5	40,000	12-2	14-2	9-3	9-9	8-4	7-7	6-10	5-6	5-4
60,000		DR	DR	DR	DR	DR	DR	DR	DR	DR	
Center distance $A^{m, n}$			1-8	2-0	1-2	1-3	1-0	0-11	0-9	STL	STL
20 <sup>i</sup>	Span without stirrups <sup>k, l</sup>		5-0	5-6	4-6	4-7	4-3	4-1	4-0	3-8	3-8
	1-#4	40,000	7-2	8-2	6-3	6-6	5-10	5-6	5-1	4-3	4-2
		60,000	8-11	9-11	7-8	7-11	7-1	6-8	6-2	5-2	5-0
	1-#5	40,000	9-1	10-2	7-9	8-1	7-3	6-10	6-4	5-4	5-2
		60,000	12-8	14-2	10-11	11-3	10-2	9-6	8-9	7-1	6-10
	2-#4 1-#6	40,000	10-3	11-5	8-9	9-1	8-2	7-8	7-1	6-0	5-10
		60,000	14-3	15-11	11-9	12-5	10-8	9-9	8-9	7-1	6-10
	2-#5	40,000	14-6	16-3	11-6	12-1	10-4	9-6	8-6	6-11	6-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
Center distance $A^{m, n}$			2-0	2-6	1-6	1-7	1-3	1-1	1-0	STL	STL

(continued)

## WALL CONSTRUCTION

**TABLE R608.8(6)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, o</sup>**  
**MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24w <sup>j</sup>	Span without stirrups <sup>k,1</sup>		6-0	6-8	5-5	5-7	5-3	5-0	4-10	4-6	4-5
	1-#4	40,000	7-11	9-0	6-11	7-2	6-5	6-0	5-7	4-8	4-7
		60,000	9-8	10-11	8-5	8-9	7-10	7-4	6-10	5-9	5-7
	1-#5	40,000	9-10	11-2	8-7	8-11	8-0	7-6	7-0	5-10	5-8
		60,000	12-0	13-7	10-6	10-10	9-9	9-2	8-6	7-2	6-11
	2-#4	40,000	11-1	12-7	9-8	10-1	9-1	8-6	7-10	6-7	6-5
		60,000	15-6	17-7	13-6	14-0	12-8	11-10	10-8	8-7	8-4
	2-#5	40,000	15-6	17-11	12-8	13-4	11-6	10-7	9-7	7-10	7-7
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance $A^{m,n}$		2-4	3-0	1-9	1-11	1-6	1-4	1-2	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch-nominal waffle-grid forms and not less than 7 inches in width for 8-inch-nominal waffle-grid forms. See Figure R608.8(3). Flat form lintels shall be permitted in place of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).
- See Table R608.3 for tolerances permitted from nominal thicknesses and minimum dimensions and spacing of cores.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes l and n. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads.
- DR indicates design required. STL indicates stirrups required throughout lintel.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Lintels less than 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or, if necessary, form material shall be removed from waffle-grid forms so as to provide the required cover for stirrups. Allowable spans for lintels formed with flat-wall forms shall be determined from Tables R608.8(2) through R608.8(5).
- Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.

## WALL CONSTRUCTION

**TABLE R608.8(7)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, o</sup>**  
**MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
8 <sup>i</sup>	Span without stirrups <sup>k,1</sup>		2-6	2-9	2-0	2-1	2-0	2-0	2-0	2-0	2-0
	1-#4	40,000	4-5	4-9	3-7	3-9	3-4	3-0	2-10	2-3	2-2
		60,000	5-6	6-2	4-0	4-3	3-7	3-1	2-10	2-3	2-2
	1-#5	40,000	5-6	6-2	4-0	4-3	3-7	3-1	2-10	2-3	2-2
	Center distance $A^{m,n}$		0-9	0-10	0-6	0-6	0-5	0-4	0-4	STL	STL
12 <sup>i</sup>	Span without stirrups <sup>k,1</sup>		2-10	3-1	2-6	2-7	2-5	2-3	2-2	2-0	2-0
	1-#4	40,000	5-7	6-1	4-8	4-10	4-4	3-11	3-8	3-0	2-11
		60,000	6-9	7-5	5-8	5-11	5-4	4-9	4-5	3-8	3-7
	1-#5	40,000	6-11	7-7	5-10	6-0	5-5	4-10	4-6	3-9	3-7
		60,000	8-8	10-1	6-7	7-0	5-11	5-2	4-8	3-9	3-7
	2-#4	40,000	8-8	9-10	6-7	7-0	5-11	5-2	4-8	3-9	3-7
		60,000	8-8	10-1	6-7	7-0	5-11	5-2	4-8	3-9	3-7
	1-#6	60,000	8-8	10-1	6-7	7-0	5-11	5-2	4-8	3-9	3-7
Center distance $A^{m,n}$		1-2	1-5	0-10	0-11	0-9	0-7	0-6	STL	STL	
16 <sup>i</sup>	Span without stirrups <sup>k,1</sup>		3-10	4-3	3-6	3-7	3-4	3-2	3-0	2-10	2-9
	1-#4	40,000	6-5	7-2	5-6	5-9	5-2	4-8	4-4	3-7	3-6
		60,000	7-9	8-9	6-9	7-0	6-3	5-8	5-3	4-4	4-3
	1-#5	40,000	7-11	8-11	6-10	7-1	6-5	5-9	5-4	4-5	4-4
		60,000	9-8	10-11	8-4	8-8	7-10	7-0	6-6	5-2	5-1
	2-#4	40,000	9-0	10-1	7-9	8-0	7-3	6-6	6-1	5-0	4-11
		60,000	11-5	13-10	9-2	9-8	8-3	7-2	6-6	5-2	5-1
	1-#6	60,000	11-5	13-10	9-2	9-8	8-3	7-2	6-6	5-2	5-1
Center distance $A^{m,n}$		1-6	1-11	1-2	1-3	1-0	0-10	0-8	STL	STL	
20 <sup>i</sup>	Span without stirrups <sup>k,1</sup>		4-10	5-5	4-5	4-7	4-3	4-0	3-11	3-7	3-7
	1-#4	40,000	7-0	8-1	6-3	6-5	5-10	5-3	4-11	4-1	3-11
		60,000	8-7	9-10	7-7	7-10	7-1	6-5	6-0	4-11	4-10
	1-#5	40,000	8-9	10-1	7-9	8-0	7-3	6-6	6-1	5-1	4-11
		60,000	10-8	12-3	9-6	9-10	8-10	8-0	7-5	6-2	6-0
	2-#4	40,000	9-10	11-4	8-9	9-1	8-2	7-4	6-10	5-8	5-7
		60,000	12-0	13-10	10-8	11-0	9-11	9-0	8-4	6-8	6-6
	1-#6	40,000	12-3	14-1	10-10	11-3	10-2	8-11	8-1	6-6	6-4
		60,000	14-0	17-6	11-8	12-3	10-6	9-1	8-4	6-8	6-6
	2-#5	60,000	14-0	17-6	11-8	12-3	10-6	9-1	8-4	6-8	6-6
Center distance $A^{m,n}$		1-10	2-5	1-5	1-7	1-3	1-0	0-11	STL	STL	

(continued)

## WALL CONSTRUCTION

**TABLE R608.8(7)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 8-INCH-THICK WAFFLE-GRID LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, o</sup>**  
**MAXIMUM ROOF CLEAR SPAN 40 FEET AND MAXIMUM FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^g$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>h</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
24 <sup>j</sup>	Span without stirrups <sup>k, l</sup>		5-9	6-7	5-5	5-6	5-2	4-11	4-9	4-5	4-4
	1-#4	40,000	7-6	8-10	6-10	7-1	6-5	5-9	5-5	4-6	4-4
		60,000	9-2	10-9	8-4	8-8	7-10	7-1	6-7	5-6	5-4
	1-#5	40,000	9-5	11-0	8-6	8-10	8-0	7-2	6-8	5-7	5-5
		60,000	11-5	13-5	10-5	10-9	9-9	8-9	8-2	6-10	6-8
	2-#4	40,000	10-7	12-5	9-8	10-0	9-0	8-1	7-7	6-3	6-2
		1-#6	60,000	12-11	15-2	11-9	12-2	11-0	9-11	9-3	7-8
	2-#5	40,000	13-2	15-6	12-0	12-5	11-2	9-11	9-2	7-5	7-3
		60,000	16-3	21-0	14-1	14-10	12-9	11-1	10-1	8-1	7-11
	2-#6	40,000	14-4	18-5	12-6	13-2	11-5	9-11	9-2	7-5	7-3
	Center distance $A^{m, n}$		2-1	2-11	1-9	1-10	1-6	1-3	1-1	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch-nominal waffle-grid forms and not less than 7 inches in width for 8-inch-nominal waffle-grid forms. See Figure R608.8(3). Flat-form lintels shall be permitted in lieu of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).
- See Table R608.3 for tolerances permitted from nominal thicknesses and minimum dimensions and spacing of cores.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes l and n. Table values are based on uniform loading. See Section R608.8.2 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads.
- STL indicates stirrups required throughout lintel.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Lintels less than 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or, if necessary, form material shall be removed from waffle-grid forms so as to provide the required cover for stirrups. Allowable spans for lintels formed with flat-wall forms shall be determined from Tables R608.8(2) through R608.8(5).
- Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than  $d/2$ .
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.

**TABLE R608.8(8)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR 6-INCH-THICK SCREEN-GRID LINTELS IN LOAD-BEARING WALLS<sup>a, b, c, d, e, f, p</sup>**  
**ROOF CLEAR SPAN 40 FEET AND FLOOR CLEAR SPAN 32 FEET**

LINTEL DEPTH, $D^p$ (inches)	NUMBER OF BARS AND BAR SIZE IN TOP AND BOTTOM OF LINTEL	STEEL YIELD STRENGTH <sup>b</sup> , $f_y$ (psi)	DESIGN LOADING CONDITION DETERMINED FROM Table R608.8(1)								
			1	2		3		4		5	
			Maximum ground snow load (psf)								
			—	30	70	30	70	30	70	30	70
			Maximum clear span of lintel (feet-inches)								
12 <sup>i,j</sup>	Span without stirrups		2-9	2-11	2-4	2-5	2-3	2-3	2-2	2-0	2-0
16 <sup>i,j</sup>	Span without stirrups		3-9	4-0	3-4	3-5	3-2	3-1	3-0	2-9	2-9
20 <sup>i,j</sup>	Span without stirrups		4-9	5-1	4-3	4-4	4-1	4-0	3-10	3-7	3-7
24 <sup>k</sup>	Span without stirrups <sup>l,m</sup>		5-8	6-3	5-2	5-3	5-0	4-10	4-8	4-4	4-4
	1-#4	40,000	7-11	9-0	6-11	7-2	6-5	6-1	5-8	4-9	4-7
		60,000	9-9	11-0	8-5	8-9	7-10	7-5	6-10	5-9	5-7
	1-#5	40,000	9-11	11-2	8-7	8-11	8-0	7-7	7-0	5-11	5-9
		60,000	12-1	13-8	10-6	10-10	9-9	9-3	8-6	7-2	7-0
	2-#4	40,000	11-2	12-8	9-9	10-1	9-1	8-7	7-11	6-8	6-6
		1-#6	60,000	15-7	17-7	12-8	13-4	11-6	10-8	9-8	7-11
	2-#5	40,000	14-11	18-0	12-2	12-10	11-1	10-3	9-4	7-8	7-5
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	DR
	Center distance $A^{n,o}$		2-0	2-6	1-6	1-7	1-4	1-2	1-0	STL	STL

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- Where lintels are formed with screen-grid forms, form material shall be removed if necessary to create top and bottom flanges of the lintel that are not less than 5 inches in width and not less than 2.5 inches in depth (in the vertical direction). See Figure R608.8(4). Flat-form lintels shall be permitted in lieu of screen-grid lintels. See Tables R608.8(2) through R608.8(5).
- See Table R608.3 for tolerances permitted from nominal thickness and minimum dimensions and spacings of cores.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Notes m and o. Table values are based on uniform loading. See Section R608.7.2.1 for lintels supporting concentrated loads.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation is permitted between ground snow loads.
- DR indicates design required. STL indicates stirrups required throughout lintel.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
- Stirrups are not required for lintels less than 24 inches in depth fabricated from screen-grid forms. Top and bottom reinforcement shall consist of a No. 4 bar having a yield strength of 40,000 psi or 60,000 psi.
- Lintels between 12 and 24 inches in depth with stirrups shall be formed from flat-wall forms [see Tables R608.8(2) through R608.8(5)], or form material shall be removed from screen-grid forms to provide a concrete section comparable to that required for a flat wall. Allowable spans for flat lintels with stirrups shall be determined from Tables R608.8(2) through R608.8(5).
- Where stirrups are required for 24-inch-deep lintels, the spacing shall not exceed 12 inches on center.
- Allowable clear span without stirrups applicable to all lintels of the same depth,  $D$ . Top and bottom reinforcement for lintels without stirrups shall be not less than the least amount of reinforcement required for a lintel of the same depth and loading condition with stirrups. All other spans require stirrups spaced at not more than 12 inches.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without stirrups that has been increased.
- Center distance,  $A$ , is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, center distance,  $A$ , shall be permitted to be multiplied by 1.10.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information only.



## WALL CONSTRUCTION

**TABLE R608.8(9)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR FLAT LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS<sup>a, b, c, d, e, g</sup>**

LINTEL DEPTH, <i>D'</i> (inches)	NUMBER OF BARS AND BAR SIZE	STEEL YIELD STRENGTH, <i>f<sub>y</sub></i> (psi)	NOMINAL WALL THICKNESS (inches)								
			4		6		8		10		
			Lintel Supporting								
			Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable	
			Maximum Clear Span of Lintel (feet-inches)								
8	1-#4	40,000	10-11	11-5	9-7	11-2	7-10	9-5	7-3	9-2	
		60,000	12-5	11-7	10-11	13-5	9-11	13-2	9-3	12-10	
	1-#5	40,000	12-7	11-7	11-1	13-8	10-1	13-5	9-4	13-1	
		60,000	DR	DR	12-7	16-4	11-6	14-7	10-9	14-6	
	2-#4	40,000	DR	DR	12-0	15-3	10-11	15-0	10-2	14-8	
		1-#6	60,000	DR	DR	DR	DR	12-2	15-3	11-7	15-3
	2-#5	40,000	DR	DR	DR	DR	12-7	16-7	11-9	16-7	
		60,000	DR	DR	DR	DR	DR	DR	13-3	16-7	
	2-#6	40,000	DR	DR	DR	DR	DR	DR	13-2	17-8	
		60,000	DR	DR	DR	DR	DR	DR	DR	DR	
12	1-#4	40,000	11-5	9-10	10-6	12-0	9-6	11-6	8-9	11-1	
		60,000	11-5	9-10	11-8	13-3	10-11	14-0	10-1	13-6	
	1-#5	40,000	11-5	9-10	11-8	13-3	11-1	14-4	10-3	13-9	
		60,000	11-5	9-10	11-8	13-3	11-10	16-0	11-9	16-9	
	2-#4	40,000	DR	DR	11-8	13-3	11-10	16-0	11-2	15-6	
		1-#6	60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
	2-#5	40,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4	
		60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4	
	16	1-#4	40,000	13-6	13-0	11-10	13-8	10-7	12-11	9-11	12-4
			60,000	13-6	13-0	13-8	16-7	12-4	15-9	11-5	15-0
1-#5		40,000	13-6	13-0	13-10	17-0	12-6	16-1	11-7	15-4	
		60,000	13-6	13-0	13-10	17-1	14-0	19-7	13-4	18-8	
2-#4		40,000	13-6	13-0	13-10	17-1	13-8	18-2	12-8	17-4	
		1-#6	60,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	—
2-#5		40,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	—	
		60,000	DR	DR	13-10	17-1	14-0	20-3	14-1	—	
20		1-#4	40,000	14-11	15-10	13-0	14-10	11-9	13-11	10-10	13-2
			60,000	15-3	15-10	14-11	18-1	13-6	17-0	12-6	16-2
	1-#5	40,000	15-3	15-10	15-2	18-6	13-9	17-5	12-8	16-6	
		60,000	15-3	15-10	15-8	20-5	15-9	—	14-7	20-1	
	2-#4	40,000	15-3	15-10	15-8	20-5	14-11	—	13-10	—	
		1-#6	60,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—
	2-#5	40,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—	
		60,000	15-3	15-10	15-8	20-5	15-10	—	15-11	—	

(continued)

**TABLE R608.8(9)—continued**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR FLAT LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS<sup>a, b, c, d, e, g</sup>**

LINTEL DEPTH, <i>D</i> (inches)	NUMBER OF BARS AND BAR SIZE	STEEL YIELD STRENGTH, <i>f<sub>y</sub></i> (psi)	NOMINAL WALL THICKNESS (inches)							
			4		6		8		10	
			Lintel Supporting							
			Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable	Concrete Wall	Light- frame Gable
			Maximum Clear Span of Lintel (feet-inches)							
24	1-#4	40,000	16-1	17-1	13-11	15-10	12-7	14-9	11-8	13-10
		60,000	16-11	18-5	16-1	19-3	14-6	18-0	13-5	17-0
	1-#5	40,000	16-11	18-5	16-3	19-8	14-9	18-5	13-8	17-4
		60,000	16-11	18-5	17-4	—	17-0	—	15-8	—
	2-#4	40,000	16-11	18-5	17-4	—	16-1	—	14-10	—
		60,000	16-11	18-5	17-4	—	17-6	—	17-1	—
	1-#6	40,000	16-11	18-5	17-4	—	17-6	—	17-4	—
		60,000	16-11	18-5	17-4	—	17-6	—	17-8	—

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

DR = Design Required.

- See Table R608.3 for tolerances permitted from nominal thickness.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note e.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Linear interpolation between lintels depths,  $D$ , is permitted provided the two cells being used to interpolate are shaded.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, spans in cells that are shaded shall be permitted to be multiplied by 1.05.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
- The maximum clear opening width between two solid wall segments shall be 18 feet. See Section R608.7.2.1. Lintel spans in the table greater than 18 feet are shown for interpolation and information purposes only.

**TABLE R608.8(10)**  
**MAXIMUM ALLOWABLE CLEAR SPANS FOR WAFFLE-GRID AND  
 SCREEN-GRID LINTELS WITHOUT STIRRUPS IN NONLOAD-BEARING WALLS<sup>c, d, e, f, g</sup>**

LINTEL DEPTH <sup>b</sup> , <i>D</i> (inches)	FORM TYPE AND NOMINAL WALL THICKNESS (inches)					
	6-inch Waffle-grid <sup>a</sup>		8-inch Waffle-grid <sup>a</sup>		6-inch Screen-grid <sup>b</sup>	
	Lintel supporting					
	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable	Concrete Wall	Light-frame Gable
	Maximum Clear Span of Lintel (feet-inches)					
8	10-3	8-8	8-8	8-3	—	—
12	9-2	7-6	7-10	7-1	8-8	6-9
16	10-11	10-0	9-4	9-3	—	—
20	12-5	12-2	10-7	11-2	—	—
24	13-9	14-2	11-10	12-11	13-0	12-9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, Grade 40 = 280 MPa, Grade 60 = 420 MPa.

- Where lintels are formed with waffle-grid forms, form material shall be removed, if necessary, to create top and bottom flanges of the lintel that are not less than 3 inches in depth (in the vertical direction), are not less than 5 inches in width for 6-inch waffle-grid forms and not less than 7 inches in width for 8-inch waffle-grid forms. See Figure R608.8(3). Flat-form lintels shall be permitted in lieu of waffle-grid lintels. See Tables R608.8(2) through R608.8(5).
- Where lintels are formed with screen-grid forms, form material shall be removed if necessary to create top and bottom flanges of the lintel that are not less than 5 inches in width and not less than 2.5 inches in depth (in the vertical direction). See Figure R608.8(4). Flat-form lintels shall be permitted in lieu of screen-grid lintels. See Tables R608.8(2) through R608.8(5).
- See Table R608.3 for tolerances permitted from nominal thickness and minimum dimensions and spacing of cores.
- Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See Note g.
- Deflection criterion is  $L/240$ , where  $L$  is the clear span of the lintel in inches, or  $1/2$  inch, whichever is less.
- Top and bottom reinforcement shall consist of a No. 4 bar having a minimum yield strength of 40,000 psi.
- Where concrete with a minimum specified compressive strength of 3,000 psi is used, spans in shaded cells shall be permitted to be multiplied by 1.05.
- Lintel depth,  $D$ , is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.

## WALL CONSTRUCTION

**R608.8.2.1 Lintels designed for gravity load-bearing conditions.** Where a lintel will be subjected to gravity load conditions 1 through 5 of Table R608.8(1), the clear span of the lintel shall not exceed that permitted by Tables R608.8(2) through R608.8(8). The maximum clear span of lintels with and without stirrups in flat walls shall be determined in accordance with Tables R608.8(2) through R608.8(5), and constructed in accordance with Figure R608.8(2). The maximum clear span of lintels with and without stirrups in waffle-grid walls shall be determined in accordance with Tables R608.8(6) and R608.8(7), and constructed in accordance with Figure R608.8(3). The maximum clear span of lintels with and without stirrups in screen-grid walls shall be determined in accordance with Table R608.8(8), and constructed in accordance with Figure R608.8(4).

Where required by the applicable table, No. 3 stirrups shall be installed in lintels at a maximum spacing of  $d/2$  where  $d$  equals the depth of the lintel,  $D$ , less the cover of the concrete as shown in Figures R608.8(2) through R608.8(4). The smaller value of  $d$  computed for the top and bottom bar shall be used to determine the maximum stirrup spacing. Where stirrups are required in a lintel with a single bar or two bundled bars in the top and bottom, they shall be fabricated like the letter “c” or “s” with 135-degree (2.36 rad) standard hooks at each end that comply with Section R608.5.4.5 and Figure R608.5.4(3) and installed as shown in Figures R608.8(2) through R608.8(4). Where two bars are required in the top and bottom of the lintel and the bars are not bundled, the bars shall be separated by not less than 1 inch (25 mm). The free end of the stirrups shall be fabricated with 90- or 135-degree (1.57 or 2.36 rad) standard hooks that comply with Section R608.5.4.5 and Figure R608.5.4(3) and installed as shown in Figures R608.8(2) and R608.8(3). For flat, waffle-grid and screen-grid lintels, stirrups are not required in the center distance,  $A$ , portion of spans in accordance with Figure R608.8(1) and Tables R608.8(2) through R608.8(8). See Section R608.8.2.2, Item 5, for requirement for stirrups through out lintels with bundled bars.

**R608.8.2.2 Bundled bars in lintels.** It is permitted to bundle two bars in contact with each other in lintels if all of the following are observed:

1. Bars equal to or less than No. 6 are bundled.
2. Where the wall thickness is not sufficient to provide not less than 3 inches (76 mm) of clear space beside bars (total on both sides) oriented horizontally in a bundle, the bundled bars shall be oriented in a vertical plane.
3. Where vertically oriented bundled bars terminate with standard hooks to develop the bars in tension beyond the support (see Section R608.5.4.4), the hook extensions shall be stag-

gered to provide not less than 1 inch (25 mm) clear spacing between the extensions.

4. Bundled bars shall not be lap spliced within the lintel span and the length on each end of the lintel that is required to develop the bars in tension.
5. Bundled bars shall be enclosed within stirrups throughout the length of the lintel. Stirrups and the installation thereof shall comply with Section R608.8.2.1.

**R608.8.2.3 Lintels without stirrups designed for nonload-bearing conditions.** The maximum clear span of lintels without stirrups designed for nonload-bearing conditions of Table R608.8(1) shall be determined in accordance with this section. The maximum clear span of lintels without stirrups in flat walls shall be determined in accordance with Table R608.8(9), and the maximum clear span of lintels without stirrups in walls of waffle-grid or screen-grid construction shall be determined in accordance with Table R608.8(10).

**R608.9 Requirements for connections—general.** Concrete walls shall be connected to footings, floors, ceilings and roofs in accordance with this section.

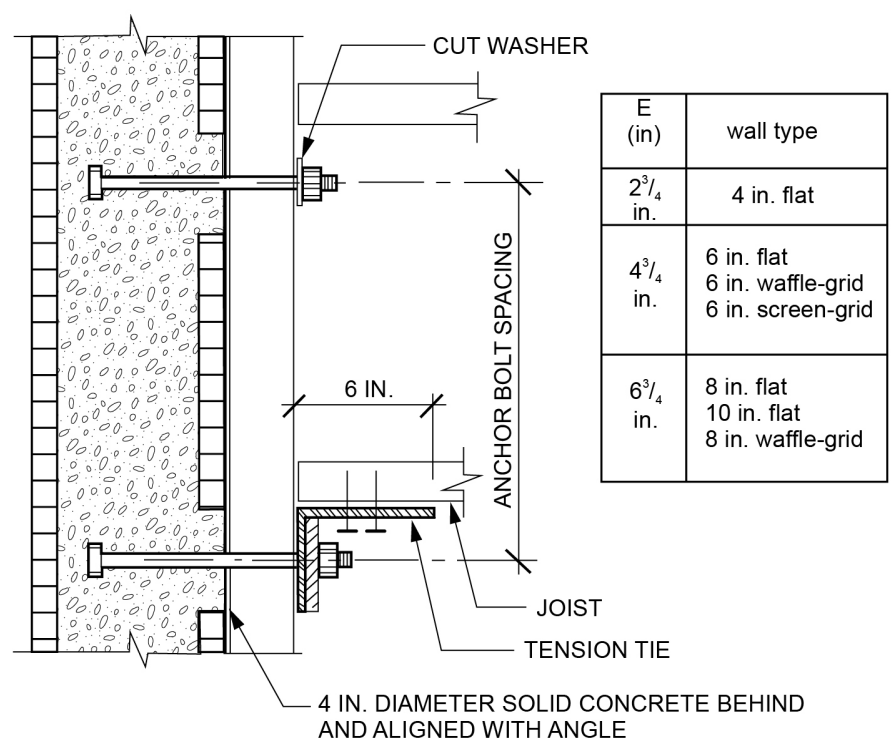
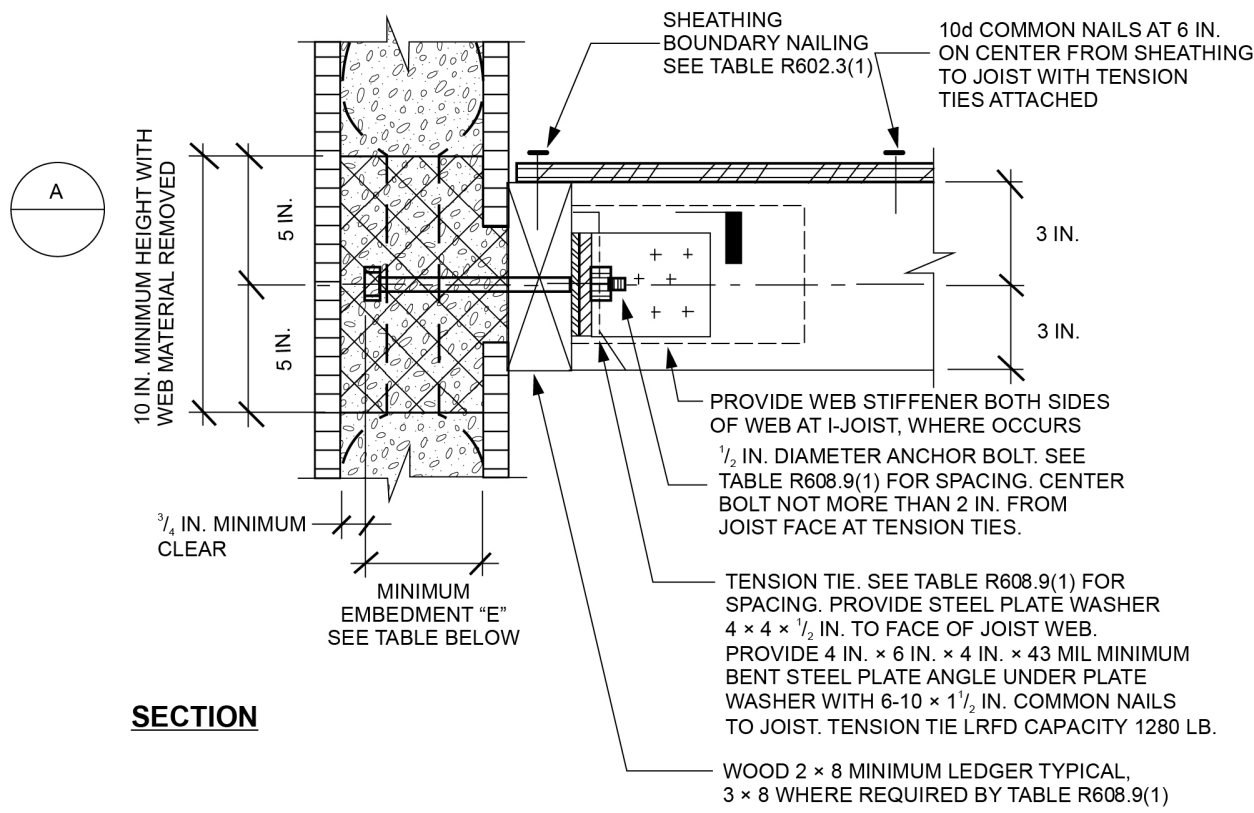
**R608.9.1 Connections between concrete walls and light-frame floor, ceiling and roof systems.** Connections between concrete walls and light-frame floor, ceiling and roof systems using the prescriptive details of Figures R608.9(1) through R608.9(12) shall comply with this section and Sections R608.9.2 and R608.9.3.

**R608.9.1.1 Anchor bolts.** Anchor bolts used to connect light-frame floor, ceiling and roof systems to concrete walls in accordance with Figures R608.9(1) through R608.9(12) shall have heads, or shall be rods with threads on both ends with a hex or square nut on the end embedded in the concrete. Bolts and threaded rods shall comply with Section R608.5.2.2. Anchor bolts with J- or L-hooks shall not be used where the connection details in these figures are used.

**R608.9.1.2 Removal of stay-in-place form material at bolts.** Holes in stay-in-place forms for installing bolts for attaching face-mounted wood ledger boards to the wall shall be not less than 4 inches (102 mm) in diameter for forms not greater than  $1\frac{1}{2}$  inches (38 mm) in thickness, and increased 1 inch (25 mm) in diameter for each  $\frac{1}{2}$ -inch (12.7 mm) increase in form thickness. Holes in stay-in-place forms for installing bolts for attaching face-mounted cold-formed steel tracks to the wall shall be not less than 4 inches (102 mm) square. The wood ledger board or steel track shall be in direct contact with the concrete at each bolt location.

**Exception:** A vapor retarder or other material less than or equal to  $\frac{1}{16}$  inch (1.6 mm) in thickness is permitted to be installed between the wood ledger or cold-formed track and the concrete.

WALL CONSTRUCTION



**DETAIL A – PLAN VIEW**

For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(1)**  
**WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR**

## WALL CONSTRUCTION

**TABLE R608.9(1)**  
**WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR<sup>a, b</sup>**

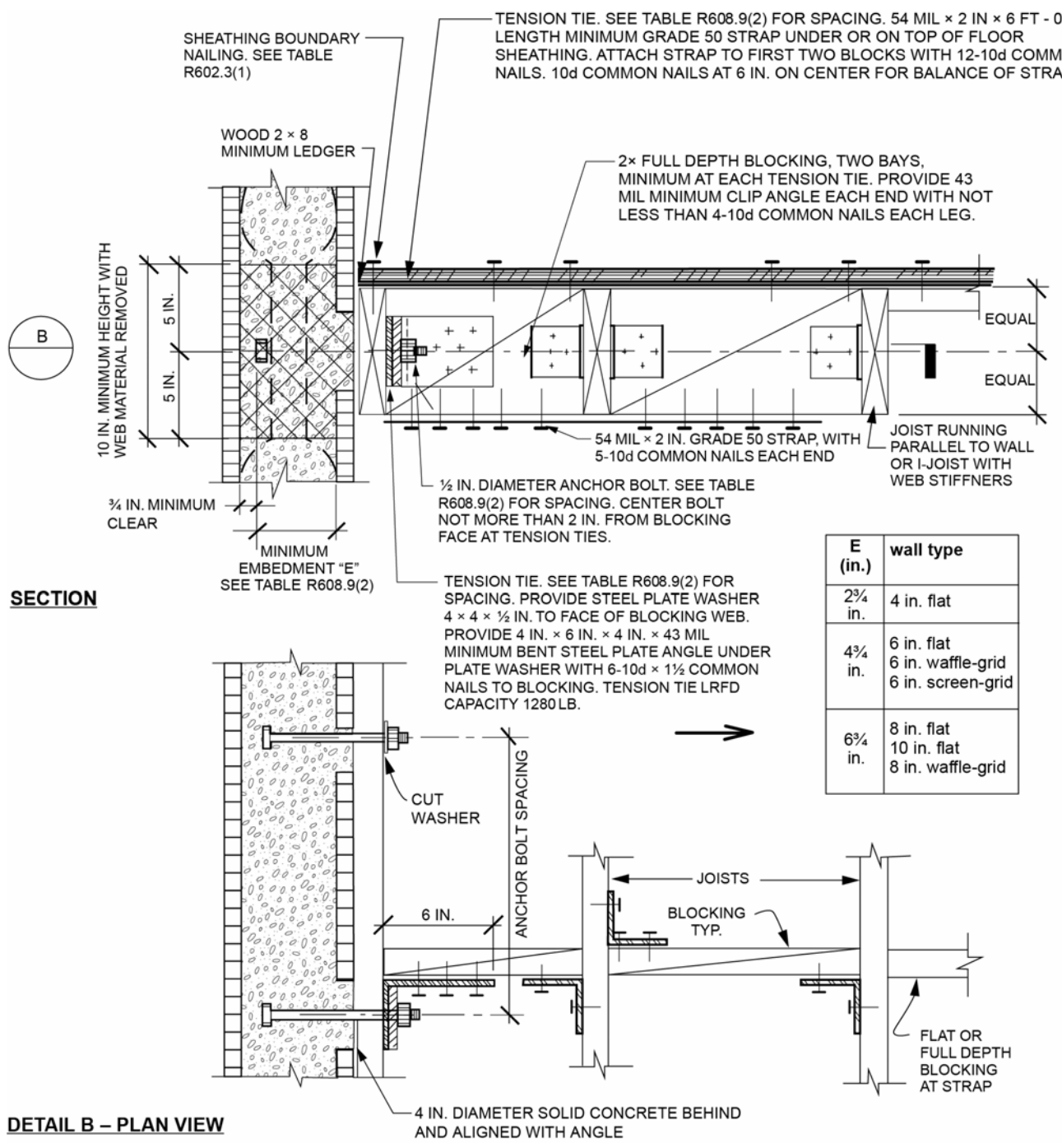
ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph)					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- a. This table is for use with the detail in Figure R608.9(1). Use of this detail is permitted where a cell is not shaded and prohibited where shaded.  
b. Wall design per other provisions of Section R608 is required.



WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(2)**  
**WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL**

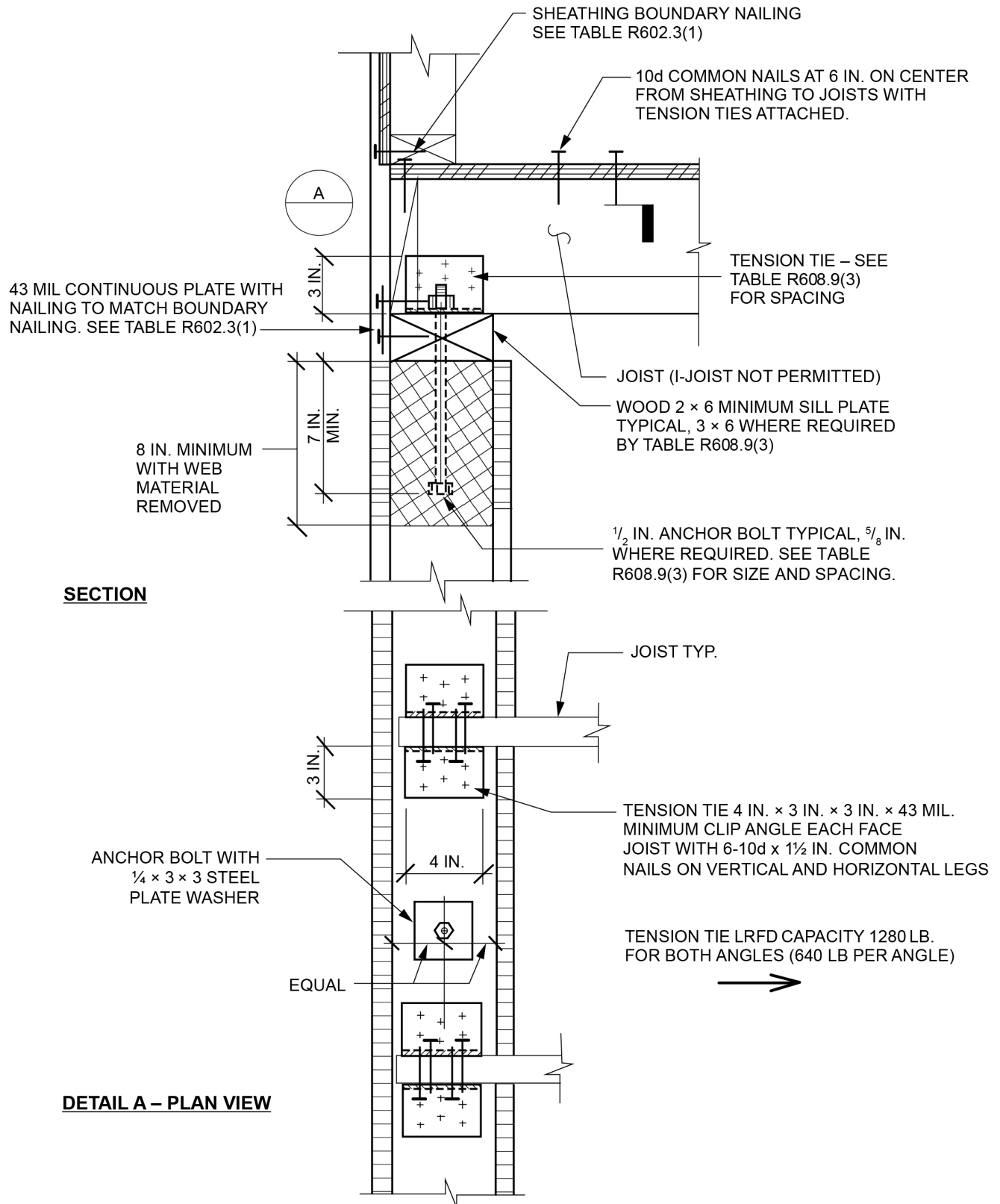
## WALL CONSTRUCTION

**TABLE R608.9(2)**  
**WOOD-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL<sup>a, b</sup>**

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						
24	24						
24	48						

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- a. This table is for use with the detail in Figure R608.9(2). Use of this detail is permitted where a cell is not shaded and prohibited where shaded.  
b. Wall design per other provisions of Section R608 is required.



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(3)**  
**WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR**

## WALL CONSTRUCTION

**TABLE R608.9(3)**  
**WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR<sup>a, b, c, d, e</sup>**

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
12	36					6	6
12	48				6	6	6
16	16					6	6A
16	32				6	6	6A
16	48			6	6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B
24	48		6	6A	6B	6B	8B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(3). Use of this detail is permitted where cell is not shaded.

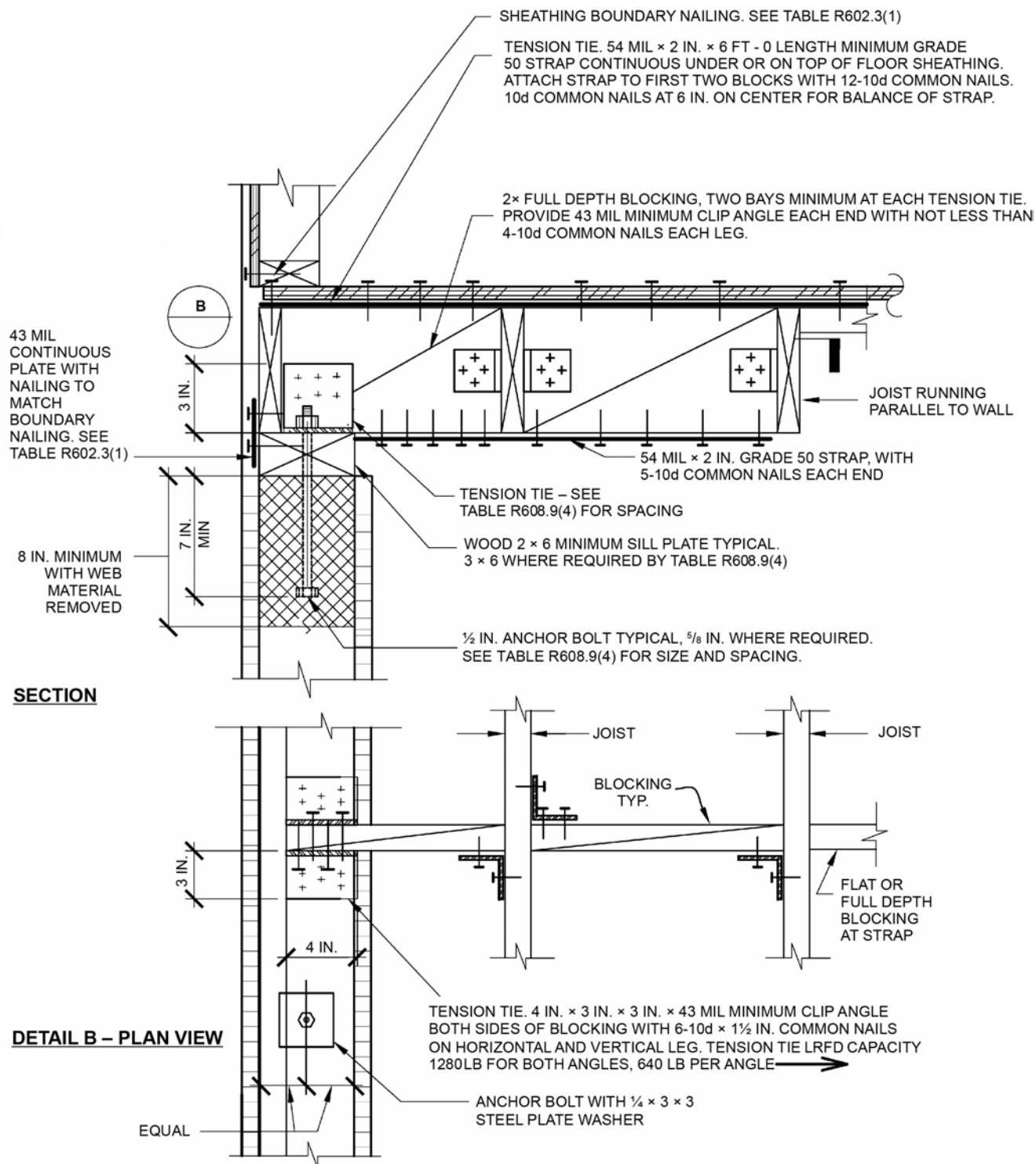
b. Wall design per other provisions in Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(3). For the remainder of the wall, see Note b.

e. Letter “A” indicates that a minimum nominal 3 × 6 sill plate is required. Letter “B” indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(4)**  
**WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL**



## WALL CONSTRUCTION

**TABLE R608.9(4)**  
**WOOD-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL** <sup>a, b, c, d, e</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
12	36					6	6
12	48				6	6	6
16	16					6	6A
16	32				6	6	6A
16	48			6	6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B
24	48		6	6A	6B	6B	8B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

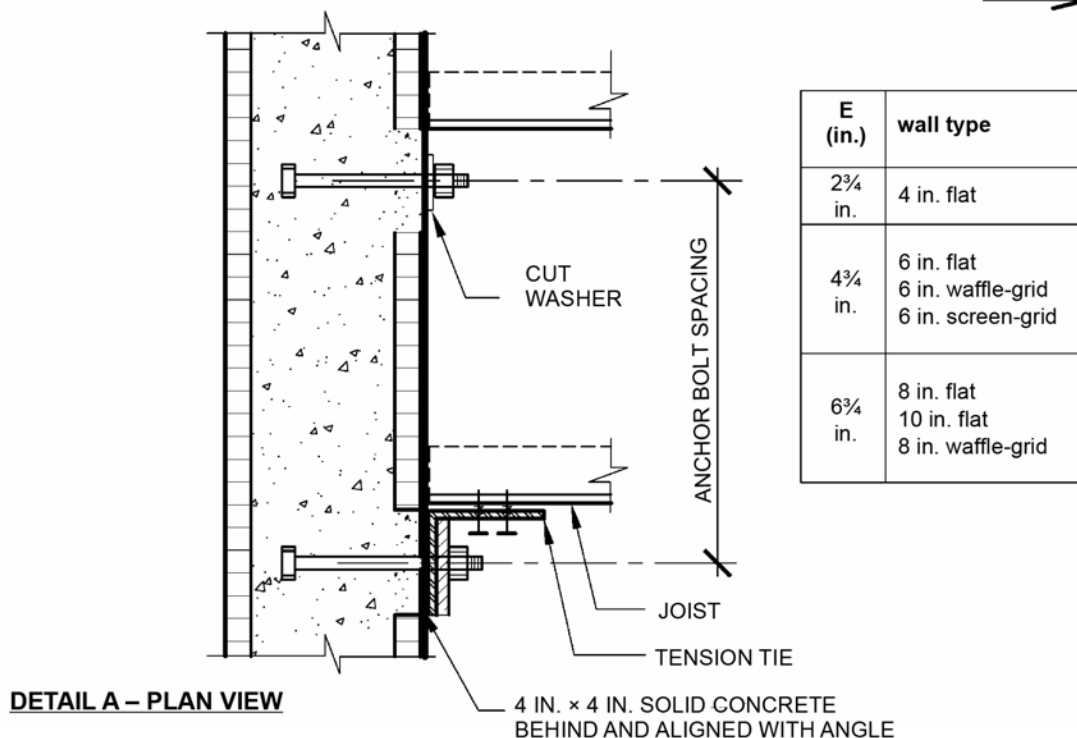
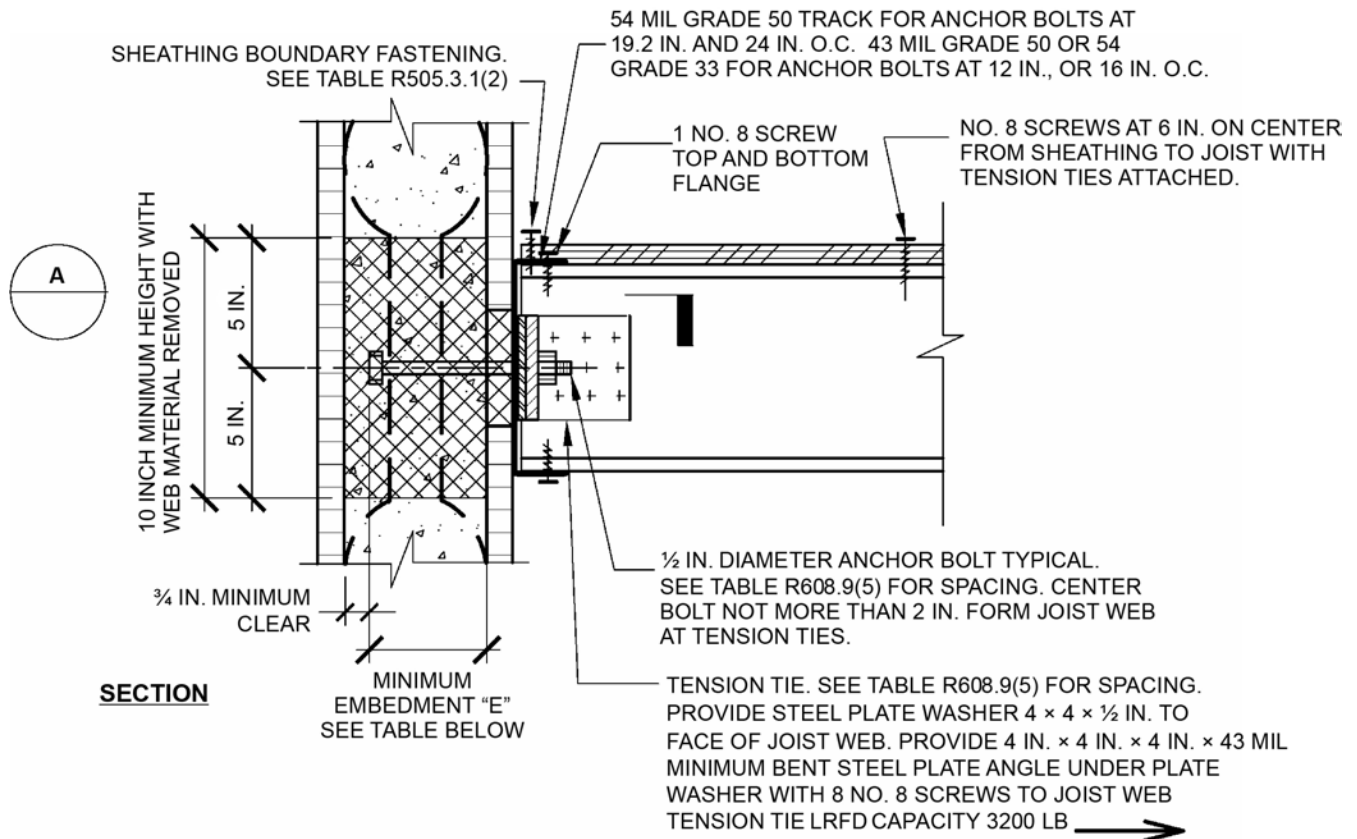
a. This table is for use with the detail in Figure R608.9(4). Use of this detail is permitted where a cell is not shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(4). For the remainder of the wall, see Note b.

e. Letter “A” indicates that a minimum nominal 3 × 6 sill plate is required. Letter “B” indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(5)**  
**COLD-FORMED STEEL FLOOR TO SIDE OF CONCRETE WALL. FRAMING PERPENDICULAR**

## WALL CONSTRUCTION

**TABLE R608.9(5)**  
**COLD-FORMED STEEL-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PERPENDICULAR<sup>a, b, c</sup>**

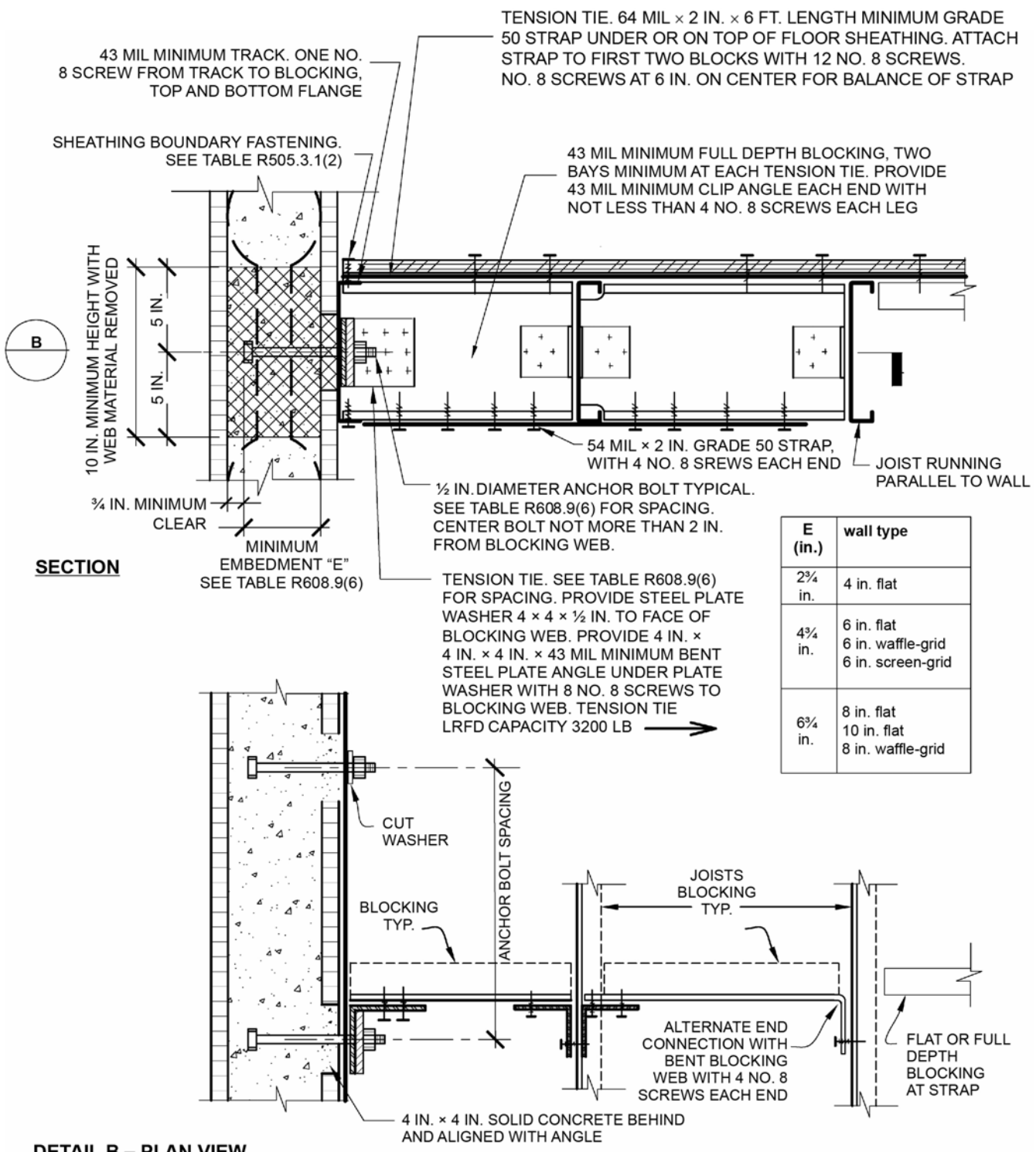
ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						
24	24						
24	48						

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.4470 m/s.

a. This table is for use with the detail in Figure R608.9(5). Use of this detail is permitted where a cell is not shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(6)**  
**COLD-FORMED STEEL FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL**

## WALL CONSTRUCTION

**TABLE R608.9(6)**  
**COLD-FORMED STEEL-FRAMED FLOOR TO SIDE OF CONCRETE WALL, FRAMING PARALLEL** <sup>a, b, c</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						
12	24						
12	36						
12	48						
16	16						
16	32						
16	48						
19.2	19.2						
19.2	38.4						
24	24						
24	48						

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

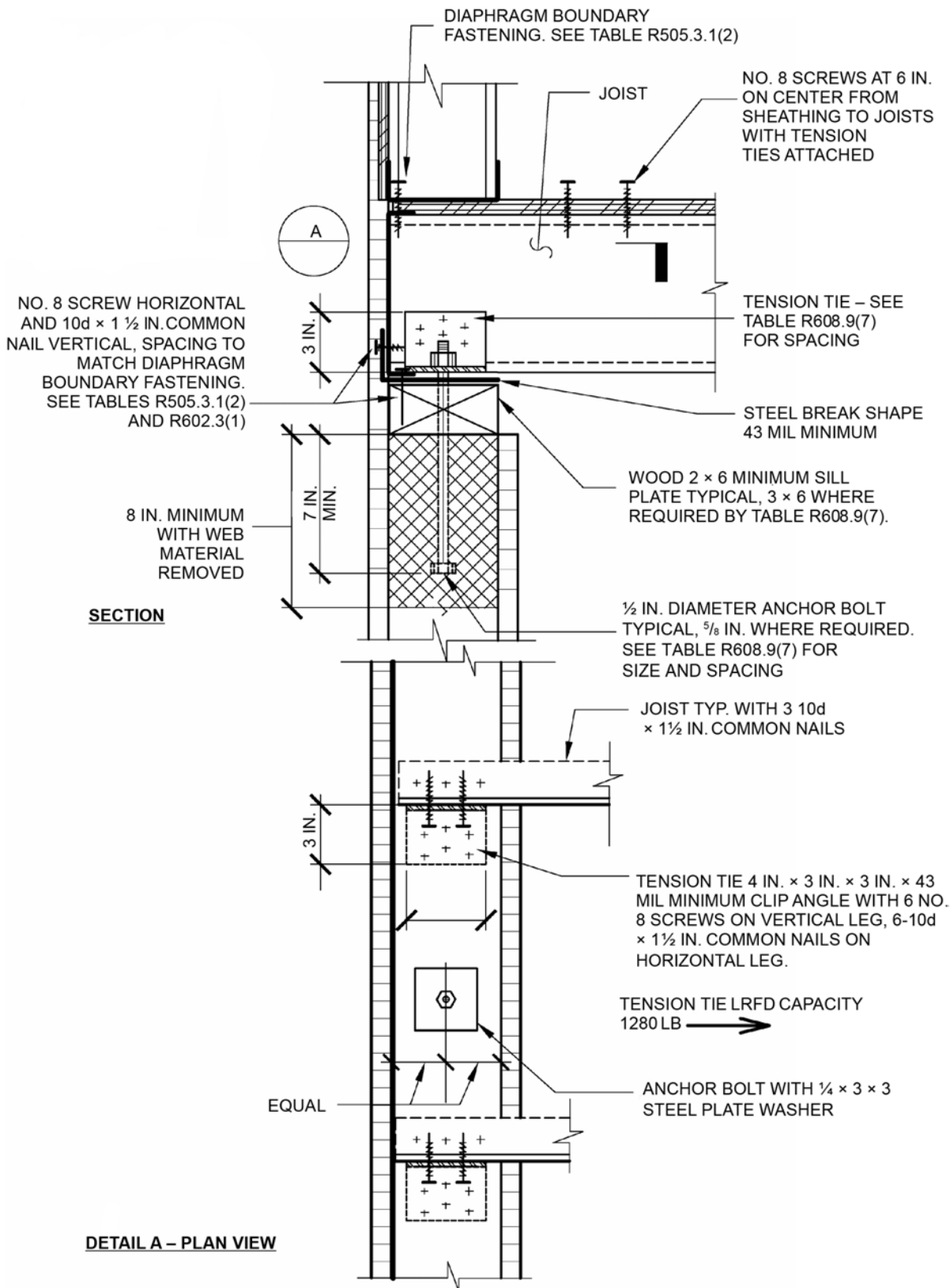
a. This table is for use with the detail in Figure R608.9(6). Use of this detail is permitted where a cell is not shaded.

b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.



## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(7)**  
COLD-FORMED STEEL FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR

## WALL CONSTRUCTION

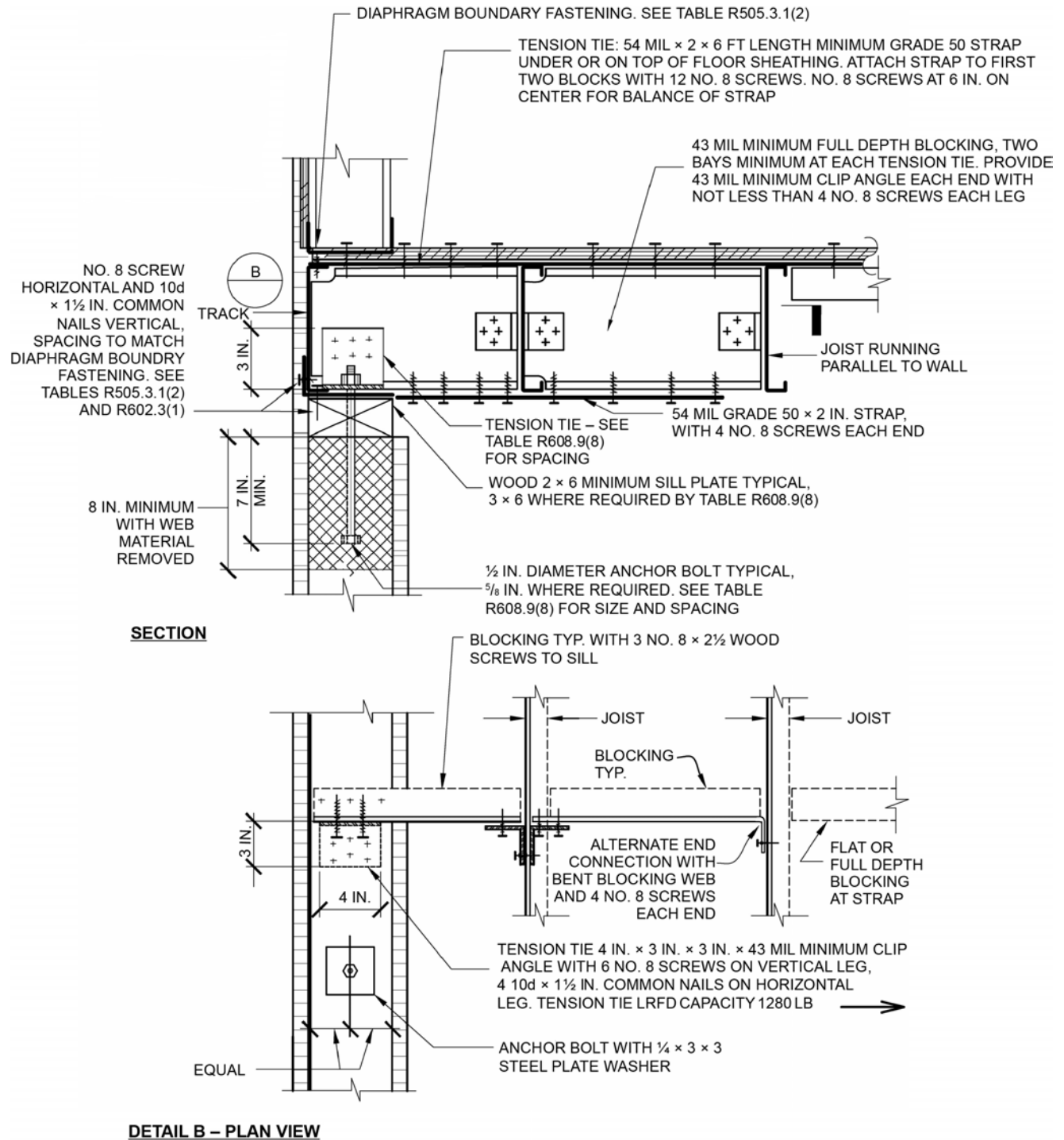
**TABLE R608.9(7)**  
**COLD-FORMED STEEL-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR<sup>a, b, c, d, e</sup>**

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED AND WIND EXPOSURE CATEGORY (mph)					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
16	16					6	6A
16	32				6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- This table is for use with the detail in Figure R608.9(7). Use of this detail is permitted where a cell is not shaded.
- Wall design per other provisions of Section R608 is required.
- For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.
- Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(7). For the remainder of the wall, see Note b.
- Letter "A" indicates that a minimum nominal 3 × 6 sill plate is required. Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.

## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(8)**  
**COLD-FORMED STEEL FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL**

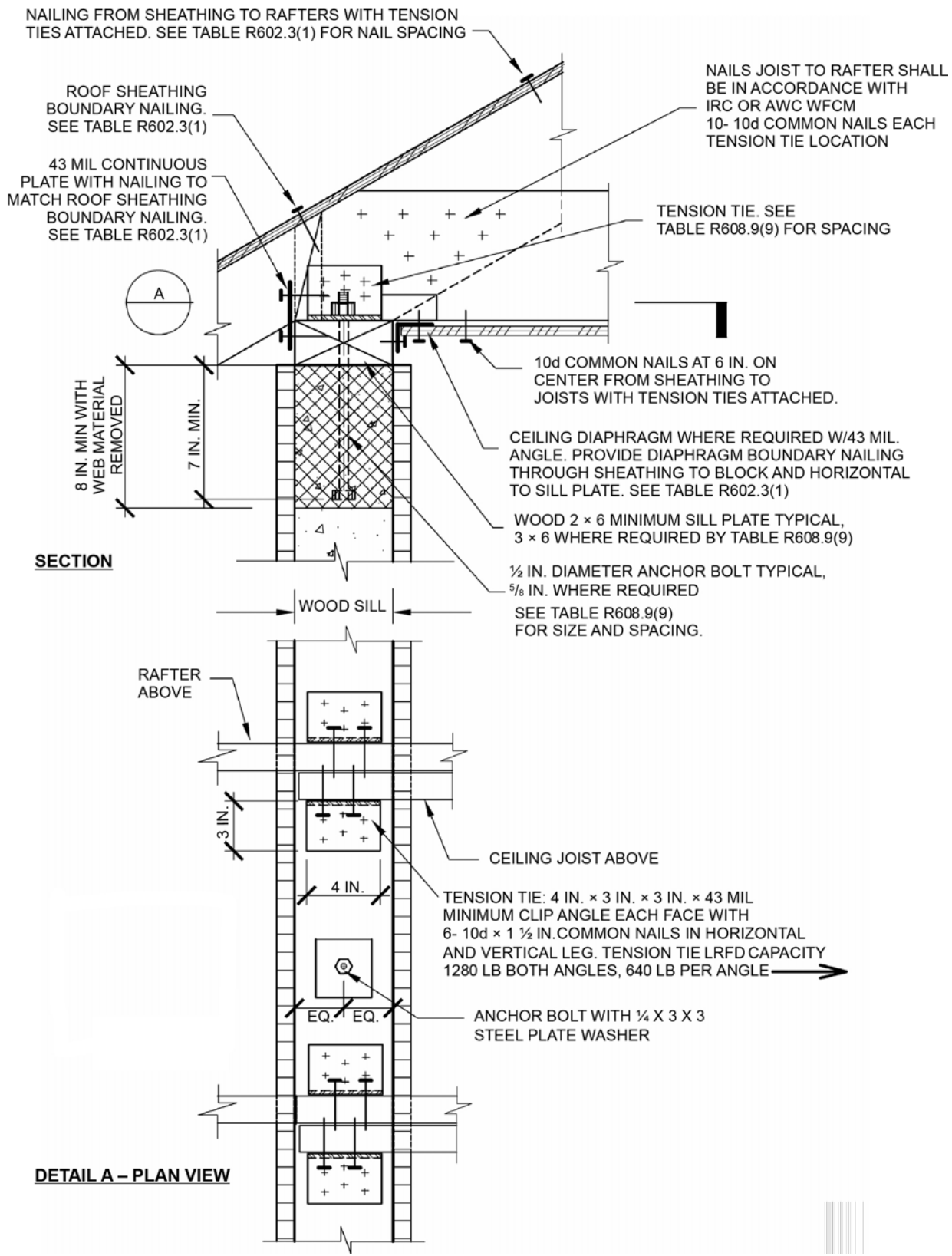
## WALL CONSTRUCTION

**TABLE R608.9(8)**  
**COLD-FORMED STEEL-FRAMED FLOOR TO TOP OF CONCRETE WALL, FRAMING PARALLEL** <sup>a, b, c, d, e</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED AND WIND EXPOSURE CATEGORY (mph)					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24					6	6
16	16					6	6A
16	32				6	6	6A
19.2	19.2				6A	6A	6B
19.2	38.4			6	6A	6A	6B
24	24			6A	6B	6B	6B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- This table is for use with the detail in Figure R608.9(8). Use of this detail is permitted where a cell is not shaded.
- Wall design per other provisions of Section R608 is required.
- For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.
- Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(8). For the remainder of the wall, see Note b.
- Letter "A" indicates that a minimum nominal 3 × 6 sill plate is required. Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(9)**  
**WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR**



## WALL CONSTRUCTION

**TABLE R608.9(9)**  
**WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR**<sup>a, b, c, d, e</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	
24	24				6		
24	48			6	8B		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

a. This table is for use with the detail in Figure R608.9(9). Use of this detail is permitted where a cell is not shaded, and prohibited where shaded.

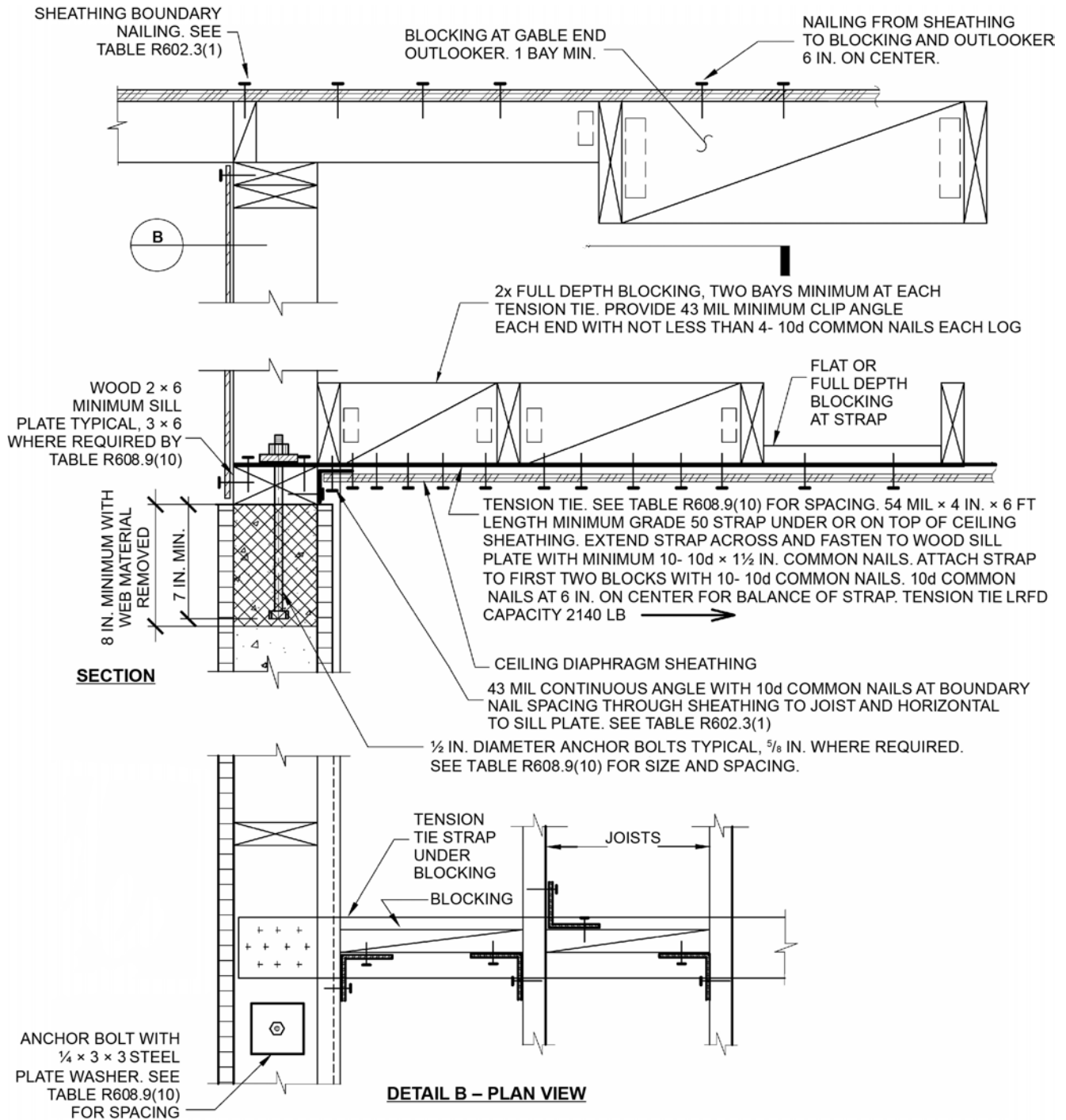
b. Wall design per other provisions of Section R608 is required.

c. For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.

d. Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(9). For the remainder of the wall, see Note b.

e. Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal  $3 \times 6$  sill plate are required.

## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(10)**  
**WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL**

## WALL CONSTRUCTION

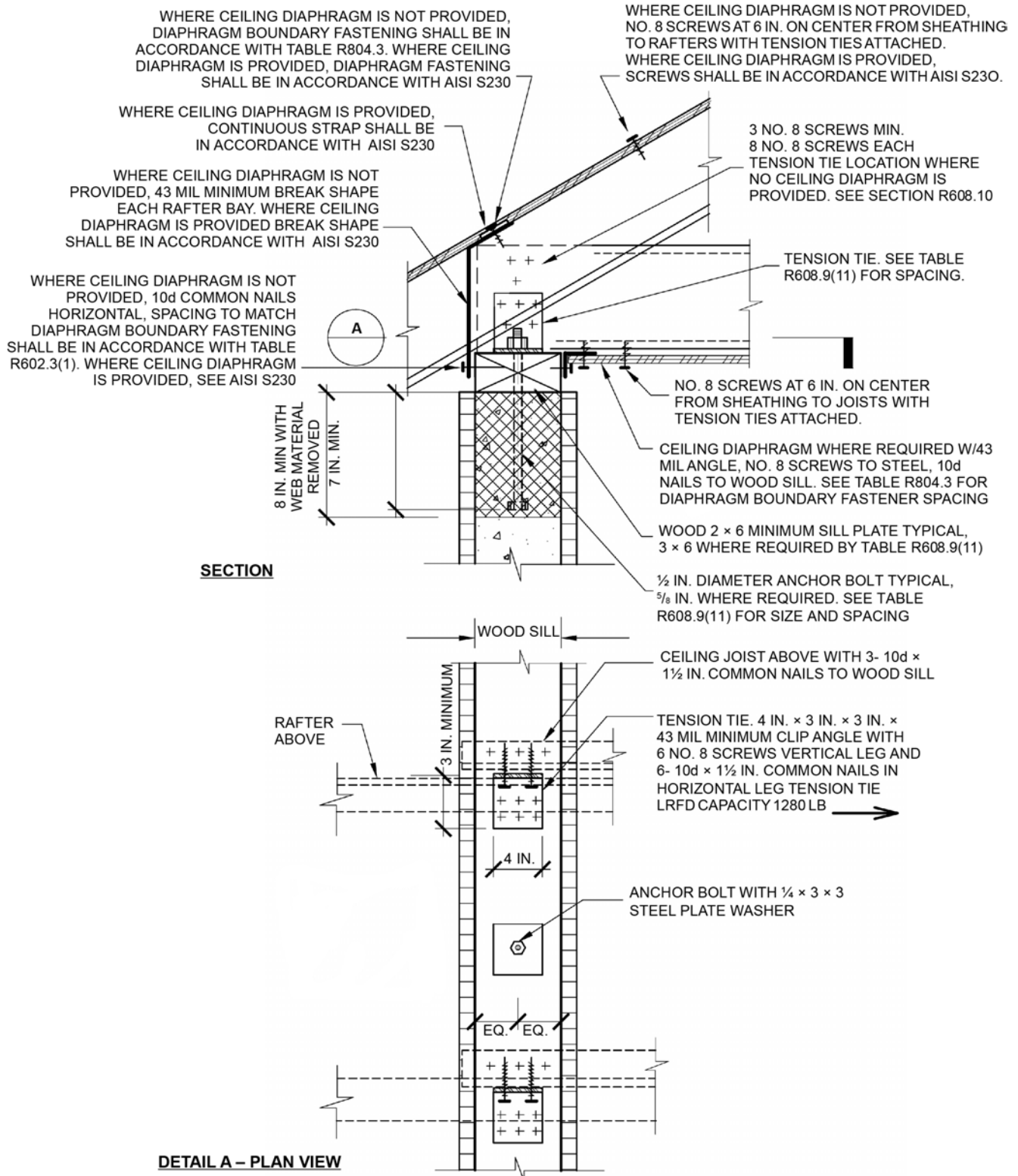
**TABLE R608.9(10)**  
**WOOD-FRAMED ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL** <sup>a, b, c, d, e</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
12	36					6	6
12	48				6	6	6
16	16					6	6
16	32					6	6
16	48				6	6	6
19.2	19.2					6	6
19.2	38.4				6	6	
24	24				6		
24	48			6	8B		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- This table is for use with the detail in Figure R608.9(10). Use of this detail is permitted where a cell is not shaded, and prohibited where shaded.
- Wall design per other provisions of Section R608 is required.
- For wind design, minimum 4-inch-nominal wall is permitted in cells that do not contain a number.
- Numbers 6 and 8 indicate minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(10). For the remainder of the wall, see Note b.
- Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal  $3 \times 6$  sill plate are required.

## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(11)**  
**COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR**

## WALL CONSTRUCTION

**TABLE R608.9(11)**  
**COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PERPENDICULAR**<sup>a, b, c, d, e</sup>

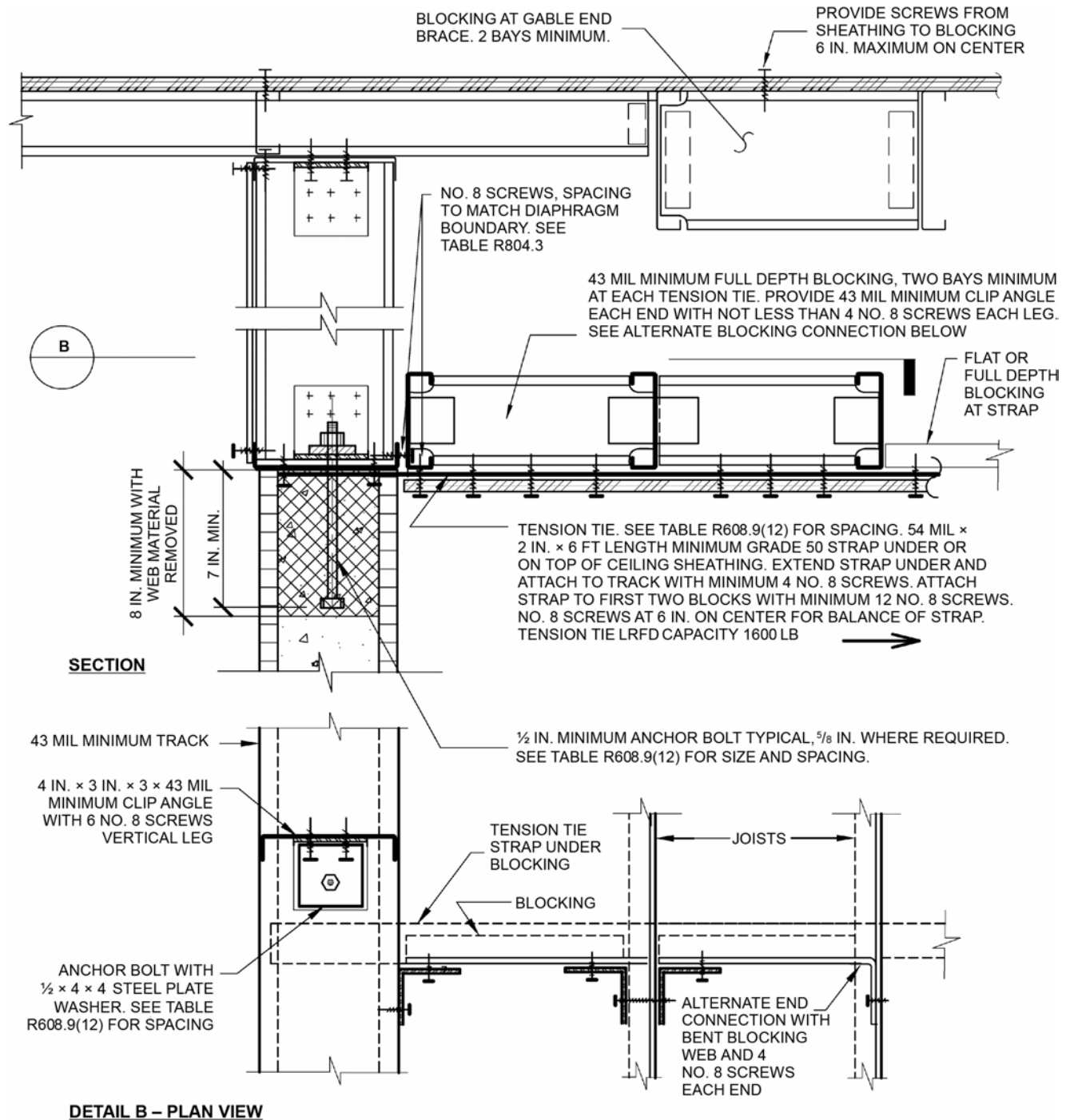
ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
16	16					6	6
16	32					6	6
19.2	19.2					6	6
19.2	38.4				6	6	6
24	24				6	6A	6B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- This table is for use with the detail in Figure R608.9(11). Use of this detail is permitted where a cell is not shaded.
- Wall design per other provisions of Section R608 is required.
- For wind design, minimum 4-inch-nominal wall is permitted in unshaded cells that do not contain a number.
- Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(11). For the remainder of the wall, see Note b.
- Letter "A" indicates that a minimum nominal 3 × 6 sill plate is required. Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt and a minimum nominal 3 × 6 sill plate are required.



## WALL CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 pound-force = 4.448 N.

**FIGURE R608.9(12)**  
**COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL**

## WALL CONSTRUCTION

**TABLE R608.9(12)**  
**COLD-FORMED STEEL ROOF TO TOP OF CONCRETE WALL, FRAMING PARALLEL** <sup>a, b, c, d, e</sup>

ANCHOR BOLT SPACING (inches)	TENSION TIE SPACING (inches)	BASIC WIND SPEED (mph) AND WIND EXPOSURE CATEGORY					
		115B	120B	130B	140B	150B	160B
		—	—	110C	119C	127C	136C
		—	—	—	110D	117D	125D
12	12						6
12	24						6
16	16					6	6
16	32					6	6
19.2	19.2					6	6
19.2	38.4				6	6	6
24	24				6	6	6B

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

- a. This table is for use with the detail in Figure R608.9(12). Use of this detail is permitted where a cell is not shaded.  
b. Wall design per other provisions of Section R608 is required.  
c. For wind design, minimum 4-inch-nominal wall is permitted in cells that do not contain a number.  
d. Number 6 indicates minimum permitted nominal wall thickness in inches necessary to develop required strength (capacity) of connection. As a minimum, this nominal thickness shall occur in the portion of the wall indicated by the cross hatching in Figure R608.9(12). For the remainder of the wall, see Note b.  
e. Letter "B" indicates that a  $\frac{5}{8}$ -inch-diameter anchor bolt is required.

**R608.9.2 Connections between concrete walls and light-frame floor systems.** Connections between concrete walls and light-frame floor systems shall be in accordance with one of the following:

- For floor systems of wood-framed construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(1) through R608.9(4), where permitted by the tables accompanying those figures. Portions of connections of wood-framed floor systems not noted in the figures shall be in accordance with Section R502, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.
- For floor systems of cold-formed steel construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(5) through R608.9(8), where permitted by the tables accompanying those figures. Portions of connections of cold-formed steel-framed floor systems not noted in the figures shall be in accordance with Section R505, or AISI S230, if applicable.
- Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
- An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
- An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood-framed construction or AISI S100 for cold-formed steel frame construction.

**R608.9.3 Connections between concrete walls and light-frame ceiling and roof systems.** Connections

between concrete walls and light-frame ceiling and roof systems shall be in accordance with one of the following:

- For ceiling and roof systems of wood-framed construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(9) and R608.9(10), where permitted by the tables accompanying those figures. Portions of connections of wood-framed ceiling and roof systems not noted in the figures shall be in accordance with Section R802, or AWC WFCM, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.
- For ceiling and roof systems of cold-formed steel construction, the provisions of Section R608.9.1 and the prescriptive details of Figures R608.9(11) and R608.9(12), where permitted by the tables accompanying those figures. Portions of connections of cold-formed steel-framed ceiling and roof systems not noted in the figures shall be in accordance with Section R804, or AISI S230, if applicable.
- Proprietary connectors selected to resist loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
- An engineered design using loads and load combinations in accordance with Appendix A (ASD) or Appendix B (LRFD) of PCA 100.
- An engineered design using loads and material design provisions in accordance with this code, or in accordance with ASCE 7, ACI 318, and AWC NDS for wood-framed construction or AISI S100 for cold-formed steel-framed construction.

**R608.10 Floor, roof and ceiling diaphragms.** Floors and roofs in buildings with exterior walls of concrete shall be

designed and constructed as diaphragms. Where gable-end walls occur, ceilings shall be designed and constructed as diaphragms. The design and construction of floors, roofs and ceilings of wood framing or cold-formed-steel framing serving as diaphragms shall comply with the applicable requirements of this code, or AWC WFCM or AISI S230, if applicable. Wood framing members shall be of a species having a specific gravity equal to or greater than 0.42.

## SECTION R609 EXTERIOR WINDOWS AND DOORS

**R609.1 General.** This section prescribes performance and construction requirements for exterior windows and doors installed in walls. Windows and doors shall be installed in accordance with the fenestration manufacturer's written instructions. Window and door openings shall be flashed in accordance with Section R703.4. Written installation instructions shall be provided by the fenestration manufacturer for each window or door.

**R609.2 Performance.** Exterior windows and doors shall be capable of resisting the design wind loads specified in Table R301.2.1(1) adjusted for height and exposure in accordance with Table R301.2.1(2) or determined in accordance with ASCE 7 using the allowable stress design load combinations of ASCE 7. For exterior windows and doors tested in accordance with Sections R609.3 and R609.5, required design wind pressures determined from ASCE 7 using the ultimate strength design (USD) are permitted to be multiplied by 0.6. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *International Building Code*. Design wind loads for exterior glazing not part of a labeled assembly shall be permitted to be determined in accordance with Chapter 24 of the *International Building Code*.

**R609.3 Testing and labeling.** Exterior windows and sliding doors shall be tested by an *approved* independent laboratory, and bear a *label* identifying manufacturer, performance characteristics and *approved* inspection agency to indicate compliance with AAMA/WDMA/CSA 101/I.S.2/A440. Exterior side-hinged doors shall be tested and *labeled* as conforming to AAMA/WDMA/CSA 101/I.S.2/A440 or AMD 100, or comply with Section R609.5.

**Exception:** Decorative glazed openings.

**R609.3.1 Comparative analysis.** Structural wind load design pressures for window and door units different than the size tested in accordance with Section R609.3 shall be permitted to be different than the design value of the tested unit where determined in accordance with one of the following comparative analysis methods:

1. Structural wind load design pressures for window and door units smaller than the size tested in accordance with Section R609.3 shall be permitted to be higher than the design value of the tested unit provided such higher pressures are determined by accepted engineering analysis. Components of the smaller unit shall be the same

as those of the tested unit. Where such calculated design pressures are used, they shall be validated by an additional test of the window or door unit having the highest allowable design pressure.

2. In accordance with WDMA I.S.11.

**R609.4 Garage doors.** Garage doors shall be tested in accordance with either ASTM E330 or ANSI/DASMA 108, and shall meet the pass/fail criteria of ANSI/DASMA 108.

**R609.4.1 Garage door labeling.** Garage doors shall be *labeled* with a permanent *label* provided by the garage door manufacturer. The *label* shall identify the garage door manufacturer, the garage door model/series number, the positive and negative design wind pressure rating, the installation instruction drawing reference number, and the applicable test standard.

**R609.5 Other exterior window and door assemblies.** Exterior windows and door assemblies not included within the scope of Section R609.3 or R609.4 shall be tested in accordance with ASTM E330. Glass in assemblies covered by this section shall comply with Section R308.5.

**R609.6 Windborne debris protection.** Protection of exterior windows, glass doors and doors with glass in buildings located in *windborne debris regions* shall be in accordance with Section R301.2.1.2.

**R609.6.1 Fenestration testing and labeling.** *Fenestration* shall be tested by an *approved* independent laboratory, *listed* by an *approved* entity, and bear a *label* identifying the manufacturer, performance characteristics and an *approved* inspection agency to indicate compliance with the requirements of the following specification(s):

1. ASTM E1886 and ASTM E1996; or
2. AAMA 506.

**R609.6.2 Impact protective systems testing and labeling.** *Impact protective systems* shall be tested for impact resistance by an *approved* independent laboratory for compliance with ASTM E1886 and ASTM E1996. *Impact protective systems* shall be tested for design wind pressure by an *approved* independent laboratory for compliance with ASTM E330. Required design wind pressures shall be determined in accordance with Table R301.2.1(1), adjusted for height and exposure in accordance with Table R301.2.1(2) or determined in accordance with ASCE 7. For the purposes of this section, design wind pressures determined in accordance with ASCE 7 are permitted to be multiplied by 0.6.

*Impact protective systems* bear a *label* identifying the manufacturer, performance characteristics and an *approved* inspection agency. *Impact protective systems* shall have a permanent *label* providing traceability to the manufacturer, product designation and performance characteristics. The permanent *label* shall be acid etched, sand blasted, ceramic fired, laser etched, embossed or of a type that, once applied, cannot be removed without being destroyed.

## WALL CONSTRUCTION

**R609.7 Anchorage methods.** The methods cited in this section apply only to anchorage of window and glass door assemblies to the main force-resisting system.

**R609.7.1 Anchoring requirements.** Window and glass door assemblies shall be anchored in accordance with the published manufacturer's recommendations to achieve the design pressure specified. Substitute anchoring systems used for substrates not specified by the fenestration manufacturer shall provide equal or greater anchoring performance as demonstrated by accepted engineering practice.

**R609.7.2 Anchorage details.** Products shall be anchored in accordance with the minimum requirements illustrated in Figures R609.7.2(1), R609.7.2(2), R609.7.2(3), R609.7.2(4), R609.7.2(5), R609.7.2(6), R609.7.2(7) and R609.7.2(8).

**R609.7.2.1 Masonry, concrete or other structural substrate.** Where the wood shim or buck thickness is less than  $1\frac{1}{2}$  inches (38 mm), window and glass door assemblies shall be anchored through the jamb, or by jamb clip and anchors shall be embedded directly into the masonry, concrete or other substantial substrate material. Anchors shall adequately transfer load from the window or door frame into the rough opening substrate [see Figures R609.7.2(1) and R609.7.2(2)].

Where the wood shim or buck thickness is  $1\frac{1}{2}$  inches (38 mm) or more, the buck is securely fastened to the masonry, concrete or other substantial substrate, and the buck extends beyond the interior face of the window or door frame, window and glass door assemblies shall be anchored through the jamb, or by jamb clip, or through the flange to the secured wood buck. Anchors shall be embedded into the secured wood buck to adequately transfer load from the window or door frame assembly [see Figures R609.7.2(3), R609.7.2(4) and R609.7.2(5)].

**R609.7.2.2 Wood or other approved framing material.** Where the framing material is wood or other approved framing material, window and glass door assemblies shall be anchored through the frame, or by frame clip, or through the flange. Anchors shall be embedded into the frame construction to adequately transfer load [see Figures R609.7.2(6), R609.7.2(7) and R609.7.2(8)].

**R609.8 Mullions.** Mullions shall be tested by an approved testing laboratory in accordance with AAMA 450, or be engineered in accordance with accepted engineering practice. Mullions tested as stand-alone units or qualified by engineering shall use performance criteria cited in Sections R609.8.1, R609.8.2 and R609.8.3. Mullions qualified by an actual test of an entire assembly shall comply with Sections R609.8.1 and R609.8.3.

**R609.8.1 Load transfer.** Mullions shall be designed to transfer the design pressure loads applied by the window and door assemblies to the rough opening substrate.

**R609.8.2 Deflection.** Mullions shall be capable of resisting the design pressure loads applied by the window and

door assemblies to be supported without deflecting more than  $L/175$ , where  $L$  is the span of the mullion in inches.

**R609.8.3 Structural safety factor.** Mullions shall be capable of resisting a load of 1.5 times the design pressure loads applied by the window and door assemblies to be supported without exceeding the appropriate material stress levels. If tested by an approved laboratory, the 1.5 times the design pressure load shall be sustained for 10 seconds, and the permanent deformation shall not exceed 0.4 percent of the mullion span after the 1.5 times design pressure load is removed.

## SECTION R610 STRUCTURAL INSULATED PANEL WALL CONSTRUCTION

**R610.1 General.** Structural insulated panel (SIP) walls shall be designed in accordance with the provisions of this section. Where the provisions of this section are used to design *structural insulated panel* walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design, unless otherwise required by the state law of the *jurisdiction* having authority.

**R610.2 Applicability limits.** The provisions of this section shall control the construction of exterior *structural insulated panel* walls and interior load-bearing *structural insulated panel* walls for buildings not greater than 60 feet (18 288 mm) in length perpendicular to the joist or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist or truss span and not greater than two stories in height with each wall not greater than 10 feet (3048 mm) high. Exterior walls installed in accordance with the provisions of this section shall be considered as *load-bearing walls*. *Structural insulated panel* walls constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed ( $V_{ult}$ ) is not greater than 155 miles per hour (69 m/s) in Exposure B or 140 miles per hour (63 m/s) in Exposure C, the ground snow load is not greater than 70 pounds per square foot (3.35 kPa), and the seismic design category is A, B or C.

**R610.3 Materials.** SIPs shall comply with the requirements of ANSI/APA PRS 610.1.

**R610.3.1 Lumber.** The minimum lumber framing material used for SIPs prescribed in this document is NLGA graded No. 2 Spruce-pine-fir. Substitution of other wood species/grades that meet or exceed the mechanical properties and specific gravity of No. 2 Spruce-pine-fir shall be permitted.

**R610.3.2 SIP screws.** Screws used for the erection of SIPs as specified in Section R610.5 shall be fabricated from steel, shall be provided by the SIP manufacturer and shall be sized to penetrate the wood member to which the assembly is being attached by not less than 1 inch (25 mm). The screws shall be corrosion resistant and have a minimum shank diameter of 0.188 inch (4.7 mm) and a minimum head diameter of 0.620 inch (15.5 mm).



## WALL CONSTRUCTION

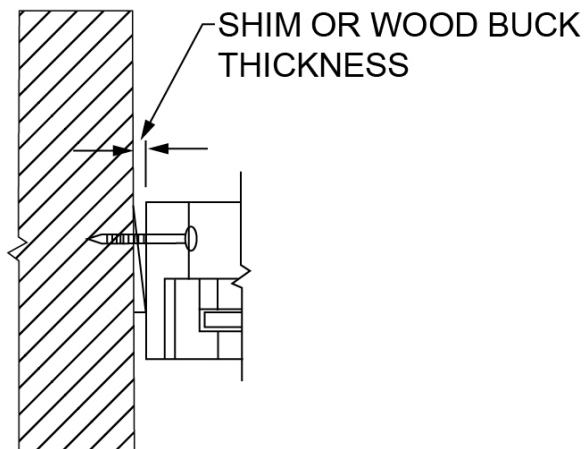


FIGURE R609.7.2(1)  
THROUGH THE FRAME

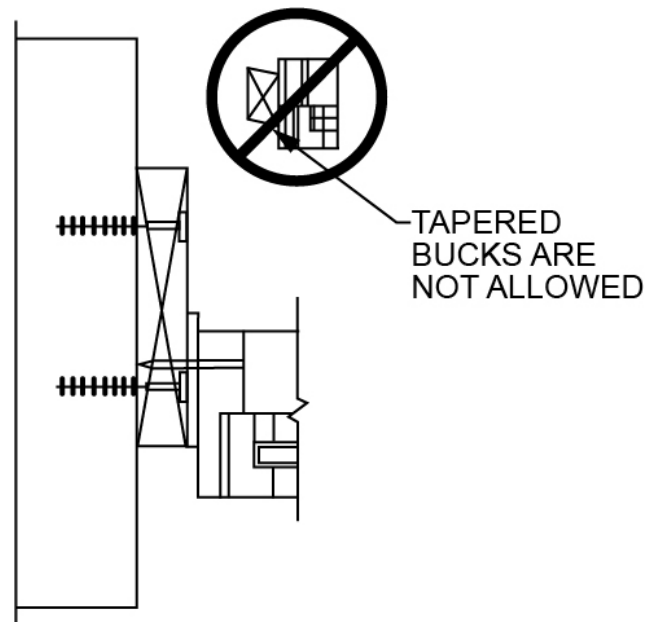


FIGURE R609.7.2(3)  
THROUGH THE FRAME

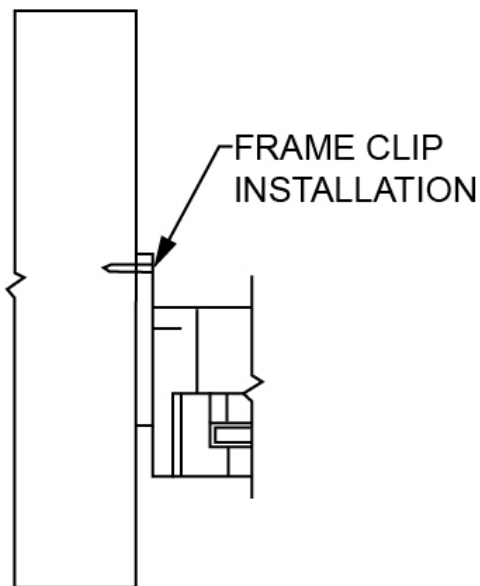


FIGURE R609.7.2(2)  
FRAME CLIP

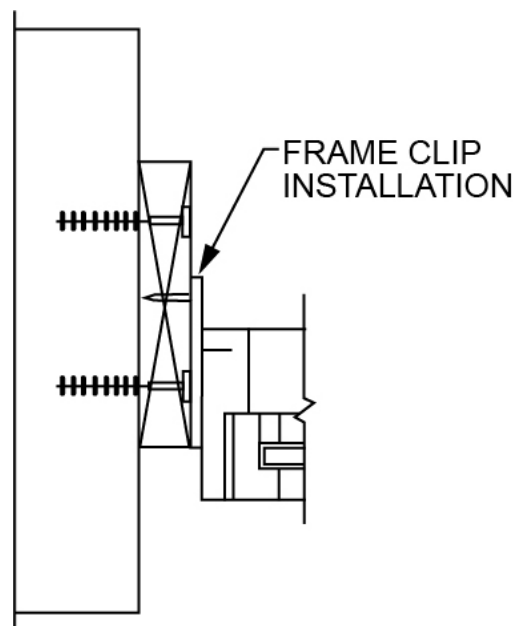


FIGURE R609.7.2(4)  
FRAME CLIP



WALL CONSTRUCTION

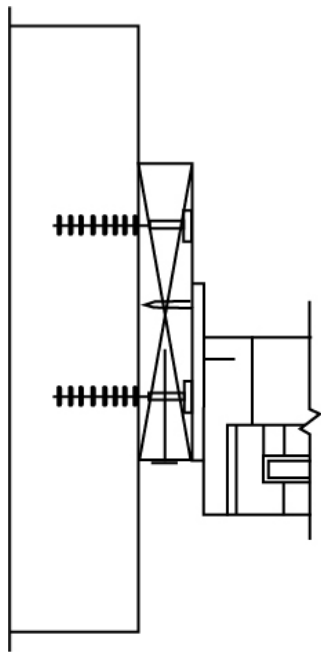


FIGURE R609.7.2(5)  
THROUGH THE FLANGE

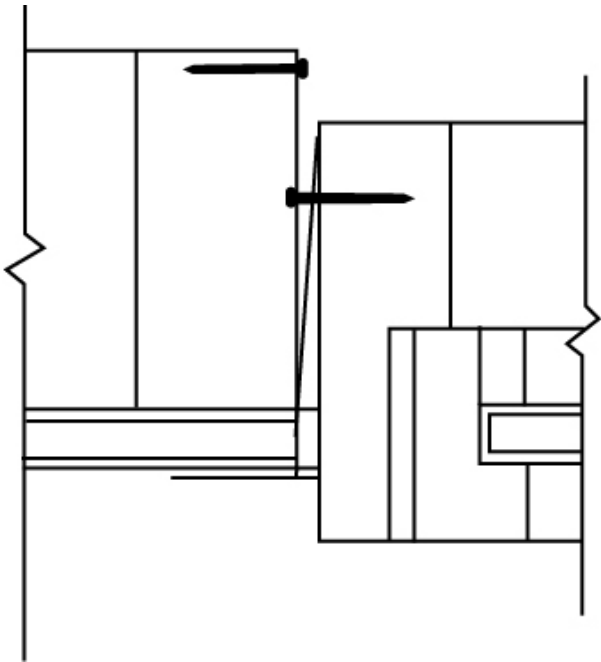


FIGURE R609.7.2(7)  
FRAME CLIP

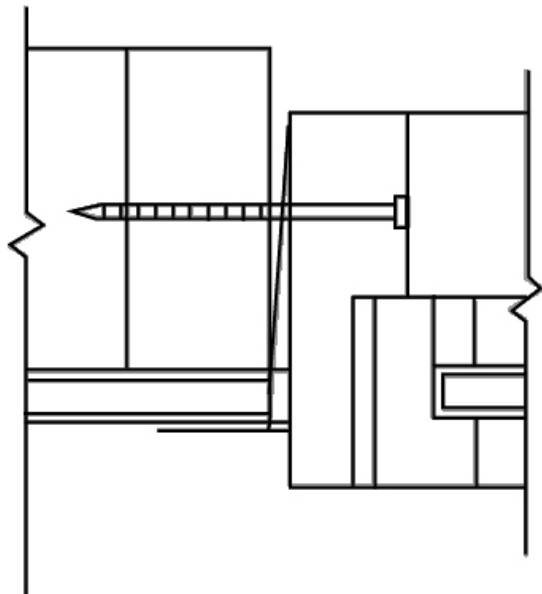


FIGURE R609.7.2(6)  
THROUGH THE FLANGE

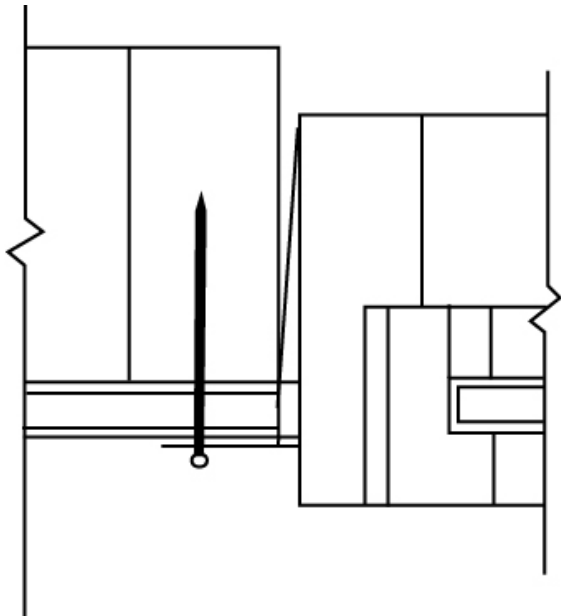
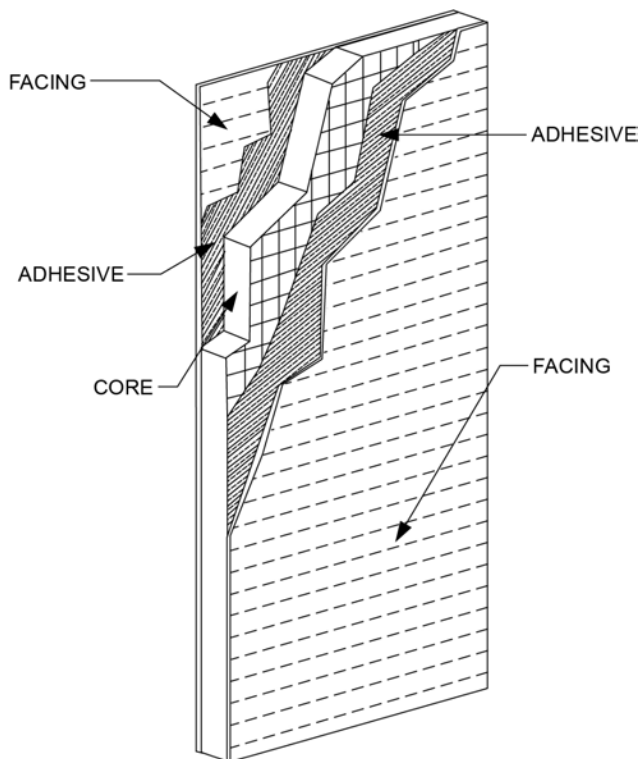


FIGURE R609.7.2(8)  
THROUGH THE FLANGE

**R610.3.3 Nails.** Nails specified in Section R610 shall be common or galvanized box unless otherwise stated.

**R610.4 SIP wall panels.** SIPs shall comply with Figure R610.4 and shall have minimum *panel thickness* in accordance with Tables R610.5(1) and R610.5(2) for above-grade walls. SIPs shall be identified by grade *mark* or certificate of inspection issued by an *approved* agency in accordance with ANSI/APA PRS 610.1.



**FIGURE R610.4**  
**SIP WALL PANEL**

**R610.5 Wall construction.** Exterior walls of SIP construction shall be designed and constructed in accordance with the provisions of this section and Tables R610.5(1) and R610.5(2) and Figures R610.5(1) through R610.5(5). SIP walls shall be fastened to other wood building components in accordance with Tables R602.3(1) through R602.3(4).

Framing shall be attached in accordance with Table R602.3(1) unless otherwise provided for in Section R610.

**R610.5.1 Top plate connection.** SIP walls shall be capped with a double top plate installed to provide overlapping at corner, intersections and *splines* in accordance with Figure R610.5.1. The double top plates shall be made up of a single 2-by (nominal 2-inch) top plate having a width equal to the width of the panel core, and shall be recessed into the SIP below. Over this top plate a cap plate shall be placed. The cap plate width shall match

the SIP thickness and overlap the facers on both sides of the panel. End joints in top plates shall be offset not less than 24 inches (610 mm).

**R610.5.2 Bottom (sole) plate connection.** SIP walls shall have full bearing on a sole plate having a width equal to the nominal width of the foam core. Where SIP walls are supported directly on continuous foundations, the wall wood sill plate shall be anchored to the foundation in accordance with Figure R610.5.2 and Section R403.1.

**R610.5.3 Panel-to-panel connection.** SIPs shall be connected at vertical in-plane joints in accordance with Figure R610.8 or by other *approved* methods.

**R610.5.4 Corner framing.** Corner framing of SIP walls shall be constructed in accordance with Figure R610.5.4.

**R610.5.5 Wall bracing.** SIP walls shall be braced in accordance with Section R602.10. SIP walls shall be considered continuous wood structural panel sheathing (bracing Method CS-WSP) for purposes of computing required bracing. SIP walls shall meet the requirements of Section R602.10.4.2 except that SIP corners shall be fabricated as shown in Figure R610.8. Where SIP walls are used for wall bracing, the SIP bottom plate shall be attached to wood framing below in accordance with Table R602.3(1).

**R610.5.6 Thermal barrier.** SIP walls shall be separated from the interior of a building by an *approved* thermal barrier in accordance with Section R316.4.

**R610.6 Interior load-bearing walls.** Interior *load-bearing walls* shall be constructed as specified for exterior walls.

**R610.7 Drilling and notching.** The maximum vertical chase penetration in SIPs shall have a maximum side dimension of 2 inches (51 mm) centered in the panel. Vertical chases shall have a minimum spacing of 24 inches (610 mm) on center. Not more than two horizontal chases shall be permitted in each wall panel, one at 14 inches (360 mm) plus or minus 2 inches (51 mm) from the bottom of the panel and one at 48 inches (1220 mm) plus or minus 2 inches (51 mm) from the bottom edge of the SIP's panel. Additional penetrations are permitted where justified by analysis.

**R610.8 Headers.** SIP headers shall be designed and constructed in accordance with Table R610.8 and Figure R610.5.1. SIP headers shall be continuous sections without *splines*. Headers shall be not less than 11<sup>7</sup>/<sub>8</sub> inches (302 mm) deep. Headers longer than 4 feet (1219 mm) shall be constructed in accordance with Section R602.7. The strength axis of the factors on the header shall be oriented horizontally.

**R610.8.1 Wood structural panel box headers.** Wood structural panel box headers shall be allowed where SIP headers are not applicable. Wood structural panel box headers shall be constructed in accordance with Figure R602.7.3 and Table R602.7.3.

## WALL CONSTRUCTION

**TABLE R610.5(1)**  
**MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ROOF ONLY (inches)<sup>a</sup>**

BUILDING WIDTH (ft)																	
ULTIMATE DESIGN WIND SPEED $V_{ult}$ (mph)		GROUND SNOW LOAD (psf)	24			28			32			36			40		
Exp. B	Exp. C		Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
			8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	6.5
115	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
		50	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5
		70	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
130	110	20	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	6.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR
		50	4.5	4.5	DR	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
140	120	20	4.5	6.5	DR	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR	4.5	DR	DR
		50	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

DR = Design Required.

a. Design assumptions:

Maximum deflection criteria:  $L/240$ .

Maximum roof dead load: 10 psf.

Maximum roof live load: 70 psf.

Maximum ceiling dead load: 5 psf.

Maximum ceiling live load: 20 psf.

Wind loads based on Table R301.2.1(1).

Strength axis of facing material applied vertically.

## WALL CONSTRUCTION

**TABLE R610.5(2)**  
**MINIMUM THICKNESS FOR SIP WALL SUPPORTING SIP OR LIGHT-FRAME ONE STORY AND ROOF ONLY (inches)<sup>a</sup>**

BUILDING WIDTH (ft)																	
ULTIMATE DESIGN WIND SPEED $V_{ult}$ (mph)		GROUND SNOW LOAD (psf)	24			28			32			36			40		
Exp. B	Exp. C		Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)			Wall Height (feet)		
			8	9	10	8	9	10	8	9	10	8	9	10	8	9	10
110	—	20	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR
		30	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR
		50	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
115	—	20	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR
		30	4.5	4.5	4.5	4.5	4.5	6.5	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR
		50	4.5	4.5	6.5	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR
		70	4.5	4.5	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
120	—	20	4.5	4.5	6.5	4.5	4.5	DR	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR
		30	4.5	4.5	DR	4.5	4.5	DR	4.5	6.5	DR	4.5	DR	DR	DR	DR	DR
		50	4.5	4.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		70	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
130	110	20	4.5	6.5	DR	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR
		30	4.5	DR	DR	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		50	4.5	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR
		70	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mile per hour = 0.447 m/s.

DR = Design Required.

a. Design assumptions:

Maximum deflection criteria:  $L/240$ .

Maximum roof dead load: 10 psf.

Maximum roof live load: 70 psf.

Maximum ceiling dead load: 5 psf.

Maximum ceiling live load: 20 psf.

Maximum second-floor dead load: 10 psf.

Maximum second-floor live load: 30 psf.

Maximum second-floor dead load from walls: 10 psf.

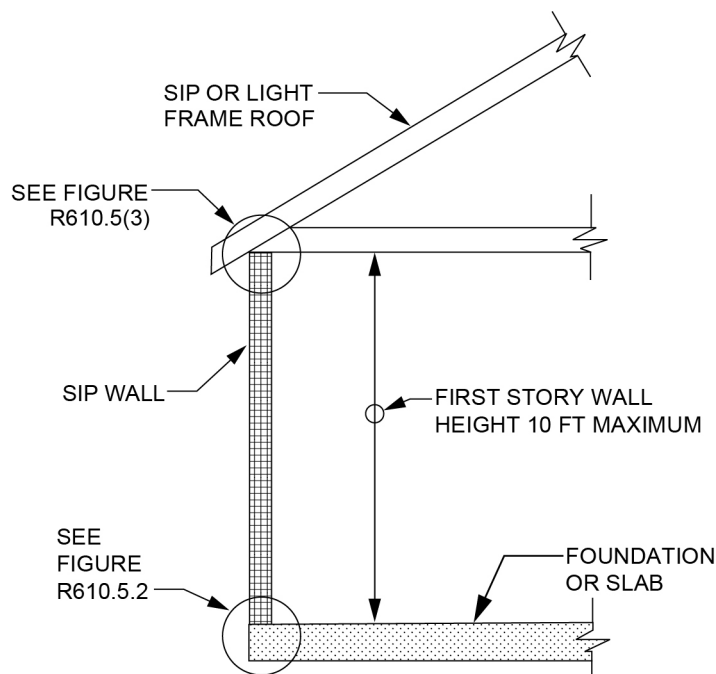
Maximum first-floor dead load: 10 psf.

Maximum first-floor live load: 40 psf.

Wind loads based on Table R301.2.1(1).

Strength axis of facing material applied vertically.

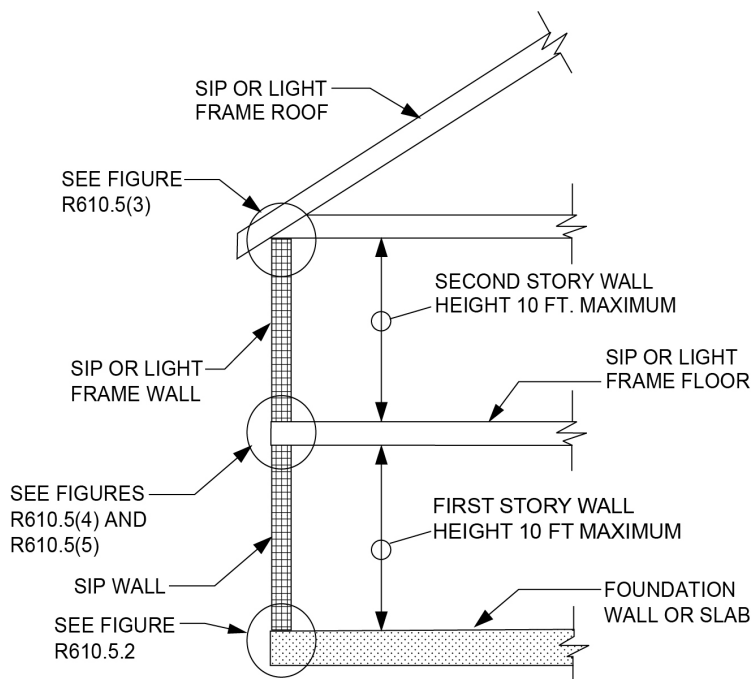
## WALL CONSTRUCTION



For SI: 1 foot = 304.8 mm.

**Note:** Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

**FIGURE R610.5(1)**  
**MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS**



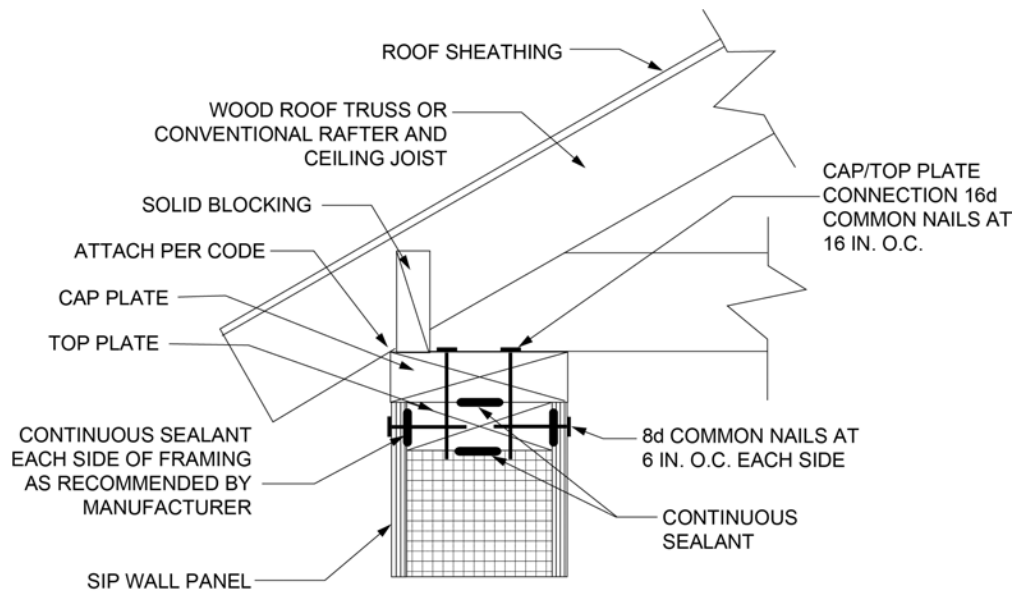
For SI: 1 foot = 304.8 mm.

**Note:** Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

**FIGURE R610.5(2)**  
**MAXIMUM ALLOWABLE HEIGHT OF SIP WALLS**



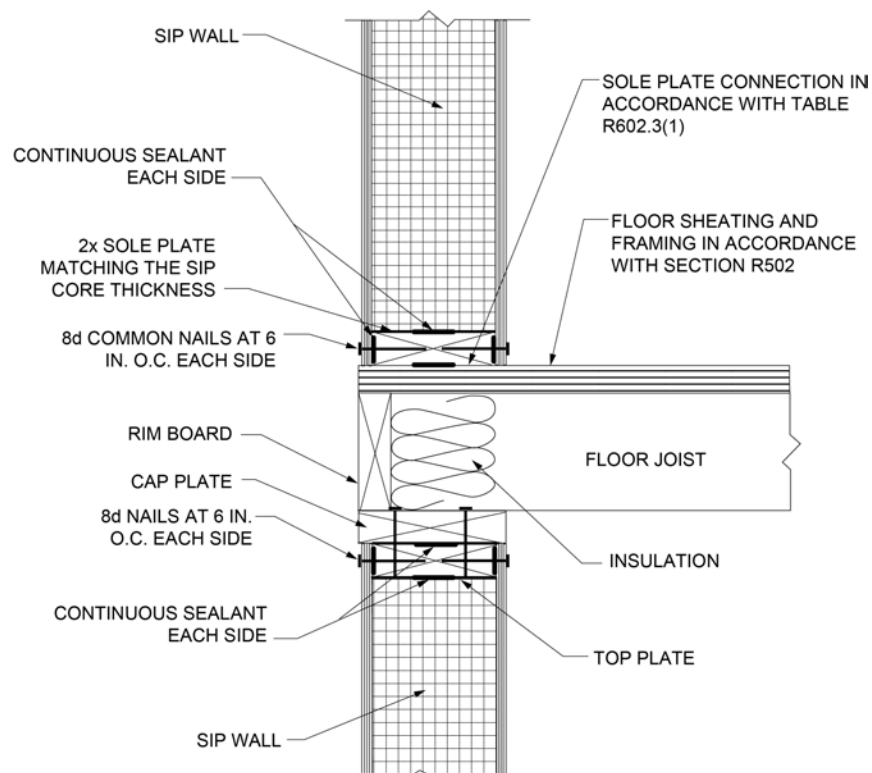
## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**Note:** Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

**FIGURE R610.5(3)**  
**TRUSSED ROOF TO TOP PLATE CONNECTION**

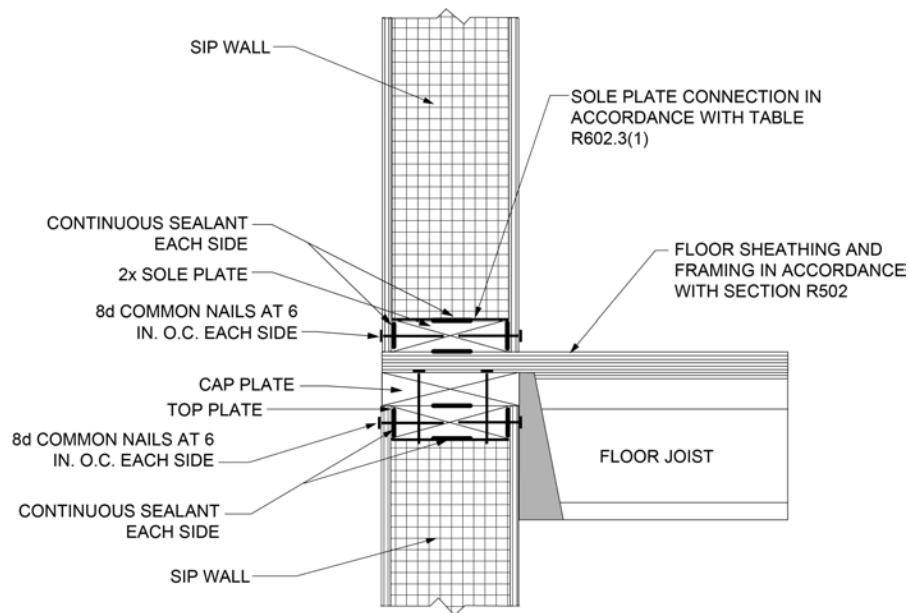


For SI: 1 inch = 25.4 mm.

**Note:** Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

**FIGURE R610.5(4)**  
**SIP WALL-TO-WALL PLATFORM FRAME CONNECTION**

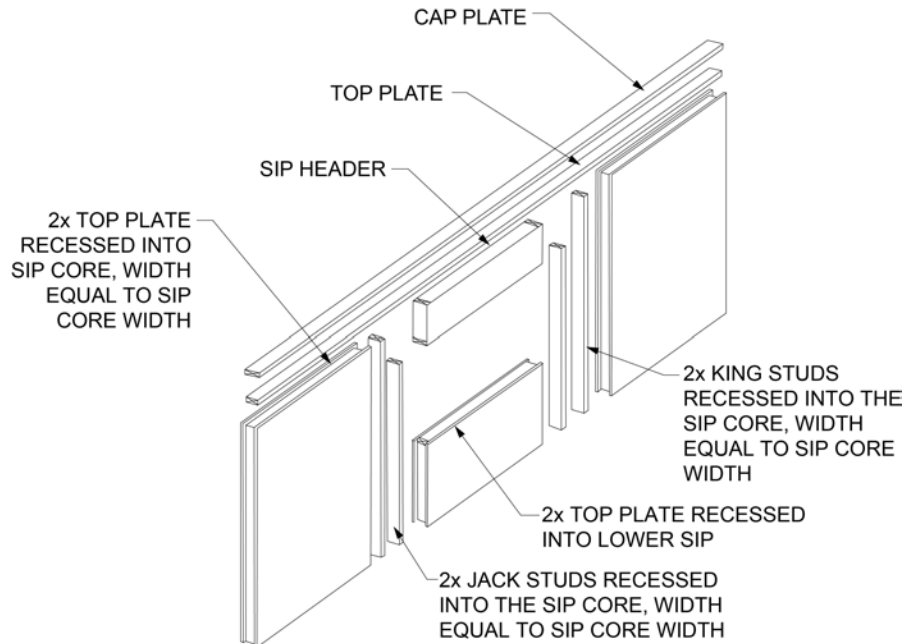
## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**Note:** Figure illustrates SIP-specific attachment requirements. Other connections shall be made in accordance with Tables R602.3(1) and R602.3(2), as appropriate.

**FIGURE R610.5(5)**  
**SIP WALL-TO-WALL HANGING FLOOR FRAME CONNECTION**  
(I-Joist floor shown for illustration only)

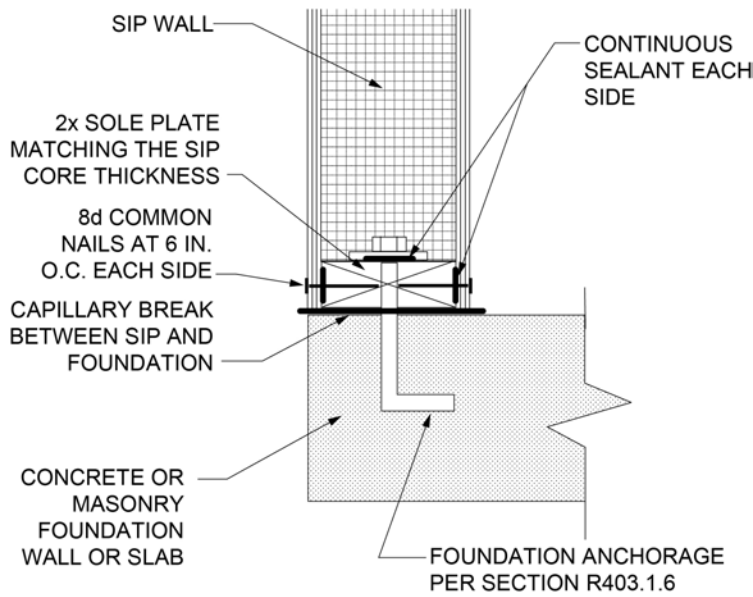


For SI: 1 inch = 25.4 mm.

### Notes:

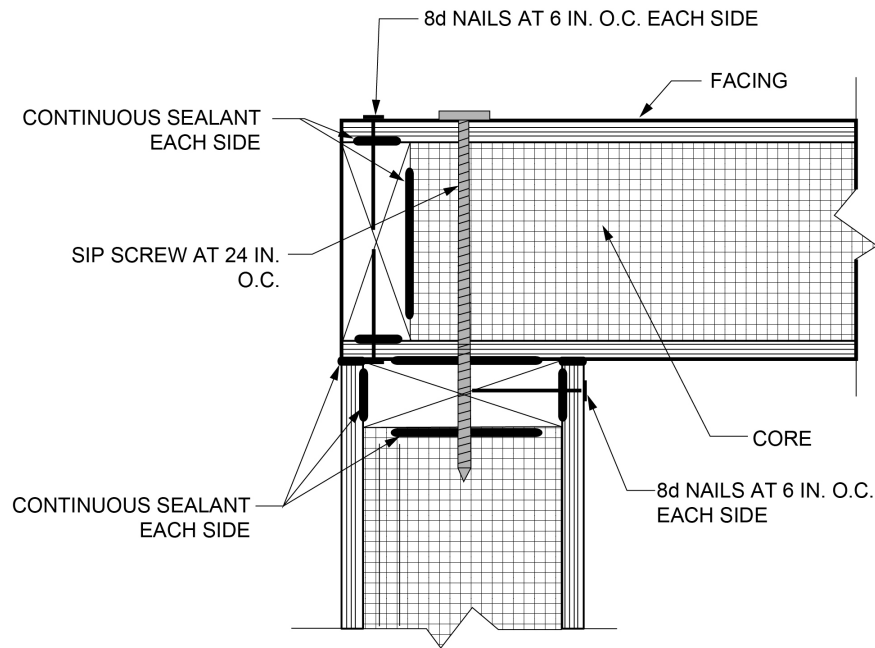
1. Top plates shall be continuous over header.
2. Lower 2x top plate shall have a width equal to the SIP core width and shall be recessed into the top edge of the panel. Cap plate shall be placed over the recessed top plate and shall have a width equal to the SIP's width.
3. SIP facing surfaces shall be nailed to framing and cripples with 8d common or galvanized box nails spaced 6 inches on center.

**FIGURE R610.5.1**  
**SIP WALL FRAMING CONFIGURATION**



For SI: 1 inch = 25.4 mm.

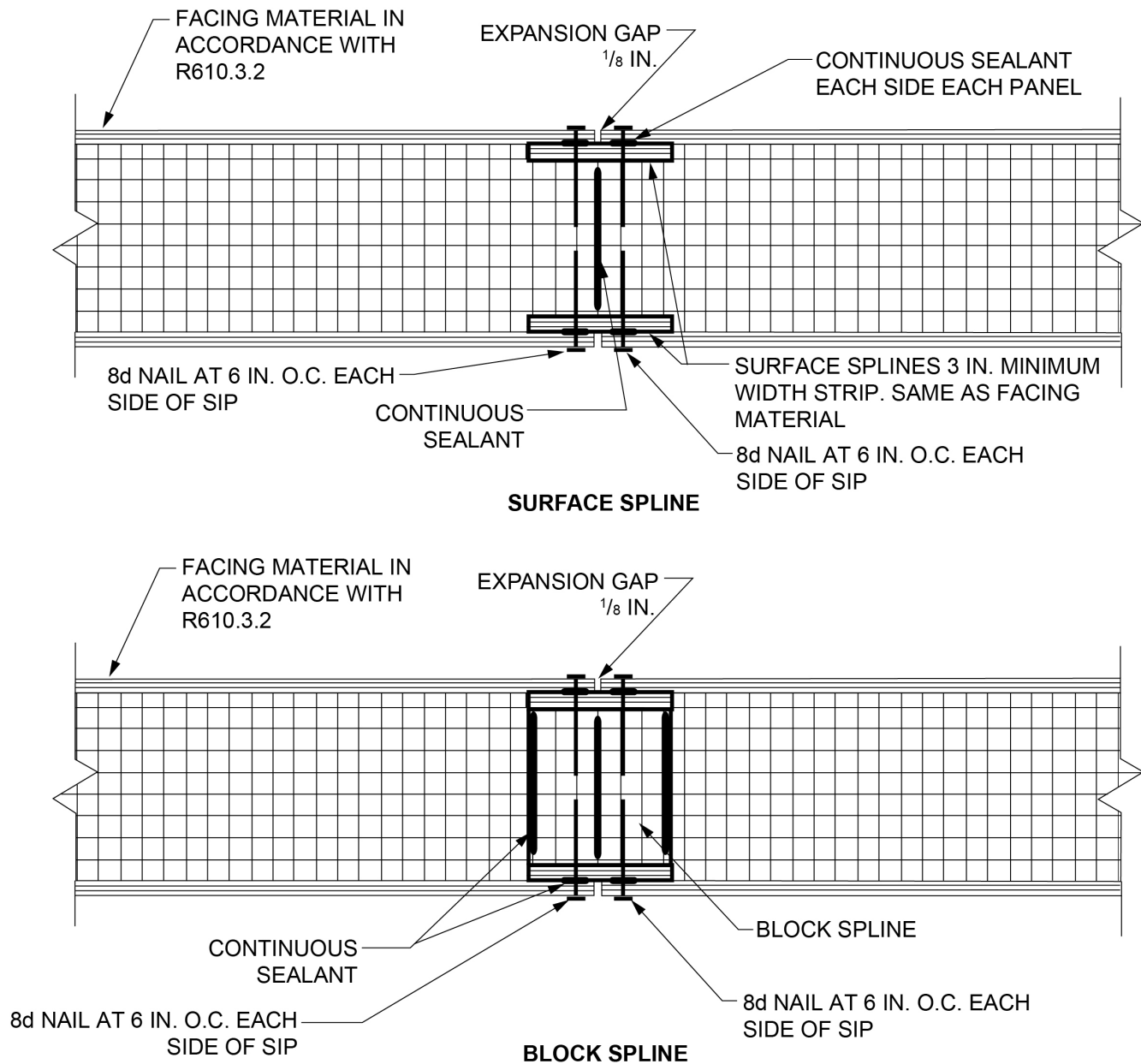
**FIGURE R610.5.2**  
**SIP WALL TO CONCRETE SLAB FOR FOUNDATION WALL ATTACHMENT**



For SI: 1 inch = 25.4 mm.

**FIGURE R610.5.4**  
**SIP CORNER FRAMING DETAIL**

## WALL CONSTRUCTION



For SI: 1 inch = 25.4 mm.

**FIGURE R610.8**  
**TYPICAL SIP WALL PANEL-TO-PANEL CONNECTION DETAILS**

**TABLE R610.8**  
**MAXIMUM SPANS FOR 11<sup>7</sup>/<sub>8</sub>-INCH OR DEEPER SIP HEADERS (feet)<sup>a, c, d</sup>**

LOAD CONDITION	GROUND SNOW LOAD (psf)	BUILDING <sup>b</sup> width (feet)				
		24	28	32	36	40
Supporting roof only	20	4	4	4	4	2
	30	4	4	4	2	2
	50	2	2	2	2	2
	70	2	2	2	DR	DR
Supporting roof and one-story	20	2	2	DR	DR	DR
	30	2	2	DR	DR	DR
	50	2	DR	DR	DR	DR
	70	DR	DR	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

DR = Design Required.

a. Design assumptions:

Maximum deflection criterion:  $L/240$ .

Maximum roof dead load: 10 psf.

Maximum ceiling load: 5 psf.

Maximum ceiling live load: 20 psf

Maximum second-floor live load: 30 psf.

Maximum second-floor dead load: 10 psf.

Maximum second-floor dead load from walls: 10 psf.

Maximum first floor dead load: 10 psf.

Wind loads based on Table R301.2.1(1).

Strength axis of facing material applied horizontally.

b. Building width is in the direction of horizontal framing members supported by the header.

c. The table provides for roof slopes between 3:12 and 12:12.

d. The maximum roof overhang is 24 inches (610 mm).





## CHAPTER 7

# WALL COVERING

### User note:

**About this chapter:** Chapter 7 establishes the various types of materials, materials standards and methods of application permitted as interior and exterior wall coverings. Interior coverings include interior plaster, gypsum board, ceramic tile, wood veneer paneling, hardboard paneling, wood shakes and wood shingles. Exterior wall coverings regulated by this section include aluminum, stone and masonry veneer, wood, hardboard, particleboard, wood structural panel siding, wood shakes and shingles, exterior plaster, steel, vinyl, fiber cement and exterior insulation finish systems. This chapter also contains requirements for the use of vapor retarders for moisture control in walls; wind resistance and water-resistive barriers for exterior wall coverings; and the water-resistive barrier required beneath exterior materials.

### SECTION R701 GENERAL

**R701.1 Application.** The provisions of this chapter shall control the design and construction of the interior and exterior wall covering for buildings.

**R701.2 Installation.** Products sensitive to adverse weather shall not be installed until adequate weather protection for the installation is provided. Exterior sheathing shall be dry before applying exterior cover.

### SECTION R702 INTERIOR COVERING

**R702.1 General.** Interior coverings or wall finishes shall be installed in accordance with this chapter and Tables R702.1(1), R702.1(2), R702.1(3) and R702.3.5. Interior masonry veneer shall comply with the requirements of Section R703.7.1 for support and Section R703.7.4 for

anchorage, except an airspace is not required. Interior finishes and materials shall conform to the flame spread and smoke-development requirements of Section R302.9.

### R702.2 Interior plaster.

**R702.2.1 Gypsum plaster.** Gypsum plaster materials shall conform to ASTM C5, C22, C28, C35, C59, C61, C587, C631, C847, C933, C1032 and C1047, and shall be installed or applied in compliance with ASTM C841, C842 and C843. Gypsum lath or gypsum base for veneer plaster shall conform to ASTM C1396 and shall be installed in compliance with ASTM C844. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section, except that veneer plaster shall be applied in one coat not to exceed  $\frac{3}{16}$  inch (4.76 mm) thickness, provided the total thickness is in accordance with Table R702.1(1).

**TABLE R702.1(1)  
THICKNESS OF PLASTER**

PLASTER BASE	FINISHED THICKNESS OF PLASTER FROM FACE OF LATH, MASONRY, CONCRETE (inches)	
	Gypsum Plaster	Cement Plaster
Expanded metal lath	$\frac{5}{8}$ , minimum <sup>a</sup>	$\frac{5}{8}$ , minimum <sup>a</sup>
Wire lath	$\frac{5}{8}$ , minimum <sup>a</sup>	$\frac{3}{4}$ , minimum (interior) <sup>b</sup>
		$\frac{7}{8}$ , minimum (exterior) <sup>b</sup>
Gypsum lath <sup>e</sup>	$\frac{1}{2}$ , minimum	$\frac{3}{4}$ , minimum (interior) <sup>b</sup>
Masonry walls <sup>c</sup>	$\frac{1}{2}$ , minimum	$\frac{1}{2}$ , minimum
Monolithic concrete walls <sup>c, d</sup>	$\frac{5}{8}$ , maximum	$\frac{7}{8}$ , maximum
Monolithic concrete ceilings <sup>c, d</sup>	$\frac{3}{8}$ , maximum <sup>e</sup>	$\frac{1}{2}$ , maximum
Gypsum veneer base <sup>f, g</sup>	$\frac{1}{16}$ , minimum	$\frac{3}{4}$ , minimum (interior) <sup>b</sup>
Gypsum sheathing <sup>g</sup>	—	$\frac{3}{4}$ , minimum (interior) <sup>b</sup>
		$\frac{7}{8}$ , minimum (exterior) <sup>b</sup>

For SI: 1 inch = 25.4 mm.

- Where measured from back plane of expanded metal lath, exclusive of ribs, or self-furring lath, plaster thickness shall be  $\frac{3}{4}$  inch minimum.
- Where measured from face of support or backing.
- Because masonry and concrete surfaces vary in plane, thickness of plaster need not be uniform.
- Where applied over a liquid bonding agent, finish coat shall be permitted to be applied directly to concrete surface.
- Approved acoustical plaster shall be permitted to be applied directly to concrete or over base coat plaster, beyond the maximum plaster thickness shown.
- Attachment shall be in accordance with Table R702.3.5.
- Where gypsum board is used as a base for cement plaster, a water-resistive barrier complying with Section R703.2 shall be provided.

## WALL COVERING

**TABLE R702.1(2)**  
**GYPSUM PLASTER PROPORTIONS<sup>a</sup>**

NUMBER	COAT	PLASTER BASE OR LATH	MAXIMUM VOLUME AGGREGATE PER 100 POUNDS NEAT PLASTER <sup>b</sup> (cubic feet)	
			Damp Loose Sand <sup>a</sup>	Perlite or Vermiculite <sup>c</sup>
Two-coat work	Base coat	Gypsum lath	2.5	2
	Base coat	Masonry	3	3
Three-coat work	First coat	Lath	2 <sup>d</sup>	2
	Second coat	Lath	3 <sup>d</sup>	2 <sup>e</sup>
	First and second coats	Masonry	3	3

For SI: 1 inch = 25.4 mm, 1 cubic foot = 0.0283 m<sup>3</sup>, 1 pound = 0.454 kg.

- Wood-fibered gypsum plaster shall be mixed in the proportions of 100 pounds of gypsum to not more than 1 cubic foot of sand where applied on masonry or concrete.
- Where determining the amount of aggregate in set plaster, a tolerance of 10 percent shall be allowed.
- Combinations of sand and lightweight aggregate shall be permitted to be used, provided the volume and weight relationship of the combined aggregate to gypsum plaster is maintained.
- If used for both first and second coats, the volume of aggregate shall be permitted to be 2.5 cubic feet.
- Where plaster is 1 inch or more in total thickness, the proportions for the second coat may be increased to 3 cubic feet.

**TABLE R702.1(3)**  
**CEMENT PLASTER PROPORTIONS, PARTS BY VOLUME**

COAT	CEMENT PLASTER TYPE	CEMENTITIOUS MATERIALS				VOLUME OF AGGREGATE PER SUM OF SEPARATE VOLUMES OF CEMENTITIOUS MATERIALS <sup>b</sup>
		Portland Cement Type I, II or III; Blended Hydraulic Cement Type IP, I (S < 70), IL, or IT (S < 70); or Hydraulic Cement Type GU, HE, MS, HS or MH	Plastic Cement	Masonry Cement Type M, S or N	Lime	
First	Portland or blended	1	—	—	$\frac{3}{4}$ –1 $\frac{1}{2}$ <sup>a</sup>	2 $\frac{1}{2}$ –4
	Masonry	—	—	1	—	2 $\frac{1}{2}$ –4
	Plastic	—	1	—	—	2 $\frac{1}{2}$ –4
Second	Portland or blended	1	—	—	$\frac{3}{4}$ –1 $\frac{1}{2}$	3–5
	Masonry	—	—	1	—	3–5
	Plastic	—	1	—	—	3–5
Finish	Portland or blended	1	—	—	1 $\frac{1}{2}$ –2	1 $\frac{1}{2}$ –3
	Masonry	—	—	1	—	1 $\frac{1}{2}$ –3
	Plastic	—	1	—	—	1 $\frac{1}{2}$ –3

- Lime by volume of 0 to  $\frac{3}{4}$  shall be used where the plaster will be placed over low-absorption surfaces such as dense clay tile or brick.
- The same or greater sand proportion shall be used in the second coat than used in the first coat.

**R702.2.2 Cement plaster.** Cement plaster materials shall conform to ASTM C91 (Type M, S or N), C150 (Types I, II and III), C595 [Types IP, I (PM), IS and I (SM)], C847, C897, C933, C1032, C1047 and C1328, and shall be installed or applied in compliance with ASTM C926 and C1063. Gypsum lath shall conform to ASTM C1396. Plaster shall be not less than three coats where applied over metal lath and not less than two coats where applied over other bases permitted by this section.

**R702.2.2.1 Application.** Each coat shall be kept in a moist condition for not less than 24 hours prior to application of the next coat.

**Exception:** Applications installed in accordance with ASTM C926.

**R702.2.2.2 Curing.** The finish coat for two-coat cement plaster shall not be applied sooner than 48 hours after application of the first coat. For three-coat cement plaster, the second coat shall not be applied sooner than 24 hours after application of the first coat. The finish coat for three-coat cement plaster shall not be applied sooner than 48 hours after application of the second coat.

**R702.2.3 Support.** Support spacing for gypsum or metal lath on walls or ceilings shall not exceed 16 inches (406 mm) for  $\frac{3}{8}$ -inch-thick (9.5 mm) or 24 inches (610 mm) for  $\frac{1}{2}$ -inch-thick (12.7 mm) plain gypsum lath. Gypsum lath shall be installed at right angles to support framing with end joints in adjacent courses staggered by not less than one framing space.

### R702.3 Gypsum board and gypsum panel products.

**R702.3.1 Materials.** Gypsum board and gypsum panel product materials and accessories shall conform to ASTM C22, C475, C514, C1002, C1047, C1177, C1178, C1278, C1396, C1658 or C1766 and shall be installed in accordance with the provisions of this section. Adhesives for the installation of gypsum board and gypsum panel products shall conform to ASTM C557.

**R702.3.1.1 Adhesives.** Expandable foam adhesives for the installation of gypsum board and gypsum panel products shall conform to ASTM D6464. Other adhesives for the installation of gypsum board and gypsum panel products shall conform to ASTM C557. Supports and fasteners used to attach gypsum board and gypsum panel products shall comply with Table R702.3.5 or other *approved* method.

**R702.3.2 Wood framing.** Wood framing supporting gypsum board and gypsum panel products shall be not less than 2 inches (51 mm) nominal thickness in the least dimension except that wood furring strips not less than 1-inch by 2-inch (25 mm by 51 mm) nominal dimension shall be permitted to be used over solid backing or framing spaced not more than 24 inches (610 mm) on center.

**R702.3.3 Cold-formed steel framing.** Cold-formed steel framing supporting gypsum board and gypsum panel products shall be not less than 1<sup>1</sup>/<sub>4</sub> inches (32 mm) wide in the least dimension. Nonload-bearing cold-formed steel framing shall comply with AISI S220. Load-bearing cold-formed steel framing shall comply with AISI S240.

**R702.3.4 Insulating concrete form walls.** Foam plastics for insulating concrete form walls constructed in accordance with Sections R404.1.2 and R608 on the interior of *habitable spaces* shall be protected in accordance with Section R316.4. Use of adhesives in conjunction with mechanical fasteners is permitted. Adhesives used for interior and exterior finishes shall be compatible with the insulating form materials.

**R702.3.5 Application.** Supports and fasteners used to attach gypsum board and gypsum panel products shall comply with Table R702.3.5. Gypsum sheathing shall be attached to exterior walls in accordance with Table R602.3(1). Gypsum board and gypsum panel products shall be applied at right angles or parallel to framing members. All edges and ends of gypsum board and gypsum panel products shall occur on the framing members, except those edges and ends that are perpendicular to the framing members. Interior gypsum board shall not be installed where it is directly exposed to the weather or to water.

**R702.3.5.1 Screw fastening.** Screws for attaching gypsum board and gypsum panel products to wood framing shall be Type W or Type S in accordance with ASTM C1002 and shall penetrate the wood not less

than <sup>5</sup>/<sub>8</sub> inch (15.9 mm). Gypsum board and gypsum panel products shall be attached to cold-formed steel framing with minimum No. 6 screws. Screws for attaching gypsum board and gypsum panel products to cold-formed steel framing less than 0.033 inch (1 mm) thick shall be Type S in accordance with ASTM C1002 or bugle head style in accordance with ASTM C1513 and shall penetrate the steel not less than <sup>3</sup>/<sub>8</sub> inch (9.5 mm). Screws for attaching gypsum board and gypsum panel products to cold-formed steel framing 0.033 inch to 0.112 inch (1 mm to 3 mm) thick shall be in accordance with ASTM C954 or bugle head style in accordance with ASTM C1513. Screws for attaching gypsum board and gypsum panel products to structural insulated panels shall penetrate the wood structural panel facing not less than <sup>7</sup>/<sub>16</sub> inch (11.1 mm).

**R702.3.6 Horizontal gypsum board diaphragm ceilings.** Gypsum board and gypsum panel products shall be permitted on wood joists to create a horizontal *diaphragm* in accordance with Table R702.3.6. Gypsum board and gypsum panel products shall be installed perpendicular to ceiling framing members. End joints of adjacent courses of board and panels shall not occur on the same joist. The maximum allowable *diaphragm* proportions shall be 1<sup>1</sup>/<sub>2</sub>:1 between shear resisting elements. Rotation or cantilever conditions shall not be permitted. Gypsum board or gypsum panel products shall not be used in *diaphragm* ceilings to resist lateral forces imposed by masonry or concrete construction. Perimeter edges shall be blocked using wood members not less than 2-inch by 6-inch (51 mm by 152 mm) nominal dimension. Blocking material shall be installed flat over the top plate of the wall to provide a nailing surface not less than 2 inches (51 mm) in width for the attachment of the gypsum board or gypsum panel product.

**R702.3.7 Water-resistant gypsum backing board.** Gypsum board used as the base or backer for adhesive application of ceramic tile or other required nonabsorbent finish material shall conform to ASTM C1178, C1278 or C1396. Use of water-resistant gypsum backing board shall be permitted on ceilings. Water-resistant gypsum board shall not be installed over a Class I or II vapor retarder in a shower or tub compartment. Cut or exposed edges, including those at wall intersections, shall be sealed as recommended by the manufacturer.

**R702.3.7.1 Limitations.** Water-resistant gypsum backing board shall not be used where there will be direct exposure to water, or in areas subject to continuous high humidity.

### R702.4 Ceramic tile.

**R702.4.1 General.** Ceramic tile surfaces shall be installed in accordance with ANSI A108.1, A108.4, A108.5, A108.6, A108.11, A118.1, A118.3, A136.1 and A137.1.

## WALL COVERING

**TABLE R702.3.5**  
**MINIMUM THICKNESS AND APPLICATION OF GYPSUM BOARD AND GYPSUM PANEL PRODUCTS**

THICKNESS OF GYPSUM BOARD OR GYPSUM PANEL PRODUCTS (inches)	APPLICATION	ORIENTATION OF GYPSUM BOARD OR GYPSUM PANEL PRODUCTS TO FRAMING	MAXIMUM SPACING OF FRAMING MEMBERS (inches o.c.)	MAXIMUM SPACING OF FASTENERS (inches)		SIZE OF NAILS FOR APPLICATION TO WOOD FRAMING <sup>c</sup>
				Nails <sup>a</sup>	Screws <sup>b</sup>	
Application without adhesive						
<sup>3</sup> / <sub>8</sub>	Ceiling <sup>d</sup>	Perpendicular	16	7	12	13 gage, 1 <sup>1</sup> / <sub>4</sub> " long, <sup>19</sup> / <sub>64</sub> " head; 0.098" diameter, 1 <sup>1</sup> / <sub>4</sub> " long, ring shank; or 4d cooler nail, 0.080" diameter, 1 <sup>3</sup> / <sub>8</sub> " long, <sup>7</sup> / <sub>32</sub> " head.
	Wall	Either direction	16	8	16	
<sup>1</sup> / <sub>2</sub>	Ceiling	Either direction	16	7	12	13 gage, 1 <sup>3</sup> / <sub>8</sub> " long, <sup>19</sup> / <sub>64</sub> " head; 0.098" diameter, 1 <sup>1</sup> / <sub>4</sub> " long, ring shank; 5d cooler nail, 0.086" diameter, 1 <sup>5</sup> / <sub>8</sub> " long, <sup>15</sup> / <sub>64</sub> " head; or gypsum board nail, 0.086" diameter, 1 <sup>5</sup> / <sub>8</sub> " long, <sup>9</sup> / <sub>32</sub> " head.
	Ceiling <sup>d</sup>	Perpendicular	24	7	12	
	Wall	Either direction	24	8	12	
	Wall	Either direction	16	8	16	
<sup>5</sup> / <sub>8</sub>	Ceiling	Either direction	16	7	12	13 gage, 1 <sup>5</sup> / <sub>8</sub> " long, <sup>19</sup> / <sub>64</sub> " head; 0.098" diameter, 1 <sup>3</sup> / <sub>8</sub> " long, ring shank; 6d cooler nail, 0.092" diameter, 1 <sup>7</sup> / <sub>8</sub> " long, <sup>1</sup> / <sub>4</sub> " head; or gypsum board nail, 0.0915" diameter, 1 <sup>7</sup> / <sub>8</sub> " long, <sup>19</sup> / <sub>64</sub> " head.
	Ceiling	Perpendicular	24	7	12	
	Type X at garage ceiling beneath habitable rooms	Perpendicular	24	6	6	1 <sup>7</sup> / <sub>8</sub> " long 0.099" diameter galvanized nails or equivalent drywall screws. Screws shall comply with Section R702.3.5.1.
	Wall	Either direction	24	8	12	13 gage, 1 <sup>5</sup> / <sub>8</sub> " long, <sup>19</sup> / <sub>64</sub> " head; 0.098" diameter, 1 <sup>3</sup> / <sub>8</sub> " long, ring shank; 6d cooler nail, 0.092" diameter, 1 <sup>7</sup> / <sub>8</sub> " long, <sup>1</sup> / <sub>4</sub> " head; or gypsum board nail, 0.0915" diameter, 1 <sup>7</sup> / <sub>8</sub> " long, <sup>19</sup> / <sub>64</sub> " head.
	Wall	Either direction	16	8	16	
Application with adhesive						
<sup>3</sup> / <sub>8</sub>	Ceiling <sup>d</sup>	Perpendicular	16	16	16	Same as above for <sup>3</sup> / <sub>8</sub> " gypsum board and gypsum panel products.
	Wall	Either direction	16	16	24	
<sup>1</sup> / <sub>2</sub> or <sup>5</sup> / <sub>8</sub>	Ceiling	Either direction	16	16	16	Same as above for <sup>1</sup> / <sub>2</sub> " and <sup>5</sup> / <sub>8</sub> " gypsum board and gypsum panel products, respectively.
	Ceiling <sup>d</sup>	Perpendicular	24	12	16	
	Wall	Either direction	24	16	24	
Two <sup>3</sup> / <sub>8</sub> layers	Ceiling	Perpendicular	16	16	16	Base ply nailed as above for <sup>1</sup> / <sub>2</sub> " gypsum board and gypsum panel products; face ply installed with adhesive.
	Wall	Either direction	24	24	24	

For SI: 1 inch = 25.4 mm.

- For application without adhesive, a pair of nails spaced not less than 2 inches apart or more than  $2\frac{1}{2}$  inches apart shall be permitted to be used with the pair of nails spaced 12 inches on center.
- Screws shall be in accordance with Section R702.3.5.1. Screws for attaching gypsum board or gypsum panel products to structural insulated panels shall penetrate the wood structural panel facing not less than  $\frac{7}{16}$  inch.
- Where cold-formed steel framing is used with a clinching design to receive nails by two edges of metal, the nails shall be not less than  $\frac{5}{8}$  inch longer than the gypsum board or gypsum panel product thickness and shall have ringed shanks. Where the cold-formed steel framing has a nailing groove formed to receive the nails, the nails shall have barbed shanks or be 0.086-inch diameter,  $\frac{15}{8}$  inches long,  $\frac{15}{64}$ -inch head for  $\frac{1}{2}$ -inch gypsum board or gypsum panel product; and 0.099-inch diameter,  $1\frac{7}{8}$  inches long,  $\frac{15}{64}$ -inch head for  $\frac{5}{8}$ -inch gypsum board or gypsum panel product.
- Three-eighths-inch-thick single-ply gypsum board or gypsum panel product shall not be used on a ceiling where a water-based textured finish is to be applied, or where it will be required to support insulation above a ceiling. On ceiling applications to receive a water-based texture material, either hand or spray applied, the gypsum board or gypsum panel product shall be applied perpendicular to framing. Where applying a water-based texture material, the minimum gypsum board thickness shall be increased from  $\frac{3}{8}$  inch to  $\frac{1}{2}$  inch for 16-inch on center framing, and from  $\frac{1}{2}$  inch to  $\frac{5}{8}$  inch for 24-inch on center framing or  $\frac{1}{2}$ -inch sag-resistant gypsum ceiling board shall be used.



**TABLE R702.3.6**  
**SHEAR CAPACITY FOR HORIZONTAL WOOD-FRAMED GYPSUM BOARD DIAPHRAGM CEILING ASSEMBLIES**

MATERIAL	THICKNESS OF MATERIAL (min.) (inch)	SPACING OF FRAMING MEMBERS (max.) (inch)	SHEAR VALUE <sup>a, b</sup> (plf of ceiling)	MINIMUM FASTENER SIZE <sup>c, d</sup>
Gypsum board or gypsum panel product	$\frac{1}{2}$	16 o.c.	90	5d cooler or wallboard nail; 1 $\frac{5}{8}$ -inch long; 0.086-inch shank; 1 $\frac{5}{64}$ -inch head
Gypsum board or gypsum panel product	$\frac{1}{2}$	24 o.c.	70	5d cooler or wallboard nail; 1 $\frac{5}{8}$ -inch long; 0.086-inch shank; 1 $\frac{5}{64}$ -inch head

For SI: 1 inch = 25.4 mm, 1 pound per linear foot = 1.488 kg/m.

- Values are not cumulative with other horizontal diaphragm values and are for short-term loading caused by wind or seismic loading. Values shall be reduced 25 percent for normal loading.
- Values shall be reduced 50 percent in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub>, D<sub>2</sub> and E.
- 1 $\frac{1}{4}$ -inch, No. 6 Type S or W screws shall be permitted to be substituted for the listed nails.
- Fasteners shall be spaced not more than 7 inches on center at all supports, including perimeter blocking, and not less than  $\frac{3}{8}$  inch from the edges and ends of the gypsum board.

**R702.4.2 Backer boards.** Materials used as backers for wall tile in tub and shower areas and wall panels in shower areas shall be of materials listed in Table R702.4.2, and installed in accordance with the manufacturer's recommendations.

**TABLE R702.4.2**  
**BACKER BOARD MATERIALS**

MATERIAL	STANDARD
Glass mat gypsum backing panel	ASTM C1178
Fiber-reinforced gypsum panels	ASTM C1278
Nonasbestos fiber-cement backer board	ASTM C1288 or ISO 8336, Category C
Nonasbestos fiber mat-reinforced cementitious backer units	ASTM C1325

**R702.5 Other finishes.** Wood veneer paneling and hard-board paneling shall be placed on wood or cold-formed steel framing spaced not more than 16 inches (406 mm) on center. Wood veneer and hard board paneling less than  $\frac{1}{4}$ -inch (6 mm) nominal thickness shall not have less than a  $\frac{3}{8}$ -inch (10 mm) gypsum board or gypsum panel product backer. Wood veneer paneling not less than  $\frac{1}{4}$ -inch (6 mm) nominal thickness shall conform to ANSI/HPVA HP-1. Hardboard paneling shall conform to CPA/ANSI A135.5.

**R702.6 Wood shakes and shingles.** Wood shakes and shingles shall conform to CSSB *Grading Rules for Wood Shakes and Shingles* and shall be permitted to be installed directly to the studs with maximum 24 inches (610 mm) on-center spacing.

**R702.6.1 Attachment.** Nails, staples or glue are permitted for attaching shakes or shingles to the wall, and attachment of the shakes or shingles directly to the surface shall be permitted provided the fasteners are appropriate for the type of wall surface material. Where nails or staples are used, two fasteners shall be provided and shall be placed so that they are covered by the course above.

**R702.6.2 Furring strips.** Where furring strips are used, they shall be 1 inch by 2 inches or 1 inch by 3 inches (25 mm by 51 mm or 25 mm by 76 mm), spaced a distance on center equal to the desired exposure, and shall be attached to the wall by nailing through other wall material into the studs.

**R702.7 Vapor retarders.** Vapor retarder materials shall be classified in accordance with Table R702.7(1). A vapor retarder shall be provided on the interior side of frame walls of the class indicated in Table R702.7(2), including compliance with Table R702.7(3) or R702.7(4) where applicable. An *approved* design using accepted engineering practice for hygrothermal analysis shall be permitted as an alternative. The climate zone shall be determined in accordance with Section N1101.7.

#### Exceptions:

- Basement walls.
- Below-grade portion of any wall.
- Construction where accumulation, condensation or freezing of moisture will not damage the materials.
- A vapor retarder shall not be required in Climate Zones 1, 2 and 3.

**R702.7.1 Spray foam plastic insulation for moisture control with Class II and III vapor retarders.** For purposes of compliance with Tables R702.7(3) and R702.7(4), spray foam with a maximum permance of 1.5 perms at the installed thickness applied to the interior side of wood structural panels, fiberboard, *insulating sheathing* or gypsum shall be deemed to meet the continuous insulation moisture control requirement in accordance with one of the following conditions:

- The spray foam *R*-value is equal to or greater than the specified continuous insulation *R*-value.
- The combined *R*-value of the spray foam and continuous insulation is equal to or greater than the specified continuous insulation *R*-value.

## WALL COVERING

**TABLE R702.7(1)**  
**VAPOR RETARDER MATERIALS AND CLASSES**

CLASS	ACCEPTABLE MATERIALS
I	Sheet polyethylene, nonperforated aluminum foil or other approved materials with a perm rating less than or equal to 0.1.
II	Kraft-faced fiberglass batts, vapor retarder paint or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating greater than 0.1 and less than or equal to 1.0.
III	Latex paint, enamel paint or other approved materials applied in accordance with the manufacturer's installation instructions for a perm rating greater than 1.0 and less than or equal to 10.0.

**TABLE R702.7(2)**  
**VAPOR RETARDER OPTIONS**

CLIMATE ZONE	VAPOR RETARDER CLASS		
	CLASS I <sup>a</sup>	CLASS II <sup>a</sup>	CLASS III
1, 2	Not Permitted	Not Permitted	Permitted
3, 4 (except Marine 4)	Not Permitted	Permitted <sup>c</sup>	Permitted
Marine 4, 5, 6, 7, 8	Permitted <sup>b</sup>	Permitted <sup>c</sup>	See Table R702.7(3)

- a. Class I and II vapor retarders with vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B) shall be allowed on the interior side of any frame wall in all climate zones.
- b. Use of a Class I interior vapor retarder in frame walls with a Class I vapor retarder on the exterior side shall require an approved design.
- c. Where a Class II vapor retarder is used in combination with foam plastic insulating sheathing installed as continuous insulation on the exterior side of frame walls, the continuous insulation shall comply with Table R702.7(4) and the Class II vapor retarder shall have a vapor permeance greater than 1 perm when measured by ASTM E96 water method (Procedure B).

**TABLE R702.7(3)**  
**CLASS III VAPOR RETARDERS**

CLIMATE ZONE	CLASS III VAPOR RETARDERS PERMITTED FOR: <sup>a, b</sup>
Marine 4	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with $R$ -value $\geq 2.5$ over $2 \times 4$ wall.
	Continuous insulation with $R$ -value $\geq 3.75$ over $2 \times 6$ wall.
5	Vented cladding over wood structural panels.
	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with $R$ -value $\geq 5$ over $2 \times 4$ wall.
	Continuous insulation with $R$ -value $\geq 7.5$ over $2 \times 6$ wall.
6	Vented cladding over fiberboard.
	Vented cladding over gypsum.
	Continuous insulation with $R$ -value $\geq 7.5$ over $2 \times 4$ wall.
	Continuous insulation with $R$ -value $\geq 11.25$ over $2 \times 6$ wall.
7	Continuous insulation with $R$ -value $\geq 10$ over $2 \times 4$ wall.
	Continuous insulation with $R$ -value $\geq 15$ over $2 \times 6$ wall.
8	Continuous insulation with $R$ -value $\geq 12.5$ over $2 \times 4$ wall.
	Continuous insulation with $R$ -value $\geq 20$ over $2 \times 6$ wall.

- a. Vented cladding shall include vinyl, polypropylene, or horizontal aluminum siding, brick veneer with a clear airspace as specified in Table R703.8.4(1), and other approved vented claddings.
- b. The requirements in this table apply only to insulation used to control moisture in order to permit the use of Class III vapor retarders. The insulation materials used to satisfy this option also contribute to but do not supersede the thermal envelope requirements of Chapter 11.

**TABLE R702.7(4)**  
**CONTINUOUS INSULATION WITH CLASS II VAPOR RETARDER**

CLIMATE ZONE	CLASS II VAPOR RETARDERS PERMITTED FOR: <sup>a</sup>
3	Continuous insulation with $R$ -value $\geq 2$ .
4, 5 and 6	Continuous insulation with $R$ -value $\geq 3$ over $2 \times 4$ wall. Continuous insulation with $R$ -value $\geq 5$ over $2 \times 6$ wall.
7	Continuous insulation with $R$ -value $\geq 5$ over $2 \times 4$ wall. Continuous insulation with $R$ -value $\geq 7.5$ over $2 \times 6$ wall.
8	Continuous insulation with $R$ -value $\geq 7.5$ over $2 \times 4$ wall. Continuous insulation with $R$ -value $\geq 10$ over $2 \times 6$ wall.

a. The requirements in this table apply only to insulation used to control moisture in order to permit the use of Class II vapor retarders. The insulation materials used to satisfy this option also contribute to but do not supersede the thermal envelope requirements of Chapter 11.

## SECTION R703 EXTERIOR COVERING

**R703.1 General.** Exterior walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing as described in Section R703.4.

**Exception:** Log walls designed and constructed in accordance with the provisions of ICC 400.

**R703.1.1 Water resistance.** The exterior wall envelope shall be designed and constructed in a manner that prevents the accumulation of water within the wall assembly by providing a water-resistant barrier behind the exterior cladding as required by Section R703.2 and a means of draining to the exterior water that penetrates the exterior cladding.

### Exceptions:

1. A weather-resistant exterior wall envelope shall not be required over concrete or masonry walls designed in accordance with Chapter 6 and flashed in accordance with Section R703.4 or R703.8.
2. Compliance with the requirements for a means of drainage, and the requirements of Sections R703.2 and R703.4, shall not be required for an exterior wall envelope that has been demonstrated to resist wind-driven rain through testing of the exterior wall envelope, including joints, penetrations and intersections with dissimilar materials, in accordance with ASTM E331 under the following conditions:
  - 2.1. Exterior wall envelope test assemblies shall include at least one opening, one control joint, one wall/eave interface and one wall sill. All tested openings and penetrations shall be representative of the intended end-use configuration.
  - 2.2. Exterior wall envelope test assemblies shall be at least 4 feet by 8 feet (1219 mm by 2438 mm) in size.

2.3. Exterior wall assemblies shall be tested at a minimum differential pressure of 6.24 pounds per square foot (299 Pa).

2.4. Exterior wall envelope assemblies shall be subjected to the minimum test exposure for a minimum of 2 hours.

The exterior wall envelope design shall be considered to resist wind-driven rain where the results of testing indicate that water did not penetrate control joints in the exterior wall envelope, joints at the perimeter of openings penetration or intersections of terminations with dissimilar materials.

**R703.1.2 Wind resistance.** Wall coverings, backing materials and their attachments shall be capable of resisting wind loads in accordance with Tables R301.2.1(1) and R301.2.1(2). Wind-pressure resistance of the siding, soffit and backing materials shall be determined by ASTM E330 or other applicable standard test methods. Where wind-pressure resistance is determined by design analysis, data from *approved* design standards and analysis conforming to generally accepted engineering practice shall be used to evaluate the siding, soffit and backing material and its fastening. All applicable failure modes including bending rupture of siding, fastener withdrawal and fastener head pull-through shall be considered in the testing or design analysis. Where the wall covering, soffit and backing material resist wind load as an assembly, use of the design capacity of the assembly shall be permitted.

**R703.2 Water-resistive barrier.** Not fewer than one layer of *water-resistive barrier* shall be applied over studs or sheathing of all exterior walls with flashing as indicated in Section R703.4, in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer. The water-resistive barrier material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1. Water-resistive barrier materials shall comply with one of the following:

1. No. 15 felt complying with ASTM D226, Type 1.
2. ASTM 2556, Type 1 or 2.

## WALL COVERING

3. ASTM E331 in accordance with Section R703.1.1.
4. Other approved materials in accordance with the manufacturer's installation instructions.

No.15 asphalt felt and *water-resistive barriers* complying with ASTM E2556 shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm), and where joints occur, shall be lapped not less than 6 inches (152 mm).

**R703.3 Wall covering nominal thickness and attachments.** The nominal thickness and attachment of exterior wall coverings shall be in accordance with Table R703.3(1), the wall covering material requirements of this section, and the wall covering manufacturer's installation instructions. Cladding attachment over foam sheathing shall comply with the additional requirements and limitations of Sections R703.15 through R703.17. Nominal material thicknesses in Table R703.3(1) are based on a maximum stud spacing of 16 inches (406 mm) on center. Where specified by the siding manufacturer's instructions and supported by a test report or other documentation, attachment to studs with greater spacing is permitted. Fasteners for exterior wall coverings attached to wood framing shall be in accordance with Section R703.3.3 and Table R703.3(1). Exterior wall coverings shall be attached to cold-formed steel light frame construction in accordance with the cladding manufacturer's installation instructions, the requirements of Table R703.3(1) using screw fasteners substituted for the nails specified in accordance with Table R703.3(2), or an *approved* design.

**R703.3.1 Soffit installation.** Soffits shall comply with Section R704.

**R703.3.2 Wind limitations.** Where the design wind pressure exceeds 30 psf or where the limits of Table R703.3.2 are exceeded, the attachment of wall coverings and soffits shall be designed to resist the component and cladding loads specified in Table R301.2.1(1) for walls, adjusted for height and exposure in accordance with Table R301.2.1(2). For the determination of wall covering and soffit attachment, component and cladding loads shall be determined using an effective wind area of 10 square feet (0.93 m<sup>2</sup>).

**R703.3.3 Fasteners.** Exterior wall coverings and roof overhang soffits shall be securely fastened with aluminum, galvanized, stainless steel or rust-preventative coated nails or staples in accordance with Table R703.3(1) or with other *approved* corrosion-resistant fasteners in accordance with the wall covering manufacturer's installation instructions. Nails and staples shall comply with ASTM F1667. Nails shall be T-head, modified round head, or round head with smooth or deformed shanks. Staples shall have a minimum crown width of  $\frac{7}{16}$  inch (11.1 mm) outside diameter and be manufactured of

minimum 16-gage wire. Where fiberboard, gypsum, or foam plastic sheathing backing is used, nails or staples shall be driven into the studs. Where wood or wood structural panel sheathing is used, fasteners shall be driven into studs unless otherwise permitted to be driven into sheathing in accordance with either the siding manufacturer's installation instructions or Table R703.3.3.

**R703.3.4 Minimum fastener length and penetration.**

Fasteners shall have the greater of the minimum length specified in Table R703.3(1) or as required to provide a minimum penetration into framing as follows:

1. Fasteners for horizontal aluminum siding, steel siding, particleboard panel siding, wood structural panel siding in accordance with ANSI/APA-PRP 210, fiber-cement panel siding and fiber-cement lap siding installed over foam plastic sheathing shall penetrate not less than  $1\frac{1}{2}$  inches (38 mm) into framing or shall be in accordance with the manufacturer's installation instructions.
2. Fasteners for hardboard panel and lap siding shall penetrate not less than  $1\frac{1}{2}$  inches (38 mm) into framing.
3. Fasteners for vinyl siding and insulated vinyl siding installed over wood or wood structural panel sheathing shall penetrate not less than  $1\frac{1}{4}$  inches (32 mm) into sheathing and framing combined. Vinyl siding and insulated vinyl siding shall be permitted to be installed with fasteners penetrating into or through wood or wood structural sheathing of minimum thickness as specified by the manufacturer's instructions or test report, with or without penetration into the framing. Where the fastener penetrates fully through the sheathing, the end of the fastener shall extend not less than  $\frac{1}{4}$  inch (6.4 mm) beyond the opposite face of the sheathing. Fasteners for vinyl siding and insulated vinyl siding installed over foam plastic sheathing shall be in accordance with Section R703.11.2. Fasteners for vinyl siding and insulated vinyl siding installed over fiberboard or gypsum sheathing shall penetrate not less than  $1\frac{1}{4}$  inches (32 mm) into framing.
4. Fasteners for vertical or horizontal wood siding shall penetrate not less than  $1\frac{1}{2}$  inches (38 mm) into studs, studs and wood sheathing combined, or blocking.
5. Fasteners for siding material installed over foam plastic sheathing shall have sufficient length to accommodate foam plastic sheathing thickness and to penetrate framing or sheathing and framing combined, as specified in Items 1 through 4.

## WALL COVERING

**TABLE R703.3(1)**  
**SIDING MINIMUM ATTACHMENT AND MINIMUM THICKNESS**

SIDING MATERIAL		NOMINAL THICKNESS (inches)	JOINT TREATMENT	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS					
				Wood or wood structural panel sheathing into stud	Fiberboard sheathing into stud	Gypsum sheathing into stud	Foam plastic sheathing into stud <sup>l</sup>	Direct to studs	Number or spacing of fasteners
Anchored veneer: brick, concrete, masonry or stone (see Section R703.8)		2	Section R703.8	Section R703.8					
Adhered veneer: concrete, stone or masonry (see Section R703.12)		—	Section R703.12	Section R703.12					
Fiber cement siding	Panel siding (see Section R703.10.1)	$\frac{5}{16}$	Section R703.10.1	6d common (2" × 0.113")	6d common (2" × 0.113")	6d common (2" × 0.113")	6d common (2" × 0.113")	4d common (1½" × 0.099")	6" panel edges 12" inter. sup.
	Lap siding (see Section R703.10.2)	$\frac{5}{16}$	Section R703.10.2	6d common (2" × 0.113")	6d common (2" × 0.113")	6d common (2" × 0.113")	6d common (2" × 0.113")	6d common (2" × 0.113") or 11 gage roofing nail	Note f
Hardboard panel siding (see Section R703.5)		$\frac{7}{16}$	—	0.120" nail (shank) with 0.225" head	0.120" nail (shank) with 0.225" head	0.120" nail (shank) with 0.225" head	0.120" nail (shank) with 0.225" head	0.120" nail (shank) with 0.225" head	6" panel edges 12" inter. sup. <sup>d</sup>
Hardboard lap siding (see Section R703.5)		$\frac{7}{16}$	Note e	0.099" nail (shank) with 0.240" head	0.099" nail (shank) with 0.240" head	0.099" nail (shank) with 0.240" head	0.099" nail (shank) with 0.240" head	0.099" nail (shank) with 0.240" head	Same as stud spacing 2 per bearing
Horizontal aluminum <sup>a</sup>	Without insulation	0.019 <sup>b</sup>	Lap	Siding nail 1½" × 0.120"	Siding nail 2" × 0.120"	Siding nail 2" × 0.120"	Siding nail <sup>h</sup> 1½" × 0.120"	Not allowed	Same as stud spacing
		0.024	Lap	Siding nail 1½" × 0.120"	Siding nail 2" × 0.120"	Siding nail 2" × 0.120"	Siding nail <sup>h</sup> 1½" × 0.120"	Not allowed	
	With insulation	0.019	Lap	Siding nail 1½" × 0.120"	Siding nail 2½" × 0.120"	Siding nail 2½" × 0.120"	Siding nail <sup>h</sup> 1½" × 0.120"	Siding nail 1½" × 0.120"	
Insulated vinyl siding <sup>j</sup>		0.035 (vinyl siding layer only)	Lap	0.120 nail (shank) with a 0.313 head or 16-gage crown <sup>h, i</sup>	0.120 nail (shank) with a 0.313 head or 16-gage crown <sup>h</sup>	0.120 nail (shank) with a 0.313 head or 16-gage crown <sup>h</sup>	0.120 nail (shank) with a 0.313 head Section R703.11.2	Not allowed	16 inches on center or specified by manufacturer instructions, test report or other sections of this code
Particleboard panels		$\frac{3}{8}$	—	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	Not allowed	6" panel edges 12" inter. sup.
		$\frac{1}{2}$	—	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	
		$\frac{5}{8}$	—	6d box nail (2" × 0.099")	8d box nail (2½" × 0.113")	8d box nail (2½" × 0.113")	6d box nail (2" × 0.099")	6d box nail (2" × 0.099")	
Polypropylene siding <sup>k</sup>		Not applicable	Lap	Section 703.14.1	Section 703.14.1	Section 703.14.1	Section 703.14.1	Not allowed	As specified by the manufacturer instructions, test report or other sections of this code

(continued)



## WALL COVERING

**TABLE R703.3(1)—continued**  
**SIDING MINIMUM ATTACHMENT AND MINIMUM THICKNESS**

SIDING MATERIAL		NOMINAL THICKNESS (inches)	JOINT TREATMENT	TYPE OF SUPPORTS FOR THE SIDING MATERIAL AND FASTENERS					Number or spacing of fasteners
				Wood or wood structural panel sheathing into stud	Fiberboard sheathing into stud	Gypsum sheathing into stud	Foam plastic sheathing into stud <sup>i</sup>	Direct to studs	
Steel <sup>c</sup>		29 ga.	Lap	Siding nail (1 <sup>3</sup> / <sub>4</sub> " × 0.113") Staple—1 <sup>3</sup> / <sub>4</sub>	Siding nail (2 <sup>3</sup> / <sub>4</sub> " × 0.113") Staple—2 <sup>1</sup> / <sub>2</sub>	Siding nail (2 <sup>1</sup> / <sub>2</sub> " × 0.113") Staple—2 <sup>1</sup> / <sub>4</sub>	Siding nail (1 <sup>3</sup> / <sub>4</sub> " × 0.113") Staple—1 <sup>3</sup> / <sub>4</sub>	Not allowed	Same as stud spacing
Vinyl siding (see Section R703.11)		0.035	Lap	0.120" nail (shank) with a 0.313" head or 16-gage staple with <sup>3</sup> / <sub>8</sub> - to 1 <sup>1</sup> / <sub>2</sub> -inch crown <sup>h, i</sup>	0.120" nail (shank) with a 0.313" head or 16-gage staple with <sup>3</sup> / <sub>8</sub> - to 1 <sup>1</sup> / <sub>2</sub> -inch crown <sup>h</sup>	0.120" nail (shank) with a 0.313" head or 16-gage staple with <sup>3</sup> / <sub>8</sub> - to 1 <sup>1</sup> / <sub>2</sub> -inch crown <sup>h</sup>	0.120" nail (shank) with a 0.313 head Section R703.11.2	Not allowed	16 inches on center or as specified by the manufacturer instructions or test report
Wood siding (see Section R703.5)	Wood rustic, drop	<sup>3</sup> / <sub>8</sub> min.	Lap	6d box or siding nail (2" × 0.099")	6d box or siding nail (2" × 0.099")	6d box or siding nail (2" × 0.099")	6d box or siding nail (2" × 0.099")	8d box or siding nail (2 <sup>1</sup> / <sub>2</sub> " × 0.113") Staple—2"	Face nailing up to 6" widths, 1 nail per bearing; 8" width sand over, 2 nails per bearing
	Shiplap	<sup>19</sup> / <sub>32</sub> average	Lap						
	Bevel	<sup>7</sup> / <sub>16</sub>							
	Butt tip	<sup>3</sup> / <sub>16</sub>	Lap						
Wood structural panel ANSI/APA PRP-210 siding (exterior grade) (see Section R703.5)		<sup>3</sup> / <sub>8</sub> — 1 <sup>1</sup> / <sub>2</sub>	Note e	2" × 0.099" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2" × 0.099" siding nail	6" panel edges 12" inter. sup.
Wood structural panel lap siding (see Section R703.5)		<sup>3</sup> / <sub>8</sub> — 1 <sup>1</sup> / <sub>2</sub>	Note e Note g	2" × 0.099" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2 <sup>1</sup> / <sub>2</sub> " × 0.113" siding nail	2" × 0.099" siding nail	8" along bottom edge

For SI: 1 inch = 25.4 mm.

- Aluminum nails shall be used to attach aluminum siding.
- Aluminum (0.019 inch) shall be unbacked only where the maximum panel width is 10 inches and the maximum flat area is 8 inches. The tolerance for aluminum siding shall be +0.002 inch of the nominal dimension.
- Shall be of approved type.
- Where used to resist shear forces, the spacing must be 4 inches at panel edges and 8 inches on interior supports.
- Vertical end joints shall occur at studs and shall be covered with a joint cover or shall be caulked.
- Face nailing: one 6d common nail through the overlapping planks at each stud. Concealed nailing: one 11-gage 1<sup>1</sup>/<sub>2</sub>-inch-long galv. roofing nail through the top edge of each plank at each stud in accordance with the manufacturer's installation instructions.
- Vertical joints, if staggered, shall be permitted to be away from studs if applied over wood structural panel sheathing.
- Minimum fastener length must be sufficient to penetrate sheathing other nailable substrate and framing a total of a minimum of 1<sup>1</sup>/<sub>4</sub> inches or in accordance with the manufacturer's installation instructions.
- Where specified by the manufacturer's instructions and supported by a test report, fasteners are permitted to penetrate into or fully through nailable sheathing or other nailable substrate of minimum thickness specified by the instructions or test report, without penetrating into framing.
- Insulated vinyl siding shall comply with ASTM D7793.
- Polypropylene siding shall comply with ASTM D7254.
- Cladding attachment over foam sheathing shall comply with the additional requirements and limitations of Sections R703.15, R703.16 and R703.17.

**TABLE R703.3(2)**  
**SCREW FASTENER SUBSTITUTION FOR**  
**SIDING ATTACHMENT TO COLD-FORMED**  
**STEEL LIGHT FRAME CONSTRUCTION<sup>a, b, c, d, e</sup>**

NAIL DIAMETER PER TABLE R703.3(1)	MINIMUM SCREW FASTENER SIZE
0.099"	No. 6
0.113"	No. 7
0.120"	No. 8

For SI: 1 inch = 25.4 mm.

- Screws shall comply with ASTM C1513 and shall penetrate a minimum of three threads through minimum 33 mil (20 gage) cold-formed steel frame construction.
- Screw head diameter shall be not less than the nail head diameter required by Table R703.3(1).
- Number and spacing of screw fasteners shall comply with Table R703.3(1).
- Pan head, hex washer head, modified truss head or other screw head types with a flat attachment surface under the head shall be used for vinyl siding attachment.
- Aluminum siding shall not be fastened directly to cold-formed steel light frame construction.

**TABLE R703.3.2**  
**LIMITS FOR ATTACHMENT PER Table R703.3(1)**

MAXIMUM MEAN ROOF HEIGHT			
Ultimate Wind Speed (mph 3-second gust)	Exposure		
	B	C	D
95	NL	NL	NL
100	NL	NL	NL
105	NL	NL	NL
110	NL	NL	40'
115	NL	50'	20'
120	NL	30'	DR
130	60'	15'	DR
140	35'	DR	DR

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

NL = Not Limited by Table R703.3.2, DR = Design Required.

**R703.4 Flashing.** *Approved* corrosion-resistant flashing shall be applied *shingle-fashion* in a manner to prevent entry of water into the wall cavity or penetration of water to the building structural framing components. Self-adhered membranes used as flashing shall comply with AAMA 711. Fluid-applied membranes used as flashing in exterior walls

shall comply with AAMA 714. The flashing shall extend to the surface of the exterior wall finish. *Approved* corrosion-resistant flashings shall be installed at the following locations:

- Exterior window and door openings. Flashing at exterior window and door openings shall be installed in accordance with Section R703.4.1.
- At the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings.
- Under and at the ends of masonry, wood or metal copings and sills.
- Continuously above all projecting wood *trim*.
- Where exterior porches, decks or stairs attach to a wall or floor assembly of wood-frame construction.
- At wall and roof intersections.
- At built-in gutters.

**R703.4.1 Flashing installation at exterior window and door openings.** Flashing at exterior window and door openings shall extend to the surface of the exterior wall finish or to a *water-resistive barrier* complying with Section 703.2 for subsequent drainage. Air sealing shall be installed around all window and door openings on the interior side of the rough opening gap. Mechanically attached flexible flashings shall comply with AAMA 712. Flashing at exterior window and door openings shall be installed in accordance with one or more of the following:

- The fenestration manufacturer's installation and flashing instructions, or for applications not addressed in the fenestration manufacturer's instructions, in accordance with the flashing manufacturer's instructions. Where flashing instructions or details are not provided, *pan flashing* shall be installed at the sill of exterior window and door openings. *Pan flashing* shall be sealed or sloped in such a manner as to direct water to the surface of the exterior wall finish or to the water-resistive barrier for subsequent drainage. Openings using *pan flashing* shall incorporate flashing or protection at the head and sides.
- In accordance with the flashing design or method of a *registered design professional*.
- In accordance with other *approved* methods.

**TABLE R703.3.3**  
**OPTIONAL SIDING ATTACHMENT SCHEDULE FOR FASTENERS WHERE NO STUD PENETRATION NECESSARY**

APPLICATION	NUMBER AND TYPE OF FASTENER	SPACING OF FASTENERS <sup>b</sup>
Exterior wall covering (weighing 3 psf or less) attachment to wood structural panel sheathing, either direct or over foam sheathing a maximum of 2 inches thick. <sup>a</sup> Note: Does not apply to vertical siding.	Ring shank roofing nail (0.120" min. dia.)	12" o.c.
	Ring shank nail (0.148" min. dia.)	15" o.c.
	No. 6 screw (0.138" min. dia.)	12" o.c.
	No. 8 screw (0.164" min. dia.)	16" o.c.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.479 kPa.

- Fastener length shall be sufficient to penetrate the back side of the wood structural panel sheathing by at least  $\frac{1}{4}$  inch. The wood structural panel sheathing shall be not less than  $\frac{7}{16}$  inch in thickness.
- Spacing of fasteners is per 12 inches of siding width. For other siding widths, multiply "Spacing of Fasteners" above by a factor of 12/s, where "s" is the siding width in inches. Fastener spacing shall never be greater than the manufacturer's minimum recommendations.

## WALL COVERING

**R703.5 Wood, hardboard and wood structural panel siding.** Wood, hardboard and wood structural panel siding shall be installed in accordance with this section and Table R703.3(1). Hardboard siding shall comply with ANSI A135.5.

**R703.5.1 Vertical wood siding.** Wood siding applied vertically shall be nailed to horizontal nailing strips or blocking set not more than 24 inches (610 mm) on center.

**R703.5.2 Panel siding.** Three-eighths-inch (9.5 mm) wood structural panel siding shall not be applied directly to studs spaced more than 16 inches (406 mm) on center where long dimension is parallel to studs. Wood structural panel siding  $\frac{7}{16}$  inch (11.1 mm) or thinner shall not be applied directly to studs spaced more than 24 inches (610 mm) on center. The stud spacing shall not exceed the panel span rating provided by the manufacturer unless the panels are installed with the face grain perpendicular to the studs or over sheathing *approved* for that stud spacing.

Joints in wood, hardboard or wood structural panel siding shall be made as follows unless otherwise *approved*. Vertical joints in panel siding shall occur over framing members, unless wood or wood structural panel sheathing is used, and shall be shiplapped or covered with a batten. Horizontal joints in panel siding shall be lapped not less than 1 inch (25 mm) or shall be shiplapped or flashed with Z-flashing and occur over solid blocking, wood or wood structural panel sheathing.

**R703.5.3 Horizontal wood siding.** Horizontal lap siding shall be installed in accordance with the manufacturer's recommendations. Where there are no recommendations the siding shall be lapped not less than 1 inch (25 mm), or  $\frac{1}{2}$  inch (12.7 mm) if rabbeted, and shall have the ends caulked, covered with a batten or sealed and installed over a strip of flashing.

**R703.6 Wood shakes and shingles.** Wood shakes and shingles shall conform to CSSB.

**R703.6.1 Application.** Wood shakes or shingles shall be applied either single course or double course over nominal  $\frac{1}{2}$ -inch (12.7 mm) wood-based sheathing or to furring strips over  $\frac{1}{2}$ -inch (12.7 mm) nominal nonwood sheathing. A *water-resistive barrier* shall be provided over all sheathing, with horizontal overlaps in the membrane of not less than 2 inches (51 mm) and vertical overlaps of not less than 6 inches (152 mm). Where horizontal furring strips are used, they shall be 1 inch by 3 inches or 1 inch by 4 inches (25 mm by 76 mm or 25 mm by 102 mm) and shall be fastened to the studs with minimum 7d or 8d box nails and shall be spaced a distance on center equal to the actual weather exposure of the shakes or shingles, not to exceed the maximum exposure specified in Table R703.6.1. When installing shakes or shingles over a nonpermeable *water-resistive barrier*, furring strips shall be placed first vertically over the barrier and in addition, horizontal furring strips shall be fastened to the vertical furring strips prior to attaching the shakes or shingles to the horizontal furring strips. The spacing between adjacent shingles to allow for expansion shall be  $\frac{1}{8}$  inch (3.2 mm) to  $\frac{1}{4}$  inch (6.4 mm) apart, and between adjacent

shakes shall be  $\frac{3}{8}$  inch (9.5 mm) to  $\frac{1}{2}$  inch (12.7 mm) apart. The offset spacing between joints in adjacent courses shall be not less than  $1\frac{1}{2}$  inches (38 mm).

**TABLE R703.6.1**  
**MAXIMUM WEATHER EXPOSURE FOR**  
**WOOD SHAKES AND SHINGLES ON EXTERIOR WALLS<sup>a, b, c</sup>**  
(Dimensions are in inches)

LENGTH	EXPOSURE FOR SINGLE COURSE	EXPOSURE FOR DOUBLE COURSE
<b>Shingles<sup>a</sup></b>		
16	7	12 <sup>b</sup>
18	8	14 <sup>c</sup>
24	10 $\frac{1}{2}$	16 <sup>d</sup>
<b>Shakes<sup>a</sup></b>		
18	8	14
24	10 $\frac{1}{2}$	18

For SI: 1 inch = 25.4 mm.

- a. Dimensions given are for No. 1 grade.
- b. A maximum 9-inch exposure is permitted for No. 2 grade.
- c. A maximum 10-inch exposure is permitted for No. 2 grade.
- d. A maximum 14-inch exposure is permitted for No. 2 grade.

**R703.6.2 Weather exposure.** The maximum weather exposure for shakes and shingles shall not exceed that specified in Table R703.6.1.

**R703.6.3 Attachment.** Wood shakes or shingles shall be installed according to this chapter and the manufacturer's instructions. Each shake or shingle shall be held in place by two stainless steel Type 304, Type 316 or hot-dipped zinc-coated galvanized corrosion-resistant box nails in accordance with Table R703.6.3(1) or R703.6.3(2). The hot-dipped zinc-coated galvanizing shall be in compliance with ASTM A153, 1.0 ounce per square foot. Alternatively, 16-gage stainless steel Type 304 or Type 316 staples with crown widths  $\frac{7}{16}$  inch (11 mm) minimum,  $\frac{3}{4}$  inch (19 mm) maximum, shall be used and the crown of the staple shall be placed parallel with the butt of the shake or the shingle. In single-course application, the fasteners shall be concealed by the course above and shall be driven approximately 1 inch (25 mm) above the butt line of the succeeding course and  $\frac{3}{4}$  inch (19 mm) from the edge. In double-course applications, the exposed shake or shingle shall be face-nailed with two fasteners, driven approximately 2 inches (51 mm) above the butt line and  $\frac{3}{4}$  inch (19 mm) from each edge. Fasteners installed within 15 miles (24 km) of saltwater coastal areas shall be stainless steel Type 316. Fasteners for fire-retardant-treated shakes or shingles in accordance with Section R902 or pressure-impregnated-preservative-treated shakes or shingles in accordance with AWP A U1 shall be stainless steel Type 316. The fasteners shall penetrate the sheathing or furring strips by not less than  $\frac{1}{2}$  inch (13 mm) and shall not be overdriven. Fasteners for untreated (natural) and treated products shall comply with ASTM F1667.

**R703.6.4 Bottom courses.** The bottom courses shall be doubled.

**TABLE R703.6.3(1)**  
**SINGLE-COURSE SIDEWALL FASTENERS**

PRODUCT TYPE	NAIL TYPE, MINIMUM LENGTH AND SHANK DIAMETER (inches)
<b>R &amp; R and sanded shingles</b>	
16" and 18" shingles	3d box $1\frac{1}{4} \times 0.076$
24" shingles	4d box $1\frac{1}{2} \times 0.076$
<b>Grooved shingles</b>	
16" and 18" shingles	3d box $1\frac{1}{4} \times 0.076$
24" shingles	4d box $1\frac{1}{2} \times 0.076$
<b>Split and sawn shakes</b>	
18" straight-split shakes	5d box $1\frac{3}{4} \times 0.080$
18" and 24" handsplit shakes	6d box $2 \times 0.099$
24" tapersplit shakes	5d box $1\frac{3}{4} \times 0.080$
18" and 24" tapersawn shakes	6d box $2 \times 0.099$

For SI: 1 inch = 25.4 mm.

**TABLE R703.6.3(2)**  
**DOUBLE-COURSE SIDEWALL FASTENERS**

PRODUCT TYPE	NAIL TYPE, MINIMUM LENGTH AND SHANK DIAMETER (inches)
<b>R &amp; R and sanded shingles</b>	
16", 8" and 24" shingles	5d box $1\frac{3}{4} \times 0.08$ or 5d casing nails $1\frac{3}{4} \times 0.080$
<b>Grooved shingles</b>	
16", 18" and 24" shingles	5d box $1\frac{3}{4} \times 0.080$
<b>Split and sawn shakes</b>	
18" straight-split shakes	7d box $2\frac{1}{4} \times 0.099$ or 8d box $2\frac{1}{2} \times 0.113$
18" and 24" handsplit shakes	7d box $2\frac{1}{4} \times 0.099$ or 8d box $2\frac{1}{2} \times 0.113$
24" tapersplit shakes	7d box $2\frac{1}{4} \times 0.099$ or 8d box $2\frac{1}{2} \times 0.113$
18" and 24" tapersawn shakes	7d box $2\frac{1}{4} \times 0.099$ or 8d box $2\frac{1}{2} \times 0.113$

For SI: 1 inch = 25.4 mm.

**R703.7 Exterior plaster (stucco).** Installation of exterior plaster shall be in compliance with ASTM C926, ASTM C1063 and the provisions of this code.

**R703.7.1 Lath.** Lath and lath attachments shall be of corrosion-resistant materials in accordance with ASTM C1063. Expanded metal, welded wire, or woven wire lath shall be attached to wood framing members or furring. Where the exterior plaster is serving as wall bracing in accordance with Table R602.10.4, the lath shall be attached directly to framing. The lath shall be attached with  $1\frac{1}{2}$ -inch-long (38 mm), 11-gage nails having a  $\frac{7}{16}$ -inch (11.1 mm) head, or  $\frac{7}{8}$ -inch-long (22.2 mm), 16-gage staples, spaced not more than 7 inches (178 mm) on center along framing members or furring and not more than 24 inches (610 mm) on center between framing members or furring, or as otherwise *approved*. Additional fastening between wood framing members shall not be prohibited. Lath attachments to cold-formed steel framing or to masonry, stone, or concrete substrates shall be in accordance with ASTM C1063. Where lath is installed directly over foam sheathing, lath connections shall also be in accordance with Section R703.15, R703.16 or R703.17. Where lath is attached to furring installed over

foam sheathing, the furring connections shall be in accordance with Section R703.15, R703.16 or R703.17.

**Exception:** Lath is not required over masonry, cast-in-place concrete, *precast concrete* or stone substrates prepared in accordance with ASTM C1063.

**703.7.1.1 Furring.** Where provided, furring shall consist of wood furring strips not less than 1 inch by 2 inches (25 mm by 51 mm), minimum  $\frac{3}{4}$ -inch (19 mm) metal channels, or self-furring lath, and shall be installed in accordance with ASTM C1063. Furring shall be spaced not greater than 24 inches (600 mm) on center and, where installed over wood or cold-formed steel framing, shall be fastened into framing members.

**R703.7.2 Plaster.** Plastering with cement plaster shall be in accordance with ASTM C926. Cement materials shall be in accordance with one of the following:

1. Masonry cement conforming to ASTM C91, Type M, S or N.
2. Portland cement conforming to ASTM C150, Type I, II or III.
3. Blended hydraulic cement conforming to ASTM C595, Type IP, IS (< 70), IL, or IT (S < 70).



## WALL COVERING

4. Hydraulic cement conforming to ASTM C1157, Type GU, HE, MS, HS or MH.
5. Plastic (stucco) cement conforming to ASTM C1328.

Plaster shall be not less than three coats where applied over metal lath or wire lath and shall be not less than two coats where applied over masonry, concrete, pressure-preservative-treated wood or decay-resistant wood as specified in Section R317.1 or gypsum backing. If the plaster surface is completely covered by veneer or other facing material or is completely concealed, plaster application need be only two coats, provided the total thickness is as set forth in Table R702.1(1).

On wood-frame construction with an on-grade floor slab system, exterior plaster shall be applied to cover, but not extend below, lath, paper and screed.

The proportion of aggregate to cementitious materials shall be as set forth in Table R702.1(3).

**R703.7.2.1 Weep screeds.** A minimum 0.019-inch (0.5 mm) (No. 26 galvanized sheet gage), corrosion-resistant weep screed or plastic weep screed, with a minimum vertical attachment flange of  $3\frac{1}{2}$  inches (89 mm), shall be provided at or below the foundation plate line on exterior stud walls in accordance with ASTM C926. The weep screed shall be placed not less than 4 inches (102 mm) above the earth or 2 inches (51 mm) above paved areas and shall be of a type that will allow trapped water to drain to the exterior of the building. The weather-resistant barrier shall lap the attachment flange. The exterior lath shall cover and terminate on the attachment flange of the weep screed.

**R703.7.3 Water-resistant barriers.** Water-resistant barriers shall be installed as required in Section R703.2 and, where applied over wood-based sheathing, shall comply with Section R703.7.3.1 or R703.7.3.2.

**R703.7.3.1 Dry climates.** In Dry (B) climate zones indicated in Figure N1101.7, *water-resistant barriers* shall comply with one of the following:

1. The *water-resistant barrier* shall be two layers of 10-minute Grade D paper or have a water resistance equal to or greater than two layers of a *water-resistant barrier* complying with ASTM E2556, Type I. The individual layers shall be installed independently such that each layer provides a separate continuous plane. Flashing installed in accordance with Section R703.4 and intended to drain to the *water-resistant barrier* shall be directed between the layers.
2. The *water-resistant barrier* shall be 60-minute Grade D paper or have a water resistance equal to or greater than one layer of a water-resistant barrier complying with ASTM E2556, Type II. The *water-resistant barrier* shall be separated from the stucco by a layer of foam plastic *insulating sheathing* or other non-water-absorbing layer, or a designed drainage space.

**R703.7.3.2 Moist or marine climates.** In the Moist (A) or Marine (C) climate zones indicated in Figure N1101.7, *water-resistant barriers* shall comply with one of the following:

1. In addition to complying with Section R703.7.3.1, a space or drainage material not less than  $\frac{3}{16}$  inch (5 mm) in depth shall be added to the exterior side of the *water-resistant barrier*.
2. In addition to complying with Section R703.7.3.1, Item 2, drainage on the exterior of the *water-resistant barrier* shall have a drainage efficiency of not less than 90 percent, as measured in accordance with ASTM E2273 or Annex A2 of ASTM E2925.

**R703.7.4 Application.** Each coat shall be kept in a moist condition for at least 48 hours prior to application of the next coat.

**Exception:** Applications installed in accordance with ASTM C926.

**R703.7.5 Curing.** The finish coat for two-coat cement plaster shall not be applied sooner than seven days after application of the first coat. For three-coat cement plaster, the second coat shall not be applied sooner than 48 hours after application of the first coat. The finish coat for three-coat cement plaster shall not be applied sooner than seven days after application of the second coat.

**R703.8 Anchored stone and masonry veneer, general.** Anchored stone and masonry veneer shall be installed in accordance with this chapter, Table R703.3(1) and Figures R703.8(1) and R703.8(2). These veneers installed over a backing of wood or cold-formed steel shall be limited to the first *story above grade plane* and shall not exceed 5 inches (127 mm) in thickness. See Section R602.10 for wall bracing requirements for masonry veneer for wood-framed construction and Section R603.9.5 for wall bracing requirements for masonry veneer for cold-formed steel construction.

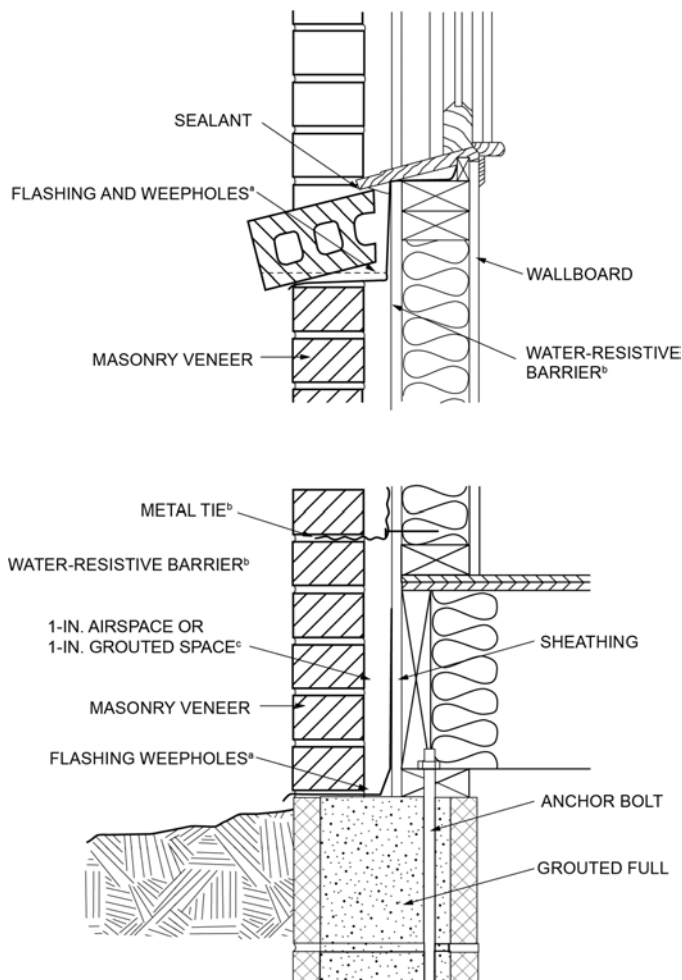
**Exceptions:**

1. For buildings in *Seismic Design Categories* A, B and C, exterior stone or masonry veneer, as specified in Table R703.8(1), with a backing of wood or steel framing shall be permitted to the height specified in Table R703.8(1) above a noncombustible foundation.
2. For detached one- or two-family dwellings in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, exterior stone or masonry veneer, as specified in Table R703.8(2), with a backing of wood framing shall be permitted to the height specified in Table R703.8(2) above a noncombustible foundation.

**R703.8.1 Interior veneer support.** Veneers used as interior wall finishes shall be permitted to be supported on wood or cold-formed steel floors that are designed to support the loads imposed.

**R703.8.2 Exterior veneer support.** Except in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, exterior masonry





For SI: 1 inch = 25.4 mm.

a. See Sections R703.4, R703.8.5 and R703.8.6.

b. See Sections R703.2 and R703.8.4.

c. See Table R703.8.4(1) and Section R703.8.4.2.

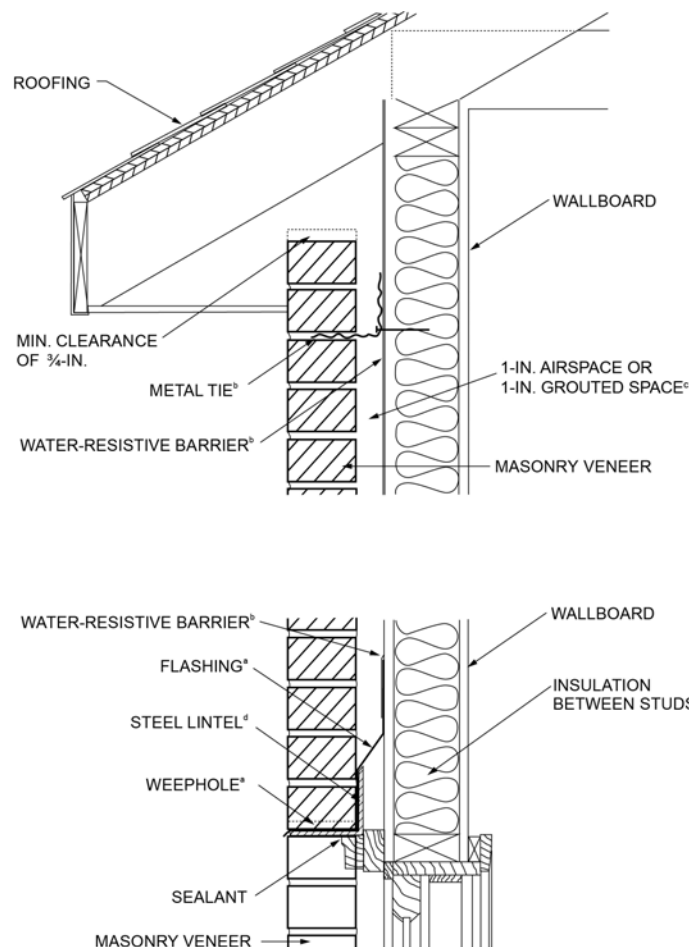
d. Figures R703.8(1) and R703.8(2) illustrate typical construction details for a masonry veneer wall. For the actual mandatory requirements of this code, see the indicated sections of text. Other details of masonry veneer wall construction shall be permitted provided the requirements of the indicated sections of text are met.

**FIGURE R703.8(1)**  
**TYPICAL MASONRY VENEER WALL DETAILS<sup>d</sup>**

veneers having an installed weight of 40 pounds per square foot (195 kg/m<sup>2</sup>) or less shall be permitted to be supported on wood or cold-formed steel construction. Where masonry veneer supported by wood or cold-formed steel construction adjoins masonry veneer supported by the foundation, there shall be a movement joint between the veneer supported by the wood or cold-formed steel construction and the veneer supported by the foundation. The wood or cold-formed steel construction supporting the masonry veneer shall be designed to limit the deflection to  $\frac{1}{600}$  of the span for the supporting members. The design of the wood or cold-formed steel construction shall consider the weight of the veneer and any other loads.

**R703.8.2.1 Support by steel angle.** A minimum 6-inch by 4-inch by  $\frac{5}{16}$ -inch (152 mm by 102 mm by 8 mm) steel angle, with the long leg placed vertically, shall be anchored to double 2-inch by 4-inch (51 mm by 102 mm) wood studs or double 350S162 cold-formed steel studs at a maximum on-center spacing of 16 inches (406 mm). Anchorage of the steel angle at every double stud spacing shall be not less than two  $\frac{7}{16}$ -inch-diameter (11 mm) by 4-inch (102 mm) lag screws for wood construction or two  $\frac{7}{16}$ -inch (11.1 mm) bolts with washers for cold-formed steel construction. The steel angle shall have a minimum clearance to underlying construction of  $\frac{1}{16}$  inch (1.6 mm). Not less than two-thirds the width of the masonry veneer thickness shall bear on the steel angle. Flashing and weep holes shall be located in the

## WALL COVERING



For SI: 1 inch = 25.4 mm.

a. See Sections R703.4, R703.8.5 and R703.8.6.

b. See Sections R703.2 and R703.8.4.

c. See Table R703.8.4(1) and Section R703.8.4.2.

d. See Section R703.8.3.

e. Figures R703.8(1) and R703.8(2) illustrate typical construction details for a masonry veneer wall. For the actual mandatory requirements of this code, see the indicated sections of text. Other details of masonry veneer wall construction shall be permitted provided that the requirements of the indicated sections of text are met.

**FIGURE R703.8(2)**  
**TYPICAL MASONRY VENEER WALL DETAILS<sup>a</sup>**

masonry veneer in accordance with Figure R703.8.2.1. The maximum height of masonry veneer above the steel angle support shall be 12 feet 8 inches (3861 mm). The airspace separating the masonry veneer from the wood backing shall be in accordance with Sections R703.8.4 and R703.8.4.2. The method of support for the masonry veneer on wood construction shall be constructed in accordance with Figure R703.8.2.1.

The maximum slope of the roof construction without stops shall be 7:12. Roof construction with slopes greater than 7:12 but not more than 12:12 shall have stops of a minimum 3-inch by 3-inch by  $\frac{1}{4}$ -inch (76 mm by 76 mm by 6.4 mm) steel plate welded to the angle at 24 inches (610 mm) on center along the angle or as approved by the building official.

**R703.8.2.2 Support by roof construction.** A steel angle shall be placed directly on top of the roof construction. The roof supporting construction for the steel angle shall consist of not fewer than three 2-inch by 6-inch (51 mm by 152 mm) wood members for wood construction or three 550S162 cold-formed steel members for cold-formed steel light frame construction. A wood member abutting the vertical wall stud construction shall be anchored with not fewer than three  $\frac{5}{8}$ -inch (15.9 mm) diameter by 5-inch (127 mm) lag screws to every wood stud spacing. Each additional wood roof member shall be anchored by the use of two 10d nails at every wood stud spacing. A cold-formed steel member abutting the vertical wall stud shall be anchored with not fewer than nine No. 8 screws to every cold-formed

**TABLE R703.8(1)**  
**STONE OR MASONRY VENEER LIMITATIONS AND REQUIREMENTS,**  
**WOOD OR STEEL FRAMING, SEISMIC DESIGN CATEGORIES A, B AND C**

SEISMIC DESIGN CATEGORY	NUMBER OF WOOD- OR STEEL-FRAMED STORIES	MAXIMUM HEIGHT OF VENEER ABOVE NONCOMBUSTIBLE FOUNDATION <sup>a</sup> (feet)	MAXIMUM NOMINAL THICKNESS OF VENEER (inches)	MAXIMUM WEIGHT OF VENEER (psf) <sup>b</sup>	WOOD- OR STEEL-FRAMED STORY
A or B	Steel: 1 or 2 Wood: 1, 2 or 3	30	5	50	all
C	1	30	5	50	1 only
	2	30	5	50	top
					bottom
	Wood only: 3	30	5	50	top
					middle
					bottom

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa.

- a. An additional 8 feet is permitted for gable end walls. See also story height limitations of Section R301.3.  
b. Maximum weight is installed weight and includes weight of mortar, grout, lath and other materials used for installation. Where veneer is placed on both faces of a wall, the combined weight shall not exceed that specified in this table.

**TABLE R703.8(2)**  
**STONE OR MASONRY VENEER LIMITATIONS AND REQUIREMENTS,**  
**ONE- AND TWO-FAMILY DETACHED DWELLINGS, SEISMIC DESIGN CATEGORIES D<sub>0</sub>, D<sub>1</sub> AND D<sub>2</sub>**

SEISMIC DESIGN CATEGORY	NUMBER OF WOOD-FRAMED STORIES <sup>a</sup>	MAXIMUM HEIGHT OF VENEER ABOVE NONCOMBUSTIBLE FOUNDATION OR FOUNDATION WALL (feet)	MAXIMUM NOMINAL THICKNESS OF VENEER (inches)	MAXIMUM WEIGHT OF VENEER (psf) <sup>b</sup>
D <sub>0</sub>	1	20 <sup>c</sup>	4	40
	2	20 <sup>c</sup>	4	40
	3	30 <sup>d</sup>	4	40
D <sub>1</sub>	1	20 <sup>c</sup>	4	40
	2	20 <sup>c</sup>	4	40
	3	20 <sup>c</sup>	4	40
D <sub>2</sub>	1	20 <sup>c</sup>	3	30
	2	20 <sup>c</sup>	3	30

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.479 kPa, 1 pound-force = 4.448 N.

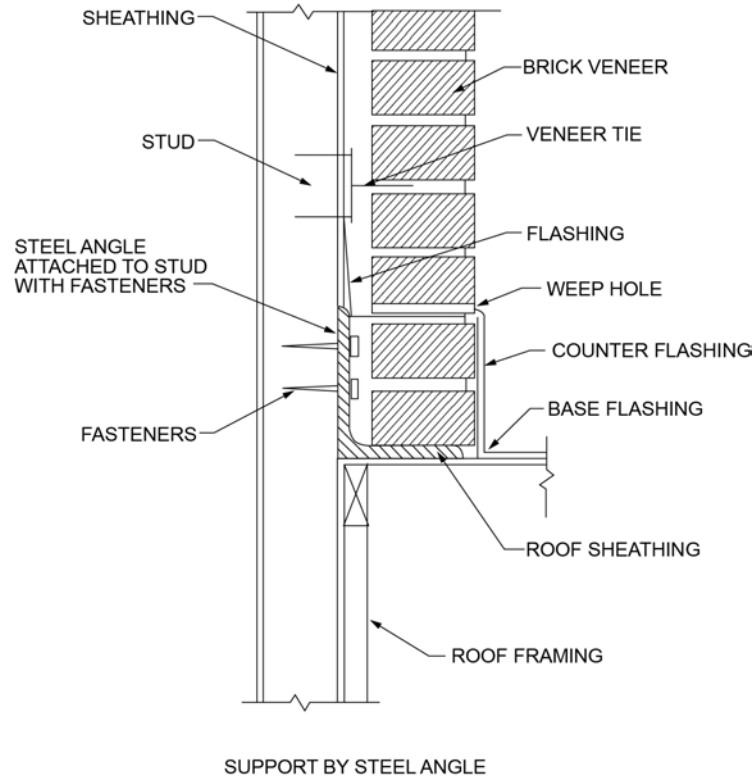
- a. Cripple walls are not permitted in *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.  
b. Maximum weight is installed weight and includes weight of mortar, grout and lath, and other materials used for installation.  
c. The veneer shall not exceed 20 feet in height above a noncombustible foundation, with an additional 8 feet permitted for gable end walls, or 30 feet in height with an additional 8 feet for gable end walls where the lower 10 feet have a backing of concrete or masonry wall. See story height limitations of Section R301.3.  
d. The veneer shall not exceed 30 feet in height above a noncombustible foundation, with an additional 8 feet permitted for gable end walls. See story height limitations of Section R301.3.

steel stud. Each additional cold-formed steel roof member shall be anchored to the adjoining roof member using two No. 8 screws at every stud spacing. Not less than two-thirds the width of the masonry veneer thickness shall bear on the steel angle. Flashing and weep holes shall be located in the masonry veneer wythe in accordance with Figure R703.8.2.2. The maximum height of the masonry veneer above the steel angle support shall be 12 feet 8 inches (3861 mm). The airspace separating the masonry veneer from the wood backing shall be in

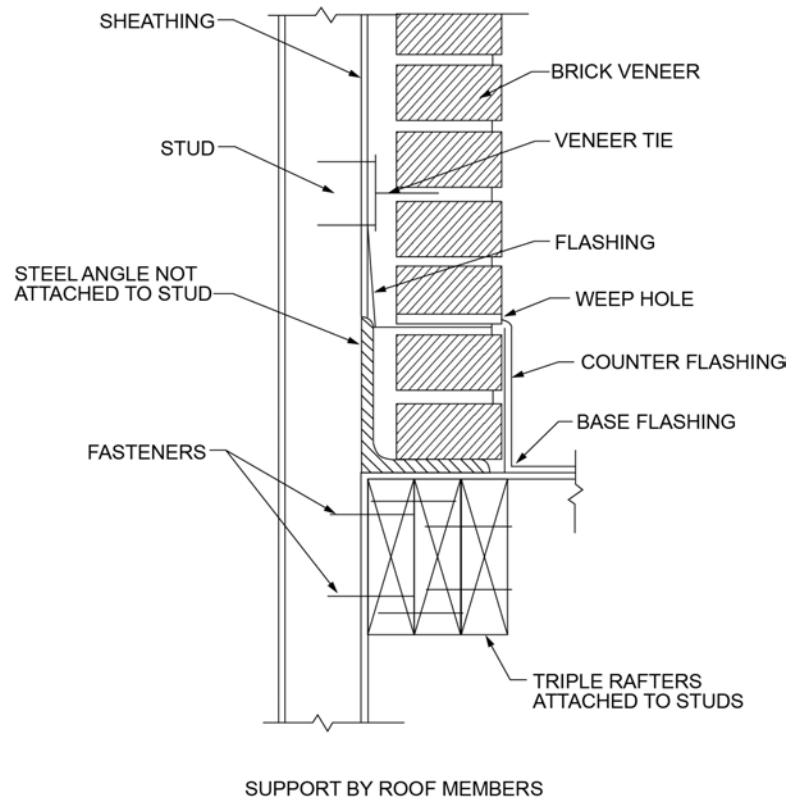
accordance with Sections R703.8.4 and R703.8.4.2. The support for the masonry veneer shall be constructed in accordance with Figure R703.8.2.2.

The maximum slope of the roof construction without stops shall be 7:12. Roof construction with slopes greater than 7:12 but not more than 12:12 shall have stops of a minimum 3-inch by 3-inch by 1/4-inch (76 mm by 76 mm by 6.4 mm) steel plate welded to the angle at 24 inches (610 mm) on center along the angle or as *approved by the building official*.

## WALL COVERING



**FIGURE R703.8.2.1**  
**EXTERIOR MASONRY VENEER SUPPORT BY STEEL ANGLES**



**FIGURE R703.8.2.2**  
**EXTERIOR MASONRY VENEER SUPPORT BY ROOF MEMBERS**

**R703.8.3 Lintels.** Masonry veneer shall not support any vertical load other than the dead load of the veneer above. Veneer above openings shall be supported on lintels of *noncombustible materials*. The lintels shall have a length of bearing not less than 4 inches (102 mm). Steel lintels shall be shop coated with a rust-inhibitive paint, except for lintels made of corrosion-resistant steel or steel treated with coatings to provide corrosion resistance. Construction of openings shall comply with either Section R703.8.3.1 or 703.8.3.2.

**R703.8.3.1 Allowable span.** The allowable span shall not exceed the values set forth in Table R703.8.3.1.

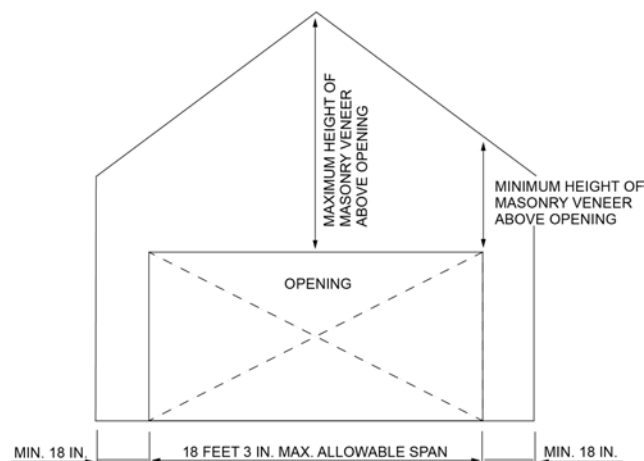
**R703.8.3.2 Maximum span.** The allowable span shall not exceed 18 feet 3 inches (5562 mm) and shall be constructed to comply with Figure R703.8.3.2 and the following:

1. Provide a minimum length of 18 inches (457 mm) of masonry veneer on each side of opening as shown in Figure R703.8.3.2.
2. Provide a minimum 5-inch by 3 $\frac{1}{2}$ -inch by  $\frac{5}{16}$ -inch (127 mm by 89 mm by 7.9 mm) steel angle above the opening and shore for a minimum of 7 days after installation.
3. Provide double-wire joint reinforcement extending 12 inches (305 mm) beyond each side of the opening. Lap splices of joint reinforcement not less than 12 inches (305 mm). Comply with one of the following:
  - 3.1. Double-wire joint reinforcement shall be  $\frac{3}{16}$ -inch (4.8 mm) diameter and shall be placed in the first two bed joints above the opening.
  - 3.2. Double-wire joint reinforcement shall be 9 gauge (0.144 inch or 3.66 mm diameter) and shall be placed in the first three bed joints above the opening.
4. Provide the height of masonry veneer above opening, in accordance with Table R703.8.3.2.

**TABLE R703.8.3.2**  
**HEIGHT OF MASONRY VENEER ABOVE OPENING**

MINIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (inches)	MAXIMUM HEIGHT OF MASONRY VENEER ABOVE OPENING (feet)
13	< 5
24	5 to < 12
60	12 to height above support allowed by Section R703.8

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R703.8.3.2**  
**MASONRY VENEER OPENING**

**R703.8.4 Anchorage.** Masonry veneer shall be anchored to the supporting wall studs with corrosion-resistant metal ties embedded in mortar or grout and extending into the veneer a minimum of 1 $\frac{1}{2}$  inches (38 mm), with not less than  $\frac{5}{8}$ -inch (15.9 mm) mortar or grout cover to outside face. Masonry veneer shall conform to Table R703.8.4(1). Where the masonry veneer tie attachment is

**TABLE R703.8.3.1**  
**ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER<sup>a, b, c, d</sup>**

SIZE OF STEEL ANGLE <sup>a, c, d</sup> (inches)	NO STORY ABOVE	ONE STORY ABOVE	TWO STORIES ABOVE	NO. OF 1/2-INCH OR EQUIVALENT REINFORCING BARS IN REINFORCED LINTEL <sup>b, d</sup>
3 × 3 × 1/4	6'-0"	4'-6"	3'-0"	1
4 × 3 × 1/4	8'-0"	6'-0"	4'-6"	1
5 × 3 1/2 × 5/16	10'-0"	8'-0"	6'-0"	2
6 × 3 1/2 × 5/16	14'-0"	9'-6"	7'-0"	2
2-6 × 3 1/2 × 5/16	20'-0"	12'-0"	9'-6"	4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. Long leg of the angle shall be placed in a vertical position.
- b. Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.
- c. Steel members indicated are adequate typical examples; other steel members meeting structural design requirements shall be permitted to be used.
- d. Either steel angle or reinforced lintel shall span opening.



## WALL COVERING

fastened to wood structural panel not less than 7/16 performance category through insulating sheathing not greater than 2 inches (51 mm) in thickness, see Table R703.8.4(2). Where Table R703.8.4(2) is used, attachment to the studs behind the sheathing is not required.

**R703.8.4.1 Size and spacing.** Veneer ties, if strand wire, shall be not less in thickness than No. 9 U.S. gage [(0.148 inch) (4 mm)] wire and shall have a hook embedded in the mortar joint, or if sheet metal, shall be not less than No. 22 U.S. gage by [(0.0299 inch) (0.76 mm)]  $\frac{7}{8}$  inch (22 mm) corrugated. Each tie shall support not more than 2.67 square feet (0.25 m<sup>2</sup>) of wall area and shall be spaced not more than 32 inches (813 mm) on center horizontally and 24 inches (635 mm) on center vertically.

**Exception:** In Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub> or townhouses in Seismic Design Category C or in wind areas of more than 30 pounds per square foot pressure (1.44 kPa), each tie shall support not more than 2 square feet (0.2 m<sup>2</sup>) of wall area.

**R703.8.4.1.1 Veneer ties around wall openings.** Additional metal ties shall be provided around wall openings greater than 16 inches (406 mm) in either dimension. Metal ties around the perimeter of openings shall be spaced not more than 3 feet (914 mm) on center and placed within 12 inches (305 mm) of the wall opening.

**R703.8.4.2 Grout fill.** As an alternative to the airspace required by Table R703.8.4(1), grout shall be permitted to fill the airspace. Where the airspace is filled with grout, a *water-resistive barrier* is required over studs or sheathing. Where the airspace is filled, replacing the sheathing and *water-resistive barrier* with a wire mesh and *approved water-resistive barrier* or an *approved water-resistive barrier*-backed reinforcement attached directly to the studs is permitted.

**R703.8.5 Flashing.** Flashing shall be located beneath the first course of masonry above finished ground level above the foundation wall or slab and at other points of support, including structural floors, shelf angles and lintels where masonry veneers are designed in accordance with Section R703.8. See Section R703.4 for additional requirements.

**R703.8.6 Weepholes.** Weepholes shall be provided in the outside wythe of masonry walls at a maximum spacing of 33 inches (838 mm) on center. Weepholes shall be not less than  $\frac{3}{16}$  inch (5 mm) in diameter. Weepholes shall be located immediately above the flashing.

**R703.9 Exterior insulation and finish system (EIFS)/EIFS with drainage.** Exterior insulation and finish systems (EIFS) shall comply with this chapter and Section R703.9.1. EIFS with drainage shall comply with this chapter and Section R703.9.2.

**TABLE R703.8.4(1)**  
**TIE ATTACHMENT AND AIRSPACE REQUIREMENTS**

BACKING AND TIE	MINIMUM TIE	MINIMUM TIE FASTENER <sup>a</sup>	AIRSPACE <sup>b</sup>	
Wood stud backing with corrugated sheet metal	22 U.S. gage (0.0299 in.) $\times$ $\frac{7}{8}$ in. wide	8d common nail <sup>c</sup> (2 $\frac{1}{2}$ in. $\times$ 0.131 in.)	Nominal 1 in. between sheathing and veneer	
Wood stud backing with adjustable metal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in. dia.) with hook embedded in mortar joint <sup>d</sup>	8d common nail <sup>c</sup> (2 $\frac{1}{2}$ in. $\times$ 0.131 in.)	Minimum nominal 1 in. between sheathing and veneer	Maximum 4 $\frac{5}{8}$ in. between backing and veneer
Wood stud backing with adjustable metal strand wire	W2.8 (0.187 in. dia.) with hook embedded in mortar joint <sup>e, f</sup>	8d common nail <sup>c</sup> (2 $\frac{1}{2}$ in. $\times$ 0.131 in.)	Greater than 4 $\frac{5}{8}$ in. between backing and veneer	Maximum 6 $\frac{5}{8}$ in. between backing and veneer
Cold-formed steel stud backing with adjustable metal strand wire	W1.7 (No. 9 U.S. gage; 0.148 in. dia.) with hook embedded in mortar joint <sup>d</sup>	No. 10 screw extending through the steel framing a minimum of three exposed threads	Minimum nominal 1 in. between sheathing and veneer	Maximum 4 $\frac{5}{8}$ in. between backing and veneer
Cold-formed steel stud backing with adjustable metal strand wire	W2.8 (0.187 in. dia.) with hook embedded in mortar joint <sup>e, f</sup>	No. 10 screw extending through the steel framing a minimum of three exposed threads	Greater than 4 $\frac{5}{8}$ in. between backing and veneer	Maximum 6 $\frac{5}{8}$ in. between backing and veneer

For SI: 1 inch = 25.4 mm.

- All fasteners shall have rust-inhibitive coating suitable for the installation in which they are being used, or be manufactured from material not susceptible to corrosion.
- An airspace that provides drainage shall be permitted to contain mortar from construction.
- In Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>, the minimum tie fastener shall be an 8d ring-shank nail (2 $\frac{1}{2}$  in.  $\times$  0.131 in.).
- Adjustable tie pintles shall include not fewer than 1 pintle leg of wire size W2.8 (MW18) with a maximum offset of 1 $\frac{1}{4}$  inches.
- Adjustable tie pintles shall include not fewer than 2 pintle legs with a maximum offset of 1 $\frac{1}{4}$  inches. Distance between inside face of brick and end of pintle shall be a maximum of 2 inches.
- Adjustable tie backing attachment components shall consist of one of the following: eyes with minimum wire W2.8 (MW18), barrel with minimum  $\frac{1}{4}$ -inch outside diameter, or plate with minimum thickness of 0.074 inch and minimum width of 1 $\frac{1}{4}$  inches.

## WALL COVERING

**TABLE R703.8.4(2)**  
**REQUIRED BRICK TIE SPACING FOR DIRECT APPLICATION TOWOOD STRUCTURAL PANEL SHEATHING<sup>a, b, c</sup>**

FASTENER TYPE <sup>a</sup>	SIZE (DIA. OR SCREW #)	REQUIRED BRICK-TIE SPACING (VERTICAL-TIE SPACING/HORIZONTAL-TIE SPACING) (inches/inches)											
		110 mph $V_{ult}$				115 mph $V_{ult}$				130 mph $V_{ult}$			
		Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D
Ring Shank Nails	0.091	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	16/12, 12/16, 12/12	12/12	12/12	16/12, 12/16, 12/12	—	—
		24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	12/12
	#6	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	12/12
		24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12	12/12
Screws	#8	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
		24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
	#10	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
		24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
	#14	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12
		24/16, 16/24, 16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	16/12, 12/16, 12/12

For SI: 1 inch = 25.4 mm, 1 mph = 0.447 m/s.

a. This table is based on attachment of brick ties directly to wood structural panel sheathing only. Additional attachment of the brick tie to lumber framing is not required. The brick ties shall be permitted to be placed over any insulating sheathing, not to exceed 2 inches in thickness. Wood structural panel sheathing shall be a minimum 7/16 performance category. The table is based on a building height of 30 feet or less.

b. Wood structural panels shall have a specific gravity of 0.42 or greater in accordance with NDS.

c. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

d. Fasteners shall be sized such that the tip of the fastener passes completely through the wood structural panel sheathing by not less than 1/4 inch.

## WALL COVERING

**R703.9.1 Exterior insulation and finish systems (EIFS).** EIFS shall comply with the following:

1. ASTM E2568.
2. EIFS shall be limited to applications over substrates of concrete or masonry wall assemblies.
3. Flashing of EIFS shall be provided in accordance with the requirements of Section R703.4.
4. EIFS shall be installed in accordance with the manufacturer's instructions.
5. EIFS shall terminate not less than 6 inches (152 mm) above the finished ground level.
6. Decorative *trim* shall not be face-nailed through the EIFS.

**R703.9.2 Exterior insulation and finish system (EIFS) with drainage.** EIFS with drainage shall comply with the following:

1. ASTM E2568.
2. EIFS with drainage shall be required over all wall assemblies with the exception of substrates of concrete or masonry wall assemblies.
3. EIFS with drainage shall have an average minimum drainage efficiency of 90 percent when tested in accordance with ASTM E2273.
4. The *water-resistive barrier* shall comply with Section R703.2 or ASTM E2570.
5. The *water-resistive barrier* shall be applied between the EIFS and the wall sheathing.
6. Flashing of EIFS with drainage shall be provided in accordance with the requirements of Section R703.4.
7. EIFS with drainage shall be installed in accordance with the manufacturer's instructions.
8. EIFS with drainage shall terminate not less than 6 inches (152 mm) above the finished ground level.
9. Decorative *trim* shall not be face-nailed through the EIFS with drainage.

**R703.10 Fiber cement siding.**

**R703.10.1 Panel siding.** Fiber-cement panels shall comply with the requirements of ASTM C1186, Type A, minimum Grade II or ISO 8336, Category A, minimum Class 2. Panels shall be installed with the long dimension either parallel or perpendicular to framing. Vertical and horizontal joints shall occur over framing members and shall be protected with caulking, or with battens or flashing, or be vertical or horizontal shiplap, or otherwise designed to comply with Section R703.1. Panel siding shall be installed with fasteners in accordance with Table R703.3(1) or the approved manufacturer's instructions.

**R703.10.2 Lap siding.** Fiber-cement lap siding having a maximum width of 12 inches (305 mm) shall comply with the requirements of ASTM C1186, Type A, minimum Grade II or ISO 8336, Category A, minimum Class 2. Lap siding shall be lapped a minimum of 1 $\frac{1}{4}$  inches (32 mm) and lap siding not having tongue-and-groove

end joints shall have the ends protected with caulking, covered with an H-section joint cover, located over a strip of flashing, or shall be designed to comply with Section R703.1. Lap siding courses shall be installed with the fastener heads exposed or concealed, in accordance with Table R703.3(1) or approved manufacturer's instructions.

**R703.11 Vinyl siding.** Vinyl siding shall be certified and *labeled* as conforming to the requirements of ASTM D3679 by an *approved* quality control agency.

**R703.11.1 Installation.** Vinyl siding, soffit and accessories shall be installed in accordance with the manufacturer's instructions.

**R703.11.1.1 Fasteners.** Unless specified otherwise by the manufacturer's instructions, fasteners for vinyl siding shall be 0.120-inch (3 mm) shank diameter nail with a 0.313-inch (8 mm) head or 16-gage staple with a  $\frac{3}{8}$ -inch (9.5 mm) to  $\frac{1}{2}$ -inch (12.7 mm) crown.

**R703.11.1.2 Penetration depth.** Unless specified otherwise by the manufacturer's instructions, fasteners shall penetrate into building framing. The total penetration into sheathing, furring framing or other *nailable substrate* shall be a minimum 1 $\frac{1}{4}$  inches (32 mm). Where specified by the manufacturer's instructions and supported by a test report, fasteners are permitted to penetrate into or fully through nailable sheathing or other *nailable substrate* of minimum thickness specified by the instructions or test report without penetrating into framing. Where the fastener penetrates fully through the sheathing, the end of the fastener shall extend a minimum of  $\frac{1}{4}$  inch (6.4 mm) beyond the opposite face of the sheathing or *nailable substrate*.

**R703.11.1.3 Spacing.** Unless specified otherwise by the manufacturer's instructions, the maximum spacing between fasteners for horizontal siding shall be 16 inches (406 mm), and for vertical siding 12 inches (305 mm) both horizontally and vertically. Where specified by the manufacturer's instructions and supported by a test report, greater fastener spacing is permitted.

**R703.11.2 Installation over foam plastic sheathing.** Where vinyl siding or *insulated vinyl siding* is installed over foam plastic sheathing, the vinyl siding shall comply with Section R703.11 and shall have a wind load design pressure rating in accordance with Table R703.11.2.

**Exceptions:**

1. Where the foam plastic sheathing is applied directly over *wood structural panels*, fiber-board, gypsum sheathing or other *approved* backing capable of independently resisting the design wind pressure, the vinyl siding shall be installed in accordance with Sections R703.3.3 and R703.11.1.
2. Where the vinyl siding manufacturer's product specifications provide an *approved* wind load design pressure rating for installation over foam plastic sheathing, use of this wind load

design pressure rating shall be permitted and the siding shall be installed in accordance with the *manufacturer's installation instructions*.

3. Where the foam plastic sheathing and its attachment have a design wind pressure resistance complying with Sections R316.8 and R301.2.1, the vinyl siding shall be installed in accordance with Sections R703.3.3 and R703.11.1.

**R703.12 Adhered masonry veneer installation.** Adhered masonry veneer shall comply with the requirements of Section R703.7.3 and the requirements in Sections 12.1 and 12.3 of TMS 402. Adhered masonry veneer shall be installed in accordance with Section R703.7.1, Article 3.3C of TMS 602 or the manufacturer's instructions.

**R703.12.1 Clearances.** On exterior stud walls, adhered masonry veneer shall be installed:

1. Minimum of 4 inches (102 mm) above the earth;
2. Minimum of 2 inches (51 mm) above paved areas; or
3. Minimum of  $\frac{1}{2}$  inch (12.7 mm) above exterior walking surfaces that are supported by the same foundation that supports the exterior wall.

**R703.12.2 Flashing at foundation.** A corrosion-resistant screed or flashing of a minimum 0.019-inch (0.48 mm) or 26-gage galvanized or plastic with a minimum vertical attachment flange of  $3\frac{1}{2}$  inches (89 mm) shall be installed to extend a minimum of 1 inch (25 mm) below the foundation plate line on exterior stud walls in accordance with Section R703.4.

**R703.12.3 Water-resistive barrier.** A *water-resistive barrier* shall be installed as required by Section R703.2 and shall comply with the requirements of Section R703.7.3. The *water-resistive barrier* shall lap over the exterior of the attachment flange of the screed or flashing provided in accordance with Section R703.12.2.

**R703.13 Insulated vinyl siding.** *Insulated vinyl siding* shall be certified and *labeled* as conforming to the requirements of ASTM D7793 by an *approved* quality control agency.

**R703.13.1 Insulated vinyl siding and accessories.** *Insulated vinyl siding* and accessories shall be installed in accordance with the manufacturer's installation instructions.

**R703.14 Polypropylene siding.** *Polypropylene siding* shall be certified and *labeled* as conforming to the requirements of ASTM D7254, and those of Section R703.14.2 or Section R703.14.3, by an *approved* quality control agency.

**R703.14.1 Polypropylene siding and accessories.** *Polypropylene siding* and accessories shall be installed in accordance with manufacturer's installation instructions.

**R703.14.1.1 Installation.** *Polypropylene siding* shall be installed over and attached to wood structural panel sheathing with minimum thickness of  $\frac{7}{16}$  inch (11.1 mm), or other substrate, composed of wood or wood-based material and fasteners having equivalent withdrawal resistance.

**R703.14.1.2 Fastener requirements.** Unless otherwise specified in the approved manufacturer's instructions, nails shall be corrosion resistant, with a minimum 0.120-inch (3 mm) shank and minimum

TABLE R703.11.2  
REQUIRED MINIMUM WIND LOAD DESIGN PRESSURE RATING FOR  
VINYL SIDING INSTALLED OVER FOAM PLASTIC SHEATHING ALONE

ULTIMATE DESIGN WIND SPEED (MPH)	ADJUSTED MINIMUM DESIGN WIND PRESSURE (ASD) (PSF) <sup>a, b</sup>					
	Case 1: With interior gypsum wallboard <sup>c</sup>			Case 2: Without interior gypsum wallboard <sup>c</sup>		
	Exposure			Exposure		
	B	C	D	B	C	D
≤ 95	-30.0	-33.2	-39.4	-33.9	-47.4	-56.2
100	-30.0	-36.8	-43.6	-37.2	-52.5	-62.2
105	-30.0	-40.5	-48.1	-41.4	-57.9	-68.6
110	-31.8	-44.5	-52.8	-45.4	-63.5	-75.3
115	-35.5	-49.7	-59.0	-50.7	-71.0	-84.2
120	-37.4	-52.4	-62.1	-53.4	-74.8	-88.6
130	-44.9	-62.8	-74.5	-64.1	-89.7	-106
> 130	See Note d					

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>, 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation is permitted.

b. The table values are based on a maximum 30-foot mean roof height, and effective wind area of 10 square feet Wall Zone 5 (corner), and the ASD design component and cladding wind pressure from Table R301.2.1(1), adjusted for exposure in accordance with Table R301.2.1(2), multiplied by the following adjustment factors: 1.87 (Case 1) and 2.67 (Case 2).

c. Gypsum wallboard, gypsum panel product or equivalent.

d. For the indicated wind speed condition and where foam sheathing is the only sheathing on the exterior of a frame wall with vinyl siding, the wall assembly shall be capable of resisting an impact without puncture at least equivalent to that of a wood frame wall with minimum  $\frac{7}{16}$ -inch OSB sheathing as tested in accordance with ASTM E1886. The vinyl siding shall comply with an adjusted design wind pressure requirement in accordance with Note b, using an adjustment factor of 2.67.



## WALL COVERING

0.313-inch (8 mm) head diameter. Nails shall be a minimum of  $1\frac{1}{4}$  inches (32 mm) long or as necessary to penetrate sheathing or substrate not less than  $\frac{3}{4}$  inch (19.1 mm). Where the nail fully penetrates the sheathing or *nailable substrate*, the end of the fastener shall extend not less than  $\frac{1}{4}$  inch (6.4 mm) beyond the opposite face of the sheathing or substrate. Staples are not permitted.

**R703.14.2 Fire separation.** *Polypropylene siding* shall not be installed on walls with a *fire separation distance* of less than 5 feet (1524 mm) and walls closer than 10 feet (3048 mm) to a building on another lot.

**Exception:** Walls perpendicular to the line used to determine the *fire separation distance*.

**R703.14.3 Flame spread index.** The certification of the flame spread index shall be accompanied by a test report stating that all portions of the test specimen ahead of the flame front remained in position during the test in accordance with ASTM E84 or UL 723.

**R703.15 Cladding attachment over foam sheathing to wood framing.** Cladding shall be specified and installed in accordance with Section R703, the cladding manufacturer's approved instructions, including any limitations for use over foam plastic sheathing, or an *approved design*. In addition, the cladding or furring attachments through foam sheathing

to framing shall meet or exceed the minimum fastening requirements of Section R703.15.1, Section R703.15.2, or an *approved design* for support of cladding weight.

**Exceptions:**

1. Where the cladding manufacturer has provided *approved* installation instructions for application over foam sheathing, those requirements shall apply.
2. For exterior insulation and finish systems, refer to Section R703.9.
3. For anchored masonry or stone veneer installed over foam sheathing, refer to Section R703.8.

**R703.15.1 Direct attachment.** Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table R703.15.1.

**R703.15.2 Furred cladding attachment.** Where wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table R703.15.2. Where placed horizontally, wood furring shall be preservative-treated wood in accordance with Section R317.1 or *naturally durable wood* and fasteners shall be corrosion resistant in accordance Section R317.3.

**TABLE R703.15.1**  
**CLADDING MINIMUM FASTENING REQUIREMENTS FOR**  
**DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a</sup>**

CLADDING FASTENER THROUGH FOAM SHEATHING <sup>b</sup>	CLADDING FASTENER TYPE AND MINIMUM SIZE <sup>c</sup>	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>d</sup> (inches)									
			16" o.c. Fastener Horizontal Spacing					24" o.c. Fastener Horizontal Spacing				
			Cladding Weight:					Cladding Weight:				
			3 psf	11 psf	15 psf	18 psf	25 psf	3 psf	11 psf	15 psf	18 psf	25 psf
Wood framing (minimum $1\frac{1}{4}$ -inch penetration)	0.113" diameter nail	6	2.00	1.45	1.00	0.75	DR	2.00	0.85	0.55	DR	DR
		8	2.00	1.00	0.65	DR	DR	2.00	0.55	DR	DR	DR
		12	2.00	0.55	DR	DR	DR	1.85	DR	DR	DR	DR
	0.120" diameter nail	6	3.00	1.70	1.15	0.90	0.55	3.00	1.05	0.65	0.50	DR
		8	3.00	1.20	0.80	0.60	DR	3.00	0.70	DR	DR	DR
		12	3.00	0.70	DR	DR	DR	2.15	DR	DR	DR	DR
	0.131" diameter nail	6	4.00	2.15	1.50	1.20	0.75	4.00	1.35	0.90	0.70	DR
		8	4.00	1.55	1.05	0.80	DR	4.00	0.90	0.55	DR	DR
		12	4.00	0.90	0.55	DR	DR	2.70	0.50	DR	DR	DR
	0.162" diameter nail	6	4.00	3.55	2.50	2.05	1.40	4.00	2.25	1.55	1.25	0.80
		8	4.00	2.55	1.80	1.45	0.95	4.00	1.60	1.10	0.85	0.50
		12	4.00	1.60	1.10	0.85	0.50	4.00	0.95	0.60	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

o.c. = On Center.

a. Wood framing shall be Spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.

b. The thickness of wood structural panels complying with the specific gravity requirement of Note a shall be permitted to be included in satisfying the minimum penetration into framing. For cladding connections to wood structural panels, refer to Table R703.8.4(2).

c. Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.



**TABLE R703.15.2**  
**FURRING MINIMUM FASTENING REQUIREMENTS FOR APPLICATION**  
**OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a, b</sup>**

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE	MINIMUM PENETRATION INTO WALL FRAMING (inches) <sup>c</sup>	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>e</sup> (inches)									
					16" o.c. Furring <sup>f</sup>					24" o.c. Furring <sup>f</sup>				
					Siding Weight:					Siding Weight:				
					3 psf	11 psf	15 psf	18 psf	25 psf	3 psf	11 psf	15 psf	18 psf	25 psf
Minimum 1× wood furring <sup>d</sup>	Minimum 2× wood stud	0.131" diameter nail	1 1/4	8	4.00	2.45	1.75	1.45	0.95	4.00	1.60	1.10	0.85	DR
				12	4.00	1.60	1.10	0.85	DR	4.00	0.95	0.55	DR	DR
				16	4.00	1.10	0.70	DR	DR	3.05	0.60	DR	DR	DR
		0.162" diameter nail	1 1/4	8	4.00	4.00	3.05	2.45	1.60	4.00	2.75	1.85	1.45	0.85
				12	4.00	2.75	1.85	1.45	0.85	4.00	1.65	1.05	0.75	DR
				16	4.00	1.90	1.25	0.95	DR	4.00	1.05	0.60	DR	DR
		No.10 wood screw	1	12	4.00	2.30	1.60	1.20	0.70	4.00	1.40	0.85	0.60	DR
				16	4.00	1.65	1.05	0.75	DR	4.00	0.90	DR	DR	DR
				24	4.00	0.90	DR	DR	DR	2.85	DR	DR	DR	DR
		1/4" lag screw	1 1/2	12	4.00	2.65	1.90	1.50	0.90	4.00	1.65	1.05	0.80	DR
				16	4.00	1.95	1.25	0.95	0.50	4.00	1.10	0.65	DR	DR
				24	4.00	1.10	0.65	DR	DR	3.25	0.50	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

o.c. = On Center.

- Wood framing and furring shall be Spruce-pine-fir or any wood species with a specific gravity of 0.42 or greater in accordance with AWC NDS.
- Nail fasteners shall comply with ASTM F1667, except nail length shall be permitted to exceed ASTM F1667 standard lengths.
- The thickness of wood structural panels complying with the specific gravity requirements of Note a shall be permitted to be included in satisfying the minimum required penetration into framing.
- Where the required cladding fastener penetration into wood material exceeds 3/4 inch and is not more than 1 1/2 inches, a minimum 2× wood furring or an approved design shall be used.
- Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.
- Furring shall be spaced not more than 24 inches on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

**R703.16 Cladding attachment over foam sheathing to cold-formed steel framing.** Cladding shall be specified and installed in accordance with Section R703, the cladding manufacturer's approved instructions, including any limitations for use over foam plastic sheathing, or an *approved* design. In addition, the cladding or furring attachments through foam sheathing to framing shall meet or exceed the minimum fastening requirements of Section R703.16.1, Section R703.16.2 or an *approved* design for support of cladding weight.

**Exceptions:**

- Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing, those requirements shall apply.
- For exterior insulation and finish systems, refer to Section R703.9.

- For anchored masonry or stone veneer installed over foam sheathing, refer to Section R703.8.

**R703.16.1 Direct attachment.** Where cladding is installed directly over foam sheathing without the use of furring, cladding minimum fastening requirements to support the cladding weight shall be as specified in Table R703.16.1.

**R703.16.2 Furred cladding attachment.** Where steel or wood furring is used to attach cladding over foam sheathing, furring minimum fastening requirements to support the cladding weight shall be as specified in Table R703.16.2. Where placed horizontally, wood furring shall be preservative-treated wood in accordance with Section R317.1 or *naturally durable wood* and fasteners shall be corrosion resistant in accordance with Section R317.3. Steel furring shall have a minimum G60 galvanized coating.

## WALL COVERING

**TABLE R703.16.1**  
**CLADDING MINIMUM FASTENING REQUIREMENTS FOR**  
**DIRECT ATTACHMENT OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a, b</sup>**

CLADDING FASTENER THROUGH FOAM SHEATHING INTO:	CLADDING FASTENER TYPE AND MINIMUM SIZE <sup>c</sup>	CLADDING FASTENER VERTICAL SPACING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>d</sup> (inches)									
			16" o.c. Fastener Horizontal Spacing					24" o.c. Fastener Horizontal Spacing				
			Cladding Weight:					Cladding Weight:				
			3 psf	11 psf	15 psf	18 psf	25 psf	3 psf	11 psf	15 psf	18 psf	25 psf
Steel framing (minimum penetration of steel thickness + 3 threads)	No. 8 screw into 33-mil steel or thicker	6	3.00	2.95	2.50	2.20	1.45	3.00	2.35	1.75	1.25	DR
		8	3.00	2.55	2.00	1.60	0.60	3.00	1.80	0.90	DR	DR
		12	3.00	1.80	0.95	DR	DR	3.00	0.65	DR	DR	DR
	No. 10 screw into 33-mil steel	6	4.00	3.50	3.05	2.70	1.95	4.00	2.90	2.20	1.70	0.55
		8	4.00	3.10	2.50	2.05	1.00	4.00	2.25	1.35	0.70	DR
		12	4.00	2.25	1.35	0.70	DR	3.70	1.05	DR	DR	DR
	No. 10 screw into 43-mil steel or thicker	6	4.00	4.00	4.00	4.00	3.60	4.00	4.00	3.80	3.45	2.70
		8	4.00	4.00	4.00	3.70	3.00	4.00	3.85	3.25	2.80	1.80
		12	4.00	3.85	3.25	2.80	1.80	4.00	3.05	2.15	1.50	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

o.c. = On Center.

a. Steel framing shall be minimum 33-ksi steel for 33-mil and 43-mil steel, and 50-ksi steel for 54-mil steel or thicker.

b. Where cladding is attached to wood structural panel sheathing only, fastening requirements shall be in accordance with Table R703.3.3.

c. Screws shall comply with the requirements of ASTM C1513.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

**TABLE R703.16.2**  
**FURRING MINIMUM FASTENING REQUIREMENTS FOR**  
**APPLICATION OVER FOAM PLASTIC SHEATHING TO SUPPORT CLADDING WEIGHT<sup>a</sup>**

FURRING MATERIAL	FRAMING MEMBER	FASTENER TYPE AND MINIMUM SIZE <sup>b</sup>	MINIMUM PENETRATION INTO WALL FRAMING (inches)	FASTENER SPACING IN FURRING (inches)	MAXIMUM THICKNESS OF FOAM SHEATHING <sup>d</sup> (inches)									
					16" o.c. Furring <sup>a</sup>					24" o.c. Furring <sup>a</sup>				
					Cladding Weight:					Cladding Weight:				
					3 psf	11 psf	15 psf	18 psf	25 psf	3 psf	11 psf	15 psf	18 psf	25 psf
Minimum 33-mil steel furring or minimum 1× wood furring <sup>c</sup>	33-mil steel stud	No. 8 screw	Steel thickness + 3 threads	12	3.00	1.80	0.95	DR	DR	3.00	0.65	DR	DR	DR
				16	3.00	1.00	DR	DR	DR	2.85	DR	DR	DR	DR
				24	2.85	DR	DR	DR	DR	2.20	DR	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	2.25	1.35	0.70	DR	3.70	1.05	DR	DR	DR
				16	3.85	1.45	DR	DR	DR	3.40	DR	DR	DR	DR
				24	3.40	DR	DR	DR	DR	2.70	DR	DR	DR	DR
	43-mil or thicker steel stud	No. 8 Screw	Steel thickness + 3 threads	12	3.00	1.80	0.95	DR	DR	3.00	0.65	DR	DR	DR
				16	3.00	1.00	DR	DR	DR	2.85	DR	DR	DR	DR
				24	2.85	DR	DR	DR	DR	2.20	DR	DR	DR	DR
		No. 10 screw	Steel thickness + 3 threads	12	4.00	3.85	3.25	2.80	1.80	4.00	3.05	2.15	1.50	DR
				16	4.00	3.30	2.55	1.95	0.60	4.00	2.25	1.05	DR	DR
				24	4.00	2.25	1.05	DR	DR	4.00	0.65	DR	DR	DR

For SI: 1 inch = 25.4 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa, 1 pound per square inch = 6.895 kPa.

DR = Design Required.

o.c. = On Center.

a. Wood furring shall be Spruce-pine-fir or any softwood species with a specific gravity of 0.42 or greater. Steel furring shall be minimum 33-ksi steel. Steel studs shall be minimum 33-ksi steel for 33-mil and 43-mil thickness, and 50-ksi steel for 54-mil steel or thicker.

b. Screws shall comply with the requirements of ASTM C1513.

c. Where the required cladding fastener penetration into wood material exceeds  $\frac{3}{4}$  inch and is not more than  $1\frac{1}{2}$  inches, a minimum 2-inch nominal wood furring or an approved design shall be used.

d. Foam sheathing shall have a minimum compressive strength of 15 psi in accordance with ASTM C578 or ASTM C1289.

e. Furring shall be spaced not more than 24 inches (610 mm) on center, in a vertical or horizontal orientation. In a vertical orientation, furring shall be located over wall studs and attached with the required fastener spacing. In a horizontal orientation, the indicated 8-inch and 12-inch fastener spacing in furring shall be achieved by use of two fasteners into studs at 16 inches and 24 inches on center, respectively.

**R703.17 Cladding attachment over foam sheathing to masonry or concrete wall construction.** Cladding shall be specified and installed in accordance with Section 703.3 and the cladding manufacturer's instructions or an *approved* design. Foam sheathing shall be attached to masonry or concrete construction in accordance with the insulation manufacturer's installation instructions or an *approved* design. Furring and furring attachments through foam sheathing into concrete or masonry substrate shall be designed to resist design loads determined in accordance with Section R301, including support of cladding weight as applicable. Fasteners used to attach cladding or furring through foam sheathing to masonry or concrete substrates shall be *approved* for application into masonry or concrete material and shall be installed in accordance with the fastener manufacturer's instructions.

**Exceptions:**

1. Where the cladding manufacturer has provided approved installation instructions for application over foam sheathing and connection to a masonry or concrete substrate, those requirements shall apply.
2. For exterior insulation and finish systems, refer to Section R703.9.
3. For anchored masonry or stone veneer installed over foam sheathing, refer to Section R703.8.

## SECTION R704 SOFFITS

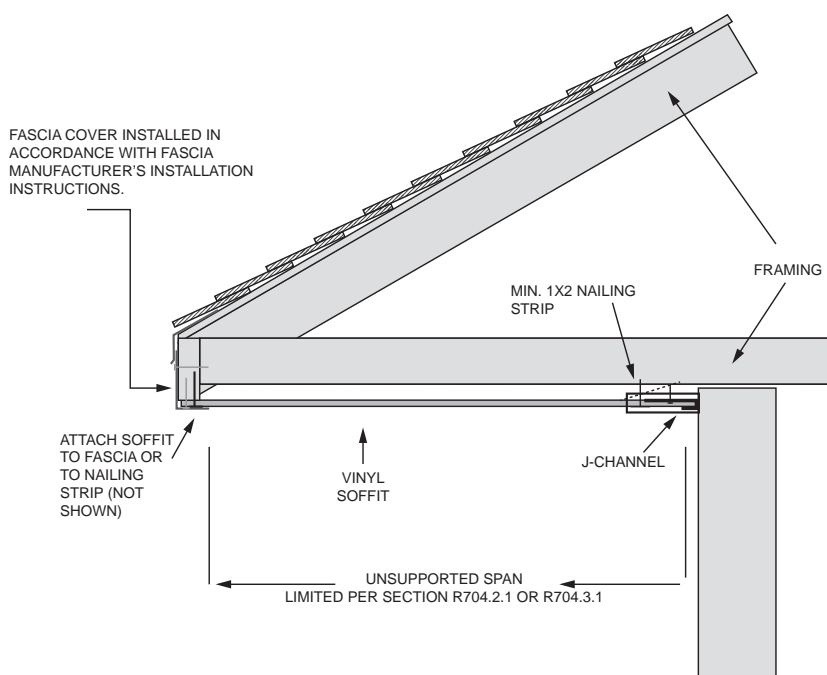
**R704.1 General wind limitations.** Where the design wind pressure is 30 pounds per square foot (1.44 kPa) or less,

soffits shall comply with Section R704.2. Where the design wind pressure exceeds 30 pounds per square foot (1.44 kPa), soffits shall comply with Section R704.3. The design wind pressure on soffits shall be determined using the component and cladding loads specified in Table R301.2.1(1) for walls using an effective wind area of 10 square feet (0.93 m<sup>2</sup>) and adjusted for height and exposure in accordance with Table R301.2.1(2).

**R704.2 Soffit installation where the design wind pressure is 30 psf or less.** Where the design wind pressure is 30 pounds per square foot (1.44 kPa) or less, soffit installation shall comply with Section R704.2.1, R704.2.2, R704.2.3 or R704.2.4. Soffit materials not addressed in Sections R704.2.1 through R704.2.4 shall be in accordance with the manufacturer's installation instructions.

**R704.2.1 Vinyl soffit panels.** Vinyl soffit panels shall be installed using fasteners specified by the manufacturer and shall be fastened at both ends to a supporting component such as a nailing strip, fascia or subfascia component in accordance with Figure R704.2.1(1). Where the unsupported span of soffit panels is greater than 16 inches (406 mm), intermediate nailing strips shall be provided in accordance with Figure R704.2.1(2). Vinyl soffit panels shall be installed in accordance with the manufacturer's installation instructions. Fascia covers shall be installed in accordance with the manufacturer's installation instructions.

**R704.2.2 Fiber-cement soffit panels.** Fiber-cement soffit panels shall be a minimum of 1/4 inch (6.4 mm) in thickness and shall comply with the requirements of ASTM C1186, Type A, minimum Grade II, or ISO 8336, Category A, minimum Class 2. Panel joints shall occur



**FIGURE R704.2.1(1)  
TYPICAL SINGLE-SPAN VINYL SOFFIT PANEL SUPPORT**

## WALL COVERING

over framing or over wood structural panel sheathing. Soffit panels shall be installed with spans and fasteners in accordance with the manufacturer's installation instructions.

**R704.2.3 Hardboard soffit panels.** Hardboard soffit panels shall be not less than  $\frac{7}{16}$  inch (11.11 mm) in thickness and shall be fastened to framing or nailing strips with  $2\frac{1}{2}$ -inch by 0.113-inch (64 mm by 2.9 mm) siding nails spaced not more than 6 inches (152 mm) on center at panel edges and 12 inches (305 mm) on center at intermediate supports.

**R704.2.4 Wood structural panel soffit.** The minimum nominal thickness for wood structural panel soffits shall be  $\frac{3}{8}$  inch (9.5 mm) and shall be fastened to framing or nailing strips with 2-inch by 0.099-inch (51 mm by 2.5 mm) nails. Fasteners shall be spaced not less than 6 inches (152 mm) on center at panel edges and 12 inches (305 mm) on center at intermediate supports.

**R704.3 Soffit installation where the design wind pressure exceeds 30 psf.** Where the design wind pressure is greater than 30 psf, soffit installation shall comply with Section R704.3.1, R704.3.2, R704.3.3 or R704.3.4. Soffit materials not addressed in Sections R704.3.1 through R704.3.4 shall be in accordance with the manufacturer's installation instructions.

**R704.3.1 Vinyl soffit panels.** Vinyl soffit panels and their attachments shall be capable of resisting wind loads specified in Table R301.2.1(1) for walls using an effective wind area of 10 square feet (0.929 m<sup>2</sup>) and adjusted for height and exposure in accordance with Table R301.2.1(2). Vinyl soffit panels shall be installed using

fasteners specified by the manufacturer and shall be fastened at both ends to a supporting component such as a nailing strip, fascia or subfascia component in accordance with Figure R704.2.1(1). Where the unsupported span of soffit panels is greater than 12 inches (305 mm), intermediate nailing strips shall be provided in accordance with Figure R704.2.1(2). Vinyl soffit panels shall be installed in accordance with the manufacturer's installation instructions. Fascia covers shall be installed in accordance with the manufacturer's installation instructions.

**R704.3.2 Fiber-cement soffit panels.** Fiber-cement soffit panels shall comply with Section R704.2.2 and shall be capable of resisting wind loads specified in Table R301.2.1(1) for walls using an effective wind area of 10 square feet (0.929 m<sup>2</sup>) and adjusted for height and exposure in accordance with Table R301.2.1(2).

**R704.3.3 Hardboard soffit panels.** Hardboard soffit panels shall comply with the manufacturer's installation instructions and shall be capable of resisting wind loads specified in Table R301.2.1(1) for walls using an effective wind area of 10 square feet (0.929 m<sup>2</sup>) and adjusted for height and exposure in accordance with Table R301.2.1(2).

**R704.3.4 Wood structural panel soffit.** Wood structural panel soffits shall be capable of resisting wind loads specified in Table R301.2.1(1) for walls using an effective wind area of 10 square feet (0.929 m<sup>2</sup>) and adjusted for height and exposure in accordance with Table R301.2.1(2). Alternatively, wood structural panel soffits shall be installed in accordance with Table R704.3.4.

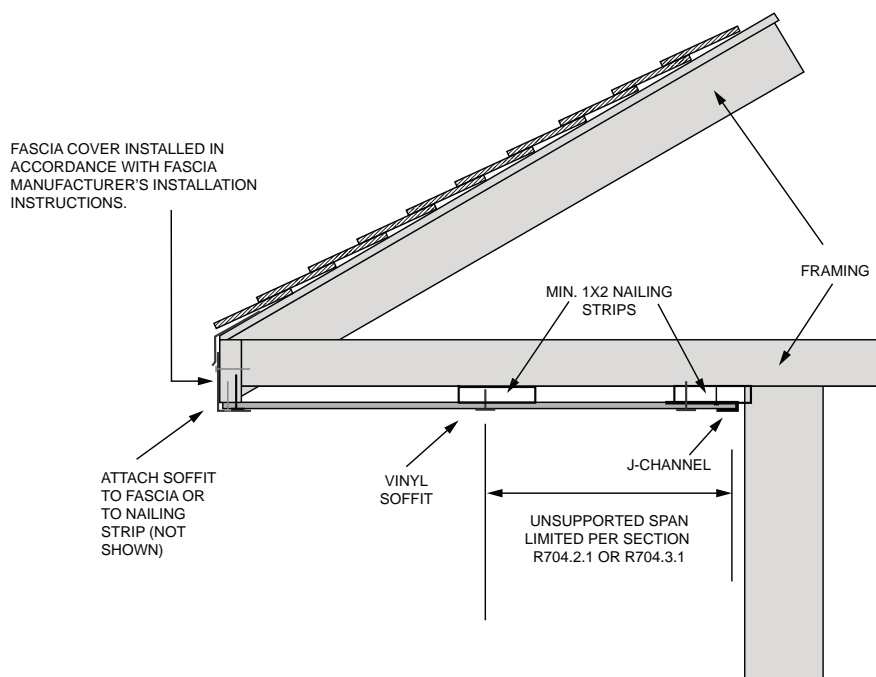


FIGURE R704.2.1(2)  
TYPICAL DOUBLE-SPAN VINYL SOFFIT PANEL SUPPORT

**TABLE R704.3.4**  
**PRESCRIPTIVE ALTERNATIVE FOR WOOD STRUCTURAL PANEL SOFFIT** <sup>b, c, d, e</sup>

MAXIMUM DESIGN PRESSURE (+ or - psf)	MINIMUM PANEL SPAN RATING	MINIMUM PANEL PERFORMANCE CATEGORY	NAIL TYPE AND SIZE	FASTENER <sup>a</sup> SPACING ALONG EDGES AND INTERMEDIATE SUPPORTS	
				Galvanized Steel	Stainless Steel
30	24/0	3/8	6d box (2 × 0.099 × 0.266 head diameter)	6 <sup>f</sup>	4
40	24/0	3/8	6d box (2 × 0.099 × 0.266 head diameter)	6	4
50	24/0	3/8	6d box (2 × 0.099 × 0.266 head diameter)	4	4
			8d common (2½ × 0.131 × 0.281 head diameter)	6	6
60	24/0	3/8	6d box (2 × 0.099 × 0.266 head diameter)	4	3
			8d common (2½ × 0.131 × 0.281 head diameter)	6	4
70	24/16	7/16	8d common (2½ × 0.131 × 0.281 head diameter)	4	4
			10d box (3 × 0.128 × 0.312 head diameter)	6	4
80	24/16	7/16	8d common (2½ × 0.131 × 0.281 head diameter)	4	4
			10d box (3 × 0.128 × 0.312 head diameter)	6	4
90	32/16	15/32	8d common (2½ × 0.131 × 0.281 head diameter)	4	3
			10d box (3 × 0.128 × 0.312 head diameter)	6	4

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

- Fasteners shall comply with Sections R703.3.2 and R703.3.3.
- Maximum spacing of soffit framing members shall not exceed 24 inches.
- Wood structural panels shall be of an exterior exposure grade.
- Wood structural panels shall be installed with strength axis perpendicular to supports with not fewer than two continuous spans.
- Wood structural panels shall be attached to soffit framing members with specific gravity of at least 0.42. Framing members shall be minimum 2 × 3 nominal with the larger dimension in the cross section aligning with the length of fasteners to provide sufficient embedment depths.
- Spacing at intermediate supports shall be not greater than 12 inches on center.





## CHAPTER 8

# ROOF-CEILING CONSTRUCTION

### User note:

**About this chapter:** Chapter 8 addresses the design and construction of roof-ceiling systems. This chapter contains two roof-ceiling framing systems: wood framing and cold-formed steel framing. Allowable span tables are provided to simplify the selection of rafter and ceiling joist size for wood roof framing and cold-formed steel framing. Chapter 8 also provides requirements for the application of ceiling finishes, the proper ventilation of concealed spaces in roofs (for example, enclosed attics and rafter spaces), unvented attic assemblies and attic access.

### SECTION R801 GENERAL

**R801.1 Application.** The provisions of this chapter shall control the design and construction of the roof-ceiling system for buildings.

**R801.2 Requirements.** Roof and ceiling construction shall be capable of accommodating all loads imposed in accordance with Section R301 and of transmitting the resulting loads to the supporting structural elements.

**R801.3 Roof drainage.** In areas where *expansive soils* or *collapsible soils* are known to exist, all *dwellings* shall have a controlled method of water disposal from roofs that will collect and discharge roof drainage to the ground surface not less than 5 feet (1524 mm) from foundation walls or to an *approved* drainage system.

### SECTION R802 WOOD ROOF FRAMING

**R802.1 General.** Wood and wood-based products used for load-supporting purposes shall conform to the applicable provisions of this section.

**R802.1.1 Sawn lumber.** Sawn lumber shall be identified by a grade *mark* of an accredited lumber grading or inspection agency and have design values certified by an accreditation body that complies with DOC PS 20. In lieu of a grade mark, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

**R802.1.1.1 End-jointed lumber.** *Approved* end-jointed lumber identified by a grade *mark* conforming to Section R802.1.1 shall be permitted to be used interchangeably with solid-sawn members of the same species and grade. End-jointed lumber used in an assembly required elsewhere in this code to have a fire-resistance rating shall have the designation “Heat-Resistant Adhesive” or “HRA” included in its grade *mark*.

**R802.1.2 Structural glued-laminated timbers.** Glued-laminated timbers shall be manufactured and identified as required in ANSI A190.1, ANSI 117 and ASTM D3737.

**R802.1.3 Structural log members.** Structural log members shall comply with the provisions of ICC 400.

**R802.1.4 Structural composite lumber.** Structural capacities for *structural composite lumber* shall be established and monitored in accordance with ASTM D5456.

**R802.1.5 Fire-retardant-treated wood.** Fire-retardant-treated wood (FRTW) is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a listed flame spread index of 25 or less. In addition, the ASTM E84 or UL 723 test shall be continued for an additional 20-minute period and the flame front shall not progress more than 10.5 feet (3200 mm) beyond the center line of the burners at any time during the test.

**R802.1.5.1 Pressure process.** For wood products impregnated with chemicals by a pressure process, the process shall be performed in closed vessels under pressures not less than 50 pounds per square inch gauge (psig) (344.7 kPa).

**R802.1.5.2 Other means during manufacture.** For wood products impregnated with chemicals by other means during manufacture, the treatment shall be an integral part of the manufacturing process of the wood product. The treatment shall provide permanent protection to all surfaces of the wood product. The use of paints, coating, stains or other surface treatments is not an *approved* method of protection as required by this section.

**R802.1.5.3 Testing.** For fire-retardant-treated wood products, the front and back faces of the wood product shall be tested in accordance with and produce the results required in Section R802.1.5.

**R802.1.5.3.1 Fire testing of wood structural panels.** *Wood structural panels* shall be tested with a ripped or cut longitudinal gap of  $\frac{1}{8}$  inch (3.2 mm).

**R802.1.5.4 Labeling.** In addition to the *labels* required by Section 802.1.1 for sawn lumber and Section 803.2.1 for *wood structural panels*, each piece of *fire-retardant-treated* lumber and *wood structural panel* shall be *labeled*. The *label* shall contain:

1. The identification *mark* of an *approved* agency in accordance with Section 1703.5 of the *International Building Code*.
2. Identification of the treating manufacturer.

## ROOF-CEILING CONSTRUCTION

3. The name of the fire-retardant treatment.
4. The species of wood treated.
5. Flame spread index and *smoke-developed index*.
6. Method of drying after treatment.
7. Conformance to applicable standards in accordance with Sections R802.1.5.5 through R802.1.5.10.
8. For FRTW exposed to weather, or a damp or wet location, the words “No increase in the listed classification when subjected to the Standard Rain Test” (ASTM D2898).

**R802.1.5.5 Strength adjustments.** Design values for untreated lumber and *wood structural panels* as specified in Section R802.1 shall be adjusted for fire-retardant-treated wood. Adjustments to design values shall be based on an *approved* method of investigation that takes into consideration the effects of the anticipated temperature and humidity to which the fire-retardant-treated wood will be subjected, the type of treatment and redrying procedures.

**R802.1.5.6 Wood structural panels.** The effect of treatment and the method of redrying after treatment, and exposure to high temperatures and high humidities on the flexure properties of fire-retardant-treated softwood plywood shall be determined in accordance with ASTM D5516. The test data developed by ASTM D5516 shall be used to develop adjustment factors, maximum loads and spans, or both for untreated plywood design values in accordance with ASTM D6305. Each manufacturer shall publish the allowable maximum loads and spans for service as floor and roof sheathing for their treatment.

**R802.1.5.7 Lumber.** For each species of wood treated, the effect of the treatment and the method of redrying after treatment and exposure to high temperatures and high humidities on the allowable design properties of fire-retardant-treated lumber shall be determined in accordance with ASTM D5664. The test data developed by ASTM D5664 shall be used to develop modification factors for use at or near room temperature and at elevated temperatures and humidity in accordance with ASTM D6841. Each manufacturer shall publish the modification factors for service at temperatures of not less than 80°F (27°C) and for roof framing. The roof framing modification factors shall take into consideration the climatological location.

**R802.1.5.8 Exposure to weather.** Where fire-retardant-treated wood is exposed to weather or damp or wet locations, it shall be identified as “Exterior” to indicate there is not an increase in the *listed* flame spread index as defined in Section R802.1.5 when subjected to ASTM D2898.

**R802.1.5.9 Interior applications.** Interior fire-retardant-treated wood shall have a moisture content of not over 28 percent when tested in accordance with ASTM D3201 procedures at 92-percent relative humidity. Interior fire-retardant-treated wood shall be tested in accordance with Section R802.1.5.6 or R802.1.5.7. Interior fire-retardant-treated wood designated as Type A shall be tested in accordance with the provisions of this section.

**R802.1.5.10 Moisture content.** Fire-retardant-treated wood shall be dried to a moisture content of 19 percent or less for lumber and 15 percent or less for *wood structural panels* before use. For wood kiln dried after treatment (KDAT) the kiln temperatures shall not exceed those used in kiln drying the lumber and plywood submitted for the tests described in Section R802.1.5.6 for plywood and R802.1.5.7 for lumber.

**R802.1.6 Cross-laminated timber.** Cross-laminated timber shall be manufactured and identified as required by ANSI/APA PRG 320.

**R802.1.7 Engineered wood rim board.** Engineered wood rim boards shall conform to ANSI/APA PRR 410 or shall be evaluated in accordance with ASTM D7672. Structural capacities shall be in accordance with ANSI/APA PRR 410 or established in accordance with ASTM D7672. Rim boards conforming to ANSI/APA PRR 410 shall be marked in accordance with that standard.

**R802.1.8 Prefabricated wood I-joists.** Structural capacities and design provisions for prefabricated wood I-joists shall be established and monitored in accordance with ASTM D5055.

**R802.2 Design and construction.** The roof and ceiling assembly shall provide continuous ties across the structure to prevent roof thrust from being applied to the supporting walls. The assembly shall be designed and constructed in accordance with the provisions of this chapter and Figures R606.11(1), R606.11(2) and R606.11(3) or in accordance with AWC NDS.

**R802.3 Ridge.** A ridge board used to connect opposing rafters shall be not less than 1 inch (25 mm) nominal thickness and not less in depth than the cut end of the rafter. Where ceiling joist or rafter ties do not provide continuous ties across the structure as required by Section R802.5.2, the ridge shall be supported by a wall or ridge beam designed in accordance with accepted engineering practice and supported on each end by a wall or column.

**R802.4 Rafters.** Rafters shall be in accordance with this section.

**R802.4.1 Rafter size.** Rafters shall be sized based on the rafter spans in Tables R802.4.1(1) through R802.4.1(8). Rafter spans shall be measured along the horizontal projection of the rafter. For other grades and species and for other loading conditions, refer to the AWC STJR.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(1)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
12	Douglas fir-larch	SS	11-6	18-0	23-9	Note b	Note b	11-6	18-0	23-9	Note b	Note b
	Douglas fir-larch	#1	11-1	17-4	22-5	Note b	Note b	10-6	15-4	19-5	23-9	Note b
	Douglas fir-larch	#2	10-10	16-10	21-4	26-0	Note b	10-0	14-7	18-5	22-6	26-0
	Douglas fir-larch	#3	8-9	12-10	16-3	19-10	23-0	7-7	11-1	14-1	17-2	19-11
	Hem-fir	SS	10-10	17-0	22-5	Note b	Note b	10-10	17-0	22-5	Note b	Note b
	Hem-fir	#1	10 -7	16-8	22-0	Note b	Note b	10-4	15-2	19-2	23-5	Note b
	Hem-fir	#2	10-1	15-11	20-8	25-3	Note b	9-8	14-2	17-11	21-11	25-5
	Hem-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern pine	SS	11-3	17-8	23-4	Note b	Note b	11-3	17-8	23-4	Note b	Note b
	Southern pine	#1	10-10	17-0	22-5	Note b	Note b	10-6	15-8	19-10	23-2	Note b
	Southern pine	#2	10-4	15-7	19-8	23-5	Note b	9-0	13-6	17-1	20-3	23-10
	Southern pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-pine-fir	SS	10-7	16-8	21-11	Note b	Note b	10-7	16-8	21-9	Note b	Note b
	Spruce-pine-fir	#1	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#2	10-4	16-3	21-0	25-8	Note b	9-10	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas fir-larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-3	20-7	25-2	Note b
	Douglas fir-larch	#1	10-0	15-4	19-5	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#2	9-10	14-7	18-5	22-6	26-0	8-7	12-7	16-0	19-6	22-7
	Douglas fir-larch	#3	7-7	11-1	14-1	17-2	19-11	6-7	9-8	12-12	14-11	17-3
	Hem-fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-11	24-4	Note b
	Hem-fir	#1	9-8	15-2	19-2	23-5	Note b	9-0	13-1	16-7	20-4	23-7
	Hem-fir	#2	9-2	14-2	17-11	21-11	25-5	8-5	12-3	15-6	18-11	22-0
	Hem-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	25-7	Note b
	Southern pine	#1	9-10	15-6	19-10	23-2	Note b	9-1	13-7	17-2	20-1	23-10
	Southern pine	#2	9-0	13-6	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	14-10	18-10	23-0	Note b
	Spruce-pine-fir	#1	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#2	9-5	14-4	18-2	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(1)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	9-10	15-5	20-4	25-11	Note b	9-10	14-10	18-10	23-0	Note b
	Douglas fir-larch	#1	9-5	14-0	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas fir-larch	#2	9-1	13-3	16-10	20-7	23-10	7-10	11-6	14-7	17-10	20-8
	Douglas fir-larch	#3	6-11	10-2	12-10	15-8	18-3	6-0	8-9	11-2	12-7	15-9
	Hem-fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-4	18-2	22-3	25-9
	Hem-fir	#1	9-1	13-10	17-6	21-5	24-10	8-2	12-0	15-2	18-6	21-6
	Hem-fir	#2	8-8	12-11	16-4	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern pine	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-7	23-4	Note b
	Southern pine	#1	9-3	14-3	18-1	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern pine	#2	8-2	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-pine-fir	SS	9-1	14-3	18-9	23-11	Note b	9-1	13-7	17-2	21-0	24-4
	Spruce-pine-fir	#1	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#2	8-10	13-1	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas fir-larch	SS	9-1	14-4	18-10	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#1	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	8-2	11-11	15-1	18-5	21-4	7-0	10-4	13-0	15-11	18-6
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1	16-3	5-4	7-10	10-0	12-2	14-1
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	12-10	16-3	19-10	23-0
	Hem-fir	#1	8-5	12-4	15-8	19-2	22-2	7-4	10-9	13-7	16-7	19-3
	Hem-fir	#2	7-11	11-7	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	13-10	17-6	20-10	24-8
	Southern pine	#1	8-7	12-9	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-pine-fir	SS	8-5	13-3	17-5	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Spruce-pine-fir	#1	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#2	8-0	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).
- Span exceeds 26 feet in length.



## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(2)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12	2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	10-5	16-4	21-7	Note b	Note b	10-5	16-4	21-7	Note b	Note b
	Douglas fir-larch	#1	10-0	15-9	20-10	Note b	Note b	10-0	15-4	19-5	23-9	Note b
	Douglas fir-larch	#2	9-10	15-6	20-5	26-0	Note b	9-10	14-7	18-5	22-6	26-0
	Douglas fir-larch	#3	8-9	12-10	16-3	19-10	23-0	7-7	11-1	14-1	17-2	19-11
	Hem-fir	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	Note b	Note b
	Hem-fir	#1	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-2	23-5	Note b
	Hem-fir	#2	9-2	14-5	19-0	24-3	Note b	9-2	14-2	17-11	21-11	25-5
	Hem-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Southern pine	SS	10-3	16-1	21-2	Note b	Note b	10-3	16-1	21-2	Note b	Note b
	Southern pine	#1	9-10	15-6	20-5	Note b	Note b	9-10	15-6	19-10	23-2	Note b
	Southern pine	#2	9-5	14-9	19-6	23-5	Note b	9-0	13-6	17-1	20-3	23-10
	Southern pine	#3	8-0	11-9	14-10	18-0	21-4	6-11	10-2	12-10	15-7	18-6
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5	Note b	9-8	15-2	19-11	25-5	Note b
	Spruce-pine-fir	#1	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#2	9-5	14-9	19-6	24-10	Note b	9-5	14-4	18-2	22-3	25-9
	Spruce-pine-fir	#3	8-7	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
16	Douglas fir-larch	SS	9-6	14-11	19-7	25-0	Note b	9-6	14-11	19-7	25-0	Note b
	Douglas fir-larch	#1	9-1	14-4	18-11	23-9	Note b	9-1	13-3	16-10	20-7	23-10
	Douglas fir-larch	#2	8-11	14-1	18-5	22-6	26-0	8-7	12-7	16-0	19-6	22-7
	Douglas fir-larch	#3	7-7	11-1	14-1	17-2	19-11	6-7	9-8	12-2	14-11	17-3
	Hem-fir	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Hem-fir	#1	8-9	13-9	18-1	23-1	Note b	8-9	13-1	16-7	20-4	23-7
	Hem-fir	#2	8-4	13-1	17-3	21-11	25-5	8-4	12-3	15-6	18-11	22-0
	Hem-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10
	Southern pine	SS	9-4	14-7	19-3	24-7	Note b	9-4	14-7	19-3	24-7	Note b
	Southern pine	#1	8-11	14-1	18-6	23-2	Note b	8-11	13-7	17-2	20-1	23-10
	Southern pine	#2	8-7	13-5	17-1	20-3	23-10	7-9	11-8	14-9	17-6	20-8
	Southern pine	#3	6-11	10-2	12-10	15-7	18-6	6-0	8-10	11-2	13-6	16-0
	Spruce-pine-fir	SS	8-9	13-9	18-1	23-1	Note b	8-9	13-9	18-1	23-0	Note b
	Spruce-pine-fir	#1	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#2	8-7	13-5	17-9	22-3	25-9	8-6	12-5	15-9	19-3	22-4
	Spruce-pine-fir	#3	7-5	10-10	13-9	16-9	19-6	6-5	9-5	11-11	14-6	16-10

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(2)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Roof live load = 20 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	8-11	14-0	18-5	23-7	Note b	8-11	14-0	18-5	23-0	Note b
	Douglas fir-larch	#1	8-7	13-6	17-9	21-8	25-2	8-4	12-2	15-4	18-9	21-9
	Douglas fir-larch	#2	8-5	13-3	16-10	20-7	23-10	7-10	11-6	14-7	17-10	20-8
	Douglas fir-larch	#3	6-11	10-2	12-10	15-8	18-3	6-0	8-9	11-2	13-7	15-9
	Hem-fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	25-9
	Hem-fir	#1	8-3	12-11	17-1	21-5	24-10	8-2	12-0	15-2	18-6	21-6
	Hem-fir	#2	7-10	12-4	16-3	20-0	23-2	7-8	11-2	14-2	17-4	20-1
	Hem-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
	Southern pine	SS	8-9	13-9	18-2	23-1	Note b	8-9	13-9	18-2	23-1	Note b
	Southern pine	#1	8-5	13-3	17-5	21-2	25-2	8-4	12-4	15-8	18-4	21-9
	Southern pine	#2	8-1	12-3	15-7	18-6	21-9	7-1	10-8	13-6	16-0	18-10
	Southern pine	#3	6-4	9-4	11-9	14-3	16-10	5-6	8-1	10-2	12-4	14-7
	Spruce-pine-fir	SS	8-3	12-11	17-1	21-9	Note b	8-3	12-11	17-1	21-0	24-4
	Spruce-pine-fir	#1	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#2	8-1	12-8	16-7	20-3	23-6	7-9	11-4	14-4	17-7	20-4
	Spruce-pine-fir	#3	6-9	9-11	12-7	15-4	17-9	5-10	8-7	10-10	13-3	15-5
24	Douglas fir-larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	16-10	20-7	23-10
	Douglas fir-larch	#1	8-0	12-6	15-10	19-5	22-6	7-5	10-10	13-9	16-9	19-6
	Douglas fir-larch	#2	7-10	11-11	15-1	18-5	21-4	7-0	10-4	13-0	15-11	18-6
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1	16-3	5-4	7-10	10-0	12-2	14-1
	Hem-fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	19-10	23-0
	Hem-fir	#1	7-8	12-0	15-8	19-2	22-2	7-4	10-9	13-7	16-7	19-3
	Hem-fir	#2	7-3	11-5	14-8	17-10	20-9	6-10	10-0	12-8	15-6	17-11
	Hem-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9
	Southern pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	20-10	24-8
	Southern pine	#1	7-10	12-3	16-2	18-11	22-6	7-5	11-1	14-0	16-5	19-6
	Southern pine	#2	7-4	11-0	13-11	16-6	19-6	6-4	9-6	12-1	14-4	16-10
	Southern pine	#3	5-8	8-4	10-6	12-9	15-1	4-11	7-3	9-1	11-0	13-1
	Spruce-pine-fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-4	18-9	21-9
	Spruce-pine-fir	#1	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#2	7-6	11-9	14-10	18-2	21-0	6-11	10-2	12-10	15-8	18-3
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8	15-11	5-3	7-8	9-9	11-10	13-9

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).
- Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(3)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 30 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	10-0	15-9	20-9	Note b	Note b	10-0	15-9	20-5	24-11	Note b
	Douglas fir-larch	#1	9-8	14-9	18-8	22-9	Note b	9-0	13-2	16-8	20-4	23-7
	Douglas fir-larch	#2	9-6	14-0	17-8	21-7	25-1	8-6	12-6	15-10	19-4	22-5
	Douglas fir-larch	#3	7-3	10-8	13-6	16-6	19-2	6-6	9-6	12-1	14-9	17-1
	Hem-fir	SS	9-6	14-10	19-7	25-0	Note b	9-6	14-10	19-7	24-1	Note b
	Hem-fir	#1	9-3	14-6	18-5	22-6	26-0	8-11	13-0	16-6	20-1	23-4
	Hem-fir	#2	8-10	13-7	17-2	21-0	24-4	8-4	12-2	15-4	18-9	21-9
	Hem-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern pine	SS	9-10	15-6	20-5	Note b	Note b	9-10	15-6	20-5	25-4	Note b
	Southern pine	#1	9-6	14-10	19-0	22-3	Note b	9-0	13-5	17-0	19-11	23-7
	Southern pine	#2	8-7	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-pine-fir	SS	9-3	14-7	19-2	24-6	Note b	9-3	14-7	18-8	22-9	Note b
	Spruce-pine-fir	#1	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#2	9-1	13-9	17-5	21-4	24-8	8-5	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas fir-larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-0	17-8	21-7	25-1
	Douglas fir-larch	#1	8-9	12-9	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch	#2	8-3	12-1	15-4	18-9	21-8	7-5	10-10	13-8	16-9	19-5
	Douglas fir-larch	#3	6-4	9-3	11-8	14-3	16-7	5-8	8-3	10-6	12-9	14-10
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-1	20-10	24-2
	Hem-fir	#1	8-5	12-7	15-11	19-6	22-7	7-8	11-3	14-3	17-5	20-2
	Hem-fir	#2	8-0	11-9	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-5	1-11	25-11
	Southern pine	#1	8-7	13-0	16-6	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-pine-fir	SS	8-5	13-3	17-5	22-1	25-7	8-5	12-9	16-2	19-9	22-10
	Spruce-pine-fir	#1	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#2	8-2	11-11	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(3)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 30 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	8-7	13-6	17-9	22-1	25-7	8-7	12-9	16-2	19-9	22-10
	Douglas fir-larch	#1	7-11	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas fir-larch	#2	7-7	11-0	14-0	17-1	19-10	6-9	9-10	12-6	15-3	17-9
	Douglas fir-larch	#3	5-9	8-5	10-8	13-1	15-2	5-2	7-7	9-7	11-8	13-6
	Hem-fir	SS	8-1	12-9	16-9	21-4	24-8	8-1	12-4	15-7	19-1	22-1
	Hem-fir	#1	7-10	11-6	14-7	17-9	20-7	7-0	10-3	13-0	15-11	18-5
	Hem-fir	#2	7-4	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Southern pine	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	16-10	20-0	23-7
	Southern pine	#1	8-0	11-10	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-pine-fir	SS	7-11	12-5	16-5	20-2	23-4	7-11	11-8	14-9	18-0	20-11
	Spruce-pine-fir	#1	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#2	7-5	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
24	Douglas fir-larch	SS	8-0	12-6	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-0	8-10	11-2	13-8	15-10
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-7	6-9	8-7	10-5	12-1
	Hem-fir	SS	7-6	11-10	15-7	19-1	22-1	7-6	11-0	13-11	17-0	19-9
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-3	9-2	11-8	14-3	16-6
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	SS	7-10	12-3	16-2	20-0	23-7	7-10	11-10	15-0	17-11	21-2
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-pine-fir	SS	7-4	11-7	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).
- Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(4)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 30 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12	2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	9-1	14-4	18-10	24-1	Note b	9-1	14-4	18-10	24-1	Note b
	Douglas fir-larch	#1	8-9	13-9	18-2	22-9	Note b	8-9	13-2	16-8	20-4	23-7
	Douglas fir-larch	#2	8-7	13-6	17-8	21-7	25-1	8-6	12-6	15-10	19-4	22-5
	Douglas fir-larch	#3	7-3	10-8	13-6	16-6	19-2	6-6	9-6	12-1	14-9	17-1
	Hem-fir	SS	8-7	13-6	17-10	22-9	Note b	8-7	13-6	17-10	22-9	Note b
	Hem-fir	#1	8-5	13-3	17-5	22-3	26-0	8-5	13-0	16-6	20-1	23-4
	Hem-fir	#2	8-0	12-7	16-7	21-0	24-4	8-0	12-2	15-4	18-9	21-9
	Hem-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Southern pine	SS	8-11	14-1	18-6	23-8	Note b	8-11	14-1	18-6	23-8	Note b
	Southern pine	#1	8-7	13-6	17-10	22-3	Note b	8-7	13-5	17-0	19-11	23-7
	Southern pine	#2	8-3	12-11	16-4	19-5	22-10	7-8	11-7	14-8	17-4	20-5
	Southern pine	#3	6-7	9-9	12-4	15-0	17-9	5-11	8-9	11-0	13-5	15-10
	Spruce-pine-fir	SS	8-5	13-3	17-5	22-3	Note b	8-5	13-3	17-5	22-3	Note b
	Spruce-pine-fir	#1	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#2	8-3	12-11	17-0	21-4	24-8	8-3	12-4	15-7	19-1	22-1
	Spruce-pine-fir	#3	7-1	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
16	Douglas fir-larch	SS	8-3	13-0	17-2	21-10	Note b	8-3	13-0	17-2	21-7	25-1
	Douglas fir-larch	#1	8-0	12-6	16-2	19-9	22-10	7-10	11-5	14-5	17-8	20-5
	Douglas fir-larch	#2	7-10	12-1	15-4	18-9	21-8	7-5	10-10	13-8	16-9	19-5
	Douglas fir-larch	#3	6-4	9-3	11-8	14-3	16-7	5-8	8-3	10-6	12-9	14-10
	Hem-fir	SS	7-10	12-3	16-2	20-8	25-1	7-10	12-3	16-2	20-8	24-2
	Hem-fir	#1	7-8	12-0	15-10	19-6	22-7	7-8	11-3	14-3	17-5	20-2
	Hem-fir	#2	7-3	11-5	14-11	18-2	21-1	7-2	10-6	13-4	16-3	18-10
	Hem-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6
	Southern pine	SS	8-1	12-9	16-10	21-6	Note b	8-1	12-9	16-10	21-6	25-11
	Southern pine	#1	7-10	12-3	16-2	19-3	22-10	7-10	11-7	14-9	17-3	20-5
	Southern pine	#2	7-6	11-2	14-2	16-10	19-10	6-8	10-0	12-8	15-1	17-9
	Southern pine	#3	5-9	8-6	10-8	13-0	15-4	5-2	7-7	9-7	11-7	13-9
	Spruce-pine-fir	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	19-9	22-10
	Spruce-pine-fir	#1	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#2	7-6	11-9	15-1	18-5	21-5	7-3	10-8	13-6	16-6	19-2
	Spruce-pine-fir	#3	6-2	9-0	11-5	13-11	16-2	5-6	8-1	10-3	12-6	14-6

(continued)



## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(4)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 30 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	7-9	12-3	16-1	20-7	25-0	7-9	12-3	16-1	19-9	22-10
	Douglas fir-larch	#1	7-6	11-8	14-9	18-0	20-11	7-1	10-5	13-2	16-1	18-8
	Douglas fir-larch	#2	7-4	11-0	14-0	17-1	19-10	6-9	9-1	12-6	15-3	17-9
	Douglas fir-larch	#3	5-9	8-5	10-8	13-1	15-2	5-2	7-7	9-7	11-8	13-6
	Hem-fir	SS	7-4	11-7	15-3	19-5	23-7	7-4	11-7	15-3	19-1	22-1
	Hem-fir	#1	7-2	11-4	14-7	17-9	20-7	7-0	16-3	13-0	15-11	18-5
	Hem-fir	#2	6-10	10-9	13-7	16-7	19-3	6-7	9-7	12-2	14-10	17-3
	Hem-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
	Southern pine	SS	7-8	12-0	15-10	20-2	24-7	7-8	12-0	15-10	20-0	23-7
	Southern pine	#1	7-4	11-7	15-1	17-7	20-11	7-1	10-7	13-5	15-9	18-8
	Southern pine	#2	6-10	10-2	12-11	15-4	18-1	6-1	9-2	11-7	13-9	16-2
	Southern pine	#3	5-3	7-9	9-9	11-10	14-0	4-8	6-11	8-9	10-7	12-6
	Spruce-pine-fir	SS	7-2	11-4	14-11	19-0	23-1	7-2	11-4	14-9	18-0	20-11
	Spruce-pine-fir	#1	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#2	7-0	10-11	13-9	16-10	19-6	6-8	9-9	12-4	15-1	17-6
	Spruce-pine-fir	#3	5-7	8-3	10-5	12-9	14-9	5-0	7-4	9-4	11-5	13-2
24	Douglas fir-larch	SS	7-3	11-4	15-0	19-1	22-10	7-3	11-4	14-5	17-8	20-5
	Douglas fir-larch	#1	7-0	10-5	13-2	16-1	18-8	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-0	8-10	11-2	13-8	15-10
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-7	6-9	8-7	10-5	12-1
	Hem-fir	SS	6-10	10-9	14-2	18-0	21-11	6-10	10-9	13-11	17-0	19-9
	Hem-fir	#1	6-8	10-3	13-0	15-11	18-5	6-3	9-2	11-8	14-3	16-6
	Hem-fir	#2	6-4	9-7	12-2	14-10	17-3	5-10	8-7	10-10	13-3	15-5
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10
	Southern pine	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	17-11	21-2
	Southern pine	#1	6-10	10-7	13-5	15-9	18-8	6-4	9-6	12-0	14-1	16-8
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-5	8-2	10-4	12-3	14-6
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-2	6-2	7-10	9-6	11-2
	Spruce-pine-fir	SS	6-8	10-6	13-10	17-8	20-11	6-8	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#1	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#2	6-6	9-9	12-4	15-1	17-6	5-11	8-8	11-0	13-6	15-7
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-6	6-7	8-4	10-2	11-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).
- Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(5)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 50 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
12	Douglas fir-larch	SS	8-5	13-3	17-6	22-4	26-0	8-5	13-3	17-3	21-1	24-5
	Douglas fir-larch	#1	8-2	12-0	15-3	18-7	21-7	7-7	11-2	14-1	17-3	20-0
	Douglas fir-larch	#2	7-10	11-5	14-5	17-8	20-5	7-3	10-7	13-4	16-4	18-11
	Douglas fir-larch	#3	6-0	8-9	11-0	13-6	15-7	5-6	8-1	10-3	12-6	14-6
	Hem-fir	SS	8-0	12-6	16-6	21-1	25-6	8-0	12-6	16-6	20-4	23-7
	Hem-fir	#1	7-10	11-10	15-0	18-4	21-3	7-6	11-0	13-11	17-0	19-9
	Hem-fir	#2	7-5	11-1	14-0	17-2	19-11	7-0	10-3	13-0	15-10	18-5
	Hem-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern pine	SS	8-4	13-1	17-2	21-11	Note b	8-4	13-1	17-2	21-5	25-3
	Southern pine	#1	8-0	12-3	15-6	18-2	21-7	7-7	11-4	14-5	16-10	20-0
	Southern pine	#2	7-0	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-pine-fir	SS	7-10	12-3	16-2	20-8	24-1	7-10	12-3	15-9	19-3	22-4
	Spruce-pine-fir	#1	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#2	7-8	11-3	14-3	17-5	20-2	7-1	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas fir-larch	SS	7-8	12-1	15-11	19-9	22-10	7-8	11-10	14-11	18-3	21-2
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-3	9-2	11-7	14-2	16-5
	Douglas fir-larch	#3	5-2	7-7	9-7	11-18	13-6	4-9	7-0	8-10	10-10	12-6
	Hem-fir	SS	7-3	11-5	15-0	19-1	22-1	7-3	11-5	14-5	17-8	20-5
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-6	9-6	12-1	14-9	17-1
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern pine	SS	7-6	11-10	15-7	19-11	23-7	7-6	11-10	15-7	18-6	21-10
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-pine-fir	SS	7-1	11-2	14-8	18-0	20-11	7-1	10-9	13-8	15-11	19-4
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(5)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 50 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
19.2	Douglas fir-larch	SS	7-3	11-4	14-9	18-0	20-11	7-3	10-9	13-8	16-8	19-4
	Douglas fir-larch	#1	6-6	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas fir-larch	#2	6-2	9-0	11-5	13-11	16-2	5-8	8-4	10-9	12-11	15-0
	Douglas fir-larch	#3	4-8	6-11	8-9	10-8	12-4	4-4	6-4	8-1	9-10	11-5
	Hem-fir	SS	6-10	10-9	14-2	17-5	20-2	6-10	10-5	13-2	16-1	18-8
	Hem-fir	#1	6-5	9-5	11-11	14-6	16-10	8-11	8-8	11-0	13-5	15-7
	Hem-fir	#2	6-0	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Southern pine	SS	7-1	11-2	14-8	18-3	21-7	7-1	11-2	14-2	16-11	20-0
	Southern pine	#1	6-6	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-pine-fir	SS	6-8	10-6	13-5	16-5	19-1	6-8	9-10	12-5	15-3	17-8
	Spruce-pine-fir	#1	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#2	6-1	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas fir-larch	SS	6-8	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas fir-larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas fir-larch	#2	5-6	8-1	10-3	12-6	14-6	5-1	7-6	9-5	11-7	13-5
	Douglas fir-larch	#3	4-3	6-2	7-10	9-6	11-1	3-11	5-8	7-3	8-10	10-3
	Hem-fir	SS	6-4	9-11	12-9	15-7	18-0	6-4	9-4	11-9	14-5	16-8
	Hem-fir	#1	5-9	8-5	10-8	13-0	15-1	8-4	7-9	9-10	12-0	13-11
	Hem-fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern pine	SS	6-7	10-4	13-8	16-4	19-3	6-7	10-0	12-8	15-2	17-10
	Southern pine	#1	5-10	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-pine-fir	SS	6-2	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Spruce-pine-fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).
- Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(6)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 50 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12	2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	7-8	12-1	15-11	20-3	24-8	7-8	12-1	15-11	20-3	24-5
	Douglas fir-larch	#1	7-5	11-7	15-3	18-7	21-7	7-5	11-2	14-1	17-3	20-0
	Douglas fir-larch	#2	7-3	11-5	14-5	17-8	20-5	7-3	10-7	13-4	16-4	18-11
	Douglas fir-larch	#3	6-0	8-9	11-0	13-6	15-7	5-6	8-1	10-3	12-6	14-6
	Hem-fir	SS	7-3	11-5	15-0	19-2	23-4	7-3	11-5	15-0	19-2	23-4
	Hem-fir	#1	7-1	11-2	14-8	18-4	21-3	7-1	11-0	13-11	17-0	19-9
	Hem-fir	#2	6-9	10-8	14-0	17-2	19-11	6-9	10-3	13-0	15-10	18-5
	Hem-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Southern pine	SS	7-6	11-10	15-7	19-11	24-3	7-6	11-10	15-7	19-11	24-3
	Southern pine	#1	7-3	11-5	15-0	18-2	21-7	7-3	11-4	14-5	16-10	20-0
	Southern pine	#2	6-11	10-6	13-4	15-10	18-8	6-6	9-9	12-4	14-8	17-3
	Southern pine	#3	5-5	8-0	10-1	12-3	14-6	5-0	7-5	9-4	11-4	13-5
	Spruce-pine-fir	SS	7-1	11-2	14-8	18-9	22-10	7-1	11-2	14-8	18-9	22-4
	Spruce-pine-fir	#1	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#2	6-11	10-11	14-3	17-5	20-2	6-11	10-5	13-2	16-1	18-8
	Spruce-pine-fir	#3	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
16	Douglas fir-larch	SS	7-0	11-0	14-5	18-5	22-5	7-0	11-0	14-5	18-3	21-2
	Douglas fir-larch	#1	6-9	10-5	13-2	16-1	18-8	6-7	9-8	12-2	14-11	17-3
	Douglas fir-larch	#2	6-7	9-10	12-6	15-3	17-9	6-3	9-2	11-7	14-2	16-5
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-9	7-0	8-10	10-10	12-6
	Hem-fir	SS	6-7	10-4	13-8	17-5	21-2	6-7	10-4	13-8	17-5	20-5
	Hem-fir	#1	6-5	10-2	13-0	15-11	18-5	6-5	9-6	12-1	14-9	17-1
	Hem-fir	#2	6-2	9-7	12-2	14-10	17-3	6-1	8-11	11-3	13-9	15-11
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3
	Southern pine	SS	6-10	10-9	14-2	18-1	22-0	6-10	10-9	14-2	18-1	21-10
	Southern pine	#1	6-7	10-4	13-5	15-9	18-8	6-7	9-10	12-5	14-7	17-3
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-8	8-5	10-9	12-9	15-0
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-4	6-5	8-1	9-10	11-7
	Spruce-pine-fir	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-8	19-4
	Spruce-pine-fir	#1	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#2	6-4	9-9	12-4	15-1	17-6	6-2	9-0	11-5	13-11	16-2
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-8	6-10	8-8	10-6	12-3

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(6)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 50 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	6-7	10-4	13-7	17-4	20-11	6-7	10-4	13-7	16-8	19-4
	Douglas fir-larch	#1	6-4	9-6	12-0	14-8	17-1	6-0	8-10	11-2	13-7	15-9
	Douglas fir-larch	#2	6-2	9-0	11-5	13-11	16-2	5-8	8-4	10-7	12-11	15-0
	Douglas fir-larch	#3	4-8	6-11	8-9	10-8	12-4	4-4	6-4	8-1	9-10	11-5
	Hem-fir	SS	6-2	9-9	12-10	16-5	19-11	6-2	9-9	12-10	16-1	18-8
	Hem-fir	#1	6-1	9-5	11-11	14-6	16-10	5-11	8-8	11-0	13-5	15-7
	Hem-fir	#2	5-9	8-9	11-1	13-7	15-9	5-7	8-1	10-3	12-7	14-7
	Hem-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
	Southern pine	SS	6-5	10-2	13-4	17-0	20-9	6-5	10-2	13-4	16-11	20-0
	Southern pine	#1	6-2	9-8	12-3	14-4	17-1	6-0	9-0	11-4	13-4	15-9
	Southern pine	#2	5-7	8-4	10-7	12-6	14-9	5-2	7-9	9-9	11-7	13-8
	Southern pine	#3	4-3	6-4	8-0	9-8	11-5	4-0	5-10	7-4	8-11	10-7
	Spruce-pine-fir	SS	6-1	9-6	12-7	16-0	19-1	6-1	9-6	12-5	15-3	17-8
	Spruce-pine-fir	#1	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#2	5-11	8-11	11-3	13-9	15-11	5-7	8-3	10-5	12-9	14-9
	Spruce-pine-fir	#3	4-7	6-9	8-6	10-5	12-1	4-3	6-3	7-11	9-7	11-2
24	Douglas fir-larch	SS	6-1	9-7	12-7	16-1	18-8	6-1	9-7	12-2	14-11	17-3
	Douglas fir-larch	#1	5-10	8-6	10-9	13-2	15-3	5-5	7-10	10-0	12-2	14-1
	Douglas fir-larch	#2	5-6	8-1	10-3	12-6	14-6	5-1	7-6	9-5	11-7	13-5
	Douglas fir-larch	#3	4-3	6-2	7-10	9-6	11-1	3-11	5-8	7-3	8-10	10-3
	Hem-fir	SS	5-9	9-1	11-11	15-2	18-0	5-9	9-1	11-9	14-5	15-11
	Hem-fir	#1	5-8	8-5	10-8	13-0	15-1	5-4	7-9	9-10	12-0	13-11
	Hem-fir	#2	5-4	7-10	9-11	12-1	14-1	4-11	7-3	9-2	11-3	13-0
	Hem-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0
	Southern pine	SS	6-0	9-5	12-5	15-10	19-3	6-0	9-5	12-5	15-2	17-10
	Southern pine	#1	5-9	8-8	11-0	12-10	15-3	5-5	8-0	10-2	11-11	14-1
	Southern pine	#2	5-0	7-5	9-5	11-3	13-2	4-7	6-11	8-9	10-5	12-3
	Southern pine	#3	3-10	5-8	7-1	8-8	10-3	3-6	5-3	6-7	8-0	9-6
	Spruce-pine-fir	SS	5-8	8-10	11-8	14-8	17-1	5-8	8-10	11-2	13-7	15-9
	Spruce-pine-fir	#1	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#2	5-5	7-11	10-1	12-4	14-3	5-0	7-4	9-4	11-5	13-2
	Spruce-pine-fir	#3	4-1	6-0	7-7	9-4	10-9	3-10	5-7	7-1	8-7	10-0

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).



## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(7)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 70 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum Rafter Spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
12	Douglas fir-larch	SS	7-7	11-10	15-8	19-9	22-10	7-7	11-10	15-3	18-7	21-7
	Douglas fir-larch	#1	7-1	10-5	13-2	16-1	18-8	6-8	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-9	9-10	12-6	15-3	17-9	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-10	7-1	9-0	11-0	12-9
	Hem-fir	SS	7-2	11-3	14-9	18-10	22-1	7-2	11-3	14-8	18-0	20-10
	Hem-fir	#1	7-0	10-3	13-0	15-11	18-5	6-7	9-8	12-3	15-0	17-5
	Hem-fir	#2	6-7	9-7	12-2	14-10	17-3	6-2	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	7-5	11-8	15-4	19-7	23-7	7-5	11-8	15-4	18-10	22-3
	Southern pine	#1	7-1	10-7	13-5	15-9	18-8	6-9	10-0	12-8	14-10	17-7
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-9	8-7	10-11	12-11	15-3
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-5	6-6	8-3	10-0	11-10
	Spruce-pine-fir	SS	7-0	11-0	14-6	18-0	20-11	7-0	11-0	13-11	17-0	19-8
	Spruce-pine-fir	#1	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-8	9-9	12-4	15-1	17-6	6-3	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
16	Douglas fir-larch	SS	6-10	10-9	14-0	17-1	19-10	6-10	10-5	13-2	16-1	18-8
	Douglas fir-larch	#1	6-2	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-10	8-7	10-10	13-3	15-4	5-6	8-1	10-3	12-6	14-6
	Douglas fir-larch	#3	4-6	6-6	8-3	10-1	11-9	4-3	6-2	7-10	9-6	11-1
	Hem-fir	SS	6-6	10-2	13-5	16-6	19-2	6-6	10-1	12-9	15-7	18-0
	Hem-fir	#1	6-1	8-11	11-3	13-9	16-0	5-9	8-5	10-8	13-0	15-1
	Hem-fir	#2	5-8	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-9	10-7	14-0	17-4	20-5	6-9	10-7	13-9	16-4	19-3
	Southern pine	#1	6-2	9-2	11-8	13-8	16-2	5-10	8-8	11-0	12-10	15-3
	Southern pine	#2	5-3	7-11	10-0	11-11	14-0	5-0	7-5	9-5	11-3	13-2
	Southern pine	#3	4-1	6-0	7-7	9-2	10-10	3-10	5-8	7-1	8-8	10-3
	Spruce-pine-fir	SS	6-4	10-0	12-9	15-7	18-1	6-4	9-6	12-0	14-8	17-1
	Spruce-pine-fir	#1	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-9	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(7)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 70 psf, ceiling not attached to rafters,  $L/\Delta = 180$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum Rafter Spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
19.2	Douglas fir-larch	SS	6-6	10-1	12-9	15-7	18-1	6-6	9-6	12-0	14-8	17-1
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-4	7-10	9-11	12-1	14-0	5-0	7-4	9-4	11-5	13-2
	Douglas fir-larch	#3	4-1	6-0	7-7	9-3	10-8	3-10	5-7	7-1	8-8	10-1
	Hem-fir	SS	6-1	9-7	12-4	15-1	17-4	6-1	9-2	11-8	14-2	15-5
	Hem-fir	#1	5-7	8-2	10-3	12-7	14-7	5-3	7-8	9-8	11-10	13-9
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Southern pine	SS	6-4	10-0	13-2	15-10	18-8	6-4	9-10	12-6	14-11	17-7
	Southern pine	#1	5-8	8-5	10-8	12-5	14-9	5-4	7-11	10-0	11-9	13-11
	Southern pine	#2	4-10	7-3	9-2	10-10	12-9	4-6	6-10	8-8	10-3	12-1
	Southern pine	#3	3-8	5-6	6-11	8-4	9-11	3-6	5-2	6-6	7-11	9-4
	Spruce-pine-fir	SS	6-0	9-2	11-8	14-3	16-6	5-11	8-8	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
24	Douglas fir-larch	SS	6-0	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-9	7-0	8-10	10-10	12-6	4-6	6-7	8-4	10-2	11-10
	Douglas fir-larch	#3	3-8	5-4	6-9	8-3	9-7	3-5	5-0	6-4	7-9	9-10
	Hem-fir	SS	5-8	8-8	11-0	13-6	13-11	5-7	8-3	10-5	12-4	12-4
	Hem-fir	#1	5-0	7-3	9-2	11-3	13-0	4-8	6-10	8-8	10-7	12-4
	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-11	9-3	11-11	14-2	16-8	5-11	8-10	11-2	13-4	15-9
	Southern pine	#1	5-0	7-6	9-6	11-1	13-2	4-9	7-1	9-0	10-6	12-5
	Southern pine	#2	4-4	6-5	8-2	9-9	11-5	4-1	6-1	7-9	9-2	10-9
	Southern pine	#3	3-4	4-11	6-2	7-6	8-10	3-1	4-7	5-10	7-1	8-4
	Spruce-pine-fir	SS	5-6	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(8)**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 70 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	6-10	10-9	14-3	18-2	22-1	6-10	10-9	14-3	18-2	21-7
	Douglas fir-larch	#1	6-7	10-5	13-2	16-1	18-8	6-7	9-10	12-5	15-2	17-7
	Douglas fir-larch	#2	6-6	9-10	12-6	15-3	17-9	6-4	9-4	11-9	14-5	16-8
	Douglas fir-larch	#3	5-2	7-7	9-7	11-8	13-6	4-10	7-1	9-0	11-0	12-9
	Hem-fir	SS	6-6	10-2	13-5	17-2	20-10	6-6	10-2	13-5	17-2	20-10
	Hem-fir	#1	6-4	10-0	13-0	15-11	18-5	6-4	9-8	12-3	15-0	17-5
	Hem-fir	#2	6-1	9-6	12-2	14-10	17-3	6-1	9-1	11-5	14-0	16-3
	Hem-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Southern pine	SS	6-9	10-7	14-0	17-10	21-8	6-9	10-7	14-0	17-10	21-8
	Southern pine	#1	6-6	10-2	13-5	15-9	18-8	6-6	10-0	12-8	14-10	17-7
	Southern pine	#2	6-1	9-2	11-7	13-9	16-2	5-9	8-7	10-11	12-11	15-3
	Southern pine	#3	4-8	6-11	8-9	10-7	12-6	4-5	6-6	8-3	10-0	11-10
	Spruce-pine-fir	SS	6-4	10-0	13-2	16-9	20-5	6-4	10-0	13-2	16-9	19-8
	Spruce-pine-fir	#1	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#2	6-2	9-9	12-4	15-1	17-6	6-2	9-2	11-8	14-2	16-6
	Spruce-pine-fir	#3	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
16	Douglas fir-larch	SS	6-3	9-10	12-11	16-6	19-10	6-3	9-10	12-11	16-1	18-8
	Douglas fir-larch	#1	6-0	9-0	11-5	13-11	16-2	5-10	8-6	10-9	13-2	15-3
	Douglas fir-larch	#2	5-10	8-7	10-10	13-3	15-4	5-6	8-1	10-3	12-6	14-6
	Douglas fir-larch	#3	4-6	6-6	8-3	10-1	11-9	4-3	6-2	7-10	9-6	11-1
	Hem-fir	SS	5-11	9-3	12-2	15-7	18-11	5-11	9-3	12-2	15-7	18-0
	Hem-fir	#1	5-9	8-11	11-3	13-9	16-0	5-9	8-5	10-8	13-0	15-1
	Hem-fir	#2	5-6	8-4	10-6	12-10	14-11	5-4	7-10	9-11	12-1	14-1
	Hem-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9
	Southern pine	SS	6-1	9-7	12-8	16-2	19-8	6-1	9-7	12-8	16-2	19-3
	Southern pine	#1	5-11	9-2	11-8	13-8	16-2	5-10	8-8	11-0	12-10	15-3
	Southern pine	#2	5-3	7-11	10-0	11-11	14-0	5-0	7-5	9-5	11-3	13-2
	Southern pine	#3	4-1	6-0	7-7	9-2	10-10	3-10	5-8	7-1	8-8	10-3
	Spruce-pine-fir	SS	5-9	9-1	11-11	15-3	18-1	5-9	9-1	11-11	14-8	17-1
	Spruce-pine-fir	#1	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#2	5-8	8-5	10-8	13-1	15-2	5-5	7-11	10-1	12-4	14-3
	Spruce-pine-fir	#3	4-4	6-4	8-1	9-10	11-5	4-1	6-0	7-7	9-4	10-9

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.4.1(8)—continued**  
**RAFTER SPANS FOR COMMON LUMBER SPECIES (Ground snow load = 70 psf, ceiling attached to rafters,  $L/\Delta = 240$ )**

RAFTER SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf					DEAD LOAD = 20 psf				
			2 × 4	2 × 6	2 × 8	2 × 10	2 × 12	2 × 4	2 × 6	2 × 8	2 × 10	2 × 12
			Maximum rafter spans <sup>a</sup>									
			(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)	(feet- inches)
19.2	Douglas fir-larch	SS	5-10	9-3	12-2	15-6	18-1	5-10	9-3	12-0	14-8	17-1
	Douglas fir-larch	#1	5-7	8-3	10-5	12-9	14-9	5-4	7-9	9-10	12-0	13-11
	Douglas fir-larch	#2	5-4	7-10	9-11	12-1	14-0	5-0	7-4	9-4	11-5	13-2
	Douglas fir-larch	#3	4-1	6-0	7-7	9-3	10-8	3-10	5-7	7-1	8-8	10-1
	Hem-fir	SS	5-6	8-8	11-6	14-8	17-4	5-6	8-8	11-6	14-2	15-5
	Hem-fir	#1	5-5	8-2	10-3	12-7	14-7	5-3	7-8	9-8	11-10	13-9
	Hem-fir	#2	5-2	7-7	9-7	11-9	13-7	4-11	7-2	9-1	11-1	12-10
	Hem-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
	Southern pine	SS	5-9	9-1	11-11	15-3	18-6	5-9	9-1	11-11	14-11	17-7
	Southern pine	#1	5-6	8-5	10-8	12-5	14-9	5-4	7-11	10-0	11-9	13-11
	Southern pine	#2	4-10	7-3	9-2	10-10	12-9	4-6	6-10	8-8	10-3	12-1
	Southern pine	#3	3-8	5-6	6-11	8-4	9-11	3-6	5-2	6-6	7-11	9-4
	Spruce-pine-fir	SS	5-5	8-6	11-3	14-3	16-6	5-5	8-6	11-0	13-5	15-7
	Spruce-pine-fir	#1	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#2	5-3	7-8	9-9	11-11	13-10	5-0	7-3	9-2	11-3	13-0
	Spruce-pine-fir	#3	4-0	5-10	7-4	9-0	10-5	3-9	5-6	6-11	8-6	9-10
24	Douglas fir-larch	SS	5-5	8-7	11-3	13-11	16-2	5-5	8-6	10-9	13-2	15-3
	Douglas fir-larch	#1	5-0	7-4	9-4	11-5	13-2	4-9	6-11	8-9	10-9	12-5
	Douglas fir-larch	#2	4-9	7-0	8-10	10-10	12-6	4-6	6-7	8-4	10-2	11-10
	Douglas fir-larch	#3	3-8	5-4	6-9	8-3	9-7	3-5	5-0	6-4	7-9	9-0
	Hem-fir	SS	5-2	8-1	10-8	13-6	13-11	5-2	8-1	10-5	12-4	12-4
	Hem-fir	#1	5-0	7-3	9-2	11-3	13-0	4-8	6-10	8-8	10-7	12-4
	Hem-fir	#2	4-8	6-9	8-7	10-6	12-2	4-4	6-5	8-1	9-11	11-6
	Hem-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10
	Southern pine	SS	5-4	8-5	11-1	14-2	16-8	5-4	8-5	11-1	13-4	15-9
	Southern pine	#1	5-0	7-6	9-6	11-1	13-2	4-9	7-1	9-0	10-6	12-5
	Southern pine	#2	4-4	6-5	8-2	9-9	11-5	4-1	6-1	7-9	9-2	10-9
	Southern pine	#3	3-4	4-11	6-2	7-6	8-10	3-1	4-7	5-10	7-1	8-4
	Spruce-pine-fir	SS	5-0	7-11	10-5	12-9	14-9	5-0	7-9	9-10	12-0	12-11
	Spruce-pine-fir	#1	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#2	4-8	6-11	8-9	10-8	12-4	4-5	6-6	8-3	10-0	11-8
	Spruce-pine-fir	#3	3-7	5-2	6-7	8-1	9-4	3-4	4-11	6-3	7-7	8-10

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- a. The tabulated rafter spans assume that ceiling joists are located at the bottom of the attic space or that some other method of resisting the outward push of the rafters on the bearing walls, such as rafter ties, is provided at that location. Where ceiling joists or rafter ties are located higher in the attic space, the rafter spans shall be multiplied by the adjustment factors in Table R802.4.1(9).

**TABLE R802.4.1(9)**  
**RAFTER SPAN ADJUSTMENT FACTOR**

$H_c/H_r^a$	RAFTER SPAN ADJUSTMENT FACTOR
1/3	0.67
1/4	0.76
1/5	0.83
1/6	0.90
1/7.5 or less	1.00

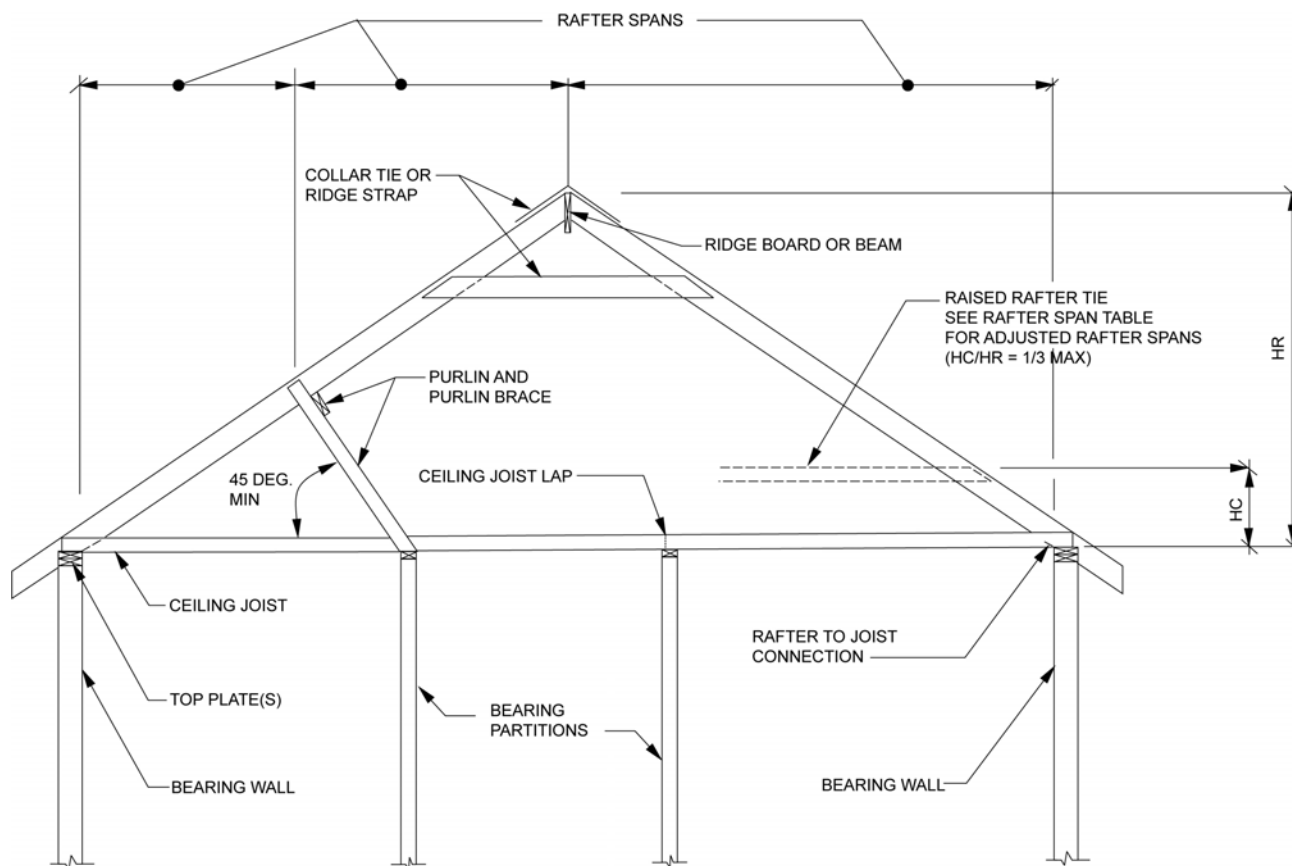
a.  $H_c$  = Height of ceiling joists or rafter ties measured vertically above the top of the rafter support walls;  $H_r$  = Height of roof ridge measured vertically above the top of the rafter support walls.

**R802.4.2 Framing details.** Rafters shall be framed opposite from each other to a ridge board, shall not be offset more than  $1\frac{1}{2}$  inches (38 mm) from each other and shall be connected with a collar tie or ridge strap in accordance with Section R802.4.6 or directly opposite from each other to a gusset plate in accordance with Table R602.3(1). Rafters shall be nailed to the top wall plates in accordance with Table R602.3(1) unless the *roof assembly* is required to comply with the uplift requirements of Section R802.11.

**R802.4.3 Hips and valleys.** Hip and valley rafters shall be not less than 2 inches (51 mm) nominal in thickness and not less in depth than the cut end of the rafter. Hip and valley rafters shall be supported at the ridge by a brace to a bearing partition or be designed to carry and distribute the specific load at that point.

**R802.4.4 Rafter supports.** Where the roof pitch is less than 3:12 (25-percent slope), structural members that support rafters, such as ridges, hips and valleys, shall be designed as beams, and bearing shall be provided for rafters in accordance with Section R802.6.

**R802.4.5 Purlins.** Installation of purlins to reduce the span of rafters is permitted as shown in Figure R802.4.5. Purlins shall be sized not less than the required size of the rafters that they support. Purlins shall be continuous and shall be supported by 2-inch by 4-inch (51 mm by 102 mm) braces installed to bearing walls at a slope not less than 45 degrees (0.79 rad) from the horizontal. The braces shall be spaced not more than 4 feet (1219 mm) on center and the unbraced length of braces shall not exceed 8 feet (2438 mm).



For SI: 1 degree = 0.018 rad.

$H_c$  = Height of ceiling joists or rafter ties measured vertically above the top of rafter support walls.

$H_r$  = Height of roof ridge measured vertically above the top of the rafter support walls.

**FIGURE R802.4.5**  
**BRACED RAFTER CONSTRUCTION**



## ROOF-CEILING CONSTRUCTION

**R802.4.6 Collar ties.** Where collar ties are used to connect opposing rafters, they shall be located in the upper third of the attic space and fastened in accordance with Table R602.3(1). Collar ties shall be not less than 1 inch by 4 inches (25 mm × 102 mm) nominal, spaced not more than 4 feet (1219 mm) on center. Ridge straps shall be permitted to replace collar ties. Ridge straps shall be not less than 1<sup>1</sup>/<sub>4</sub>-inch (32 mm) × 20 gage and shall be nailed to the top edge of each rafter with not fewer than three 10d common (3" × 0.148") nails with the closest nail not closer than 2<sup>3</sup>/<sub>8</sub> inches (60.3 mm) from the end of the rafter.

**R802.5 Ceiling joists.** Ceiling joists shall be continuous across the structure or securely joined where they meet over interior partitions in accordance with Section R802.5.2.1. Ceiling joists shall be fastened to the top plate in accordance with Table R602.3(1).

**R802.5.1 Ceiling joist size.** Ceiling joists shall be sized based on the joist spans in Tables R802.5.1(1) and R802.5.1(2). For other grades and species and for other loading conditions, refer to the AWC STJR.

**TABLE R802.5.1(1)**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES (Uninhabitable attics without storage, live load = 10 psf, L/Δ = 240)**

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	13-2	20-8	Note a	Note a
	Douglas fir-larch	#1	12-8	19-11	Note a	Note a
	Douglas fir-larch	#2	12-5	19-6	25-8	Note a
	Douglas fir-larch	#3	11-1	16-3	20-7	25-2
	Hem-fir	SS	12-5	19-6	25-8	Note a
	Hem-fir	#1	12-2	19-1	25-2	Note a
	Hem-fir	#2	11-7	18-2	24-0	Note a
	Hem-fir	#3	10-10	15-10	20-1	24-6
	Southern pine	SS	12-11	20-3	Note a	Note a
	Southern pine	#1	12-5	19-6	25-8	Note a
	Southern pine	#2	11-10	18-8	24-7	Note a
	Southern pine	#3	10-1	14-11	18-9	22-9
	Spruce-pine-fir	SS	12-2	19-1	25-2	Note a
	Spruce-pine-fir	#1	11-10	18-8	24-7	Note a
	Spruce-pine-fir	#2	11-10	18-8	24-7	Note a
	Spruce-pine-fir	#3	10-10	15-10	20-1	24-6
16	Douglas fir-larch	SS	11-11	18-9	24-8	Note a
	Douglas fir-larch	#1	11-6	18-1	23-10	Note a
	Douglas fir-larch	#2	11-3	17-8	23-4	Note a
	Douglas fir-larch	#3	9-7	14-1	17-10	21-9
	Hem-fir	SS	11-3	17-8	23-4	Note a
	Hem-fir	#1	11-0	17-4	22-10	Note a
	Hem-fir	#2	10-6	16-6	21-9	Note a
	Hem-fir	#3	9-5	13-9	17-5	21-3
	Southern pine	SS	11-9	18-5	24-3	Note a
	Southern pine	#1	11-3	17-8	23-10	Note a
	Southern pine	#2	10-9	16-11	21-7	25-7
	Southern pine	#3	8-9	12-11	16-3	19-9
	Spruce-pine-fir	SS	11-0	17-4	22-10	Note a
	Spruce-pine-fir	#1	10-9	16-11	22-4	Note a
	Spruce-pine-fir	#2	10-9	16-11	22-4	Note a
	Spruce-pine-fir	#3	9-5	13-9	17-5	21-3

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.5.1(1)—continued**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES (Uninhabitable attics without storage, live load = 10 psf,  $L/\Delta = 240$ )**

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 5 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	11-3	17-8	23-3	Note a
	Douglas fir-larch	#1	10-10	17-0	22-5	Note a
	Douglas fir-larch	#2	10-7	16-8	21-4	26-0
	Douglas fir-larch	#3	8-9	12-10	16-3	19-10
	Hem-fir	SS	10-7	16-8	21-11	Note a
	Hem-fir	#1	10-4	16-4	21-6	Note a
	Hem-fir	#2	9-11	15-7	20-6	25-3
	Hem-fir	#3	8-7	12-6	15-10	19-5
	Southern -pine	SS	11-0	17-4	22-10	Note a
	Southern pine	#1	10-7	16-8	22-0	Note a
	Southern pine	#2	10-2	15-7	19-8	23-5
	Southern pine	#3	8-0	11-9	14-10	18-0
	Spruce-pine-fir	SS	10-4	16-4	21-6	Note a
	Spruce-pine-fir	#1	10-2	15-11	21-0	25-8
	Spruce-pine-fir	#2	10-2	15-11	21-0	25-8
	Spruce-pine-fir	#3	8-7	12-6	15-10	19-5
24	Douglas fir-larch	SS	10-5	16-4	21-7	Note a
	Douglas fir-larch	#1	10-0	15-9	20-1	24-6
	Douglas fir-larch	#2	9-10	15-0	19-1	23-3
	Douglas fir-larch	#3	7-10	11-6	14-7	17-9
	Hem-fir	SS	9-10	15-6	20-5	Note a
	Hem-fir	#1	9-8	15-2	19-10	24-3
	Hem-fir	#2	9-2	14-5	18-6	22-7
	Hem-fir	#3	7-8	11-2	14-2	17-4
	Southern pine	SS	10-3	16-1	21-2	Note a
	Southern pine	#1	9-10	15-6	20-5	24-0
	Southern pine	#2	9-3	13-11	17-7	20-11
	Southern pine	#3	7-2	10-6	13-3	16-1
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5
	Spruce-pine-fir	#1	9-5	14-9	18-9	22-11
	Spruce-pine-fir	#2	9-5	14-9	18-9	22-11
	Spruce-pine-fir	#3	7-8	11-2	14-2	17-4

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.5.1(2)**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES (Uninhabitable attics with limited storage, live load = 20 psf,  $L/\Delta = 240$ )**

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
12	Douglas fir-larch	SS	10-5	16-4	21-7	Note a
	Douglas fir-larch	#1	10-0	15-9	20-1	24-6
	Douglas fir-larch	#2	9-10	15-0	19-1	23-3
	Douglas fir-larch	#3	7-10	11-6	14-7	17-9
	Hem-fir	SS	9-10	15-6	20-5	Note a
	Hem-fir	#1	9-8	15-2	19-10	24-3
	Hem-fir	#2	9-2	14-5	18-6	22-7
	Hem-fir	#3	7-8	11-2	14-2	17-4
	Southern pine	SS	10-3	16-1	21-2	Note a
	Southern pine	#1	9-10	15-6	20-5	24-0
	Southern pine	#2	9-3	13-11	17-7	20-11
	Southern pine	#3	7-2	10-6	13-3	16-1
	Spruce-pine-fir	SS	9-8	15-2	19-11	25-5
	Spruce-pine-fir	#1	9-5	14-9	18-9	22-11
	Spruce-pine-fir	#2	9-5	14-9	18-9	22-11
	Spruce-pine-fir	#3	7-8	11-2	14-2	17-4
16	Douglas fir-larch	SS	9-6	14-11	19-7	25-0
	Douglas fir-larch	#1	9-1	13-9	17-5	21-3
	Douglas fir-larch	#2	8-11	13-0	16-6	20-2
	Douglas fir-larch	#3	6-10	9-11	12-7	15-5
	Hem-fir	SS	8-11	14-1	18-6	23-8
	Hem-fir	#1	8-9	13-7	17-2	21-0
	Hem-fir	#2	8-4	12-8	16-0	19-7
	Hem-fir	#3	6-8	9-8	12-4	15-0
	Southern pine	SS	9-4	14-7	19-3	24-7
	Southern pine	#1	8-11	14-0	17-9	20-9
	Southern pine	#2	8-0	12-0	15-3	18-1
	Southern pine	#3	6-2	9-2	11-6	14-0
	Spruce-pine-fir	SS	8-9	13-9	18-1	23-1
	Spruce-pine-fir	#1	8-7	12-10	16-3	19-10
	Spruce-pine-fir	#2	8-7	12-10	16-3	19-10
	Spruce-pine-fir	#3	6-8	9-8	12-4	15-0

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.5.1(2)—continued**  
**CEILING JOIST SPANS FOR COMMON LUMBER SPECIES (Uninhabitable attics with limited storage, live load = 20 psf,  $L/\Delta = 240$ )**

CEILING JOIST SPACING (inches)	SPECIES AND GRADE		DEAD LOAD = 10 psf			
			2 × 4	2 × 6	2 × 8	2 × 10
			Maximum ceiling joist spans			
			(feet-inches)	(feet-inches)	(feet-inches)	(feet-inches)
19.2	Douglas fir-larch	SS	8-11	14-0	18-5	23-7
	Douglas fir-larch	#1	8-7	12-6	15-10	19-5
	Douglas fir-larch	#2	8-2	11-11	15-1	18-5
	Douglas fir-larch	#3	6-2	9-1	11-6	14-1
	Hem-fir	SS	8-5	13-3	17-5	22-3
	Hem-fir	#1	8-3	12-4	15-8	19-2
	Hem-fir	#2	7-10	11-7	14-8	17-10
	Hem-fir	#3	6-1	8-10	11-3	13-8
	Southern pine	SS	8-9	13-9	18-2	23-1
	Southern pine	#1	8-5	12-9	16-2	18-11
	Southern pine	#2	7-4	11-0	13-11	16-6
	Southern pine	#3	5-8	8-4	10-6	12-9
	Spruce-pine-fir	SS	8-3	12-11	17-1	21-8
	Spruce-pine-fir	#1	8-0	11-9	14-10	18-2
	Spruce-pine-fir	#2	8-0	11-9	14-10	18-2
	Spruce-pine-fir	#3	6-1	8-10	11-3	13-8
24	Douglas fir-larch	SS	8-3	13-0	17-2	21-3
	Douglas fir-larch	#1	7-8	11-2	14-2	17-4
	Douglas fir-larch	#2	7-3	10-8	13-6	16-5
	Douglas fir-larch	#3	5-7	8-1	10-3	12-7
	Hem-fir	SS	7-10	12-3	16-2	20-6
	Hem-fir	#1	7-7	11-1	14-0	17-1
	Hem-fir	#2	7-1	10-4	13-1	16-0
	Hem-fir	#3	5-5	7-11	10-0	12-3
	Southern pine	SS	8-1	12-9	16-10	21-6
	Southern pine	#1	7-8	11-5	14-6	16-11
	Southern pine	#2	6-7	9-10	12-6	14-9
	Southern pine	#3	5-1	7-5	9-5	11-5
	Spruce-pine-fir	SS	7-8	12-0	15-10	19-5
	Spruce-pine-fir	#1	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#2	7-2	10-6	13-3	16-3
	Spruce-pine-fir	#3	5-5	7-11	10-0	12-3

Check sources for availability of lumber in lengths greater than 20 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Span exceeds 26 feet in length.

## ROOF-CEILING CONSTRUCTION

**R802.5.2 Ceiling joist and rafter connections.** Where ceiling joists run parallel to rafters and are located in the bottom third of the rafter height, they shall be installed in accordance with Figure R802.4.5 and fastened to rafters in accordance with Table R802.5.2(1). Where the ceiling joists are installed above the bottom third of the rafter height, the ridge shall be designed as a beam in accordance with Section R802.3. Where ceiling joists do not run parallel to rafters, rafters shall be tied across the structure with a rafter tie in accordance with Section R802.5.2.2, or the ridge shall be designed as a beam in accordance with Section R802.3.

**TABLE R802.5.2(2)**  
**HEEL JOINT CONNECTION ADJUSTMENT FACTORS**

$H_c/H_R^{a,b}$	HEEL JOINT CONNECTION ADJUSTMENT FACTOR
1/3	1.5
1/4	1.33
1/5	1.25
1/6	1.2
1/10 or less	1.11

a.  $H_c$  = Height of ceiling joists or rafter ties measured vertically from the top of the rafter support walls to the bottom of the ceiling joists or rafter ties;  $H_R$  = Height of roof ridge measured vertically from the top of the rafter support walls to the bottom of the roof ridge.

b. Where  $H_c/H_R$  exceeds 1/3, connections shall be designed in accordance with accepted engineering practice.

**TABLE R802.5.2(1)**  
**RAFTER/CEILING JOIST HEEL JOINT CONNECTIONS<sup>a</sup>**

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)											
		20°			30			50			70		
		Roof span (feet)											
		12	24	36	12	24	36	12	24	36	12	24	36
		Required number of 16d common nails per heel joint splices <sup>a, b, c, d, f</sup>											
3:12	12	3	5	8	3	6	9	5	9	13	6	12	17
	16	4	7	10	4	8	12	6	12	17	8	15	23
	19.2	4	8	12	5	10	14	7	14	21	9	18	27
	24	5	10	15	6	12	18	9	17	26	12	23	34
4:12	12	3	4	6	3	5	7	4	7	10	5	9	13
	16	3	5	8	3	6	9	5	9	13	6	12	17
	19.2	3	6	9	4	7	11	6	11	16	7	14	21
	24	4	8	11	5	9	13	7	13	19	9	17	26
5:12	12	3	3	5	3	4	6	3	6	8	4	7	11
	16	3	4	6	3	5	7	4	7	11	5	9	14
	19.2	3	5	7	3	6	9	5	9	13	6	11	17
	24	3	6	9	4	7	11	6	11	16	7	14	21
7:12	12	3	3	4	3	3	4	3	4	6	3	5	8
	16	3	3	5	3	4	5	3	5	8	4	7	10
	19.2	3	4	5	3	4	6	3	6	9	4	8	12
	24	3	5	7	3	5	8	4	8	11	5	10	15
9:12	12	3	3	3	3	3	3	3	3	5	3	4	6
	16	3	3	4	3	3	4	3	4	6	3	5	8
	19.2	3	3	4	3	4	5	3	5	7	3	6	9
	24	3	4	5	3	4	6	3	6	9	4	8	12
12:12	12	3	3	3	3	3	3	3	3	4	3	3	5
	16	3	3	3	3	3	3	3	3	5	3	4	6
	19.2	3	3	3	3	3	4	3	4	6	3	5	7
	24	3	3	4	3	3	5	3	5	7	3	6	9

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

- 10d common (3" × 0.148") nails shall be permitted to be substituted for 16d common (3 1/2" × 0.162") nails where the required number of nails is taken as 1.2 times the required number of 16d common nails, rounded up to the next full nail.
- Heel joint connections are not required where the ridge is supported by a load-bearing wall, header or ridge beam.
- Where intermediate support of the rafter is provided by vertical struts or purlins to a load-bearing wall, the tabulated heel joint connection requirements shall be permitted to be reduced proportionally to the reduction in span.
- Equivalent nailing patterns are required for ceiling joist to ceiling joist lap splices.
- Applies to roof live load of 20 psf or less.
- Tabulated heel joint connection requirements assume that ceiling joists or rafter ties are located at the bottom of the attic space. Where ceiling joists or rafter ties are located higher in the attic, heel joint connection requirements shall be increased by the adjustment factors in Table 802.5.2(2).
- Tabulated requirements are based on 10 psf roof dead load in combination with the specified roof snow load and roof live load.



**R802.5.2.1 Ceiling joists lapped.** Ends of ceiling joists shall be lapped not less than 3 inches (76 mm) or butted over bearing partitions or beams and toenailed to the bearing member. Where ceiling joists are used to provide the continuous tie across the building, lapped joists shall be nailed together in accordance with Table R802.5.2(1) and butted joists shall be tied together with a connection of equivalent capacity. Laps in joists that do not provide the continuous tie across the building shall be permitted to be nailed in accordance with Table R602.3(1).

**R802.5.2.2 Rafter ties.** Wood rafter ties shall be not less than 2 inches by 4 inches (51 mm × 102 mm) installed in accordance with Table R802.5.2(1) at a maximum of 24 inches (610 mm) on center. Other *approved* rafter tie methods shall be permitted.

**R802.5.2.3 Blocking.** Blocking shall be not less than utility grade lumber.

**R802.6 Bearing.** The ends of each rafter or ceiling joist shall have not less than  $1\frac{1}{2}$  inches (38 mm) of bearing on wood or metal and not less than 3 inches (76 mm) on masonry or concrete. The bearing on masonry or concrete shall be direct, or a sill plate of 2-inch (51 mm) minimum nominal thickness shall be provided under the rafter or ceiling joist. The sill plate shall provide a minimum nominal bearing area of 48 square inches (30 968 mm<sup>2</sup>). Where the roof pitch is greater than or equal to 3 units vertical in 12 units horizontal (25-percent slope), and ceiling joists or rafter ties are connected to rafters to provide a continuous tension tie in accordance

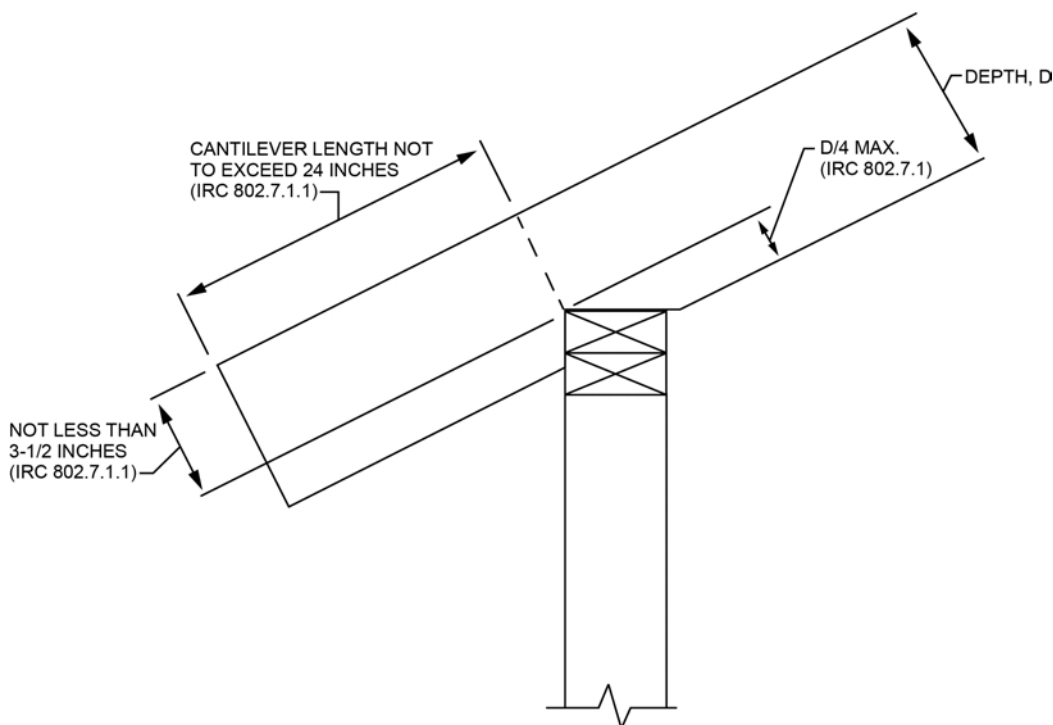
with Section R802.5.2, vertical bearing of the top of the rafter against the ridge board shall satisfy this bearing requirement.

**R802.6.1 Finished ceiling material.** If the finished ceiling material is installed on the ceiling prior to the attachment of the ceiling to the walls, such as in construction at a factory, a compression strip of the same thickness as the finished ceiling material shall be installed directly above the top plate of bearing walls if the compressive strength of the finished ceiling material is less than the loads it will be required to withstand. The compression strip shall cover the entire length of such top plate and shall be not less than one-half the width of the top plate. It shall be of material capable of transmitting the loads transferred through it.

**R802.7 Cutting, drilling and notching.** Structural roof members shall not be cut, bored or notched in excess of the limitations specified in this section.

**R802.7.1 Sawn lumber.** Cuts, notches and holes in solid lumber joists, rafters, blocking and beams shall comply with the provisions of Section R502.8.1 except that cantilevered portions of rafters shall be permitted in accordance with Section R802.7.1.1.

**R802.7.1.1 Cantilevered portions of rafters.** Notches on cantilevered portions of rafters are permitted provided the dimension of the remaining portion of the rafter is not less than  $3\frac{1}{2}$  inches (89 mm) and the length of the cantilever does not exceed 24 inches (610 mm) in accordance with Figure R802.7.1.1.



For SI: 1 inch = 25.4 mm.

**FIGURE R802.7.1.1  
RAFTER NOTCH**

## ROOF-CEILING CONSTRUCTION

**R802.7.1.2 Ceiling joist taper cut.** Taper cuts at the ends of the ceiling joist shall not exceed one-fourth the depth of the member in accordance with Figure R802.7.1.2.

**R802.7.2 Engineered wood products.** Cuts, notches and holes bored in trusses, *structural composite lumber*, structural glue-laminated members, cross-laminated timber members or I-joists are prohibited except where permitted by the manufacturer's recommendations or where the effects of such alterations are specifically considered in the design of the member by a *registered design professional*.

**R802.8 Lateral support.** Roof framing members and ceiling joists having a depth-to-thickness ratio exceeding 5 to 1 based on nominal dimensions shall be provided with lateral support at points of bearing to prevent rotation. For roof rafters with ceiling joists attached in accordance with Table R602.3(1), the depth-to-thickness ratio for the total assembly shall be determined using the combined thickness of the rafter plus the attached ceiling joist.

**Exception:** Roof trusses shall be braced in accordance with Section R802.10.3.

**R802.8.1 Bridging.** Rafters and ceiling joists having a depth-to-thickness ratio exceeding 6 to 1 based on nominal dimensions shall be supported laterally by solid blocking, diagonal bridging (wood or metal) or a continuous 1-inch by 3-inch (25 mm by 76 mm) wood strip nailed across the rafters or ceiling joists at intervals not exceeding 8 feet (2438 mm).

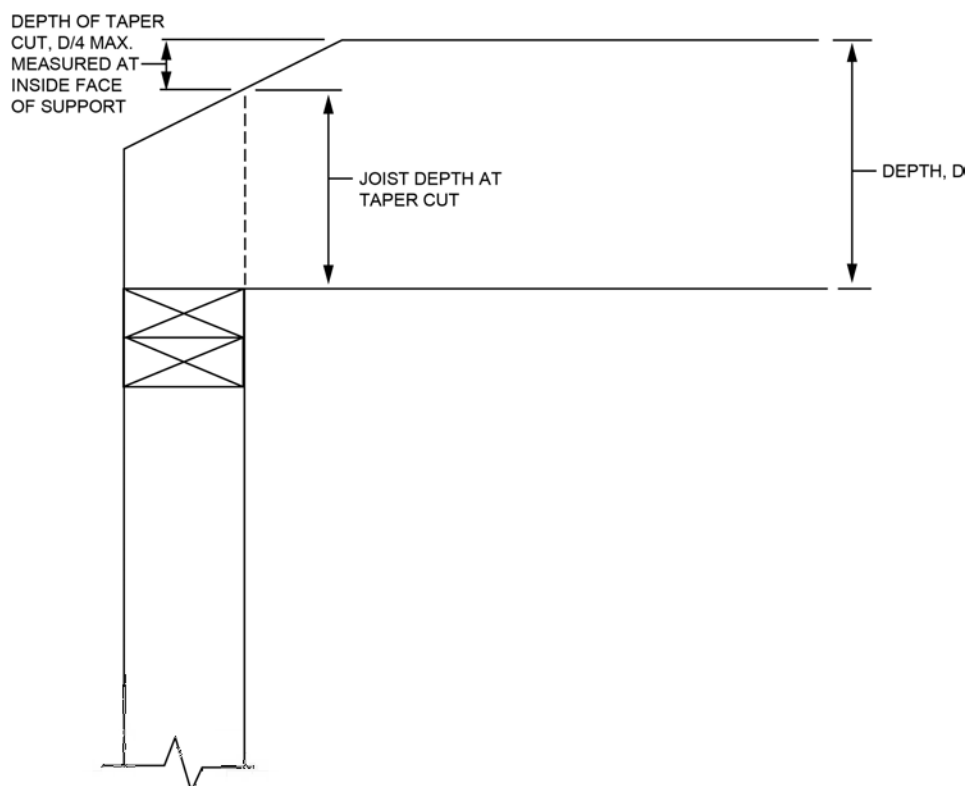


FIGURE R802.7.1.2  
CEILING JOIST TAPER CUT

**R802.9 Framing of openings.** Openings in roof and ceiling framing shall be framed with header and trimmer joists. Where the header joist span does not exceed 4 feet (1219 mm), the header joist shall be permitted to be a single member the same size as the ceiling joist or rafter. Single trimmer joists shall be permitted to be used to carry a single header joist that is located within 3 feet (914 mm) of the trimmer joist bearing. Where the header joist span exceeds 4 feet (1219 mm), the trimmer joists and the header joist shall be doubled and of sufficient cross section to support the ceiling joists or rafter framing into the header. *Approved* hangers shall be used for the header joist to trimmer joist connections where the header joist span exceeds 6 feet (1829 mm). Tail joists over 12 feet (3658 mm) long shall be supported at the header by framing anchors or on ledger strips not less than 2 inches by 2 inches (51 mm by 51 mm).

### R802.10 Wood trusses.

**R802.10.1 Truss design drawings.** *Truss design drawings*, prepared in conformance to Section R802.10.1, shall be provided to the *building official* and *approved* prior to installation. *Truss design drawings* shall be provided with the shipment of trusses delivered to the job site. *Truss design drawings* shall include, at a minimum, the following information:

1. Slope or depth, span and spacing.
2. Location of all joints.
3. Required bearing widths.

4. Design loads as applicable.
  - 4.1. Top chord *live load* (as determined from Section R301.6).
  - 4.2. Top chord dead load.
  - 4.3. Bottom chord *live load*.
  - 4.4. Bottom chord dead load.
  - 4.5. Concentrated loads and their points of application.
  - 4.6. Controlling wind and earthquake loads.
5. Adjustments to lumber and joint connector design values for conditions of use.
6. Each reaction force and direction.
7. Joint connector type and description such as size, thickness or gage and the dimensioned location of each joint connector except where symmetrically located relative to the joint interface.
8. Lumber size, species and *grade for each member*.
9. Connection requirements for:
  - 9.1. Truss to girder-truss.
  - 9.2. Truss ply to ply.
  - 9.3. Field splices.
10. Calculated deflection ratio or maximum description for live and total load.
11. Maximum axial compression forces in the truss members to enable the building designer to design the size, connections and anchorage of the permanent continuous lateral bracing. Forces shall be shown on the *truss design drawing* or on supplemental documents.
12. Required permanent truss member bracing location.

**R802.10.2 Design.** Wood trusses shall be designed in accordance with accepted engineering practice. The design and manufacture of metal-plate-connected wood trusses shall comply with ANSI/TPI 1. The *truss design drawings* shall be prepared by a *registered design professional* where required by the statutes of the *jurisdiction* in which the project is to be constructed in accordance with Section R106.1.

**R802.10.2.1 Applicability limits.** The provisions of this section shall control the design of truss roof framing where snow controls for buildings that are not greater than 60 feet (18 288 mm) in length perpendicular to the joist, rafter or truss span, not greater than 36 feet (10 973 mm) in width parallel to the joist, rafter or truss span, not more than three stories above *grade plane* in height, and have roof slopes not smaller than 3:12 (25-percent slope) or greater than 12:12 (100-percent slope). Truss roof framing constructed in accordance with the provisions of this section shall be limited to sites subjected to a maximum design wind speed of 140 miles per hour (63 m/s), Exposure B or

C, and a maximum ground snow load of 70 psf (3352 Pa). For consistent loading of all truss types, roof snow load is to be computed as:  $0.7 p_g$ .

**R802.10.3 Bracing.** Trusses shall be braced to prevent rotation and provide lateral stability in accordance with the requirements specified in the *construction documents* for the building and on the individual *truss design drawings*. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practice such as the SBCA *Building Component Safety Information (BCSI) Guide to Good Practice for Handling, Installing & Bracing of Metal Plate Connected Wood Trusses*.

**R802.10.4 Alterations to trusses.** Truss members shall not be cut, notched, drilled, spliced or otherwise altered in any way without the approval of a registered *design professional*. *Alterations* resulting in the addition of load such as HVAC equipment water heater that exceeds the design load for the truss shall not be permitted without verification that the truss is capable of supporting such additional loading.

**R802.11 Roof tie uplift resistance.** *Roof assemblies* shall have uplift resistance in accordance with Sections R802.11.1 and R802.11.2.

**Exceptions:** Rafters or trusses shall be permitted to be attached to their supporting wall assemblies in accordance with Table R602.3(1) where either of the following occur:

1. Where the uplift force per rafter or truss does not exceed 200 pounds (90.8 kg) as determined by Table R802.11.
2. Where the basic wind speed does not exceed 115 miles per hour (51.4 m/s), the wind exposure category is B, the roof pitch is 5 units vertical in 12 units horizontal (42-percent slope) or greater, the roof span is 32 feet (9754 mm) or less, and rafters and trusses are spaced not more than 24 inches (610 mm) on center.

**R802.11.1 Truss uplift resistance.** Trusses shall be attached to supporting wall assemblies by connections capable of resisting uplift forces as specified on the *truss design drawings* for the ultimate design wind speed as determined by Figure R301.2(2) and listed in Table R301.2 or as shown on the *construction documents*. Uplift forces shall be permitted to be determined as specified by Table R802.11, if applicable, or as determined by accepted engineering practice.

**R802.11.2 Rafter uplift resistance.** Individual rafters shall be attached to supporting wall assemblies by connections capable of resisting uplift forces as determined by Table R802.11 or as determined by accepted engineering practice. Connections for beams used in a roof system shall be designed in accordance with accepted engineering practice.

## ROOF-CEILING CONSTRUCTION

**TABLE R802.11**  
**RAFTER OR TRUSS UPLIFT CONNECTION FORCES FROM WIND (ASD) (POUNDS PER CONNECTION)<sup>a, b, c, d, e, f, g, h</sup>**

RAFTER OR TRUSS SPACING	ROOF SPAN (feet)	EXPOSURE B									
		Ultimate Design Wind Speed $V_{ULT}$ (mph)									
		110		115		120		130		140	
		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch	
		< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12
12" o.c.	12	48	43	59	53	70	64	95	88	122	113
	18	59	52	74	66	89	81	122	112	157	146
	24	71	62	89	79	108	98	149	137	192	178
	28	79	69	99	88	121	109	167	153	216	200
	32	86	75	109	97	134	120	185	170	240	222
	36	94	82	120	106	146	132	203	186	264	244
	42	106	92	135	120	166	149	230	211	300	278
	48	118	102	151	134	185	166	258	236	336	311
16" o.c.	12	64	57	78	70	93	85	126	117	162	150
	18	78	69	98	88	118	108	162	149	209	194
	24	94	82	118	105	144	130	198	182	255	237
	28	105	92	132	117	161	145	222	203	287	266
	32	114	100	145	129	178	160	246	226	319	295
	36	125	109	160	141	194	176	270	247	351	325
	42	141	122	180	160	221	198	306	281	399	370
	48	157	136	201	178	246	221	343	314	447	414
24" o.c.	12	96	86	118	106	140	128	190	176	244	226
	18	118	104	148	132	178	162	244	224	314	292
	24	142	124	178	158	216	196	298	274	384	356
	28	158	138	198	176	242	218	334	306	432	400
	32	172	150	218	194	268	240	370	340	480	444
	36	188	164	240	212	292	264	406	372	528	488
	42	212	184	270	240	332	298	460	422	600	556
	48	236	204	302	268	370	332	516	472	672	622
		EXPOSURE C									
12" o.c.	12	95	88	110	102	126	118	161	151	198	186
	18	121	111	141	131	163	151	208	195	257	242
	24	148	136	173	160	200	185	256	239	317	298
	28	166	152	195	179	225	208	289	269	358	335
	32	184	168	216	199	249	231	321	299	398	373
	36	202	185	237	219	274	254	353	329	438	411
	42	229	210	269	248	312	289	402	375	499	468
	48	256	234	302	278	349	323	450	420	560	524
16" o.c.	12	126	117	146	136	168	157	214	201	263	247
	18	161	148	188	174	217	201	277	259	342	322
	24	197	181	230	213	266	246	340	318	422	396
	28	221	202	259	238	299	277	384	358	476	446
	32	245	223	287	265	331	307	427	398	529	496
	36	269	246	315	291	364	338	469	438	583	547
	42	305	279	358	330	415	384	535	499	664	622
	48	340	311	402	370	464	430	599	559	745	697

(continued)

## ROOF-CEILING CONSTRUCTION

**TABLE R802.11—continued**  
**RAFTER OR TRUSS UPLIFT CONNECTION FORCES FROM WIND (ASD) (POUNDS PER CONNECTION)<sup>a, b, c, d, e, f, g, h</sup>**

RAFTER OR TRUSS SPACING	ROOF SPAN (feet)	EXPOSURE B									
		Ultimate Design Wind Speed $V_{ULT}$ (mph)									
		110		115		120		130		140	
		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch		Roof Pitch	
		< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12	< 5:12	≥ 5:12
24" o.c.	12	190	176	220	204	252	236	322	302	396	372
	18	242	222	282	262	326	302	416	390	514	484
	24	296	272	346	320	400	370	512	478	634	596
	28	332	304	390	358	450	416	578	538	716	670
	32	368	336	432	398	498	462	642	598	796	746
	36	404	370	474	438	548	508	706	658	876	822
	42	458	420	538	496	624	578	804	750	998	936
	48	512	468	604	556	698	646	900	840	1,120	1,048

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s, 1 pound = 0.454 kg, 1 pound per square foot = 47.9 N/m<sup>2</sup>,  
1 pound per linear foot = 14.6 N/m.

- The uplift connection forces are based on a maximum 33-foot mean roof height and Wind Exposure Category B or C. For Exposure D, the uplift connection force shall be selected from the Exposure C portion of the table using the next highest tabulated ultimate design wind speed. The adjustment coefficients in Table R301.2.1(2) shall not be used to multiply the tabulated forces for Exposures C and D or for other mean roof heights.
- The uplift connection forces include an allowance for roof and ceiling assembly dead load of 15 psf.
- The tabulated uplift connection forces are limited to a maximum roof overhang of 24 inches.
- The tabulated uplift connection forces shall be permitted to be multiplied by 0.75 for connections not located within 8 feet of building corners.
- For buildings with hip roofs with 5:12 and greater pitch, the tabulated uplift connection forces shall be permitted to be multiplied by 0.70. This reduction shall not be combined with any other reduction in tabulated forces.
- For wall-to-wall and wall-to-foundation connections, the uplift connection force shall be permitted to be reduced by 60 pounds per linear foot for each full wall above.
- Linear interpolation between tabulated roof spans and wind speeds shall be permitted.
- The tabulated forces for a 12-inch on-center spacing shall be permitted to be used to determine the uplift load in pounds per linear foot.



## ROOF-CEILING CONSTRUCTION

SECTION R803  
ROOF SHEATHING

**R803.1 Lumber sheathing.** Allowable spans for lumber used as roof sheathing shall conform to Table R803.1. Spaced lumber sheathing for wood shingle and shake roofing shall conform to the requirements of Sections R905.7 and R905.8. Spaced lumber sheathing is not allowed in Seismic Design Category D<sub>2</sub>.

**TABLE R803.1**  
**MINIMUM THICKNESS OF LUMBER ROOF SHEATHING**

RAFTER OR BEAM SPACING (inches)	MINIMUM NET THICKNESS (inches)
24	$\frac{5}{8}$
48 <sup>a</sup>	1½ T & G
60 <sup>b</sup>	
72 <sup>c</sup>	

For SI: 1 inch = 25.4 mm.

a. Minimum  $270F_b$ , 340,000E.

b. Minimum  $420F_b$ , 660,000E.

c. Minimum  $600F_b$ , 1,150,000E.

**R803.2 Wood structural panel sheathing.**

**R803.2.1 Identification and grade.** *Wood structural panels* shall conform to DOC PS 1, DOC PS 2, CSA O325 or CSA O437, and shall be identified for grade, bond classification and performance category by a grade mark or certificate of inspection issued by an *approved* agency. *Wood structural panels* shall comply with the grades specified in Table R503.2.1.1(1).

**R803.2.1.1 Exposure durability.** *Wood structural panels*, when designed to be permanently exposed in outdoor applications, shall be of an exterior exposure durability. *Wood structural panel* roof sheathing exposed to the underside shall be permitted to be of interior type bonded with exterior glue, identified as Exposure 1.

**R803.2.1.2 Fire-retardant-treated plywood.** The allowable unit stresses for fire-retardant-treated plywood, including fastener values, shall be developed from an *approved* method of investigation that considers the effects of anticipated temperature and humidity to which the fire-retardant-treated plywood will be subjected, the type of treatment and redrying process. The fire-retardant-treated plywood shall be graded by an *approved* agency.

**R803.2.2 Allowable spans.** The maximum allowable spans for *wood structural panel* roof sheathing shall not exceed the values set forth in Table R503.2.1.1(1) or APA E30.

**R803.2.3 Installation.** *Wood structural panel* used as roof sheathing shall be installed with joints staggered or not staggered in accordance with Table R602.3(1), APA E30 for wood roof framing or with Table R804.3 for cold-

formed steel roof framing. Wood structural panel roof sheathing in accordance with Table R503.2.1.1(1) shall not cantilever more than 9 inches (229 mm) beyond the gable endwall unless supported by gable overhang framing.

SECTION R804  
COLD-FORMED STEEL ROOF FRAMING

**R804.1 General.** Elements shall be straight and free of any defects that would significantly affect their structural performance. Cold-formed steel roof framing members shall be in accordance with the requirements of this section.

**R804.1.1 Applicability limits.** The provisions of this section shall control the construction of cold-formed steel roof framing for buildings not greater than 60 feet (18 288 mm) perpendicular to the joist, rafter or truss span, not greater than 40 feet (12 192 mm) in width parallel to the joist span or truss, less than or equal to three stories above *grade* plane and with roof slopes not less than 3:12 (25-percent slope) or greater than 12:12 (100-percent slope). Cold-formed steel roof framing constructed in accordance with the provisions of this section shall be limited to sites where the ultimate design wind speed is less than 140 miles per hour (63 m/s), Exposure Category B or C, and the ground snow load is less than or equal to 70 pounds per square foot (3350 Pa).

**R804.1.1.1 Alternate applications.** Cold-formed steel roof and ceiling framing for buildings exceeding the applicability limits of Section R804.1.1 is permitted to be designed and constructed in accordance with AISI S230, subject to the limits therein.

**R804.1.2 In-line framing.** Cold-formed steel roof framing constructed in accordance with Section R804 shall be located in line with the tolerances specified in AISI S240, Section B1.2.3.

**R804.2 Structural framing.** Load-bearing, cold-formed steel roof framing members shall be in accordance with this section.

**R804.2.1 Material.** Load-bearing, cold-formed steel framing members shall be cold formed to shape from structural quality sheet steel complying with the requirements of AISI S240, Section A3.

**R804.2.2 Corrosion protection.** Load-bearing, cold-formed steel framing shall have a protective coating complying with AISI S240, Section A4.

**R804.2.3 Dimension, thickness and material grade.** Load-bearing, cold-formed steel roof framing members shall comply with AISI S230, Section A4.3 and material grade requirements as specified in AISI S230, Section A4.4.

**R804.2.4 Identification.** Load-bearing, cold-formed steel framing members shall meet the product identification requirements of AISI S240, Section A5.5.

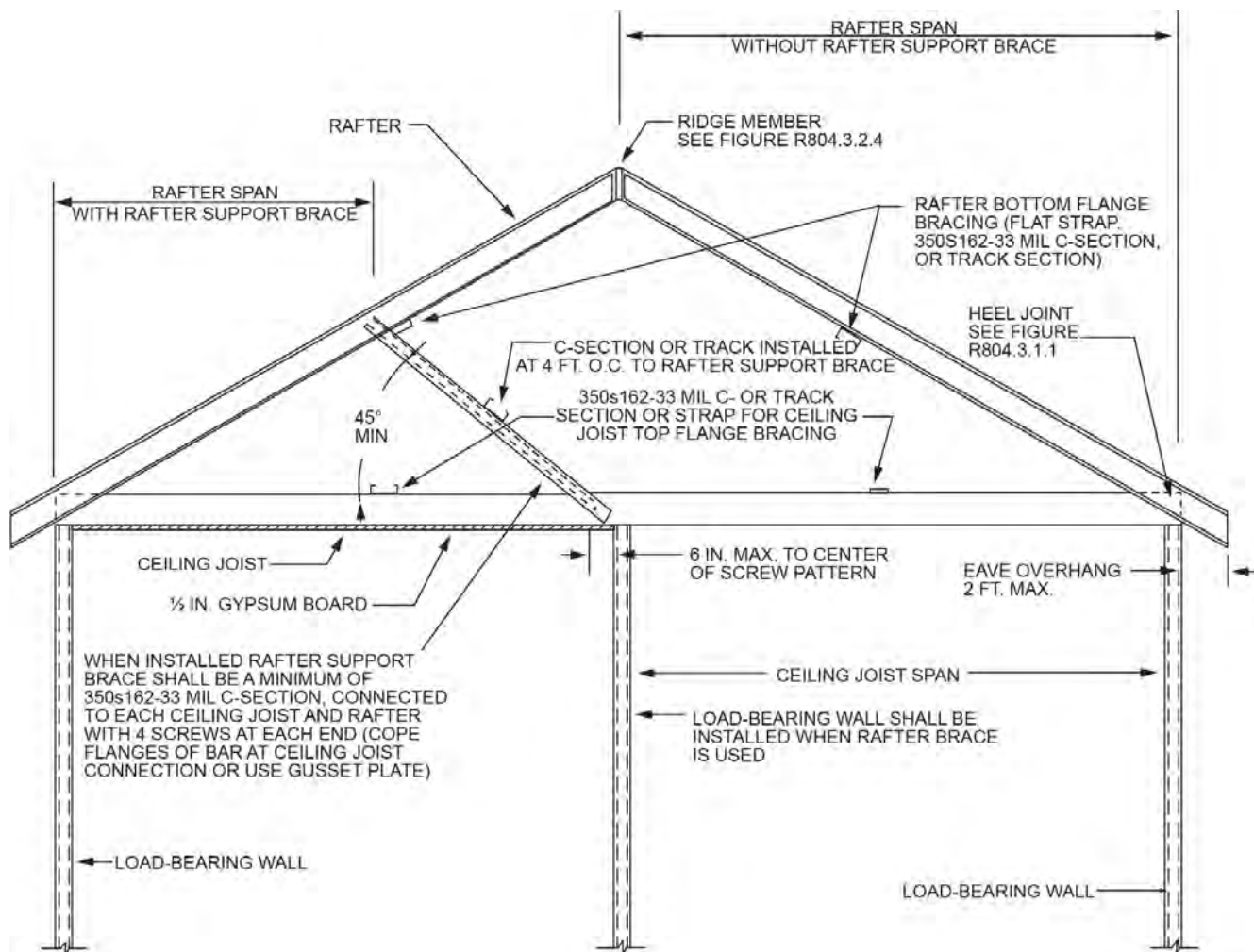
**R804.2.5 Fastening requirements.** Screws for steel-to-steel connections shall be installed with a minimum edge distance and center-to-center spacing of  $\frac{1}{2}$  inch (12.7 mm), shall be self-drilling tapping and shall conform to ASTM C1513. Structural sheathing shall be attached to cold-formed steel roof rafters with minimum No. 8 self-drilling tapping screws that conform to ASTM C1513. Screws for attaching structural sheathing to cold-formed steel roof framing shall have a minimum head diameter of 0.292 inch (7.4 mm) with countersunk heads and shall be installed with a minimum edge distance of  $\frac{3}{8}$  inch (9.5 mm). Gypsum board ceilings shall be attached to cold-formed steel joists with minimum No. 6 screws conforming to ASTM C954 or ASTM C1513 with a bugle-head style and shall be installed in accordance with Section R805. For all connections, screws shall extend through the steel not fewer than three exposed threads. Fasteners shall have rust-inhibitive coating suitable for the installa-

tion in which they are being used, or be manufactured from material not susceptible to corrosion.

**R804.2.6 Web holes, web hole reinforcing and web hole patching.** Web holes in roof or ceiling joists shall comply with the conditions as prescribed in AISI S230, Section A4.5. Web holes not in conformance to the conditions of AISI S230, Section A4.5 shall be reinforced in accordance with the provisions of AISI S230, Section A4.6 or patched in accordance with the provisions of AISI S230, Section A4.7.

**R804.3 Roof construction.** Cold-formed steel roof systems constructed in accordance with the provisions of this section shall consist of both ceiling joists and rafters in accordance with Figure R804.3 and fastened in accordance with Table R804.3.

**R804.3.1 Ceiling joists.** Cold-formed steel ceiling joists shall be in accordance with this section.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

**FIGURE R804.3**  
**COLD-FORMED STEEL ROOF CONSTRUCTION**

## ROOF-CEILING CONSTRUCTION

**TABLE R804.3**  
**ROOF FRAMING FASTENING SCHEDULE<sup>a, b</sup>**

DESCRIPTION OF BUILDING ELEMENTS			NUMBER AND SIZE OF FASTENERS <sup>a</sup>				SPACING OF FASTENERS
Roof sheathing (oriented strand board or plywood) to rafter			No. 8 screws				6" o.c. on edges and 12" o.c. at interior supports. 6" o.c. at gable end truss.
Gypsum board to ceiling joists			No. 6 screws				12" o.c.
Gable end truss to endwall top track			No. 10 screws				12" o.c.
Rafter to ceiling joist and to ridge member			Minimum No. 10 screws, in accordance with Table R804.3.1.1(3)				Evenly spaced, not less than 1½" from all edges.
Ceiling joist or roof truss to top track of bearing wall <sup>b</sup>	Ceiling joist or truss spacing (in.)	Roof Span (ft)	Ultimate Design Wind Speed (mph) and Exposure Category				Each ceiling joist or roof truss.
			130 B 115 C	< 139 B 120 C	130 C	< 139 C	
	16	24	3	3	4	5	
		28	3	3	4	5	
		32	3	4	5	6	
		36	4	4	5	6	
		40	4	4	6	7	
	24	24	4	5	6	7	
		28	4	5	6	8	
		32	4	6	7	8	
		36	4	6	8	9	
		40	6	6	8	10	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa, 1 mil = 0.0254 mm.

a. Screws are a minimum No. 10 unless noted otherwise.

b. Indicated number of screws shall be applied through the flanges of the truss or ceiling joist or through each leg of a 54 mil clip angle. See Section R804.3.8 for additional requirements to resist uplift forces.

**R804.3.1.1 Minimum ceiling joist size.** Ceiling joist size and thickness shall be determined in accordance with the limits set forth in Tables R804.3.1.1(1) and R804.3.1.1(2). When determining the size of ceiling joists, the lateral support of the top flange shall be classified as unbraced, braced at midspan or braced at third points in accordance with Section R804.3.1.3. Where sheathing material is attached to the top flange of ceiling joists or where the bracing is spaced closer than at third points of the joists, the "third point" values from Tables R804.3.1.1(1) and R804.3.1.1(2) shall be used.

Ceiling joists shall have a bearing support length of not less than 1½ inches (38 mm) and shall be connected to roof rafters (heel joint) with No. 10 screws in accordance with Figure R804.3.1.1 and Table R804.3.1.1(3).

Where continuous joists are framed across interior bearing supports, the interior bearing supports shall be located within 24 inches (610 mm) of midspan of the ceiling joist, and the individual spans shall not exceed the applicable spans in Tables R804.3.1.1(1) and R804.3.1.1(2).

Where the attic is to be used as an *occupied space*, the ceiling joists shall be designed in accordance with Section R505.

**R804.3.1.2 Ceiling joist bottom flange bracing.** The bottom flanges of ceiling joists shall be laterally braced by the application of gypsum board or continuous steel straps installed perpendicular to the joist run in accordance with one of the following:

1. Gypsum board shall be fastened with No. 6 screws in accordance with Section R702.
2. Steel straps with a minimum size of 1½ inches by 33 mils (38 mm by 0.84 mm) shall be installed at a maximum spacing of 4 feet (1219 mm). Straps shall be fastened to the bottom flange at each joist with one No. 8 screw and shall be fastened to blocking with two No. 8 screws. Blocking shall be installed between joists at a maximum spacing of 12 feet (3658 mm) measured along a line of continuous strapping (perpendicular to the joist run), and at the termination of all straps.

## ROOF-CEILING CONSTRUCTION

**TABLE R804.3.1.1(1)**  
**CEILING JOIST SPANS 10 PSF LIVE LOAD (NO ATTIC STORAGE)<sup>a, b, c, d</sup>**

MEMBER DESIGNATION	ALLOWABLE SPAN (feet-inches)					
	Lateral Support of Top (Compression) Flange					
	Unbraced		Midspan Bracing		Third-point Bracing	
	Ceiling Joist Spacing (inches)					
	16	24	16	24	16	24
350S162-33	9'-6"	8'-6"	11'-10"	9'-10"	11'-10"	10'-4"
350S162-43	10'-4"	9'-3"	12'-10"	11'-3"	12'-10"	11'-3"
350S162-54	11'-1"	9'-11"	13'-9"	12'-0"	13'-9"	12'-0"
350S162-68	12'-2"	10'-10"	14'-9"	12'-10"	14'-9"	12'-10"
550S162-33	10'-11"	9'-10"	15'-7"	12'-0"	16'-10"	12'-0"
550S162-43	11'-8"	10'-6"	16'-10"	14'-10"	18'-4"	16'-0"
550S162-54	12'-7"	11'-3"	18'-0"	16'-2"	19'-4"	17'-2"
550S162-68	13'-7"	12'-1"	19'-3"	17'-3"	20'-6"	18'-5"
800S162-33	—	—	—	—	—	—
800S162-43	13'-1"	11'-9"	18'-9"	16'-9"	21'-2"	18'-7"
800S162-54	13'-11"	12'-6"	20'-1"	18'-1"	21'-5"	20'-5"
800S162-68	14'-11"	13'-4"	21'-4"	19'-2"	22'-9"	21'-9"
1000S162-43	—	—	—	—	—	—
1000S162-54	14'-10"	13'-4"	21'-4"	19'-2"	22'-8"	21'-8"
1000S162-68	15'-10"	14'-3"	22'-9"	20'-5"	24'-3"	23'-3"
1200S162-43	—	—	—	—	—	—
1200S162-54	—	—	—	—	—	—
1200S162-68	16'-8"	14'-11"	23'-11"	21'-7"	25'-5"	24'-5"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.

a. Deflection criterion:  $L/240$  for total loads.

b. Ceiling dead load = 5 psf.

c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

d. Listed allowable spans are not applicable for 350S162-33, 550S162-33, 550S162-43 and 800S162-43 continuous joist members.

## ROOF-CEILING CONSTRUCTION

**TABLE R804.3.1.1(2)**  
**CEILING JOIST SPANS 20 PSF LIVE LOAD (LIMITED ATTIC STORAGE)<sup>a, b, c, d</sup>**

MEMBER DESIGNATION	ALLOWABLE SPAN (feet-inches)					
	Lateral Support of Top (Compression) Flange					
	Unbraced		Midspan Bracing		Third-point Bracing	
	Ceiling Joist Spacing (inches)					
	16	24	16	24	16	24
350S162-33	8'-0"	6'-5"	9'-2"	7'-5"	9'-11"	7'-5"
350S162-43	8'-11"	7'-8"	10'-9"	8'-9"	10'-0"	9'-6"
350S162-54	9'-7"	8'-7"	11'-7"	10'-2"	11'-7"	10'-2"
350S162-68	10'-4"	9'-3"	12'-5"	10'-10"	12'-5"	10'-10"
550S162-33	9'-5"	6'-11"	10'-5"	6'-11"	10'-5"	6'-11"
550S162-43	10'-2"	9'-2"	14'-2"	11'-8"	15'-2"	11'-8"
550S162-54	10'-10"	9'-9"	15'-7"	14'-0"	16'-7"	14'-5"
550S162-68	11'-8"	10'-5"	16'-7"	14'-10"	17'-9"	15'-6"
800S162-33	—	—	—	—	—	—
800S162-43	11'-4"	10'-2"	16'-1"	11'-0"	16'-6"	11'-0"
800S162-54	12'-0"	10'-10"	17'-4"	15'-7"	18'-7"	17'-7"
800S162-68	12'-10"	11'-6"	18'-6"	16'-7"	19'-11"	18'-11"
1000S162-43	—	—	—	—	—	—
1000S162-54	12'-10"	11'-7"	18'-5"	16'-6"	19'-8"	18'-8"
1000S162-68	13'-8"	12'-3"	19'-8"	17'-9"	21'-1"	20'-1"
1200S162-43	—	—	—	—	—	—
1200S162-54	—	—	—	—	—	—
1200S162-68	14'-5"	12'-11"	20'-9"	18'-7"	22'-0"	21'-0"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm, 1 pound per square foot = 0.0479 kPa.

a. Deflection criterion:  $L/240$  for total loads.

b. Ceiling dead load = 5 psf.

c. Minimum Grade 33 ksi steel shall be used for 33 mil and 43 mil thicknesses. Minimum Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

d. Listed allowable spans are not applicable for 350S162-33, 350S162-43, 550S162-33, 550S162-43 and 800S162-43 continuous joist members.

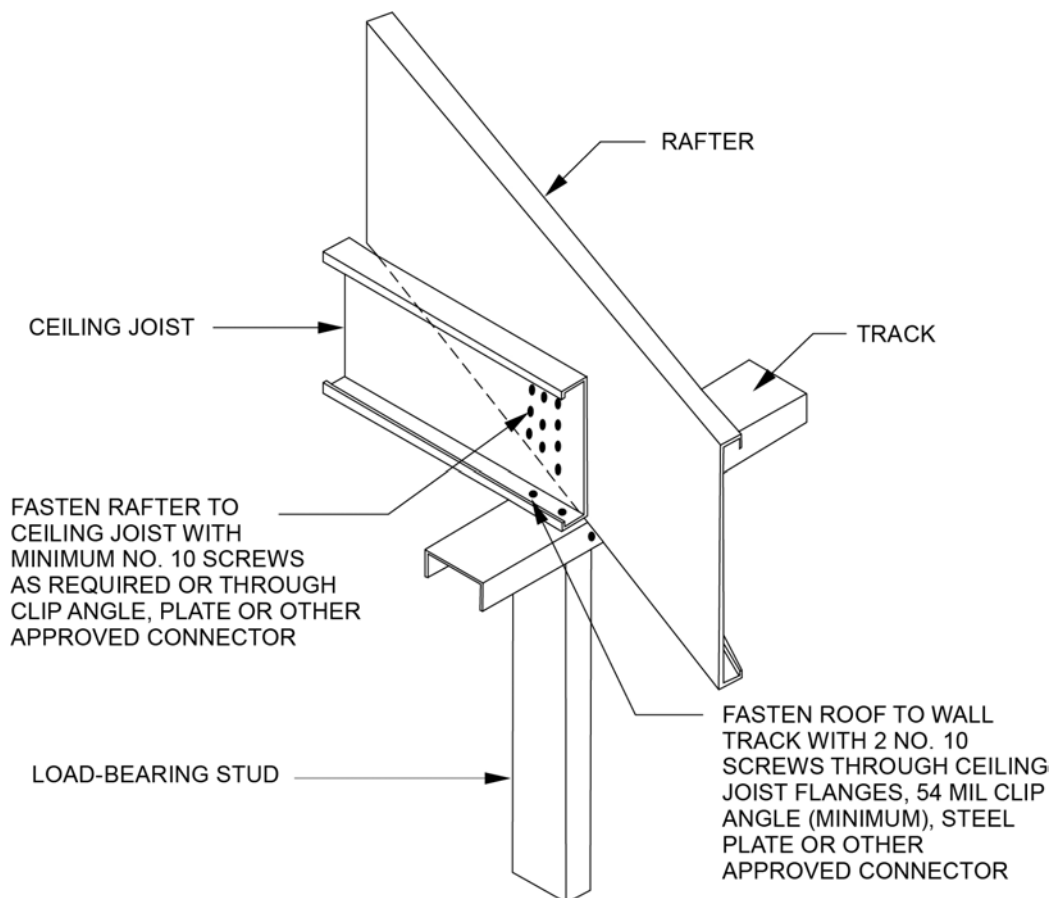


**TABLE R804.3.1.1(3)**  
**NUMBER OF SCREWS REQUIRED FOR CEILING JOIST TO ROOF RAFTER CONNECTION<sup>a</sup>**

ROOF SLOPE	NUMBER OF SCREWS																			
	Building width (feet)																			
	24				28				32				36				40			
	Ground snow load (psf)																			
	20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70	20	30	50	70
3/12	5	6	9	11	5	7	10	13	6	8	11	15	7	8	13	17	8	9	14	19
4/12	4	5	7	9	4	5	8	10	5	6	9	12	5	7	10	13	6	7	11	14
5/12	3	4	6	7	4	4	6	8	4	5	7	10	5	5	8	11	5	6	9	12
6/12	3	3	5	6	3	4	6	7	4	4	6	8	4	5	7	9	4	5	8	10
7/12	3	3	4	6	3	3	5	7	3	4	6	7	4	4	6	8	4	5	7	9
8/12	2	3	4	5	3	3	5	6	3	4	5	7	3	4	6	8	4	4	6	8
9/12	2	3	4	5	3	3	4	6	3	3	5	6	3	4	5	7	3	4	6	8
10/12	2	2	4	5	2	3	4	5	3	3	5	6	3	3	5	7	3	4	6	7
11/12	2	2	3	4	2	3	4	5	3	3	4	6	3	3	5	6	3	4	5	7
12/12	2	2	3	4	2	3	4	5	2	3	4	5	3	3	5	6	3	4	5	7

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479kPa.

a. Screws shall be No. 10.



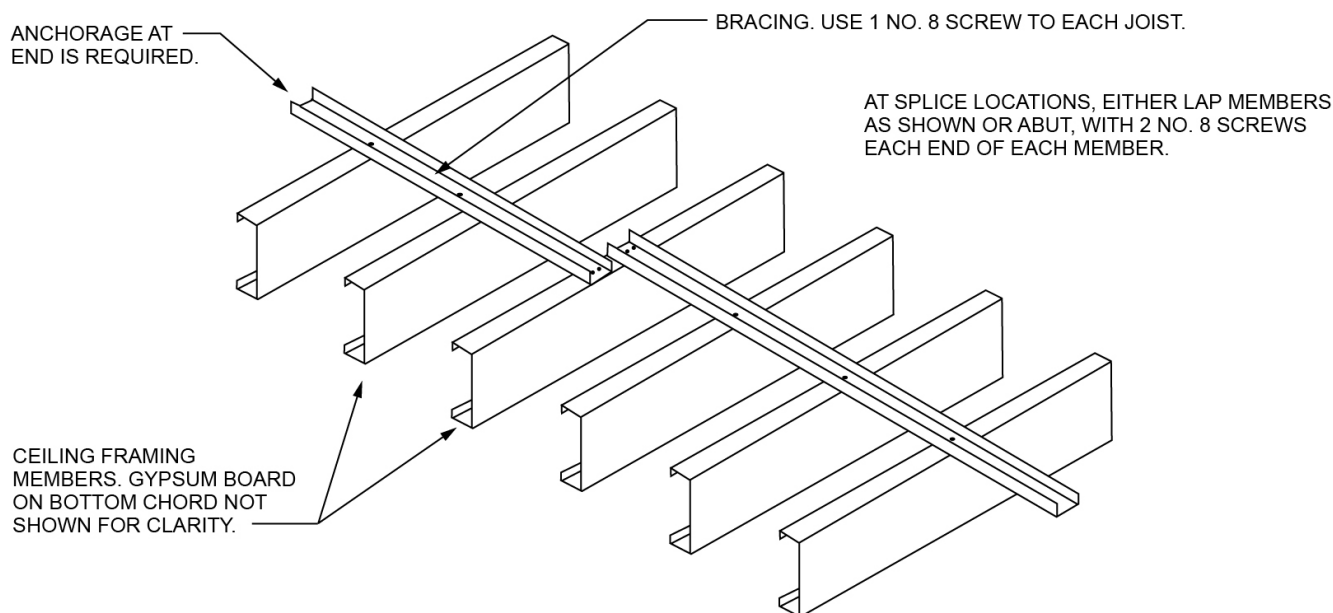
For SI: 1 mil = 0.0254 mm.

**FIGURE R804.3.1.1**  
**JOIST TO RAFTER CONNECTION**

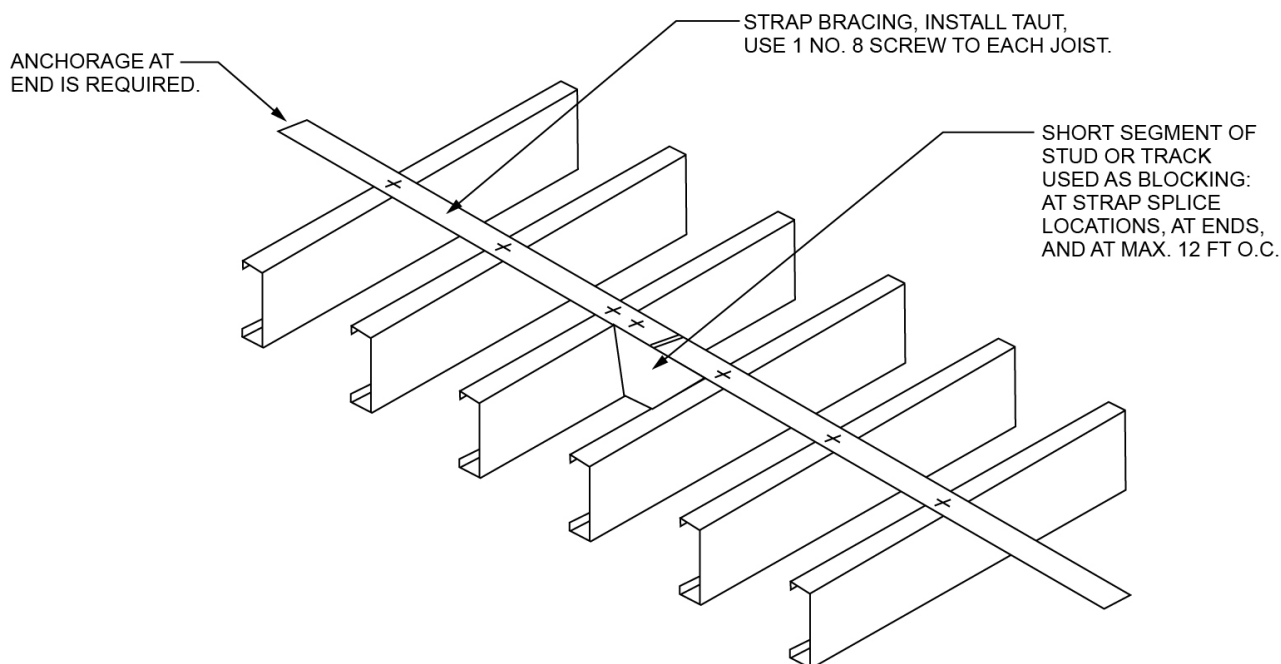
## ROOF-CEILING CONSTRUCTION

**R804.3.1.3 Ceiling joist top flange bracing.** The top flanges of ceiling joists shall be laterally braced as required by Tables R804.3.1.1(1) and R804.3.1.1(2), in accordance with one of the following:

1. Minimum 33-mil (0.84 mm) C-shaped member in accordance with Figure R804.3.1.3(1).
2. Minimum 33-mil (0.84 mm) track section in accordance with Figure R804.3.1.3(1).
3. Minimum 33-mil (0.84 mm) hat section in accordance with Figure R804.3.1.3(1).
4. Minimum 54-mil (1.37 mm) 1½-inch (38 mm) cold-rolled channel section in accordance with Figure R804.3.1.3(1).



**FIGURE R804.3.1.3(1)**  
**CEILING JOIST TOP FLANGE BRACING WITH C-SHAPED, TRACK OR COLD-ROLLED CHANNEL**



For SI: 1 foot = 304.8 mm.

**FIGURE R804.3.1.3(2)**  
**CEILING JOIST TOP FLANGE BRACING WITH CONTINUOUS STEEL STRAP AND BLOCKING**

5. Minimum  $1\frac{1}{2}$ -inch by 33-mil (38 mm by 0.84 mm) continuous steel strap in accordance with Figure R804.3.1.3(2).

Lateral bracing shall be installed perpendicular to the ceiling joists and shall be fastened to the top flange of each joist with one No. 8 screw. Blocking shall be installed between joists in line with bracing at a maximum spacing of 12 feet (3658 mm) measured perpendicular to the joists. Ends of lateral bracing shall be attached to blocking or anchored to a stable building component with two No. 8 screws.

**R804.3.1.4 Ceiling joist splicing.** Splices in ceiling joists shall be permitted, if ceiling joist splices are supported at interior bearing points and are constructed in accordance with Figure R804.3.1.4. The number of screws on each side of the splice shall be the same as required for the heel joint connection in Table R804.3.1.1(3).

**R804.3.2 Roof rafters.** Cold-formed steel roof rafters shall be in accordance with this section.

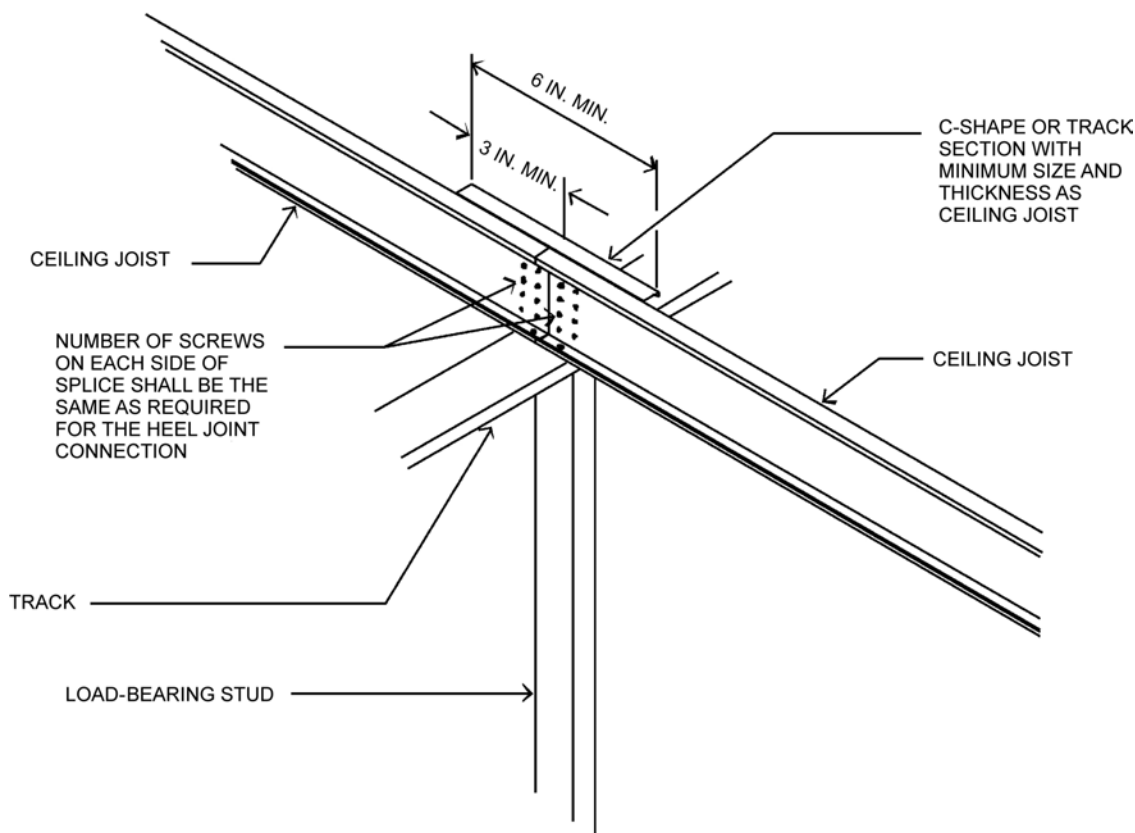
**R804.3.2.1 Minimum roof rafter sizes.** Roof rafter size and thickness shall be determined in accordance with the limits set forth in Table R804.3.2.1(1) based on the horizontal projection of the roof rafter span. For

determination of roof rafter sizes, reduction of roof spans shall be permitted where a roof rafter support brace is installed in accordance with Section R804.3.2.2. The reduced roof rafter span shall be taken as the larger of the distances from the roof rafter support brace to the ridge or to the heel measured horizontally.

For the purpose of determining roof rafter sizes in Table R804.3.2.1(1), ultimate design wind speeds shall be converted to equivalent ground snow loads in accordance with Table R804.3.2.1(2). Roof rafter sizes shall be based on the higher of the ground snow load or the equivalent snow load converted from the ultimate design wind speed.

**R804.3.2.1.1 Eave overhang.** Eave overhangs shall not exceed 24 inches (610 mm) measured horizontally.

**R804.3.2.1.2 Rake overhangs.** Rake overhangs shall not exceed the limitations provided for Option 1 or 2 in Figure R804.3.2.1.2. Outlookers at gable endwalls shall be installed in accordance with Figure R804.3.2.1.2. The required strength for uplift connectors required for Option 1 shall be determined in accordance with AISI S230, Table F3-4.



For SI: 1 foot = 304.8 mm.

**FIGURE R804.3.1.4  
SPliced CEILING JOISTS**

# ROOF-CEILING CONSTRUCTION

**TABLE R804.3.2.1(1)**  
**ROOF RAFTER SPANS<sup>a, b, c, d</sup>**

MEMBER DESIGNATION	ALLOWABLE SPAN MEASURED HORIZONTALLY (feet-inches)							
	Ground snow load (psf)							
	20		30		50		70	
	Rafter spacing (inches)							
	16	24	16	24	16	24	16	24
550S162-33	13'-11"	11'-4"	11'-9"	9'-7"	9'-5"	7'-8"	8'-1"	6'-7"
550S162-43	15'-9"	13'-8"	14'-3"	11'-8"	11'-4"	9'-3"	9'-9"	7'-11"
550S162-54	16'-11"	14'-10"	15'-3"	13'-4"	13'-3"	11'-7"	12'-0"	10'-6"
550S162-68	18'-2"	15'-10"	16'-5"	14'-4"	14'-3"	12'-5"	12'-11"	11'-3"
800S162-33	16'-4"	13'-4"	13'-11"	11'-4"	11'-1"	9'-0"	9'-6"	6'-7"
800S162-43	19'-7"	16'-0"	16'-8"	13'-7"	13'-4"	10'-10"	11'-5"	9'-4"
800S162-54	22'-9"	19'-11"	20'-7"	17'-11"	17'-10"	4'-9"	15'-6"	12'-7"
800S162-68	24'-7"	21'-6"	22'-2"	19'-5"	19'-3"	16'-10"	17'-5"	14'-8"
1000S162-43	22'-2"	18'-1"	18'-10"	15'-4"	15'-1"	12'-4"	12'-11"	10'-7"
1000S162-54	27'-1"	23'-8"	24'-6"	20'-9"	20'-5"	16'-8"	17'-6"	14'-3"
1000S162-68	29'-5"	25'-8"	26'-6"	23'-2"	23'-0"	19'-6"	20'-6"	16'-9"
1200S162-54	31'-3"	27'-0"	28'-1"	22'-11"	22'-6"	18'-4"	19'-4"	15'-9"
1200S162-68	34'-0"	29'-8"	30'-8"	26'-9"	26'-6"	21'-7"	22'-8"	18'-6"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

a. Table provides maximum horizontal rafter spans in feet and inches for slopes between 3:12 and 12:12.

b. Deflection criteria:  $L/240$  for live loads and  $L/180$  for total loads.

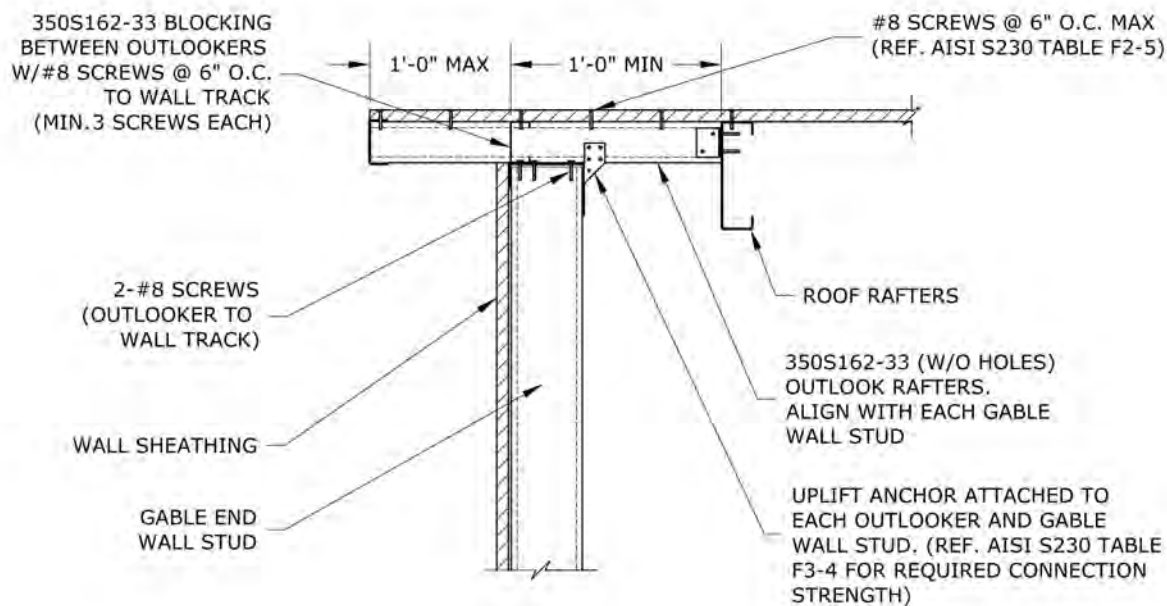
c. Roof dead load = 12 psf.

d. Grade 33 ksi steel is permitted to be used for 33 mil and 43 mil thicknesses. Grade 50 ksi steel shall be used for 54 and 68 mil thicknesses.

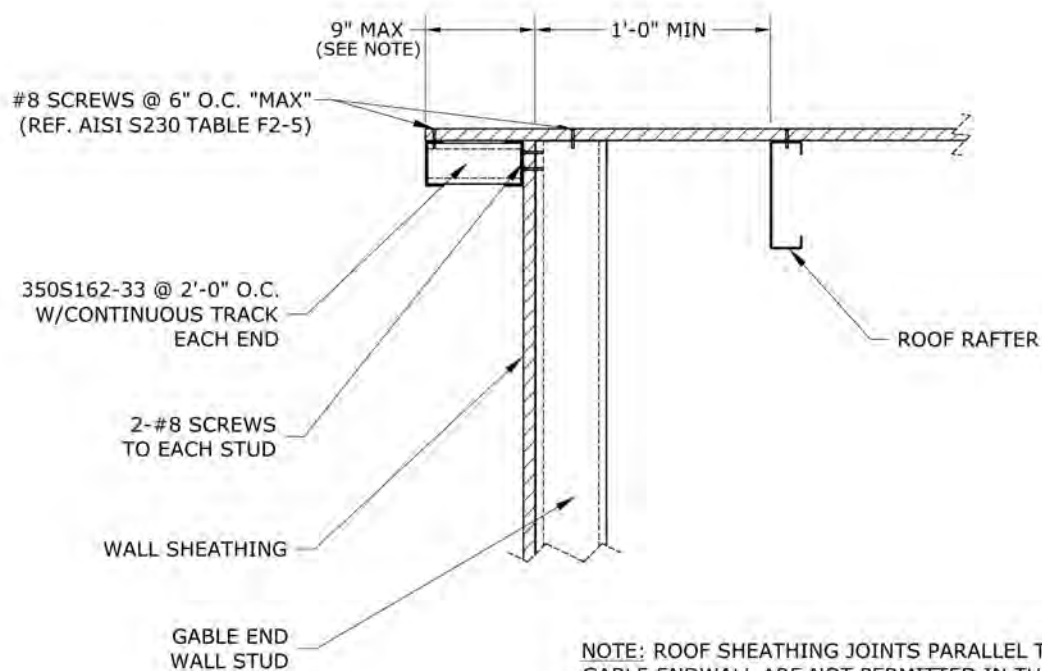
**TABLE R804.3.2.1(2)**  
**ULTIMATE DESIGN WIND SPEED TO EQUIVALENT SNOW LOAD CONVERSION**

ULTIMATE WIND SPEED AND EXPOSURE		EQUIVALENT GROUND SNOW LOAD (psf)									
		Roof slope									
Exposure	Wind speed (mph)	3:12	4:12	5:12	6:12	7:12	8:12	9:12	10:12	11:12	12:12
B	115	20	20	20	20	20	20	20	20	20	20
	120	20	20	20	20	20	20	20	20	20	20
	130	20	20	20	20	20	20	20	20	20	20
	< 140	20	20	20	20	20	20	20	30	30	30
C	115	20	20	20	20	20	20	20	20	30	30
	120	20	20	20	20	20	20	20	30	30	50
	130	20	20	30	30	30	30	30	30	50	50
	< 140	30	30	50	50	30	30	50	50	50	50

For SI: 1 mile per hour = 0.447 m/s, 1 pound per square foot = 0.0479 kPa.

**OPTION #1****OPTION #2**

(NOT APPLICABLE FOR WIND SPEEDS &gt; 130 mph)



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.6 kph.

**FIGURE R804.3.2.1.2**  
**GABLE ENDWALL OVERHANG DETAILS**



## ROOF-CEILING CONSTRUCTION

**R804.3.2.2 Roof rafter support brace.** Where used to reduce roof rafter spans in determining roof rafter sizes, a roof rafter support brace shall meet all of the following conditions:

1. Minimum 350S162-33 C-shaped brace member with maximum length of 8 feet (2438 mm).
2. Minimum brace member slope of 45 degrees (0.785 rad) to the horizontal.
3. Minimum connection of brace to a roof rafter and ceiling joist with four No.10 screws at each end.
4. Maximum 6 inches (152 mm) between brace/ceiling joist connection and *load-bearing wall* below.
5. Each roof rafter support brace greater than 4 feet (1219 mm) in length, shall be braced with a supplemental brace having a minimum size of 350S162-33 or 350T162-33 such that the maximum unsupported length of the roof rafter support brace is 4 feet (1219 mm). The supplemental brace shall be continuous and shall be connected to each roof rafter support brace using two No. 8 screws.

**R804.3.2.3 Roof rafter splice.** Roof rafters shall not be spliced.

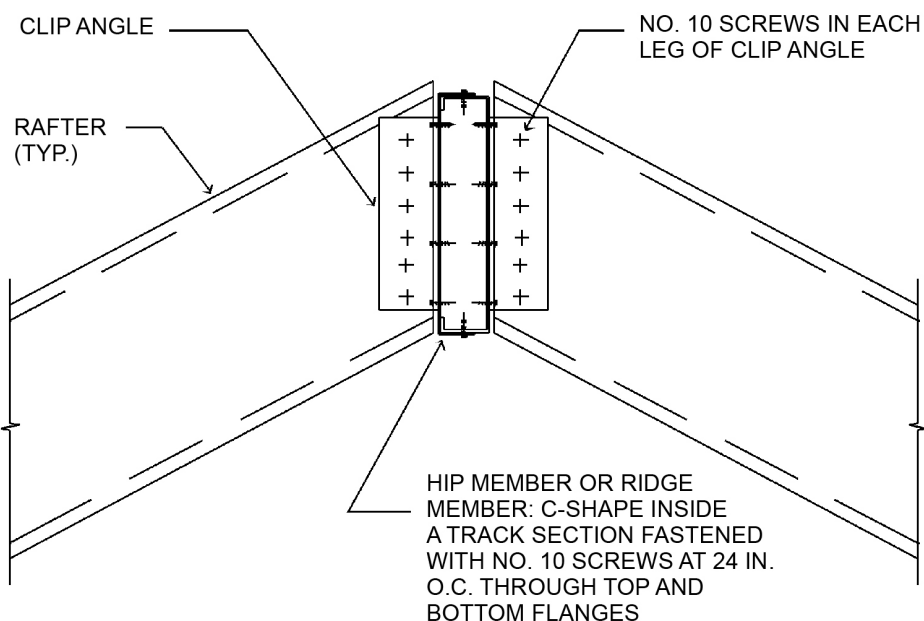
**R804.3.2.4 Roof rafter to ceiling joist and ridge member connection.** Roof rafters shall be connected to a parallel ceiling joist to form a continuous tie between exterior walls in accordance with Figure R804.3.1.1 and Table R804.3.1.1(3). Ceiling joists

shall be connected to the top track of the *load-bearing wall* in accordance with Table R804.3, either with the required number of No. 10 screws applied through the flange of the ceiling joist or by using a 54-mil (1.37 mm) clip angle with the required number of No.10 screws in each leg. Roof rafters shall be connected to a ridge member with a minimum 2-inch by 2-inch (51 mm by 51 mm) clip angle fastened with No. 10 screws to the ridge member in accordance with Figure R804.3.2.4 and Table R804.3.2.4. The clip angle shall have a steel thickness equivalent to or greater than the roof rafter thickness and shall extend the depth of the roof rafter member to the extent possible. The ridge member shall be fabricated from a C-shaped member and a track section that shall have a minimum size and steel thickness equivalent to or greater than that of adjacent roof rafters and shall be installed in accordance with Figure R804.3.2.4. The ridge member shall extend the full depth of the sloped roof rafter cut.

**R804.3.2.5 Roof rafter bottom flange bracing.** The bottom flanges of roof rafters shall be continuously braced, at a maximum spacing of 4 feet (1219 mm) as measured parallel to the roof rafters, with one of the following members:

1. Minimum 33-mil (0.84 mm) C-shaped member.
2. Minimum 33-mil (0.84 mm) track section.
3. Minimum 1½-inch by 33-mil (38 mm by 0.84 mm) steel strap.

The bracing element shall be fastened to the bottom flange of each roof rafter with one No. 8 screw and shall be fastened to blocking with two No. 8 screws.



For SI: 1 inch = 25.4 mm.

**FIGURE R804.3.2.4**  
**RIDGE MEMBER CONNECTION**

Blocking shall be installed between roof rafters in-line with the continuous bracing at a maximum spacing of 12 feet (3658 mm) measured perpendicular to the roof rafters. The ends of continuous bracing shall be fastened to blocking or anchored to a stable building component with two No. 8 screws.

**R804.3.3 Cutting and notching.** Flanges and lips of load-bearing, cold-formed steel roof framing members shall not be cut or notched.

**R804.3.4 Headers.** Roof-ceiling framing above wall openings shall be supported on headers. The allowable spans for headers in *load-bearing walls* shall not exceed the values set forth in Section R603.6 and Tables R603.6(1) through R603.6(6).

**R804.3.5 Framing of openings in roofs and ceilings.** Openings in roofs and ceilings shall be framed with header and trimmer joists. Header joist spans shall not exceed 4 feet (1219 mm) in length. Header and trimmer joists shall be fabricated from joist and track members having a minimum size and thickness equivalent to the adjacent ceiling joists or roof rafters and shall be installed in accordance with Figures R804.3.5(1) and R804.3.5(2). Each header joist shall be connected to trimmer joists with not less than four 2-inch by 2-inch (51 by 51 mm) clip angles. Each clip angle shall be fastened to both the header and trimmer joists with four No. 8 screws, evenly spaced, through each leg of the clip angle. The steel thickness of the clip angles shall be not less than that of the ceiling joist or roof rafter. Each track section for a built-up header or trimmer joist shall extend the full length of the joist (continuous).

**R804.3.6 Roof trusses.** Cold-formed steel trusses shall be designed and installed in accordance with AISI S230, Section F6. In the absence of specific bracing requirements, trusses shall be braced in accordance with accepted industry practices, such as the *SBCA Cold-Formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice for Handling, Installing & Bracing of Cold-Formed Steel Trusses*. Trusses shall be connected to the top track of the *load-bearing wall* in accordance with Table R804.3, either with the required number of No. 10 screws applied through the flange of the truss or by using a 54-mil (1.37 mm) clip angle with the required number of No. 10 screws in each leg.

**R804.3.7 Ceiling and roof diaphragms.** Ceiling and roof diaphragms shall be in accordance with this section.

**R804.3.7.1 Ceiling diaphragms.** At gable endwalls a ceiling *diaphragm* shall be provided by attaching a minimum  $\frac{1}{2}$ -inch (12.7 mm) gypsum board or a minimum  $\frac{3}{8}$ -inch (9.5 mm) wood structural panel sheathing, that complies with Section R803, to the bottom of ceiling joists or roof trusses and connected to wall framing in accordance with Figures R804.3.7.1(1) and R804.3.7.1(2), unless studs are designed as full height without bracing at the ceiling. Flat blocking shall consist of C-shaped or track section with a minimum thickness of 33 mils (0.84 mm). For a gypsum board sheathed ceiling, the *diaphragm* length shall be in accordance with Table R804.3.7.1. For a wood structural panel sheathed ceiling, the *diaphragm* length shall be not less than 12 feet (3658 mm) for building widths less than 36 feet (10 973 mm), or not less than 14 feet (4267 mm) for building widths greater than or equal to 36 feet (10 973 mm).

The ceiling *diaphragm* shall be secured with screws spaced at a maximum 6 inches (152 mm) o.c. at panel edges and a maximum 12 inches (305 mm) o.c. in the field. The required lengths in Table R804.3.7.1 for gypsum board sheathed ceiling diaphragms shall be permitted to be multiplied by 0.35 if all panel edges are blocked. Multiplying the required lengths in Table R804.3.7.1 for gypsum board sheathed ceiling diaphragms by 0.9 shall be permitted if all panel edges are secured with screws spaced at 4 inches (102 mm) o.c.

**R804.3.7.2 Roof diaphragm.** A roof *diaphragm* shall be provided by attaching not less than  $\frac{3}{8}$ -inch (9.5 mm) wood structural panel that complies with Section R803 to roof rafters or truss top chords in accordance with Table R804.3. Buildings with 3:1 or larger plan *aspect ratio* and with roof rafter slope (pitch) of 9:12 or larger shall have the roof rafters and ceiling joists blocked in accordance with Figure R804.3.7.2.

**R804.3.8 Roof tie-down.** Roof assemblies shall be connected to walls below in accordance with Table R804.3. A continuous load path shall be provided to transfer uplift loads to the foundation.

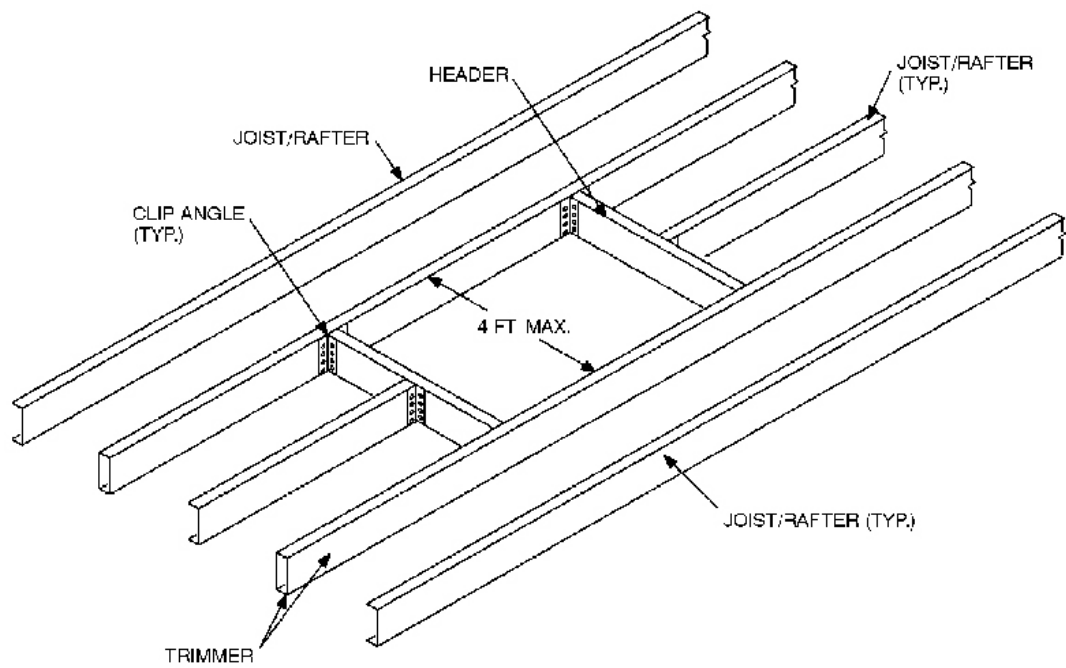
**TABLE R804.3.2.4**  
**SCREWS REQUIRED AT EACH LEG OF CLIP ANGLE FOR ROOF RAFTER TO RIDGE MEMBER CONNECTION<sup>a</sup>**

BUILDING WIDTH (feet)	NUMBER OF SCREWS			
	Ground snow load (psf)			
	0 to 20	21 to 30	31 to 50	51 to 70
24	2	2	3	4
28	2	3	4	5
32	2	3	4	5
36	3	3	5	6
40	3	4	5	7

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa.

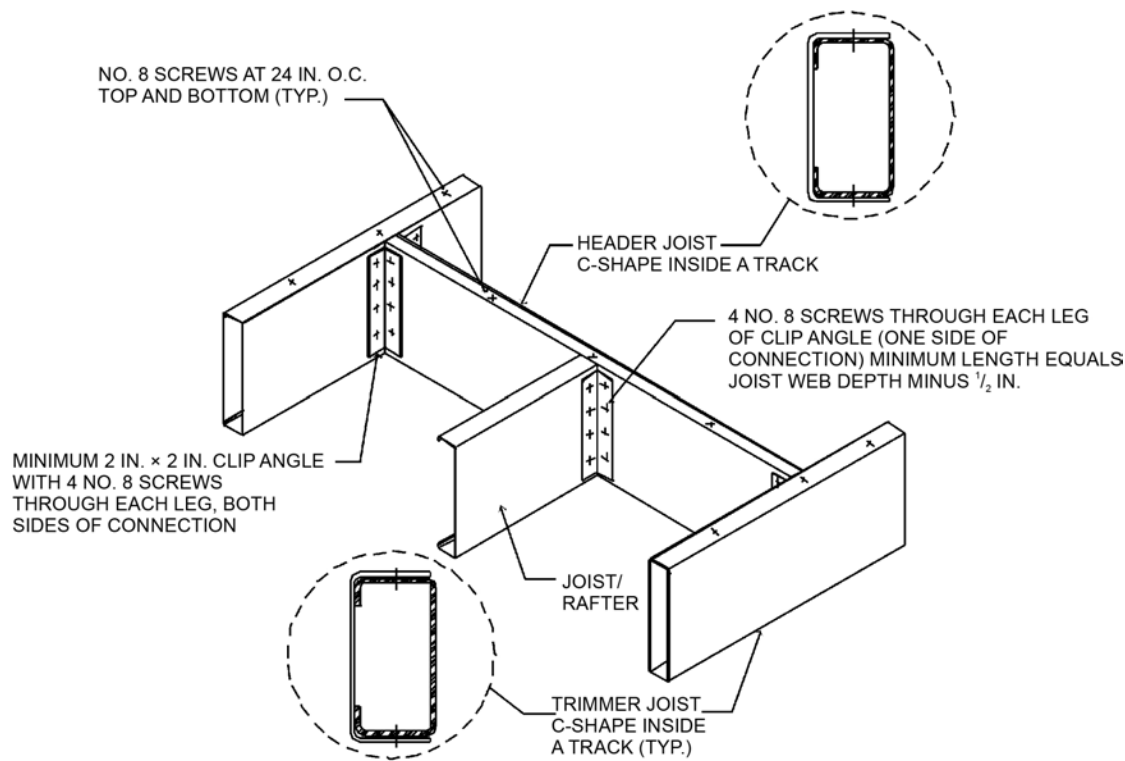
a. Screws shall be No. 10 minimum.

ROOF-CEILING CONSTRUCTION



For SI: 1 foot = 304.8 mm.

FIGURE R804.3.5(1)  
ROOF OR CEILING OPENING



For SI: 1 inch = 25.4 mm.

FIGURE R804.3.5(2)  
HEADER TO TRIMMER CONNECTION

## ROOF-CEILING CONSTRUCTION

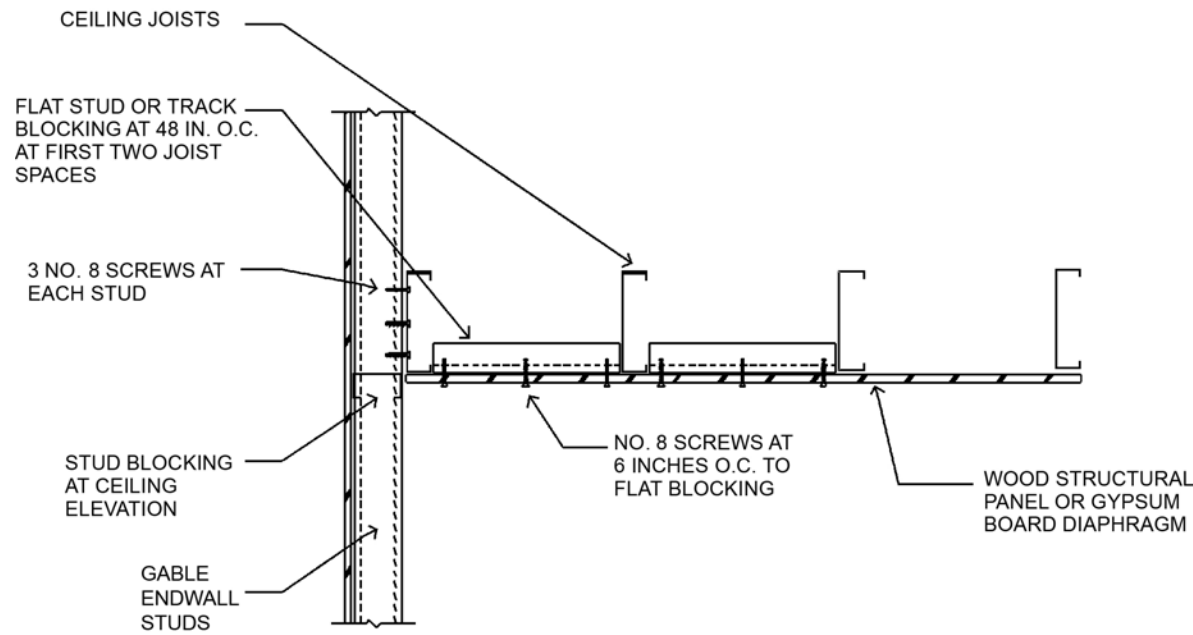
**TABLE R804.3.7.1**  
**REQUIRED LENGTHS FOR CEILING DIAPHRAGMS AT GABLE**  
**ENDWALLS GYPSUM BOARD SHEATHED, CEILING HEIGHT = 8 FEET<sup>a, b, c, d, e, f, g</sup>**

EXPOSURE CATEGORY		ULTIMATE DESIGN WIND SPEED (mph)					
B		115	120	130	< 140	—	—
C		—	—	115	120	130	< 140
Roof pitch	Building endwall width (feet)	Minimum diaphragm length (feet)					
3:12 to 6:12	24–28	16	18	24	26	30	34
	> 28–32	20	20	26	32	34	40
	> 32–36	24	26	30	36	42	46
	> 36–40	26	28	36	40	48	52
6:12 to 9:12	> 24–28	20	20	26	30	34	38
	> 28–32	24	26	30	36	42	46
	> 32–36	26	30	38	42	48	54
	> 36–40	30	34	40	50	56	62
9:12 to 12:12	> 24–28	22	24	30	34	38	44
	> 28–32	26	28	36	40	46	52
	> 32–36	30	32	40	48	54	62
	> 36–40	36	38	48	56	64	72

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

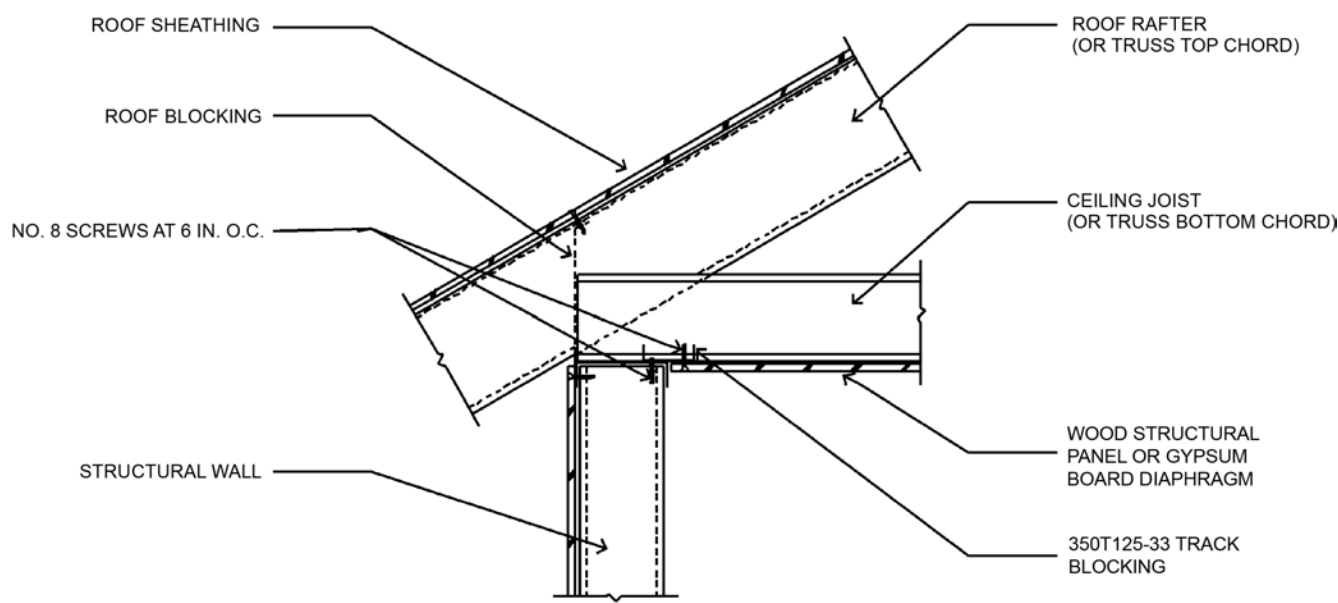
- Ceiling diaphragm is composed of  $\frac{1}{2}$ -inch gypsum board (min. thickness) secured with screws spaced at 6 inches o.c. at panel edges and 12 inches o.c. infield. Use No. 8 screws (min.) where framing members have a designation thickness of 54 mils or less and No. 10 screws (min.) where framing members have a designation thickness greater than 54 mils.
- Maximum aspect ratio (length/width) of diaphragms is 2:1.
- Building width is in the direction of horizontal framing members supported by the wall studs.
- Required diaphragm lengths are to be provided at each end of the structure.
- Multiplying required diaphragm lengths by 0.35 is permitted if all panel edges are blocked.
- Multiplying required diaphragm lengths by 0.9 is permitted if all panel edges are secured with screws spaced at 4 inches o.c.
- To determine the minimum diaphragm length for buildings with ceiling heights of 9 feet or 10 feet values in this table shall be multiplied by 1.15.

ROOF-CEILING CONSTRUCTION



For SI: 1 inch = 25.4 mm.

FIGURE R804.3.7.1(1)  
CEILING DIAPHRAGM TO GABLE ENDWALL DETAIL

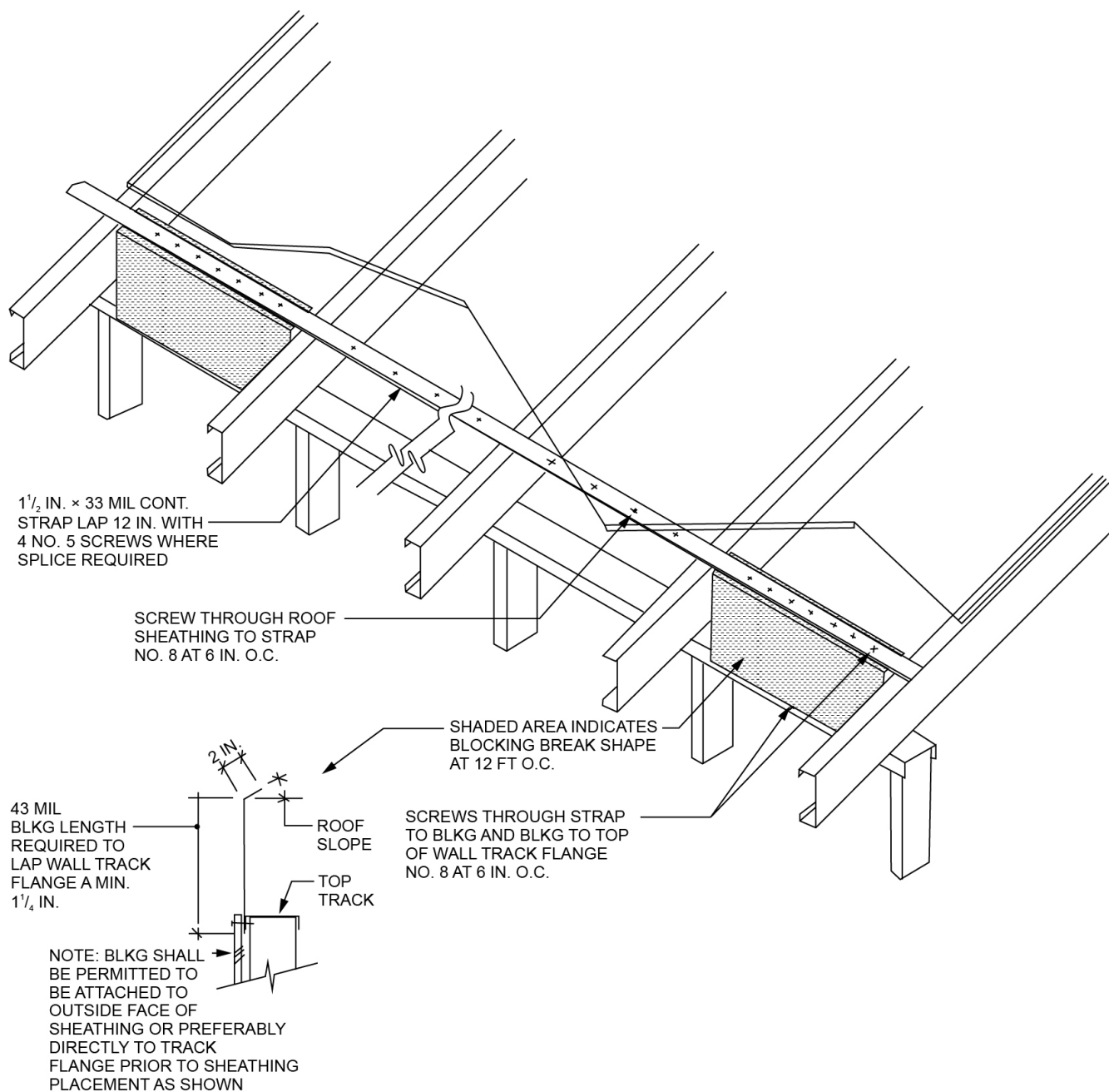


For SI: 1 inch = 25.4 mm.

FIGURE R804.3.7.1(2)  
CEILING DIAPHRAGM TO SIDEWALL DETAIL



## ROOF-CEILING CONSTRUCTION



For SI: 1 mil = 0.0254 mm, 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R804.3.7.2  
ROOF BLOCKING DETAIL**

## ROOF-CEILING CONSTRUCTION

### SECTION R805 CEILING FINISHES

**R805.1 Ceiling installation.** Ceilings shall be installed in accordance with the requirements for interior wall finishes as provided in Sections R702.1 through R702.6.

### SECTION R806 ROOF VENTILATION

**R806.1 Ventilation required.** Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross *ventilation* for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilation openings shall have a least dimension of  $\frac{1}{16}$  inch (1.6 mm) minimum and  $\frac{1}{4}$  inch (6.4 mm) maximum. Ventilation openings having a least dimension larger than  $\frac{1}{4}$  inch (6.4 mm) shall be provided with corrosion-resistant wire cloth screening, hardware cloth, perforated vinyl or similar material with openings having a least dimension of  $\frac{1}{16}$  inch (1.6 mm) minimum and  $\frac{1}{4}$  inch (6.4 mm) maximum. Openings in roof framing members shall conform to the requirements of Section R802.7. Required ventilation openings shall open directly to the outside air and shall be protected to prevent the entry of birds, rodents, snakes and other similar creatures.

**R806.2 Minimum vent area.** The minimum net free ventilating area shall be  $\frac{1}{150}$  of the area of the vented space.

**Exception:** The minimum net free ventilation area shall be  $\frac{1}{300}$  of the vented space provided both of the following conditions are met:

1. In Climate Zones 6, 7 and 8, a Class I or II vapor retarder is installed on the warm-in-winter side of the ceiling.
2. Not less than 40 percent and not more than 50 percent of the required ventilating area is provided by ventilators located in the upper portion of the attic or rafter space. Upper ventilators shall be located not more than 3 feet (914 mm) below the ridge or highest point of the space, measured vertically. The balance of the required *ventilation* provided shall be located in the bottom one-third of the attic space. Where the location of wall or roof framing members conflicts with the installation of upper ventilators, installation more than 3 feet (914 mm) below the ridge or highest point of the space shall be permitted.

**R806.3 Vent and insulation clearance.** Where eave or cornice vents are installed, blocking, bridging and insulation shall not block the free flow of air. Not less than a 1-inch (25 mm) space shall be provided between the insulation and the roof sheathing and at the location of the vent.

**R806.4 Installation and weather protection.** Ventilators shall be installed in accordance with manufacturer's instructions. Installation of ventilators in roof systems shall be in accordance with the requirements of Section R903. Installa-

tion of ventilators in wall systems shall be in accordance with the requirements of Section R703.1.

**R806.5 Unvented attic and unvented enclosed rafter assemblies.** Unvented *attics* and unvented enclosed roof framing assemblies created by ceilings that are applied directly to the underside of the roof framing members and structural roof sheathing applied directly to the top of the roof framing members/rafters, shall be permitted where all the following conditions are met:

1. The unvented *attic* space is completely within the *building thermal envelope*.
2. Interior Class I vapor retarders are not installed on the ceiling side (*attic* floor) of the unvented *attic* assembly or on the ceiling side of the unvented enclosed roof framing assembly.
3. Where wood shingles or shakes are used, a minimum  $\frac{1}{4}$ -inch (6.4 mm) vented airspace separates the shingles or shakes and the roofing underlayment above the structural sheathing.
4. In Climate Zones 5, 6, 7 and 8, any *air-impermeable insulation* shall be a Class II vapor retarder, or shall have a Class II vapor retarder coating or covering in direct contact with the underside of the insulation.
5. Insulation shall comply with Item 5.3 and either Item 5.1 or 5.2:
  - 5.1. Item 5.1.1, 5.1.2, 5.1.3 or 5.1.4 shall be met, depending on the air permeability of the insulation directly under the structural roof sheathing.
    - 5.1.1. Where only *air-impermeable insulation* is provided, it shall be applied in direct contact with the underside of the structural roof sheathing.
    - 5.1.2. Where *air-permeable insulation* is installed directly below the structural sheathing, rigid board or sheet insulation shall be installed directly above the structural roof sheathing in accordance with the *R*-values in Table R806.5 for condensation control.
    - 5.1.3. Where both *air-impermeable* and *air-permeable insulation* are provided, the *air-impermeable insulation* shall be applied in direct contact with the underside of the structural roof sheathing in accordance with Item 5.1.1 and shall be in accordance with the *R*-values in Table R806.5 for condensation control. The *air-permeable insulation* shall be installed directly under the *air-impermeable insulation*.

## ROOF-CEILING CONSTRUCTION

- 5.1.4. Alternatively, sufficient rigid board or sheet insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.
- 5.2. In Climate Zones 1, 2 and 3, air-permeable insulation installed in unvented *attics* shall meet the following requirements:
- 5.2.1. An approved *vapor diffusion port* shall be installed not more than 12 inches (305 mm) from the highest point of the roof, measured vertically from the highest point of the roof to the lower edge of the port.
  - 5.2.2. The port area shall be greater than or equal to 1:600 of the ceiling area. Where there are multiple ports in the attic, the sum of the port areas shall be greater than or equal to the area requirement.
  - 5.2.3. The vapor-permeable membrane in the *vapor diffusion port* shall have a vapor permeance rating of greater than or equal to 20 perms when tested in accordance with Procedure A of ASTM E96.
  - 5.2.4. The *vapor diffusion port* shall serve as an air barrier between the *attic* and the exterior of the building.
  - 5.2.5. The *vapor diffusion port* shall protect the *attic* against the entrance of rain and snow.
  - 5.2.6. Framing members and blocking shall not block the free flow of water vapor to the port. Not less than a 2-inch (51 mm) space shall be provided between any blocking and the roof sheathing. Air-permeable insulation shall be permitted within that space.
  - 5.2.7. The roof slope shall be greater than or equal to 3:12 (vertical/horizontal).
  - 5.2.8. Where only air-permeable insulation is used, it shall be installed directly below the structural roof sheathing, on top of the attic floor, or on top of the ceiling.
  - 5.2.9. *Air-impermeable insulation*, where used in conjunction with air-permeable insulation, shall be directly above or below the structural roof sheathing and is not required to meet the *R*-value in Table R806.5. Where directly below the structural roof sheathing, there shall be no space between the *air-impermeable insulation* and air-permeable insulation.
  - 5.2.10. Where air-permeable insulation is used and is installed directly below the roof structural sheathing, air shall be supplied at a flow rate greater than or equal to 50 CFM (23.6 L/s) per 1,000 square feet (93 m<sup>2</sup>) of ceiling. The air shall be supplied from ductwork providing supply air to the occupiable space when the conditioning system is operating. Alternatively, the air shall be supplied by a supply fan when the conditioning system is operating.
- Exceptions:**
- 1. Where both air-impermeable and air-permeable insulation are used, and the *R*-value in Table 806.5 is met, air supply to the attic is not required.
  - 2. Where only air-permeable insulation is used and is installed on top of the attic floor, or on top of the ceiling, air supply to the attic is not required.

## ROOF-CEILING CONSTRUCTION

- 5.3. Where preformed insulation board is used as the air-impermeable insulation layer, it shall be sealed at the perimeter of each individual sheet interior surface to form a continuous layer.

**TABLE R806.5**  
**INSULATION FOR CONDENSATION CONTROL**

CLIMATE ZONE	MINIMUM RIGID BOARD ON AIR-IMPERMEABLE INSULATION R-VALUE <sup>a, b</sup>
2B and 3B tile roof only	0 (none required)
1, 2A, 2B, 3A, 3B, 3C	R-5
4C	R-10
4A, 4B	R-15
5	R-20
6	R-25
7	R-30
8	R-35

- a. Contributes to but does not supersede the requirements in Section N1102.
- b. Alternatively, sufficient continuous insulation shall be installed directly above the structural roof sheathing to maintain the monthly average temperature of the underside of the structural roof sheathing above 45°F (7°C). For calculation purposes, an interior air temperature of 68°F (20°C) is assumed and the exterior air temperature is assumed to be the monthly average outside air temperature of the three coldest months.

## SECTION R807

### ATTIC ACCESS

**R807.1 Attic access.** Buildings with combustible ceiling or roof construction shall have an attic access opening to attic areas that have a vertical height of 30 inches (762 mm) or greater over an area of not less than 30 square feet (2.8 m<sup>2</sup>). The vertical height shall be measured from the top of the ceiling framing members to the underside of the roof framing members.

The rough-framed opening shall be not less than 22 inches by 30 inches (559 mm by 762 mm) and shall be located in a hallway or other location with *ready access*. Where located in a wall, the opening shall be not less than 22 inches wide by 30 inches high (559 mm wide by 762 mm high). Where the access is located in a ceiling, minimum unobstructed headroom in the attic space shall be 30 inches (762 mm) at some point above the access measured vertically from the bottom of ceiling framing members. See Section M1305.1.2 for access requirements where mechanical *equipment* is located in *attics*.

## CHAPTER 9

# ROOF ASSEMBLIES

### User note:

**About this chapter:** Chapter 9 addresses the design and construction of roof assemblies. A roof assembly includes the roof deck, substrate or thermal barrier, insulation, vapor retarder and roof covering. This chapter provides the requirement for wind resistance of roof coverings. The types of roof covering materials and installation addressed by Chapter 9 are: asphalt shingles, clay and concrete tile, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shakes and shingles, built-up roofs, metal roof panels, modified bitumen roofing, thermoset and thermoplastic single-ply roofing, sprayed polyurethane foam roofing, liquid applied coatings and photovoltaic shingles. Chapter 9 also provides requirements for roof drainage, flashing, above-deck thermal insulation, rooftop-mounted photovoltaic systems and recovering or replacing an existing roof covering.

### SECTION R901 GENERAL

**R901.1 Scope.** The provisions of this chapter shall govern the design, materials, construction and quality of *roof assemblies*.

### SECTION R902 FIRE CLASSIFICATION

**R902.1 Roof covering materials.** Roofs shall be covered with materials as set forth in Sections R904 and R905. Class A, B or C roofing shall be installed in *jurisdictions* designated by law as requiring their use or where the edge of the roof is less than 3 feet (914 mm) from a *lot line*. Class A, B and C roofing required by this section to be *listed* shall be tested in accordance with ASTM E108 or UL 790.

#### Exceptions:

1. Class A *roof assemblies* include those with coverings of brick, masonry and exposed concrete *roof deck*.
2. Class A *roof assemblies* include ferrous or copper shingles or sheets, metal sheets and shingles, clay or concrete roof tile, or slate installed on noncombustible decks.
3. Class A *roof assemblies* include minimum 16 ounces per square foot (4.882 kg/m<sup>2</sup>) copper sheets installed over combustible decks.
4. Class A *roof assemblies* include slate installed over *underlayment* over combustible decks.

**R902.2 Fire-retardant-treated shingles and shakes.** Fire-retardant-treated wood shakes and shingles shall be treated by impregnation with chemicals by the full-cell vacuum-pressure process, in accordance with AWWA C1. Each bundle shall be marked to identify the manufactured unit and the manufacturer, and shall be *labeled* to identify the classification of the material in accordance with the testing required in Section R902.1, the treating company and the quality control agency.

**R902.3 Building-integrated photovoltaic product.** *Building-integrated photovoltaic* (BIPV) products installed as the roof covering shall be tested, *listed* and *labeled* for fire classification in accordance with UL 7103. Class A, B or C BIPV products shall be installed where the edge of the roof is less than 3 feet (914 mm) from a *lot line*.

**R902.4 Rooftop-mounted photovoltaic panel systems.** Rooftop-mounted *photovoltaic panel systems* installed on or above the roof covering shall be tested, *listed* and identified with a fire classification in accordance with UL 2703. Class A, B or C *photovoltaic panel systems* and modules shall be installed in *jurisdictions* designated by law as requiring their use or where the edge of the roof is less than 3 feet (914 mm) from a *lot line*.

### SECTION R903 WEATHER PROTECTION

**R903.1 General.** *Roof decks* shall be covered with *approved* roof coverings secured to the building or structure in accordance with the provisions of this chapter. *Roof assemblies* shall be designed and installed in accordance with this code and the *approved* manufacturer's instructions such that the *roof assembly* shall serve to protect the building or structure.

**R903.2 Flashing.** Flashings shall be installed in a manner that prevents moisture from entering the wall and roof through joints in copings, through moisture permeable materials and at intersections with parapet walls and other penetrations through the roof plane.

**R903.2.1 Locations.** Flashings shall be installed at wall and roof intersections, wherever there is a change in roof slope or direction and around roof openings. A flashing shall be installed to divert the water away from where the eave of a sloped roof intersects a vertical sidewall. Where flashing is of metal, the metal shall be corrosion resistant with a thickness of not less than 0.019 inch (0.5 mm) (No. 26 galvanized sheet).

**R903.2.2 Crickets and saddles.** A cricket or saddle shall be installed on the ridge side of any chimney or penetra-



## ROOF ASSEMBLIES

tion more than 30 inches (762 mm) wide as measured perpendicular to the slope. Cricket or saddle coverings shall be sheet metal or of the same material as the roof covering.

**Exception:** *Unit skylights* installed in accordance with Section R308.6 and flashed in accordance with the manufacturer's instructions shall be permitted to be installed without a cricket or saddle.

**R903.3 Coping.** Parapet walls shall be properly coped with noncombustible, weatherproof materials of a width not less than the thickness of the parapet wall.

**R903.4 Roof drainage.** Unless roofs are sloped to drain over roof edges, roof drains shall be installed at each low point of the roof.

**R903.4.1 Secondary (emergency overflow) drains or scuppers.** Where roof drains are required, secondary emergency overflow roof drains or *scuppers* shall be provided where the roof perimeter construction extends above the roof in such a manner that water will be entrapped if the primary drains allow buildup for any reason. Overflow drains having the same size as the roof drains shall be installed with the inlet flow line located 2 inches (51 mm) above the low point of the roof, or overflow *scuppers* having three times the size of the roof drains and having a minimum opening height of 4 inches (102 mm) shall be installed in the adjacent parapet walls with the inlet flow located 2 inches (51 mm) above the low point of the roof served. The installation and sizing of overflow drains, leaders and conductors shall comply with Sections 1106 and 1108 of the *International Plumbing Code*, as applicable.

Overflow drains shall discharge to an *approved* location and shall not be connected to roof drain lines.

## SECTION R904 MATERIALS

**R904.1 Scope.** The requirements set forth in this section shall apply to the application of roof covering materials specified herein. *Roof assemblies* shall be applied in accordance with this chapter and the manufacturer's installation instructions. Installation of *roof assemblies* shall comply with the applicable provisions of Section R905.

**R904.2 Compatibility of materials.** *Roof assemblies* shall be of materials that are compatible with each other and with the building or structure to which the materials are applied.

**R904.3 Material specifications and physical characteristics.** Roof covering materials shall conform to the applicable standards listed in this chapter.

**R904.4 Product identification.** Roof covering materials shall be delivered in packages bearing the manufacturer's identifying marks and *approved* testing agency *labels* required. Bulk shipments of materials shall be accompanied by the same information issued in the form of a certificate or on a bill of lading by the manufacturer.

## SECTION R905 REQUIREMENTS FOR ROOF COVERINGS

**R905.1 Roof covering application.** Roof coverings shall be applied in accordance with the applicable provisions of this section and the manufacturer's installation instructions. Unless otherwise specified in this section, roof coverings shall be installed to resist the component and cladding loads specified in Table R301.2.1(1), adjusted for height and exposure in accordance with Table R301.2.1(2).

**R905.1.1 Underlayment.** *Underlayment* for asphalt shingles, clay and concrete tile, *metal roof shingles*, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles, wood shakes, *metal roof panels* and *photovoltaic shingles* shall conform to the applicable standards listed in this chapter. *Underlayment* materials required to comply with ASTM D226, D1970, D4869 and D6757 shall bear a *label* indicating compliance to the standard designation and, if applicable, type classification indicated in Table R905.1.1(1). *Underlayment* shall be applied in accordance with Table R905.1.1(2). *Underlayment* shall be attached in accordance with Table R905.1.1(3).

### Exceptions:

1. As an alternative, self-adhering polymer-modified bitumen underlayment bearing a *label* indicating compliance with ASTM D1970 and installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed, shall be permitted.
2. As an alternative, a minimum 4-inch-wide (102 mm) strip of self-adhering polymer-modified bitumen membrane bearing a *label* indicating compliance with ASTM D1970, installed in accordance with the *manufacturer's installation instructions* for the deck material, shall be applied over all joints in the roof decking. An *approved underlayment* complying with Table R905.1.1(1) for the applicable roof covering for areas where wind design is not required in accordance with Figure R301.2.1.1 shall be applied over the entire roof over the 4-inch-wide (102 mm) membrane strips. Underlayment shall be applied in accordance with Table R905.1.1(2) using the application requirements for areas where wind design is not required in accordance with Figure R301.2.1.1. Underlayment shall be attached in accordance with Table R905.1.1(3).

**R905.1.2 Ice barriers.** In areas where there has been a history of ice forming along the eaves causing a backup of water as designated in Table R301.2, an ice barrier shall be installed for asphalt shingles, metal roof shingles, mineral-surfaced roll roofing, slate and slate-type shingles, wood shingles and wood shakes. The ice barrier shall consist of not fewer than two layers of *underlayment* cemented together, or a self-adhering polymer-modified bitumen sheet shall be used in place of normal *underlay-*

ment and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building. On roofs with slope equal to or greater than 8 units vertical in 12 units horizontal (67-percent slope), the ice barrier shall also be applied not less than 36 inches (914 mm) measured along the roof slope from the eave edge of the building.

**Exception:** Detached *accessory structures* not containing conditioned floor area.

**R905.2 Asphalt shingles.** The installation of asphalt shingles shall comply with the provisions of this section.

**R905.2.1 Sheathing requirements.** Asphalt shingles shall be fastened to solidly sheathed decks.

**R905.2.2 Slope.** Asphalt shingles shall be used only on roof slopes of 2 units vertical in 12 units horizontal (17-percent slope) or greater. For roof slopes from 2 units vertical in 12 units horizontal (17-percent slope) up to 4 units vertical in 12 units horizontal (33-percent slope), double *underlayment* application is required in accordance with Section R905.1.1.

**R905.2.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.2.4 Asphalt shingles.** Asphalt shingles shall comply with ASTM D3462.

**R905.2.4.1 Wind resistance of asphalt shingles.** Asphalt shingles shall be tested in accordance with ASTM D7158. Asphalt shingles shall meet the classi-

fication requirements of Table R905.2.4.1 for the appropriate ultimate design wind speed. Asphalt shingle packaging shall bear a *label* to indicate compliance with ASTM D7158 and the required classification in Table R905.2.4.1.

**Exception:** Asphalt shingles not included in the scope of ASTM D7158 shall be tested and *labeled* in accordance with ASTM D3161. Asphalt shingle packaging shall bear a *label* to indicate compliance with ASTM D3161 and the required classification in Table R905.2.4.1.

**R905.2.5 Fasteners.** Fasteners for asphalt shingles shall be galvanized steel, stainless steel, aluminum or copper roofing nails, minimum 12-gage [0.105 inch (3 mm)] shank with a minimum  $\frac{3}{8}$ -inch-diameter (9.5 mm) head, complying with ASTM F1667, of a length to penetrate through the roofing materials and not less than  $\frac{3}{4}$  inch (19.1 mm) into the roof sheathing. Where the roof sheathing is less than  $\frac{3}{4}$  inch (19.1 mm) thick, the fasteners shall penetrate through the sheathing.

**R905.2.6 Attachment.** Asphalt shingles shall have the minimum number of fasteners required by the manufacturer's *approved* installation instructions, but not less than four fasteners per strip shingle or two fasteners per individual shingle. Where the roof slope exceeds 21 units vertical in 12 units horizontal (21:12, 175-percent slope), shingles shall be installed in accordance with the manufacturer's *approved* installation instructions.

TABLE R905.1.1(1)  
UNDERLAYMENT TYPES

ROOF COVERING	SECTION	AREAS WHERE WIND DESIGN IS NOT REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1	AREAS WHERE WIND DESIGN IS REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1
Asphalt shingles	R905.2	ASTM D226 Type I or II ASTM D4696 Type I, II, III or IV ASTM D6757	ASTM D226 Type II ASTM D4869 Type III or Type IV
Clay and concrete tile	R905.3	ASTM D226 Type II ASTM D2626 Type I ASTM D6380 Class M mineral-surfaced roll roofing	ASTM D226 Type II
Metal roof shingles	R905.4	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Mineral-surfaced roll roofing	R905.5	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Slate and slate-type shingles	R905.6	ASTM D226 Type I ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Wood shingles	R905.7	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Wood shakes	R905.8	ASTM D226 Type I or II ASTM D4869 Type I, II, III or IV	ASTM D226 Type II ASTM D4869 Type III or Type IV
Metal panels	R905.10	Manufacturer's instructions	ASTM D226 Type II ASTM D4869 Type III or Type IV
Photovoltaic shingles	R905.16	ASTM D4869 Type I, II, III or IV ASTM D6757	ASTM D4869 Type III or Type IV

For SI: 1 mile per hour = 0.447 m/s.

## ROOF ASSEMBLIES

**TABLE R905.1.1(2)**  
**UNDERLAYMENT APPLICATION**

ROOF COVERING	SECTION	AREAS WHERE WIND DESIGN IS NOT REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1	AREAS WHERE WIND DESIGN IS REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1
Asphalt shingles	R905.2	For roof slopes from 2 units vertical in 12 units horizontal (2:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied in the following manner: underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.	Underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.
Clay and concrete tile	R905.3	For roof slopes from 2½ units vertical in 12 units horizontal (2½:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be not fewer than two layers applied as follows: starting at the eave, apply a 19-inch strip of underlayment parallel with the eave. Starting at the eave, apply 36-inch-wide strips of underlayment felt, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be not fewer than one layer of underlayment felt applied shingle fashion, parallel to and starting from the eaves and lapped 2 inches. End laps shall be 4 inches and shall be offset by 6 feet.	Underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.
Metal roof shingles	R905.4	Apply in accordance with the manufacturer's installation instructions.	Underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. End laps shall be 4 inches and shall be offset by 6 feet.
Mineral-surfaced roll roofing	R905.5		
Slate and slate-type shingles	R905.6		
Wood shingles	R905.7		
Wood shakes	R905.8		
Metal panels	R905.10		
Photovoltaic shingles	R905.16	For roof slopes from 2 units vertical in 12 units horizontal (2:12), up to 4 units vertical in 12 units horizontal (4:12), underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet. For roof slopes of 4 units vertical in 12 units horizontal (4:12) or greater, underlayment shall be one layer applied in the following manner: underlayment shall be applied shingle fashion, parallel to and starting from the eave and lapped 2 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.	Underlayment shall be two layers applied in the following manner: apply a 19-inch strip of underlayment felt parallel to and starting at the eaves. Starting at the eave, apply 36-inch-wide sheets of underlayment, overlapping successive sheets 19 inches. Distortions in the underlayment shall not interfere with the ability of the shingles to seal. End laps shall be 4 inches and shall be offset by 6 feet.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

## ROOF ASSEMBLIES

**TABLE R905.1.1(3)**  
**UNDERLAYMENT APPLICATION**

ROOF COVERING	SECTION	AREAS WHERE WIND DESIGN IS NOT REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1	AREAS WHERE WIND DESIGN IS REQUIRED IN ACCORDANCE WITH FIGURE R301.2.1.1
Asphalt shingles	R905.2	Fastened sufficiently to hold in place	The underlayment shall be attached with corrosion-resistant fasteners in a grid pattern of 12 inches between side laps with a 6-inch spacing at side and end laps. Underlayment shall be attached using annular ring or deformed shank nails with 1-inch-diameter metal or plastic caps. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch. The cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than $\frac{3}{4}$ inch into the roof sheathing.
Clay and concrete tile	R905.3		
Photovoltaic	R905.16		
Metal roof shingles	R905.4	Manufacturer's installation instructions.	The underlayment shall be attached with corrosion-resistant fasteners in a grid pattern of 12 inches between side laps with a 6-inch spacing at side and end laps. Underlayment shall be attached using annular ring or deformed shank nails with 1-inch-diameter metal or plastic caps. Metal caps shall have a thickness of not less than 32-gage sheet metal. Power-driven metal caps shall have a minimum thickness of 0.010 inch. Minimum thickness of the outside edge of plastic caps shall be 0.035 inch. The cap nail shank shall be not less than 0.083 inch. The cap nail shank shall have a length sufficient to penetrate through the roof sheathing or not less than $\frac{3}{4}$ inch into the roof sheathing.
Mineral-surfaced roll roofing	R905.5		
Slate and slate-type shingles	R905.6		
Wood shingles	R905.7		
Wood shakes	R905.8		
Metal panels	R905.10		

For SI: 1 inch = 25.4 mm, 1 mile per hour = 0.447 m/s.

**TABLE R905.2.4.1**  
**CLASSIFICATION OF ASPHALT ROOF SHINGLES**

MAXIMUM ULTIMATE DESIGN WIND SPEED, $V_{ult}$ FROM Figure R301.2(2) (mph)	MAXIMUM BASIC WIND SPEED, $V_{ASD}$ FROM TABLE R301.2.1.3 (mph)	ASTM D7158 <sup>a</sup> SHINGLE CLASSIFICATION	ASTM D3161 SHINGLE CLASSIFICATION
110	85	D, G or H	A, D or F
116	90	D, G or H	A, D or F
129	100	G or H	A, D or F
142	110	G or H	F
155	120	G or H	F
168	130	H	F
181	140	H	F
194	150	H	F

For SI: 1 foot = 304.8 mm, 1 mile per hour = 0.447 m/s.

- a. The standard calculations contained in ASTM D7158 assume Exposure Category B or C and a building height of 60 feet or less. Additional calculations are required for conditions outside of these assumptions.



## ROOF ASSEMBLIES

**R905.2.7 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.2.8 Flashing.** Flashing for asphalt shingles shall comply with this section and the asphalt shingle manufacturer's *approved* installation instructions.

**R905.2.8.1 Base and cap flashing.** Base and cap flashing shall be installed in accordance with manufacturer's instructions. Base flashing shall be of either corrosion-resistant metal of minimum nominal 0.019-inch (0.5 mm) thickness or mineral-surfaced roll roofing weighing not less than 77 pounds per 100 square feet (4 kg/m<sup>2</sup>). Cap flashing shall be corrosion-resistant metal of minimum nominal 0.019-inch (0.5 mm) thickness.

**R905.2.8.2 Valleys.** Valley linings shall be installed in accordance with the manufacturer's instructions before applying shingles. Valley linings of the following types shall be permitted:

1. For open valleys (valley lining exposed) lined with metal, the valley lining shall be not less than 24 inches (610 mm) wide and of any of the corrosion-resistant metals in Table R905.2.8.2.
2. For open valleys, valley lining of two plies of mineral-surfaced roll roofing, complying with ASTM D3909 or ASTM D6380 Class M, shall be permitted. The bottom layer shall be 18 inches (457 mm) and the top layer not less than 36 inches (914 mm) wide.
3. For closed valleys (valley covered with shingles), valley lining of one ply of smooth roll roofing complying with ASTM D6380 and not less than 36 inches wide (914 mm) or valley lining as described in Item 1 or 2 shall be permitted. Self-adhering polymer-modified bitumen *underlayment* complying with ASTM D1970 shall be permitted in lieu of the lining material.

**R905.2.8.3 Sidewall flashing.** Base flashing against a vertical sidewall shall be continuous or step flashing

and shall be not less than 4 inches (102 mm) in height and 4 inches (102 mm) in width and shall direct water away from the vertical sidewall onto the roof or into the gutter. Where siding is provided on the vertical sidewall, the vertical leg of the flashing shall be continuous under the siding. Where anchored masonry veneer is provided on the vertical sidewall, the base flashing shall be provided in accordance with this section and counterflashing shall be provided in accordance with Section R703.8.2.2. Where exterior plaster or adhered masonry veneer is provided on the vertical sidewall, the base flashing shall be provided in accordance with this section and Section R703.6.3.

**R905.2.8.4 Other flashing.** Flashing against a vertical front wall, as well as soil stack, vent pipe and chimney flashing, shall be applied in accordance with the asphalt shingle manufacturer's printed instructions.

**R905.2.8.5 Drip edge.** A drip edge shall be provided at eaves and rake edges of shingle roofs. Adjacent segments of drip edge shall be overlapped not less than 2 inches (51 mm). Drip edges shall extend not less than 1/4 inch (6.4 mm) below the roof sheathing and extend up back onto the *roof deck* not less than 2 inches (51 mm). Drip edges shall be mechanically fastened to the *roof deck* at not more than 12 inches (305 mm) o.c. with fasteners as specified in Section R905.2.5. *Underlayment* shall be installed over the drip edge along eaves and under the drip edge along rake edges.

**R905.3 Clay and concrete tile.** The installation of clay and concrete tile shall comply with the provisions of this section.

**R905.3.1 Deck requirements.** Concrete and clay tile shall be installed only over solid sheathing.

**Exception:** Spaced lumber sheathing in accordance with Section R803.1 shall be permitted in *Seismic Design Categories A, B and C*.

**R905.3.2 Deck slope.** Clay and concrete roof tile shall be installed on roof slopes of 2 1/2 units vertical in 12 units horizontal (25-percent slope) or greater. For roof slopes from 2 1/2 units vertical in 12 units horizontal (25-percent

**TABLE R905.2.8.2  
VALLEY LINING MATERIAL**

MATERIAL	MINIMUM THICKNESS (inches)	GAGE	WEIGHT (pounds)
Aluminum	0.024	—	—
Cold-rolled copper	0.0216 nominal	—	ASTM B370, 16 oz. per square foot
Galvanized steel	0.0179	26 (zinc coated G90)	—
High-yield copper	0.0162 nominal	—	ASTM B370, 12 oz. per square foot
Lead	—	—	2 1/2
Lead-coated copper	0.0216 nominal	—	ASTM B101, 16 oz. per square foot
Lead-coated high-yield copper	0.0162 nominal	—	ASTM B101, 12 oz. per square foot
Painted terne	—	—	20
Stainless steel	—	28	—
Zinc alloy	0.027	—	—

For SI: 1 inch = 25.4 mm, 1 pound = 0.454 kg, 1 square foot = 0.93 m<sup>2</sup>.



slope) to 4 units vertical in 12 units horizontal (33-percent slope), double *underlayment* application is required in accordance with Section R905.3.3.

**R905.3.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.3.4 Clay tile.** Clay roof tile shall comply with ASTM C1167.

**R905.3.5 Concrete tile.** Concrete roof tile shall comply with ASTM C1492.

**R905.3.6 Fasteners.** Nails shall be corrosion resistant and not less than 11-gage [0.120 inch (3 mm)],  $\frac{5}{16}$ -inch (11 mm) head, and of sufficient length to penetrate the deck not less than  $\frac{3}{4}$  inch (19 mm) or through the thickness of the deck, whichever is less. Attaching wire for clay or concrete tile shall not be smaller than 0.083 inch (2 mm). Perimeter fastening areas include three tile courses but not less than 36 inches (914 mm) from either side of hips or ridges and edges of eaves and gable rakes.

**R905.3.7 Application.** Tile shall be applied in accordance with this chapter and the manufacturer's installation instructions, based on the following:

1. Climatic conditions.
2. Roof slope.
3. *Underlayment* system.
4. Type of tile being installed.

Clay and concrete roof tiles shall be fastened in accordance with this section and the manufacturer's installation instructions. Perimeter tiles shall be fastened with not less than one fastener per tile. Tiles with installed weight less than 9 pounds per square foot (0.4 kg/m<sup>2</sup>) require not less than one fastener per tile regardless of roof slope. Clay and concrete roof tile attachment shall be in accordance with the manufacturer's installation instructions where applied in areas where the ultimate design wind speed exceeds 130 miles per hour (58 m/s) and on buildings where the roof is located more than 40 feet (12 192 mm) above grade. In areas subject to snow, not less than two fasteners per tile are required. In other areas, clay and concrete roof tiles shall be attached in accordance with Table R905.3.7.

**TABLE R905.3.7**  
**CLAY AND CONCRETE TILE ATTACHMENT**

SHEATHING	ROOF SLOPE	NUMBER OF FASTENERS
Solid without battens	All	One per tile
Spaced or solid with battens and slope < 5:12	Fasteners not required	—
Spaced sheathing without battens	5:12 ≤ slope < 12:12	One per tile/ every other row
	12:12 ≤ slope < 24:12	One per tile

**R905.3.8 Flashing.** At the juncture of roof vertical surfaces, flashing and counterflashing shall be provided in accordance with this chapter and the manufacturer's

installation instructions and, where of metal, shall be not less than 0.019 inch (0.5 mm) (No. 26 galvanized sheet gage) corrosion-resistant metal. The valley flashing shall extend not less than 11 inches (279 mm) from the centerline each way and have a splash diverter rib not less than 1 inch (25 mm) in height at the flow line formed as part of the flashing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). For roof slopes of 3 units vertical in 12 units horizontal (25-percent slope) and greater, valley flashing shall have a 36-inch-wide (914 mm) *underlayment* of one layer of Type I *underlayment* running the full length of the valley, in addition to other required *underlayment*. In areas where the average daily temperature in January is 25°F (-4°C) or less, metal valley flashing *underlayment* shall be solid-cemented to the roofing *underlayment* for slopes less than 7 units vertical in 12 units horizontal (58-percent slope) or be of self-adhering polymer-modified bitumen sheet.

**R905.4 Metal roof shingles.** The installation of metal roof shingles shall comply with the provisions of this section.

**R905.4.1 Deck requirements.** *Metal roof shingles* shall be applied to a solid or closely fitted deck, except where the roof covering is specifically designed to be applied to spaced sheathing.

**R905.4.2 Deck slope.** *Metal roof shingles* shall not be installed on roof slopes below 3 units vertical in 12 units horizontal (25-percent slope).

**R905.4.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.4.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.4.4 Material standards.** *Metal roof shingle* roof coverings shall comply with Table R905.10.3(1). The materials used for *metal roof shingle* roof coverings shall be naturally corrosion resistant or be made corrosion resistant in accordance with the standards and minimum thicknesses listed in Table R905.10.3(2).

**R905.4.4.1 Wind resistance of metal roof shingles.**

*Metal roof shingles* applied to a solid or closely fitted deck shall be tested in accordance with ASTM D3161, FM 4474, UL 580 or UL 1897. *Metal roof shingles* tested in accordance with ASTM D3161 shall meet the classification requirements of Table R905.4.4.1 for the appropriate maximum basic wind speed and the metal shingle packaging shall bear a *label* to indicate compliance with ASTM D3161 and the required classification in Table R905.2.4.1.

**R905.4.5 Application.** *Metal roof shingles* shall be secured to the roof in accordance with this chapter and the *approved* manufacturer's installation instructions.

**R905.4.6 Flashing.** Roof valley flashing shall be of corrosion-resistant metal of the same material as the roof covering or shall comply with the standards in Table R905.10.3(1). The valley flashing shall extend not less than 8 inches (203 mm) from the centerline each way and shall have a splash diverter rib not less than  $\frac{3}{4}$  inch (19 mm) in height at the flow line formed as part of the flash-

## ROOF ASSEMBLIES

ing. Sections of flashing shall have an end lap of not less than 4 inches (102 mm). The metal valley flashing shall have a 36-inch-wide (914 mm) *underlayment* directly under it consisting of one layer of *underlayment* running the full length of the valley, in addition to *underlayment* required for *metal roof shingles*. In areas where the average daily temperature in January is 25°F (-4°C) or less, the metal valley flashing *underlayment* shall be solid-cemented to the roofing *underlayment* for roof slopes under 7 units vertical in 12 units horizontal (58-percent slope) or self-adhering polymer-modified bitumen sheet.

**R905.5 Mineral-surfaced roll roofing.** The installation of mineral-surfaced roll roofing shall comply with this section.

**R905.5.1 Deck requirements.** Mineral-surfaced roll roofing shall be fastened to solidly sheathed roofs.

**R905.5.2 Deck slope.** Mineral-surfaced roll roofing shall not be applied on roof slopes below 1 unit vertical in 12 units horizontal (8-percent slope).

**R905.5.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.5.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.5.4 Material standards.** Mineral-surfaced roll roofing shall conform to ASTM D3909 or ASTM D6380, Class M.

**R905.5.5 Application.** Mineral-surfaced roll roofing shall be installed in accordance with this chapter and the manufacturer's instructions.

**R905.6 Slate shingles.** The installation of slate shingles shall comply with the provisions of this section.

**R905.6.1 Deck requirements.** Slate shingles shall be fastened to solidly sheathed roofs.

**R905.6.2 Deck slope.** Slate shingles shall be used only on slopes of 4 units vertical in 12 units horizontal (33-percent slope) or greater.

**R905.6.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.6.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.6.4 Material standards.** Slate shingles shall comply with ASTM C406.

**R905.6.5 Application.** Minimum headlap for slate shingles shall be in accordance with Table R905.6.5. Slate shingles shall be secured to the roof with two fasteners per slate. Slate shingles shall be installed in accordance with this chapter and the manufacturer's instructions.

**TABLE R905.6.5  
SLATE SHINGLE HEADLAP**

SLOPE	HEADLAP (inches)
4:12 ≤ slope < 8:12	4
8:12 ≤ slope < 20:12	3
Slope ≥ 20:12	2

For SI: 1 inch = 25.4 mm.

**R905.6.6 Flashing.** Flashing and counterflashing shall be made with sheet metal. Valley flashing shall be not less than 15 inches (381 mm) wide. Valley and flashing metal shall be a minimum uncoated thickness of 0.0179-inch (0.5 mm) zinc coated G90. Chimneys, stucco or brick walls shall have not less than two plies of felt for a cap flashing consisting of a 4-inch-wide (102 mm) strip of felt set in plastic cement and extending 1 inch (25 mm) above the first felt and a top coating of plastic cement. The felt shall extend 2 inches (51 mm) over the base flashing.

**R905.7 Wood shingles.** The installation of wood shingles shall comply with the provisions of this section.

**R905.7.1 Deck requirements.** Wood shingles shall be installed on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners.

**R905.7.1.1 Solid sheathing required.** In areas where the average daily temperature in January is 25°F (-4°C) or less, solid sheathing is required on that portion of the roof requiring the application of an ice barrier.

**R905.7.2 Deck slope.** Wood shingles shall be installed on slopes of 3 units vertical in 12 units horizontal (25-percent slope) or greater.

**TABLE R905.4.4.1  
CLASSIFICATION OF STEEP SLOPE METAL ROOF SHINGLES TESTED IN ACCORDANCE WITH ASTM D3161**

MAXIMUM ULTIMATE DESIGN WIND SPEED, $V_{ult}$ FROM FIGURE R301.2(2) (mph)	MAXIMUM BASIC WIND SPEED, $V_{ASD}$ FROM TABLE R301.2.1.3 (mph)	ASTM D3161 SHINGLE CLASSIFICATION
110	85	A, D or F
116	90	A, D or F
129	100	A, D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

For SI: 1 mile per hour = 1.609 kph.

**R905.7.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.7.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.7.4 Material standards.** Wood shingles shall be of *naturally durable wood* and comply with the requirements of Table R905.7.4.

**TABLE R905.7.4  
WOOD SHINGLE MATERIAL REQUIREMENTS**

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shingles of naturally durable wood	1, 2 or 3	CSSB

**R905.7.5 Application.** Wood shingles shall be installed in accordance with this chapter and the manufacturer's instructions. Wood shingles shall be laid with a side lap not less than  $1\frac{1}{2}$  inches (38 mm) between joints in courses, and two joints shall not be in direct alignment in any three adjacent courses. Spacing between shingles shall be not less than  $\frac{1}{4}$  inch to  $\frac{3}{8}$  inch (6.4 mm to 9.5 mm). Weather exposure for wood shingles shall not exceed those set in Table R905.7.5(1). Fasteners for untreated (naturally durable) wood shingles shall be box nails in accordance with Table R905.7.5(2). Nails shall be stainless steel Type 304 or 316 or hot-dipped galvanized with a coating weight of ASTM A153 Class D (1.0 oz/ft<sup>2</sup>). Alternatively, two 16-gage stainless steel Type 304 or 316 staples with crown widths  $\frac{7}{16}$  inch (11.1 mm) minimum,  $\frac{3}{4}$  inch (19.1 mm) maximum, shall be used. Fasteners installed within 15 miles (24 km) of saltwater coastal areas shall be stainless steel Type 316. Fasteners for fire-retardant-treated shingles in accordance with Section R902 or pressure-impregnated-preservative-treated shingles of naturally durable wood in accordance with AWP A U1 shall be stainless steel Type 316. Fasteners shall have a minimum penetration into the sheathing of  $\frac{3}{4}$  inch (19.1 mm). For sheathing less than  $\frac{3}{4}$  inch (19.1 mm) thickness, each fastener shall penetrate through the sheathing. Wood shingles shall be attached to the roof with two fasteners per shingle, positioned in

**TABLE R905.7.5(1)  
WOOD SHINGLE WEATHER EXPOSURE AND ROOF SLOPE**

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches)	
			3:12 pitch to < 4:12	4:12 pitch or steeper
Shingles of naturally durable wood	16	No. 1	$3\frac{3}{4}$	5
		No. 2	$3\frac{1}{2}$	4
		No. 3	3	$3\frac{1}{2}$
	18	No. 1	$4\frac{1}{4}$	$5\frac{1}{2}$
		No. 2	4	$4\frac{1}{2}$
		No. 3	$3\frac{1}{2}$	4
	24	No. 1	$5\frac{3}{4}$	$7\frac{1}{2}$
		No. 2	$5\frac{1}{2}$	$6\frac{1}{2}$
		No. 3	5	$5\frac{1}{2}$

For SI: 1 inch = 25.4 mm.

accordance with the manufacturer's installation instructions. Fastener packaging shall bear a *label* indicating the appropriate grade material or coating weight.

**TABLE R905.7.5(2)  
NAIL REQUIREMENTS FOR  
WOOD SHAKES AND WOOD SHINGLES**

PRODUCT TYPE	NAIL TYPE, MINIMUM LENGTH AND SHANK DIAMETER (inches)
<b>Shakes</b>	
18" straight-split	5d box $1\frac{3}{4}$ " $\times$ 0.080
18" and 24" handsplit and resawn	6d box 2" $\times$ 0.099
24" taper-split	5d box $1\frac{3}{4}$ " $\times$ 0.080
18" and 24" tapersawn	6d box 2" $\times$ 0.099
<b>Shingles</b>	
16" and 18"	3d box $1\frac{1}{4}$ " $\times$ 0.076
24"	4d box $1\frac{1}{2}$ " $\times$ 0.076

For SI: 1 inch = 25.4 mm.

**R905.7.6 Valley flashing.** Roof flashing shall be not less than No. 26 gage [0.019 inches (0.5 mm)] corrosion-resistant sheet metal and shall extend 10 inches (254 mm) from the centerline each way for roofs having slopes less than 12 units vertical in 12 units horizontal (100-percent slope), and 7 inches (178 mm) from the centerline each way for slopes of 12 units vertical in 12 units horizontal (100-percent slope) and greater. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

**R905.7.7 Label required.** Each bundle of shingles shall be identified by a *label* of an *approved* grading or inspection bureau or agency.

**R905.8 Wood shakes.** The installation of wood shakes shall comply with the provisions of this section.

**R905.8.1 Deck requirements.** Wood shakes shall be used only on solid or spaced sheathing. Where spaced sheathing is used, sheathing boards shall be not less than 1-inch by 4-inch (25 mm by 102 mm) nominal dimensions and shall be spaced on centers equal to the weather exposure to coincide with the placement of fasteners. Where 1-inch by 4-inch (25 mm by 102 mm) spaced sheathing is installed at 10 inches (254 mm) on center, additional 1-inch by 4-inch (25 mm by 102 mm) boards shall be installed between the sheathing boards.

**R905.8.1.1 Solid sheathing required.** In areas where the average daily temperature in January is 25°F (-4°C) or less, solid sheathing is required on that portion of the roof requiring an ice barrier.

**R905.8.2 Deck slope.** Wood shakes shall only be used on slopes of 3 units vertical in 12 units horizontal (25-percent slope) or greater.

**R905.8.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.8.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

## ROOF ASSEMBLIES

**R905.8.4 Interlayment.** Interlayment shall comply with ASTM D226, Type I.

**R905.8.5 Material standards.** Wood shakes shall comply with the requirements of Table R905.8.5.

**R905.8.6 Application.** Wood shakes shall be installed in accordance with this chapter and the manufacturer's installation instructions. Wood shakes shall be laid with a side lap not less than  $1\frac{1}{2}$  inches (38 mm) between joints in adjacent courses. Spacing between shakes in the same course shall be  $\frac{3}{8}$  inch to  $\frac{5}{8}$  inch (9.5 mm to 15.9 mm) including tapersawn shakes. Weather exposures for wood shakes shall not exceed those set in Table R905.8.6. Fasteners for untreated (naturally durable) wood shakes shall be box nails in accordance with Table R905.7.5(2). Nails shall be stainless steel Type 304, or Type 316 or hot-dipped with a coating weight of ASTM A153 Class D (1.0 oz/ft<sup>2</sup>). Alternatively, two 16-gage Type 304 or Type 316 stainless steel staples, with crown widths  $\frac{7}{16}$  inch (11.1 mm) minimum,  $\frac{3}{4}$  inch (19.1 mm) maximum, shall be used. Fasteners installed within 15 miles (24 km) of salt-water coastal areas shall be stainless steel Type 316. Wood shakes shall be attached to the roof with two fasteners per shake positioned in accordance with the manufacturer's installation instructions. Fasteners for fire-retardant-treated (as defined in Section R902) shakes or pressure-impregnated-preservative-treated shakes of *naturally durable wood* in accordance with AWP A U1 shall be

stainless steel Type 316. Fasteners shall have a minimum penetration into the sheathing of  $\frac{3}{4}$  inch (19.1 mm). Where the sheathing is less than  $\frac{3}{4}$  inch (19.1 mm) thick, each fastener shall penetrate through the sheathing. Fastener packaging shall bear a *label* indicating the appropriate grade material or coating weight.

**R905.8.7 Shake placement.** The starter course at the eaves shall be doubled and the bottom layer shall be either 15-inch (381 mm), 18-inch (457 mm) or 24-inch (610 mm) wood shakes or wood shingles. Fifteen-inch (381 mm) or 18-inch (457 mm) wood shakes shall be permitted to be used for the final course at the ridge. Shakes shall be interlaid with 18-inch-wide (457 mm) strips of not less than No. 30 felt shingled between each course in such a manner that felt is not exposed to the weather by positioning the lower edge of each felt strip above the butt end of the shake it covers a distance equal to twice the weather exposure.

**R905.8.8 Valley flashing.** Roof valley flashing shall be not less than No. 26 gage [0.019 inch (0.5 mm)] corrosion-resistant sheet metal and shall extend not less than 11 inches (279 mm) from the centerline each way. Sections of flashing shall have an end lap of not less than 4 inches (102 mm).

**R905.8.9 Label required.** Each bundle of shakes shall be identified by a *label* of an *approved* grading or inspection bureau or agency.

**TABLE R905.8.5**  
**WOOD SHAKE MATERIAL REQUIREMENTS**

MATERIAL	MINIMUM GRADES	APPLICABLE GRADING RULES
Wood shakes of naturally durable wood	1	Cedar Shake and Shingle Bureau
Tapersawn shakes of naturally durable wood	1 or 2	Cedar Shake and Shingle Bureau
Preservative-treated shakes and shingles of naturally durable wood	1	Cedar Shake and Shingle Bureau
Fire-retardant-treated shakes and shingles of naturally durable wood	1	Cedar Shake and Shingle Bureau
Preservative-treated tapersawn shakes of Southern pine treated in accordance with AWP A Standard U1 (Commodity Specification A, Special Requirement 4.6)	1 or 2	Forest Products Laboratory of the Texas Forest Services

**TABLE R905.8.6**  
**WOOD SHAKE WEATHER EXPOSURE AND ROOF SLOPE**

ROOFING MATERIAL	LENGTH (inches)	GRADE	EXPOSURE (inches)
			4:12 pitch or steeper
Shakes of naturally durable wood	18	No. 1	$7\frac{1}{2}$
	24	No. 1	10 <sup>a</sup>
Preservative-treated tapersawn shakes of Southern Yellow Pine	18	No. 1	$7\frac{1}{2}$
	24	No. 1	10
	18	No. 2	$5\frac{1}{2}$
	24	No. 2	$7\frac{1}{2}$
Taper-sawn shakes of naturally durable wood	18	No. 1	$7\frac{1}{2}$
	24	No. 1	10
	18	No. 2	$5\frac{1}{2}$
	24	No. 2	$7\frac{1}{2}$

For SI: 1 inch = 25.4 mm.

a. For 24-inch by  $\frac{3}{8}$ -inch handsplit shakes, the maximum exposure is  $7\frac{1}{2}$  inches.



**R905.9 Built-up roofs.** The installation of built-up roofs shall comply with the provisions of this section and the manufacturer's *approved* installation instructions.

**R905.9.1 Slope.** Built-up roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage, except for coal-tar built-up roofs, which shall have a design slope of a minimum  $\frac{1}{8}$  unit vertical in 12 units horizontal (1-percent slope).

**R905.9.2 Material standards.** *Built-up roof covering* materials shall comply with the standards in Table R905.9.2 or UL 55A.

**R905.9.3 Application.** Built-up roofs shall be installed in accordance with this chapter and the manufacturer's instructions.

**R905.10 Metal roof panels.** The installation of *metal roof panels* shall comply with the provisions of this section.

**R905.10.1 Deck requirements.** *Metal roof panel* roof coverings shall be applied to solid or spaced sheathing, except where the roof covering is specifically designed to be applied to spaced supports.

**R905.10.2 Slope.** Minimum slopes for *metal roof panels* shall comply with the following:

1. The minimum slope for lapped, nonsoldered-seam metal roofs without applied lap sealant shall be 3 units vertical in 12 units horizontal (25-percent slope).
2. The minimum slope for lapped, nonsoldered-seam metal roofs with applied lap sealant shall be  $\frac{1}{2}$  unit vertical in 12 units horizontal (4-percent

slope). Lap sealants shall be applied in accordance with the *approved* manufacturer's installation instructions.

3. The minimum slope for standing-seam roof systems shall be  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope).

**R905.10.3 Material standards.** Metal-sheet roof covering systems that incorporate supporting structural members shall be designed in accordance with the *International Building Code*. Metal-sheet roof coverings installed over structural decking shall comply with Table R905.10.3(1). The materials used for metal-sheet roof coverings shall be naturally corrosion resistant or provided with corrosion resistance in accordance with the standards and minimum thicknesses shown in Table R905.10.3(2).

**R905.10.4 Attachment.** *Metal roof panels* shall be secured to the supports in accordance with this chapter and the manufacturer's installation instructions. In the absence of manufacturer's installation instructions, the following fasteners shall be used:

1. Galvanized fasteners shall be used for steel roofs.
2. Copper, brass, bronze, copper alloy and 300-series stainless steel fasteners shall be used for copper roofs.
3. Stainless steel fasteners are acceptable for metal roofs.

**R905.10.5 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**TABLE R905.9.2  
BUILT-UP ROOFING MATERIAL STANDARDS**

MATERIAL STANDARD	STANDARD
Acrylic coatings used in roofing	ASTM D6083
Aggregate surfacing	ASTM D1863
Asphalt adhesive used in roofing	ASTM D3747
Asphalt cements used in roofing	ASTM D2822; D3019; D4586
Asphalt-coated glass fiber base sheet	ASTM D4601
Asphalt coatings used in roofing	ASTM D1227; D2823; D2824; D4479
Asphalt glass felt	ASTM D2178
Asphalt primer used in roofing	ASTM D41
Asphalt-saturated and asphalt-coated organic felt base sheet	ASTM D2626
Asphalt-saturated organic felt (perforated)	ASTM D2626
Asphalt used in roofing	ASTM D312
Coal-tar cements used in roofing	ASTM D4022; D5643
Coal-tar primer used in roofing, dampproofing and waterproofing	ASTM D43
Coal-tar saturated organic felt	ASTM D227
Coal-tar used in roofing	ASTM D450, Type I or II
Glass mat, coal tar	ASTM D4990
Glass mat, venting type	ASTM D4897
Mineral-surfaced inorganic cap sheet	ASTM D3909
Thermoplastic fabrics used in roofing	ASTM D5665; D5726



## ROOF ASSEMBLIES

**R905.11 Modified bitumen roofing.** The installation of modified bitumen roofing shall comply with the provisions of this section and the manufacturer's *approved* installation instructions.

**R905.11.1 Slope.** Modified bitumen roofing shall have a design slope of not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) for drainage.

**R905.11.2 Material standards.** Modified bitumen roofing shall comply with the standards in Table R905.11.2.

**R905.11.2.1 Base sheet.** A base sheet that complies with the requirements of Section 1507.11.2 of the *International Building Code*, ASTM D1970 or ASTM D4601 shall be permitted to be used with a modified bitumen cap sheet.

**R905.11.3 Application.** Modified bitumen roofs shall be installed in accordance with this chapter and the manufacturer's instructions.

**R905.12 Thermoset single-ply roofing.** The installation of thermoset single-ply roofing shall comply with the provisions of this section.

**R905.12.1 Slope.** Thermoset *single-ply membrane* roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**R905.12.2 Material standards.** Thermoset single-ply roof coverings shall comply with ASTM D4637 or ASTM D5019.

**TABLE R905.10.3(1)**  
**METAL ROOF COVERING STANDARDS**

ROOF COVERING TYPE	STANDARD APPLICATION RATE/THICKNESS
Aluminum	ASTM B209, 0.024 minimum thickness for roll-formed panels and 0.019-inch minimum thickness for press-formed shingles.
Cold-rolled copper	ASTM B370 minimum 16 oz/sq ft and 12 oz/sq ft high-yield copper for metal-sheet roof-covering systems; 12 oz/sq ft for preformed metal shingle systems.
Galvanized steel	ASTM A653 G90 Zinc coated
Hard lead	2 lb/sq ft
Lead-coated copper	ASTM B101
Soft lead	3 lb/sq ft
Stainless steel	ASTM A240, 300 Series alloys
Steel	ASTM A924
Terne (tin) and terne-coated stainless	Terne coating of 40 lb per double base box, field painted where applicable in accordance with manufacturer's installation instructions.
Zinc	0.027 inch minimum thickness: 99.995% electrolytic high-grade zinc with alloy additives of copper (0.08–0.20%), titanium (0.07%–0.12%) and aluminum (0.015%).

For SI: 1 ounce per square foot = 0.305 kg/m<sup>2</sup>, 1 pound per square foot = 4.214 kg/m<sup>2</sup>, 1 inch = 25.4 mm, 1 pound = 0.454 kg.

**TABLE R905.10.3(2)**  
**MINIMUM CORROSION RESISTANCE**

55% aluminum-zinc-alloy-coated steel	ASTM A792 AZ 50
5% aluminum alloy-coated steel	ASTM A875 GF60
Aluminum-coated steel	ASTM A463 T2 65
Galvanized steel	ASTM A653 G-90
Prepainted steel	ASTM A755 <sup>a</sup>

a. Paint systems in accordance with ASTM A755 shall be applied over steel products with corrosion-resistant coatings complying with ASTM A792, ASTM A875, ASTM A463 or ASTM A653.

**TABLE R905.11.2**  
**MODIFIED BITUMEN ROOFING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Asphalt adhesive	ASTM D3747
Asphalt cement	ASTM D3019
Asphalt coating	ASTM D1227; D2824
Asphalt primer	ASTM D41
Modified bitumen roof membrane	ASTM D6162; D6163; D6164; D6222; D6223; D6298

**R905.12.3 Application.** Thermoset single-ply roofs shall be installed in accordance with this chapter and the manufacturer's instructions.

**R905.13 Thermoplastic single-ply roofing.** The installation of thermoplastic single-ply roofing shall comply with the provisions of this section.

**R905.13.1 Slope.** Thermoplastic *single-ply membrane* roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope).

**R905.13.2 Material standards.** Thermoplastic single-ply roof coverings shall comply with ASTM D4434, D6754 or D6878.

**R905.13.3 Application.** Thermoplastic single-ply roofs shall be installed in accordance with this chapter and the manufacturer's instructions.

**R905.14 Sprayed polyurethane foam roofing.** The installation of sprayed polyurethane foam roofing shall comply with the provisions of this section.

**R905.14.1 Slope.** Sprayed polyurethane foam roofs shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope) for drainage.

**R905.14.2 Material standards.** Spray-applied polyurethane foam insulation shall comply with ASTM C1029, Type III or IV or ASTM D7425.

**R905.14.3 Application.** Foamed-in-place roof insulation shall be installed in accordance with this chapter and the manufacturer's instructions. A liquid-applied protective coating that complies with Table R905.14.3 shall be applied not less than 2 hours nor more than 72 hours following the application of the foam.

**TABLE R905.14.3**  
**PROTECTIVE COATING MATERIAL STANDARDS**

MATERIAL	STANDARD
Acrylic coating	ASTM D6083
Moisture-cured polyurethane coating	ASTM D6947
Silicone coating	ASTM D6694

**R905.14.4 Foam plastics.** Foam plastic materials and installation shall comply with Section R316.

**R905.15 Liquid-applied roofing.** The installation of liquid-applied roofing shall comply with the provisions of this section.

**R905.15.1 Slope.** Liquid-applied roofing shall have a design slope of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope).

**R905.15.2 Material standards.** Liquid-applied roofing shall comply with ASTM C836, C957, D1227, D3468, D6083, D6694 or D6947.

**R905.15.3 Application.** Liquid-applied roofing shall be installed in accordance with this chapter and the manufacturer's installation instructions.

**R905.16 Photovoltaic shingles.** The installation of *photovoltaic shingles* shall comply with the provisions of this section, Section R324 and NFPA 70.

**R905.16.1 Deck requirements.** *Photovoltaic shingles* shall be applied to a solid or closely-fitted deck, except where the roof covering is specifically designed to be applied over spaced sheathing.

**R905.16.2 Deck slope.** *Photovoltaic shingles* shall be used only on roof slopes of 2 units vertical in 12 units horizontal (2:12) or greater.

**R905.16.3 Underlayment.** *Underlayment* shall comply with Section R905.1.1.

**R905.16.3.1 Ice barrier.** Where required, ice barriers shall comply with Section R905.1.2.

**R905.16.4 Material standards.** *Photovoltaic shingles* shall be *listed* and *labeled* in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

**R905.16.5 Attachment.** *Photovoltaic shingles* shall be attached in accordance with the manufacturer's installation instructions.

**R905.16.6 Wind resistance.** *Photovoltaic shingles* shall comply with the classification requirements of Table R905.16.6 for the appropriate maximum basic wind speed.

**R905.17 Building-integrated photovoltaic (BIPV) roof panels applied directly to the roof deck.** The installation of *BIPV roof panels* shall comply with the provisions of this section, Section R324 and NFPA 70.

**TABLE R905.16.6**  
**CLASSIFICATION OF PHOTOVOLTAIC SHINGLES**

MAXIMUM ULTIMATE DESIGN WIND SPEED, $V_{ult}$ FROM FIGURE R301.2(2) (mph)	MAXIMUM BASIC WIND SPEED, $V_{ASD}$ FROM TABLE R301.2.1.3 (mph)	UL 7103 SHINGLE CLASSIFICATION
110	85	A, D or F
116	90	A, D or F
129	100	A, D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

For SI: 1 mile per hour = 1.609 kph.

## ROOF ASSEMBLIES

**R905.17.1 Deck requirements.** *BIPV roof panels* shall be applied to a solid or closely-fitted deck, except where the roof covering is specifically designed to be applied over spaced sheathing.

**R905.17.2 Deck slope.** *BIPV roof panels* shall be used only on roof slopes of 2 units vertical in 12 units horizontal (17-percent slope) or greater.

**R905.17.3 Underlayment.** *Underlayment* shall comply with Section 905.1.1.

**R905.17.3.1 Ice barrier.** Where required, an ice barrier shall comply with Section R905.1.2.

**R905.17.4 Ice barrier.** In areas where there has been a history of ice forming along the eaves causing a backup of water, as designated in Table R301.2, an ice barrier that consists of not less than two layers of *underlayment* cemented together or of a self-adhering polymer-modified bitumen sheet shall be used in lieu of normal *underlayment* and extend from the lowest edges of all roof surfaces to a point not less than 24 inches (610 mm) inside the exterior wall line of the building.

**Exception:** Detached *accessory structures* that do not contain conditioned floor area.

**R905.17.5 Material standards.** *BIPV roof panels* shall be *listed* and *labeled* in accordance with UL 7103 or with both UL 61730-1 and UL 61730-2.

**R905.17.6 Attachment.** *BIPV roof panels* shall be attached in accordance with the manufacturer's installation instructions.

## SECTION R906 ROOF INSULATION

**R906.1 General.** Where above-deck thermal insulation is installed, such insulation shall be covered with an *approved* roof covering and shall comply with NFPA 276 or UL 1256.

**R906.2 Material standards.** Above-deck thermal insulation board shall comply with the standards in Table R906.2.

**TABLE R906.2**  
**MATERIAL STANDARDS FOR ROOF INSULATION**

Cellular glass board	ASTM C552
Composite boards	ASTM C1289, Type III, IV, V or VI
Expanded polystyrene	ASTM C578
Extruded polystyrene board	ASTM C578
Fiber-reinforced gypsum board	ASTM C1278
Glass-faced gypsum board	ASTM C1177
Mineral wool board	ASTM C726
Perlite board	ASTM C728
Polyisocyanurate board	ASTM C1289, Type I or II
Wood fiberboard	ASTM C208

## SECTION R907 ROOFTOP-MOUNTED PHOTOVOLTAIC PANEL SYSTEMS

**R907.1 Rooftop-mounted photovoltaic panel systems.** Rooftop-mounted *photovoltaic panel systems* shall be designed and installed in accordance with Section R324 and NFPA 70.

## SECTION R908 REROOFING

**R908.1 General.** Materials and methods of application used for recovering or replacing an existing roof covering shall comply with the requirements of Chapter 9.

### Exceptions:

1. *Reroofing* shall not be required to meet the minimum design slope requirement of one-quarter unit vertical in 12 units horizontal (2-percent slope) in Section R905 for roofs that provide *positive roof drainage*.
2. For roofs that provide positive drainage, recovering or replacing an existing roof covering shall not require the secondary (emergency overflow) drains or *scuppers* of Section R903.4.1 to be added to an existing roof.

**R908.2 Structural and construction loads.** The structural roof components shall be capable of supporting the roof covering system and the material and equipment loads that will be encountered during installation of the roof covering system.

**R908.3 Roof replacement.** *Roof replacement* shall include the removal of existing layers of roof coverings down to the *roof deck*.

**Exception:** Where the existing *roof assembly* includes an ice barrier membrane that is adhered to the *roof deck*, the existing ice barrier membrane shall be permitted to remain in place and covered with an additional layer of ice barrier membrane in accordance with Section R905.

**R908.3.1 Roof recover.** The installation of a new roof covering over an existing roof covering shall be permitted where any of the following conditions occur:

1. Where the new roof covering is installed in accordance with the roof covering manufacturer's approved instructions
2. Complete and separate roofing systems, such as standing-seam metal roof systems, that are designed to transmit the roof loads directly to the building's structural system and do not rely on existing roofs and roof coverings for support, shall not require the removal of existing roof coverings.
3. Metal panel, metal shingle and concrete and clay tile roof coverings shall be permitted to be installed over existing wood shake roofs where applied in accordance with Section R908.4.

4. The application of a new protective *roof coating* over an existing protective *roof coating*, *metal roof panel*, *metal roof shingle*, mineral surfaced roll roofing, built-up roof, modified bitumen roofing, thermoset and thermoplastic single-ply roofing and spray polyurethane foam roofing system shall be permitted without tear-off of existing roof coverings.

**R908.3.1.1 Roof recover not allowed.** A *roof recover* shall not be permitted where any of the following conditions occur:

1. Where the existing roof or roof covering is water soaked or has deteriorated to the point that the existing roof or roof covering is not adequate as a base for additional roofing.
2. Where the existing roof covering is slate, clay, cement or asbestos-cement tile.
3. Where the existing roof has two or more applications of any type of roof covering.

**R908.4 Roof recovering.** Where the application of a new roof covering over wood shingle or shake roofs creates a combustible concealed space, the entire existing surface shall be covered with gypsum board, mineral fiber, glass fiber or other *approved* materials securely fastened in place.

**R908.5 Reinstallation of materials.** Existing slate, clay or cement tile shall be permitted for reinstallation, except that damaged, cracked or broken slate or tile shall not be reinstalled. Any existing flashings, edgings, outlets, vents or similar devices that are a part of the assembly shall be replaced where rusted, damaged or deteriorated. Aggregate surfacing materials shall not be reinstalled.

**R908.6 Flashings.** Flashings shall be reconstructed in accordance with *approved* manufacturer's installation instructions. Metal flashing to which bituminous materials are to be adhered shall be primed prior to installation.





## CHAPTER 10

# CHIMNEYS AND FIREPLACES

### User note:

**About this chapter:** Chapter 10 contains requirements for the construction, seismic reinforcing and anchorage of masonry chimneys and fireplaces; and establishes standards for the use and installation of factory-built chimneys, fireplaces and masonry heaters. Chimneys and fireplaces constructed of masonry rely on prescriptive requirements for the details of their construction; factory-built versions rely on the listing and labeling method of approval.

### SECTION R1001 MASONRY FIREPLACES

**R1001.1 General.** Masonry fireplaces shall be constructed in accordance with this section and the applicable provisions of Chapters 3 and 4.

**R1001.2 Footings and foundations.** Footings for masonry fireplaces and their chimneys shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not less than 6 inches (152 mm) beyond the face of the fireplace or foundation wall on all sides. Footings shall be founded on natural, undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished *grade*.

**R1001.2.1 Ash dump cleanout.** Cleanout openings located within foundation walls below fireboxes, where provided, shall be equipped with ferrous metal or masonry doors and frames constructed to remain tightly closed except when in use. Cleanouts shall be located to allow *access* so that ash removal will not create a hazard to *combustible materials*.

**R1001.3 Seismic reinforcing.** Masonry or concrete chimneys in Seismic Design Category  $D_0$ ,  $D_1$  or  $D_2$  shall be reinforced. Reinforcing shall conform to the requirements set forth in Table R1001.1 and Section R606.

**R1001.3.1 Vertical reinforcing.** For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars shall be placed between wythes of *solid masonry* or within the cells of hollow unit masonry and grouted in accordance with Section R606. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys more than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional flue incorporated into the chimney or for each additional 40 inches (1016 mm) in width or fraction thereof.

**R1001.3.2 Horizontal reinforcing.** Vertical reinforcement shall be placed within  $\frac{1}{4}$ -inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, placed in the bed joints in accordance with Section R606 at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be installed at each bend in the vertical bars.

**R1001.4 Seismic anchorage.** Masonry or concrete chimneys in Seismic Design Category  $D_0$ ,  $D_1$  or  $D_2$  shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above *grade*, except where constructed completely within the exterior walls. Anchorage shall conform to the requirements of Section R1001.4.1.

**R1001.4.1 Anchorage.** Two  $\frac{3}{16}$ -inch by 1-inch (5 mm by 25 mm) straps shall be embedded not less than 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not less than four floor ceiling or floor joists or rafters with two  $\frac{1}{2}$ -inch (12.7 mm) bolts.

**R1001.4.1.1 Cold-formed steel framing.** Where cold-formed steel framing is used, the location where the  $\frac{1}{2}$ -inch (12.7 mm) bolts are used to attach the straps to the framing shall be reinforced with not less than a 3-inch  $\times$  3-inch  $\times$  0.0229-inch (76 mm  $\times$  76 mm  $\times$  5.8 mm) steel plate on top of the strap that is screwed to the framing with not fewer than seven No. 6 screws for each bolt.

**R1001.5 Firebox walls.** Masonry fireboxes shall be constructed of *solid masonry* units, *hollow masonry units* grouted solid, stone or concrete. Where a lining of firebrick not less than 2 inches (51 mm) thick or other *approved* lining is provided, the minimum thickness of back and sidewalls shall each be 8 inches (203 mm) of *solid masonry*, including the lining. The width of joints between firebricks shall not be greater than  $\frac{1}{4}$  inch (6.4 mm). Where a lining is not provided, the total minimum thickness of back and side walls shall be 10 inches (254 mm) of *solid masonry*. Firebrick shall conform to ASTM C27 or C1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C199.

**R1001.5.1 Steel fireplace units.** Installation of steel fireplace units with *solid masonry* to form a masonry fireplace is permitted where installed either in accordance with the requirements of their listing or the requirements of this section. Steel fireplace units incorporating a steel firebox lining shall be constructed with steel not less than  $\frac{1}{4}$  inch (6.4 mm) thick, and an air-circulating chamber that is ducted to the interior of the building. The firebox lining shall be encased with *solid masonry* to provide a total thickness at the back and sides of not less than 8 inches (203 mm), of which not less than 4 inches (102 mm) shall be of *solid masonry* or concrete. Circulating air ducts used with steel fireplace units shall be constructed of metal or masonry.

## CHIMNEYS AND FIREPLACES

**TABLE R1001.1**  
**SUMMARY OF REQUIREMENTS FOR MASONRY FIREPLACES AND CHIMNEYS**

ITEM	LETTER <sup>a</sup>	REQUIREMENTS
Hearth slab thickness	A	4 inches
Hearth extension (each side of opening)	B	8-inch fireplace opening < 6 square feet. 12-inch fireplace opening ≥ 6 square feet.
Hearth extension (front of opening)	C	16-inch fireplace opening < 6 square feet. 20-inch fireplace opening ≥ 6 square feet.
Hearth slab reinforcing	D	Reinforced to carry its own weight and all imposed loads.
Thickness of wall of firebox	E	10-inch solid brick or 8 inches where a firebrick lining is used. Joints in firebrick 1/4-inch maximum.
Distance from top of opening to throat	F	8 inches
Smoke chamber wall thickness Unlined walls	G	6 inches 8 inches
Chimney Vertical reinforcing <sup>b</sup>	H	Four No. 4 full-length bars for chimney up to 40 inches wide. Add two No. 4 bars for each additional 40 inches or fraction of width or each additional flue.
Horizontal reinforcing	J	1/4-inch ties at 18 inches and two ties at each bend in vertical steel.
Bond beams	K	No specified requirements.
Fireplace lintel	L	Noncombustible material.
Chimney walls with flue lining	M	Solid masonry units or hollow masonry units grouted solid with not less than 4-inch nominal thickness.
Distances between adjacent flues	—	See Section R1003.13.
Effective flue area (based on area of fireplace opening)	P	See Section R1003.15.
Clearances Combustible material Mantel and trim Above roof	R	See Sections R1001.11 and R1003.18. See Section R1001.11, Exception 4. 3 feet at roofline and 2 feet at 10 feet.
Anchorage <sup>b</sup> Strap Number Embedment into chimney Fasten to Bolts	S	3/16-inch × 1-inch Two 12 inches hooked around outer bar with 6-inch extension. 4 joists Two 1/2-inch diameter.
Footing Thickness Width	T	12 inches min. 6 inches each side of fireplace wall.

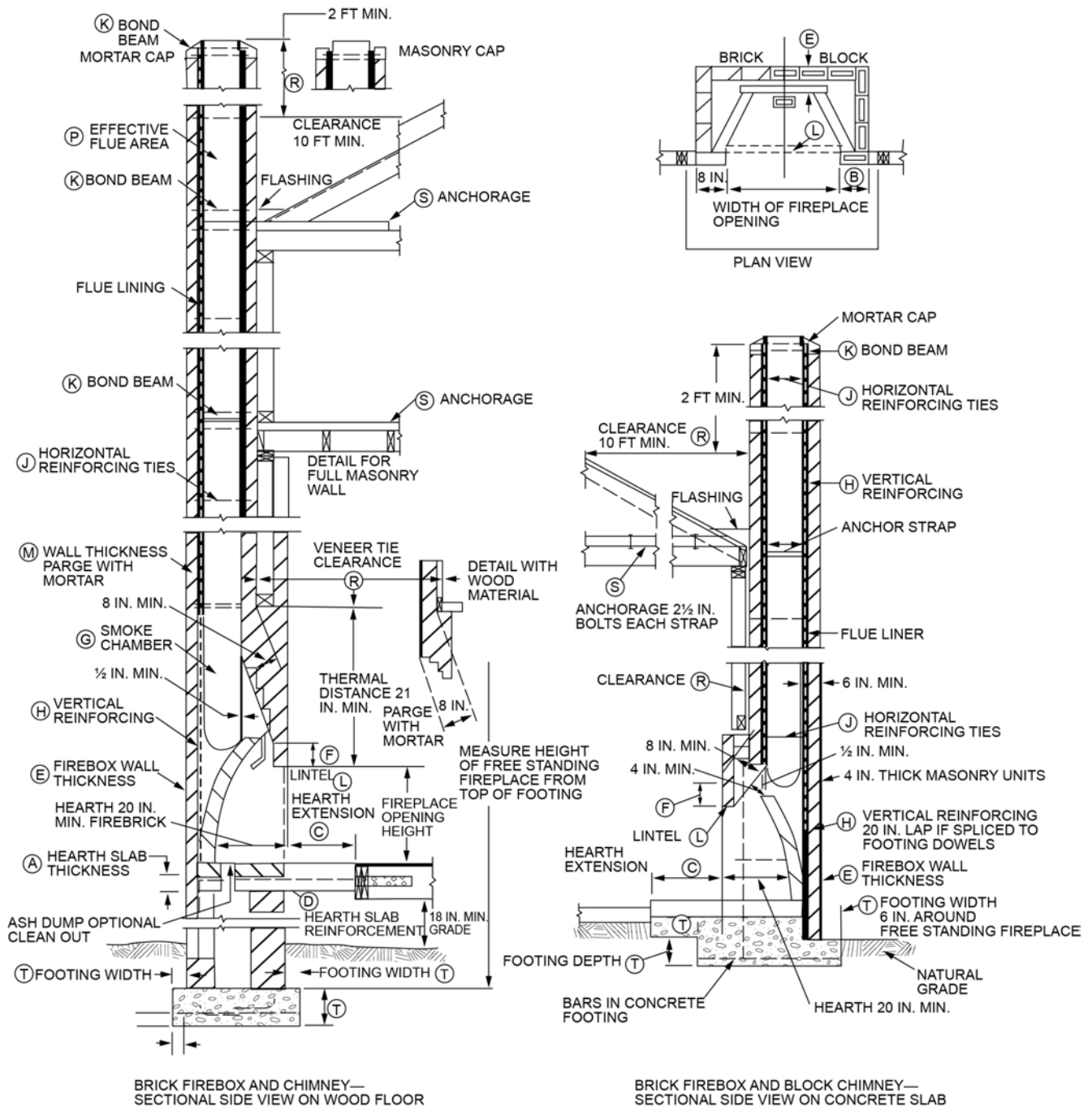
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square foot = 0.0929 m<sup>2</sup>.

**Note:** This table provides a summary of major requirements for the construction of masonry chimneys and fireplaces. Letter references are to Figure R1001.1, which shows examples of typical construction. This table does not cover all requirements, nor does it cover all aspects of the indicated requirements. For the actual mandatory requirements of the code, see the indicated section of text.

a. The letters refer to Figure R1001.1.

b. Not required in Seismic Design Category A, B or C.

## CHIMNEYS AND FIREPLACES



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE R1001.1**  
**FIREPLACE AND CHIMNEY DETAILS**

## CHIMNEYS AND FIREPLACES

**R1001.6 Firebox dimensions.** The firebox of a concrete or masonry fireplace shall have a depth of not less than 20 inches (508 mm). The throat shall be not less than 8 inches (203 mm) above the fireplace opening. The throat opening shall be not less than 4 inches (102 mm) deep. The cross-sectional area of the passageway above the firebox, including the throat, damper and smoke chamber, shall be not less than the cross-sectional area of the flue.

**Exception:** Rumford fireplaces shall be permitted provided that the depth of the fireplace is not less than 12 inches (305 mm) and not less than one-third of the width of the fireplace opening, that the throat is not less than 12 inches (305 mm) above the lintel and is not less than one-twentieth the cross-sectional area of the fireplace opening.

**R1001.7 Lintel and throat.** Masonry over a fireplace opening shall be supported by a lintel of *noncombustible material*. The minimum required bearing length on each end of the fireplace opening shall be 4 inches (102 mm). The fireplace throat or damper shall be located not less than 8 inches (203 mm) above the lintel.

**R1001.7.1 Damper.** Masonry fireplaces shall be equipped with a ferrous metal damper located not less than 8 inches (203 mm) above the top of the fireplace opening. Dampers shall be installed in the fireplace or the chimney venting the fireplace, and shall be operable from the room containing the fireplace.

**R1001.8 Smoke chamber.** Smoke chamber walls shall be constructed of *solid masonry units*, *hollow masonry units* grouted solid, stone or concrete. The total minimum thickness of front, back and side walls shall be 8 inches (203 mm) of *solid masonry*. The inside surface shall be parged smooth with refractory mortar conforming to ASTM C199. Where a lining of firebrick not less than 2 inches (51 mm) thick, or a lining of vitrified clay not less than  $\frac{5}{8}$  inch (16 mm) thick, is provided, the total minimum thickness of front, back and side walls shall be 6 inches (152 mm) of *solid masonry*, including the lining. Firebrick shall conform to ASTM C1261 and shall be laid with medium-duty refractory mortar conforming to ASTM C199. Vitrified clay linings shall conform to ASTM C315.

**R1001.8.1 Smoke chamber dimensions.** The inside height of the smoke chamber from the fireplace throat to the beginning of the flue shall not be greater than the inside width of the fireplace opening. The inside surface of the smoke chamber shall not be inclined more than 45 degrees (0.79 rad) from vertical where prefabricated smoke chamber linings are used or where the smoke chamber walls are rolled or sloped rather than corbeled. Where the inside surface of the smoke chamber is formed by corbeled masonry, the walls shall not be corbeled more than 30 degrees (0.52 rad) from vertical.

**R1001.9 Hearth and hearth extension.** Masonry fireplace hearths and hearth extensions shall be constructed of concrete or masonry, supported by *noncombustible materials*, and reinforced to carry their own weight and all imposed loads. *Combustible material* shall not remain against the

underside of hearths and hearth extensions after construction.

**R1001.9.1 Hearth thickness.** The minimum thickness of fireplace hearths shall be 4 inches (102 mm).

**R1001.9.2 Hearth extension thickness.** The minimum thickness of hearth extensions shall be 2 inches (51 mm).

**Exception:** Where the bottom of the firebox opening is raised not less than 8 inches (203 mm) above the top of the hearth extension, a hearth extension of not less than  $\frac{3}{8}$ -inch-thick (10 mm) brick, concrete, stone, tile or other *approved noncombustible material* is permitted.

**R1001.10 Hearth extension dimensions.** Hearth extensions shall extend not less than 16 inches (406 mm) in front of and not less than 8 inches (203 mm) beyond each side of the fireplace opening. Where the fireplace opening is 6 square feet (0.6 m<sup>2</sup>) or larger, the hearth extension shall extend not less than 20 inches (508 mm) in front of and not less than 12 inches (305 mm) beyond each side of the fireplace opening.

**R1001.11 Fireplace clearance.** Wood beams, joists, studs and other *combustible material* shall have a clearance of not less than 2 inches (51 mm) from the front faces and sides of masonry fireplaces and not less than 4 inches (102 mm) from the back faces of masonry fireplaces. The airspace shall not be filled, except to provide fireblocking in accordance with Section R1001.12.

### Exceptions:

1. Masonry fireplaces *listed* and *labeled* for use in contact with combustibles in accordance with UL 127 and installed in accordance with the manufacturer's instructions are permitted to have *combustible material* in contact with their exterior surfaces.
2. Where masonry fireplaces are part of masonry or concrete walls, *combustible materials* shall not be in contact with the masonry or concrete walls less than 12 inches (306 mm) from the inside surface of the nearest firebox lining.
3. Exposed combustible *trim* and the edges of sheathing materials such as wood siding, flooring and gypsum board shall be permitted to abut the masonry fireplace sidewalls and hearth extension in accordance with Figure R1001.11, provided such combustible *trim* or sheathing is not less than 12 inches (305 mm) from the inside surface of the nearest firebox lining.
4. Exposed combustible mantels or *trim* is permitted to be placed directly on the masonry fireplace front surrounding the fireplace opening providing such *combustible materials* are not placed within 6 inches (152 mm) of a fireplace opening. *Combustible material* within 12 inches (306 mm) of the fireplace opening shall not project more than  $\frac{1}{8}$  inch (3 mm) for each 1-inch (25 mm) distance from such an opening.



**R1001.12 Fireplace fireblocking.** Fireplace fireblocking shall comply with the provisions of Section R602.8.

**R1001.13 Fireplace accessories.** *Listed* and *labeled* fireplace accessories shall be installed in accordance with the conditions of the listing and the manufacturer's instructions. Fireplace accessories shall comply with UL 907.

## SECTION R1002 MASONRY HEATERS

**R1002.1 Definition.** A *masonry heater* is a heating *appliance* constructed of concrete or *solid masonry*, hereinafter referred to as masonry, that is designed to absorb and store heat from a solid-fuel fire built in the firebox by routing the exhaust gases through internal heat exchange channels in which the flow path downstream of the firebox includes flow in a horizontal or downward direction before entering the chimney and that delivers heat by radiation from the masonry surface of the heater.

**R1002.2 Installation.** *Masonry heaters* shall be installed in accordance with this section and comply with one of the following:

1. *Masonry heaters* shall comply with the requirements of ASTM E1602.
2. *Masonry heaters* shall be *listed* and *labeled* in accordance with UL 1482 or CEN 15250 and installed in accordance with the manufacturer's instructions.

**R1002.3 Footings and foundation.** The firebox floor of a *masonry heater* shall be a minimum thickness of 4 inches (102 mm) of *noncombustible material* and be supported on a noncombustible footing and foundation in accordance with Section R1003.2.

**R1002.4 Seismic reinforcing.** In *Seismic Design Categories* D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, *masonry heaters* shall be anchored to the masonry foundation in accordance with Section R1003.3. Seismic reinforcing shall not be required within the body of a *masonry heater* whose height is equal to or less than 3.5 times its body width and where the *masonry chimney* serving

the heater is not supported by the body of the heater. Where the *masonry chimney* shares a common wall with the facing of the *masonry heater*, the chimney portion of the structure shall be reinforced in accordance with Section R1003.

**R1002.5 Masonry heater clearance.** *Combustible materials* shall not be placed within 36 inches (914 mm) of the outside surface of a *masonry heater* in accordance with NFPA 211 Section 8-7 (clearances for solid-fuel-burning *appliances*), and the required space between the heater and *combustible material* shall be fully vented to permit the free flow of air around all heater surfaces.

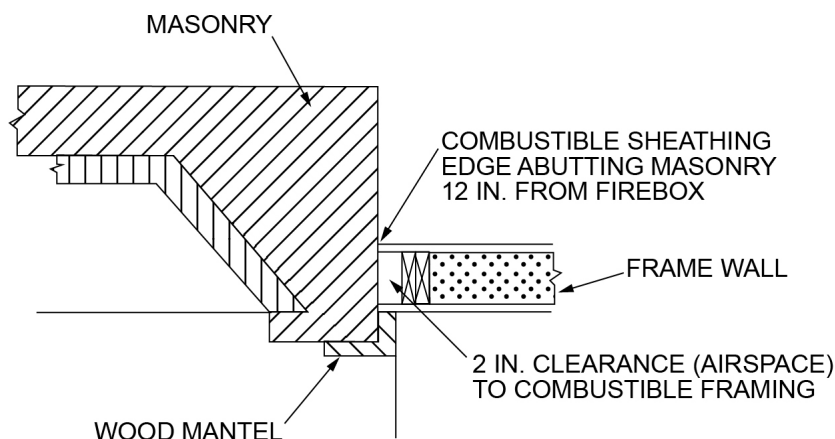
### Exceptions:

1. Where the *masonry heater* wall is not less than 8 inches (203 mm) thick of *solid masonry* and the wall of the heat exchange channels is not less than 5 inches (127 mm) thick of *solid masonry*, *combustible materials* shall not be placed within 4 inches (102 mm) of the outside surface of a *masonry heater*. A clearance of not less than 8 inches (203 mm) shall be provided between the gas-tight capping slab of the heater and a combustible ceiling.
2. *Masonry heaters listed and labeled* in accordance with UL 1482 or CEN 15250 shall be installed in accordance with the listing specifications and the manufacturer's written instructions.

## SECTION R1003 MASONRY CHIMNEYS

**R1003.1 Definition.** A *masonry chimney* is a chimney constructed of *solid masonry units*, *hollow masonry units* grouted solid, stone or concrete, hereinafter referred to as masonry. *Masonry chimneys* shall be constructed, anchored, supported and reinforced as required in this chapter.

**R1003.2 Footings and foundations.** Footings for *masonry chimneys* shall be constructed of concrete or *solid masonry* not less than 12 inches (305 mm) thick and shall extend not



For SI: 1 inch = 25.4 mm.

FIGURE R1001.11  
CLEARANCE FROM COMBUSTIBLES



## CHIMNEYS AND FIREPLACES

less than 6 inches (152 mm) beyond the face of the foundation or support wall on all sides. Footings shall be founded on natural undisturbed earth or engineered fill below frost depth. In areas not subjected to freezing, footings shall be not less than 12 inches (305 mm) below finished *grade*.

**R1003.3 Seismic reinforcing.** Masonry or concrete chimneys shall be constructed, anchored, supported and reinforced as required in this chapter. In Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub> masonry and concrete chimneys shall be reinforced and anchored as detailed in Sections R1003.3.1, R1003.3.2 and R1003.4. In Seismic Design Category A, B or C, reinforcement and seismic anchorage are not required.

**R1003.3.1 Vertical reinforcing.** For chimneys up to 40 inches (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete, or between wythes of *solid masonry*, or within the cells of hollow unit masonry, and grouted in accordance with Section R608.1.1. Grout shall be prevented from bonding with the flue liner so that the flue liner is free to move with thermal expansion. For chimneys more than 40 inches (1016 mm) wide, two additional No. 4 vertical bars shall be installed for each additional 40 inches (1016 mm) in width or fraction thereof.

**R1003.3.2 Horizontal reinforcing.** Vertical reinforcement shall be placed enclosed within  $\frac{1}{4}$ -inch (6.4 mm) ties, or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 inches (457 mm) on center in concrete, or placed in the bed joints of unit masonry, at not less than every 18 inches (457 mm) of vertical height. Two such ties shall be installed at each bend in the vertical bars.

**R1003.4 Seismic anchorage.** Masonry and concrete chimneys and foundations in Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub> shall be anchored at each floor, ceiling or roof line more than 6 feet (1829 mm) above *grade*, except where constructed completely within the exterior walls. Anchorage shall conform to the requirements in Section R1003.4.1.

**R1003.4.1 Anchorage.** Two  $\frac{3}{16}$ -inch by 1-inch (5 mm by 25 mm) straps shall be embedded not less than 12 inches (305 mm) into the chimney. Straps shall be hooked around the outer bars and extend 6 inches (152 mm) beyond the bend. Each strap shall be fastened to not less than four floor joists with two  $\frac{1}{2}$ -inch (12.7 mm) bolts.

**R1003.4.1.1 Cold-formed steel framing.** Where cold-formed steel framing is used, the location where the  $\frac{1}{2}$ -inch (12.7 mm) bolts are used to attach the straps to the framing shall be reinforced with not less than a 3-inch  $\times$  3-inch  $\times$  0.229-inch (76 mm  $\times$  76 mm  $\times$  5.8 mm) steel plate on top of a strap that is screwed to the framing with not fewer than seven No. 6 screws for each bolt.

**R1003.5 Corbeling.** *Masonry chimneys* shall not be corbeled more than one-half of the chimney's wall thickness from a wall or foundation, nor shall a chimney be corbeled from a wall or foundation that is less than 12 inches (305 mm) thick unless it projects equally on each side of the wall, except that on the second *story* of a two-story *dwelling*,

corbeling of chimneys on the exterior of the enclosing walls shall be permitted to be equal to the wall thickness. The projection of a single course shall not exceed one-half the unit height or one-third of the unit bed depth, whichever is less.

**R1003.6 Changes in dimension.** The chimney wall or chimney flue lining shall not change in size or shape within 6 inches (152 mm) above or below where the chimney passes through floor components, ceiling components or roof components.

**R1003.7 Offsets.** Where a *masonry chimney* is constructed with a fireclay flue liner surrounded by one wythe of masonry, the maximum offset shall be such that the centerline of the flue above the offset does not extend beyond the center of the chimney wall below the offset. Where the chimney offset is supported by masonry below the offset in an *approved* manner, the maximum offset limitations shall not apply. Each individual corbeled masonry course of the offset shall not exceed the projection limitations specified in Section R1003.5.

**R1003.8 Additional load.** Chimneys shall not support loads other than their own weight unless they are designed and constructed to support the additional load. Construction of *masonry chimneys* as part of the masonry walls or reinforced concrete walls of the building shall be permitted.

**R1003.9 Termination.** Chimneys shall extend not less than 2 feet (610 mm) higher than any portion of a building within 10 feet (3048 mm), but shall be not less than 3 feet (914 mm) above the highest point where the chimney passes through the roof.

**R1003.9.1 Chimney caps.** *Masonry chimneys* shall have a concrete, metal or stone cap, a drip edge and a caulked bond break around any flue liners in accordance with ASTM C1283. The concrete, metal or stone cap shall be sloped to shed water.

**R1003.9.2 Spark arrestors.** Where a spark arrestor is installed on a *masonry chimney*, the spark arrestor shall meet all of the following requirements:

1. The net free area of the arrestor shall be not less than four times the net free area of the outlet of the chimney flue it serves.
2. The arrestor screen shall have heat and corrosion resistance equivalent to 19-gage galvanized steel or 24-gage stainless steel.
3. Openings shall not permit the passage of spheres having a diameter greater than  $\frac{1}{2}$  inch (12.7 mm) nor block the passage of spheres having a diameter less than  $\frac{3}{8}$  inch (9.5 mm).
4. The spark arrestor shall be located with *access* for cleaning and the screen or chimney cap shall be removable to allow for cleaning of the chimney flue.

**R1003.9.3 Rain caps.** Where a masonry or metal rain cap is installed on a *masonry chimney*, the net free area under the cap shall be not less than four times the net free area of the outlet of the chimney flue it serves.

**R1003.10 Wall thickness.** *Masonry chimney* walls shall be constructed of *solid masonry* units or *hollow masonry units* grouted solid with not less than a 4-inch (102 mm) nominal thickness.

**R1003.10.1 Masonry veneer chimneys.** Where masonry is used to veneer a frame chimney, through-flashing and weep holes shall be installed as required by Section R703.

**R1003.11 Flue lining (material).** *Masonry chimneys* shall be lined. The lining material shall be appropriate for the type of *appliance* connected, in accordance with the terms of the *appliance* listing and manufacturer's instructions.

**R1003.11.1 Residential-type appliances (general).** Flue lining systems shall comply with one of the following:

1. Clay flue lining complying with the requirements of ASTM C315.
2. *Listed* and *labeled* chimney lining systems complying with UL 1777.
3. Factory-built chimneys or chimney units *listed* for installation within *masonry chimneys*.
4. Other *approved* materials that will resist corrosion, erosion, softening or cracking from flue gases and condensate at temperatures up to 1,800°F (982°C).

**R1003.11.2 Flue linings for specific appliances.** Flue linings other than these covered in Section R1003.11.1, intended for use with specific types of *appliances*, shall comply with Sections R1003.11.3 through R1003.11.6.

**R1003.11.3 Gas appliances.** Flue lining systems for gas *appliances* shall be in accordance with Chapter 24.

**R1003.11.4 Pellet fuel-burning appliances.** Flue lining and vent systems for use in *masonry chimneys* with pellet fuel-burning *appliances* shall be limited to the following:

1. Flue lining systems complying with Section R1003.11.1.
2. Pellet vents *listed* for installation within *masonry chimneys* (see Section R1003.11.6 for marking).

**R1003.11.5 Oil-fired appliances approved for use with Type L vent.** Flue lining and vent systems for use in *masonry chimneys* with oil-fired *appliances approved* for use with Type L vent shall be limited to the following:

1. Flue lining systems complying with Section R1003.11.1.
2. *Listed* chimney liners complying with UL 641 (see Section R1003.11.6 for marking).

**R1003.11.6 Notice of usage.** Where a flue is relined with a material not complying with Section R1003.11.1, the chimney shall be plainly and permanently identified by a

*label* attached to a wall, ceiling or other conspicuous location adjacent to where the connector enters the chimney. The *label* shall include the following message or equivalent language:

THIS CHIMNEY FLUE IS FOR USE ONLY WITH  
[TYPE OR CATEGORY OF APPLIANCE] APPLI-  
ANCES THAT BURN [TYPE OF FUEL]. DO NOT  
CONNECT OTHER TYPES OF APPLIANCES.

**R1003.12 Clay flue lining (installation).** Clay flue liners shall be installed in accordance with ASTM C1283 and extend from a point not less than 8 inches (203 mm) below the lowest inlet or, in the case of fireplaces, from the top of the smoke chamber to a point above the enclosing walls. The lining shall be carried up vertically, with a slope not greater than 30 degrees (0.52 rad) from the vertical.

Clay flue liners shall be laid in medium-duty water insoluble refractory mortar conforming to ASTM C199 with tight mortar joints left smooth on the inside and installed to maintain an airspace or insulation not to exceed the thickness of the flue liner separating the flue liners from the interior face of the chimney masonry walls. Flue liners shall be supported on all sides. Only enough mortar shall be placed to make the joint and hold the liners in position.

**R1003.12.1 Listed materials.** *Listed* materials used as flue linings shall be installed in accordance with the terms of their listings and manufacturer's instructions.

**R1003.12.2 Space around lining.** The space surrounding a chimney lining system or vent installed within a *masonry chimney* shall not be used to vent any other *appliance*.

**Exception:** This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's instructions.

**R1003.13 Multiple flues.** Where two or more flues are located in the same chimney, masonry wythes shall be built between adjacent flue linings. The masonry wythes shall be not less than 4 inches (102 mm) thick and bonded into the walls of the chimney.

**Exception:** Where venting only one *appliance*, two flues shall be permitted to adjoin each other in the same chimney with only the flue lining separation between them. The joints of the adjacent flue linings shall be staggered not less than 4 inches (102 mm).

**R1003.14 Flue area (appliance).** Chimney flues shall not be smaller in area than that of the area of the connector from the *appliance* [see Tables R1003.14(1) and R1003.14(2)]. The sizing of a chimney flue to which multiple *appliance* venting systems are connected shall be in accordance with Section M1805.3.

## CHIMNEYS AND FIREPLACES

**TABLE R1003.14(1)**  
**NET CROSS-SECTIONAL AREA OF ROUND FLUE SIZES<sup>a</sup>**

FLUE SIZE, INSIDE DIAMETER (inches)	CROSS-SECTIONAL AREA (square inches)
6	28
7	38
8	50
10	78
10 <sup>3</sup> / <sub>4</sub>	90
12	113
15	176
18	254

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.

a. Flue sizes are based on ASTM C315.

**TABLE R1003.14(2)**  
**NET CROSS-SECTIONAL AREA OF  
SQUARE AND RECTANGULAR FLUE SIZES**

FLUE SIZE, OUTSIDE NOMINAL DIMENSIONS (inches)	CROSS-SECTIONAL AREA (square inches)
4.5 × 8.5	23
4.5 × 13	34
8 × 8	42
8.5 × 8.5	49
8 × 12	67
8.5 × 13	76
12 × 12	102
8.5 × 18	101
13 × 13	127
12 × 16	131
13 × 18	173
16 × 16	181
16 × 20	222
18 × 18	233
20 × 20	298
20 × 24	335
24 × 24	431

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.

**R1003.15 Flue area (masonry fireplace).** Flue sizing for chimneys serving fireplaces shall be in accordance with Section R1003.15.1 or R1003.15.2.

**R1003.15.1 Option 1.** Round chimney flues shall have a minimum net cross-sectional area of not less than one-twelfth of the fireplace opening. Square chimney flues shall have a minimum net cross-sectional area of one-tenth of the fireplace opening. Rectangular chimney flues with an *aspect ratio* less than 2 to 1 shall have a minimum net cross-sectional area of one-tenth of the fireplace opening. Rectangular chimney flues with an *aspect ratio* of 2 to 1 or more shall have a minimum net cross-sectional area of one-eighth of the fireplace opening. Cross-sectional areas of clay flue linings are shown in Tables

R1003.14(1) and R1003.14(2) or as provided by the manufacturer or as measured in the field.

**R1003.15.2 Option 2.** The minimum net cross-sectional area of the chimney flue shall be determined in accordance with Figure R1003.15.2. A flue size providing not less than the equivalent net cross-sectional area shall be used. Cross-sectional areas of clay flue linings are shown in Tables R1003.14(1) and R1003.14(2) or as provided by the manufacturer or as measured in the field. The height of the chimney shall be measured from the firebox floor to the top of the chimney flue.

**R1003.16 Inlet.** Inlets to *masonry chimneys* shall enter from the side. Inlets shall have a thimble of fireclay, rigid refractory material or metal that will prevent the connector from pulling out of the inlet or from extending beyond the wall of the liner.

**R1003.17 Masonry chimney cleanout openings.** Cleanout openings shall be provided within 6 inches (152 mm) of the base of each flue within every *masonry chimney*. The upper edge of the cleanout shall be located not less than 6 inches (152 mm) below the lowest chimney inlet opening. The height of the opening shall be not less than 6 inches (152 mm). The cleanout shall be provided with a noncombustible cover.

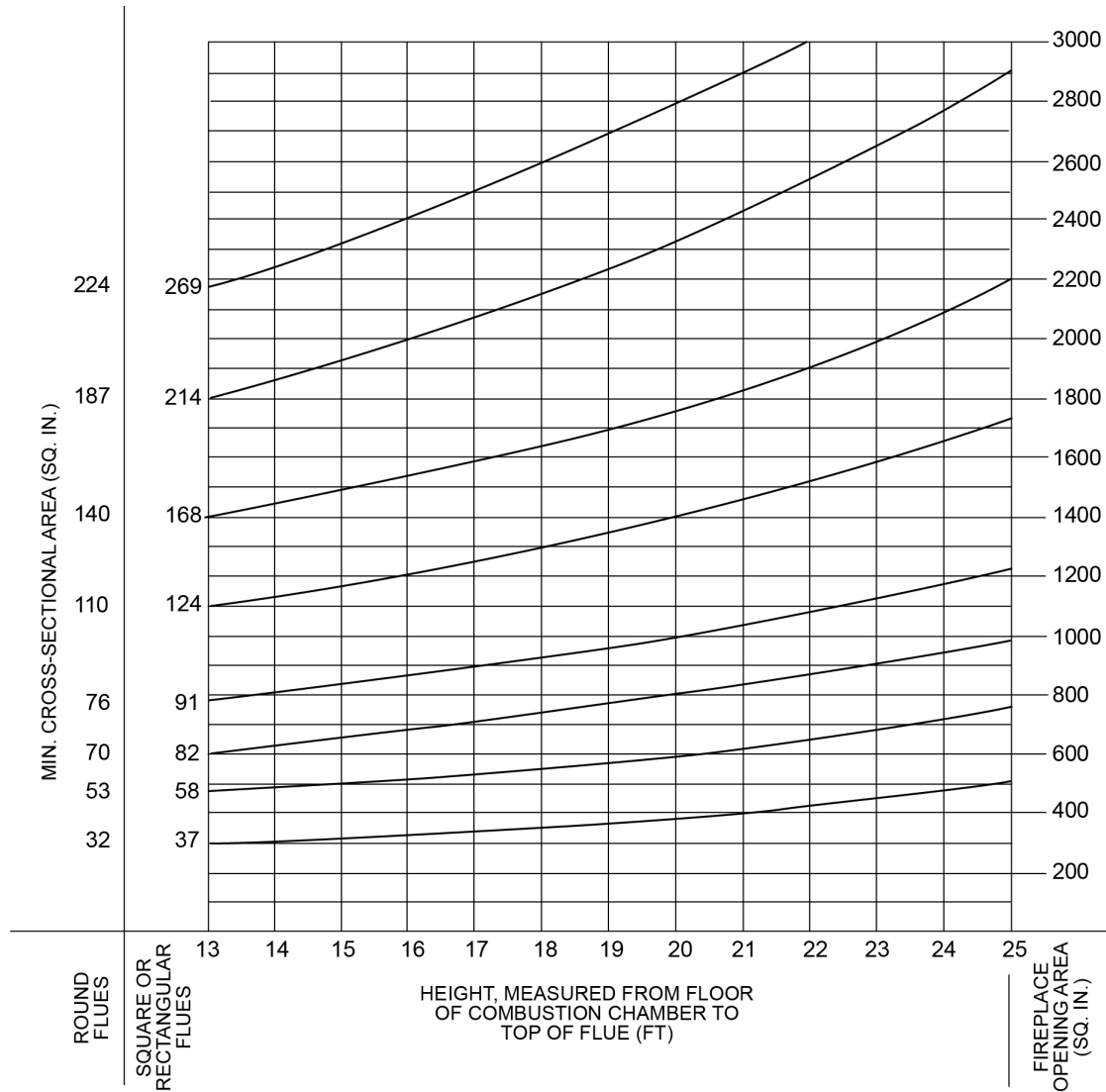
**Exception:** Chimney flues serving masonry fireplaces where cleaning is possible through the fireplace opening.

**R1003.18 Chimney clearances.** Any portion of a *masonry chimney* located in the interior of the building or within the exterior wall of the building shall have a minimum airspace clearance to combustibles of 2 inches (51 mm). Chimneys located entirely outside the exterior walls of the building, including chimneys that pass through the soffit or cornice, shall have a minimum airspace clearance of 1 inch (25 mm). The airspace shall not be filled, except to provide fire blocking in accordance with Section R1003.19.

**Exceptions:**

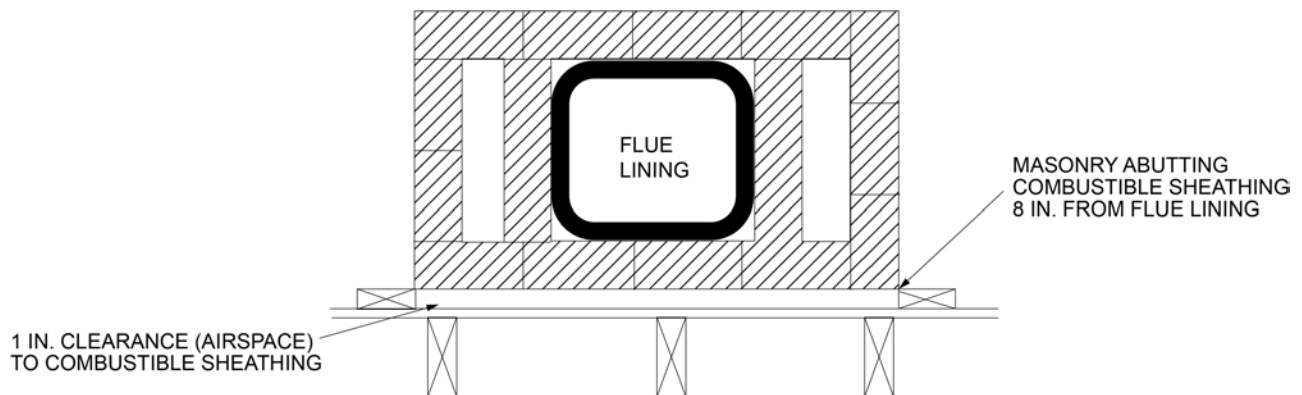
1. *Masonry chimneys* equipped with a chimney lining system *listed* and *labeled* for use in chimneys in contact with combustibles in accordance with UL 1777 and installed in accordance with the manufacturer's instructions are permitted to have *combustible material* in contact with their exterior surfaces.
2. Where *masonry chimneys* are constructed as part of masonry or concrete walls, *combustible materials* shall not be in contact with the masonry or concrete wall less than 12 inches (305 mm) from the inside surface of the nearest flue lining.
3. Exposed combustible *trim* and the edges of sheathing materials, such as wood siding and flooring, shall be permitted to abut the *masonry chimney* side walls, in accordance with Figure R1003.18, provided such combustible trim or sheathing is not less than 8 inches (203 mm) from the inside surface of the nearest flue lining.

## CHIMNEYS AND FIREPLACES



For SI: 1 foot = 304.8 mm, 1 square inch = 645.16 mm<sup>2</sup>.

**FIGURE R1003.15.2**  
**FLUE SIZES FOR MASONRY CHIMNEYS**



For SI: 1 inch = 25.4 mm.

**FIGURE R1003.18**  
**CLEARANCE FROM COMBUSTIBLES**



## CHIMNEYS AND FIREPLACES

**R1003.19 Chimney fireblocking.** Spaces between chimneys and floors and ceilings through which chimneys pass shall be fireblocked with *noncombustible material* securely fastened in place. The fireblocking of spaces between chimneys and wood joists, beams or headers shall be self-supporting or be placed on strips of metal or metal lath laid across the spaces between *combustible material* and the chimney.

**R1003.20 Chimney crickets.** Chimneys shall be provided with crickets where the dimension parallel to the ridgeline is greater than 30 inches (762 mm) and does not intersect the ridgeline. The intersection of the cricket and the chimney shall be flashed and counterflashed in the same manner as normal roof-chimney intersections. Crickets shall be constructed in compliance with Figure R1003.20 and Table R1003.20.

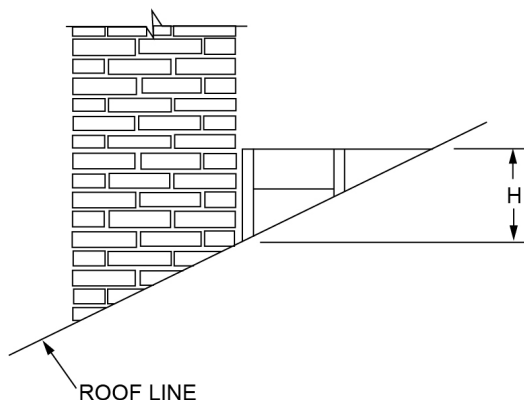
**TABLE R1003.20  
CRICKET DIMENSIONS**

ROOF SLOPE	H
12:12	$\frac{1}{2}$ of W
8:12	$\frac{1}{3}$ of W
6:12	$\frac{1}{4}$ of W
4:12	$\frac{1}{6}$ of W
3:12	$\frac{1}{8}$ of W

### SECTION R1004 FACTORY-BUILT FIREPLACES

**R1004.1 General.** Factory-built fireplaces shall be *listed* and *labeled* and shall be installed in accordance with the conditions of the *listing*. Factory-built fireplaces shall be tested in accordance with UL 127.

**R1004.2 Hearth extensions.** Hearth extensions of *approved* factory-built fireplaces shall be installed in accordance with the *listing* of the fireplace. The hearth extension shall be



For SI: 1 inch = 25.4 mm.

**FIGURE R1003.20  
CHIMNEY CRICKET**

readily distinguishable from the surrounding floor area. *Listed* and *labeled* hearth extensions shall comply with UL 1618.

**R1004.3 Decorative shrouds.** Decorative shrouds shall not be installed at the termination of chimneys for factory-built fireplaces except where the shrouds are *listed* and *labeled* for use with the specific factory-built fireplace system and installed in accordance with the manufacturer's instructions.

**R1004.4 Unvented gas log heaters.** An unvented gas log heater shall not be installed in a factory-built fireplace unless the fireplace system has been specifically tested, *listed* and *labeled* for such use in accordance with UL 127.

**R1004.5 Gasketed fireplace doors.** A gasketed fireplace door shall not be installed on a factory-built fireplace except where the fireplace system has been specifically tested, *listed* and *labeled* for such use in accordance with UL 127.

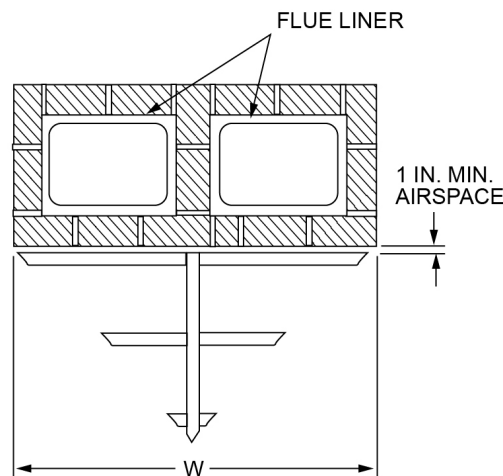
### SECTION R1005 FACTORY-BUILT CHIMNEYS

**R1005.1 Listing.** *Factory-built chimneys* shall be *listed* and *labeled* and shall be installed and terminated in accordance with the *manufacturer's installation instructions*.

**R1005.2 Decorative shrouds.** Decorative shrouds shall not be installed at the termination of *factory-built chimneys* except where the shrouds are *listed* and *labeled* for use with the specific *factory-built chimney* system and installed in accordance with the *manufacturer's installation instructions*.

**R1005.3 Solid-fuel appliances.** *Factory-built chimneys* installed in *dwelling units* with solid-fuel-burning *appliances* shall comply with the Type HT requirements of UL 103 and shall be marked "Type HT" and "Residential Type and Building Heating Appliance Chimney."

**Exception:** *Chimneys* for use with open combustion chamber fireplaces shall comply with the requirements of





UL 103 and shall be marked “Residential Type and Building Heating Appliance Chimney.”

*Chimneys* for use with open combustion chamber *appliances* installed in buildings other than *dwelling units* shall comply with the requirements of UL 103 and shall be marked “Building Heating Appliance Chimney” or “Residential Type and Building Heating Appliance Chimney.”

**R1005.4 Factory-built fireplaces.** *Chimneys* for use with factory-built fireplaces shall comply with the requirements of UL 127.

**R1005.5 Support.** Where *factory-built chimneys* are supported by structural members, such as joists and rafters, those members shall be designed to support the additional load.

**R1005.6 Medium-heat appliances.** *Factory-built chimneys* for medium-heat *appliances* producing flue gases having a temperature above 1,000°F (538°C), measured at the entrance to the *chimney*, shall comply with UL 959.

**R1005.7 Factory-built chimney offsets.** Where a *factory-built chimney* assembly incorporates offsets, no part of the *chimney* shall be at an angle of more than 30 degrees (0.52 rad) from vertical at any point in the assembly and the chimney assembly shall not include more than four elbows.

**R1005.8 Insulation shield.** Where *factory-built chimneys* pass through insulated assemblies, an insulation shield constructed of steel having a thickness of not less than 0.0187 inch (0.4712 mm) (No. 26 gage) shall be installed to provide clearance between the *chimney* and the insulation material. The clearance shall be not less than the clearance to combustibles specified by the chimney *manufacturer's installation instructions*. Where *chimneys* pass through attic space, the shield shall terminate not less than 2 inches (51 mm) above the insulation materials and shall be secured in place to prevent displacement. Insulation shields provided as part of a *listed chimney system* shall be installed in accordance with the manufacturer's installation instructions.

## SECTION R1006 EXTERIOR AIR SUPPLY

**R1006.1 Exterior air.** Factory-built or masonry fireplaces covered in this chapter shall be equipped with an exterior air supply to ensure proper fuel combustion unless the room is mechanically ventilated and controlled so that the indoor pressure is neutral or positive.

**R1006.1.1 Factory-built fireplaces.** Exterior *combustion air* ducts for factory-built fireplaces shall be a *listed* component of the fireplace and shall be installed in accordance with the fireplace manufacturer's instructions.

**R1006.1.2 Masonry fireplaces.** *Listed combustion air* ducts for masonry fireplaces shall be installed in accordance with the terms of their *listing* and the manufacturer's instructions.

**R1006.2 Exterior air intake.** The exterior air intake shall be capable of supplying all *combustion air* from the exterior of

the *dwelling* or from spaces within the *dwelling* ventilated with outdoor air such as nonmechanically ventilated crawl or attic spaces. The exterior air intake shall not be located within the garage or *basement* of the dwelling. The exterior air intake, for other than *listed* factory-built fireplaces, shall not be located at an elevation higher than the firebox. The exterior air intake shall be covered with a corrosion-resistant screen of 1/4-inch (6.4 mm) mesh.

**R1006.3 Clearance.** Unlisted *combustion air* ducts shall be installed with a minimum 1-inch (25 mm) clearance to combustibles for all parts of the duct within 5 feet (1524 mm) of the duct outlet.

**R1006.4 Passageway.** The *combustion air* passageway shall be not less than 6 square inches (3870 mm<sup>2</sup>) and not more than 55 square inches (0.035 m<sup>2</sup>), except that *combustion air* systems for *listed* fireplaces shall be constructed in accordance with the fireplace manufacturer's instructions.

**R1006.5 Outlet.** The exterior air outlet shall be located in the back or side of the firebox chamber or shall be located outside of the firebox, at the level of the hearth and not greater than 24 inches (610 mm) from the firebox opening. The outlet shall be closable and designed to prevent burning material from dropping into concealed combustible spaces.



## ***Part IV—Energy Conservation***

### **CHAPTER 11 [RE] ENERGY EFFICIENCY**

*Delete and refer to the Arkansas Energy Code.*



ENERGY EFFICIENCY

# Part V—Mechanical

## CHAPTER 12 MECHANICAL ADMINISTRATION

### User notes:

**About this chapter:** Chapter 12 supplements Chapter 1 and establishes the scope of coverage for Chapters 13 through 24. The applicability of code provisions to existing mechanical systems and appliances is established herein.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1201 GENERAL

**M1201.1 Scope.** The provisions of Chapters 12 through 24 shall regulate the design, installation, maintenance, *alteration* and inspection of mechanical systems that are permanently installed and used to control environmental conditions within buildings. These chapters shall also regulate those mechanical systems, system components, *equipment* and *appliances* specifically addressed in this code.

**M1201.2 Application.** In addition to the general administration requirements of Chapter 1, the administrative provisions of this chapter shall apply to the mechanical requirements of Chapters 13 through 24.

that are required by this code shall be maintained in compliance with the code edition under which such devices and safeguards were installed. The *owner* or the owner's designated agent shall be responsible for maintenance of the mechanical systems. To determine compliance with this provision, the *building official* shall have the authority to require a mechanical system to be reinspected.

### SECTION M1202 EXISTING MECHANICAL SYSTEMS

**M1202.1 Additions, alterations or repairs.** *Additions, alterations*, renovations or repairs to a mechanical system shall conform to the requirements for a new mechanical system without requiring the existing mechanical system to comply with all of the requirements of this code. *Additions, alterations* or repairs shall not cause an existing mechanical system to become unsafe, hazardous or overloaded. Minor *additions, alterations* or repairs to existing mechanical systems shall meet the provisions for new construction, unless such work is done in the same manner and arrangement as was in the existing system, is not hazardous, and is *approved*.

**M1202.2 Existing installations.** Except as otherwise provided for in this code, a provision in this code shall not require the removal, *alteration* or abandonment of, nor prevent the continued use and maintenance of, an existing mechanical system lawfully in existence at the time of the adoption of this code.

**M1202.3 Maintenance.** Mechanical systems, both existing and new, and parts thereof shall be maintained in proper operating condition in accordance with the original design and in a safe and sanitary condition. Devices or safeguards





## CHAPTER 13

# GENERAL MECHANICAL SYSTEM REQUIREMENTS

### User notes:

**About this chapter:** Chapter 13 contains general requirements that apply broadly and that would not be at home in other chapters that address specific subject matter. Coverage includes: Testing and certification of materials, installation requirements, listing and labeling, access to appliances, clearances to combustibles, and protection of mechanical systems and the building structure.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1301 GENERAL

**M1301.1 Scope.** The provisions of this chapter shall govern the installation of mechanical systems not specifically covered in other chapters applicable to mechanical systems. Installations of mechanical *appliances, equipment* and systems not addressed by this code shall comply with the applicable provisions of the *International Fuel Gas Code* and the *International Mechanical Code*.

**M1301.1.1 Flood-resistant installation.** In flood hazard areas as established by Table R301.2, mechanical *appliances, equipment* and systems shall be located or installed in accordance with Section R322.1.6.

**M1301.2 Identification.** Each length of pipe and tubing and each pipe fitting utilized in a mechanical system shall bear the identification of the manufacturer.

**M1301.3 Installation of materials.** Materials shall be installed in strict accordance with the standards under which the materials are accepted and *approved*. In the absence of such installation procedures, the manufacturer's instructions shall be followed. Where the requirements of referenced standards or manufacturer's instructions do not conform to minimum provisions of this code, the provisions of this code shall apply.

**M1301.4 Plastic pipe, fittings and components.** Plastic pipe, fittings and components shall be third-party certified as conforming to NSF 14.

**M1301.5 Third-party testing and certification.** Piping, tubing and fittings shall comply with the applicable referenced standards, specifications and performance criteria of this code and shall be identified in accordance with Section M1301.2. Piping, tubing and fittings shall either be tested by an *approved* third-party testing agency or certified by an *approved* third-party certification agency.

### SECTION M1302 APPROVAL

**M1302.1 Listed and labeled.** *Appliances* regulated by this code shall be *listed* and *labeled* for the application in which they are installed and used, unless otherwise *approved* in accordance with Section R104.11.

### SECTION M1303 LABELING OF APPLIANCES

**M1303.1 Label information.** A permanent factory-applied nameplate(s) shall be affixed to *appliances* on which shall appear, in legible lettering, the manufacturer's name or trademark, the model number, a serial number and the seal or *mark* of the testing agency. A *label* also shall include the following:

1. Electrical *appliances*. Electrical rating in volts, amperes and motor phase; identification of individual electrical components in volts, amperes or watts and motor phase; and in Btu/h (W) output and required clearances.
2. Absorption units. Hourly rating in Btu/h (W), minimum hourly rating for units having step or automatic modulating controls, type of fuel, type of refrigerant, cooling capacity in Btu/h (W) and required clearances.
3. Fuel-burning units. Hourly rating in Btu/h (W), type of fuel approved for use with the *appliance* and required clearances.
4. Electric comfort-heating *appliances*. The electric rating in volts, amperes and phase; Btu/h (W) output rating; individual marking for each electrical component in amperes or watts, volts and phase; and required clearances from combustibles.
5. Maintenance instructions. Required regular maintenance actions and title or publication number for the operation and maintenance manual for that particular model and type of product.

### SECTION M1304 TYPE OF FUEL

**M1304.1 Fuel types.** Fuel-fired *appliances* shall be designed for use with the type of fuel to which they will be connected and the altitude at which they are installed. *Appliances* that comprise parts of the building mechanical system shall not be converted for the use of a different fuel, except where *approved* and converted in accordance with the manufacturer's instructions. The fuel input rate shall not be increased or decreased beyond the limit rating for the altitude at which the *appliance* is installed.

## GENERAL MECHANICAL SYSTEM REQUIREMENTS

SECTION M1305  
APPLIANCE ACCESS

**M1305.1 Appliance access for inspection service, repair and replacement.** *Appliances* shall be located to allow for access for inspection, service, repair and replacement without removing permanent construction, other *appliances*, or any other piping or ducts not connected to the *appliance* being inspected, serviced, repaired or replaced. A level working space not less than 30 inches deep and 30 inches wide (762 mm by 762 mm) shall be provided in front of the control side to service an *appliance*.

**M1305.1.1 Appliances in rooms.** *Appliances* installed in a compartment, alcove, *basement* or similar space shall be accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest *appliance* in the space, provided there is a level service space of not less than 30 inches (762 mm) deep and the height of the *appliance*, but not less than 30 inches (762 mm), at the front or service side of the *appliance* with the door open.

**M1305.1.2 Appliances in attics.** *Attics* containing *appliances* shall be provided with an opening and a clear and unobstructed passageway large enough to allow removal of the largest *appliance*, but not less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) long measured along the centerline of the passageway from the opening to the *appliance*. The passageway shall have continuous solid flooring in accordance with Chapter 5 not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present along all sides of the *appliance* where access is required. The clear access opening dimensions shall be not less than of 20 inches by 30 inches (508 mm by 762 mm), and large enough to allow removal of the largest *appliance*.

**Exceptions:**

1. The passageway and level service space are not required where the *appliance* can be serviced and removed through the required opening.
2. Where the passageway is unobstructed and not less than 6 feet (1829 mm) high and 22 inches (559 mm) wide for its entire length, the passageway shall be not more than 50 feet (15 250 mm) long.

**M1305.1.2.1 Electrical requirements.** A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be installed at or near the *appliance* location in accordance with Chapter 39. Exposed lamps shall be protected from damage by location or lamp guards.

**M1305.1.3 Appliances under floors.** Underfloor spaces containing *appliances* shall be provided with an unob-

structed passageway large enough to remove the largest *appliance*, but not less than 30 inches (762 mm) high and 22 inches (559 mm) wide, nor more than 20 feet (6096 mm) long measured along the centerline of the passageway from the opening to the *appliance*. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the *appliance*. If the depth of the passageway or the service space exceeds 12 inches (305 mm) below the adjoining grade, the walls of the passageway shall be lined with concrete or masonry extending 4 inches (102 mm) above the adjoining grade in accordance with Chapter 4. The rough-framed access opening dimensions shall be not less than 22 inches by 30 inches (559 mm by 762 mm), and large enough to remove the largest *appliance*.

**Exceptions:**

1. The passageway is not required where the level service space is present when the access is open, and the *appliance* can be serviced and removed through the required opening.
2. Where the passageway is unobstructed and not less than 6 feet (1829 mm) high and 22 inches (559 mm) wide for its entire length, the passageway shall not be limited in length.

**M1305.1.3.1 Ground clearance.** *Equipment* and *appliances* supported from the ground shall be level and firmly supported on a concrete slab or other *approved* material extending not less than 3 inches (76 mm) above the adjoining ground. Such support shall be in accordance with the manufacturer's installation instructions. *Appliances* suspended from the floor shall have a clearance of not less than 6 inches (152 mm) from the ground.

**M1305.1.3.2 Pit locations.** *Appliances* installed in pits or excavations shall not come in direct contact with the surrounding soil and shall be installed not less than 3 inches (76 mm) above the pit floor. The sides of the pit or excavation shall be held back not less than 12 inches (305 mm) from the *appliance*. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry. Such concrete or masonry shall extend not less than 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. Excavation on the control side of the *appliance* shall extend horizontally not less than 30 inches (762 mm). The *appliance* shall be protected from flooding in an *approved* manner.

**M1305.1.3.3 Electrical requirements.** A luminaire controlled by a switch located at the required passageway opening and a receptacle outlet shall be installed at or near the *appliance* location in accordance with Chapter 39. Exposed lamps shall be protected from damage by location or lamp guards.

### SECTION M1306 CLEARANCES FROM COMBUSTIBLE CONSTRUCTION

**M1306.1 Appliance clearance.** *Appliances* shall be installed with the clearances from unprotected *combustible materials* as indicated on the *appliance label* and in the manufacturer's installation instructions.

**M1306.2 Clearance reduction.** The reduction of required clearances to combustible assemblies or *combustible materials* shall be based on Section M1306.2.1 or M1306.2.2.

**M1306.2.1 Labeled assemblies.** The allowable clearance shall be based on an approved reduced clearance protective assembly that is *listed* and *labeled* in accordance with UL 1618.

**M1306.2.2 Reduction table.** Reduction of clearances shall be in accordance with the *appliance* manufacturer's instructions and Table M1306.2. Forms of protection with ventilated airspace shall conform to the following requirements:

1. Not less than 1-inch (25 mm) airspace shall be provided between the protection and combustible wall surface.
2. Air circulation shall be provided by having edges of the wall protection open not less than 1 inch (25 mm).
3. If the wall protection is mounted on a single flat wall away from corners, air circulation shall be provided by having the bottom and top edges, or the side and top edges not less than 1 inch (25 mm).
4. Wall protection covering two walls in a corner shall be open at the bottom and top edges not less than 1 inch (25 mm).

**M1306.2.3 Solid-fuel appliances.** Table M1306.2 shall not be used to reduce the clearance required for solid-fuel *appliances listed* for installation with minimum clearances of 12 inches (305 mm) or less. For *appliances listed* for installation with minimum clearances greater than 12 inches (305 mm), Table M1306.2 shall not be used to reduce the clearance to less than 12 inches (305 mm).

### SECTION M1307 APPLIANCE INSTALLATION

**M1307.1 General.** Installation of *appliances* shall conform to the conditions of their *listing* and *label* and the manufacturer's instructions. The manufacturer's operating and installation instructions shall remain attached to the *appliance*.

**M1307.2 Anchorage of appliances.** *Appliances* designed to be fixed in position shall be fastened or anchored in an

*approved* manner. In Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>, and in townhouses in Seismic Design Category C, water heaters and thermal storage units shall be anchored or strapped to resist horizontal displacement caused by earthquake motion in accordance with one of the following:

1. Anchorage and strapping shall be designed to resist a horizontal force equal to one-third of the operating weight of the water heater storage tank, acting in any horizontal direction. Strapping shall be at points within the upper one-third and lower one-third of the *appliance's* vertical dimensions. At the lower point, the strapping shall maintain a minimum distance of 4 inches (102 mm) above the controls.
2. The anchorage strapping shall be in accordance with the appliance manufacturer's recommendations.

**M1307.3 Elevation of ignition source.** *Appliances* having an *ignition source* shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in garages. For the purpose of this section, rooms or spaces that are not part of the *living space* of a *dwelling unit* and that communicate with a private garage through openings shall be considered to be part of the garage.

**Exception:** Elevation of the *ignition source* is not required for *appliances* that are *listed* as flammable-vapor-ignition resistant.

**M1307.3.1 Protection from impact.** *Appliances* shall not be installed in a location subject to vehicle damage except where protected by *approved* barriers.

**M1307.4 Hydrogen-generating and refueling operations.** *Ventilation* shall be required in accordance with Section M1307.4.1, M1307.4.2 or M1307.4.3 in private garages that contain hydrogen-generating *appliances* or refueling systems. For the purpose of this section, rooms or spaces that are not part of the *living space* of a *dwelling unit* and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

**M1307.4.1 Natural ventilation.** Indoor locations intended for hydrogen-generating or refueling operations shall be limited to a maximum floor area of 850 square feet (79 m<sup>2</sup>) and shall communicate with the outdoors in accordance with Sections M1307.4.1.1 and M1307.4.1.2. The maximum rated output capacity of hydrogen-generating *appliances* shall not exceed 4 standard cubic feet per minute (1.9 L/s) of hydrogen for each 250 square feet (23 m<sup>2</sup>) of floor area in such spaces. The minimum cross-sectional dimension of air openings shall be 3 inches (76 mm). Where ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. In those locations, *equipment* and *appliances* having an *ignition source* shall be located so that the source of ignition is not within 12 inches (305 mm) of the ceiling.

## GENERAL MECHANICAL SYSTEM REQUIREMENTS

**TABLE M1306.2**  
**REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION<sup>a, c, d, e, f, g, h, i, j, k, l</sup>**

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION (See Figures M1306.1 and M1306.2)	WHERE THE REQUIRED CLEARANCE WITHOUT PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS:									
	36 inches		18 inches		12 inches		9 inches		6 inches	
	Allowable clearances with specified protection (Inches) <sup>b</sup>									
	Use Column 1 for clearances above an appliance or horizontal connector. Use column 2 for clearances from an appliance, vertical connector and single-wall metal pipe.									
	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2
3½-inch-thick masonry wall without ventilated airspace	—	24	—	12	—	9	—	6	—	5
½-inch insulation board over 1-inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) over 1-inch glass fiber or mineral wool batts reinforced with wire or rear face with a ventilated airspace	18	12	9	6	6	4	5	3	3	3
3½-inch-thick masonry wall with ventilated airspace	—	12	—	6	—	6	—	6	—	6
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated airspace 1 inch off the combustible assembly	18	12	9	6	6	4	5	3	3	2
½-inch-thick insulation board with ventilated airspace	18	12	9	6	6	4	5	3	3	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with ventilated airspace over 24 gage sheet steel with a ventilated space	18	12	9	6	6	4	5	3	3	3
1-inch glass fiber or mineral wool batts sandwiched between two sheets of galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated airspace	18	12	9	6	6	4	5	3	3	3

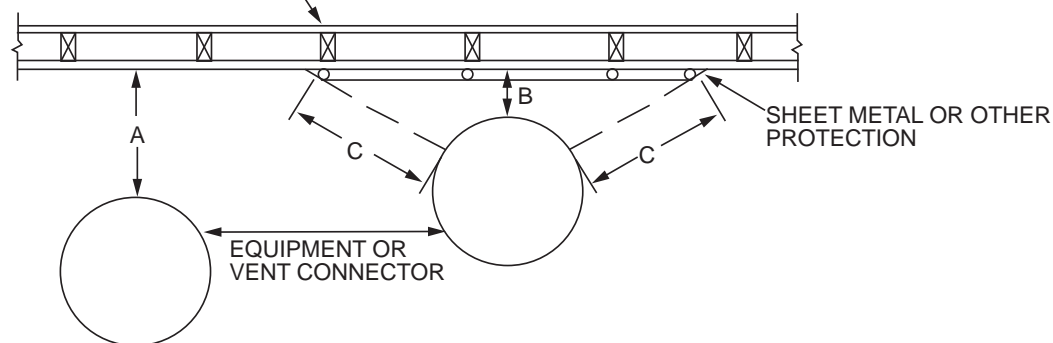
For SI: 1 inch = 25.4 mm, 1 pound per cubic foot = 16.019 kg/m<sup>3</sup>, °C = [(°F) – 32]/1.8, 1 Btu/(h × ft<sup>2</sup> × °F/in.) = 0.001442299 (W/cm<sup>2</sup> × °C/cm).

- Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
- Clearances shall be measured from the surface of the heat-producing appliance or equipment to the outer surface of the combustible material or combustible assembly.
- Spacers and ties shall be of noncombustible material. Spacers and ties shall not be used directly opposite appliance or connector.
- Where all clearance reduction systems use a ventilated airspace, adequate provision for air circulation shall be provided as described (see Figures M1306.1 and M1306.2).
- There shall be not less than 1 inch between clearance reduction systems and combustible walls and ceilings for reduction systems using ventilated airspace.
- If a wall protector is mounted on a single flat wall away from corners, adequate air circulation shall be permitted to be provided by leaving only the bottom and top edges or only the side and top edges open with not less than a 1-inch air gap.
- Mineral wool and glass fiber batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1,500°F.
- Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu inch per square foot per hour °F or less. Insulation board shall be formed of noncombustible material.
- There shall be not less than 1 inch between the appliance and the protector. The clearance between the appliance and the combustible surface shall not be reduced below that allowed in this table.
- All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
- Listed single-wall connectors shall be permitted to be installed in accordance with the terms of their listing and the manufacturer's instructions.
- For limitations on clearance reduction for solid-fuel-burning appliances, see Section M1306.2.3.



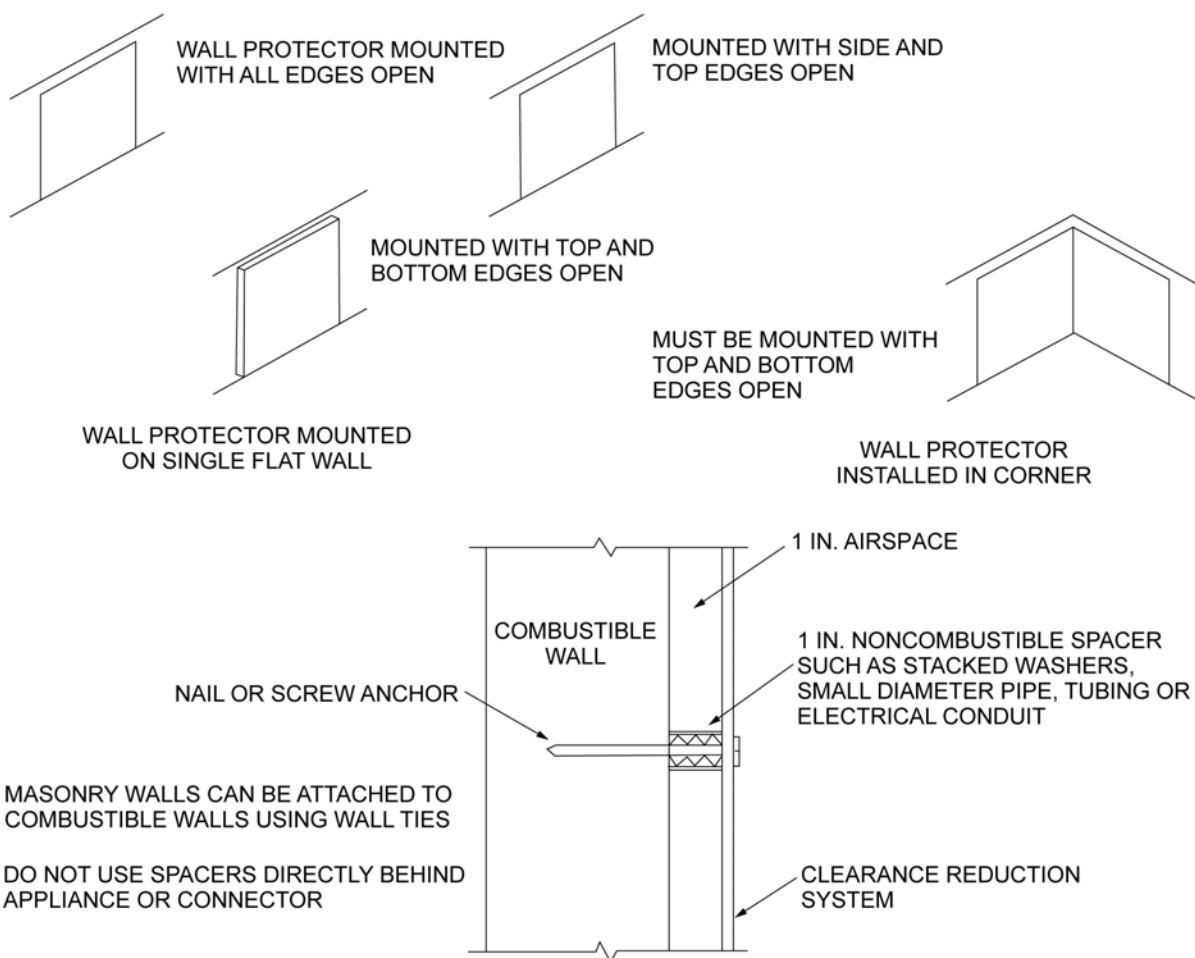
## GENERAL MECHANICAL SYSTEM REQUIREMENTS

CONSTRUCTION USING COMBUSTIBLE MATERIAL,  
PLASTERED OR UNPLASTERED



**Note:** "A" equals the required clearance with no protection. "B" equals the reduced clearance permitted in accordance with Table M1306.2. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

**FIGURE M1306.1  
REDUCED CLEARANCE DIAGRAM**



For SI: 1 inch = 25.4 mm.

**FIGURE M1306.2  
WALL PROTECTOR CLEARANCE REDUCTION SYSTEM**

## GENERAL MECHANICAL SYSTEM REQUIREMENTS

**M1307.4.1.1 Two openings.** Two permanent openings shall be constructed within the garage. The upper opening shall be located entirely within 12 inches (305 mm) of the ceiling of the garage. The lower opening shall be located entirely within 12 inches (305 mm) of the floor of the garage. Both openings shall be constructed in the same exterior wall. The openings shall communicate directly with the outdoors and shall have a minimum free area of  $\frac{1}{2}$  square foot per 1,000 cubic feet ( $1.7 \text{ m}^2/1000 \text{ m}^3$ ) of garage volume.

**M1307.4.1.2 Louvers and grilles.** In calculating free area required by Section M1307.4.1, the required size of openings shall be based on the net free area of each opening. If the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. If the design and free area are not known, it shall be assumed that wood louvers will have a 25-percent free area and metal louvers and grilles will have a 75-percent free area. Louvers and grilles shall be fixed in the open position.

**M1307.4.2 Mechanical ventilation.** Indoor locations intended for hydrogen-generating or refueling operations shall be ventilated in accordance with Section 502.16 of the *International Mechanical Code*. In these locations, *equipment* and *appliances* having an *ignition source* shall be located so that the source of ignition is below the mechanical *ventilation* outlet(s).

**M1307.4.3 Specially engineered installations.** As an alternative to the provisions of Sections M1307.4.1 and M1307.4.2, the necessary supply of air for *ventilation* and dilution of flammable gases shall be provided by an *approved* engineered system.

**M1307.5 Electrical appliances.** Electrical *appliances* shall be installed in accordance with Chapters 14, 15, 19, 20 and 34 through 43.

**M1307.6 Plumbing connections.** Potable water and drainage system connections to *equipment* and *appliances* regulated by this code shall be in accordance with Chapters 29 and 30.

**M1307.7 Prohibited support.** Gypsum board shall not be used as a support base under an *appliance*.

lated panels (SIPs) shall be drilled and notched or altered in accordance with the provisions of Section R610.7.

**M1308.2 Protection against physical damage.** Where piping will be concealed within *light-frame construction* assemblies, the piping shall be protected against penetration by fasteners in accordance with Sections M1308.2.1 through M1308.2.3.

**Exception:** Cast-iron piping and galvanized steel piping shall not be required to be protected.

**M1308.2.1 Piping through bored holes or notches.** Where *piping* is installed through holes or notches in framing members and is located less than  $1\frac{1}{2}$  inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the pipe shall be protected by shield plates that cover the width of the pipe and the framing member and that extend 2 inches (51 mm) to each side of the framing member. Where the framing member that the piping passes through is a bottom plate, bottom track, top plate or top track, the shield plates shall cover the framing member and extend 2 inches (51 mm) above the bottom framing member and 2 inches (51 mm) below the top framing member.

**M1308.2.2 Piping in other locations.** Where piping is located within a framing member and is less than  $1\frac{1}{2}$  inches (38 mm) from the framing member face to which wall, ceiling or floor membranes will be attached, the piping shall be protected by shield plates that cover the width and length of the piping. Where piping is located outside of a framing member and is located less than  $1\frac{1}{2}$  inches (38 mm) from the nearest edge of the face of the framing member to which the membrane will be attached, the piping shall be protected by shield plates that cover the width and length of the piping.

**M1308.2.3 Shield plates.** Shield plates shall be of steel material having a thickness of not less than 0.0575 inch (1.463 mm) (No. 16 gage).

## SECTION M1308 MECHANICAL SYSTEMS INSTALLATION

**M1308.1 Drilling and notching.** Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R502.8, R602.6, R602.6.1 and R802.7. Holes in load-bearing members of cold-formed steel *light-frame construction* shall be permitted only in accordance with Sections R505.2.6, R603.2.6 and R804.2.6. In accordance with the provisions of Sections R505.3.5, R603.3.4 and R804.3.3, cutting and notching of flanges and lips of load-bearing members of cold-formed steel light frame construction shall not be permitted. Structural insu-

## CHAPTER 14

# HEATING AND COOLING EQUIPMENT AND APPLIANCES

### User notes:

**About this chapter:** Chapter 14 addresses the indoor environmental control systems and appliances typically found in dwelling units. Coverage includes general requirements for equipment and appliance sizing, condensate disposal, access and support, and specific coverage for more than a dozen different types of space conditioning equipment and appliances common to dwelling units.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1401 GENERAL

**M1401.1 Installation.** Heating and cooling *equipment* and *appliances* shall be installed in accordance with the manufacturer's instructions and the requirements of this code.

**M1401.2 Access.** Heating and cooling *equipment* and *appliances* shall be located with respect to building construction and other *equipment* and *appliances* to permit maintenance, servicing and replacement. Clearances shall be maintained to permit cleaning of heating and cooling surfaces; replacement of filters, blowers, motors, controls and vent connections; lubrication of moving parts; and adjustments.

**Exception:** Access shall not be required for ducts, piping, or other components *approved* for concealment.

**M1401.3 Equipment and appliance sizing.** Heating and cooling *equipment* and *appliances* shall be sized in accordance with ACCA Manual S or other *approved* sizing methodologies based on building loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.

**Exception:** Heating and cooling *equipment* and *appliance* sizing shall not be limited to the capacities determined in accordance with ACCA Manual S where either of the following conditions applies:

1. The specified *equipment* or *appliance* utilizes multistage technology or variable refrigerant flow technology and the loads calculated in accordance with the *approved* heating and cooling calculation methodology are within the range of the manufacturer's published capacities for that *equipment* or *appliance*.
2. The specified *equipment* or *appliance* manufacturer's published capacities cannot satisfy both the total and sensible heat gains calculated in accordance with the *approved* heating and cooling calculation methodology and the next larger standard size unit is specified.

**M1401.4 Outdoor installations.** *Equipment* and *appliances* installed outdoors shall be *listed* and *labeled* for outdoor installation. Supports and foundations shall prevent excessive vibration, settlement or movement of the *equipment*.

Supports and foundations shall be in accordance with Section M1305.1.3.1.

**M1401.5 Flood hazard.** In flood hazard areas as established by Table R301.2, heating and cooling *equipment* and *appliances* shall be located or installed in accordance with Section R322.1.6.

### SECTION M1402 CENTRAL FURNACES

**M1402.1 General.** Oil-fired central furnaces shall conform to ANSI/UL 727. Electric furnaces shall conform to UL 1995 or UL/CSA/ANCE 60335-2-40.

**M1402.2 Clearances.** Clearances shall be provided in accordance with the *listing* and the manufacturer's installation instructions.

**M1402.3 Combustion air.** *Combustion air* shall be supplied in accordance with Chapter 17. *Combustion air* openings shall be unobstructed for a distance of not less than 6 inches (152 mm) in front of the openings.

### SECTION M1403 HEAT PUMP EQUIPMENT

**M1403.1 Heat pumps.** Electric heat pumps shall be *listed* and *labeled* in accordance with UL 1995 or UL/CSA/ANCE 60335-2-40.

### SECTION M1404 REFRIGERATION COOLING EQUIPMENT

**M1404.1 Compliance.** Refrigeration cooling *equipment* shall comply with Section M1411.

### SECTION M1405 BASEBOARD CONVECTORS

**M1405.1 General.** Electric baseboard convectors shall be installed in accordance with the manufacturer's instructions and Chapters 34 through 43. Electric baseboard heaters shall be *listed* and *labeled* in accordance with UL 1042.

## HEATING AND COOLING EQUIPMENT AND APPLIANCES

### SECTION M1406 RADIANT HEATING SYSTEMS

**M1406.1 General.** Electric radiant heating systems shall be installed in accordance with the manufacturer's instructions and Chapters 34 through 43 and shall be *listed* for the application.

**M1406.2 Clearances.** Clearances for radiant heating panels or elements to any wiring, outlet boxes and junction boxes used for installing electrical devices or mounting luminaires shall comply with Chapters 34 through 43.

**M1406.3 Installation of radiant panels.** Radiant panels installed on wood framing shall conform to the following requirements:

1. Heating panels shall be installed parallel to framing members and secured to the surface of framing members or mounted between framing members.
2. Mechanical fasteners shall penetrate only the unheated portions provided for this purpose. Panels shall not be fastened at any point closer than  $\frac{1}{4}$  inch (6.4 mm) to an element. Other methods of attachment of the panels shall be in accordance with the panel manufacturer's instructions.
3. Unless *listed* and *labeled* for field cutting, heating panels shall be installed as complete units.

**M1406.4 Installation in concrete or masonry.** Radiant heating systems installed in concrete or masonry shall conform to the following requirements:

1. Radiant heating systems shall be identified as being suitable for the installation, and shall be secured in place as specified in the manufacturer's installation instructions.
2. Radiant heating panels or radiant heating panel sets shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

**M1406.5 Finish surfaces.** Finish materials installed over radiant heating panels or systems shall be installed in accordance with the manufacturer's instructions. Surfaces shall be secured so that nails or other fastenings do not pierce the radiant heating elements.

### SECTION M1407 DUCT HEATERS

**M1407.1 General.** Electric duct heaters shall be installed in accordance with the manufacturer's instructions and Chapters 34 through 43. Electric duct heaters shall comply with UL 1996.

**M1407.2 Installation.** Electric duct heaters shall be installed so that they will not create a fire hazard. Class 1 ducts, duct coverings and linings shall be interrupted at each heater to provide the clearances specified in the manufacturer's installation instructions. Such interruptions are not required for duct heaters *listed* and *labeled* for zero clearance to *combustible*

*materials*. Insulation installed in the immediate area of each heater shall be classified for the maximum temperature produced on the duct surface.

**M1407.3 Installation with heat pumps and air conditioners.** Duct heaters located within 4 feet (1219 mm) of a heat pump or air conditioner shall be *listed* and *labeled* for such installations. The heat pump or air conditioner shall additionally be *listed* and *labeled* for such duct heater installations.

**M1407.4 Access.** Duct heaters shall be located to allow access for servicing, and clearance shall be maintained to permit adjustment, servicing and replacement of controls and heating elements.

**M1407.5 Fan interlock.** The fan circuit shall be provided with an interlock to prevent heater operation when the fan is not operating.

### SECTION M1408 VENTED FLOOR FURNACES

**M1408.1 General.** Oil-fired vented *floor furnaces* shall comply with UL 729 and shall be installed in accordance with their *listing*, the manufacturer's instructions and the requirements of this code.

**M1408.2 Clearances.** Vented *floor furnaces* shall be installed in accordance with their listing and the manufacturer's instructions.

**M1408.3 Location.** Location of *floor furnaces* shall conform to the following requirements:

1. Floor registers of *floor furnaces* shall be installed not less than 6 inches (152 mm) from a wall.
2. Wall registers of *floor furnaces* shall be installed not less than 6 inches (152 mm) from the adjoining wall at inside corners.
3. The furnace register shall be located not less than 12 inches (305 mm) from doors in any position, draperies or similar combustible objects.
4. The furnace register shall be located not less than 5 feet (1524 mm) below any projecting *combustible materials*.
5. The *floor furnace* burner assembly shall not project into an occupied under-floor area.
6. The *floor furnaces* shall not be installed in concrete floor construction built on grade.
7. The *floor furnaces* shall not be installed where a door can swing within 12 inches (305 mm) of the grille opening.

**M1408.4 Access.** An opening in the foundation not less than 18 inches by 24 inches (457 mm by 610 mm), or a trap door not less than 22 inches by 30 inches (559 mm by 762 mm) shall be provided for access to a *floor furnace*. The opening and passageway shall be large enough to allow replacement of any part of the *equipment*.



## HEATING AND COOLING EQUIPMENT AND APPLIANCES

**M1408.5 Installation.** *Floor furnace* installations shall conform to the following requirements:

1. Thermostats controlling *floor furnaces* shall be located in the room in which the register of the *floor furnace* is located.
2. *Floor furnaces* shall be supported independently of the furnace floor register.
3. *Floor furnaces* shall be installed not closer than 6 inches (152 mm) to the ground. The minimum clearance shall be 2 inches (51 mm), where the lower 6 inches (152 mm) of the furnace is sealed to prevent water entry.
4. Where excavation is required for a *floor furnace* installation, the excavation shall extend 30 inches (762 mm) beyond the control side of the *floor furnace* and 12 inches (305 mm) beyond the remaining sides. Excavations shall slope outward from the perimeter of the base of the excavation to the surrounding *grade* at an angle not exceeding 45 degrees (0.79 rad) from horizontal.
5. *Floor furnaces* shall not be supported from the ground.

### SECTION M1409 VENTED WALL FURNACES

**M1409.1 General.** Oil-fired vented wall furnaces shall comply with UL 730 and shall be installed in accordance with their *listing*, the manufacturer's instructions and the requirements of this code.

**M1409.2 Location.** The location of vented wall furnaces shall conform to the following requirements:

1. Vented wall furnaces shall be located where they will not cause a fire hazard to walls, floors, combustible furnishings or doors. Vented wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.
2. Vented wall furnaces shall not be located where a door can swing within 12 inches (305 mm) of the furnace air inlet or outlet measured at right angles to the opening. Doorstops or door closers shall not be installed to obtain this clearance.

**M1409.3 Installation.** Vented wall furnace installations shall conform to the following requirements:

1. Required wall thicknesses shall be in accordance with the manufacturer's installation instructions.
2. Ducts shall not be attached to a wall furnace. Casing extensions or boots shall be installed only where listed as part of a *listed* and *labeled* appliance.
3. A manual shutoff valve shall be installed ahead of all controls.

**M1409.4 Access.** Vented wall furnaces shall be provided with access for cleaning of heating surfaces; removal of burners; replacement of sections, motors, controls, filters and other working parts; and for adjustments and lubrication

of parts requiring such attention. Panels, grilles and access doors that must be removed for normal servicing operations shall not be attached to the building construction.

### SECTION M1410 VENTED ROOM HEATERS

**M1410.1 General.** Vented room heaters shall be tested in accordance with ASTM E1509 for pellet-fuel burning, UL 896 for oil-fired or UL 1482 for solid fuel-fired and installed in accordance with their *listing*, the manufacturer's installation instructions and the requirements of this code.

**M1410.2 Floor mounting.** Room heaters shall be installed on noncombustible floors or *approved* assemblies constructed of *noncombustible materials* that extend not less than 18 inches (457 mm) beyond the *appliance* on all sides.

#### Exceptions:

1. *Listed* room heaters shall be installed on noncombustible floors, assemblies constructed of *noncombustible materials* or floor protectors *listed* and *labeled* in accordance with UL 1618. The materials and dimensions shall be in accordance with the *appliance* manufacturer's instructions.
2. Room heaters *listed* for installation on combustible floors without floor protection shall be installed in accordance with the *appliance* manufacturer's instructions.

### SECTION M1411 HEATING AND COOLING EQUIPMENT

**M1411.1 Approved refrigerants.** Refrigerants used in direct refrigerating systems shall conform to the applicable provisions of ANSI/ASHRAE 34.

**M1411.2 Refrigeration coils in warm-air furnaces.** Where a cooling coil is located in the supply plenum of a warm-air furnace, the furnace blower shall be rated at not less than 0.5-inch water column (124 Pa) static pressure unless the furnace is *listed* and *labeled* for use with a cooling coil. Cooling coils shall not be located upstream from heat exchangers unless *listed* and *labeled* for such use. Conversion of existing furnaces for use with cooling coils shall be permitted provided that the furnace will operate within the temperature rise specified for the furnace.

**M1411.3 Condensate disposal.** Condensate from cooling coils and evaporators shall be conveyed from the drain pan outlet to an *approved* place of disposal. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than  $\frac{1}{8}$  unit vertical in 12 units horizontal (1-percent slope). Condensate shall not discharge into a street, alley or other area where it would cause a nuisance.

**M1411.3.1 Auxiliary and secondary drain systems.** In addition to the requirements of Section M1411.3, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where damage to any building components will occur as a result of overflow



## HEATING AND COOLING EQUIPMENT AND APPLIANCES

from the *equipment* drain pan or stoppage in the condensate drain piping. Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than  $\frac{1}{8}$  unit vertical in 12 units horizontal (1-percent slope). Drain piping shall be not less than  $\frac{3}{4}$ -inch (19 mm) nominal pipe size. One of the following methods shall be used:

1. An auxiliary drain pan with a separate drain shall be installed under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 1.5 inches (38 mm), shall be not less than 3 inches (76 mm) larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion-resistant material. Galvanized sheet steel pans shall have a minimum thickness of not less than 0.0236-inch (0.6010 mm) (No. 24 Gage). Nonmetallic pans shall have a minimum thickness of not less than 0.0625 inch (1.6 mm).
2. A separate overflow drain line shall be connected to the drain pan installed with the *equipment*. This overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.
3. An auxiliary drain pan without a separate drain line shall be installed under the coils on which condensation will occur. This pan shall be equipped with a water level detection device conforming to UL 508 that will shut off the *equipment* served prior to overflow of the pan. The pan shall be equipped with a fitting to allow for drainage. The auxiliary drain pan shall be constructed in accordance with Item 1 of this section.
4. A water-level detection device conforming to UL 508 shall be installed that will shut off the *equipment* served in the event that the primary drain is blocked. The device shall be installed in the primary drain line, the overflow drain line or the *equipment*-supplied drain pan, located at a point higher than the primary drain line connection and below the overflow rim of such pan.

**M1411.3.1.1 Water-level monitoring devices.** On down-flow units and other coils that do not have secondary drain or provisions to install a secondary or auxiliary drain pan, a water-level monitoring device shall be installed inside the primary drain pan. This device shall shut off the *equipment* served in the event that the primary drain becomes restricted. Devices shall not be installed in the drain line.

**M1411.3.1.2 Appliance, equipment and insulation in pans.** Where *appliances*, *equipment* or insulation are subject to water damage when auxiliary drain pans fill, that portion of the *appliance*, *equipment* and insulation shall be installed above the rim of the pan.

Supports located inside of the pan to support the *appliance* or *equipment* shall be water resistant and *approved*.

**M1411.3.2 Drain pipe materials and sizes.** Components of the condensate disposal system shall be ABS, cast iron, copper, cross-linked polyethylene, CPVC, galvanized steel, PE-RT, polyethylene, polypropylene or PVC pipe or tubing. Components shall be selected for the pressure and temperature rating of the installation. Joints and connections shall be made in accordance with the applicable provisions of Chapter 30. Condensate waste and drain line size shall be not less than  $\frac{3}{4}$ -inch (19 mm) nominal diameter from the drain pan connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with an *approved* method.

**M1411.3.3 Drain line maintenance.** Condensate drain lines shall be configured to permit the clearing of blockages and performance of maintenance without requiring the drain line to be cut.

**M1411.3.4 Appliances, equipment and insulation in pans.** Where *appliances*, *equipment* or insulation are subject to water damage when auxiliary drain pans fill, those portions of the *appliances*, *equipment* and insulation shall be installed above the flood level rim of the pan. Supports located inside of the pan to support the *appliance* or *equipment* shall be water resistant and *approved*.

**M1411.4 Condensate pumps.** Condensate pumps located in uninhabitable spaces, such as attics and crawl spaces, shall be connected to the *appliance* or *equipment* served such that when the pump fails, the *appliance* or *equipment* will be prevented from operating. Pumps shall be installed in accordance with the manufacturer's instructions.

**M1411.5 Auxiliary drain pan.** Category IV condensing *appliances* shall have an auxiliary drain pan where damage to any building component will occur as a result of stoppage in the condensate drainage system. These pans shall be installed in accordance with the applicable provisions of Section M1411.3.

**Exception:** Fuel-fired *appliances* that automatically shut down operation in the event of a stoppage in the condensate drainage system.

**M1411.6 Insulation of refrigerant piping.** Piping and fittings for refrigerant vapor (suction) lines shall be insulated with insulation having a thermal resistivity of not less than R-3 and having external surface permeance not exceeding 0.05 perm [2.87 ng/(s × m<sup>2</sup> × Pa)] when tested in accordance with ASTM E96.

**M1411.6.1 Refrigerant line insulation protection.** Refrigerant piping insulation shall be protected in accordance with Section N1103.4.1.

**M1411.7 Location and protection of refrigerant piping.** Refrigerant piping installed within 1½ inches (38 mm) of the underside of *roof decks* shall be protected from damage caused by nails and other fasteners.

**M1411.8 Support of refrigerant piping.** Refrigerant piping and tubing shall be securely fastened to a permanent support within 6 feet (1829 mm) of the condensing unit.

**M1411.9 Locking access port caps.** Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper-resistant caps or shall be otherwise secured to prevent unauthorized access.

## SECTION M1412 ABSORPTION COOLING EQUIPMENT

**M1412.1 Approval of equipment.** Absorption systems shall be installed in accordance with the manufacturer's instructions. Absorption *equipment* shall comply with UL 1995 or UL/CSA/ANCE 60335-2-40.

**M1412.2 Condensate disposal.** Condensate from the cooling coil shall be disposed of as provided in Section M1411.3.

**M1412.3 Insulation of piping.** Refrigerant piping, brine piping and fittings within a building shall be insulated to prevent condensation from forming on piping.

**M1412.4 Pressure-relief protection.** Absorption systems shall be protected by a pressure-relief device. Discharge from the pressure-relief device shall be located where it will not create a hazard to persons or property.

## SECTION M1413 EVAPORATIVE COOLING EQUIPMENT

**M1413.1 General.** Evaporative cooling *equipment* and *appliances* shall comply with UL 1995 or UL/CSA/ANCE 60335-2-40 and shall be installed:

1. In accordance with the manufacturer's instructions.
2. On level platforms in accordance with Section M1305.1.3.1.
3. So that openings in exterior walls are flashed in accordance with Section R703.4.
4. So as to protect the potable water supply in accordance with Section P2902.
5. So that air intake opening locations are in accordance with Section R303.5.1.

## SECTION M1414 FIREPLACE STOVES

**M1414.1 General.** Fireplace stoves shall be *listed, labeled* and installed in accordance with the terms of the listing. Fireplace stoves shall be tested in accordance with UL 737.

**M1414.2 Hearth extensions.** Hearth extensions for fireplace stoves shall be installed in accordance with the *listing* of the fireplace stove. The supporting structure for a hearth extension for a fireplace stove shall be at the same level as the supporting structure for the fireplace unit. The hearth extension shall be readily distinguishable from the surrounding floor area.

## SECTION M1415 MASONRY HEATERS

**M1415.1 General.** *Masonry heaters* shall be constructed in accordance with Section R1002.



## CHAPTER 15

# EXHAUST SYSTEMS

### User notes:

**About this chapter:** Chapter 15 is specific to exhaust systems related to clothes dryers, domestic cooking, toilet rooms, bathrooms and whole-house ventilation systems. Included are requirements for exhaust discharge locations, protection of exhaust ducts from damage, exhaust duct construction, duct length limits, and exhaust termination clearances. This chapter contains prohibitions for exhaust recirculation and discharge locations and addresses the design of whole-house ventilation systems required by Chapter 3.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1501 GENERAL

**M1501.1 Outdoor discharge.** The air removed by every mechanical exhaust system shall be discharged to the outdoors in accordance with Section M1504.3. Air shall not be exhausted into an attic, soffit, ridge vent or *crawl space*.

**Exception:** Whole-house *ventilation*-type attic fans that discharge into the attic space of *dwelling units* having private *attics* shall be permitted.

### SECTION M1502 CLOTHES DRYER EXHAUST

**M1502.1 General.** Clothes dryers shall be exhausted in accordance with the manufacturer's instructions.

**M1502.2 Independent exhaust systems.** Dryer exhaust systems shall be independent of all other systems and shall convey the moisture to the outdoors.

**Exception:** This section shall not apply to *listed* and *labeled* condensing (ductless) clothes dryers.

**M1502.3 Duct termination.** Exhaust ducts shall terminate on the outside of the building. Exhaust duct terminations shall be in accordance with the dryer manufacturer's installation instructions. If the manufacturer's instructions do not specify a termination location, the exhaust duct shall terminate not less than 3 feet (914 mm) in any direction from openings into buildings, including openings in ventilated soffits. Exhaust duct terminations shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination.

**M1502.3.1 Exhaust termination outlet and passageway size.** The passageway of dryer exhaust duct terminals shall be undiminished in size and shall provide an open area of not less than 12.5 square inches (8065 mm<sup>2</sup>).

**M1502.4 Dryer exhaust ducts.** Dryer exhaust ducts shall conform to the requirements of Sections M1502.4.1 through M1502.4.8.

**M1502.4.1 Material and size.** Exhaust ducts shall have a smooth interior finish and shall be constructed of metal

not less than 0.0157 inch (0.3950 mm) in thickness (No. 28 gage). The duct shall be 4 inches (102 mm) nominal in diameter.

**M1502.4.2 Duct installation.** Exhaust ducts shall be supported at intervals not to exceed 12 feet (3658 mm) and shall be secured in place. The insert end of the duct shall extend into the adjoining duct or fitting in the direction of airflow. Exhaust duct joints shall be sealed in accordance with Section M1601.4.1 and shall be mechanically fastened. Ducts shall not be joined with screws or similar fasteners that protrude more than 1/8 inch (3.2 mm) into the inside of the duct. Where dryer exhaust ducts are enclosed in wall or ceiling cavities, such cavities shall allow the installation of the duct without deformation.

**M1502.4.3 Transition duct.** Transition ducts used to connect the dryer to the exhaust *duct system* shall be a single length that is *listed* and *labeled* in accordance with UL 2158A. Transition ducts shall be not greater than 8 feet (2438 mm) in length. Transition ducts shall not be concealed within construction.

**M1502.4.4 Dryer exhaust duct power ventilators.** Domestic dryer exhaust duct power ventilators shall conform to UL 705 for use in dryer exhaust duct systems. The dryer exhaust duct power ventilator shall be installed in accordance with the manufacturer's instructions.

**M1502.4.5 Booster fans prohibited.** Domestic booster fans shall not be installed in dryer exhaust systems.

**M1502.4.6 Duct length.** The maximum allowable exhaust duct length shall be determined by one of the methods specified in Sections M1502.4.6.1 through M1502.4.6.3.

**M1502.4.6.1 Specified length.** The maximum length of the exhaust duct shall be 35 feet (10 668 mm) from the connection to the transition duct from the dryer to the outlet terminal. Where fittings are used, the maximum length of the exhaust duct shall be reduced in accordance with Table M1502.4.6.1. The maximum length of the exhaust duct does not include the transition duct.

## EXHAUST SYSTEMS

**TABLE M1502.4.6.1**  
**DRYER EXHAUST DUCT FITTING EQUIVALENT LENGTH**

DRYER EXHAUST DUCT FITTING TYPE	EQUIVALENT LENGTH
4-inch radius mitered 45-degree elbow	2 feet 6 inches
4-inch radius mitered 90-degree elbow	5 feet
6-inch radius smooth 45-degree elbow	1 foot
6-inch radius smooth 90-degree elbow	1 foot 9 inches
8-inch radius smooth 45-degree elbow	1 foot
8-inch radius smooth 90-degree elbow	1 foot 7 inches
10-inch radius smooth 45-degree elbow	9 inches
10-inch radius smooth 90-degree elbow	1 foot 6 inches

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad.

**M1502.4.6.2 Manufacturer's instructions.** The size and maximum length of the exhaust duct shall be determined by the dryer manufacturer's installation instructions. The code official shall be provided with a copy of the installation instructions for the make and model of the dryer at the concealment inspection. In the absence of fitting equivalent length calculations from the clothes dryer manufacturer, Table M1502.4.6.1 shall be used.

**M1502.4.6.3 Dryer exhaust duct power ventilator.** The maximum length of the exhaust duct shall be determined in accordance with the manufacturer's instructions for the dryer exhaust duct power ventilator.

**M1502.4.7 Length identification.** Where the exhaust duct equivalent length exceeds 35 feet (10 668 mm), the equivalent length of the exhaust duct shall be identified on a permanent *label* or tag. The *label* or tag shall be located within 6 feet (1829 mm) of the exhaust duct connection.

**M1502.4.8 Exhaust duct required.** Where space for a clothes dryer is provided, an exhaust *duct system* shall be installed. Where the clothes dryer is not installed at the time of occupancy the exhaust duct shall be capped or plugged in the space in which it originates and identified and marked "future use."

**Exception:** Where a *listed* condensing clothes dryer is installed prior to occupancy of the structure.

**M1502.5 Protection required.** Protective shield plates shall be placed where nails or screws from finish or other work are likely to penetrate the clothes dryer exhaust duct. Shield plates shall be placed on the finished face of framing members where there is less than  $1\frac{1}{4}$  inches (32 mm) between the duct and the finished face of the framing member. Protective shield plates shall be constructed of steel, shall have a minimum thickness of 0.062 inch (1.6 mm) and shall extend not less than 2 inches (51 mm) above sole plates and below top plates.

## SECTION M1503

### DOMESTIC COOKING EXHAUST EQUIPMENT

**M1503.1 General.** Domestic cooking exhaust equipment shall comply with the requirements of this section.

**M1503.2 Domestic cooking exhaust.** Where domestic cooking exhaust equipment is provided, it shall comply with one of the following:

1. The fan for overhead range hoods and downdraft exhaust equipment not integral with the cooking *appliance* shall be *listed* and *labeled* in accordance with UL 507.
2. Overhead range hoods and downdraft exhaust equipment with integral fans shall comply with UL 507.
3. Domestic cooking *appliances* with integral downdraft exhaust equipment shall be *listed* and *labeled* in accordance with ANSI Z21.1 or UL 858.
4. Microwave ovens with integral exhaust for installation over the cooking surface shall be *listed* and *labeled* in accordance with UL 923.

**M1503.2.1 Open-top broiler exhaust.** Domestic open-top broiler units shall be provided with a metal exhaust hood having a thickness of not less than 0.0157 inch (0.3950 mm) (No. 28 gage). Such hoods shall be installed with a clearance of not less than  $\frac{1}{4}$  inch (6.4 mm) between the hood and the underside of *combustible material* and cabinets. A clearance of not less than 24 inches (610 mm) shall be maintained between the cooking surface and *combustible material* and cabinets. The hood width shall be not less than the width of the broiler unit and shall extend over the entire unit.

**Exception:** Broiler units that incorporate an integral exhaust system, and that are *listed* and *labeled* for use without an exhaust hood, shall not be required to have an exhaust hood.

**M1503.3 Exhaust discharge.** Domestic cooking exhaust equipment shall discharge to the outdoors through a duct. The duct shall have a smooth interior surface, shall be airtight, shall be equipped with a backdraft damper and shall



be independent of all other exhaust systems. Ducts serving domestic cooking exhaust equipment shall not terminate in an attic or *crawl space* or areas inside the building.

**Exception:** Where installed in accordance with the manufacturer's instructions, and where mechanical or natural *ventilation* is otherwise provided, *listed* and *labeled* ductless range hoods shall not be required to discharge to the outdoors.

**M1503.4 Duct material.** Ducts serving domestic cooking exhaust equipment shall be constructed of galvanized steel, stainless steel or copper.

**Exception:** Ducts for domestic kitchen cooking *appliances* equipped with down-draft exhaust systems shall be permitted to be constructed of schedule 40 PVC pipe and fittings provided that the installation complies with all of the following:

1. The duct is installed under a concrete slab poured on grade.
2. The underfloor trench in which the duct is installed is completely backfilled with sand or gravel.
3. The PVC duct extends not more than 1 inch (25 mm) above the indoor concrete floor surface.
4. The PVC duct extends not more than 1 inch (25 mm) above grade outside of the building.
5. The PVC ducts are solvent cemented.

**M1503.5 Kitchen exhaust rates.** Where domestic kitchen cooking *appliances* are equipped with ducted range hoods or down-draft exhaust systems, the fans shall be sized in accordance with Section M1505.4.4.

**M1503.6 Makeup air required.** Where one or more gas, liquid or solid fuel-burning *appliance* that is neither direct-vent nor uses a mechanical draft venting system is located within a dwelling unit's air barrier, each exhaust system capable of exhausting in excess of 400 cubic feet per minute (0.19 m<sup>3</sup>/s) shall be mechanically or passively provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with not fewer than one damper complying with Section M1503.6.2.

**Exception:** Makeup air is not required for exhaust systems installed for the exclusive purpose of space cooling and intended to be operated only when windows or other air inlets are open.

**M1503.6.1 Location.** Kitchen exhaust makeup air shall be discharged into the same room in which the exhaust system is located or into rooms or *duct systems* that communicate through one or more permanent openings with the room in which such exhaust system is located. Such permanent openings shall have a net cross-sectional area not less than the required area of the makeup air supply openings.

**M1503.6.2 Makeup air dampers.** Where makeup air is required by Section M1503.6, makeup air dampers shall comply with this section. Each damper shall be a gravity damper or an electrically operated damper that automatically opens when the exhaust system operates. Dampers

shall be located to allow access for inspection, service, repair and replacement without removing permanent construction or any other ducts not connected to the damper being inspected, serviced, repaired or replaced. Gravity or barometric dampers shall not be used in passive makeup air systems except where the dampers are rated to provide the design makeup airflow at a pressure differential of 0.01 in. w.c. (3 Pa) or less.

## SECTION M1504

### EXHAUST DUCTS AND EXHAUST OPENINGS

**M1504.1 Duct construction.** Where exhaust duct construction is not specified in this chapter, construction shall comply with Chapter 16.

**M1504.2 Duct length.** The length of exhaust and supply ducts used with ventilating *equipment* shall not exceed the lengths determined in accordance with Table M1504.2.

**Exception:** Duct length shall not be limited where the *duct system* complies with the manufacturer's design criteria or where the flow rate of the installed ventilating *equipment* is verified by the installer or *approved* third party using a flow hood, flow grid or other airflow measuring device.

**M1504.3 Exhaust openings.** Air exhaust openings shall terminate as follows:

1. Not less than 3 feet (914 mm) from property lines.
2. Not less than 3 feet (914 mm) from gravity air intake openings, operable windows and doors.
3. Not less than 10 feet (3048 mm) from mechanical air intake openings except where the exhaust opening is located not less than 3 feet (914 mm) above the air intake opening. Openings shall comply with Sections R303.5.2 and R303.6.

## SECTION M1505

### MECHANICAL VENTILATION

**M1505.1 General.** Where local exhaust or whole-house mechanical *ventilation* is provided, the ventilation system shall be designed in accordance with this section.

**M1505.2 Recirculation of air.** Exhaust air from bathrooms and toilet rooms shall not be recirculated within a residence or circulated to another *dwelling unit* and shall be exhausted directly to the outdoors. Exhaust air from bathrooms, toilet rooms and kitchens shall not discharge into an attic, *crawl space* or other areas inside the building. This section shall not prohibit the installation of ductless range hoods in accordance with the exception to Section M1503.3.

**M1505.3 Exhaust equipment.** Exhaust fans and whole-house mechanical ventilation fans shall be *listed* and *labeled* as providing the minimum required airflow in accordance with ANSI/AMCA 210-ANSI/ASHRAE 51.

**M1505.4 Whole-house mechanical ventilation system.** Whole-house mechanical ventilation systems shall be designed in accordance with Sections M1505.4.1 through M1505.4.4.

## EXHAUST SYSTEMS

TABLE M1504.2  
DUCT LENGTH

DUCT TYPE	FLEX DUCT								SMOOTH-WALL DUCT							
Fan airflow rating (CFM @ 0.25 inch wc <sup>a</sup> )	50	80	100	125	150	200	250	300	50	80	100	125	150	200	250	300
Diameter <sup>b</sup> (inches)	Maximum length <sup>c, d, e</sup> (feet)															
3	X	X	X	X	X	X	X	X	5	X	X	X	X	X	X	X
4	56	4	X	X	X	X	X	X	114	31	10	X	X	X	X	X
5	NL	81	42	16	2	X	X	X	NL	152	91	51	28	4	X	X
6	NL	NL	158	91	55	18	1	X	NL	NL	NL	168	112	53	25	9
7	NL	NL	NL	NL	161	78	40	19	NL	NL	NL	NL	NL	148	88	54
8 and above	NL	NL	NL	NL	NL	189	111	69	NL	NL	NL	NL	NL	NL	198	133

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. Fan airflow rating shall be in accordance with ANSI/AMCA 210-ANSI/ASHRAE 51.

b. For noncircular ducts, calculate the diameter as four times the cross-sectional area divided by the perimeter.

c. This table assumes that elbows are not used. Fifteen feet of allowable duct length shall be deducted for each elbow installed in the duct run.

d. NL = no limit on duct length of this size.

e. X = not allowed. Any length of duct of this size with assumed turns and fittings will exceed the rated pressure drop.

**M1505.4.1 System design.** The whole-house ventilation system shall consist of one or more supply or exhaust fans, or a combination of such, and associated ducts and controls. Local exhaust or supply fans are permitted to serve as such a system. Outdoor air ducts connected to the return side of an air handler shall be considered as providing supply ventilation.

**M1505.4.2 System controls.** The whole-house mechanical ventilation system shall be provided with controls that enable manual override. Controls shall include text or a symbol indicating their function.

**M1505.4.3 Mechanical ventilation rate.** The whole-house mechanical ventilation system shall provide outdoor air at a continuous rate not less than that determined in accordance with Table M1505.4.3(1) or not less than that determined by Equation 15-1.

Ventilation rate in cubic feet per minute =  $(0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$   
(Equation 15-1)

**Exceptions:**

1. Ventilation rate credit. The minimum mechanical ventilation rate determined in accordance with Table M1505.4.3(1) or Equation 15-1 shall be reduced by 30 percent, provided that both of the following conditions apply:
  - 1.1. A ducted system supplies ventilation air directly to each bedroom and to one or more of the following rooms:
    - 1.1.1. Living room.
    - 1.1.2. Dining room.
    - 1.1.3. Kitchen.

TABLE M1505.4.3(1)  
CONTINUOUS WHOLE-HOUSE MECHANICAL VENTILATION SYSTEM AIRFLOW RATE REQUIREMENTS

DWELLING UNIT FLOOR AREA (square feet)	NUMBER OF BEDROOMS				
	0-1	2-3	4-5	6-7	> 7
	Airflow in CFM				
< 1,500	30	45	60	75	90
1,501-3,000	45	60	75	90	105
3,001-4,500	60	75	90	105	120
4,501-6,000	75	90	105	120	135
6,001-7,500	90	105	120	135	150
> 7,500	105	120	135	150	165

For SI: 1 square foot = 0.0929 m<sup>2</sup>, 1 cubic foot per minute = 0.0004719 m<sup>3</sup>/s.

TABLE M1505.4.3(2)  
INTERMITTENT WHOLE-HOUSE MECHANICAL VENTILATION RATE FACTORS<sup>a, b</sup>

RUN-TIME PERCENTAGE IN EACH 4-HOUR SEGMENT	25%	33%	50%	66%	75%	100%
Factor <sup>a</sup>	4	3	2	1.5	1.3	1.0

a. For ventilation system run-time values between those given, the factors are permitted to be determined by interpolation.

b. Extrapolation beyond the table is prohibited.

- 1.2. The whole-house ventilation system is a balanced ventilation system.
2. Programmed intermittent operation. The whole-house mechanical ventilation system is permitted to operate intermittently where the system has controls that enable operation for not less than 25 percent of each 4-hour segment and the ventilation rate prescribed in Table M1505.4.3(1), by Equation 15-1 or by Exception 1 is multiplied by the factor determined in accordance with Table M1505.4.3(2).

**M1505.4.4 Local exhaust rates.** *Local exhaust* systems shall be designed to have the capacity to exhaust the minimum airflow rate determined in accordance with Table M1505.4.4.

**TABLE M1505.4.4**  
**MINIMUM REQUIRED LOCAL EXHAUST RATES FOR**  
**ONE- AND TWO-FAMILY DWELLINGS**

AREA TO BE EXHAUSTED	EXHAUST RATES <sup>a</sup>
Kitchens	100 cfm intermittent or 25 cfm continuous
Bathrooms-Toilet Rooms	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous

For SI: 1 cubic foot per minute = 0.0004719 m<sup>3</sup>/s,  
1 inch water column = 0.2488 kPa.

- a. The listed exhaust rate for bathrooms-toilet rooms shall equal or exceed the exhaust rate at a minimum static pressure of 0.25 inch water column in accordance with Section M1505.3.



## CHAPTER 16

# DUCT SYSTEMS

### User notes:

**About this chapter:** Chapter 16 addresses duct construction for HVAC and most exhaust systems. This chapter covers duct materials, duct construction, duct installation, duct insulation properties, duct sealing, above-ground and underground ducts, return air intake locations and air plenums.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1601 DUCT CONSTRUCTION

**M1601.1 Duct design.** Duct systems serving heating, cooling and ventilation equipment shall be installed in accordance with the provisions of this section and ACCA Manual D, the appliance manufacturer's installation instructions or other approved methods.

**M1601.1.1 Above-ground duct systems.** Above-ground duct systems shall conform to the following:

1. Equipment connected to duct systems shall be designed to limit discharge air temperature to not greater than 250°F (121°C).
2. Factory-made ducts shall be listed and labeled in accordance with UL 181 and installed in accordance with the manufacturer's instructions.
3. Fibrous glass duct construction shall conform to the SMACNA Fibrous Glass Duct Construction Standards or NAIMA Fibrous Glass Duct Construction Standards.
4. Field-fabricated and shop-fabricated metal and flexible duct constructions shall conform to the SMACNA HVAC Duct Construction Standards—Metal and Flexible except as allowed by Table M1601.1.1. Galvanized steel shall conform to ASTM A653.
5. The use of gypsum products to construct return air ducts or plenums is permitted, provided that the air temperature does not exceed 125°F (52°C) and exposed surfaces are not subject to condensation.
6. Duct systems shall be constructed of materials having a flame spread index of not greater than 200.
7. Stud wall cavities and the spaces between solid floor joists to be used as air plenums shall comply with the following conditions:
  - 7.1. These cavities or spaces shall not be used as a plenum for supply air.
  - 7.2. These cavities or spaces shall not be part of a required fire-resistance-rated assembly.
  - 7.3. Stud wall cavities shall not convey air from more than one floor level.

7.4. Stud wall cavities and joist-space plenums shall be isolated from adjacent concealed spaces by tight-fitting fireblocking in accordance with Section R302.11. Fireblocking materials used for isolation shall comply with Section R302.11.1.

7.5. Stud wall cavities in the outside walls of building envelope assemblies shall not be utilized as air plenums.

7.6. Building cavities used as plenums shall be sealed.

8. Volume dampers, equipment and other means of supply, return and exhaust air adjustment used in system balancing shall be provided with access.

**M1601.1.2 Underground duct systems.** Underground duct systems shall be constructed of approved concrete, clay, metal or plastic. The maximum design temperature for systems utilizing plastic duct and fittings shall be 150°F (66°C). Metal ducts shall be protected from corrosion in an approved manner or shall be completely encased in concrete not less than 2 inches (51 mm) thick. Nonmetallic ducts shall be installed in accordance with the manufacturer's instructions. Plastic pipe and fitting materials shall conform to cell classification 12454-B of ASTM D1248 or ASTM D1784 and external loading properties of ASTM D2412. Ducts shall slope to a drainage point that has access. Ducts shall be sealed, secured and tested prior to encasing the ducts in concrete or direct burial. Duct tightness shall be verified as required by Section N1103.3. Metallic ducts having an approved protective coating and nonmetallic ducts shall be installed in accordance with the manufacturer's instructions.

**M1601.2 Vibration isolators.** Vibration isolators installed between mechanical equipment and metal ducts shall be fabricated from approved materials and shall not exceed 10 inches (254 mm) in length.

**M1601.3 Duct insulation materials.** Duct insulation materials shall conform to the following requirements:

1. Duct coverings and linings, including adhesives where used, shall have a flame spread index not higher than 25, and a smoke-developed index not over 50 when tested in accordance with ASTM E84



## DUCT SYSTEMS

or UL 723, using the specimen preparation and mounting procedures of ASTM E2231.

**Exception:** Spray application of polyurethane foam to the exterior of ducts in *attics* and *crawl spaces* shall be permitted subject to all of the following:

1. The flame spread index is not greater than 25 and the *smoke-developed index* is not greater than 450 at the specified installed thickness.
2. The foam plastic is protected in accordance with the ignition barrier requirements of Sections R316.5.3 and R316.5.4.
3. The foam plastic complies with the requirements of Section R316.
2. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C). Coverings and linings shall be *listed* and *labeled*.
3. External reflective duct insulation shall be legibly printed or identified at intervals not greater than 36 inches (914 mm) with the name of the manufacturer, the product *R*-value at the specified installed thickness and the flame spread and smoke-developed indices. The installed thickness of the external duct insulation shall include the enclosed airspace(s). The product *R*-value for external reflective duct insula-

tion shall be determined in accordance with ASTM C1668.

4. External duct insulation and factory-insulated flexible ducts shall be legibly printed or identified at intervals not longer than 36 inches (914 mm) with the name of the manufacturer, the thermal resistance *R*-value at the specified installed thickness and the flame spread and smoke-developed indices of the composite materials. Spray polyurethane foam manufacturers shall provide the same product information and properties, at the nominal installed thickness, to the customer in writing at the time of foam application. Nonreflective duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor retarders or other duct components, and shall be based on tested *C*-values at 75°F (24°C) mean temperature at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-value shall be determined as follows:
  - 4.1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
  - 4.2. For ductwrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.
  - 4.3. For factory-made flexible air ducts, The installed thickness shall be determined by dividing the difference between the actual

**TABLE M1601.1.1**  
**DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESS FOR SINGLE DWELLING UNITS<sup>a</sup>**

ROUND DUCT DIAMETER (inches)	STATIC PRESSURE			
	$\frac{1}{2}$ -inch water gauge		1-inch water gauge	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
< 12	0.013	0.018	0.013	0.018
12 to 14	0.013	0.018	0.016	0.023
15 to 17	0.016	0.023	0.019	0.027
18	0.016	0.023	0.024	0.034
19 to 20	0.019	0.027	0.024	0.034
RECTANGULAR DUCT DIMENSION (inches)	STATIC PRESSURE			
	$\frac{1}{2}$ -inch water gauge		1-inch water gauge	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
≤ 8	0.013	0.018	0.013	0.018
9 to 10	0.013	0.018	0.016	0.023
11 to 12	0.016	0.023	0.019	0.027
13 to 16	0.019	0.027	0.019	0.027
17 to 18	0.019	0.027	0.024	0.034
19 to 20	0.024	0.034	0.024	0.034

For SI: 1 inch = 25.4 mm, 1 inch water gauge = 249 Pa.

- a. Ductwork that exceeds 20 inches by dimension or exceeds a pressure of 1 inch water gauge shall be constructed in accordance with SMACNA *HVAC Duct Construction Standards—Metal and Flexible*.

outside diameter and nominal inside diameter by two.

- 4.4. For spray polyurethane foam, the aged *R*-value per inch measured in accordance with recognized industry standards shall be provided to the customer in writing at the time of foam application. In addition, the total *R*-value for the nominal application thickness shall be provided.

**M1601.4 Installation.** Duct installation shall comply with Sections M1601.4.1 through M1601.4.10.

**M1601.4.1 Joints, seams and connections.** Longitudinal and transverse joints, seams and connections in metallic and nonmetallic ducts shall be constructed as specified in SMACNA *HVAC Duct Construction Standards—Metal and Flexible* and NAIMA *Fibrous Glass Duct Construction Standards*. Joints, longitudinal and transverse seams, and connections in ductwork shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, liquid sealants or tapes. Tapes and mastics used to seal fibrous glass ductwork shall be *listed* and *labeled* in accordance with UL 181A and shall be marked “181A-P” for pressure-sensitive tape, “181 A-M” for mastic or “181 A-H” for heat-sensitive tape.

Tapes and mastics used to seal metallic and flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked “181 B-FX” for pressure-sensitive tape or “181 BM” for mastic. Duct connections to flanges of air distribution system *equipment* shall be sealed and mechanically fastened. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply with UL 181B and shall be marked 181B-C. Crimp joints for round metallic ducts shall have a contact lap of not less than 1 inch (25 mm) and shall be mechanically fastened by means of not less than three sheet-metal screws or rivets equally spaced around the joint.

Closure systems used to seal all ductwork shall be installed in accordance with the manufacturers’ instructions.

**Exceptions:**

1. Spray polyurethane foam shall be permitted to be applied without additional joint seals.
2. Where a duct connection is made that is partially without access, three screws or rivets shall be equally spaced on the exposed portion of the joint so as to prevent a hinge effect.
3. For ducts having a static pressure classification of less than 2 inches of water column (500 Pa), additional closure systems shall not be required for continuously welded joints and seams and locking-type joints and seams. This exception shall not apply to snap-lock and button-lock type joints and seams that are located outside of *conditioned spaces*.

**M1601.4.2 Duct lap.** Crimp joints for round and oval metal ducts shall be lapped not less than 1 inch (25 mm) and the male end of the duct shall extend into the adjoining duct in the direction of airflow.

**M1601.4.3 Plastic duct joints.** Joints between plastic ducts and plastic fittings shall be made in accordance with the manufacturer’s installation instructions.

**M1601.4.4 Support.** Factory-made ducts *listed* in accordance with UL 181 shall be supported in accordance with the manufacturer’s installation instructions. Field- and shop-fabricated fibrous glass ducts shall be supported in accordance with the SMACNA *Fibrous Glass Duct Construction Standards* or the NAIMA *Fibrous Glass Duct Construction Standards*. Field- and shop-fabricated metal and flexible ducts shall be supported in accordance with the SMACNA *HVAC Duct Construction Standards—Metal and Flexible*.

**M1601.4.5 Fireblocking.** Duct installations shall be fireblocked in accordance with Section R302.11.

**M1601.4.6 Duct insulation.** Duct insulation shall be installed in accordance with the following requirements:

1. A vapor retarder having a permeance of not greater than 0.05 perm [2.87 ng/(s × m<sup>2</sup> × Pa)] in accordance with ASTM E96, or aluminum foil with a thickness of not less than 2 mils (0.05 mm), shall be installed on the exterior of insulation on cooling supply ducts that pass through unconditioned spaces conducive to condensation except where the insulation is spray polyurethane foam with a water vapor permeance of not greater than 3 perms per inch [1722 ng/(s × m<sup>2</sup> × Pa)] at the installed thickness.
2. Outdoor *duct systems* shall be protected against the elements.
3. Duct coverings shall not penetrate a fireblocked wall or floor.

**M1601.4.7 Factory-made air ducts.** Factory-made air ducts shall not be installed in or on the ground, in tile or metal pipe, or within masonry or concrete.

**M1601.4.8 Duct separation.** Ducts shall be installed with not less than 4 inches (102 mm) separation from earth except where they meet the requirements of Section M1601.1.2.

**M1601.4.9 Ducts located in garages.** Ducts in garages shall comply with the requirements of Section R302.5.2.

**M1601.4.10 Flood hazard areas.** In flood hazard areas as established by Table R301.2, *duct systems* shall be located or installed in accordance with Section R322.1.6.

**M1601.5 Under-floor plenums.** Under-floor plenums shall be prohibited in new structures. Modification or repairs to under-floor plenums in existing structures shall conform to the requirements of this section.

**M1601.5.1 General.** The space shall be cleaned of loose *combustible materials* and scrap, and shall be tightly enclosed. The ground surface of the space shall be

## DUCT SYSTEMS

covered with a moisture barrier having a thickness of not less than 4 mils (0.1 mm). Plumbing waste cleanouts shall not be located within the space.

**Exception:** Plumbing waste cleanouts shall be permitted to be located in unvented *crawl spaces* that receive *conditioned air* in accordance with Section R408.3.

**M1601.5.2 Materials.** The under-floor space, including the sidewall insulation, shall be formed by materials having flame spread index values not greater than 200 when tested in accordance with ASTM E84 or UL 723.

**M1601.5.3 Furnace connections.** A duct shall extend from the furnace supply outlet to not less than 6 inches (152 mm) below the combustible framing. This duct shall comply with the provisions of Section M1601.1. A noncombustible receptacle shall be installed below any floor opening into the plenum in accordance with the following requirements:

1. The receptacle shall be securely suspended from the floor members and shall be not more than 18 inches (457 mm) below the floor opening.
2. The area of the receptacle shall extend 3 inches (76 mm) beyond the opening on all sides.
3. The perimeter of the receptacle shall have a vertical lip not less than 1 inch (25 mm) in height at the open sides.

**M1601.5.4 Access.** Access to an under-floor plenum shall be provided through an opening in the floor with minimum dimensions of 18 inches by 24 inches (457 mm by 610 mm).

**M1601.5.5 Furnace controls.** The furnace shall be equipped with an automatic control that will start the air-circulating fan when the air in the furnace bonnet reaches a temperature not higher than 150°F (66°C). The furnace shall additionally be equipped with an *approved* automatic control that limits the outlet air temperature to 200°F (93°C).

**M1601.6 Independent garage HVAC systems.** Furnaces and air-handling systems that supply air to living spaces shall not supply air to or return air from a garage.

2. The amount of return air taken from any room or space shall be not greater than the flow rate of supply air delivered to such room or space.
3. Return and transfer openings shall be sized in accordance with the *appliance* or *equipment* manufacturer's installation instructions, Manual D or the design of the *registered design professional*.
4. Return air shall not be taken from a closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room, furnace room or unconditioned attic.

### Exceptions:

1. Taking return air from a kitchen is not prohibited where such return air openings serve the kitchen only, and are located not less than 10 feet (3048 mm) from the cooking *appliances*.
2. Dedicated forced-air systems serving only the garage shall not be prohibited from obtaining return air from the garage.
5. For other than dedicated HVAC systems, return air shall not be taken from indoor swimming pool enclosures and associated deck areas except where the air in such spaces is dehumidified.
6. Taking return air from an unconditioned *crawl space* shall not be accomplished through a direct connection to the return side of a forced-air furnace. Transfer openings in the *crawl space* enclosure shall not be prohibited.
7. Return air from one *dwelling unit* shall not be discharged into another *dwelling unit*.

## SECTION M1602 RETURN AIR

**M1602.1 Outdoor air openings.** Outdoor intake openings shall be located in accordance with Section R303.5.1. Opening protection shall be in accordance with Section R303.6

**M1602.2 Return air openings.** Return air openings for heating, *ventilation* and air-conditioning systems shall comply with all of the following:

1. Openings shall not be located less than 10 feet (3048 mm) measured in any direction from an open combustion chamber or draft hood of another *appliance* located in the same room or space.

## CHAPTER 17

# COMBUSTION AIR

---

### User notes:

**About this chapter:** Chapter 17 applies only to oil-fired and solid fuel-fired appliances. Chapter 24 applies to combustion air for gas-fired appliances.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

---

### SECTION M1701 GENERAL

**M1701.1 Scope.** Solid fuel-burning *appliances* shall be provided with *combustion air* in accordance with the *appliance* manufacturer's installation instructions. Oil-fired *appliances* shall be provided with *combustion air* in accordance with NFPA 31. The methods of providing *combustion air* in this chapter do not apply to fireplaces, fireplace stoves and direct-vent *appliances*. The requirements for combustion and dilution air for gas-fired *appliances* shall be in accordance with Chapter 24.

**M1701.2 Opening location.** In flood hazard areas as established in Table R301.2, *combustion air* openings shall be located at or above the elevation required in Section R322.2.1 or R322.3.2.





## CHAPTER 18

# CHIMNEYS AND VENTS

### User notes:

**About this chapter:** Chapter 18 addresses chimneys and vents that serve oil- and solid fuel-fired appliances, including wood pellet appliances. Gas-fired appliances are vented in accordance with Chapter 24. Chapter 10 addresses chimneys for fireplaces and masonry and factory-built chimneys in general. Note that chimneys and vents are distinct.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1801 GENERAL

**M1801.1 Venting required.** Fuel-burning *appliances* shall be vented to the outdoors in accordance with their *listing* and *label* and manufacturer's installation instructions except *appliances* listed and *labeled* for unvented use. Venting systems shall consist of *approved* chimneys or vents, or venting assemblies that are integral parts of *labeled appliances*. Gas-fired *appliances* shall be vented in accordance with Chapter 24.

**M1801.2 Draft requirements.** A venting system shall satisfy the draft requirements of the *appliance* in accordance with the manufacturer's installation instructions, and shall be constructed and installed to develop a positive flow to convey combustion products to the outside atmosphere.

**M1801.3 Existing chimneys and vents.** Where an *appliance* is permanently disconnected from an existing chimney or vent, or where an *appliance* is connected to an existing chimney or vent during the process of a new installation, the chimney or vent shall comply with Sections M1801.3.1 through M1801.3.4.

**M1801.3.1 Size.** The chimney or vent shall be resized as necessary to control flue gas condensation in the interior of the chimney or vent and to provide the *appliance*, or *appliances* served, with the required draft. For the venting of oil-fired *appliances* to masonry chimneys, the resizing shall be done in accordance with NFPA 31.

**M1801.3.2 Flue passageways.** The flue gas passageway shall be free of obstructions and combustible deposits and shall be cleaned if previously used for venting a solid or liquid fuel-burning *appliance* or fireplace. The flue liner, chimney inner wall or vent inner wall shall be continuous and free of cracks, gaps, perforations, or other damage or deterioration that would allow the escape of combustion products, including gases, moisture and creosote.

**M1801.3.3 Cleanout.** Masonry chimneys shall be provided with a cleanout opening complying with Section R1003.17.

**M1801.3.4 Clearances.** Chimneys and vents shall have airspace clearance to combustibles in accordance with this code and the chimney or vent manufacturer's installation instructions.

**Exception:** Masonry chimneys equipped with a chimney lining system tested and *listed* for installation in chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, shall not be required to have a clearance between *combustible materials* and exterior surfaces of the *masonry chimney*. Noncombustible firestopping shall be provided in accordance with this code.

**M1801.4 Space around lining.** The space surrounding a flue lining system or other vent installed within a *masonry chimney* shall not be used to vent any other *appliance*. This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's installation instructions and this code.

**M1801.5 Mechanical draft systems.** A *mechanical draft system* shall be used only with *appliances listed and labeled* for such use. Provisions shall be made to prevent the flow of fuel to the *equipment* when the draft system is not operating. Forced draft systems and portions of induced draft systems under positive pressure during operation shall be designed and installed to prevent leakage of flue gases into a building.

**M1801.6 Direct-vent appliances.** Direct-vent *appliances* shall be installed in accordance with the manufacturer's instructions.

**M1801.7 Support.** Venting systems shall be adequately supported for the weight of the material used.

**M1801.8 Duct penetrations.** Chimneys, vents and vent connectors shall not extend into or through supply and return air ducts or plenums.

**M1801.9 Fireblocking.** Vent and chimney installations shall be fireblocked in accordance with Section R602.8.

**M1801.10 Unused openings.** Unused openings in any venting system shall be closed or capped.

## CHIMNEYS AND VENTS

**M1801.11 Multiple-appliance venting systems.** Two or more *listed* and *labeled appliances* connected to a common natural draft venting system shall comply with the following requirements:

1. *Appliances* that are connected to common venting systems shall be located on the same floor of the *dwelling*.  
**Exception:** Engineered systems as provided for in Section G2427.
2. Inlets to common venting systems shall be offset such that no portion of an inlet is opposite another inlet.
3. Connectors serving *appliances* operating under a natural draft shall not be connected to any portion of a *mechanical draft system* operating under positive pressure.

**M1801.12 Multiple solid fuel prohibited.** A solid fuel-burning *appliance* or fireplace shall not connect to a chimney passageway venting another *appliance*.

### SECTION M1802 VENT COMPONENTS

**M1802.1 Draft hoods.** Draft hoods shall be located in the same room or space as the *combustion air* openings for the *appliances*.

**M1802.2 Vent dampers.** Vent dampers shall comply with Sections M1802.2.1 and M1802.2.2.

**M1802.2.1 Manually operated.** Manually operated dampers shall not be installed except in connectors or chimneys serving solid fuel-burning *appliances*.

**M1802.2.2 Automatically operated.** Automatically operated dampers shall conform to UL 17 and be installed in accordance with the terms of their *listing* and *label*. The installation shall prevent firing of the burner when the damper is not opened to a safe position.

**M1802.3 Draft regulators.** Draft regulators shall be provided for oil-fired *appliances* that must be connected to a chimney. Draft regulators provided for solid fuel-burning *appliances* to reduce draft intensity shall be installed and set in accordance with the manufacturer's installation instructions.

**M1802.3.1 Location.** Where required, draft regulators shall be installed in the same room or enclosure as the *appliance* so that a difference in pressure will not exist between the air at the regulator and the *combustion air* supply.

**M1802.4 Blocked vent switch.** Oil-fired *appliances* shall be equipped with a device that will stop burner operation in the event that the venting system is obstructed. Such device shall have a manual reset and shall be installed in accordance with the manufacturer's instructions.

### SECTION M1803 CHIMNEY AND VENT CONNECTORS

**M1803.1 General.** Connectors shall be used to connect fuel-burning *appliances* to a vertical chimney or vent except where the chimney or vent is attached directly to the *appliance*.

**M1803.2 Connectors for oil and solid fuel-burning appliances.** Connectors for oil and solid fuel-burning *appliances* shall be constructed of *factory-built chimney* material, Type L vent material or single-wall metal pipe having resistance to corrosion and heat and thickness not less than that of galvanized steel as specified in Table M1803.2.

**TABLE M1803.2**  
**THICKNESS FOR SINGLE-WALL METAL PIPE CONNECTORS**

DIAMETER OF CONNECTOR (inches)	GALVANIZED SHEET METAL GAGE NUMBER	MINIMUM THICKNESS (inch)
Less than 6	26	0.019
6 to 10	24	0.024
Over 10 through 16	22	0.029

For SI: 1 inch = 25.4 mm.

**M1803.3 Installation.** Vent and chimney connectors shall be installed in accordance with the manufacturer's instructions and within the space where the *appliance* is located. *Appliances* shall be located as close as practical to the vent or chimney. Connectors shall be as short and straight as possible and installed with a slope of not less than  $\frac{1}{4}$  inch (6 mm) rise per foot of run. Connectors shall be securely supported and joints shall be fastened with sheet metal screws or rivets. Devices that obstruct the flow of flue gases shall not be installed in a connector unless *listed* and *labeled* or *approved* for such installation.

**M1803.3.1 Floor, ceiling and wall penetrations.** A chimney connector or vent connector shall not pass through any floor or ceiling. A chimney connector or vent connector shall not pass through a wall or partition unless the connector is *listed* and *labeled* for wall pass-through, or is routed through a device *listed* and *labeled* for wall pass-through and is installed in accordance with the conditions of its *listing* and *label*. Connectors for oil-fired *appliances listed* and *labeled* for Type L vents, passing through walls or partitions shall be in accordance with the following:

1. Type L vent material for oil *appliances* shall be installed with not less than *listed* and *labeled* clearances to *combustible material*.
2. Single-wall metal pipe shall be *guarded* by a ventilated metal thimble not less than 4 inches (102 mm) larger in diameter than the vent connector. Not less than 6 inches (152 mm) of clearance shall be maintained between the thimble and combustibles.

**M1803.3.2 Length.** The horizontal run of an uninsulated connector to a natural draft chimney shall not exceed 75 percent of the height of the vertical portion of the chimney above the connector. The horizontal run of a *listed* connector to a natural draft chimney shall not exceed 100 percent of the height of the vertical portion of the chimney above the connector.

**M1803.3.3 Size.** A connector shall not be smaller than the flue collar of the *appliance*.

**Exception:** Where installed in accordance with the *appliance* manufacturer's instructions.

**M1803.3.4 Clearance.** Connectors shall be installed with clearance to combustibles as set forth in Table M1803.3.4. Reduced clearances to *combustible materials* shall be in accordance with Table M1306.2 and Figure M1306.1.

**TABLE M1803.3.4**  
**CHIMNEY AND VENT CONNECTOR**  
**CLEARANCES TO COMBUSTIBLE MATERIALS<sup>a</sup>**

TYPE OF CONNECTOR	MINIMUM CLEARANCE (inches)
Single-wall metal pipe connectors:	
Oil and solid-fuel appliances	18
Oil appliances listed for use with Type L vents	9
Type L vent piping connectors:	
Oil and solid-fuel appliances	9
Oil appliances listed for use with Type L vents	3 <sup>b</sup>

For SI: 1 inch = 25.4 mm.

- a. These minimum clearances apply to unlisted single-wall chimney and vent connectors. Reduction of required clearances is permitted as in Table M1306.2.
- b. Where listed Type L vent piping is used, the clearance shall be in accordance with the vent listing.

**M1803.3.5 Access.** The entire length of a connector shall allow access for inspection, cleaning and replacement.

**M1803.4 Connection to fireplace flue.** Connection of *appliances* to chimney flues serving fireplaces shall comply with Sections M1803.4.1 through M1803.4.4.

**M1803.4.1 Closure and accessibility.** A noncombustible seal shall be provided below the point of connection to prevent entry of room air into the flue. Means shall be provided for access to the flue for inspection and cleaning.

**M1803.4.2 Connection to factory-built fireplace flue.** A different *appliance* shall not be connected to a flue serving a factory-built fireplace unless the *appliance* is specifically *listed* for such an installation. The connection shall be made in compliance with the *appliance* manufacturer's instructions.

**M1803.4.3 Connection to masonry fireplace flue.** A connector shall extend from the *appliance* to the flue serving a masonry fireplace to convey the flue gases directly into the flue. The connector shall be provided with access or shall be removable for inspection and cleaning of both the connector and the flue. *Listed* direct-

connection devices shall be installed in accordance with their *listing*.

**M1803.4.4 Size of flue.** The size of the fireplace flue shall be in accordance with Section M1805.3.1.

## SECTION M1804 VENTS

**M1804.1 Type of vent required.** *Appliances* shall be provided with a *listed* and *labeled* venting system as set forth in Table M1804.1.

**TABLE M1804.1**  
**VENT SELECTION CHART**

VENT TYPES	APPLIANCE TYPES
Type L oil vents	Oil-burning appliances listed and labeled for venting with Type L vents
Pellet vents	Pellet fuel-burning appliances listed and labeled for use with pellet vents

**M1804.2 Termination.** Vent termination shall comply with Sections M1804.2.1 through M1804.2.6.

**M1804.2.1 Through the roof.** Vents passing through a roof shall extend through flashing and terminate in accordance with the manufacturer's installation requirements.

**M1804.2.2 Decorative shrouds.** Decorative shrouds shall not be installed at the termination of vents except where the shrouds are *listed* and *labeled* for use with the specific venting system and are installed in accordance with the manufacturer's instructions.

**M1804.2.3 Natural draft appliances.** Vents for natural draft *appliances* shall terminate not less than 5 feet (1524 mm) above the highest connected *appliance* outlet, and natural draft gas vents serving wall furnaces shall terminate at an elevation not less than 12 feet (3658 mm) above the bottom of the furnace.

**M1804.2.4 Type L vent.** Type L venting systems shall conform to UL 641 and shall terminate with a *listed* and *labeled* cap in accordance with the vent manufacturer's installation instructions not less than 2 feet (610 mm) above the roof and not less than 2 feet (610 mm) above any portion of the building within 10 feet (3048 mm).

**M1804.2.5 Direct vent terminations.** Vent terminals for direct-vent *appliances* shall be installed in accordance with the manufacturer's instructions.

**M1804.2.6 Mechanical draft systems.** *Mechanical draft systems* shall comply with UL 378 and shall be installed in accordance with their *listing*, the manufacturer's instructions and, except for direct-vent *appliances*, the following requirements:

1. The vent terminal shall be located not less than 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm).
2. The vent terminal shall be located not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, window or gravity air inlet into a *dwelling*.

## CHIMNEYS AND VENTS

3. The vent termination point shall be located not closer than 3 feet (914 mm) to an interior corner formed by two walls perpendicular to each other.
4. The bottom of the vent terminal shall be located not less than 12 inches (305 mm) above finished ground level.
5. The vent termination shall not be mounted directly above or within 3 feet (914 mm) horizontally of an oil tank vent or gas meter.
6. Power exhaustor terminations shall be located not less than 10 feet (3048 mm) from *lot lines* and adjacent buildings.
7. The discharge shall be directed away from the building.

**M1804.3 Installation.** Type L and pellet vents shall be installed in accordance with the terms of their *listing* and *label* and the manufacturer's instructions.

### **M1804.3.1 Size of single-appliance venting systems.**

An individual vent for a single *appliance* shall have a cross-sectional area equal to or greater than the area of the connector to the *appliance*, but not less than 7 square inches (4515 mm<sup>2</sup>) except where the vent is an integral part of a *listed* and *labeled appliance*.

**M1804.4 Door swing.** Appliance and *equipment* vent terminals shall be located such that doors cannot swing within 12 inches (305 mm) horizontally of the vent terminals. Door stops or closers shall not be installed to obtain this clearance.

facturer's installation instructions, the cross-sectional area of a flue connected to a solid fuel-burning *appliance* shall be not less than the area of the flue collar or connector, and not larger than three times the area of the flue collar.

## SECTION M1805

### MASONRY AND FACTORY-BUILT CHIMNEYS

**M1805.1 General.** Masonry and factory-built chimneys shall be built and installed in accordance with Sections R1003 and R1005, respectively. Flue lining for masonry chimneys shall comply with Section R1003.11.

**M1805.2 Masonry chimney connection.** A chimney connector shall enter a *masonry chimney* not less than 6 inches (152 mm) above the bottom of the chimney. Where it is not possible to locate the connector entry not less than 6 inches (152 mm) above the bottom of the chimney flue, a cleanout shall be provided by installing a capped tee in the connector next to the chimney. A connector entering a *masonry chimney* shall extend through, but not beyond, the wall and shall be flush with the inner face of the liner. Connectors, or thimbles where used, shall be firmly cemented into the masonry.

**M1805.3 Size of chimney flues.** The effective area of a natural draft chimney flue for one *appliance* shall be not less than the area of the connector to the *appliance*. The area of chimney flues connected to more than one *appliance* shall be not less than the area of the largest connector plus 50 percent of the areas of additional chimney connectors.

**Exception:** Chimney flues serving oil-fired *appliances* sized in accordance with NFPA 31.

**M1805.3.1 Size of chimney flue for solid-fuel appliance.** Except where otherwise specified in the manu-



## CHAPTER 19

# SPECIAL APPLIANCES, EQUIPMENT AND SYSTEMS

### User notes:

**About this chapter:** Chapter 19 is specific to appliances and systems that are not related to HVAC, including cooking appliances, sauna heaters, fuel cells and hydrogen systems. Chapter 24 also applies to cooking appliances and sauna heaters.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M1901 RANGES AND OVENS

**M1901.1 Clearances.** Freestanding or built-in ranges shall have a vertical clearance above the cooking top of not less than 30 inches (762 mm) to unprotected *combustible material*. Reduced clearances are permitted in accordance with the *listing* and *labeling* of the range hoods or ovens with integral exhaust.

**M1901.2 Cooking appliances.** Cooking *appliances* shall be *listed* and *labeled* for household use and shall be installed in accordance with the manufacturer's instructions. The installation shall not interfere with *combustion air* or access for operation and servicing. Electric cooking *appliances* shall comply with UL 858 or UL 1026. Solid-fuel-fired fireplace stoves shall comply with UL 737. Microwave ovens shall comply with UL 923.

### SECTION M1902 SAUNA HEATERS

**M1902.1 Locations and protection.** Sauna heaters shall be protected from accidental contact by persons with a guard of material having a low thermal conductivity, such as wood. The guard shall not have a substantial effect on the transfer of heat from the heater to the room.

**M1902.2 Installation.** Sauna heaters shall be installed in accordance with the manufacturer's instructions. Sauna heaters shall comply with UL 875.

**M1902.3 Combustion air.** *Combustion air* and venting for a nondirect vent-type heater shall be provided in accordance with Chapters 17 and 18, respectively.

**M1902.4 Controls.** Sauna heaters shall be equipped with a thermostat that will limit room temperature to not greater than 194°F (90°C). Where the thermostat is not an integral part of the heater, the heat-sensing element shall be located within 6 inches (152 mm) of the ceiling.

### SECTION M1903 STATIONARY FUEL CELL POWER PLANTS

**M1903.1 General.** Stationary fuel cell power plants having a power output not exceeding 1,000 kW shall comply with ANSI/CSA America FC 1 and shall be installed in accordance with the manufacturer's instructions and NFPA 853.

### SECTION M1904 GASEOUS HYDROGEN SYSTEMS

**M1904.1 Installation.** Gaseous hydrogen systems shall be installed in accordance with the applicable requirements of Sections M1307.4 and M1903.1, the *International Building Code*, the *International Fire Code* and the *International Fuel Gas Code*.





## CHAPTER 20

# BOILERS AND WATER HEATERS

### User notes:

**About this chapter:** Chapter 20 is specific to boilers and water heaters. The provisions of this chapter apply to appliances generally without regard to the energy source. Gas-fired boilers and water heaters are also addressed in Chapter 24; therefore, Chapters 20 and 24 both apply to such appliances.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M2001 BOILERS

**M2001.1 Installation.** In addition to the requirements of this code, the installation of boilers shall conform to the manufacturer's instructions. The manufacturer's rating data, the nameplate and operating instructions of a permanent type shall be attached to the boiler. Boilers shall have their controls set, adjusted and tested by the installer. A complete control diagram together with complete boiler operating instructions shall be furnished by the installer. Solid and liquid fuel-burning boilers shall be provided with *combustion air* as required by Chapter 17.

**M2001.1.1 Standards.** Packaged oil-fired boilers shall be *listed* and *labeled* in accordance with UL 726. Packaged electric boilers shall be *listed* and *labeled* in accordance with UL 834. Solid fuel-fired boilers shall be *listed* and *labeled* in accordance with UL 2523. Boilers shall be designed, constructed and certified in accordance with the *ASME Boiler and Pressure Vessel Code*, Section I or IV. Controls and safety devices for boilers with fuel input ratings of 12,500,000 Btu/hr (3663 kW) or less shall meet the requirements of ASME CSD-1. Gas-fired boilers shall conform to the requirements listed in Chapter 24.

**M2001.2 Clearance.** Boilers shall be installed in accordance with their *listing* and *label*.

**M2001.3 Valves.** Every boiler or modular boiler shall have a shutoff valve in the supply and return piping. For multiple boiler or multiple modular boiler installations, each boiler or modular boiler shall have individual shutoff valves in the supply and return piping.

**Exception:** Shutoff valves are not required in a system having a single low-pressure steam boiler.

**M2001.4 Flood-resistant installation.** In flood hazard areas established in Table R301.2, boilers, water heaters and their control systems shall be located or installed in accordance with Section R322.1.6.

### SECTION M2002 OPERATING AND SAFETY CONTROLS

**M2002.1 Safety controls.** Electrical and mechanical operating and safety controls for boilers shall be *listed* and *labeled*.

**M2002.2 Hot water boiler gauges.** Every hot water boiler shall have a pressure gauge and a temperature gauge, or combination pressure and temperature gauge. The gauges shall indicate the temperature and pressure within the normal range of the system's operation.

**M2002.3 Steam boiler gauges.** Every steam boiler shall have a water-gauge glass and a pressure gauge. The pressure gauge shall indicate the pressure within the normal range of the system's operation. The gauge glass shall be installed so that the midpoint is at the normal water level.

**M2002.4 Pressure relief valve.** Boilers shall be equipped with pressure relief valves with minimum rated capacities for the equipment served. Pressure relief valves shall be set at the maximum rating of the boiler. Discharge shall be piped to drains by gravity to within 18 inches (457 mm) of the floor or to an open receptor.

**M2002.5 Boiler low-water cutoff.** Steam and hot water boilers shall be protected with a low-water cutoff control.

**Exception:** A low-water cutoff is not required for coil-type and water-tube-type boilers that require forced circulation of water through the boiler and that are protected with a flow-sensing control.

**M2002.6 Operation.** Low-water cutoff controls and flow-sensing controls required by Section M2002.5 shall automatically stop the combustion operation of the *appliance* when the water level drops below the lowest safe water level as established by the manufacturer or when the water circulation flow is less than that required for safe operation of the *appliance*, respectively.

### SECTION M2003 EXPANSION TANKS

**M2003.1 General.** Hot water boilers shall be provided with expansion tanks. Nonpressurized expansion tanks shall be securely fastened to the structure or boiler and supported to carry twice the weight of the tank filled with water. Provisions shall be made for draining nonpressurized tanks without emptying the system.

**M2003.1.1 Pressurized expansion tanks.** Pressurized expansion tanks shall be consistent with the volume and capacity of the system. Tanks shall be capable of with-

## BOILERS AND WATER HEATERS

standing a hydrostatic test pressure of two and one-half times the allowable working pressure of the system.

**M2003.2 Minimum capacity.** The minimum capacity of expansion tanks shall be determined from Table M2003.2.

**TABLE M2003.2**  
**EXPANSION TANK MINIMUM CAPACITY<sup>a</sup>**  
**FOR FORCED HOT-WATER SYSTEMS**

SYSTEM VOLUME <sup>b</sup> (gallons)	PRESSURIZED DIAPHRAGM TYPE	NONPRESSURIZED TYPE
10	1.0	1.5
20	1.5	3.0
30	2.5	4.5
40	3.0	6.0
50	4.0	7.5
60	5.0	9.0
70	6.0	10.5
80	6.5	12.0
90	7.5	13.5
100	8.0	15.0

For SI: 1 gallon = 3.785 L, 1 pound per square inch gauge = 6.895 kPa,  
°C = [(°F) – 32]/1.8.

- Based on average water temperature of 195°F, fill pressure of 12 psig and an operating pressure of not greater than 30 psig.
- System volume includes volume of water in boiler, convectors and piping, not including the expansion tank.

### SECTION M2004 WATER HEATERS USED FOR SPACE HEATING

**M2004.1 General.** Water heaters used to supply both potable hot water and hot water for space heating shall be installed in accordance with this chapter, Chapter 24, Chapter 28 and the manufacturer's instructions.

### SECTION M2005 WATER HEATERS

**M2005.1 General.** Water heaters shall be installed in accordance with Chapter 28, the manufacturer's instructions and the requirements of this code. Water heaters installed in an attic shall comply with the requirements of Section M1305.1.2. Gas-fired water heaters shall comply with the requirements in Chapter 24. Domestic electric water heaters shall comply with UL 174. Oiled-fired water heaters shall comply with UL 732. Solar thermal water heating systems shall comply with Chapter 23 and ICC 900/SRCC 300. Solid fuel-fired water heaters shall comply with UL 2523.

**M2005.2 Prohibited locations.** Fuel-fired water heaters shall not be installed in a room used as a storage closet. Water heaters located in a bedroom or bathroom shall be installed in a sealed enclosure so that *combustion air* will not be taken from the living space. Installation of direct-vent water heaters within an enclosure is not required.

**M2005.2.1 Water heater access.** Access to water heaters that are located in an *attic* or underfloor *crawl space* is permitted to be through a closet located in a sleeping

room or bathroom where *ventilation* of those spaces is in accordance with this code.

**M2005.3 Electric water heaters.** Electric water heaters shall be installed in accordance with the applicable provisions of Chapters 34 through 43.

**M2005.4 Supplemental water-heating devices.** Potable water-heating devices that use refrigerant-to-water heat exchangers shall be *approved* and installed in accordance with the manufacturer's instructions.

### SECTION M2006 POOL HEATERS

**M2006.1 General.** Pool and spa heaters shall be installed in accordance with the manufacturer's installation instructions. Oil-fired pool heaters shall comply with UL 726. Electric pool and spa heaters shall comply with UL 1261. Pool and spa heat pump water heaters shall comply with UL 1995, UL/CSA/ANCE 60335-2-40 or CSA C22.2 No. 236.

**Exception:** Portable residential spas and portable residential exercise spas shall comply with UL 1563 or CSA C22.2 No. 218.1.

**M2006.2 Clearances.** The clearances shall not interfere with *combustion air*, draft hood or flue terminal relief, or accessibility for servicing.

**M2006.3 Bypass valves.** Where an integral bypass system is not provided as a part of the pool heater, a bypass line and valve shall be installed between the inlet and outlet piping for use in adjusting the flow of water through the heater.

## CHAPTER 21

# HYDRONIC PIPING

### User notes:

**About this chapter:** Chapter 21 is specific to hydronic piping, which includes steam, hot water and ground-source heat-pump system loop piping. This chapter addresses piping materials, joining methods, support, protection of the structure, testing, protection of potable water and general installation requirements.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M2101

#### HYDRONIC PIPING SYSTEMS INSTALLATION

**M2101.1 General.** Hydronic piping shall conform to Table M2101.1. *Approved* piping, valves, fittings and connections shall be installed in accordance with the manufacturer's instructions. Pipe and fittings shall be rated for use at the operating temperature and pressure of the hydronic system. Used pipe, fittings, valves or other materials shall be free of foreign materials.

**M2101.2 System drain down.** Hydronic piping systems shall be installed to permit draining of the system. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of Chapters 25 through 32 of this code.

**Exception:** The buried portions of systems embedded underground or under floors.

**M2101.3 Protection of potable water.** The potable water system shall be protected from backflow in accordance with the provisions listed in Section P2902.

**M2101.4 Pipe penetrations.** Openings through concrete or masonry building elements shall be sleeved.

**M2101.5 Contact with building material.** A hydronic piping system shall not be in direct contact with any building material that causes the piping material to degrade or corrode.

**M2101.6 Drilling and notching.** Wood-framed structural members shall be drilled, notched or altered in accordance with the provisions of Sections R502.8, R602.6, R602.6.1 and R802.7. Holes in load-bearing members of cold-formed steel *light-frame construction* shall be permitted only in accordance with Sections R505.2.6, R603.2.6 and R804.2.6. In accordance with the provisions of Sections R505.3.5, R603.3.4 and R804.3.3, cutting and notching of flanges and lips of load-bearing members of cold-formed steel *light-frame construction* shall not be permitted. Structural insulated panels (SIPs) shall be drilled and notched or altered in accordance with the provisions of Section R610.7.

**M2101.7 Prohibited tee applications.** Fluid in the supply side of a hydronic system shall not enter a tee fitting through the branch opening.

**M2101.8 Expansion, contraction and settlement.** Piping shall be installed so that piping, connections and *equipment* shall not be subjected to excessive strains or stresses. Provisions shall be made to compensate for expansion, contraction, shrinkage and structural settlement.

**M2101.9 Piping support.** Hangers and supports shall be of material of sufficient strength to support the piping, and shall be fabricated from materials compatible with the piping material. Piping shall be supported at intervals not exceeding the spacing specified in Table M2101.9.

**TABLE M2101.9**  
**HANGER SPACING INTERVALS**

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS	4	10 <sup>a</sup>
CPVC ≤ 1-inch pipe or tubing	3	5 <sup>a</sup>
CPVC ≥ 1 1/4 inches	4	10 <sup>a</sup>
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	6	10
PB pipe or tubing	2.67	4
PE pipe or tubing	2.67	4
PE-RT ≤ 1 inch	2.67	10 <sup>a</sup>
PE-RT ≥ 1 1/4 inches	4	10 <sup>a</sup>
PEX tubing ≤ 1 inch	2.67	4
PEX tubing ≥ 1 1/4 inches	4	10 <sup>a</sup>
PP < 1-inch pipe or tubing	2.67	4
PP > 1 1/4 inches	4	10 <sup>a</sup>
PVC	4	10 <sup>a</sup>
Steel pipe	12	15
Steel tubing	8	10

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

- a. For sizes 2 inches and smaller, a guide shall be installed midway between required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.

## HYDRONIC PIPING

**TABLE M2101.1**  
**HYDRONIC PIPING AND FITTING MATERIALS**

MATERIAL	USE CODE <sup>a</sup>	STANDARD <sup>b</sup>	JOINTS	NOTES
Acrylonitrile butadiene styrene (ABS) plastic pipe	1, 5	ASTM D1527, ASTM F2806, ASTM F2969	Solvent cement joints	—
Chlorinated poly (vinyl chloride) (CPVC) pipe and tubing	1, 2, 3	ASTM D2846	Solvent cement joints, compression joints and threaded adapters	—
Copper and copper-alloy pipe	1	ASTM B42, ASTM B43, ASTM B302	Brazed, soldered and mechanical fittings threaded, welded and flanged	—
Copper and copper-alloy tubing (Type K, L or M)	1, 2	ASME B16.51, ASTM B75, ASTM B88, ASTM B135, ASTM B251, ASTM B306	Brazed, soldered, press-connected and flared mechanical fittings	Joints embedded in concrete shall be brazed
Cross-linked polyethylene (PEX)	1, 2, 3	ASTM F876; ASTM F3253	(See PEX fittings)	Install in accordance with manufacturer's instructions
Cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	1, 2	ASTM F1281 or CAN/CSA B137.10	Mechanical, crimp/insert	Install in accordance with manufacturer's instructions
PEX fittings	—	ASTM F877, ASTM F1807, ASTM F1960, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F3253	Copper crimp/insert fittings, cold expansion fittings, stainless steel clamp, insert fittings	Install in accordance with manufacturer's instructions
Polybutylene (PB) pipe and tubing	1, 2, 3	ASTM D3309	Heat-fusion, crimp/insert and compression	Joints in concrete shall be heat-fused
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	1, 2, 3	ASTM F1282, CSA B137.9	Mechanical, crimp/insert	—
Polypropylene (PP)	1, 2, 3	ISO 15874, ASTM F2389	Heat-fusion joints, mechanical fittings, threaded adapters, compression joints	—
Raised temperature polyethylene (PE-RT)	1, 2, 3	ASTM F2623, ASTM F2769, CSA B137.18	Copper crimp/insert fitting, stainless steel clamp, insert fittings	—
Raised temperature polyethylene (PE-RT) fittings	1, 2, 3	ASTM D3261, ASTM F1807, ASTM F2098, ASTM F2159, ASTM F2735, ASTM F2769, CSA B137.18	Copper crimp/insert fitting, stainless steel clamp, insert fittings	—
Steel pipe	1, 2	ASTM A53, ASTM A106	Brazed, welded, threaded, flanged and mechanical fittings	Joints in concrete shall be welded. Galvanized pipe shall not be welded or brazed.
Steel tubing	1	ASTM A254	Mechanical fittings, welded	—

For SI: °C = [(°F) – 32]/1.8.

a. Use code:

1. Above ground.
2. Embedded in radiant systems.
3. Temperatures below 180°F only.
4. Low-temperature (below 130°F) applications only.
5. Temperatures below 160°F only.

b. Standards as listed in Chapter 44.



**M2101.10 Tests.** Hydronic piping systems shall be tested hydrostatically at a pressure of one and one-half times the maximum system design pressure, but not less than 100 pounds per square inch (689 kPa). The duration of each test shall be not less than 15 minutes.

**Exception:** For PEX piping systems, testing with a compressed gas shall be an alternative to hydrostatic testing where compressed air or other gas pressure testing is specifically authorized by all of the manufacturers' instructions for the PEX pipe and fittings products installed at the time the system is being tested, and compressed air or other gas testing is not otherwise prohibited by applicable codes, laws, or regulations outside of this code.

**M2101.11 Used materials.** Used pipe, fittings, valves and other materials shall not be reused in hydronic systems.

**M2101.12 Material rating.** Pipe and tubing shall be rated for the operating temperature and pressure of the system. Fittings shall be suitable for the pressure applications and recommended by the manufacturer for use with the pipe and tubing material installed. Where used underground, materials shall be suitable for burial.

**M2101.13 Joints and connections.** Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the system. Joints used underground shall be *approved* for such applications.

**M2101.13.1 Joints between different piping materials.** Joints between different piping materials shall be made with *approved* transition fittings.

**M2101.14 Preparation of pipe ends.** Pipe shall be cut square and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall be prepared in accordance with the pipe manufacturer's instructions.

**M2101.15 Joint preparation and installation.** Where required by Sections M2101.16 through M2101.18, the preparation and installation of mechanical and thermoplastic-welded joints shall comply with Sections M2101.15.1 and M2101.15.2.

**M2101.15.1 Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2101.15.2 Thermoplastic-welded joints.** Joint surfaces for thermoplastic-welded joints shall be cleaned by an *approved* procedure. Joints shall be welded in accordance with the manufacturer's instructions.

**M2101.16 CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent cemented in accordance with Section P2906.9.1.2. Threaded joints between fittings and CPVC plastic pipe shall be in accordance with Section M2101.16.1.

**M2101.16.1 Threaded joints.** Threads shall conform to ASME B1.20.1 The pipe shall be Schedule 80, 40 or heavier plastic pipe and shall be threaded with dies specifically designed for plastic pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male

threads only and shall be *approved* for application on the piping material.

**M2101.17 Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall comply with Sections M2101.17.1 and M2101.17.2. Mechanical joints shall comply with Section M2101.15.1.

**M2101.17.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**M2101.17.2 Plastic-to-metal.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to plastic pipe or tubing.

**M2101.18 Polyethylene plastic pipe and tubing.** Joints between polyethylene plastic pipe and tubing or fittings for systems shall be heat-fusion joints complying with Section M2101.18.1, electrofusion joints complying with Section M2101.18.2, or stab-type insertion joints complying with Section M2101.18.3.

**M2101.18.1 Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2101.18.2 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2101.18.3 Stab-type insert fittings.** Joint surfaces shall be clean and free from moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F1924.

**M2101.19 Polypropylene (PP) plastic.** Joints between PP plastic pipe and fittings shall comply with Sections M2101.19.1 and M2101.19.2.

**M2101.19.1 Heat-fusion joints.** Heat-fusion joints for polypropylene (PP) pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, electrofusion polypropylene fittings or by butt fusion. Joint surfaces shall be clean and free from moisture. The joint shall remain undisturbed until cool. Joints shall be made in accordance with ASTM F2389.

**M2101.19.2 Mechanical and compression sleeve joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

**M2101.20 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature poly-

## HYDRONIC PIPING

ethylene tubing and fittings shall comply with Sections M2101.20.1 through M2101.20.4. Mechanical joints shall comply with Section M2101.15.1.

**M2101.20.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**M2101.20.2 PE-RT-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe or tubing.

**M2101.20.3 Heat-fusion joints.** Heat-fusion joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and shall be joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2101.20.4 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2101.21 PVC plastic pipe.** Joints between PVC plastic pipe or fittings shall be solvent cemented in accordance with Section P2906.9.1.4. Threaded joints between fittings and PVC plastic pipe shall be in accordance with Section M2101.16.1.

**M2101.22 Shutoff valves.** Shutoff valves shall be installed in ground-source loop piping systems in the locations indicated in Sections M2101.22.1 through M2101.22.6.

**M2101.22.1 Heat exchangers.** Shutoff valves shall be installed on the supply and return sides of a heat exchanger.

**Exception:** Shutoff valves shall not be required where heat exchangers are integral with a boiler or are a component of a manufacturer's boiler and heat exchanger packaged unit and are capable of being isolated from the hydronic system by the supply and return valves required by Section M2001.3.

**M2101.22.2 Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**M2101.22.3 Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

**M2101.22.4 Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**M2101.22.5 Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical equipment and *appliances*. This requirement does not apply to components of ground-source loop systems such as

pumps, air separators, metering devices, and similar equipment.

**M2101.22.6 Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**M2101.23 Reduced pressure.** A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section M2002.

**M2101.24 Installation.** Piping, valves, fittings and connections shall be installed in accordance with the manufacturer's instructions.

**M2101.25 Protection of potable water.** Where hydronic systems have a connection to a potable water supply, the potable water system shall be protected from backflow in accordance with Section P2902.

**M2101.26 Pipe penetrations.** Openings for pipe penetrations in walls, floors and ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with Section P2606.1.

**M2101.27 Clearance from combustibles.** A pipe in a piping system having an exterior surface temperature exceeding 250°F (121°C) shall have a clearance of not less than 1 inch (25 mm) from *combustible materials*.

**M2101.28 Contact with building material.** A piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interfere with the operation of the system.

**M2101.29 Strains and stresses.** Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

**M2101.29.1 Flood hazard.** Piping located in a flood hazard area shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation.

**M2101.30 Chemical compatibility.** Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings and mechanical systems.

**M2101.31 Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

## SECTION M2102 BASEBOARD CONVECTORS

**M2102.1 General.** Baseboard convectors shall be installed in accordance with the manufacturer's instructions. Convectors shall be supported independently of the hydronic piping.

## SECTION M2103 FLOOR HEATING SYSTEMS

**M2103.1 Piping materials.** Piping for embedment in concrete or gypsum materials shall be standard-weight steel pipe, copper and copper-alloy pipe and tubing, cross-linked polyethylene/aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe, chlorinated polyvinyl chloride (CPVC), cross-linked polyethylene (PEX) tubing, polyethylene of raised temperature (PE-RT) or polypropylene (PP) with a rating of not less than 80 pounds per square inch at 180°F (552 kPa at 82°C).

**M2103.2 Thermal barrier required.** Radiant floor heating systems shall have a thermal barrier in accordance with Sections M2103.2.1 and M2103.2.2. Insulation *R*-values for slab-on-grade and suspended floor installations shall be in accordance with Chapter 11.

**Exception:** Insulation shall not be required in engineered systems where it can be demonstrated that the insulation will decrease the efficiency or have a negative effect on the installation.

**M2103.2.1 Thermal break required.** A thermal break consisting of asphalt expansion joint materials or similar insulating materials shall be provided at a point where a heated slab meets a foundation wall or other conductive slab.

**M2103.2.2 Thermal barrier material marking.** Insulating materials used in thermal barriers shall be installed so that the manufacturer's *R*-value mark is readily observable upon inspection.

**M2103.3 Piping joints.** Copper and copper-alloy systems shall be soldered, brazed, or press connected. Soldering shall be in accordance with ASTM B828. Fluxes for soldering shall be in accordance with ASTM B813. Brazing fluxes shall be in accordance with AWS A5.31. Press-connect joints shall be in accordance with ASME B16.51. Piping joints that are embedded shall be installed in accordance with the following requirements:

1. Steel pipe joints shall be welded.
2. Copper tubing shall be joined by brazing complying with Section P3003.6.1.
3. Polybutylene pipe and tubing joints shall be installed with socket-type heat-fused polybutylene fittings.
4. CPVC tubing shall be joined using solvent cement joints.
5. Polypropylene pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings.
6. Cross-linked polyethylene (PEX) tubing shall be joined using cold expansion, insert or compression fittings.
7. Raised temperature polyethylene (PE-RT) tubing shall be joined using insert or compression fittings.

**M2103.4 Testing.** Piping or tubing to be embedded shall be tested by applying a hydrostatic pressure of not less than 100

psi (690 kPa). The pressure shall be maintained for 30 minutes, during which the joints shall be visually inspected for leaks.

## SECTION M2104 LOW TEMPERATURE PIPING

**M2104.1 Piping materials.** Low temperature piping for embedment in concrete or gypsum materials shall be as indicated in Table M2101.1.

**M2104.2 Piping joints.** Piping joints that are embedded, other than those in Section M2103.3, shall comply with the following requirements:

1. Cross-linked polyethylene (PEX) tubing shall be installed in accordance with the manufacturer's instructions.
2. Polyethylene tubing shall be installed with heat-fusion joints.
3. Polypropylene (PP) tubing shall be installed in accordance with the manufacturer's instructions.
4. Raised temperature polyethylene (PE-RT) shall be installed in accordance with the manufacturer's instructions.

**M2104.3 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature polyethylene tubing and fittings shall conform to Sections M2104.3.1 through M2104.3.3. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2104.3.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting such inserts and ferrules or O-rings.

**M2104.3.2 PE-RT-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe.

**M2104.3.3 PE-RT insert fittings.** PE-RT insert fittings shall be installed in accordance with the manufacturer's instructions.

**M2104.4 Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe.** Joints between polyethylene/aluminum/polyethylene pressure pipe and fittings shall conform to Sections M2104.4.1 and M2104.4.2. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**M2104.4.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting such inserts and ferrules or O-rings.

**M2104.4.2 PE-AL-PE-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-AL-PE pipe.

## HYDRONIC PIPING

### SECTION M2105 GROUND-SOURCE HEAT-PUMP SYSTEM LOOP PIPING

**M2105.1 Plastic ground-source heat-pump loop piping.** Plastic piping and tubing material used in water-based ground-source heat-pump ground-loop systems shall conform to the standards specified in this section.

**M2105.2 Used materials.** Reused pipe, fittings, valves, and other materials shall not be used in ground-source heat-pump loop systems.

**M2105.3 Material rating.** Pipe and tubing shall be rated for the operating temperature and pressure of the ground-source heat-pump loop system. Fittings shall be suitable for the pressure applications and recommended by the manufacturer for installation with the pipe and tubing material installed. Where used underground, materials shall be suitable for burial.

**M2105.4 Piping and tubing materials standards.** Ground-source heat-pump ground-loop pipe and tubing shall conform to the standards listed in Table M2105.4.

**M2105.5 Fittings.** Ground-source heat-pump pipe fittings shall be *approved* for installation with the piping materials to be installed, shall conform to the standards listed in Table

M2105.5 and, where installed underground, shall be suitable for burial.

**M2105.6 Joints and connections.** Joints and connections shall be of an *approved* type. Joints and connections shall be tight for the pressure of the ground-source loop system. Joints used underground shall be *approved* for such applications.

**M2105.6.1 Joints between different piping materials.** Joints between different piping materials shall be made with *approved* transition fittings.

**M2105.7 Preparation of pipe ends.** Pipe shall be cut square and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall be prepared in accordance with the pipe manufacturer's instructions.

**M2105.8 Joint preparation and installation.** Where required by Sections M2105.9 through M2105.11, the preparation and installation of mechanical and thermoplastic-welded joints shall comply with Sections M2105.8.1 and M2105.8.2.

**M2105.8.1 Mechanical joints.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

**TABLE M2105.4  
GROUND-SOURCE LOOP PIPE**

MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC)	ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F441; ASTM F442; CSA B137.6
Cross-linked polyethylene (PEX)	ASTM F876; CSA B137.5; ANSI/CSA/IGSHPA C448; NSF 358-3
High-density polyethylene (HDPE)	ASTM D2737; ASTM D3035; ASTM F714; AWWA C901; CSA B137.1; ANSI/CSA/IGSHPA C448; NSF 358-1
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	ASTM F1282; AWWA C903; CSA B137.9
Polypropylene (PP-R)	ASTM F2389; CSA B137.11; NSF 358-2
Polyvinyl chloride (PVC)	ASTM D1785; ASTM D2241; CSA B137.3
Raised temperature polyethylene (PE-RT)	ASTM F2623; ASTM F2769; CSA B137.18; ANSI/CSA/IGSHPA C448; NSF 358-4

**TABLE M2105.5  
GROUND-SOURCE LOOP PIPE FITTINGS**

PIPE MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC)	ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F1970; CSA B137.6
Cross-linked polyethylene (PEX)	ASTM F877; ASTM F1807; ASTM F1960; ASTM F2080; ASTM F2159; ASTM F2434; CSA B137.5; ANSI/CSA/IGSHPA C448; NSF 358-3
High-density polyethylene (HDPE)	ASTM D2683; ASTM D3261; ASTM F1055; CSA B137.1; ANSI/CSA/IGSHPA C448; NSF 358-1
Polyethylene/aluminum/polyethylene (PE-AL-PE)	ASTM F1282; ASTM F2434; CSA B137.9
Polypropylene (PP-R)	ASTM F2389; CSA B137.11; NSF 358-2
Polyvinyl chloride (PVC)	ASTM D2464; ASTM D2466; ASTM D2467; ASTM F1970; CSA B137.2; CSA B137.3
Raised temperature polyethylene (PE-RT)	ASTM D2683; ASTM D3261; ASTM F1055; ASTM F1807; ASTM F2098; ASTM F2159; ASTM F2735; ASTM F2769; CSA B137.1; CSA B137.18; ANSI/CSA/IGSHPA C448; NSF 358-4



**M2105.8.2 Thermoplastic-welded joints.** Joint surfaces for thermoplastic-welded joints shall be cleaned by an *approved* procedure. Joints shall be welded in accordance with the manufacturer's instructions.

**M2105.9 CPVC plastic pipe.** Joints between CPVC plastic pipe or fittings shall be solvent-cemented in accordance with Section P2906.9.1.2. Threaded joints between fittings and CPVC plastic pipe shall be in accordance with Section M2105.9.1.

**M2105.9.1 Threaded joints.** Threads shall conform to ASME B1.20.1. The pipe shall be Schedule 80 or heavier plastic pipe and shall be threaded with dies specifically designed for plastic pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male threads only and shall be *approved* for application on the piping material.

**M2105.10 Cross-linked polyethylene (PEX) plastic tubing.** Joints between cross-linked polyethylene plastic tubing and fittings shall comply with Sections M2105.10.1 and M2105.10.2. Mechanical joints shall comply with Section M2105.8.1.

**M2105.10.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**M2105.10.2 Plastic-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to plastic pipe or tubing.

**M2105.11 Polyethylene plastic pipe and tubing.** Joints between polyethylene plastic pipe and tubing or fittings for ground-source heat-pump loop systems shall be heat-fusion joints complying with Section M2105.11.1, electrofusion joints complying with Section M2105.11.2, or stab-type insertion joints complying with Section M2105.11.3.

**M2105.11.1 Heat-fusion joints.** Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2105.11.2 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2105.11.3 Stab-type insert fittings.** Joint surfaces shall be clean and free from moisture. Pipe ends shall be chamfered and inserted into the fittings to full depth. Fittings shall be manufactured in accordance with ASTM F1924.

**M2105.12 Polypropylene (PP) plastic.** Joints between PP plastic pipe and fittings shall comply with Sections M2105.12.1 and M2105.12.2.

**M2105.12.1 Heat-fusion joints.** Heat-fusion joints for polypropylene (PP) pipe and tubing joints shall be installed with socket-type heat-fused polypropylene fittings, electrofusion polypropylene fittings or by butt fusion. Joint surfaces shall be clean and free from moisture. The joint shall remain undisturbed until cool. Joints shall be made in accordance with ASTM F2389.

**M2105.12.2 Mechanical and compression sleeve joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

**M2105.13 Raised temperature polyethylene (PE-RT) plastic tubing.** Joints between raised temperature polyethylene tubing and fittings shall comply with Sections M2105.13.1 through M2105.13.4. Mechanical joints shall comply with Section M2105.8.1.

**M2105.13.1 Compression-type fittings.** Where compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

**M2105.13.2 PE-RT-to-metal connections.** Solder joints in a metal pipe shall not occur within 18 inches (457 mm) of a transition from such metal pipe to PE-RT pipe or tubing.

**M2105.13.3 Heat-fusion joints.** Heat-fusion joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, and shall be joined in accordance with ASTM D2657. Joint surfaces shall be clean and free from moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D2683 or ASTM D3261.

**M2105.13.4 Electrofusion joints.** Joints shall be of the electrofusion type. Joint surfaces shall be clean and free from moisture and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer and joined. The joint shall remain undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F1055.

**M2105.14 PVC plastic pipe.** Joints between PVC plastic pipe or fittings shall be solvent-cemented in accordance with Section P2906.9.1.4. Threaded joints between fittings and PVC plastic pipe shall be in accordance with Section M2105.9.1.

**M2105.15 Shutoff valves.** Shutoff valves shall be installed in ground-source loop piping systems in the locations indicated in Sections M2105.15.1 through M2105.15.6.

**M2105.15.1 Heat exchangers.** Shutoff valves shall be installed on the supply and return side of a heat exchanger.

**Exception:** Shutoff valves shall not be required where heat exchangers are integral with a boiler or are a component of a manufacturer's boiler and heat exchanger packaged unit and are capable of being isolated from the hydronic system by the supply and return valves required by Section M2001.3.



## HYDRONIC PIPING

**M2105.15.2 Central systems.** Shutoff valves shall be installed on the building supply and return of a central utility system.

**M2105.15.3 Pressure vessels.** Shutoff valves shall be installed on the connection to any pressure vessel.

**M2105.15.4 Pressure-reducing valves.** Shutoff valves shall be installed on both sides of a pressure-reducing valve.

**M2105.15.5 Equipment and appliances.** Shutoff valves shall be installed on connections to mechanical equipment and *appliances*. This requirement does not apply to components of ground-source loop systems such as pumps, air separators, metering devices, and similar equipment.

**M2105.15.6 Expansion tanks.** Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

**M2105.16 Reduced pressure.** A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section M2002.

**M2105.17 Installation.** Piping, valves, fittings, and connections shall be installed in accordance with the manufacturer's instructions.

**M2105.18 Protection of potable water.** Where ground-source heat-pump ground-loop systems have a connection to a potable water supply, the potable water system shall be protected from backflow in accordance with Section P2902.

**M2105.19 Pipe penetrations.** Openings for pipe penetrations in walls, floors and ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with Section P2606.1.

**M2105.20 Clearance from combustibles.** A pipe in a ground-source heat pump piping system having an exterior surface temperature exceeding 250°F (121°C) shall have a clearance of not less than 1 inch (25 mm) from *combustible materials*.

**M2105.21 Contact with building material.** A ground-source heat-pump ground-loop piping system shall not be in direct contact with building materials that cause the piping or fitting material to degrade or corrode, or that interfere with the operation of the system.

**M2105.22 Strains and stresses.** Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

**M2105.22.1 Flood hazard.** Piping located in a flood hazard area shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of

buoyancy, during the occurrence of flooding to the *design flood elevation*.

**M2105.23 Pipe support.** Pipe shall be supported in accordance with Section M2101.9.

**M2105.24 Velocities.** Ground-source heat-pump ground-loop systems shall be designed so that the flow velocities do not exceed the maximum flow velocity recommended by the pipe and fittings manufacturer. Flow velocities shall be controlled to reduce the possibility of water hammer.

**M2105.25 Labeling and marking.** Ground-source heat-pump ground-loop system piping shall be marked with tape, metal tags or other methods where it enters a building. The marking shall state the following words: "GROUND-SOURCE HEAT-PUMP LOOP SYSTEM." The marking shall indicate if antifreeze is used in the system and shall indicate the chemicals by name and concentration.

**M2105.26 Chemical compatibility.** Antifreeze and other materials used in the system shall be chemically compatible with the pipe, tubing, fittings and mechanical systems.

**M2105.27 Makeup water.** The transfer fluid shall be compatible with the makeup water supplied to the system.

**M2105.28 Testing.** Before connection header trenches are backfilled, the assembled loop system shall be pressure tested with water at 100 psi (689 kPa) for 15 minutes without observed leaks. Flow and pressure loss testing shall be performed and the actual flow rates and pressure drops shall be compared to the calculated design values. If actual flow rate or pressure drop values differ from calculated design values by more than 10 percent, the cause shall be identified and corrective action taken.

**M2105.29 Embedded piping.** Ground-source heat-pump ground-loop piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

## CHAPTER 22

# SPECIAL PIPING AND STORAGE SYSTEMS

### User notes:

**About this chapter:** Chapter 22 addresses fuel oil piping and storage related to oil-fired heating appliances. Materials, joining methods, tanks, pumps, valves and installation of such are covered.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M2201 OIL TANKS

**M2201.1 Materials.** Supply tanks shall be *listed* and *labeled* and shall conform to UL 58 for underground tanks and UL 80 for indoor tanks.

**M2201.2 Above-ground tanks.** The maximum amount of fuel oil stored above ground or inside of a building shall be 660 gallons (2498 L). The supply tank shall be supported on rigid noncombustible supports to prevent settling or shifting.

**Exception:** The storage of fuel oil, used for space or water heating, above ground or inside buildings in quantities exceeding 660 gallons (2498 L) shall comply with NFPA 31.

**M2201.2.1 Tanks within buildings.** Supply tanks for use inside of buildings shall be of such size and shape to permit installation and removal from *dwelling*s as whole units. Supply tanks larger than 10 gallons (38 L) shall be placed not less than 5 feet (1524 mm) from any fire or flame either within or external to any fuel-burning *appliance*.

**M2201.2.2 Outdoor above-ground tanks.** Tanks installed outdoors, above ground shall be not less than 5 feet (1524 mm) from an adjoining property line. Such tanks shall be suitably protected from the weather and from physical damage.

**M2201.3 Underground tanks.** Excavations for underground tanks shall not undermine the foundations of existing structures. The clearance from the tank to the nearest wall of a *basement*, pit or property line shall be not less than 1 foot (305 mm). Tanks shall be set on and surrounded with noncorrosive inert materials such as clean earth, sand or gravel well-tamped in place. Tanks shall be covered with not less than 1 foot (305 mm) of earth. Corrosion protection shall be provided in accordance with Section M2203.7.

**M2201.4 Multiple tanks.** Cross connection of two supply tanks shall be permitted in accordance with Section M2203.6.

**M2201.5 Oil gauges.** Inside tanks shall be provided with a device to indicate when the oil in the tank has reached a predetermined safe level. Glass gauges or a gauge subject to breakage that could result in the escape of oil from the tank shall not be used. Liquid-level indicating gauges shall comply with UL 180.

**M2201.6 Flood-resistant installation.** In flood hazard areas as established by Table R301.2, tanks shall be installed in accordance with Section R322.2.4 or R322.3.10.

**M2201.7 Tanks abandoned or removed.** Outdoor above-grade fill piping shall be removed when tanks are abandoned or removed. Tank abandonment and removal shall be in accordance with the *International Fire Code*.

### SECTION M2202 OIL PIPING, FITTING AND CONNECTIONS

**M2202.1 Materials.** Piping shall consist of steel pipe, copper and copper-alloy pipe and tubing, steel tubing conforming to ASTM A539, or stainless steel tubing conforming to ASTM A254 or ASTM A269. Aluminum tubing shall not be used between the fuel-oil tank and the burner units.

**M2202.2 Joints and fittings.** Piping shall be connected with fittings compatible with the piping material. Cast-iron fittings shall not be used for oil piping. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point less than 1,000°F (538°C) shall not be used for oil piping. Threaded joints and connections shall be made tight with a lubricant or pipe thread compound.

**M2202.3 Flexible connectors.** Flexible metallic hoses shall be *listed* and *labeled* in accordance with UL 536 and shall be installed in accordance with their *listing* and *labeling* and the manufacturer's installation instructions. Connectors made from *combustible materials* shall not be used inside of buildings or above ground outside of buildings.

### SECTION M2203 INSTALLATION

**M2203.1 General.** Piping shall be installed in a manner to avoid placing stresses on the piping, and to accommodate expansion and contraction of the piping system.

**M2203.2 Supply piping.** Supply piping used in the installation of oil burners and *appliances* shall be not smaller than  $\frac{3}{8}$ -inch (9 mm) pipe or  $\frac{3}{8}$ -inch (9 mm) outside diameter tubing. Copper tubing and fittings shall be Type L or heavier.

## SPECIAL PIPING AND STORAGE SYSTEMS

**M2203.3 Fill piping.** Fill piping shall terminate outside of buildings at a point not less than 2 feet (610 mm) from any building opening at the same or lower level. Fill openings shall be equipped with a tight metal cover.

**M2203.4 Vent piping.** Vent piping shall be not smaller than 1 $\frac{1}{4}$ -inch (32 mm) pipe. Vent piping shall be laid to drain toward the tank without sags or traps in which the liquid can collect. Vent pipes shall not be cross connected with fill pipes, lines from burners or overflow lines from auxiliary tanks. The lower end of a vent pipe shall enter the tank through the top and shall extend into the tank not more than 1 inch (25 mm).

**M2203.5 Vent termination.** Vent piping shall terminate outside of buildings at a point not less than 2 feet (610 mm), measured vertically or horizontally, from any building opening. Outer ends of vent piping shall terminate in a weather-proof cap or fitting having an unobstructed area equal to or greater than the cross-sectional area of the vent pipe, and shall be located sufficiently above the ground to avoid being obstructed by snow and ice.

**M2203.6 Cross connection of tanks.** Cross connection of two supply tanks, not exceeding 660 gallons (2498 L) aggregate capacity, with gravity flow from one tank to another, shall be acceptable providing that the two tanks are on the same horizontal plane.

**M2203.7 Corrosion protection.** Underground tanks and buried piping shall be protected by corrosion-resistant coatings or special alloys or fiberglass-reinforced plastic.

## SECTION M2204 OIL PUMPS AND VALVES

**M2204.1 Pumps.** Oil pumps shall be positive displacement types that automatically shut off the oil supply when stopped. Automatic pumps shall be *listed* and *labeled* in accordance with UL 343 and shall be installed in accordance with their *listing*.

**M2204.2 Shutoff valves.** A manual shutoff valve shall be installed between the oil supply tank and the burner. Such valve shall be provided with *ready access*. Where the shutoff valve is installed in the discharge line of an oil pump, a pressure relief valve shall be incorporated to bypass or return surplus oil. Valves shall comply with UL 842.

**M2204.3 Maximum pressure.** Pressure at the oil supply inlet to an *appliance* shall be not greater than 3 pounds per square inch (20.7 kPa).

**M2204.4 Relief valves.** Fuel-oil lines incorporating heaters shall be provided with relief valves that will discharge to a return line when excess pressure exists.

## CHAPTER 23

# SOLAR THERMAL ENERGY SYSTEMS

### User notes:

**About this chapter:** Chapter 23 is specific to thermal solar systems and equipment. Solar voltaic systems are not addressed in this chapter. This chapter covers solar collectors, system design, safety devices, relief valves, freeze protection, expansion tanks, signage, labeling, heat transfer fluids, protection of potable water and potable water heating.

**Code development reminder:** Code change proposals to this chapter will be considered by the IRC—Plumbing/Mechanical Code Development Committee during the 2021 (Group A) Code Development Cycle.

### SECTION M2301

#### SOLAR THERMAL ENERGY SYSTEMS

**M2301.1 General.** This section provides for the design, construction, installation, *alteration* and *repair* of equipment and systems using solar thermal energy to provide space heating or cooling, hot water heating and swimming pool heating.

**M2301.2 Design and installation.** The design and installation of solar thermal energy systems shall comply with Sections M2301.2.1 through M2301.2.13.

**M2301.2.1 Access.** Access shall be provided to solar energy equipment for maintenance. Solar systems and appurtenances shall not obstruct or interfere with the operation of any doors, windows or other building components requiring operation or access. Roof-mounted solar thermal equipment shall not obstruct or interfere with the operation of roof-mounted equipment, *appliances*, chimneys, plumbing vents, roof hatches, smoke vents, skylights and other roof penetrations and openings.

**M2301.2.2 Collectors and panels.** Solar collectors and panels shall comply with Sections M2301.2.2.1 and M2301.2.2.2.

**M2301.2.2.1 Roof-mounted collectors.** The roof shall be constructed to support the loads imposed by roof-mounted solar collectors. Roof-mounted solar collectors that serve as a roof covering shall conform to the requirements for roof coverings in Chapter 9 of this code. Where mounted on or above the roof coverings, the collectors and supporting structure shall be constructed of *noncombustible materials* or fire-retardant-treated wood equivalent to that required for the roof construction.

**M2301.2.2.2 Collector sensors.** Collector sensor installation, sensor location and the protection of exposed sensor wires from degradation shall be in accordance with ICC 900/SRCC 300.

**M2301.2.3 Pressure and temperature relief valves and system components.** System components containing fluids shall be protected with temperature and pressure relief valves or pressure relief valves. Relief devices shall be installed in sections of the system so that a section cannot be valved off or isolated from a relief device. Direct systems and the potable water portion of indirect

systems shall be equipped with a relief valve in accordance with Section P2804. For indirect systems, pressure relief valves in solar loops shall comply with ICC 900/SRCC 300. System components shall have a working pressure rating of not less than the setting of the pressure relief device.

**M2301.2.4 Vacuum relief.** System components that might be subjected to a vacuum during operation or shutdown shall be designed to withstand such a vacuum or shall be protected with vacuum relief valves.

**M2301.2.5 Piping insulation.** Piping shall be insulated in accordance with the requirements of Chapter 11. Exterior insulation shall be protected from ultraviolet degradation. The entire solar loop shall be insulated. Where split-style insulation is used, the seam shall be sealed. Fittings shall be fully insulated.

#### Exceptions:

1. Those portions of the piping that are used to help prevent the system from overheating shall not be required to be insulated.
2. Those portions of piping that are exposed to solar radiation, made of the same material as the solar collector absorber plate and are covered in the same manner as the solar collector absorber, or that are used to collect additional solar energy, shall not be required to be insulated.
3. Piping in thermal solar systems using unglazed solar collectors to heat a swimming pool shall not be required to be insulated.

**M2301.2.6 Protection from freezing.** System components shall be protected from damage resulting from freezing of heat-transfer liquids at the winter design temperature provided in Table R301.2. Freeze protection shall be provided in accordance with ICC 900/SRCC 300. Drain-back systems shall be installed in compliance with Section M2301.2.6.1. Systems utilizing freeze-protection valves shall comply with Section M2301.2.6.2.

**Exception:** Where the 97.5-percent winter design temperature is greater than or equal to 48°F (9°C).

**M2301.2.6.1 Drain-back systems.** Drain-back systems shall be designed and installed to allow for



## SOLAR THERMAL ENERGY SYSTEMS

manual gravity draining of fluids from areas subject to freezing to locations not subject to freezing, and air filling of the components and piping. Such piping and components shall maintain a horizontal slope in the direction of flow of not less than  $\frac{1}{4}$  unit vertical in 12 units horizontal (2-percent slope). Piping and components subject to manual gravity draining shall permit subsequent air filling upon drainage and air venting upon refilling.

**M2301.2.6.2 Freeze-protection valves.** Freeze-protection valves shall discharge in a manner that does not create a hazard or structural damage.

**M2301.2.7 Storage tank sensors.** Storage tank sensors shall comply with ICC 900/SRCC 300.

**M2301.2.8 Expansion tanks.** Expansion tanks in *solar energy systems* shall be installed in accordance with Section M2003 in solar collector loops that contain pressurized heat transfer fluid. Where expansion tanks are used, the system shall be designed in accordance with ICC 900/SRCC 300 to provide an expansion tank that is sized to withstand the maximum operating pressure of the system.

**Exception:** Expansion tanks shall not be required in the collector loop of *drain-back systems*.

**M2301.2.9 Roof and wall penetrations.** Roof and wall penetrations shall be flashed and sealed in accordance with Chapter 9 to prevent entry of water, rodents and insects.

**M2301.2.10 Description and warning labels.** Solar thermal systems shall comply with description *label* and warning *label* requirements of Section M2301.2.11.2 and ICC 900/SRCC 300.

**M2301.2.11 Solar loop.** Solar loops shall be in accordance with Sections M2301.2.11.1 and M2301.2.11.2.

**M2301.2.11.1 Solar loop isolation.** Valves shall be installed to allow the solar loop to be isolated from the remainder of the system.

**M2301.2.11.2 Drain and fill valve labels and caps.** Drain and fill valves shall be *labeled* with a description and warning that identifies the fluid in the solar loop and a warning that the fluid might be discharged at high temperature and pressure. Drain caps shall be installed at drain and fill valves.

**M2301.2.12 Maximum temperature limitation.** Systems shall be equipped with means to limit the maximum water temperature of the system fluid entering or exchanging heat with any pressurized vessel inside the *dwelling* to 180°F (82°C). This protection is in addition to the required temperature and pressure relief valves required by Section M2301.2.3.

**M2301.2.13 Thermal storage unit seismic bracing.** In Seismic Design Categories  $D_0$ ,  $D_1$  and  $D_2$  and in townhouses in Seismic Design Category C, thermal storage units shall be anchored in accordance with Section M1307.2.

**M2301.3 Labeling.** *Labeling* shall comply with Sections M2301.3.1 and M2301.3.2.

**M2301.3.1 Collectors and panels.** Solar thermal collectors and panels shall be *listed* and *labeled* in accordance with ICC 901/SRCC 100. Factory-built collectors shall bear a *label* indicating the manufacturer's name, model number and serial number.

**M2301.3.2 Thermal storage units.** Pressurized water storage tanks shall bear a *label* indicating the manufacturer's name and address, model number, serial number, storage unit maximum and minimum allowable operating temperatures and storage unit maximum and minimum allowable operating pressures. The *label* shall clarify that these specifications apply only to the water storage tanks.

**M2301.4 Heat transfer gases or liquids and heat exchangers.** *Essentially toxic transfer fluids*, ethylene glycol, flammable gases and flammable liquids shall not be used as heat transfer fluids. Heat transfer gases and liquids shall be rated to withstand the system's maximum design temperature under operating conditions without degradation. Heat exchangers used in solar thermal systems shall comply with Section P2902.5.2 and ICC 900/SRCC 300.

Heat transfer fluids shall be in accordance with ICC 900/SRCC 300. The flash point of the heat transfer fluids utilized in solar thermal systems shall be not less than 50°F (28°C) above the design maximum nonoperating or no-flow temperature attained by the fluid in the collector.

**M2301.5 Backflow protection.** Connections from the potable water supply to solar systems shall comply with Section P2902.5.5.

**M2301.6 Filtering.** Air provided to *occupied spaces* that passes through thermal mass storage systems by mechanical means shall be filtered for particulates at the outlet of the thermal mass storage system.

**M2301.7 Solar thermal systems for heating potable water.** Where a solar thermal system heats potable water to supply a potable hot water distribution system, the solar thermal system shall be in accordance with Sections M2301.7.1, M2301.7.2 and P2902.5.5.

**M2301.7.1 Indirect systems.** Heat exchangers that are components of indirect solar thermal heating systems shall comply with Section P2902.5.2.

**M2301.7.2 Direct systems.** Where potable water is directly heated by a solar thermal system, the pipe, fittings, valves and other components that are in contact with the potable water in the solar heating system shall comply with the requirements of Chapter 29.



## ***Part VI—Fuel Gas***

### **CHAPTER 24 FUEL GAS**

*Delete Chapter and refer to Arkansas Fuel Gas Code.*





## ***Part VII—Plumbing***

### **CHAPTER 25**

## **PLUMBING ADMINISTRATION**

*Delete Chapter and refer to Arkansas Plumbing Code.*





## CHAPTER 26

# GENERAL PLUMBING REQUIREMENTS

*Delete Chapter and refer to Arkansas Plumbing Code.*







## CHAPTER 27

# PLUMBING FIXTURES

*Delete Chapter and refer to Arkansas Plumbing Code.*





## CHAPTER 28

# WATER HEATERS

*Delete Chapter and refer to Arkansas Plumbing Code.*







## CHAPTER 29

# WATER SUPPLY AND DISTRIBUTION

*Delete Chapter and refer to Arkansas Plumbing Code.*





## CHAPTER 30

# SANITARY DRAINAGE

*Delete Chapter and refer to Arkansas Plumbing Code.*





## CHAPTER 31

# VENTS

*Delete Chapter and refer to Arkansas Plumbing Code.*







## CHAPTER 32

# TRAPS

*Delete Chapter and refer to Arkansas Plumbing Code.*





## CHAPTER 33

# STORM DRAINAGE

*Delete Chapter and refer to Arkansas Plumbing Code.*







## ***Part VIII—Electrical***

### **CHAPTER 34**

## **GENERAL REQUIREMENTS**

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★



## CHAPTER 35

# ELECTRICAL DEFINITIONS

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★



## CHAPTER 36

# SERVICES

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★





## CHAPTER 37

# BRANCH CIRCUIT AND FEEDER REQUIREMENTS

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★



## CHAPTER 38

# WIRING METHODS

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★





## CHAPTER 39

# POWER AND LIGHTING DISTRIBUTION

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*





## CHAPTER 40

# DEVICES AND LUMINAIRES

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*





## CHAPTER 41

# APPLIANCE INSTALLATION

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★

★





## CHAPTER 42

# SWIMMING POOLS

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*





**CHAPTER 43**

**CLASS 2 REMOTE-CONTROL,  
SIGNALING AND POWER-LIMITED CIRCUITS**

*Delete Chapter and refer to the National Electrical Code of the  
National Fire Protection Association as adopted by the Arkansas Board of Electrical Examiners.*

★  
★





# Part IX—Referenced Standards

## CHAPTER 44 REFERENCED STANDARDS

---

### User notes:

**About this chapter:** The one- and two-family dwelling code contains numerous references to standards promulgated by other organizations that are used to provide requirements for materials, products and methods of construction. Chapter 44 contains a comprehensive list of all standards that are referenced in this code. These standards, in essence, are part of this code to the extent of the reference to the standard.

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section R102.4.

---

### AAMA

American Architectural Manufacturers Association  
1900 E. Golf Road, Suite 1250  
Schaumburg, IL 60173

#### 450—20: Performance Rating Method for Mulled Combination Assemblies, Composite Units, and Other Mulled Fenestration Systems

R609.8

#### 506—16: Voluntary Specifications for Impact and Cycle Testing of Fenestration Products

R609.6.1

#### 711—20: Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products

R703.4

#### 712—14: Voluntary Specification for Mechanically Attached Flexible Flashing

R703.4

#### 714—19: Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal around Exterior Wall Openings in Buildings

R703.4

#### AAMA/NSA 2100—19: Specifications for Sunrooms

R301.2.1.1.1

#### AAMA/WDMA/CSA 101/IS.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors, and Skylights

N1102.4.3, R308.6.9, R609.3

### ACCA

Air Conditioning Contractors of America  
1330 Braddock Place, Suite 350  
Alexandria, VA 22314

#### ANSI/ACCA 1 Manual D—2016: Residential Duct Systems

Table R301.2(1), M1601.1, M1602.2

#### ANSI/ACCA 2 Manual J—2016: Residential Load Calculation

N1103.7, M1401.3

#### ANSI/ACCA 3 Manual S—2014: Residential Equipment Selection

N1103.7, M1401.3

## REFERENCED STANDARDS

### ACI

American Concrete Institute  
38800 Country Club Drive  
Farmington Hills, MI 48331

#### 318—19: Building Code Requirements for Structural Concrete

R402.2, Table R404.1.2(2), Table R404.1.2(5), Table R404.1.2(6), Table R404.1.2(7),  
Table R404.1.2(8), R404.1.3, R404.1.3.1, R404.1.3.3, R404.1.3.4, R404.1.4.2, R404.5.1, R608.1,  
R608.1.1, R608.1.2, R608.2, R608.5.1, R608.6.1, R608.8.2, R608.9.2, R608.9.3

#### 332—20: Residential Code Requirements for Structural Concrete

R402.2, R403.1, R404.1.3, R404.1.3.4, R404.1.4.2, R506.1

### AIISI

American Iron and Steel Institute  
25 Massachusetts Avenue, NW Suite 800  
Washington, DC 20001

#### AIISI S100—16 (2020) w/S2—20: North American Specification for the Design of Cold-Formed Steel Structural Members, 2016 Edition (Reaffirmed 2020), with Supplement 2, 2020 Edition

R608.9.2, R608.9.3

#### AIISI S220—20: North American Standard for Cold-Formed Steel Nonstructural Framing, 2020

R702.3.3

#### AIISI S230—19: Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings, 2019

R301.1.1, R301.2.1.1, R301.2.2.7, R301.2.2.8, R603.6, R603.9.4.1, R603.9.4.2, Figure 608.9(11),  
R608.9.2, R608.9.3, R608.10

#### AIISI S240—20: North American Standard for Cold-Formed Steel Structural Framing, 2020

R505.1.3, R603.6, R702.3.3, R804.3.6

### AMCA

Air Movement and Control Association International  
30 West University Drive  
Arlington Heights, IL 60004

#### ANSI/AMCA 210-ANSI/ASHRAE 51—16: Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

Table M1504.2, M1505.3

### ANCE

Association of Standardization and Certification  
Av. Lázaro Cárdenas No. 869  
Fraccion 3  
Col. Nva. Industrial Vallejo  
Deleg. Gustavo A. Madero  
Mexico, D.F.

#### NMX-J-521/2-40-ANCE—2014/CAN/CSA-22.2 No. 60335-2-40—12/UL 60335-2-40: Safety of Household and Similar Electric Appliances, Part 2-40: Particular Requirements for Heat Pumps, Air-Conditioners and Dehumidifiers

M1403.1, M1412.1, M1413.1

### ANSI

American National Standards Institute  
25 West 43rd Street, 4th Floor  
New York, NY 10036

#### A108.1A—17: Installation of Ceramic Tile in the Wet-set Method, with Portland Cement Mortar

R702.4.1

#### A108.1B—2017: Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar

R702.4.1

#### A108.4—09: Installation of Ceramic Tile with Organic Adhesives or Water-cleanable Tile-setting Epoxy Adhesive

R702.4.1

#### A108.5—20: Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex-Portland Cement Mortar

R702.4.1

**ANSI—continued**

**A108.6—99 (Reaffirmed 2019): Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy**

R702.4.1

**A108.11—10: Interior Installation of Cementitious Backer Units**

R702.4.1

**A118.1—18: American National Standard Specifications for Dry-set Portland Cement Mortar**

R702.4.1

**A118.3—13: American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy and Water Cleanable Tile-setting Epoxy Adhesive**

R702.4.1

**A118.4—18: American National Standard Specifications for Modified Dry-set Cement Mortar**

R606.2.11

**A118.10—14: Specification for Load-bearing, Bonded, Waterproof Membranes for Thin-set Ceramic Tile and Dimension Stone Installation**

P2709.2, P2709.2.4

**A136.1—20: American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile**

R702.4.1

**A137.1—19: American National Standard Specifications for Ceramic Tile**

R702.4.1

**ANSI 117—2020: Standard Specification for Structural Glued Laminated Timber of Softwood Species**

R502.1.3, R602.1.3, R802.1.3

**ANSI/CSA FC 1—2014: Fuel Cell Technologies—Part 3-100: Stationary Fuel Cell Power Systems—Safety**

M1903.1

**ANSI LC 1—2018/CSA 6.26—2016: Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)**

G2411.3, G2414.4.4, G2415.5

**ANSI LC 4—2012/CSA 6.32—2012: Press-Connect Metallic Fittings for Use in Fuel Gas Distribution Systems**

G2414.9.1, G2414.9.2, G2414.9.3, G2415.5

**ANSI Z21.1—2016/CSA 1.1—2016: Household Cooking Gas Appliances**

M1503.2, G2447.1

**ANSI Z21.5.1—2017/CSA 7.1—2017: Gas Clothes Dryers—Volume I—Type 1 Clothes Dryers**

G2438.1

**ANSI Z21.8—1994 (R2017): Installation of Domestic Gas Conversion Burners**

G2443.1

**ANSI Z21.10.1—2017/CSA 4.1—2017: Gas Water Heaters, Volume I, Storage Water Heaters with Input Ratings of 75,000 Btu per hour or Less**

G2448.1

**Z21.10.3/CSA 4.3—2017: Gas Water Heaters—Volume III—Storage Water Heaters with Input Ratings above 75,000 Btu per hour, Circulating and Instantaneous**

G2448.1

**ANSI Z21.11.2—2016: Gas-Fired Room Heaters, Volume II, Unvented Room Heaters**

G2445.1

**ANSI Z21.13—2017/CSA 4.9—2017: Gas-Fired Low-pressure Steam and Hot Water Boilers**

G2452.1

**ANSI Z21.15—2009/CSA 9.1—2009 (2014): Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves**

Table G2420.1.1

**ANSI Z21.22—2015: Relief Valves for Hot Water Supply Systems**

P2804.2, P2804.7

**ANSI Z21.24—2015/CSA 6.10—2015: Connectors for Gas Appliances**

G2422.1, G2422.2

**ANSI 40.11—1996 (R2017)/CGA 2.91—M96 (R2017): Gas-Fired, Heat-Activated Air-Conditioning and Heat Pump Appliances**

G2449.1

## REFERENCED STANDARDS

### ANSI—continued

- ANSI Z21.40.2—1996 (R2017)/CGA 2.92—M96 (R2017): Gas-Fired Work Activated Air-Conditioning and Heat Pump Appliances (Internal Combustion)**  
G2449.1
- ANSI Z21.41—2014/CSA 6.9—2014: Quick Disconnect Devices for Use with Gas Fuel Appliances**  
G2422.1
- ANSI Z21.42—2013: Gas-Fired Illuminating Appliances**  
G2450.1
- ANSI Z21.47—2016/CSA 2.3—2016: Gas-Fired Central Furnaces**  
G2442.1
- ANSI Z21.50—2016/CSA 2.22—2016: Vented Decorative Gas Fireplaces**  
G2434.1
- ANSI Z21.54—2014/CSA 8.4—2014: Gas Hose Connectors For Portable Outdoor Gas-Fired Appliances**  
G2422.1
- ANSI Z21.56—2017/CSA 4.7—2017: Gas-Fired Pool Heaters**  
G2441.1
- ANSI Z21.58—2018/CSA 1.6—2018: Outdoor Cooking Gas Appliances**  
G2447.1
- ANSI Z21.60—2017/CSA 2.26—2017: Decorative Gas Appliances for Installation in Solid-Fuel-Burning Fireplaces**  
G2432.1
- ANSI Z21.69—2015/CSA 6.16—2015: Connectors for Moveable Gas Appliances**  
G2422.1.5
- ANSI Z21.75—2016/CSA 6.27—2016: Connectors for Outdoor Gas Appliances and Manufactured Homes**  
G2422.1
- ANSI Z21.80—2011/CSA 6.22—2011 (R2016): Line Pressure Regulators**  
G2421.1
- ANSI Z21.84—2017: Standard for Manually Lighted, Natural Gas, Decorative Gas Appliances for Installation in Solid-Fuel-Burning Appliances**  
G2432.1, G2432.2
- ANSI Z21.86—2016/CSA 2.32—2016: Vented Gas-Fired Space Heating Appliances**  
G2436.1, G2437.1, G2446.1
- ANSI Z21.88—2016/CSA 2.33—2016: Vented Gas Fireplace Heaters**  
G2435.1
- ANSI Z21.90—2015/CSA 6.24—2015: Gas Convenience Outlets and Optional Enclosures**  
G2422.1
- ANSI Z21.91—2017: Ventless Firebox Enclosures for Gas-Fired Unvented Decorative Room Heaters**  
G2445.7.1
- ANSI Z21.93—2017/CSA 6.30—2017: Excess Flow Valves For Natural Gas and Propane Gas With Pressures Up To 5 Psig**  
G2421.4
- ANSI Z21.97—2017/CSA 2.41—2017: Outdoor Decorative Gas Appliances**  
G2453.1
- Z83.6—90 (R1998): Gas-fired Infrared Heaters**  
G2451.1
- ANSI Z83.8—2016/CSA 2.6—2016: Gas Unit Heater, Gas Packaged Heaters, Gas Utility Heaters And Gas-Fired Duct Furnaces**  
G2444.1
- ANSI Z83.19—2017/CSA 2.35—2017: Gas-Fired High-Intensity Infrared Heaters**  
G2451.1
- ANSI Z83.20—2016/CSA 2.34—2016: Gas-Fired Tubular and Low-Intensity Infrared Heaters**  
G2451.1
- Z97.1—2017: Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test**  
R308.1.1, R308.3.1

---

## APA

APA—The Engineered Wood Association  
7011 South 19th Street  
Tacoma, WA 98466

**ANSI/A190.1—2017: Structural Glued-laminated Timber**

R502.1.3, R602.1.3, R802.1.2

**ANSI/APA PRG 320—2019: Standard for Performance-rated Cross Laminated Timber**

R502.1.6, R602.1.6, R802.1.6

**ANSI/APA PRP 210—2019: Standard for Performance-rated Engineered Wood Siding**

R604.1, Table R703.3(1), R703.3.4

**ANSI/APA PRR 410—2016: Standard for Performance-rated Engineered Wood Rim Boards**

R502.1.7, R602.1.7, R802.1.7

**ANSI/APA PRS 610.1—2018: Standard for Performance-Rated Structural Insulated Panels in Wall Applications**

R602.1.11, R610.3, R610.4

**APA E30—19: Engineered Wood Construction Guide**

Table R503.2.1.1(1), R503.2.2, R803.2.2, R803.2.3

---

## APSP

Pool & Hot Tub Alliance (formerly the Association of Pool & Spa Professionals)  
211 Eisenhower Avenue, Suite 500  
Alexander, VA 22314

**ANSI/APSP/ICC 14—2019: American National Standard for Portable Electric Spa Energy Efficiency**

N1103.11

**ANSI/APSP/ICC 15a—2011: American National Standard for Residential Swimming Pool and Spas—Includes Addenda A**

Approved January 9, 2013

N1103.12

---

## ASCE/SEI

American Society of Civil Engineers  
Structural Engineering Institute  
Reston, VA 20191-4400

**7—16 with Supplement 1: Minimum Design Loads and Associated Criteria for Buildings and Other Structures**

Table R608.7(1A), Table R608.7(1B), Table R608.7(1C), R301.2.1.1, R301.2.1.2, R301.2.1.2.1, R301.2.1.5, R301.2.1.5.1, Table R608.6(1), Table R608.6(2), Table R608.6(3), Table R608.6(4), R608.9.2, R608.9.3, R609.2, R609.6.2

**24—14: Flood-resistant Design and Construction**

R301.2.4, R301.2.4.1, R322.1, R322.1.1, R322.1.6, R322.1.9, R322.2.2, R322.3.3

**32—01: Design and Construction of Frost-protected Shallow Foundations**

R403.1.4.1

---

## ASHRAE

ASHRAE  
180 Technology Parkway NW  
Peachtree Corners, GA 30092

**ASHRAE 34—2019: Designation and Safety Classification of Refrigerants**

M1411.1

**ASHRAE 193—2010(RA 2014): Method of Test for Determining Airtightness of HVAC Equipment**

N1103.3.4.1

**ASHRAE—2001: 2001 ASHRAE Handbook of Fundamentals**

Table N1105.4.2(1)

**ASHRAE—2017: ASHRAE Handbook of Fundamentals**

N1102.1.5, P3001.2, P3101.4



## REFERENCED STANDARDS

# ASME

American Society of Mechanical Engineers  
Two Park Avenue  
New York, NY 10016-5990

### **A18.1—2020: Safety Standard for Platforms and Stairway Chair Lifts**

R321.2

### **A112.1.2—2012(R2017): Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water Connected Receptors)**

P2717.1, Table P2902.3, P2902.3.1

### **A112.1.3—2000 (R2019): Air Gap Fittings for Fixtures, Appliances and Appurtenances**

Table P2701.1, P2717.1, Table P2902.3, P2902.3.1

### **A112.3.1—2007(R2017): Stainless Steel Drainage Systems for Sanitary, DWV, Storm and Vacuum Applications Above and Below Ground**

Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1

### **A112.3.4—2018/CSA B45.9—2018: Macerating Toilet Systems and Related Components**

Table P2701.1, P3007.5

### **A112.4.1—2019: Water Heater Relief Valve Drain Tubes**

P2804.6.1

### **A112.4.3—1999(R2020): Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System**

P3003.14

### **A112.4.4—2017: Plastic Push-Fit Drain, Waste, and Vent (DWV) Fittings**

Table P3002.3, P3003.9.4

### **A112.4.14—2019/CSA B125.14—19: Manually Operated Valves for Use in Plumbing Systems**

Table P2903.9.4

### **A112.6.2—2017: Framing-affixed Supports for Off-the-floor Water Closets with Concealed Tanks**

Table P2701.1, P2702.4

### **A112.6.3—2019: Floor and Trench Drains**

Table P2701.1

### **A112.14.1—03(2017): Backwater Valves**

P3008.3

### **A112.18.1—2018/CSA B125.1—2018: Plumbing Supply Fittings**

Table P2701.1, P2708.5, P2722.1, P2722.3, P2902.2, Table P2903.9.4

### **A112.18.2—2020/CSA B125.2—2020: Plumbing Waste Fittings**

Table P2701.1, P2702.2

### **A112.18.3M—2002(R2017): Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings**

P2708.5, P2722.3

### **A112.18.6—2017/CSA B125.6—2017: Flexible Water Connectors**

P2906.7

### **A112.19.1—2018/CSA B45.2—2018: Enameled Cast-iron and Enameled Steel Plumbing Fixtures**

Table P2701.1, P2711.1

### **A112.19.2—2018/CSA B45.1—2018: Ceramic Plumbing Fixtures**

Table P2701.1, P2705.1, P2711.1, P2712.1, P2712.2, P2712.9

### **A112.19.3—2017/CSA B45.4—2017: Stainless Steel Plumbing Fixtures**

Table P2701.1, P2705.1, P2711.1, P2712.1

### **A112.19.5—2017/CSA B45.15—2017: Flush Valves and Spuds for Water-closets, Urinals and Tanks**

Table P2701.1

### **A112.19.7—2012/CSA B45.10—2012(2017): Hydromassage Bathtub Systems**

Table P2701.1

### **A112.19.12—2014(R2019): Wall-mounted and Pedestal-mounted, Adjustable, Elevating, Tilting, and Pivoting Lavatory and Sink, and Shampoo Bowl Carrier Systems and Drain Waste Systems**

Table P2701.1, P2711.4, P2714.2

### **A112.19.14—2013(R2018): Six-Liter Water Closets Equipped with Dual Flushing Device**

P2712.1

**ASME—continued**

- A112.19.15—2012(R2017): Bathtub/Whirlpool Bathtubs with Pressure-sealed Doors**  
Table P2701.1, P2713.2
- A112.36.2M—1991(R2017): Cleanouts**  
P3005.2.10.2
- ASME A17.1—2019/CSA B44—2019: Safety Code for Elevators and Escalators**  
R321.1
- ASME A112.4.2—2015/CSA B45.16—2015(R2020): Water-closet Personal Hygiene Devices**  
P2722.5
- ASSE 1002—2020/ASME A112.1002—2020/CSA B125.12—20: Anti-Siphon Fill Valves**  
Table P2701.1, Table P2902.3, P2902.4.1
- ASSE 1016—2017/ASME A112.1016—2017/CSA B125.16—2017: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations**  
Table P2701.1, P2708.4, P2722.2
- ASSE 1070—2020/ASME A112.1070—2020: Performance Requirements for Water-temperature-limiting Devices**  
P2713.3, P2721.2
- B1.20.1—2013(R2018): Pipe Threads, General-purpose (Inch)**  
G2414.9, P3003.3.3, P3003.6.4, P3003.7.1, P3003.9.3
- B16.3—2016: Malleable-iron-threaded Fittings, 150 and 300**  
Table P2906.6
- B16.4—2016: Gray-iron-threaded Fittings**  
Table P2906.6, Table P3002.3
- B16.9—2018: Factory-made, Wrought-steel Butt welding Fittings**  
Table P2906.6
- B16.11—2016: Forged Fittings, Socket-welding and Threaded**  
Table P2906.6
- B16.12—2009(R2014): Cast-iron-threaded Drainage Fittings**  
Table P3002.3
- B16.15—2018: Cast Alloy Threaded Fittings: Classes 125 and 250**  
Table P2906.6, Table P3002.3
- B16.18—2018: Cast-copper-alloy Solder Joint Pressure Fittings**  
Table P2906.6, Table P3002.3
- B16.22—2018: Wrought-copper and Copper-alloy Solder Joint Pressure Fittings**  
Table P2906.6, Table P3002.3
- B16.23—2016: Cast-copper-alloy Solder Joint Drainage Fittings (DWV)**  
Table P3002.3
- B16.26—2018: Cast-copper-alloy Fittings for Flared Copper Tubes**  
Table P2906.6, Table P3002.3
- B16.28—1994: Wrought-steel Butt welding Short Radius Elbows and Returns**  
Table P2906.6
- B16.29—2017: Wrought-copper and Wrought-copper-alloy Solder Joint Drainage Fittings (DWV)**  
Table P3002.3
- B16.33—2012(R2017): Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig (Sizes 1/2 through 2)**  
Table G2420.1.1
- B16.34—2017: Valves—Flanged, Threaded and Welding End**  
Table P2903.9.4
- B16.44—2012(R2017): Manually Operated Metallic Gas Valves for Use in Above-ground Piping Systems up to 5 psi**  
Table G2420.1.1
- B16.51—2018: Copper and Copper Alloy Press-Connect Pressure Fittings**  
Table M2101.1, M2103.3, Table P2906.6
- B36.10M—2018: Welded and Seamless Wrought-steel Pipe**  
G2414.4.2

## REFERENCED STANDARDS

### ASME—continued

**BPVC—2019: ASME Boiler and Pressure Vessel Code (Sections I, II, IV, V, VI and VIII)**

M2001.1.1, G2452.1

**CSD-1—2018: Controls and Safety Devices for Automatically Fired Boilers**

M2001.1.1, G2452.1

## ASSE

ASSE International  
18927 Hickory Creek Drive, Suite 220  
Mokena, IL 60448

**1001—2017: Performance Requirements for Atmospheric-type Vacuum Breakers**

Table P2902.3, P2902.3.2

**1003—2009: Performance Requirements for Water-pressure-reducing Valves for Domestic Water Distribution Systems**

P2903.3.1

**1008—2006: Performance Requirements for Plumbing Aspects of Residential Food Waste Disposer Units**

Table P2701.1

**1010—2004: Performance Requirements for Water Hammer Arresters**

P2903.5

**1011—2017: Performance Requirements for Hose Connection Vacuum Breakers**

Table P2902.3, P2902.3.2

**1012—2009: Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent**

Table P2902.3, P2902.3.3, P2902.5.1, P2902.5.5.3

**1013—2011: Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers**

Table P2902.3, P2902.3.5, P2902.5.1, P2902.5.5.3

**1015—2011: Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies**

Table P2902.3, P2902.3.6

**1017—2009: Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems**

P2724.1, P2802.1, P2803.2

**1018—2001: Performance Requirements for Trap Seal Primer Valves—Potable Water Supplied**

P3201.2.1.1, P3201.2.1.2

**1019—2011(R2016): Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance**

Table P2701.1, Table P2902.3, P2902.3.2

**1020—2004: Performance Requirements for Pressure Vacuum Breaker Assembly**

Table P2902.3, P2902.3.4

**1023—1979: Performance Requirements for Hot Water Dispensers, Household-storage-type—Electrical**

Table P2701.1

**1024—2017: Performance Requirements for Dual Check Backflow Preventers**

Table P2902.3, P2902.3.7

**1035—2008: Performance Requirements for Laboratory Faucet Backflow Preventers**

Table P2902.3, P2902.3.2

**1044—2015: Performance Requirements for Trap Seal Primer Drainage Types and Electric Design Types**

P3201.2.1.3

**1047—2011: Performance Requirements for Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies**

Table P2902.3, P2902.3.5

**1048—2011: Performance Requirements for Double Check Detector Fire Protection Backflow Prevention Assemblies**

Table P2902.3, P2902.3.6

**1050—2009: Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems**

P3114.1

**1051—2009: Performance Requirements for Individual and Branch-type Air Admittance Valves for Sanitary Drainage Systems**

P3114.1

**1052—2016: Performance Requirements for Hose Connection Backflow Preventers**

Table P2701.1, Table P2902.3, P2902.3.2

**ASSE—continued****1056—2013: Performance Requirements for Spill-resistant Vacuum Breaker Assemblies**

Table P2902.3, P2902.3.4

**1060—2017: Performance Requirements for Outdoor Enclosures for Fluid-conveying Components**

P2902.6.1

**1061—2015: Performance Requirements for Push-Fit Fittings**

Table P2906.6, P2906.21

**1062—2017: Performance Requirements for Temperature-actuated, Flow Reduction (TAFR) Valves for Individual Supply Fittings**

Table P2701.1, P2724.2

**1066—1997: Performance Requirements for Individual Pressure Balancing In-line Valves for Individual Fixture Fittings**

P2722.4

**1072—2007: Performance Requirements for Barrier-type Floor Drain Trap Seal Protection Devices**

P3201.2.1.4

**1081—2014: Performance Requirements for Backflow Preventers with Integral Pressure Reducing Boiler Feed Valve and Intermediate Atmospheric Vent Style for Domestic and Light Commercial Water Distribution Systems**

Table P2902.3, P2902.3.3

**ASSE 1002—2020/ASME A112.1002—2020/CSA B125.12—20: Anti-Siphon Fill Valves for Water Closet Tanks**

Table P2701.1, Table P2902.3, P2902.4.1

**ASSE 1016—2017/ASME 112.1016—2017/CSA B125.16—2017: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations**

Table P2701.1, P2708.4, P2722.2

**ASSE 1037—2015/ASME A112.1037—2015/CSA B125.37—15: Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures**

Table P2701.1

**ASSE 1070—2020/ASME A112.1070—2020/ CSA B125.70—20: Performance Requirements for Water-temperature-limiting Devices**

P2713.3, P2721.2, P2724.1

---

**ASTM**ASTM International  
100 Barr Harbor Drive, P.O. Box C700  
West Conshohocken, PA 19428**A36/A36M—14: Specification for Carbon Structural Steel**

R608.5.2.2

**A53/A53M—2018: Specification for Pipe, Steel, Black and Hot-dipped, Zinc-coated Welded and Seamless**

R407.3, Table M2101.1, G2414.4.2, Table P2906.4, Table P2906.5, Table P3002.1(1)

**A74—2017: Specification for Cast-iron Soil Pipe and Fittings**

Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3005.2.6, Table P3302.1

**A106/A106M—2018: Specification for Seamless Carbon Steel Pipe for High-temperature Service**

Table M2101.1, G2414.4.2

**A123/A123M—2017: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products**

Table 507.2.3

**A126—04(2014): Gray Iron Castings for Valves, Flanges and Pipe Fittings**

Table P2903.9.4

**A153/A153M—2016A: Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware**

R317.3, Table 507.2.3, Table R606.3.4.1, R703.6.3, R905.7.5, R905.8.6

**A167—99(2009): Specification for Stainless and Heat-resisting Chromium-nickel Steel Plate, Sheet and Strip**

Table R606.3.4.1

**A240/A240M—17: Standard Specification for Chromium and Chromium-nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications**

Table R905.10.3(1)

**A254—2010(2018): Specification for Copper Brazed Steel Tubing**

Table M2101.1, G2414.5.1

## REFERENCED STANDARDS

### ASTM—continued

**A268/A268M—2010(16): Standard Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service**

G2414.5.2

**A269/A269M—2015A: Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service**

G2414.5.2

**A307—2014E1: Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength**

Table R507.2.3, R608.5.2.2

**A312/A312M—2018: Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes**

Table P2906.4, Table P2906.5, Table P2906.6, P2906.13.2

**A463/A463M—15: Standard Specification for Steel Sheet, Aluminum-coated by the Hot-dip Process**

Table R905.10.3(2)

**A539—99: Specification for Electric-resistance-welded Coiled Steel Tubing for Gas and Fuel Oil Lines**

M2202.1

**A563—15: Standard Specification for Carbon and Alloy Steel Nuts**

Table R507.2.3

**A615/A615M—2015aE1: Specification for Deformed and Plain Carbon-steel Bars for Concrete Reinforcement**

R402.3.1, R403.1.3.5.1, R404.1.3.3.7.1, R608.5.2.1

**A641/A641M—09a(2014): Specification for Zinc-coated (Galvanized) Carbon Steel Wire**

Table R606.3.4.1

**A653/A653M—2017: Specification for Steel Sheet, Zinc-coated Galvanized or Zinc-iron Alloy-coated Galvannealed by the Hot-dip Process**

R317.3.1, R505.2.2, Table R507.2.3, R603.2.2, Table R606.3.4.1, R608.5.2.3, R804.2.2, R804.2.3, Table R905.10.3(1), Table R905.10.3(2), M1601.1.1

**A706/A706M—2016: Specification for Low-alloy Steel Deformed and Plain Bars for Concrete Reinforcement**

R402.3.1, R403.1.3.5.1, R404.1.3.3.7.1, R608.5.2.1

**A755/A755M—2016E1: Specification for Steel Sheet, Metallic Coated by the Hot-dip Process and Prepainted by the Coil-coating Process for Exterior Exposed Building Products**

Table R905.10.3(2)

**A778/A778M—2016: Specification for Welded Unannealed Austenitic Stainless Steel Tubular Products**

Table P2906.4, Table P2906.5, Table P2906.6

**A792/A792M—10(2015): Specification for Steel Sheet, 55% Aluminum-zinc Alloy-coated by the Hot-dip Process**

R505.2.2, R603.2.2, R608.5.2.3, R804.2.2, Table 905.10.3(2)

**A875/A875M—13: Specification for Steel Sheet, Zinc-5%, Aluminum Alloy-coated by the Hot-dip Process**

R608.5.2.3, Table R905.10.3(2)

**A888—2018: Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Application**

Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1

**A924/A924M—2017A: Standard Specification for General Requirements for Steel Sheet, Metallic-coated by the Hot-dip Process**

Table R905.10.3(1)

**A996M—2016: Specifications for Rail-steel and Axle-steel Deformed Bars for Concrete Reinforcement**

R403.1.3.5.1, Table R404.1.2(9), R404.1.3.3.7.1, R608.5.2.1, Table R608.5.4(2)

**A1003/A1003M—15: Standard Specification for Steel Sheet, Carbon, Metallic and Nonmetallic-coated for Cold-formed Framing Members**

R505.2.1, R505.2.2, R603.2.1, R603.2.2, R804.2.1, R804.2.2

**B32—08(2014): Specification for Solder Metal**

P3003.6.3

**B42—2015A: Specification for Seamless Copper Pipe, Standard Sizes**

Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)

**B43—15: Specification for Seamless Red Brass Pipe, Standard Sizes**

Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)

**B75/B75M—11: Specification for Seamless Copper Tube**

Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1), Table P3002.1(2), Table P3002.2



**ASTM—continued**

- B88—2016: Specification for Seamless Copper Water Tube**  
Table M2101.1, G2414.5.2, Table P2906.4, Table P2906.5, Table P3002.1(1), Table P3002.1(2),  
Table P3002.2
- B101—12: Specification for Lead-coated Copper Sheet and Strip for Building Construction**  
Table R905.2.8.2, Table R905.10.3(1)
- B135/B135M—2017: Specification for Seamless Brass Tube**  
Table M2101.1
- B209—14: Specification for Aluminum and Aluminum-alloy Sheet and Plate**  
Table 905.10.3(1)
- B251/B251M—2017: Specification for General Requirements for Wrought Seamless Copper and Copper-alloy Tube**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1), Table P3002.1(2), Table P3002.2
- B280—2018: Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service**  
G2414.4.3
- B302—2017: Specification for Threadless Copper Pipe, Standard Sizes**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P3002.1(1)
- B306—13: Specification for Copper Drainage Tube (DWV)**  
Table M2101.1, Table P3002.1(1), Table P3002.1(2)
- B370—12: Specification for Copper Sheet and Strip for Building Construction**  
Table R905.2.8.2, Table R905.10.3(1), Table P2701.1
- B447—12a: Specification for Welded Copper Tube**  
Table P2906.4, Table P2906.5
- B695—2004(2016): Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel**  
R317.3.1, R317.3.3, Table R507.2.3
- B813—2016: Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube**  
Table M2101.1, M2103.3, P2906.15, P3003.6.3
- B828—2016: Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings**  
M2103.3, P2906.15, P3003.6.3
- C4—2004(2018): Specification for Clay Drain Tile and Perforated Clay Drain Tile**  
Table P3302.1
- C5—2018: Specification for Quicklime for Structural Purposes**  
R702.2.1
- C14—15a: Specification for Non-reinforced Concrete Sewer, Storm Drain and Culvert Pipe**  
Table P3002.2
- C22/C22M—2015: Specification for Gypsum**  
R702.2.1, R702.3.1
- C27—1998(2018): Specification for Standard Classification of Fireclay and High-alumina Refractory Brick**  
R1001.5
- C28/C28M—10(2015): Specification for Gypsum Plasters**  
R702.2.1
- C33/C33M—2018: Specification for Concrete Aggregates**  
R403.4.1
- C34—2017: Specification for Structural Clay Load-bearing Wall Tile**  
Table R301.2(1), R606.2.2
- C35/C35M—01(2014): Specification for Inorganic Aggregates for Use in Gypsum Plaster**  
R702.2.1
- C55—2017: Specification for Concrete Building Brick**  
R202, Table R301.2(1), R606.2.1
- C56—2013(2017): Standard Specification for Structural Clay Nonloadbearing Tile**  
R606.2.2
- C59/C59M—00(2015): Specification for Gypsum Casting Plaster and Molding Plaster**  
R702.2.1

## REFERENCED STANDARDS

### ASTM—continued

- C61/C61M—00(2015): Specification for Gypsum Keene's Cement**  
R702.2.1
- C62—2017: Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)**  
R202, Table R301.2(1), R606.2.2
- C73—2017: Specification for Calcium Silicate Face Brick (Sand Lime Brick)**  
R202, Table R301.2(1), R606.2.1
- C76—2018A: Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe**  
Table P3002.2
- C90—2016A: Specification for Load-bearing Concrete Masonry Units**  
Table R301.2(1), 606.2.1
- C91/C91M—2018: Specification for Masonry Cement**  
R702.2.2, R703.7.2
- C94/C94M—2017A: Standard Specification for Ready-mixed Concrete**  
R404.1.3.3.2, R608.5.1.2
- C126—2017: Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units**  
R606.2.2
- C129—2017: Specification for Nonload-bearing Concrete Masonry Units**  
Table R301.2(1)
- C143/C143M—15A: Test Method for Slump of Hydraulic Cement Concrete**  
R404.1.3.3.4, R608.5.1.4
- C145—85: Specification for Solid Load-bearing Concrete Masonry Units**  
R202, Table R301.2(1)
- C150/C150M—2018: Specification for Portland Cement**  
R608.5.1.1, R702.7.2
- C199—1984(2016): Test Method for Pier Test for Refractory Mortar**  
R1001.5, R1001.8, R1003.12
- C207—2018: Specification for Hydrated Lime for Masonry Purposes**  
Table R606.2.8
- C208—2012(2017)E1: Specification for Cellulosic Fiber Insulating Board**  
R602.1.10, Table R602.3(1), Table R906.2
- C212—2017: Standard Specification for Structural Clay Facing Tile**  
R606.2.2
- C216—2017A: Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale)**  
R202, Table R301.2(1), R606.2.2
- C270—14A: Specification for Mortar for Unit Masonry**  
R606.2.8, Table R606.2.8, R606.2.11
- C315—2007(2016): Specification for Clay Flue Liners and Chimney Pots**  
R1001.8, R1003.11.1, Table R1003.14(1), G2425.12
- C406/C406M—2015: Specifications for Roofing Slate**  
R905.6.4
- C411—2017: Test Method for Hot-surface Performance of High-temperature Thermal Insulation**  
M1601.3
- C425—2004(2018): Specification for Compression Joints for Vitrified Clay Pipe and Fittings**  
Table P3002.2, P3003.10, P3003.13
- C443—2012(2017): Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets**  
P3003.5, P3003.13
- C475/C475M—2017: Specification for Joint Compound and Joint Tape for Finishing Gypsum Board**  
R702.3.1
- C476—2018: Specification for Grout for Masonry**  
R606.2.12
- C503M—2015: Standard Specification for Marble Dimension Stone**  
R606.2.4

**ASTM—continued**

- C514—04(2014): Specification for Nails for the Application of Gypsum Wallboard**  
R702.3.1
- C552—2017E1: Standard Specification for Cellular Glass Thermal Insulation**  
Table R906.2
- C557—2003(2017): Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing**  
R702.3.1.1
- C564—14: Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings**  
P3003.4.2, P3003.4.3, P3003.13
- C568M—2015: Standard Specification for Limestone Dimension Stone**  
R606.2.4
- C578—2018: Specification for Rigid, Cellular Polystyrene Thermal Insulation**  
R316.8, R403.3, Table 703.8.4(2), Table R703.15.1, Table R703.15.2, Table R703.16.1, Table R703.16.2, Table R906.2
- C587—2004(2018): Specification for Gypsum Veneer Plaster**  
R702.2.1
- C595/C595M—2018: Specification for Blended Hydraulic Cements**  
R608.5.1.1, R702.2.2, R703.7.2
- C615/C615M—2018E1: Standard Specification for Granite Dimension Stone**  
R606.2.4
- C616/C616M—2015: Standard Specification for Quartz-based Dimension Stone**  
R606.2.4
- C629/C629M—2015: Standard Specification for Slate Dimension Stone**  
R606.2.4
- C631—09(2014): Specification for Bonding Compounds for Interior Gypsum Plastering**  
R702.2.1
- C645—2018: Specification for Nonstructural Steel Framing Members**  
R702.3.3
- C652—2017A: Specification for Hollow Brick (Hollow Masonry Units Made from Clay or Shale)**  
R202, Table R301.2(1), R606.2.2
- C685/C685M—2017: Specification for Concrete Made by Volumetric Batching and Continuous Mixing**  
R404.1.3.3.2, R608.5.1.2
- C700—2018: Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated**  
Table P3002.2, Table P3002.3, Table P3302.1
- C726—2017: Standard Specification for Mineral Wool Roof Insulation Board**  
Table R906.2
- C728—2017A: Standard Specification for Perlite Thermal Insulation Board**  
Table R906.2
- C744—2016: Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units**  
R606.2.1
- C836/C836M—2018: Specification for High Solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course**  
R905.15.2
- C841—2003(2018): Standard Specification for Installation of Interior Lathing and Furring**  
R702.2.1
- C842—05(2015): Standard Specification for Application of Interior Gypsum Plaster**  
R702.2.1
- C843—2017: Specification for Application of Gypsum Veneer Plaster**  
R702.2.1
- C844—2015: Specification for Application of Gypsum Base to Receive Gypsum Veneer Plaster**  
R702.2.1
- C847—2018: Specification for Metal Lath**  
R702.2.1, R702.2.2

## REFERENCED STANDARDS

### ASTM—continued

- C887—13: Specification for Packaged, Dry, Combined Materials for Surface Bonding Mortar**  
R406.1, R606.2.9
- C897—15: Specification for Aggregate for Job-mixed Portland Cement-based Plasters**  
R702.2.2
- C920—2018: Standard Specification for Elastomeric Joint Sealants**  
R406.4.1
- C926—2018B: Specification for Application of Portland Cement-based Plaster**  
R702.2.2, R702.2.2.1, R703.7, R703.7.2, R703.7.2.1, R703.7.4
- C933—2018: Specification for Welded Wire Lath**  
R702.2.1, R702.2.2
- C946—2018: Standard Practice for Construction of Dry-Stacked, Surface-Bonded Walls**  
R606.2.9
- C954—2018: Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in (0.84 mm) or to 0.112 in. (2.84 mm) in Thickness**  
R505.2.5, R603.2.5, R702.3.5.1, R804.2.5
- C957/C957M—2017: Specification for High-solids Content, Cold Liquid-applied Elastomeric Waterproofing Membrane with Integral Wearing Surface**  
R905.15.2
- C1002—2018: Specification for Steel Self-piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs**  
R702.3.1, R702.3.5.1
- C1029—15: Specification for Spray-applied Rigid Cellular Polyurethane Thermal Insulation**  
R905.14.2
- C1032—2018: Specification for Woven Wire Plaster Base**  
R702.2.1, R702.2.2
- C1047—2014a: Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base**  
R702.2.1, R702.2.2, R702.3.1
- C1063—2018B: Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-based Plaster**  
R702.2.2, R703.7, R703.7.1
- C1088—2018: Standard Specification for Thin Veneer Brick Units Made from Clay or Shale**  
R606.2.2
- C1107/C1107M—2017: Standard Specification for Packaged Dry, Hydraulic-cement Grout (Nonshrink)**  
R402.3.1
- C1116/C116M—10(2015): Standard Specification for Fiber-reinforced Concrete and Shotcrete**  
R402.3.1
- C1157/C1157M—2017: Standard Performance Specification for Hydraulic Cement**  
R608.5.1.1, R703.7.2
- C1167—2011(2017): Specification for Clay Roof Tiles**  
R905.3.4
- C1173—2018: Specification for Flexible Transition Couplings for Underground Piping Systems**  
P3003.3.1, P3003.5, P3003.9.1, P3003.10, P3003.12.2, P3003.13
- C1177/C1177M—2017: Specification for Glass Mat Gypsum Substrate for Use as Sheathing**  
R702.3.1, Table 906.2
- C1178/C1178M—2018: Specification for Glass Mat Water-resistant Gypsum Backing Panel**  
R702.3.1, R702.3.7, Table R702.4.2
- C1186—2008(2016): Specification for Flat Fiber Cement Sheets**  
R703.10.1, R703.10.2
- C1261—2013(2017)E1: Specification for Firebox Brick for Residential Fireplaces**  
R1001.5, R1001.8
- C1277—2018: Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings**  
P3003.4.3

**ASTM—continued**

- C1278/C1278M—2017: Specification for Fiber-reinforced Gypsum Panels**  
R702.3.1, R702.3.7, Table R702.4.2, Table R906.2
- C1280—13a: Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing**  
R602.3(1)
- C1283—2015: Practice for Installing Clay Flue Lining**  
R1003.9.1, R1003.12
- C1288—2017: Standard Specification for Discrete Nonasbestos Fiber-cement Interior Substrate Sheets**  
Table R503.2.1.1(1), Table R503.2.1.1(2), Table 602.3(2), Table R702.4.2
- C1289—2018: Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board**  
R316.8, Table R703.15.1, Table R703.15.2, Table R703.16.1, Table R703.16.2, Table R906.2
- C1325—2018: Standard Specification for Fiber-mat Reinforced Cementitious Interior Substrate Sheets Backer Units**  
Table R702.4.2
- C1328/C1328M—12: Specification for Plastic (Stucco) Cement**  
R702.2.2, R703.7.2
- C1363—11: The Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus**  
N1101.10.4.1
- C1364—2017: Standard Specification for Architectural Cast Stone**  
R606.2.5
- C1396/C1396M—2017: Specification for Gypsum Board**  
Table R602.3(1), R702.2.1, R702.2.2, R702.3.1, R702.3.7
- C1405—2016: Standard Specification for Glazed Brick (Single Fired, Brick Units)**  
R606.2.2
- C1440—2017: Specification for Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems**  
P3003.13
- C1460—2017: Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground**  
P3003.13
- C1461—2008(2017): Specification for Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste and Vent (DWV) Sewer, Sanitary and Storm Plumbing Systems for Above and Below Ground Use**  
P3003.13
- C1492—2003(2016): Specification for Concrete Roof Tile**  
R905.3.5
- C1513—2018: Standard Specification for Steel Tapping Screws for Cold-formed Steel Framing Connections**  
R505.2.5, R603.2.5, R702.3.5.1, Table R703.3(2), Table R703.16.1, Table R703.16.2, R804.2.5
- C1540—2018: Specification for Heavy Duty Shielded Couplings Joining Hubless Cast-iron Soil Pipe and Fittings**  
P3003.4.3
- C1634—2017: Standard Specification for Concrete Facing Brick**  
R606.2.1
- C1658/C1658M—2018: Standard Specification for Glass Mat Gypsum Panels**  
R702.3.1
- C1668—13a: Standard Specification for Externally Applied Reflective Insulation Systems on Rigid Duct in Heating, Ventilation, and Air Conditioning (HVAC) Systems**  
M1601.3
- C1670/1670M—2018: Standard Specification for Adhered Manufactured Stone Masonry Veneer Units**  
R606.2.6
- C1691—2011(2017): Standard Specification for Unreinforced Autoclaved Aerated Concrete (AAC) Masonry Units**  
R606.2.3
- C1693—2011(2017): Standard Specification for Autoclaved Aerated Concrete (AAC)**  
R606.2.3
- C1766—2015: Standard Specification for Factory-Laminated Gypsum Panel Products**  
R702.3.1



## REFERENCED STANDARDS

### ASTM—continued

- D41/D41M—2011(2016): Specification for Asphalt Primer Used in Roofing, Dampproofing and Waterproofing**  
Table R905.9.2, Table R905.11.2
- D43/D43M—2000(20118): Specification for Coal Tar Primer Used in Roofing, Dampproofing and Waterproofing**  
Table R905.9.2
- D226/D226M—2017: Specification for Asphalt-saturated (Organic Felt) Used in Roofing and Waterproofing**  
R703.2, R905.1.1, Table R905.1.1(1), R905.8.4, Table R905.9.2
- D227/D227M—2003(2018): Specification for Coal Tar Saturated (Organic Felt) Used in Roofing and Waterproofing**  
Table R905.9.2
- D312/D312M—2016M: Specification for Asphalt Used in Roofing**  
Table R905.9.2
- D422—63(2007)E2: Test Method for Particle-size Analysis of Soils**  
R403.1.8.1
- D449/D449M—03(2014)E1: Specification for Asphalt Used in Dampproofing and Waterproofing**  
R406.2
- D450/D450M—2017(2018): Specification for Coal-tar Pitch Used in Roofing, Dampproofing and Waterproofing**  
Table R905.9.2
- D1227—13: Specification for Emulsified Asphalt Used as a Protective Coating for Roofing**  
Table R905.9.2, Table R905.11.2, R905.15.2
- D1248—2016: Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable**  
M1601.1.2
- D1527—99(2005): Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe, Schedules 40 and 80**  
Table P2906.4
- D1693—15: Test Method for Environmental Stress-cracking of Ethylene Plastics**  
Table M2101.1
- D1784—11: Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds**  
M1601.1.2
- D1785—15E1: Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120**  
Table P2906.4
- D1863/D1863M—2005(2018): Specification for Mineral Aggregate Used on Built-up Roofs**  
Table R905.9.2
- D1869—15: Specification for Rubber Rings for Fiber-Reinforced Cement Pipe**  
P2906.18, P3003.13
- D1970/D1970M—2017A: Specification for Self-adhering Polymer Modified Bitumen Sheet Materials Used as Steep Roof Underlayment for Ice Dam Protection**  
R905.1.1, R905.2.8.2, R905.11.2.1
- D2104—03: Specification for Polyethylene (PE) Plastic Pipe, Schedule 40**  
Table P2906.4
- D2178/D2178M—15A: Specification for Asphalt Glass Felt Used in Roofing and Waterproofing**  
Table R905.9.2
- D2235—2004(2016): Specification for Solvent Cement for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe and Fittings**  
P2906.9.1.1, P3003.3.2
- D2239—12A: Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter**  
Table P2906.4
- D2241—15: Specification for Poly (Vinyl Chloride) (PVC) Pressure-rated Pipe (SDR-Series)**  
Table P2906.4
- D2282—99(2005): Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe (SDR-PR)**  
Table P2906.4
- D2412—2011(2018): Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-plate Loading**  
M1601.1.2
- D2447—03: Specification for Polyethylene (PE) Plastic Pipe Schedules 40 and 80, Based on Outside Diameter**  
Table M2101.1

**ASTM—continued**

- D2464—15: Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80**  
Table P2906.6
- D2466—20: 17: Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40**  
Table P2906.6
- D2467—15: Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80**  
Table P2906.6
- D2468—96a: Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe Fittings, Schedule 40**  
Table P2906.6
- D2513—2018A: Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing and Fittings**  
Table M2101.1, G2414.6, G2414.6.1, G2414.11, G2415.17.2
- D2564—2012(2018): Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems**  
P2906.9.1.4, P3003.9.2
- D2609—15: Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe**  
Table P2906.6
- D2626/D2626M—04 (2012)e1: Specification for Asphalt-saturated and Coated Organic Felt Base Sheet Used in Roofing**  
Table R905.1.1(1), Table R905.9.2
- D2657—2007(2015): Standard Practice for Heat Fusion Joining of Polyolefin Pipe Fittings**  
M2105.11.1, P2906.3.1, P2906.20.2, P3003.12.1
- D2661—14E1: Specification for Acrylonitrile-butadiene-styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.3.2
- D2665—14: Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3
- D2672—14: Specification for Joints for IPS PVC Pipe Using Solvent Cement**  
Table P2906.4
- D2680—01(2014): Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping**  
Table P3002.2
- D2683—14: Specification for Socket-type Polyethylene Fittings for Outside Diameter-controlled Polyethylene Pipe and Tubing**  
Table M2105.5, M2105.11.1, P2906.20.2, P3002.3, P3010.5
- D2729—2017: Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings**  
P3009.11, Table P3302.1
- D2737—2012A: Specification for Polyethylene (PE) Plastic Tubing**  
Table P2906.4
- D2751—05: Specification for Acrylonitrile-butadiene-styrene (ABS) Sewer Pipe and Fittings**  
Table P3002.2, Table P3002.3
- D2822/D2822M—2005(2011): Specification for Asphalt Roof Cement, Asbestos Containing**  
Table R905.9.2
- D2823/D2823M—05(2011)e1: Specification for Asphalt Roof Coatings, Asbestos Containing**  
Table R905.9.2
- D2824/D2824M—2018: Standard Specification for Aluminum-pigmented Asphalt Roof Coatings, Nonfibered and Fibered without Asbestos**  
Table R905.9.2, Table R905.11.2
- D2846/D2846M—2017BE1: Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-water Distribution Systems**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.9.1.2, P2906.9.1.3
- D2855—2015: Standard Practice for Making Solvent-cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings**  
P3003.9.2
- D2898—2010(2017): Test Methods for Accelerated Weathering of Fire-retardant-treated Wood for Fire Testing**  
R802.1.5.4, R802.1.5.8
- D2949—10: Specification for 3.25-in. Outside Diameter Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3

## REFERENCED STANDARDS

### ASTM—continued

**D3019/D3019—2017: Specification for Lap Cement Used with Asphalt Roll Roofing, Nonfibered, Asbestos Fibered and Nonasbestos Fibered**

Table R905.9.2, Table R905.11.2

**D3034—2016: Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings**

Table P3002.2, Table P3002.3

**D3035—15: Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter**

Table M2105.4

**D3138—04(2016): Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Non-Pressure Piping Components**

P3003.13.4

**D3161/D3161M—2016A: Test Method for Wind-Resistance of Steep Slope Roofing Products (Fan Induced Method)**

R905.2.4.1, Table R905.2.4.1, R905.16.6

**D3201/D3201M—2013: Test Method for Hygroscopic Properties of Fire-retardant Wood and Wood-base Products**

R802.1.5.9

**D3212—07(2013): Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals**

P3003.3.1, P3003.9.1, P3003.12.2

**D3261—2016: Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing**

Table M2101.1, Table M2105.5, M2105.11.1, M2105.13.3, P2906.20.2

**D3309—96a(2002): Specification for Polybutylene (PB) Plastic Hot- and Cold-water Distribution System**

Table M2101.1

**D3311—2017: Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns**

P3002.3

**D3350—14: Specification for Polyethylene Plastic Pipe and Fitting Materials**

Table M2101.1

**D3462/D3462M—2016: Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules**

R905.2.4

**D3468/D3468M—99(2013)E1: Specification for Liquid-applied Neoprene and Chlorosulfanated Polyethylene Used in Roofing and Waterproofing**

R905.15.2

**D3679—2017: Specification for Rigid Poly (Vinyl Chloride) (PVC) Siding**

R703.11

**D3737—2018E1: Practice for Establishing Allowable Properties for Structural Glued Laminated Timber (Glulam)**

R502.1.3, R602.1.3, R802.1.2

**D3747—79(2007): Specification for Emulsified Asphalt Adhesive for Adhering Roof Insulation**

Table R905.9.2, Table R905.11.2

**D3909/D3909M—14: Specification for Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules**

R905.2.8.2, R905.5.4, Table R905.9.2

**D4022/D4022M—2007(2012)e1: Specification for Coal Tar Roof Cement, Asbestos Containing**

Table R905.9.2

**D4068—2017: Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water Containment Membrane**

P2709.2, P2709.2.2

**D4318—2017E1: Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils**

R403.1.8.1

**D4434/D4434M—2015: Specification for Poly (Vinyl Chloride) Sheet Roofing**

R905.13.2

**D4479/D4479M—2007(2018): Specification for Asphalt Roof Coatings—asbestos-free**

Table R905.9.2

**D4551—2017: Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-containment Membrane**

P2709.2, P2709.2.1

**D4586/D4586M—2007(2018): Specification for Asphalt Roof Cement—asbestos-free**

Table R905.9.2

**D4601/D4601M—04(2012)e1: Specification for Asphalt-coated Glass Fiber Base Sheet Used in Roofing**

Table R905.9.2, R905.11.2.1

**ASTM—continued**

- D4637/D4637M—2015: Specification for EPDM Sheet Used in Single-ply Roof Membrane**  
R905.12.2
- D4829—11: Test Method for Expansion Index of Soils**  
R403.1.8.1
- D4869/D4869M—2016A: Specification for Asphalt-saturated (Organic Felt) Underlayment Used in Steep Slope Roofing**  
R905.1.1.1, Table R905.1.1(1)
- D4897/D4897M—2016: Specification for Asphalt Coated Glass-fiber Venting Base Sheet Used in Roofing**  
Table R905.9.2
- D4990—1997a(2013): Specification for Coal Tar Glass Felt Used in Roofing and Waterproofing**  
Table R905.9.2
- D5019—07a: Specification for Reinforced Nonvulcanized Polymeric Sheet Used in Roofing Membrane**  
R905.12.2
- D5055—2016: Specification for Establishing and Monitoring Structural Capacities of Prefabricated Wood I-joists**  
R502.1.2, R802.1.8
- D5456—2018: Standard Specification for Evaluation of Structural Composite Lumber Products**  
R502.1.5, R602.1.5, R802.1.4
- D5516—2018: Test Method for Evaluating the Flexural Properties of Fire-retardant-treated Softwood Plywood Exposed to the Elevated Temperatures**  
R802.1.5.6
- D5643/D5643M—2006(2018): Specification for Coal Tar Roof Cement Asbestos-free**  
Table R905.9.2
- D5664—2017: Test Methods for Evaluating the Effects of Fire-retardant Treatments and Elevated Temperatures on Strength Properties of Fire-retardant-treated Lumber**  
R802.1.5.7
- D5665/D5665M—99a(2014)E1: Specification for Thermoplastic Fabrics Used in Cold-applied Roofing and Waterproofing**  
Table R905.9.2
- D5726—98(2013): Specification for Thermoplastic Fabrics Used in Hot-applied Roofing and Waterproofing**  
Table R905.9.2
- D6083/D6083M—2018: Specification for Liquid-applied Acrylic Coating Used in Roofing**  
Table R905.9.2, Table R905.11.2, Table R905.14.3, R905.15.2
- D6162/D6162M—2016: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements**  
Table R905.11.2
- D6163/D6163M—2016: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements**  
Table R905.11.2
- D6164/D6164M—2016: Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements**  
Table R905.11.2
- D6222/D6222M—2016: Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using Polyester Reinforcements**  
Table R905.11.2
- D6223/D6223M—2016: Specification for Atactic Polypropylene (APP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcement**  
Table R905.11.2
- D6298—2016: Specification for Fiberglass-reinforced Styrene Butadiene Styrene (SBS) Modified Bituminous Sheets with a Factory Applied Metal Surface**  
Table R905.11.2
- D6305—08(2015)E1: Practice for Calculating Bending Strength Design Adjustment Factors for Fire-retardant-treated Plywood Roof Sheathing**  
R802.1.5.6
- D6380/D6380M—2003(2018): Standard Specification for Asphalt Roll Roofing (Organic Felt)**  
Table R905.1.1(1), R905.2.8.2, R905.5.4

## REFERENCED STANDARDS

### ASTM—continued

- D6464—2003A(2017): Standard Specification for Expandable Foam Adhesives for Fastening Gypsum Wallboard to Wood Framing**  
R702.3.1.1
- D6694/D6694M—08(2013)E1: Standard Specification for Liquid-applied Silicone Coating Used in Spray Polyurethane Foam Roofing Systems**  
Table R905.14.3, R905.15.2
- D6754/D6754M—2015: Standard Specification for Ketone-ethylene-ester-based Sheet Roofing**  
R905.13.2
- D6757/D6757M—2018: Specification for Underlayment Felt Containing Inorganic Fibers Used with Steep Slope Roofing**  
R905.1.1, Table R905.1.1(1)
- D6841—2016: Standard Practice for Calculating Design Value Treatment Adjustment Factors for Fire-retardant-treated Lumber**  
R802.1.5.7
- D6878/D6878M—2017: Standard Specification for Thermoplastic-polyolefin-based Sheet Roofing**  
R905.13.2
- D6947/D6947M—2016: Standard Specification for Liquid Applied Moisture Cured Polyurethane Coating Used in Spray Polyurethane Foam Roofing System**  
Table R905.14.3, R905.15.2
- D7032—2017: Standard Specification for Establishing Performance Ratings for Wood-plastic Composite Deck Boards and Guardrail Systems (Guards or Handrails)**  
R507.2.2, R507.2.2.1, 507.2.2.3, 507.2.2.4
- D7158—D7158M—2019: Standard Test Method for Wind Resistance of Asphalt Shingles (Uplift Force/Uplift Resistance Method)**  
R905.2.4.1, Table R905.2.4.1
- D7254—2017: Standard Specification for Polypropylene (PP) siding**  
Table R703.3(1), R703.14
- D7425/D7425M—13: Standard Specification for Spray Polyurethane Foam Used for Roofing Application**  
R905.14.2
- D7672—2014E1: Standard Specification for Evaluating Structural Capacities of Rim Board Products and Assemblies**  
R502.1.7, R602.1.7, R802.1.7
- D7793—2017: Standard Specification for Insulated Vinyl Siding**  
Table R703.3(1), R703.13
- E84—2018B: Standard Test Method for Surface Burning Characteristics of Building Materials**  
R202, R302.9.3, R302.9.4, R302.10.1, R302.10.2, R316.3, R316.5.9, R316.5.11, R507.2.2.2, R703.14.3, R802.1.5, M1601.3, M1601.5.2, P2801.6
- E96/E96M—2016: Test Method for Water Vapor Transmission of Materials**  
R202, Table R806.5, M1411.6, M1601.4.6
- E108—2017: Test Methods for Fire Tests of Roof Coverings**  
R302.2.4, R902.1
- E119—2018B: Test Methods for Fire Tests of Building Construction and Materials**  
Table R302.1(1), Table R302.1(2), R302.2.1, R302.2.2, R302.3, R302.4.1, R302.11.1, R606.2.2
- E136—2019: Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 Degrees C**  
R202, R302.11
- E283—2004(2012): Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences across the Specimen**  
R202, N1102.4.5
- E330/E330M—14: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference**  
R609.4, R609.5, R609.6.2, R703.1.2
- E331—2000(2016): Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference**  
R703.1.1
- E779—2010(2018): Standard Test Method for Determining Air Leakage Rate by Fan Pressurization**  
N1102.4.1.2
- E814—2013A(2017): Standard Test Method for Fire Tests of Penetration Firestop Systems**  
R302.4.1.2



**ASTM—continued**

- E970—2017: Standard Test Method for Critical Radiant Flux of Exposed Attic Floor Insulation Using a Radiant Heat Energy Source**  
R302.10.5
- E1509—2012(2017): Standard Specification for Room Heaters, Pellet Fuel-burning Type**  
M1410.1
- E1554/E1554 M—13(2018): Standard Test Methods for Determining Air Leakage of Air Distribution Systems by Fan Pressurization**  
N1103.3.5
- E1602—2003(20117): Guide for Construction of Solid Fuel Burning Masonry Heaters**  
R1002.2
- E1745—17: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs**  
R506.2.3
- E1827—2011(2017): Standard Test Methods for Determining Airtightness of Building Using an Orifice Blower Door**  
N1102.4.1.2
- E1886—2013A: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials**  
R301.2.1.2, R609.6.1, R609.6.2, Table R703.11.2
- E1996—2017: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes**  
R301.2.1.2, R301.2.1.2.1, R609.6.1, R609.6.2
- E2178—2013: Standard Test Method for Air Permeance of Building Materials**  
R202
- E2231—2018: Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics**  
M1601.3
- E2273—2018: Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish Systems (EIFS) Clad Wall Assemblies**  
R703.9.2
- E2556/E2556M—2010(2016): Standard Specification for Vapor Permeable Flexible Sheet Water-resistive Barriers Intended for Mechanical Attachment**  
R703.2
- E2568—2017A: Standard Specification for PB Exterior Insulation and Finish Systems**  
R703.9.1, R703.9.2
- E2570/E2570M—07(2014)E1: Standard Test Methods for Evaluating Water-resistive Barrier (WRB) Coatings Used Under Exterior Insulation and Finish Systems (EIFS) or EIFS with Drainage**  
R703.9.2
- E2634—2018: Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems**  
R404.1.3.3.6.1, R608.4.4
- E2925—17: Standard Specification for Manufactured Polymeric Drainage and Ventilation Materials Used to Provide a Rainscreen Function**  
R703.7.3.2
- F405—05: Specification for Corrugated Polyethylene (PE) Pipe and Fittings**  
Table P3009.11, Table P3302.1
- F409—2017: Specification for Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings**  
Table P2701.1, P2702.2, P2702.3
- F437—15: Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80**  
Table P2906.6
- F438—2017: Specification for Socket-type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40**  
Table P2906.6
- F439—13: Specification for Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80**  
Table P2906.6

## REFERENCED STANDARDS

### ASTM—continued

- F441/F441M—15: Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80**  
Table P2906.4, Table P2906.5
- F442/F442M—13E1: Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)**  
Table P2906.4, Table P2906.5
- F477—14: Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe**  
P2906.18, P3003.13
- F493—14: Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings**  
P2906.9.1.2, P2906.9.1.3, P2906.18.2
- F628—2012E2: Specification for Acrylonitrile-butadiene-styrene (ABS) Schedule 40 Plastic Drain, Waste and Vent Pipe with a Cellular Core**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.3.2
- F656—2015: Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings**  
P2906.9.1.4, P3003.9.2
- F714—13: Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter**  
Table P3002.1(2), Table P3002.2, P3010.4
- F844—07a(2013): Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use**  
Table R507.2.3
- F876—2017: Specification for Cross-linked Polyethylene (PEX) Tubing**  
Table M2101.1, Table P2906.4, Table P2906.5
- F877—2018A: Specification for Cross-linked Polyethylene (PEX) Plastic Hot- and Cold-water Distribution Systems**  
Table M2101.1, Table P2906.6
- F891—2016: Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3302.1
- F1055—2016A: Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene Pipe and Tubing**  
Table M2105.5, M2105.11.2, P2906.20.2
- F1281—2017: Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Pressure Pipe**  
Table M2101.1, P2506.12.1, Table P2906.4, Table P2906.5, Table P2906.6
- F1282—2017: Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.12.1
- F1412—2016: Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage**  
Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.11.1
- F1488—14E1: Specification for Coextruded Composite Pipe**  
Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3009.11
- F1504—2014: Standard Specification for Folded Poly (Vinyl Chloride) (PVC) for Existing Sewer and Conduit Rehabilitation**  
P3011.4
- F1554—2018: Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength**  
R608.5.2.2
- F1667—2018: Specification for Driven Fasteners: Nails, Spikes and Staples**  
R317.3, Table R507.2.3, Table R602.3(1), R703.3.3, R703.6.3, Table R703.15.1, Table R703.15.2, R905.2.5
- F1807—2018: Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing**  
Table M2101.1, Table P2906.6
- F1866—2018: Specification for Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings**  
Table P3002.3
- F1871—2011: Standard Specification for Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation**  
P3011.4
- F1924—12: Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing**  
M2105.11.1

**ASTM—continued**

- F1960—2018: Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing**  
Table M2101.1, Table P2906.6
- F1970—12E1: Standard Specification for Special Engineered Fittings, Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems**  
M2105.5, Table 2903.9.4
- F1973—2013(2018): Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA 11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems**  
G2415.17.2
- F1974—09(2015): Specification for Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene Composite Pressure Pipe**  
Table P2906.6, P2906.12.1
- F1986—2001(2011): Specification for Multilayer Pipe, Type 2, Compression Fittings and Compression Joints for Hot and Cold Drinking Water Systems**  
Table P2906.4, Table P2906.5, Table P2906.6
- F2080—2016: Specification for Cold-expansion Fittings with Metal Compression-sleeves for Cross-linked Polyethylene (PEX) Pipe**  
Table P2906.6
- F2090—17: Specification for Window Fall Prevention Devices with Emergency Escape (Egress) Release Mechanisms**  
R310.1.1, R312.2.1, R312.2.2
- F2098—2015: Standard Specification for Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings**  
Table M2101.1, Table P2906.6
- F2159—2018: Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing**  
Table P2906.6
- F2262—09: Standard Specification for Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene Tubing OD Controlled SDR9**  
Table P2906.4, Table P2906.5
- F2389—2017A: Standard for Pressure-rated Polypropylene (PP) Piping Systems**  
Table P2906.4, Table P2906.5, Table P2906.6, P2906.11.1
- F2434—14: Standard Specification for Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX AL-PEX) Tubing**  
Table P2906.6
- F2623—14: Standard Specification for Polyethylene of Raised Temperature (PE-RT) SDR9 Tubing**  
Table M2101.1
- F2735—2009(2016): Standard Specification for Plastic Insert Fittings for SDR9 Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing**  
Table M2101.1, Table P2906.6
- F2769—2018: Polyethylene or Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6
- F2806—10(2015): Standard Specification for Acrylonitrile-butadiene-styrene (ABS) Plastic Pipe (Metric SDR-PR)**  
Table M2101.1
- F2855—12: Standard Specification for Chlorinated Poly (Vinyl Chloride)/Aluminum/Chlorinated Poly (Vinyl Chloride) (CPVC AL CPVC) Composite Pressure Tubing**  
Table P2906.4, Table P2906.5
- F2945—2018: Standard Specification for Polyamide 11 Gas Pressure Pipe, Tubing and Fittings**  
G2414.6
- F2969—12: Standard Specification for Acrylonitrile-butadiene-styrene (ABS) IPS Dimensioned Pressure Pipe**  
Table M2101.1
- F3226/F3226M—16: Standard Specification for Metallic Press-Connect Fittings for Piping and Tubing Systems**  
Table P2906.6
- F3253—2017: Standard Specification for Crosslinked Polyethylene (PEX) Tubing with Oxygen Barrier for Hot- and Cold-Water Hydronic Distribution Systems**  
Table M2101.1

## REFERENCED STANDARDS

### AWC

American Wood Council  
222 Catocin Circle SE, Suite 201  
Leesburg, VA 20175

**ANSI/AWC NDS—2018: National Design Specification (NDS) for Wood Construction—with 2018 Supplement**

R404.2.2, R502.2, Table R503.1, R507.2.1, R602.3, R608.9.2, R608.9.3, Table R703.15.1,  
Table R703.15.2, R802.2

**ANSI/AWC PWF—2021: Permanent Wood Foundation Design Specification**

R317.3.2, R401.1, R404.2.3

**ANSI/AWC WFCM—2018: Wood Frame Construction Manual for One- and Two-family Dwellings**

R301.1.1, R301.2.1.1, R602.10.8.2, Figure R608.9(9), R608.9.2, R608.9.3, R608.10

**AWC STJR—2021: Span Tables for Joists and Rafters**

R502.3, R802.4.1, R802.5.1

### AWPA

American Wood Protection Association  
P.O. Box 361784  
Birmingham, AL 35236-1784

**C1—03: All Timber Products—Preservative Treatment by Pressure Processes**

R902.2

**M4—15: Standard for the Care of Preservative-treated Wood Products**

R317.1.1, R318.1.2

**U1—20: USE CATEGORY SYSTEM: User Specification for Treated Wood Except Commodity Specification H**

R317.1, R402.1.2, R504.3, R703.6.3, R905.7.5, Table R905.8.5, R905.8.6

### AWS

American Welding Society  
8669 NW 36 Street, #130  
Miami, FL 33166

**A5.8M/A5.8—2011—AMD1: Specification for Filler Metals for Brazing and Braze Welding**

P3003.6.1

**ANSI/AWS A5.31M/A5.31—2012: Specification for Fluxes for Brazing and Braze Welding Edition: 2nd**

M2103.3, M2202.2, P2906.15

### AWWA

American Water Works Association  
6666 West Quincy Avenue  
Denver, CO 80235

**C104/A21.4—16: Cement-mortar Lining for Ductile-iron Pipe and Fittings**

P2906.4

**C110/A21.10—12: Ductile-iron and Gray-iron Fittings**

Table P2906.6, P3002.3

**C115/A21.15—11: Flanged Ductile-iron Pipe with Ductile-iron or Gray-iron Threaded Flanges**

Table P2906.4

**C151/A21.51—17: Ductile-iron Pipe, Centrifugally Cast, for Water**

Table P2906.4

**C153/A21.53—11: Ductile-iron Compact Fittings for Water Service**

Table P2906.6

**C500—09: Standard for Metal-seated Gate Valves for Water Supply Service**

Table P2903.9.4

**C504—15: Standard for Rubber-seated Butterfly Valves**

Table P2903.9.4

**C507—15: Standard for Ball Valves, 6 In. Through 60 In. (150 mm through 1,500 mm)**

Table P2903.9.4

**C510—07: Double Check Valve Backflow Prevention Assembly**

Table P2902.3, P2902.3.6

## REFERENCED STANDARDS

### AWWA—continued

**C511—17: Reduced-pressure Principle Backflow Prevention Assembly**

Table P2902.3, P2902.3.5, P2902.5.1

**C901—16: Polyethylene (PE) Pressure Pipe and Tubing  $\frac{1}{2}$  in. (13 mm) through 3 in. (76 mm) for Water Service**

P2906.4

**C903—16: Polyethylene-aluminum-polyethylene (PE-AL-PE) Composite Pressure Pipe, 12 mm ( $\frac{1}{2}$  in.) through 50 mm (2 in.), for Water Service**

Table M2105.4

**C904—16: Cross-linked Polyethylene (PEX) Pressure Tubing,  $\frac{1}{2}$  in. (13 mm) through 3 in. (76 mm) for Water Service**

P2906.4

---

## CEN

European Committee for Standardization (EN)

Rue de la Science 23

Brussels, Belgium B - 1040

**EN 15250—2007: Slow Heat Release Appliances Fired by Solid Fuel Requirements and Test Methods**

R1002.2

---

## CISPI

Cast Iron Soil Pipe Institute

2401 Fieldcrest Drive

Mundelein, IL 60060

**301—18: Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications**

Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, Table P3302.1

**310—18: Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications**

P3003.4.3

---

## CPA

Composite Panel Association

19465 Deerfield Avenue, Suite 306

Leesburg, VA 20176

**ANSI A135.4—2012: Basic Hardboard**

Table R602.3(2)

**ANSI A135.5—2012: Prefinished Hardboard Paneling**

R702.5

**ANSI A135.6—2012: Engineered Wood Siding**

R703.5

**ANSI A135.7—2012: Engineered Wood Trim**

R703.5

**ANSI A208.1—2016: Particleboard**

R503.3.1, R602.1.9, R605.1

---

## CPSC

Consumer Product Safety Commission

4330 East-West Highway

Bethesda, MD 20814

**16 CFR, Part 1201—(2002): Safety Standard for Architectural Glazing**

R308.1.1, R308.3.1, Table R308.3.1(1)

**16 CFR, Part 1209—(2002): Interim Safety Standard for Cellulose Insulation**

R302.10.3

**16 CFR, Part 1404—(2002): Cellulose Insulation**

R302.10.3



## REFERENCED STANDARDS

# CSA

CSA Group  
8501 East Pleasant Valley Road  
Cleveland, OH 44131-5516

- A112.18.6—2017/CSA B125.6—2017: Flexible Water Connectors**  
P2906.7
- A112.19.5—2017/CSA B45.15—2017: Flush Valves and Spuds for Water-closets, Urinals and Tanks**  
Table P2701.1
- A112.19.7—2012/CSA B45.10—2012(R2017): Hydromassage Bathtub Systems**  
Table P2701.1
- A257.2—14: Reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings**  
Table P3002.2, P3003.13
- A257.3—14: Joints for Circular Concrete Sewer and Culvert Pipe, Manhole Sections and Fittings Using Rubber Gaskets**  
P3003.5, P3003.13
- AAMA/WDMA/CSA 101/IS.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Unit Skylights**  
R308.6.9, R609.3, N1102.4.3
- ANSI/CSA FC I—2014: Fuel Cell Technologies—Part 3-100; Stationary Fuel Cell Power Systems—Safety**  
M1903.1
- ANSI/CSA/IGSHPA C448 Series—16: Design and Installation of Ground Source Heat Pump Systems for Commercial and Residential Buildings**  
Table M2105.4, Table M2105.5
- ASME A17.1/CSA B44—2019: Safety Code for Elevators and Escalators**  
R321.1
- ASME A112.3.4—2018/CSA B45.9—2018: Macerating Toilet Systems and Related Components**  
Table P2701.1, P3007.5
- ASME A112.4.2—2015/CSA B45.16—2015(2020): Water-closet Personal Hygiene Device**  
P2722.5
- ASME A112.18.1—2018/CSA B125.1—2018: Plumbing Supply Fittings**  
Table P2701.1, P2708.4, P2708.5, P2722.1, P2722.3, P2902.2, Table P2903.9.4
- ASME A112.18.2—2020/CSA B125.2—2020: Plumbing Waste Fittings**  
Table P2701.1, P2702.2
- ASME A112.19.1—2018/CSA B45.2—18: Enameled Cast-iron and Enameled Steel Plumbing Fixtures**  
Table P2701.1, P2711.1
- ASME A112.19.2—2018/CSA B45.1—18: Ceramic Plumbing Fixtures**  
Table P2701.1, P2705.1, P2711.1, P2712.1, P2712.2, P2712.9
- ASME A112.19.3—2017/CSA B45.4—2017: Stainless Steel Plumbing Fixtures**  
Table P2701.1, P2705.1, P2711.1, P2712.1
- ASSE 1002—2020/ASME A112.1002—2020/CSA B125.12—20: Anti-Siphon Fill Valves for Water Closet Tanks**  
Table P2701.1, Table P2902.3, P2902.4.1
- ASSE 1016—2017/ASME 112.1016—2017/CSA B125.16—2017: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations**  
Table P2701.1, P2708.4, P2722.2
- ASSE 1070—2020/ASME A112.1070—2020/CSA B125.70—2020: Performance Requirements for Water-temperature-limiting Devices**  
P2713.3, P2721.2, P2724.1
- B44—2019: Safety Code for Elevators and Escalators**  
R321.1
- B55.1—2015: Test Method for Measuring Efficiency and Pressure Loss of Drain Water Heat Recovery Units**  
N1103.5.4
- B55.2—2015: Drain Water Heat Recovery Units**  
N1103.5.4

**CSA—continued**

- B64.1.1—11(R2016): Vacuum Breakers, Atmospheric Type (AVB)**  
Table P2902.3, P2902.3.2
- B64.1.2—11(R2016): Pressure Vacuum Breakers (PVB)**  
Table P2902.3, P2902.3.4
- B64.1.3—11(R2016): Spill Resistant Pressure Vacuum Breakers (SRPVB)**  
Table P2902.3
- B64.2—11(R2016): Vacuum Breakers, Hose Connection Type (HCVB)**  
Table P2902.3, P2902.3.2
- B64.2.1—11(R2016): Hose Connection Vacuum Breakers (HCVB) with Manual Draining Feature**  
Table P2902.3, P2902.3.2
- B64.2.1.1—11(2016): Hose Connection Dual Check Vacuum Breakers (HCDVB)**  
Table P2902.3, P2902.3.2
- B64.2.2—11(2016): Vacuum Breakers, Hose Connection Type (HCVB) with Automatic Draining Feature**  
Table P2902.3, P2902.3.2
- B64.3—11(2016): Dual Check Backflow Preventers with Atmospheric Port (DCAP)**  
Table P2902.3, P2902.3.2, P2902.5.1
- B64.4—11(2016): Backflow Preventers, Reduced Pressure Principle Type (RP)**  
Table P2902.3, P2902.3.5
- B64.4.1—11(2016): Reduced Pressure Principle for Fire Sprinklers (RPF)**  
Table P2902.3, P2902.3.5
- B64.5—11(2016): Double Check Backflow Preventers (DCVA)**  
Table P2902.3, P2902.3.6
- B64.5.1—11(2016): Double Check Valve Backflow Preventers, Type for Fire Systems (DCVAF)**  
Table P2902.3, P2902.3.6
- B64.6—11(2016): Dual Check Valve Backflow Preventers (DuC)**  
Table P2902.3, P2902.3.7
- B64.7—11(2016): Laboratory Faucet Vacuum Breakers (LFVB)**  
Table P2902.3, P2902.3.2
- B125.3—18: Plumbing Fittings**  
Table P2701.1, P2713.3, P2721.2, Table P2902.3, P2902.4.1, Table P2903.9.4
- B137.1—17: Polyethylene (PE) Pipe, Tubing and Fittings for Cold Water Pressure Services**  
Table P2906.4, Table P2906.6
- B137.2—17: Polyvinylchloride PVC Injection-moulded Gasketed Fittings for Pressure Applications**  
Table P2906.6
- B137.3—17: Rigid Poly (Vinyl Chloride) (PVC) Pipe for Pressure Applications**  
Table P2906.4, Table P2906.6, P3003.9.2
- B137.5—17: Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications**  
Table P2906.4, Table P2906.5, Table P2906.6
- B137.6—17: Chlorinated polyvinylchloride CPVC Pipe, Tubing and Fittings For Hot- and Cold-water Distribution Systems**  
Table P2906.4, Table P2906.5, Table 2906.6
- B137.9—17: Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe Systems**  
Table M2101.1, Table P2906.4
- B137.10—17: Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PE-AL-PE) Composite Pressure Pipe Systems**  
Table M2101.1, Table P2906.4, Table P2906.5, Table P2906.6, P2906.12.1
- B137.11—17: Polypropylene (PP-R) Pipe and Fittings for Pressure Applications**  
Table P2906.4, Table P2906.5, Table P2906.6
- B137.18—17: Polyethylene of Raised Temperature (PE-RT) Tubing Systems for Pressure Applications**  
Table M2101.1, Table M2105.4, Table M2105.5, Table P2906.4, Table P2906.5, Table P2906.6
- B181.1—18: Acrylonitrile-butadiene-styrene (ABS) Drain, Waste and Vent Pipe and Pipe Fittings**  
Table P3002.1(1), Table P3002.1(2), Table P3002.3, P3003.3.2
- B181.2—18: Polyvinylchloride (PVC) and chlorinated polyvinylchloride (CPVC) Drain, Waste and Vent Pipe and Pipe Fittings**  
Table P3002.1(1), Table P3002.1(2), P3003.9.2, P3008.3

## REFERENCED STANDARDS

### CSA—continued

**B181.3—18: Polyolefin and polyvinylidene (PVDF) Laboratory Drainage Systems**

Table P3002.1(1), Table P3002.1(2), Table P3002.2, Table P3002.3, P3003.11.1

**B182.1—18: Plastic Drain and Sewer Pipe and Pipe Fittings**

Table P3302.1

**B182.2—18: PSM Type polyvinylchloride (PVC) Sewer Pipe and Fittings**

Table P3002.2, Table P3302.1

**B182.4—18: Profile polyvinylchloride (PVC) Sewer Pipe & Fittings**

Table P3002.2, Table P3302.1

**B182.6—18: Profile Polyethylene (PE) Sewer Pipe and Fittings for leak-proof Sewer Applications**

Table P3302.1

**B182.8—18: Profile Polyethylene (PE) Storm Sewer and Drainage Pipe and Fittings**

Table P3302.1

**B356—10(R2020): Water Pressure Reducing Valves for Domestic Water Supply Systems**

P2903.3.1

**B483.1—07(R2017): Drinking Water Treatment Systems**

P2909.1, P2909.2

**B602—16: Mechanical Couplings for Drain, Waste and Vent Pipe and Sewer Pipe**

P3003.3.1, P3003.4.3, P3003.5, P3003.9.1, P3003.10, P3003.12.2, P3003.13

**C22.2 No. 218.1—13(R2017): Spas, Hot Tubs and Associated Equipment**

M2006.1

**C22.2 No. 236—15: Heating and Cooling Equipment**

M2006.1

**CAN/CSA/C22.2 No. 60335-2-40—2012: Safety of Household and Similar Electrical Appliances, Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers**

M1403.1, M1412.1, M1413.1

**CSA 8—93: Requirements for Gas Fired Log Lighters for Wood Burning Fireplaces**

G2433.1

**CSA A257.1—2014: Non-reinforced Circular Concrete Culvert, Storm Drain, Sewer Pipe and Fittings**

Table P3002.2

**CSA B45.5—2017/IAPMO Z124—2017 with Errata dated August 2017: Plastic Plumbing Fixtures**

Table P2701.1, P2711.1, P2711.2, P2712.1

**CSA B805—18/ICC 805—18: Rainwater Harvesting Systems**

P2912.1

**CSA O325—16: Construction Sheathing**

R503.2.1, R602.1.8, R604.1, R803.2.1

**O437-Series—93(R2011): Standards on OSB and Waferboard**

R503.2.1, R602.1.8, R604.1, R803.2.1

---

## CSSB

Cedar Shake & Shingle Bureau

P.O. Box 1178

Sumas, WA 98295-1178

**CSSB—97: Grading and Packing Rules for Western Red Cedar Shakes and Western Red Cedar Shingles of the Cedar Shake and Shingle Bureau**

R702.6, R703.6

---

## DASMA

Door & Access Systems Manufacturers Association International

1300 Sumner Avenue

Cleveland, OH 44115-2851

**105—2017: Test Method for Thermal Transmittance and Air Infiltration of Garage Doors and Rolling Doors**

N1101.10.3

## REFERENCED STANDARDS

**DASMA—continued**

**ANSI/DASMA 108—2017: Standard Method for Testing Sectional Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Uniform Static Air Pressure Difference**  
R609.4

**ANSI/DASMA 115—2017: Standard Method for Testing Sectional Garage Doors, Rolling Doors and Flexible Doors: Determination of Structural Performance Under Missile Impact and Cyclic Wind Pressure**  
R301.2.1.2

---

**DHA**

Decorative Hardwoods Association (formerly HPVA)  
42777 Trade West Drive  
Sterling, Virginia 20166

**ANSI/HPVA HP-1—2016: American National Standard for Hardwood and Decorative Plywood**  
R702.5

---

**DOC**

United States Department of Commerce  
1401 Constitution Avenue, NW  
Washington, DC 20230

**PS 1—19: Structural Plywood**  
R404.2.1, Table R404.2.3, R503.2.1, R602.1.8, R604.1, R803.2.1

**PS 2—18: Performance Standard for Wood Structural Panels**  
R404.2.1, Table R404.2.3, R503.2.1, R602.1.8, R604.1, R803.2.1

**PS 20—05: American Softwood Lumber Standard**  
R404.2.1, R502.1.1, R602.1.1, R802.1.1

---

**DOTn**

U.S. Department of Transportation  
1200 New Jersey Avenue SE  
Washington, DC 20590

**49 CFR, Parts 192.281(e) & 192.283 (b) (2009): Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards**  
G2414.5.1

---

**FEMA**

Federal Emergency Management Agency  
500 C Street SW  
Washington, DC 20472

**FEMA TB-2—08: Flood Damage-resistant Materials Requirements**  
R322.1.8

**FEMA TB-11—01: Crawlspace Construction for Buildings Located in Special Flood Hazard Area**  
R408.7

---

**FM**

FM Approvals  
Headquarters Office  
Norwood, MA 02062

**4450—(1989): Approval Standard for Class 1 Insulated Steel Deck Roofs—with Supplements through July 1992**  
R906.1

**4474—2011: American National Standard for Evaluating the Simulated Wind Uplift Resistance of Roof Assemblies Using Static Positive and/or Negative Differential Pressures**  
R905.4.4.1

**ANSI/FM 4880—(2017): American National Standard for Evaluating the Fire Performance of Insulated Building Panel Assemblies and Interior Finish Materials**  
R316.6

## REFERENCED STANDARDS

### GA

Gypsum Association  
6525 Belcrest Road, Suite 480  
Hyattsville, MD 20782

**GA-253—2018: Application of Gypsum Sheathing**  
Table R602.3(1)

### HVI

Home Ventilating Institute  
1740 Dell Range Blvd., Suite H, PMB 450  
Cheyenne, WY 82009

**916—18: Airflow Test Procedure**  
N1103.6.2

### IAPMO

IAPMO Group  
4755 E. Philadelphia Street  
Ontario, CA 91761-USA

**CSA B45.5—17/IAPMO Z124—2017: Plastic Plumbing Fixtures**  
Table P2701.1, P2711.1, P2711.2, P2712.1

### ICC

International Code Council, Inc.  
500 New Jersey Avenue NW  
6th Floor  
Washington, DC 20001

**ANSI/RESNET/ICC 301—2019: Standard for the Calculation and Labeling of the Energy Performance of Low-rise Dwelling and Sleeping Units Using the Energy Rating Index**  
N1106.4

**ANSI/RESNET/ICC 380—2019: Standard for Testing Airtightness of Building, Dwelling Unit and Sleeping Unit Enclosures; Airtightness of Heating and Cooling Air Distribution Systems and Airflow of Mechanical Ventilation Systems**  
N1102.4.1.2

**IBC—21: International Building Code®**  
R320.1.1, R101.2, R202, R301.1.1, R301.1.3, R301.2.1.1, R301.2.2.1.1, R301.2.2.1.2, R301.3,  
Table R302.1(1), Table R302.1(2), R302.2.1, R302.2.2, R302.3, R308.5, R320.1, R321.3, R403.1.8,  
Table R602.10.3(3), Table R606.12.2.1, R609.2, R802.1.5.4, R905.10.3, G2402.3

**ICC 400—17: Standard on the Design and Construction of Log Structures**  
R301.1.1, R502.1.4, R602.1.4, R703.1, R802.1.3, N1102.1, Table N1102.4.1.1

**ICC 500—2020: ICC/NSSA Standard for the Design and Construction of Storm Shelters**  
R323.1

**ICC 600—2020: Standard for Residential Construction in High-wind Regions**  
R301.2.1.1

**ICC 900/SRCC 300—2020: Solar Thermal System Standard**  
M2301.2.2.2, M2301.2.3, M2301.2.6, M2301.2.7, M2301.2.8, M2301.2.10, M2301.4

**ICC 901/SRCC 100—2020: Solar Thermal Collector Standard**  
M2301.3.1

**ICC/ANSI A117.1—17: Accessible and Usable Buildings and Facilities**  
R321.3

**IEBC—21: International Existing Building Code®**  
R110.2

**IECC—06: International Energy Conservation Code®**  
N1101.6

**IECC—21: International Energy Conservation Code®**  
N1101.1, N1103.8, Table N1105.4.2(1)

**IFC—21: International Fire Code®**  
R102.7, R324.2, M2201.7, G2402.3, G2412.2



**ICC—continued****IFGC—21: International Fuel Gas Code®**

G2401.1, G2402.3, G2423.1

**IMC—21: International Mechanical Code®**

G2402.3

**IPC—21: International Plumbing Code®**

Table R301.2(1), R903.4.1, G2402.3, P2601.1

**IPMC—21: International Property Maintenance Code®**

R102.7

**IPSDC—21: International Private Sewage Disposal Code®**

R322.1.7

**ISPSC—21: International Swimming Pool and Spa Code®**

R327.1

---

**IEEE**Institute of Electrical and Electronic Engineers, Inc.  
3 Park Avenue, 17th Floor  
New York, NY 10016-5997**515.1—2012: IEEE Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications**

N1103.5.2.2

---

**ISO**International Organization for Standardization  
Chemin de Blandonnet 8  
Geneva, Switzerland CP 401 - 1214**8336—2009: Fibre-cement Flat Sheets-product Specification and Test Methods**

Table R503.2.1.1(1), Table R503.2.1.1(2), Table R602.3(2), Table R702.4.2, R703.10.1, R703.10.2

**15874—2002: Polypropylene Plastic Piping Systems for Hot and Cold Water Installations**

Table M2101.1

---

**MSS**Manufacturers Standardization Society of the Valve and Fittings Industry  
127 Park Street, NE  
Vienna, VA 22180**SP-42—2013: Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300 & 600)**

Table P2903.9.4

**SP-58—2009: Pipe Hangers and Supports—Materials, Design, Manufacture, Selection, Application, and Installation**

G2418.2

**SP-67—2011: Butterfly Valves**

Table P2903.9.4

**SP-70—2011: Gray Iron Gate Valves, Flanged and Threaded Ends**

Table P2903.9.4

**SP-71—2011: Gray Iron Swing Check Valves, Flanged and Threaded Ends**

Table P2903.9.4

**SP-72—2010a: Ball Valves with Flanged or Butt-Welding Ends for General Service**

P2903.9.4

**SP-78—2011: Cast Iron Plug Valves, Flanged and Threaded Ends**

Table P2903.9.4

**SP-80—2019: Bronze Gate, Globe, Angle and Check Valves**

Table P2903.9.4

**SP-110—2010: Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends (incl. a 2010 Errata Sheet)**

Table P2903.9.4

## REFERENCED STANDARDS

### MSS—continued

**SP-122—2012: Plastic Industrial Ball Valves**

Table P2903.9.4

**SP-139—2014: Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/ Low Temperature Plumbing Applications**

Table P2903.9.4

---

## NAIMA

North American Insulation Manufacturers Association  
11 Canal Center Plaza, Suite 101  
Alexandria, VA 22314

**AH 116—09: Fibrous Glass Duct Construction Standards, Fifth Edition**

M1601.1.1

---

## NEMA

National Electrical Manufacturers Association  
12300 17th Street North No. 900  
Arlington, VA 22209

**OS 4—2016: Requirements for Air-Sealed Boxes for Electrical and Communication Applications**

N1102.4.6

---

## NFPA

National Fire Protection Association  
1 Batterymarch Park  
Quincy, MA 02169-7471

**13D—19: Standard for the Installation of Sprinkler Systems in One- and Two-family Dwellings and Manufactured Homes**

R313.1.1, R313.2.1, R324.6.2.1, P2904.1, P2904.6.1

**13R—19: Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies**

R325.5

**31—20: Standard for the Installation of Oil-burning Equipment**

M1701.1, M1801.3.1, M1805.3, M2201.2

**58—20: Liquefied Petroleum Gas Code**

G2412.2, G2414.5.2

**70—20: National Electrical Code**

R107.3, R324.3, R328.6, E3401.1, E3401.2, E4301.1, Table E4303.2, E4304.3, E4304.4

**72—19: National Fire Alarm and Signaling Code**

R314.1, R314.7.1

**85—19: Boiler and Combustion Systems Hazards Code**

G2452.1

**211—19: Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances**

R1002.5, G2427.5.5.1

**259—18: Standard for Test Method for Potential Heat of Building Materials**

R316.5.7, R316.5.8

**275—17: Standard Method of Fire Tests for the Evaluation of Thermal Barriers**

R316.4

**276—15: Standard Method of Fire Tests for Determining the Heat Release Rate of Roofing Assemblies with Combustible Above-deck Roofing Components**

R906.1

**286—19: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth**

R302.9.4, R316.6

**501—17: Standard on Manufactured Housing**

R202

**720—15: Standard for the Installation of Carbon Monoxide (CO) Detectors and Warning Equipment**

R315.7.1, R315.7.2

**853—20: Standard on the Installation of Stationary Fuel Cell Power Systems**

M1903.1

---

**REFERENCED STANDARDS**


---

**NFRC**

National Fenestration Rating Council, Inc.  
6305 Ivy Lane, Suite 140  
Greenbelt, MD 20770

**100—2020: Procedure for Determining Fenestration Products *U*-Factors**

N1101.10.3

**200—2020: Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence**

N1101.10.3

**400—2020: Procedure for Determining Fenestration Product Air Leakage**

N1102.4.3

---

**NGWA**

National Ground Water Association  
601 Dempsey Road  
Westerville, OH 43081

**ANSI/NGWA 01—14: Water Well Construction Standard**

P2602.1

---

**NSF**

NSF International  
789 N. Dixboro Road  
Ann Arbor, MI 48105

**14—2017: Plastics Piping System Components and Related Materials**

M1301.4, P2609.3, P2909.3

**41—2016: Non-Liquid Saturated Treatment Systems**

P2725.1

**42—2017: Drinking Water Treatment Units—Aesthetic Effects**

P2909.1, P2909.3

**44—2017: Residential Cation Exchange Water Softeners**

P2909.1, P2909.3

**50—2017: Equipment for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities**

P2911.8.1

**53—2017: Drinking Water Treatment Units—Health Effects**

P2909.1, P2909.3

**58—2017: Reverse Osmosis Drinking Water Treatment Systems**

P2909.2, P2909.3

**61—2018: Drinking Water System Components—Health Effects**

P2609.5, P2722.1, P2903.9.4, P2906.4, P2906.5, P2906.6, P2909.3

**62—2017: Drinking Water Distillation Systems**

P2909.1

**350—2017a: Onsite Residential and Commercial Water Reuse Treatment Systems**

P2911.6.1

**358-1—2017: Polyethylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems**

M2105.4, M2105.5

**358-2—2017: Polypropylene Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems**

Table M2105.4, M2105.5

**358-3—2016: Cross-linked Polyethylene (PEX) Pipe and Fittings for Water-Based Ground-Source “Geothermal” Heat Pump Systems**

Table M2105.4, Table M2105.5

**358-4—2018: Polyethylene of Raised Temperature (PE-RT) Tubing and Fittings for Water-Based Ground-Source (Geothermal) Heat Pump Systems**

Table 2105.4, Table 2105.5

**359—2016: Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems**

Table P2903.9.4

**372—2016: Drinking Water Systems Components—Lead Content**

P2906.2.1

## REFERENCED STANDARDS

---

### PCA

Portland Cement Association  
5420 Old Orchard Road  
Skokie, IL 60077

**100—17: Prescriptive Design of Exterior Concrete Walls for One- and Two-family Dwellings (Pub. No. PCA 100.3)**

R301.2.2.5, R404.1.3, R404.1.3.2.1, R404.1.3.2.2, R404.1.3.4, R404.1.4.2, R608.1, R608.2,  
R608.5.1, R608.9.2, R608.9.3

---

### SBCA

Structural Building Components Association  
6300 Enterprise Lane  
Madison, WI 53719

**ANSI/SBCA FS100—2012(R2018): Standard Requirements for Wind Pressure Resistance of Foam Plastic Insulating Sheathing  
Used in Exterior Wall Covering Assemblies**

R316.8

**BCSI—2018: Building Component Safety Information Guide to Good Practice for Handling, Installing, Restraining & Bracing of  
Metal Plate Connected Wood Trusses**

R502.11.2, R802.10.3

**CFS-BCSI—(updated June 2016): Cold-formed Steel Building Component Safety Information (CFSBCSI) Guide to Good Practice  
for Handling, Installing & Bracing of Cold-formed Steel Trusses**

R505.1.3, R804.3.6

---

### SMACNA

Sheet Metal & Air Conditioning Contractors National Assoc. Inc.  
4021 Lafayette Center Road  
Chantilly, VA 22021

**SMACNA—2010: Fibrous Glass Duct Construction Standards 7th edition**

M1601.1.1, M1601.4.1

**ANSI/SMACNA 006—2020: HVAC Duct Construction Standards—Metal and Flexible 4th Edition**

M1601.4.1

---

### TMS

The Masonry Society  
105 South Sunset Street, Suite Q  
Longmont, CO 80501

**402—2016: Building Code Requirements for Masonry Structures**

R404.1.2, R606.1, R606.1.1, R606.12.1, R606.12.2.3.1, R606.12.3.1, R703.12

**403—2017: Direct Design Handbook for Masonry Structures**

R606.1, R606.1.1, R606.12.1, R606.12.3.1

**404—2016: Standard for the Design of Architectural Cast Stone**

R606.1

**602—2016: Specification for Masonry Structures**

R606.2.10, R606.2.13, R703.12

---

### TPI

Truss Plate Institute  
2670 Crain Highway, Suite 203  
Waldorf, MD 20601

**TPI 1—2014: National Design Standard for Metal Plate Connected Wood Truss Construction**

R502.11.1, R802.10.2

---

### UL

UL LLC  
333 Pfingsten Road  
Northbrook, IL 60062

**17—2008: Vent or Chimney Connector Dampers for Oil-fired Appliances—with revisions through September 2013**

M1802.2.2

## UL—continued

- 55A—2004: Materials for Built-up Roof Coverings**  
R905.9.2
- 58—2018: Steel Underground Tanks for Flammable and Combustible Liquids**  
M2201.1
- 80—2007: Steel Tanks for Oil-burner Fuel—with revisions through January 2014**  
M2201.1
- 103—2010: Factory-built Chimneys for Residential Type and Building Heating Appliances—with revisions through March 2017**  
R202, R1005.3, G2430.1
- 127—2011: Factory-built Fireplaces—with revisions through July 2016**  
R1001.11, R1004.1, R1004.4, R1004.5, R1005.4, N1102.4.2, G2445.7
- 174—2004: Household Electric Storage Tank Water Heaters—with revisions through December 2016**  
M2005.1
- 180—2012: Liquid-level Indicating Gauges for Oil Burner Fuels and Other Combustible Liquids—with revisions through May 2017**  
M2201.5
- 181—2005: Factory-made Air Ducts and Air Connectors—with revisions through April 2017**  
M1601.1.1, M1601.4.1
- 181A—2013: Closure Systems for Use with Rigid Air Ducts and Air Connectors—with revisions through March 2017**  
M1601.2, M1601.4.1
- 181B—2013: Closure Systems for Use with Flexible Air Ducts and Air Connectors—with revisions through March 2017**  
M1601.4.1
- 217—2015: Smoke Alarms—with revisions through November 2016**  
R314.1.1, R315.1.1
- 263—2011: Fire Test of Building Construction and Materials—with revisions through March 2018**  
Table R302.1(2), R302.2, R302.2.1, R302.2.2, R302.4.1, R302.11.1, R606.2.2
- 268—2016: Smoke Detectors for Fire Alarm Systems—with revisions through July 2016**  
R314.7.1, R314.7.4, R315.7.4
- 325—2017: Door, Drapery, Gate, Louver and Window Operations and Systems**  
R309.4
- 343—2017: Pumps for Oil-burning Appliances**  
M2204.1
- 378—06: Draft Equipment—with revisions through September 2013**  
M1804.2.6, G2427.3.3
- 441—16: Gas Vents—with revisions through July 2016**  
G2426.1, G2427.6.1
- 467—13: Grounding and Bonding Equipment**  
G2411.2.5
- 507—2017: Electric Fans—with revisions through August 2018**  
M1503.2
- 508—2018: Industrial Control Equipment**  
M1411.3.1
- 515—11: Electrical Resistance Heat Tracing for Commercial and Industrial Applications Including Revisions through July 2015**  
N1103.5.1.2
- 536—2014: Flexible Metallic Hose**  
M2202.3
- 580—2006: Test for Uplift Resistance of Roof Assemblies—with Revisions through October 2013**  
R905.4.4.1
- 641—2010: Type L, Low-temperature Venting Systems—with revisions through April 2018**  
R202, R1003.11.5, M1804.2.4, G2426.1, G2427.6.1
- 651—2011: Schedule 40, Type EB and A Rigid PVC Conduit and Fittings—with revisions through June 2016**  
G2414.5.3
- 705—2017: Power Ventilators—with revisions through October 2018**  
M1502.4.4



## REFERENCED STANDARDS

### UL—continued

- 723—2018: Standard for Test for Surface Burning Characteristics of Building Materials**  
R202, R302.9.3, R302.9.4, R302.10.1, R302.10.2, R316.3, R316.5.9, R316.5.11, R507.2.2.2, R703.14.3, R802.1.5, M1601.3, M1601.5.2, P2801.6
- 726—95: Oil-fired Boiler Assemblies—with revisions through October 2013**  
M2001.1.1, M2006.1
- 727—2018: Oil-fired Central Furnaces**  
M1402.1
- 729—2003: Oil-fired Floor Furnaces**  
M1408.1
- 730—03: Oil-fired Wall Furnaces—with revisions through November 2016**  
M1409.1
- 732—2018: Oil-fired Storage Tank Water Heaters—with revisions through August 2018**  
M2005.1
- 737—2011: Fireplaces Stoves**  
M1414.1, M1901.2
- 790—04: Standard Test Methods for Fire Tests of Roof Coverings—with revisions through October 2018**  
R302.2.4, R902.1
- 795—2016: Commercial-industrial Gas Heating Equipment**  
G2442.1, G2452.1
- 834—2004: Heating, Water Supply and Power Boilers—Electric—with revisions through September 2018**  
M2001.1.1
- 842—2015: Valves for Flammable Fluids—with revisions through May 2015**  
M2204.2
- 858—2014: Household Electric Ranges—with revisions through June 2018**  
M1503.2, M1901.2
- 875—09: Electric Dry-bath Heaters—with revisions through September 2017**  
M1902.2
- 896—1993: Oil-burning Stoves—with revisions through November 2016**  
M1410.1
- 907—94: Fireplace Accessories—with revisions through November 2014**  
R1001.13
- 923—2013: Microwave Cooking Appliances—with revisions through July 2017**  
M1503.2, M1504.1, M1901.2
- 959—2010: Medium Heat Appliance Factory-built Chimneys—with revisions through June 2014**  
R1005.6
- 1026—2012: Electric Household Cooking and Food Serving Appliances—with revisions through July 2018**  
M1901.2
- 1040—1996: Fire Test of Insulated Wall Construction—with revisions through April 2017**  
R316.6
- 1042—2009: Electric Baseboard Heating Equipment—with revisions through December 2016**  
M1405.1
- 1256—02: Fire Test of Roof Deck Construction—with revisions through August 2018**  
R906.1
- 1261—2016: Electric Water Heaters for Pools and Tubs—with revisions through September 2017**  
M2006.1
- 1479—2015: Fire Tests of Through-Penetration Firestops**  
R302.4.1.2
- 1482—2011: Solid-Fuel-type Room Heaters—with revisions through August 2015**  
R1002.2, R1002.5, M1410.1
- 1563—2009: Electric Spas, Equipment Assemblies, and Associated Equipment—with revisions through October 2017**  
M2006.1

## REFERENCED STANDARDS

## UL—continued

- 1618—2015: Wall Protectors, Floor Protectors, and Hearth Extensions—with revisions through January 2018**  
R1004.2, M1410.2
- 1693—2010: Electric Radiant Heating Panels and Heating Panel Sets—with revisions through October 2011**  
M1406.1
- 1703—2002: Flat-plate Photovoltaic Modules and Panels—with revisions through September 2018**  
R324.3.1, R902.4, R905.16.4
- 1715—97: Fire Test of Interior Finish Material—with revisions through April 2017**  
R316.6
- 1738—2010: Venting Systems for Gas-burning Appliances, Categories II, III and IV**  
G2426.1, G2427.4.1, G2427.4.1.1, G2427.4.2
- 1741—2010: Inverters, Converters, Controllers and Interconnection System Equipment with Distributed Energy Resources—with revisions through February 2018**  
R324.3.1, R328.6
- 1777—07: Chimney Liners—with revisions through April 2014**  
R1003.11.1, R1003.18, M1801.3.4, G2425.12, G2425.15.4, G2427.5.1, G2427.5.2
- 1897—15: Uplift Tests for Roof Covering Systems**  
R905.4.4.1
- 1995—2015: Heating and Cooling Equipment—with revisions through August 2018**  
M1402.1, M1403.1, M1407.1, M1412.1, M1413.1, M2006.1
- 1996—2009: Electric Duct Heaters—with revisions through July 2016**  
M1402.1, M1407.1
- 2034—2017: Standard for Single- and Multiple-station Carbon Monoxide Alarms—with revisions through September 2018**  
R314.1.1, R315.1.1
- 2075—2013: Gas and Vapor Detectors and Sensors—with revisions through December 2017**  
R314.7.4, R315.7.1, R315.7.4
- 2158A—2013: Outline of Investigation for Clothes Dryer Transition Duct—with revisions through April 2017**  
M1502.4.3, G2439.7.3
- 2200—2012: Stationary Engine Generator Assemblies—with revisions through October 2015**  
R329.1
- 2523—2009: Standard for Solid Fuel-fired Hydronic Heating Appliances, Water Heaters and Boilers—with revisions through March 2018**  
M2001.1.1, M2005.1
- 2703—2014: Mounting Systems, Mounting Devices, Clamping/Retention Devices and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels—with revisions through December 2019**  
R902.4
- 7103—19: Outline of Investigation for Building-Integrated Photovoltaic Roof Covering**  
R902.3, R905.16.4, Table 905.16.6, R905.17.5
- 9540—2016: Standard for Energy Storage Systems and Equipment**  
R328.2, R328.6
- 61730-1—2017: Photovoltaic (PV) Module Safety Qualification—Part 1: Requirements for Construction**  
R324.3.1, R905.16.4, 905.17.5
- 61730-2—2017: Photovoltaic (PV) Module Safety Qualification—Part 2: Requirements for Testing**  
R324.3.1, R905.16.4, R905.17.5
- UL/CSA/ANCE 60335-2-40—2012: Standard for Household and Similar Electrical Appliances, Part 2: Particular Requirements for Motor-compressors**  
M1402.1, M1403.1, M1412.1, M1413.1, M2006.1

---

**ULC**

ULC

13775 Commerce Parkway  
Richmond, BC V6V 2V4

**CAN/ULC S 102.2—2018: Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies**  
R302.10.1, R302.10.2

## REFERENCED STANDARDS

---

### US-FTC

United States-Federal Trade Commission  
600 Pennsylvania Avenue NW  
Washington, DC 20580

**CFR Title 16(2015): R-value Rule**  
N1101.10.4

---

### WDMA

Window and Door Manufacturers Association  
2025 M Street NW, Suite 800  
Washington, DC 20036-3309

**AAMA/WDMA/CSA 101/LS.2/A440—17: North American Fenestration Standard/Specification for Windows, Doors and Skylights**  
R308.6.9, R609.3, N1102.4.3

**I.S. 11—18: Industry Standard Analytical Method for Design Pressure (DP) Ratings of Fenestration Products**  
R308.6.9.1, R609.3.1

---

### WMA

World Millwork Alliance (formerly Association of Millwork Distributors Standards AMD)  
10047 Robert Trent Parkway  
New Port Richey, FL 34655-4649

**ANSI WMA 100—2018: Standard Method of Determining Structural Performance Ratings of Side-Hinged Exterior Door Systems and Procedures for Component Substitution**  
R609.3

## APPENDIX AA

# SIZING AND CAPACITIES OF GAS PIPING

*Deleted in its entirety.*







## APPENDIX AB

# SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

*Deleted in its entirety.*





**APPENDIX AC**  
**EXIT TERMINALS OF MECHANICAL DRAFT**  
**AND DIRECT-VENT VENTING SYSTEMS**

*Deleted in its entirety.*





**APPENDIX AD**

**RECOMMENDED PROCEDURE FOR SAFETY  
INSPECTION OF AN EXISTING APPLIANCE INSTALLATION**

*Deleted in its entirety.*







## APPENDIX AE

# MANUFACTURED HOUSING USED AS DWELLINGS

*Deleted in its entirety.*





## APPENDIX AF

# RADON CONTROL METHODS

*Deleted in its entirety.*







## APPENDIX AG

# PIPING STANDARDS FOR VARIOUS APPLICATIONS

*Deleted in its entirety.*





## APPENDIX AH

# PATIO COVERS

*Deleted in its entirety.*





## APPENDIX AI

# PRIVATE SEWAGE DISPOSAL

*Deleted in its entirety.*







## APPENDIX AJ

# EXISTING BUILDINGS AND STRUCTURES

*Deleted in its entirety.*





## APPENDIX AK

# SOUND TRANSMISSION

*Deleted in its entirety.*







## APPENDIX AL

# PERMIT FEES

*Deleted in its entirety.*





## APPENDIX AM

# HOME DAY CARE—R-3 OCCUPANCY

*Deleted in its entirety.*





## APPENDIX AN

# VENTING METHODS

*Deleted in its entirety.*







## APPENDIX AO

# AUTOMATIC VEHICULAR GATES

*Deleted in its entirety.*





## APPENDIX AP

# SIZING OF WATER PIPING SYSTEM

*Deleted in its entirety.*







## APPENDIX AQ

# TINY HOUSES

*Deleted in its entirety.*





## APPENDIX AR

# LIGHT STRAW-CLAY CONSTRUCTION

*Deleted in its entirety.*





## APPENDIX AS

# STRAWBALE CONSTRUCTION

*Deleted in its entirety.*







APPENDIX AT [RE]

**SOLAR-READY PROVISIONS—DETACHED ONE- AND  
TWO-FAMILY DWELLINGS AND TOWNHOUSES**

*Deleted in its entirety.*





## APPENDIX AU

# COB CONSTRUCTION (MONOLITHIC ADOBE)

*Deleted in its entirety.*







# APPENDIX AV

## BOARD OF APPEALS

*Deleted in its entirety.*





## APPENDIX AW

# 3D-PRINTED BUILDING CONSTRUCTION

*Deleted in its entirety.*





## APPENDIX AX

# ZERO ENERGY RESIDENTIAL BUILDING PROVISIONS

*Deleted in its entirety.*







# INDEX

## A

<b>ABSORPTION COOLING EQUIPMENT</b> . . . . .	M1412
<b>ACCESS (TO)</b> . . . . .	N1101
Definition . . . . .	R202
To appliances . . . . .	M1305
To attic . . . . .	R807
To crawl space . . . . .	R408.4
To equipment . . . . .	M1401.2
To floor furnace . . . . .	M1408.4
To plumbing connections . . . . .	P2704
To plumbing fixtures . . . . .	P2705
To whirlpool pumps . . . . .	P2720.1
<b>ACCESS HATCHES</b> . . . . .	N1102.2.4
<b>ACCESSIBILITY</b> . . . . .	R320
<b>ACCESSIBLE</b>	
Definition . . . . .	E3501
Readily accessible, definition . . . . .	E3501
<b>ACCESSORY STRUCTURE</b>	
Definition . . . . .	R202
<b>ADDITIONS</b>	
Defined . . . . .	N1101.6
Requirements . . . . .	N1110
<b>ADDRESS (SITE)</b> . . . . .	R319
<b>ADMINISTRATIVE</b> . . . . .	Chapter 1
Applicability . . . . .	R102
Authority . . . . .	R104
Board of appeals . . . . .	R112
Certificate of occupancy . . . . .	R110
Construction documents . . . . .	R106
Department of building safety . . . . .	R103
Entry . . . . .	R104.6
Fees . . . . .	R106
General . . . . .	R101
Inspections . . . . .	R109
Permits . . . . .	R105
Purpose . . . . .	R101.3
Service utilities . . . . .	R111
Stop work order . . . . .	R114
Temporary structures and uses . . . . .	R107
Violations . . . . .	R113
<b>AIR</b>	
Combustion . . . . .	Chapter 17, G2407
Combustion air, definition . . . . .	R202
Return . . . . .	M1602
<b>AIR BARRIER</b>	
Installation . . . . .	N1102.4.1.1, Table N1102.4.1.1
Testing . . . . .	N1102.4.1.2

## AIR CONDITIONERS

Branch circuits . . . . .	E3702.11
Room air conditioners . . . . .	E3702.12

## AIR INFILTRATION

Requirements . . . . .	N1102.4.1.2
------------------------	-------------

## AIR LEAKAGE . . . . . N1102.4, N1103.3.5, N1103.3.6

## ALLOWABLE SPANS

Of floor joists . . . . .	R502.3, R505.3.2
Of headers . . . . .	R602.7, R603.6
Of rafters and ceiling joists . . . . .	R802.4, R802.5, R804.3.1, R804.3.2

## ALTERATIONS

Defined . . . . .	N1101.6
Requirements . . . . .	N1111

## AMPACITY . . . . . E3501

## ANCHOR BOLTS . . . . . R403.1.6

## APPEAL

Board of . . . . .	R112.1
Right of . . . . .	R112

## APPLIANCE

Access to . . . . .	M1305
Attic . . . . .	M1305.1.3
Clearance for . . . . .	M1306
Connectors, fuel-gas . . . . .	Chapter 24
Definition . . . . .	R202
Definition applied to electrical equipment . . . . .	E3501
Electrical appliance	
disconnection means . . . . .	E4101.5
Electrical appliance installation . . . . .	E4101
Equipment (general) . . . . .	Chapter 14
Floor furnace . . . . .	M1408
Flue area . . . . .	R1003.14
Fuel-burning . . . . .	Chapter 24
Heating and cooling . . . . .	Chapter 14
Installation . . . . .	M1307
Labeling . . . . .	M1303
Open-top broiler units . . . . .	M1505.1
Ranges . . . . .	M1901
Room heaters . . . . .	M1410
Special fuel-burning equipment . . . . .	Chapter 19
Vented (decorative) . . . . .	Chapter 24
Wall furnace . . . . .	M1409
Warm-air furnace . . . . .	M1402
Water heaters . . . . .	Chapter 20, Chapter 24

## APPLICATION

Plywood . . . . .	R703.3
-------------------	--------

## APPROVAL

Mechanical . . . . .	M1302
----------------------	-------

## INDEX

**APPROVED**

- Agent (definition) . . . . . R202
- Definition . . . . . R202
- Definition applied to electrical equipment . . . . . E3501
- Source (definition) . . . . . R202

**ARC-FAULT CIRCUIT INTERRUPTER** . . . . . E3902**AREA**

- Disposal, private sewage disposal . . . . . P2602
- Flue (appliances) . . . . . R1003.14
- Flue masonry . . . . . R1003.15
- Room, minimum . . . . . R304

**AREA WELLS** . . . . . R310.4**ARMORED CABLE** . . . . . Table E3801.2**ASPHALT SHINGLES** . . . . . R905.2**ATTACHMENT PLUG (PLUG CAP) (CAP)**

- Definition . . . . . E3501

**ATTIC**

- Access . . . . . R807
- Appliances . . . . . M1305.1.2
- Habitable . . . . . R326

**AUTOMATIC** . . . . . N1101.6**AUTOMATIC FIRE SPRINKLER SYSTEMS** . . . . . R313**B****BACKFILL**

- For piping . . . . . P2604

**BACKFLOW, DRAINAGE**

- Definition . . . . . R202

**BACKWATER VALVE**

- Allowed types . . . . . P3008.2
- Defined . . . . . R202
- Required . . . . . P3008.1

**BASEMENT WALL**

- Definition . . . . . R202, N1101.6
- Requirements . . . . . Table N1102.1.3, N1102.2.8, Table N1105.4.2(1)

**BATH, TOILET AND SHOWER SPACES** . . . . . R307**BATHROOM**

- Exhaust . . . . . M1505.4.4
- Group . . . . . R202, Table P3004.1

**BATHTUB**

- Enclosure . . . . . P2713.2
- Finish . . . . . R307.2
- Hydromassage . . . . . E4209
- Outlets for . . . . . P2713.1
- Space required . . . . . R307.1
- Whirlpool . . . . . P2720

**BEAM SUPPORTS** . . . . . R606.14**BEARING**

- Of joists . . . . . R502.6

**BIDETS** . . . . . P2721**BOILER**

- Definition . . . . . R202
- Outdoor temperature setback control . . . . . N1103.2
- Requirements . . . . . Chapter 20

**BONDING** . . . . . E3609, E4204

- Definition applied to electrical installations . . . . . E3501

**BONDING JUMPER** . . . . . E3501

- Bonding of service equipment . . . . . E3609.2
- Bonding to other systems . . . . . E3609.3
- Main bonding jumper . . . . . E3607.5
- Metal water piping bonding . . . . . E3608.1.1
- Sizing bonding jumpers . . . . . E3609.5

**BOXES** . . . . . E3906

- Nonmetallic boxes . . . . . E3905.3
- Support of boxes . . . . . E3904.3
- Where required . . . . . E3905.1

**BRANCH CIRCUIT** . . . . . E3501, Chapter 37

- Ampacity . . . . . E3701.2
- Ratings . . . . . E3702
- Required . . . . . E3703

**BUILDING**

- Definition . . . . . R202, N1101.6
- Drain, definition . . . . . R202
- Existing, definition . . . . . R202
- Sewer, definition . . . . . R202

**BUILDING OFFICIAL**

- Definition . . . . . R202
- Inspection and tests of fuel-gas piping . . . . . Chapter 24

**BUILDING PLANNING**

- Accessibility . . . . . R320
- Automatic fire sprinkler systems . . . . . R313
- Carbon monoxide alarms . . . . . R315
- Ceiling height . . . . . R305
- Design criteria . . . . . R301
- Elevators and platform lifts . . . . . R321
- Emergency escape . . . . . R310
- Exterior wall . . . . . R302.1
- Fire-resistant construction . . . . . R302
- Flood-resistant construction . . . . . R322
- Foam plastic . . . . . R316
- Garages and carports . . . . . R309
- Glazing . . . . . R308
- Guardrails . . . . . R312
- Handrails . . . . . R311.7.8, R311.8.3
- Insulation . . . . . R302.10
- Landing . . . . . R311.3, R311.3.1, R311.3.2
- Light, ventilation and heating . . . . . R303
- Means of egress . . . . . R311
- Mezzanines . . . . . R325

Minimum room area .....	R304
Planning .....	Chapter 3
Plumbing fixture clearances .....	R307
Protection of wood against decay .....	R317
Ramps .....	R311.8
Sanitation .....	R306
Site address .....	R319
Smoke alarms .....	R314
Solar energy systems .....	R324
Stairways .....	R311.7
Stationary storage battery systems .....	R328
Storm shelters .....	R323
Swimming pools, spas and hot tub .....	R327
Termite protection .....	R318
Toilet, bath and shower spaces .....	R307

### **BUILDING THERMAL ENVELOPE**

Air tightness .....	N1102.4.1
Compliance documentation ....	N1101.5, N1101.14
Definition .....	R202
Insulation .....	N1101.10.1
Insulation and fenestration criteria .....	N1102.1.2
Performance method .....	Table N1105.4.2(1)
Requirements .....	N1101.4

### **BUILDING-INTEGRATED PHOTOVOLTAIC ROOF PANEL**

As roof covering .....	R324.5.2
Definition .....	R202

### **BUILT-UP ROOFING (see ROOFING)**

## **C**

### **CABINETS AND PANELBOARDS.....E3907**

#### **CAPACITY**

Expansion tank .....	M2003.2
----------------------	---------

### **CARBON MONOXIDE ALARMS .....**

Definition .....	R202
------------------	------

### **CARPORTS .....**

.....	R309.2
-------	--------

### **CATHODIC PROTECTION.....**

.....	G2415.11.2
-------	------------

### **CAVITY INSULATION ...**

N1101.6, Table N1102.1.3,	
N1102.1.4, Table N1102.2.6,	
N1102.2.7, Table N1102.4.1.1	

### **CEILING**

Finishes .....	R302.9, R805
----------------	--------------

Height .....	R305
--------------	------

### **CEILING FANS.....**

.....	E4203.4
-------	---------

### **CEILINGS .....**

N1102.2.1, N1102.2.2	
----------------------	--

For standard reference	
design.....	Table N1105.4.2(1)

### **CENTRAL FURNACES (see FURNACES)**

### **CERTIFICATE.....**

N1101.14	
----------	--

### **CERTIFICATE OF OCCUPANCY.....**

R110	
------	--

### **CHANGE OF OCCUPANCY**

Definition .....	R202
------------------	------

Energy use .....	N1113
------------------	-------

### **CHASES .....**

R606.8	
--------	--

### **CHIMNEYS**

And fireplaces .....	Chapter 10
----------------------	------------

Caps .....	R1003.9.1
------------	-----------

Clearance .....	R1003.18
-----------------	----------

Corbeling .....	R1003.5
-----------------	---------

Crickets .....	R1003.20
----------------	----------

Design (masonry) .....	R1003.1
------------------------	---------

Factory-built .....	R1005
---------------------	-------

Fireblocking .....	R1003.19
--------------------	----------

Flue area .....	R1003.14, R1003.15
-----------------	--------------------

Flue lining .....	R1003.11
-------------------	----------

Load .....	R1003.8
------------	---------

Masonry and factory-built, size .....	M1805
---------------------------------------	-------

Multiple flue .....	R1003.14
---------------------	----------

Rain caps .....	R1003.9.3
-----------------	-----------

Spark arrestors .....	R1003.9.2
-----------------------	-----------

Termination .....	R1003.9
-------------------	---------

Wall thickness .....	R1003.10
----------------------	----------

### **CIRCUIT BREAKER**

Definition .....	E3501
------------------	-------

### **CIRCULATION SYSTEMS .....**

N1103.5.1	
-----------	--

### **CLASS 2 CIRCUITS**

Class 2 remote-control, signaling and	
power-limited circuits .....	Chapter 43

### **CLAY**

Tiles .....	R905.3
-------------	--------

### **CLEANOUT**

Definition .....	R202
------------------	------

Drainage .....	P3005.2
----------------	---------

Masonry chimney .....	R1003.17
-----------------------	----------

### **CLEARANCE**

Above cooking top .....	M1901.1
-------------------------	---------

For appliances .....	M1306.1
----------------------	---------

For chimneys .....	R1003.18
--------------------	----------

Reduction methods .....	M1306.2
-------------------------	---------

Vent connector .....	M1803.3.4
----------------------	-----------

### **CLEARANCES**

Around electrical equipment .....	E3405.1,
-----------------------------------	----------

E3604.1, E3604.2, E3604.3	
---------------------------	--

### **CLIMATE TYPES**

Defined .....	Table N1101.7.2(1)
---------------	--------------------

### **CLIMATE ZONES .....**

N1101.7, Figure N1101.7,	
Table N1101.7	

By state or territory .....	Figure N1101.7,
-----------------------------	-----------------

Table N1101.7	
---------------	--

International climate zones .....	N1101.7.2,
-----------------------------------	------------

Table N1101.7.2	
-----------------	--

## INDEX

- Tropical . . . . . N1101.8
- Warm Humid . . . . . N1101.7.1, Table N1101.7
- CLOTHES CLOSETS**
- Lighting fixtures . . . . . E4003.12
- CLOTHES DRYERS** . . . . . M1502, Chapter 24
- CLOTHES WASHING MACHINES** . . . . . P2718
- COLUMNS** . . . . . R407
- COMBUSTIBLE**
- Materials . . . . . R202
- COMBUSTION AIR**
- Air . . . . . Chapter 17, Chapter 24
- Definition . . . . . R202
- COMMON VENT**
- Definition . . . . . R202
- Requirements . . . . . M1801.11
- COMPLIANCE** . . . . . N1101.13
- Energy Rating Index . . . . . N1101.13.3, N1106
- Prescriptive . . . . . N1101.13.1
- Total Building Performance . . . . . N1101.13.2, N1105
- Tropical zone . . . . . N1101.13.5, N1107
- COMPLIANCE REPORT** . . . . . N1105.3.2.2
- COMPOSTING TOILET SYSTEM** . . . . . P2725.1
- CONCRETE**
- Compressive strength . . . . . R402.2
- Floors (on ground) . . . . . R506
- Tile (roof) . . . . . R905.3
- Weathering . . . . . Figure R301.2(1), R402.2
- CONCRETE-ENCASED ELECTRODE** . . . . . E3608.1.2
- CONDITIONED FLOOR AREA** . . . . . R202
- CONDITIONED SPACE** . . . . . R202
- CONDUCTOR** . . . . . E3406
- Ampacity . . . . . E3705.1
- Definition . . . . . E3501
- Identification . . . . . E3407
- Insulation . . . . . E3406.5
- Material . . . . . E3406.2
- Parallel . . . . . E3406.6
- Size . . . . . E3406.3, E3704.1
- Ungrounded . . . . . E3603.1
- CONDUIT BODY**
- Definition . . . . . E3501
- CONNECTION**
- Access to connections . . . . . P2704
- For fuel-burning appliances . . . . . Chapter 24
- For fuel-oil piping . . . . . M2202
- Joints . . . . . P2904
- Plumbing fixture . . . . . P2601.2
- To water supply . . . . . P2902.1
- CONNECTIONS**
- Aluminum . . . . . E3406.8
- Device . . . . . E3406.11.2
- CONNECTOR**
- Chimney and vent . . . . . M1803
- Vent, definition . . . . . R202
- CONNECTOR, PRESSURE (SOLDERLESS)**
- Definition . . . . . E3501
- CONSTRUCTION**
- Cavity wall masonry . . . . . R608
- Flood-resistant . . . . . R322
- Floors . . . . . Chapter 5
- Footings . . . . . R403
- Foundation material . . . . . R402
- Foundation walls . . . . . R404
- Foundations . . . . . Chapter 4
- Masonry . . . . . R606, R607, R608, R610
- Roofs . . . . . Chapter 8
- Steel framing . . . . . R505, R603, R804
- Walls . . . . . Chapter 6
- Wood framing . . . . . R502, R602, R802
- CONSTRUCTION DOCUMENTS** . . . . . R106, N1101.5
- Thermal envelope depiction . . . . . N1101.5.1
- CONTINUOUS AIR BARRIER** . . . . . R202
- CONTINUOUS LOAD**
- Definition . . . . . E3501
- CONTINUOUS WASTE**
- Definition . . . . . R202
- CONTROL**
- Devices . . . . . Chapter 24
- CONTROLS**
- For forced-air furnaces . . . . . Chapter 24
- For heat pumps . . . . . N1103.1.2
- For heating and cooling . . . . . N1103.1
- For service water heating . . . . . N1103.5
- COOKING UNIT, COUNTER-MOUNTED**
- Definition . . . . . E3501
- COOLING**
- Absorption cooling equipment . . . . . M1412
- Access to equipment . . . . . M1401.2
- Evaporative cooling equipment . . . . . M1413
- Installation . . . . . M1401.1
- Loads for energy calculation . . . . . N1101.9
- Refrigeration cooling equipment . . . . . M1404
- Return air-supply source . . . . . M1602
- COPPER-CLAD ALUMINUM CONDUCTORS**
- Definition . . . . . E3501
- CORDS**
- Flexible . . . . . E4101.3, E4202.2
- CORROSION**
- Protection of metallic piping . . . . . P2603.3
- COURT**
- Definition . . . . . R202



<b>COVER REQUIREMENTS</b> .....	E3803.1
<b>COVERING</b>	
Exterior .....	R703
Interior .....	R702
Roof .....	Chapter 9
Wall .....	Chapter 7
<b>CRAWL SPACE</b> .....	R408
Energy conservation requirements. ....	N1101.11.1, Table N1102.1.2, Table N1102.1.3, N1102.2.10, N1102.2.10.1, Table N1105.4.2(1)
Wall (definition) .....	R202
<b>CROSS CONNECTION</b>	
CSST .....	G2411.2, G2411.3, G2414.4.4, G2415.2
Definition .....	R202

## D

<b>DAMPER, VOLUME</b>	
Definition .....	R202
<b>DAMPROOFING</b> .....	R406
<b>DECAY</b>	
Protection against .....	R317
<b>DECK</b>	
Supported by exterior wall .....	R507
Wood/plastic composite boards .....	R507.2.2
<b>DECORATIVE APPLIANCES</b>	
Vented .....	Chapter 24
<b>DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES</b> .....	Table N1105.4.2(2)
<b>DEFINITIONS</b>	
Building .....	R202
Electrical .....	E3501
Mechanical system .....	R202
Plumbing .....	R202
<b>DEGREE DAY COOLING</b> .....	Table N1101.7.2(2)
<b>DEGREE DAY HEATING</b> .....	Table N1101.7.2(2)
<b>DEMAND RECIRCULATION WATER SYSTEM</b>	
Defined .....	N1101.6
Requirements .....	N1103.5.1.1
<b>DESIGN CONDITIONS, INTERIOR</b> .....	N1101.9
<b>DESIGN CRITERIA</b> .....	R301
Alternative provisions .....	R301.1.1
Application .....	R301.1
Climatic and geographic .....	R301.2
Dead load .....	R301.4
Deflection .....	R301.6
Engineered design .....	R301.1.3
Live load .....	R301.5
Nominal sizes .....	R301.8
Roof load .....	R301.6
Seismic .....	R301.2.2
Snow loads .....	R301.2.3
Story height .....	R301.3
Sunrooms .....	R301.2.1.1.1
Wind .....	R301.2.1
<b>DIMMER</b> .....	N1101.6, N1104.2
<b>DIRECTIONAL</b>	
Fittings, plumbing .....	P2707
<b>DISCONNECTING MEANS</b>	
Definition .....	E3501
<b>DISHWASHING MACHINES</b> .....	P2717
<b>DOORS</b>	
Attics .....	N1102.2.4.1
Crawl space .....	N1102.2.4.1
Default <i>U</i> -factor .....	Table N1101.10.3(2)
Egress .....	R311.2
Exterior .....	R311.3, R609
Opaque .....	N1102.3.4
Performance requirements. ....	Table N1105.4.2(1)
SHGC values .....	Table N1102.1.3
<i>U</i> -factors .....	Table N1102.1.2
<b>DRAFT HOOD</b>	
Definition .....	R202
<b>DRAFTSTOPPING</b> .....	R302.12, R502.12
<b>DRAIN</b>	
Floor .....	P2719
Shower receptors .....	P2709
<b>DRAINAGE</b>	
Cleanouts .....	P3005.2
Foundation .....	R405
Inspection and tests .....	P2503
Storm drainage .....	Chapter 33
<b>DRILLING AND NOTCHING (see NOTCHING)</b>	
<b>DRINKING WATER TREATMENT</b> .....	P2909
<b>DRIP LOOPS</b> .....	E3605.9.5
<b>DRYERS</b>	
Domestic clothes .....	M1502
<b>DUCTS</b> .....	Chapter 16
Defined .....	R202
Dwelling-garage wall and ceiling penetration .....	R302.5.2
Installation .....	M1601.4
Insulation .....	N1101.5, N1101.14, N1103.3.1, N1103.3.2, N1103.3.3, N1103.3.3.1, M1601.3
Material .....	M1601
Sealing .....	N1101.5, N1103.3.4, M1601.4.1
System, definition .....	R202
Tightness verification .....	N1103.3.5
Within unconditioned space .....	N1103.3.1

## INDEX

**DWELLING**

Definition . . . . . R202, E3501

**DWELLING UNIT**

Definition . . . . . R202, E3501

Multiple units . . . . . N1103.8

Separation . . . . . R302.2, R302.3

**DWELLING UNIT ENCLOSURE****AREA** . . . . . N1101.6, N1102.4.1.2**DYNAMIC GLAZING** . . . . . N1102.3.2**E****EAVE BAFFLE**

Installation . . . . . N1102.2.3

**EJECTORS (see SUMPS AND EJECTORS)****ELECTRICAL**

Appliance (labeling) . . . . . M1303

Inspection . . . . . E3403

**ELECTRICAL METALLIC****TUBING** . . . . . Table E3904.6(1)**ELECTRICAL NONMETALLIC****TUBING** . . . . . Table E3904.6(2)**ELECTRICAL POWER AND LIGHTING** . . . . . N1104**ELECTRICAL RESISTANCE HEATERS**

Baseboard convectors . . . . . M1405

Duct heaters . . . . . M1407

Radiant heating . . . . . M1406

**ELECTRODES**

Grounding . . . . . E3608

**ELEVATORS AND PLATFORM LIFTS** . . . . . R321**EMERGENCY ESCAPE AND****RESCUE OPENINGS** . . . . . R310

Area wells . . . . . R310.3.2

At additions . . . . . R310.6

At existing basements . . . . . R310.7

Bars, grilles, covers and screens . . . . . R310.4.4

Definition . . . . . R202

Dimensions . . . . . R310.2

Doors . . . . . R310.3

Replacement window sill height . . . . . R310.5

Under decks and porches . . . . . R310.2.4

Where required . . . . . R310.1

**ENCLOSURE**

Definition . . . . . E3501

**ENERGY ANALYSIS, ANNUAL**

Defined . . . . . R202

Documentation . . . . . N1105.3

Requirements . . . . . N1105.3

**ENERGY CONSERVATION** . . . . . Chapter 11**ENERGY COST**

Defined . . . . . R202

Energy Rating Index . . . . . R202, N1106.4

Energy Rating Index compliance

alternative . . . . . N1106

ERI-based compliance . . . . . N1106.5

**ENERGY PERFORMANCE ANALYSIS** . . . . . N1105**ENERGY RECOVERY VENTILATION SYSTEMS**

Requirements . . . . . Table N1105.4.2(1)

**ENERGY SIMULATION TOOL**

Defined . . . . . N1101.6

**ENERGY STORAGE SYSTEMS** . . . . . R328

Defined . . . . . R202

**ENTRY** . . . . . R104.6**ENVELOPE, BUILDING THERMAL**

Defined . . . . . R202

**ENVELOPE DESIGN PROCEDURES** . . . . . N1102**EQUIPMENT**

Definition applied to electrical equipment . . . . E3501

Efficiencies . . . . . N1101.5, N1101.14

General, mechanical . . . . . Chapter 14

Heating and cooling . . . . . Chapter 14

Room for fuel-burning appliances . . . . . N1102.4.4

**EXCAVATIONS**

For appliance installation . . . . . M1305.1.3.2

**EXHAUST**

Domestic cooking . . . . . M1503

General . . . . . Chapter 15

**EXISTING BUILDINGS** . . . . . N1109**EXISTING PLUMBING SYSTEMS** . . . . . P2502**EXTERIOR**

Covering . . . . . R703

Insulation finish systems . . . . . R703.9

Lath . . . . . R703.7.1

Plaster . . . . . R703.7

**EXTERIOR WALL**

Construction . . . . . R302.1

Defined . . . . . R202

Fire-resistance rating . . . . . R302.1

Thermal performance . . . . . N1102, N1102.1.2,

Table N1105.4.2(1)

**F****FACEPLATES** . . . . . E4001.11, E4002.4**FACTORY BUILT**

Chimneys . . . . . R1005, M1805

Fireplace stoves . . . . . R1005.3

Fireplaces . . . . . R1004

**FASTENING** . . . . . Table R602.3(1)**FAUCETS** . . . . . P2701

Handle orientation . . . . . P2722.2

Requirements . . . . . P2701

**FEEDER**

Ampacity . . . . .	E3704.5
Conductor size . . . . .	E3704.1
Feeder neutral load . . . . .	E3704.3
Loads . . . . .	E3704.2
Requirements . . . . .	E3704

**FEES, PERMIT . . . . . R108****FENESTRATION . . . . . N1101.10.3, N1102.3, N1102.3.2, N1102.4.3**

Default <i>U</i> -factors . . . . .	Table N1101.10.3(1)
Defined . . . . .	R202
Rating and labeling . . . . .	N1101.10.3, N1102.1.2
Replacement . . . . .	N1102.3.5
Requirements . . . . .	Table N1102.1.2

**FENESTRATION, SITE-BUILT**

Defined . . . . .	R202
-------------------	------

**FINISHES**

Flame spread and smoke density . . . . .	R302.9
For ceilings . . . . .	R805
Interior . . . . .	R302.9, R315, R702

**FIRE SPRINKLER SYSTEM . . . . . R313, P2904**

Inspections of . . . . .	P2904.8
Sizing of . . . . .	P2904.6
Sprinkler location . . . . .	P2904.1.1

**FIREBLOCKING**

Barrier between stories . . . . .	R302.11, R602.8
Chimney . . . . .	R1003.19
Fireplace . . . . .	R1001.12

**FIREPLACES . . . . . Chapter 10**

Clearance . . . . .	R1001.11
Corbeling . . . . .	R1001.8
Doors for . . . . .	N1102.4.2
Factory-built . . . . .	R1004
Fireblocking . . . . .	R1001.12
Walls . . . . .	R1001.5

**FIRE-RESISTANT CONSTRUCTION . . . . . R302**

Draftstopping . . . . .	R302.1
Dwelling-garage fire separation . . . . .	R302.6
Dwelling-garage opening and penetration . . . . .	R302.5
Exterior walls . . . . .	R302.1
Fireblocking . . . . .	R302.11
Floors . . . . .	R302.13
Foam plastics . . . . .	R302.8
Insulation . . . . .	R302.10, R302.14
Penetrations . . . . .	R302.4
Townhouse separation . . . . .	R302.2
Two-family dwellings . . . . .	R302.3
Under-stair protection . . . . .	R302.7
Wall and ceiling finishes . . . . .	R302.9

**FIRE-SEPARATION DISTANCE**

Definition . . . . .	R202
----------------------	------

Exterior walls and wall projections . . . . .	R302.1
Ground-mounted photovoltaic systems . . . . .	R324.7

**FITTING**

Definition applied to electrical installations . . . . .	E3501
--	-------

**FITTINGS**

DWV piping . . . . .	P3002.3
Prohibited joints . . . . .	P3003.2
Water supply . . . . .	P2906.6

**FIXTURE UNIT**

Drainage, definition . . . . .	R202
Water supply, definition . . . . .	R202

**FIXTURES**

Clearance . . . . .	R307.1
Plumbing fixture, definition . . . . .	R202
Plumbing fixture, general . . . . .	Chapter 27
Trap seals . . . . .	P3201.2

**FLAME SPREAD INDEX . . . . . R302.9, R302.10****FLASHING . . . . . R703.4, R703.8.5, R903.2, R905****FLEXIBLE CORDS . . . . . E3909, E4101.3, E4202.2****FLEXIBLE METAL CONDUIT . . . E3801.1, E3908.9.1****FLOOD-RESISTANT CONSTRUCTION**

General and structural . . . . .	R301.2.4, R322
Plumbing systems . . . . .	P2601.3

**FLOOR DRAIN . . . . . P2719****FLOOR FURNACE . . . . . M1408****FLOORS**

Above-grade . . . . .	Table N1105.4.2(1)
Bathtub and shower . . . . .	R307.2
Concrete (on ground) . . . . .	R506
Insulation for steel framed . . . . .	N1102.2.6
Insulation requirements . . . . .	N1102.1.2, Table N1102.1.2, Table N1102.1.3, N1102.2.6, N1102.2.7, N1102.2.9
Loads . . . . .	R301, R501.2
Steel framing . . . . .	R505
Treated-wood (on ground) . . . . .	R504
Wood framing . . . . .	R502

**FLUE**

Area . . . . .	R1003.14, R1003.15
Lining . . . . .	R1003.11, R1003.12
Multiple . . . . .	R1003.13

**FOAM PLASTICS . . . . . R316****FOOD-WASTE DISPOSERS**

Discharge connection to sink tailpiece . . . . .	P2707.1
General . . . . .	P2716

**FOOTINGS . . . . . R403**

Excavation for piping near . . . . .	P2604.4
Requirements . . . . .	R403

**FORCED MAIN SEWER**

Materials . . . . .	P3002.2
Testing . . . . .	P2503.4

## INDEX

**FOUNDATIONS** ..... Chapter 4  
 Cripple walls ..... R602.9, R602.10.9, R602.11.2  
 Frost protection ..... R403.1.4.1  
 Inspection ..... R109.1.1  
 Insulation requirements ..... Table N1102.4.1.1,  
 Table N1105.4.2(1)  
 Walls ..... R404  
**FRAME**  
 Inspection ..... R109.1.4  
**FREEZE PROTECTION OF PLUMBING** .... P2603.5  
**FUEL GAS** ..... Chapter 24  
**FUEL OIL**  
 Oil tanks ..... M2201  
 Piping, fittings and connections ..... M2202  
 Pumps and valves ..... M2204  
**FUEL-BURNING APPLIANCES**  
 (see **APPLIANCE, definition**) ..... N1102.4.4  
**FURNACES**  
 Clearance of warm-air furnaces ..... M1402.2  
 Efficiency ..... Table N1105.4.2(1)  
 Exterior ..... M1401.4  
 Floor (see Floor Furnace)  
 Wall (see Wall Furnace)  
 Warm-air ..... M1402, Chapter 24  
**FUSES** ..... **E3705.6**

**G**

**GARAGES AND CARPORTS** ..... **R309**  
**GAS**  
 Appliance labeling ..... Chapter 24  
**GAS PIPING SYSTEM NOT TO BE USED AS**  
**GROUNDING ELECTRODE** ..... Chapter 24  
**GIRDERS** ..... R502.5  
**GLASS MAT GYPSUM PANEL** ..... R202  
**GLAZED FENESTRATION** .... N1102.3.2, N1102.3.3  
**GLAZING**  
 Aggregate area ..... R303.1  
 Greenhouses, glass in. .... R308.6.6  
 Protection of openings ..... R301.2.1.2  
 Required glazed openings ..... R303.9  
 Safety glazing and hazardous locations ..... R308  
 Site-built ..... R308.5  
 Skylights and sloped ..... R202, R308.6  
**GRADE**  
 Definition ..... R202  
 Of lumber ..... R502.1.1, R602.1.1, R802.1.1  
 Plane, definition ..... R202  
 Slope of piping, definition ..... R202  
**GRAYWATER**  
 For subsurface irrigation ..... P3009  
 Identification for ..... P2901.2

Supply to fixtures ..... P2901.1  
**GROUND**  
 Definition of electrical ..... E3501  
 Floors (on ground) ..... R504, R506  
 Joint connection ..... P2906.8  
**GROUNDED**  
 Definition ..... E3501  
**GROUNDED, EFFECTIVELY**  
 Definition ..... E3501  
**GROUNDED CONDUCTOR**  
 Definition ..... E3501  
 Identification ..... E3407  
**GROUND-FAULT CIRCUIT-INTERRUPTER**  
**PROTECTION** ..... E3902, E4203, E4206,  
 E4207.2, E4208

**GROUNDING**

Effective grounding path ..... E3611.3  
 Of equipment ..... E3908, E4205.1

**GROUNDING CONDUCTOR**

Definition ..... E3501  
 Equipment ..... E3501, E3607.3.1, E3908

**GROUNDING ELECTRODE**

**CONDUCTOR** ..... E3607.4  
 Connection ..... E3607.2, E3611  
 Definition ..... E3501  
 Size ..... E3603.4

**GROUNDING ELECTRODE SYSTEM** ..... E3608**GROUNDING ELECTRODES** ..... E3608, E3608.1

Resistance of. .... E3608

**GROUND-SOURCE HEAT PUMP** ..... M2105**GUARDED**

Definition applied to electrical equipment .... E3501

**GUARDING OF ENERGIZED PARTS** ..... E3404.9**GUARDS** ..... R312

Definition ..... R202  
 Exterior ..... R507.10

**GYPSUM**

Wallboard ..... R702.3

**GYPSUM SHEATHING** ..... R202**GYPSUM WALLBOARD** ..... R202**H****HABITABLE ATTIC** ..... R326**HABITABLE SPACE**

Definition ..... R202

**HALLWAYS** ..... R311.6**HAND SHOWER (see SHOWER)****HANDRAILS** ..... R311.7.8, R311.8.3

Definition ..... R202

**HEADERS**

SIP ..... R610.8

- Steel . . . . . R603.6  
 Wood . . . . . R602.7  
**HEARTH** . . . . . R1001.9  
   Extension . . . . . R1001.9, R1001.10  
**HEATED SLAB**  
   Defined . . . . . R202  
**HEATERS**  
   Baseboard . . . . . M1405  
   Central furnaces . . . . . M1402  
   Duct . . . . . M1407  
   Heat pumps . . . . . N1103.1.2, M1403  
   Masonry . . . . . R1002  
   Pool . . . . . M2006, Chapter 24  
   Radiant . . . . . M1406  
   Sauna . . . . . Chapter 24  
   Unvented . . . . . G2445  
   Vented room . . . . . M1410, Chapter 24  
   Water . . . . . Chapter 20, Chapter 28  
**HEATING**  
   Load for calculation of energy . . . . . N1101.9  
   Required . . . . . R303.10  
**HEATING EQUIPMENT** . . . . . Chapter 14  
**HEIGHT**  
   Ceiling . . . . . R305  
**HIGH-EFFICACY LAMPS** . . . . . N1104.1  
   Defined . . . . . R202, N1101.6  
**HISTORIC BUILDING**  
   Definition . . . . . R202  
   Energy conservation requirements . . . . . N1109.6  
**HOLLOW-UNIT MASONRY (see MASONRY)**  
**HORIZONTAL**  
   Pipe, definition . . . . . R202  
   Vent length . . . . . M1803.3.2  
**HOT TUBS** . . . . . R327, E4201, Appendix AG  
**HOT WATER**  
   Definition . . . . . R202  
   Distribution pipe rating . . . . . P2906.5  
   Distribution systems . . . . . P2905  
   Energy conservation measures . . . . . N1103.5  
   Heaters . . . . . M2005, Chapter 24  
   Piping insulation . . . . . N1103.5.2  
   Supplied to bathtubs . . . . . P2713  
   Temperature actuated valves for . . . . . P2724  
**HUB DRAIN (see WASTE RECEPTOR)**  
**HVAC SYSTEM**  
   Leakage tests . . . . . N1103.3.6  
**HYDROGEN GENERATING  
 AND REFUELING** . . . . . M1307.4  
**HYDRONIC HEATING SYSTEMS**  
   Baseboard convectors . . . . . M2102  
   Boilers . . . . . M2001  
   Expansion tanks . . . . . M2003  
   Floor heating systems . . . . . M2103  
   Operating and safety controls . . . . . M2002  
   Piping systems installation . . . . . M2101
- I**
- IDENTIFICATION**  
   Materials, systems and equipment  
     for energy compliance . . . . . N1101.10  
**IDENTIFIED**  
   Definition applied to electrical equipment . . . . . E3501  
**INDIRECTLY CONDITIONED SPACE  
 (see CONDITIONED SPACE)**  
**INDIVIDUAL**  
   Branch circuit, definition . . . . . E3501  
   Sewage disposal systems . . . . . R202, P2602  
   Water supply and sewage disposal  
     systems . . . . . P2602  
**INFILTRATION**  
   Air leakage . . . . . N1002.4, Table N1105.4.2(1)  
   Defined . . . . . R202  
**INLET**  
   To masonry chimneys . . . . . R1003.16  
**INSPECTION**  
   Excavation for piping . . . . . P2604.1  
   Fuel-supply system . . . . . Chapter 24  
   Of plumbing system . . . . . P2503  
   On-site . . . . . R109.1  
**INSTALLATION**  
   Of appliances . . . . . M1307  
   Of cooling and heating equipment . . . . . M1401.1  
   Of ducts . . . . . M1601.4  
   Of flue liners . . . . . R1003.12  
   Of plumbing fixtures . . . . . P2705  
   Of wall furnaces . . . . . M1409.3  
**INSULATING SHEATHING**  
   Defined . . . . . R202  
   Requirements . . . . . N1102.1.2, Table N1102.1.3  
**INSULATION**  
   Above-deck . . . . . R906  
   Air-impermeable . . . . . R202, N1101.10.5  
   Basement wall . . . . . N1102.2.8  
   Ceilings with attic spaces . . . . . N1102.2.1  
   Ceilings without attic spaces . . . . . N1102.2.2  
   Crawl space walls . . . . . N1102.2.9  
   Duct . . . . . N1103.3.1  
   Eave baffle for . . . . . N1102.2.3  
   Flame spread . . . . . R302.10  
   Floors . . . . . N1102.2.6, N1102.2.7  
   Foam plastic . . . . . R316  
   Hot water piping . . . . . N1103.5.3



Copyright © 2021 ICC. ALL RIGHTS RESERVED. Accessed by Mariah Jeffcoat (mjeffcoat@cityofpottsville.com), (-) Order Number #101518597 on Mar 27, 2023 05:59 PM (CDT) pursuant to License Agreement with ICC. No further reproduction, no further reproductions by any third party, or distribution authorized. Single user only, copying and networking prohibited. ANY UNAUTHORIZED REPRODUCTION OR DISTRIBUTION IS A VIOLATION OF THE FEDERAL COPYRIGHT ACT AND THE LICENSE AGREEMENT, AND SUBJECT TO CIVIL AND CRIMINAL PENALTIES THEREUNDER.

Potable water components. . . . . P2609

**LIVE/WORK UNIT** . . . . . R202

Accessibility . . . . . R320.2

**LOAD**

Additional . . . . . R1003.8

Dead load . . . . . R301.4

Definition, dead and live . . . . . R202

Live load . . . . . R301.5

Roof . . . . . R301.6

Seismic risk map . . . . . Figure R301.2.2.1(1),  
Figure R301.2.2.1(2), Figure R301.2.2.1(3),  
Figure R301.2.2.1(4), Figure R301.2.2.1(5),  
Figure R301.2.2.1(6)

Snow load map . . . . . Figure R301.2(1),  
Figure R301.2(3)

Wind speed map . . . . . Figure R301.2(2)

**LOADS**

Branch circuit loads . . . . . E3702, E3703.6

Feeder load . . . . . E3704.2

Feeder neutral load . . . . . E3704.3

Horizontal load . . . . . Appendix AE123.1

Service load . . . . . E3602.2

**LOCATION**

Of furnaces . . . . . M1408.3, M1409.2

**LOCATION (DAMP) (DRY) (WET)**

Definitions . . . . . E3501

**LOG HOMES** . . . . . N1102.1, Table N1102.4.1.1

**LUMBER**

Grade . . . . . R502.1.1, R602.1.1, R802.1.1

**LUMINAIRE** . . . . . E4004

Clearances . . . . . E4004.8

## M

**MACERATING TOILET** . . . . . P2723

**MAKEUP AIR** . . . . . M1503.4

**MANUFACTURED HOME**

Definition . . . . . R202

Provisions . . . . . Appendix AE

**MASONRY**

Anchorage . . . . . R606.11

Cavity wall . . . . . R606.13

Chases . . . . . R606.8

General . . . . . R606

Hollow unit . . . . . R202, R606.3.2.2, R606.13.1.2

Inspection . . . . . R109.1.4

Seismic requirements . . . . . R606.12

Solid, definition . . . . . R202

Veneer . . . . . R703.8

Veneer attachment . . . . . R703.3

**MASS WALLS** . . . . . Table N1102.1.3, N1102.2.5

**MATERIALS**

Alternative . . . . . R104.11

Combustible . . . . . R202, R1001.11, R1001.12,  
R1003.18, R1003.19

For ducts . . . . . M1601

For fixture accessories . . . . . P2702

For flue liners . . . . . R1003.11

For fuel-supply systems . . . . . Chapter 24

For hearth extension . . . . . R1001.9

For siding . . . . . R703.5

Hydronic pipe . . . . . M2101, M2103, M2104

Plumbing pipe . . . . . P2906, P3002

**MEANS OF EGRESS** . . . . . R311

Attachment of landings, decks,  
balconies and stairs . . . . . R311.5

Door . . . . . R311.2

Floors and landings at exterior doors . . . . . R311.3

Hallways . . . . . R311.6

Ramps . . . . . R311.8

Stairways . . . . . R311.7

Vertical egress . . . . . R311.4

## MECHANICAL

Inspection . . . . . R109.1.2

System requirements . . . . . N1103, Chapter 13

## MEDIUM PRESSURE FUEL-GAS

**PIPING SYSTEM** . . . . . Chapter 24

## MEMBRANE

Penetration . . . . . R302.4.2

Polyethylene . . . . . R504.2.2, R506.2.3

Waterproofing . . . . . R406.2

Water-resistive . . . . . R703.2

## METAL

Ducts . . . . . Chapter 16

Roof panels . . . . . R905.10

Roof shingles . . . . . R905.4

**METAL-CLAD CABLE** . . . . . Table E3801.2

## METHODS

Water distribution pipe sizing . . . . . Appendix AP

**MEZZANINES** . . . . . R325

**MODIFICATIONS** . . . . . R104.10

**MOISTURE CONTROL** . . . . . R702.7

## MORTAR

Joints . . . . . R606.3.1

## MOTORS

Motor branch circuits . . . . . E3702.6, E3702.7

## MULTIPLE

Appliance venting systems . . . . . M1801.11

Flues . . . . . R1003.13

**MULTIWIRE BRANCH CIRCUITS** . . . . . E3701.5

## INDEX

## N

**NONCOMBUSTIBLE MATERIAL**

Definition . . . . . R202

**NONMETALLIC BOXES** . . . . . E3905.3, E3908.17**NONMETALLIC RIGID CONDUIT** . . . . . E3801.4**NONMETALLIC-SHEATHED CABLE** . . . . . E3705.4.4,  
E3801.4, E3905.3.1, E3908.9.3**NONPOTABLE WATER SYSTEMS** . . . . . P2910,  
P2911, P2912, P2913**NOTCHING**

Electrical . . . . . E3402.1

For mechanical systems . . . . . M1308

For plumbing piping . . . . . P2603.2

Steel joists . . . . . R505.2.5, R505.3.5,  
R804.2.5, R804.3.3

Steel studs . . . . . R603.2.6, R603.3.4

Wood joists . . . . . R502.8, R802.7.1

Wood studs . . . . . R602.6

Wood top plates . . . . . R602.6.1

## O

**OCCUPANT SENSOR****CONTROL** . . . . . N1101.6, N1104.2**OCCUPIED SPACE**

Definition . . . . . R202

**OIL**

Piping and connections . . . . . M2202

Supply pumps and valves . . . . . M2204

Tanks . . . . . M2201

**ON-SITE RENEWABLE ENERGY** . . . . . N1101.6,  
N1106.3, N1106.4**OPENING**

Protection . . . . . R302.5

Requirements, combustion air . . . . . Chapter 17,  
Chapter 24

Waterproofing of piping penetrations . . . . . P2606.1

**OPEN-TOP GAS BROILER UNITS** . . . . . M1505.1**OUTLET**

Definition . . . . . Chapter 24, E3501

**OVEN, WALL-MOUNTED**

Definition applied to electrical provisions . . . . . E3501

**OVERCURRENT**

Definition . . . . . E3501

**OVERCURRENT PROTECTION** . . . . . E3705**OVERCURRENT-PROTECTION RATING** . . . . . E3705**OVERLOAD**

Definition . . . . . E3501

## P

**PANELBOARD** . . . . . E3706Clearance and dedicated space . . . . . E3405.2,  
E3405.3

Definition . . . . . E3501

Headroom . . . . . E3405.3

**PARAPETS** . . . . . R302.2.2, R606.4.4**PARTICLEBOARD**

Floor . . . . . R503.3

Walls . . . . . R605

**PENETRATIONS** . . . . . R302.4, R302.5**PERMITS** . . . . . R105**PHOTOVOLTAIC PANEL SYSTEMS** . . . . . R907**PIERS** . . . . . R606.7

Masonry . . . . . R404.1.9

**PIPE**

Fittings . . . . . P2906.6, P3002.3

Materials listing . . . . . P2609, Table M2101.1

Protection . . . . . P2603

Standards, drain, waste and  
vent . . . . . Table P3002.1(1),  
Table P3002.1(2)

Standards, sewer . . . . . Table P3002.2

Standards, water supply . . . . . P2906

**PIPING**Connections and materials . . . . . Table M2101.1,  
P2906

Drain, waste and vent . . . . . P3002.1

Excavations next to footings . . . . . P2604.4

Fuel-gas size determination . . . . . Chapter 24

Penetrations . . . . . P2606

Protection . . . . . P2603

Sizing methods, water distribution . . . . . P2903.7

Support . . . . . M2101.9, Chapter 24, P2605

**PITS**

Appliance location . . . . . M1305.1.3.2

**PLANNING**

Building . . . . . Chapter 3

**PLANS** . . . . . R106**PLASTER**

Exterior . . . . . R703.7

Interior . . . . . R702.2

**PLATFORM LIFTS AND ELEVATORS** . . . . . R321**PLENUM**

Definition . . . . . R202

Definition, electrical installations . . . . . E3501

**PLUMBING**

Fixture clearances . . . . . R307

Fixtures . . . . . Chapter 27

- Inspection . . . . . R109.1.2  
 Materials . . . . . P2702.2, P2905, P3002  
 Requirements and definitions . . . . . R202  
 System, definition . . . . . R202  
 Third-party certification . . . . . P2609.4  
 Traps . . . . . Chapter 32  
 Vents . . . . . Chapter 31
- PLYWOOD**
- Application . . . . . R703.5  
 Materials, walls . . . . . R604
- POTABLE WATER**
- Definition . . . . . R202  
 Piping listing . . . . . P2609.4
- PRECAST CONCRETE**
- Footings . . . . . R403.4  
 Foundation material . . . . . R402.3.1  
 Foundation walls . . . . . R404.5
- PRESSURE, WATER SUPPLY**
- Maximum . . . . . P2903.3.2  
 Minimum . . . . . P2903.3
- PRIVATE**
- Sewage disposal system . . . . . Appendix AI
- PROHIBITED**
- Receptors . . . . . P2706  
 Return air sources . . . . . M1602.2  
 Traps . . . . . P3201.5  
 Valves below grade . . . . . P2903.9.5  
 Water closets . . . . . P2712.1
- PROPOSED DESIGN (ENERGY)** . . . . . R202, N1105.3
- PROTECTION**
- Against decay and termites . . . . . R317, R318  
 Against radon . . . . . Appendix AF  
 Of backflow preventers . . . . . P2902.6  
 Of ferrous gas piping . . . . . Chapter 24  
 Of potable water supply . . . . . P2902
- PURLINS** . . . . . R802.4.5
- PURPOSE** . . . . . R101.3
- PUSH-FIT FITTING** . . . . . R202, P2906.21
- R**
- RACEWAY**
- Definition . . . . . E3501  
 Raceway installations . . . . . E3904  
 Raceway seals . . . . . E3601.5, E3803.6  
 Raceways as means of support . . . . . E3904.4
- RADON**
- Map . . . . . Appendix AF
- RAFTERS**
- Grade of lumber . . . . . R802.1
- Spans . . . . . R802.1.1,  
Tables R802.4.1(1) – R802.4.1(8)
- RAINPROOF**
- Definition applied to electrical provisions . . . . E3501
- RAINTIGHT**
- Definition applied to electrical provisions . . . . E3501
- RAINWATER**
- Identification for . . . . . P2901.2  
 Supply to fixtures . . . . . P2901.1
- RAMPS** . . . . . R311.8
- RANGES**
- Branch circuits for ranges . . . . . E3702.9
- RANGES AND OVENS**
- Vertical clearance above cooking top . . . . . M1901.1
- READILY ACCESSIBLE**
- Definition . . . . . R202  
 Definition, electrical installations . . . . . E3501
- READY ACCESS (TO)** . . . . . N1101.6, N1103.5.2,  
N1103.10.1
- RECEPTACLE**
- Definition . . . . . E3501
- RECEPTACLE OUTLET**
- Definition . . . . . E3501  
 Required outlets . . . . . E3901
- RECEPTACLES**
- Rating, type and installation . . . . . E4002
- RECEPTORS**
- Plumbing fixtures and traps . . . . . Chapter 27  
 Site-built shower . . . . . P2709.2  
 Waste . . . . . P2706
- RECESSED LUMINAIRES** . . . . . E4003.5, E4003.12,  
E4004.8, E4004.9
- RECLAIMED WATER**
- Identification for . . . . . P2901.2  
 Supply to fixtures . . . . . P2901.1
- RENEWABLE ENERGY**
- CERTIFICATE (REC)** . . . . . N1101.6, N1106.7.3
- RENEWABLE ENERGY RESOURCES** . . . . . N1101.6
- REPAIR**
- Defined . . . . . R202  
 Requirements, energy . . . . . N1112
- REQUIREMENTS**
- Connections for fuel-burning  
 appliances . . . . . Chapter 24  
 Return air . . . . . M1602
- RESISTANCE TO GROUND**
- Electrodes . . . . . E3608.4
- RESISTANT SIDING MATERIAL (see MATERIALS)**
- RETURN-AIR** . . . . . M1602
- RIDGE BOARD** . . . . . R802.4

## INDEX

<b>RIGID METALLIC CONDUIT</b> . . . . .	E3908
<b>RIGID NONMETALLIC CONDUIT</b> . . . . .	E3801.4
<b>ROOF</b>	
Coverings . . . . .	R905
Drainage . . . . .	R903.4
Fire classification . . . . .	R902
Flashing . . . . .	R703.4, R903.2, R905
Materials . . . . .	R904
Reroofing . . . . .	R908
Rooftop-mounted solar energy systems . . . . .	R324.3, R324.6
Steel framing . . . . .	R804
Wood framing . . . . .	R802
<b>ROOF ASSEMBLY</b>	
Defined . . . . .	R202
Insulation installation . . . . .	N1101.10.1.1
<b>ROOF-CEILING CONSTRUCTION</b> (see <b>CONSTRUCTION</b> )	
<b>ROOFING</b>	
Built-up . . . . .	R905.9
Liquid-applied coating . . . . .	R905.15
Modified bitumen . . . . .	R905.11
Sprayed polyurethane foam . . . . .	R905.14
Thermoplastic single-ply . . . . .	R905.13
Thermoset single-ply . . . . .	R905.12
<b>ROOM</b>	
Area, height and dimensions . . . . .	R304, R305
Heaters, vented . . . . .	M1410, Chapter 24
Minimum Sizes . . . . .	R304
<b>R-VALUE</b>	
Definition . . . . .	N1101.6
Installation requirements . . . . .	N1102.2
Minimum . . . . .	Table N1102.1.3
R-value alternative . . . . .	N1102.1.3

**S**

<b>SANITATION</b> . . . . .	R306
<b>SEISMIC RISK MAP</b> . . . . .	Figure R301.2(2), Figure R301.2(3)
<b>SEPTIC TANK</b>	
Definition . . . . .	R202
<b>SERVICE</b>	
Definition . . . . .	E3501
<b>SERVICE CABLE</b>	
Definition . . . . .	E3501
<b>SERVICE CONDUCTORS</b>	
Definition . . . . .	E3501
Drip loops . . . . .	E3605.9.5
Insulation . . . . .	E3605.1
Overload protection . . . . .	E3603.3

Rating of ungrounded service conductors . . . . .	E3602.1
Size . . . . .	E3603.1
<b>SERVICE DISCONNECT</b>	
Location . . . . .	E3601.6.2
Marking of . . . . .	E3601.6.1
Maximum number of . . . . .	E3601.7
Rating of . . . . .	E3602.3
Required . . . . .	E3601.6
<b>SERVICE DROP</b>	
Clearances . . . . .	E3604.1, E3604.2
Definition . . . . .	E3501
Point of attachment . . . . .	E3604.3
<b>SERVICE EQUIPMENT</b>	
Definition . . . . .	E3501
<b>SERVICE LATERAL</b>	
Definition . . . . .	E3501
<b>SERVICE LOAD</b> . . . . .	E3602.2
<b>SERVICE POINT</b>	
Definition . . . . .	E3501
<b>SERVICE UTILITIES</b> . . . . .	R111
<b>SERVICE VOLTAGE RATING</b> . . . . .	E3602.4
<b>SERVICE-ENTRANCE CONDUCTORS, OVERHEAD SYSTEM</b>	
Definition . . . . .	E3501
<b>SERVICE-ENTRANCE CONDUCTORS, UNDERGROUND SYSTEM</b>	
Definition . . . . .	E3501
<b>SERVICES</b> . . . . .	Chapter 36
<b>SEWAGE</b>	
Disposal, private . . . . .	P2602
<b>SEWER, BUILDING</b>	
Definition . . . . .	R202
Replacement by PVC fold and form method . . . . .	P3011
Separation from water service . . . . .	P2604.2, P2906.4.1
Size . . . . .	P3005.4.2
Testing . . . . .	P2503.4
<b>SHAKES</b>	
Wood . . . . .	R702.6, R703.6, R905.8
<b>SHINGLE</b>	
Asphalt shingles . . . . .	R905.2
Metal . . . . .	R905.4
Slate . . . . .	R905.6
Wood . . . . .	R905.7
<b>SHOWER</b>	
Compartment . . . . .	R307.2
Control valve . . . . .	P2708.4
Control valve riser to shower head . . . . .	P2708.3
Drain size . . . . .	P2708.2



- Finishes . . . . . R307.2  
 Hand. . . . . P2708.5  
 Receptor. . . . . P2709  
 Space required. . . . . R307.1  
 Stall dimensions. . . . . P2708  
 Walls . . . . . P2710
- SHUTOFF VALVE (see VALVES)**
- SIDING**  
 Exterior coverings . . . . . R703
- SINKS** . . . . . P2714
- SITE**  
 Address . . . . . R319  
 Preparation. . . . . R408.5, R504.2, R506.2
- SIZE**  
 Of combustion air openings . . . . . Chapter 17  
 Of rooms . . . . . R304  
 Of trap . . . . . P3201.7
- SIZING METHODS**  
 Water piping. . . . . P2903.7
- SKYLIGHTS** . . . . . R308.6
- SLATE SHINGLES** . . . . . R905.6
- SLEEPING UNIT** . . . . . R202
- SMOKE ALARMS** . . . . . R314
- SMOKE-DEVELOPED INDEX** . . . . R302.9, R302.10
- SNOW LOAD MAP** . . . . . Figure R301.2(3),  
 Figure R301.2(4)
- SNOW MELT SYSTEMS** . . . . . N1103.9
- SOFFIT** . . . . . R704  
 Fiber-cement . . . . . R704.2.2, R704.3.2  
 Hardboard . . . . . R704.2.3, R704.3.3  
 Vinyl . . . . . R704.2.1, R704.3.1  
 Wood . . . . . R704.2.4, R704.3.4
- SOILS**  
 Collapsible (definition) . . . . . R202  
 Compressible (definition) . . . . . R202  
 Expansive (definition) . . . . . R202
- SOLAR ENERGY SYSTEMS** . . . . . R324, M2301  
 Building-integrated photovoltaic systems. . . R324.5  
 Definition . . . . . R202  
 Ground-mounted photovoltaic systems . . . . R324.7  
 Photovoltaic systems . . . . . R324.3  
 Roof access and pathways . . . . . R324.6  
 Rooftop-mounted photovoltaic systems . . . . R324.3  
 Solar thermal systems . . . . . R202, Chapter 23
- SOLAR FRACTION** . . . . . N1101.6,  
 N1103.5.1, N1108.2.3
- SOLAR HEAT GAIN COEFFICIENT (SHGC)**  
 Default . . . . . Table N1101.10.3(3)  
 Defined. . . . . R202  
 Requirements. . . . . Table N1102.1.2, Table N1102.1.3
- SPANS**  
 Steel (allowable). . . . . R505.3.2, R804.3.2.1  
 Wood (allowable) . . . . . R502.3, R802.5
- SPAS** . . . . . R327, E4208
- SPLICES** . . . . . E3406.11
- SPLICES AND TAPS** . . . . . E3803.4
- SPRINKLER (see FIRE SPRINKLER SYSTEMS)**
- STAIRWAYS** . . . . . R311.7  
 Alternating tread devices . . . . . R311.7.11  
 Bulkhead enclosure . . . . . R311.7.10.2  
 Handrails . . . . . R311.7.8  
 Headroom. . . . . R311.7.2  
 Illumination . . . . . R311.7.9  
 Landings for . . . . . R311.7.6  
 Nosings . . . . . R311.7.5.3  
 Ship's ladders. . . . . R311.7.12  
 Spiral . . . . . R311.7.10  
 Treads and risers . . . . . R311.7.5, R311.7.5.4  
 Vertical rise. . . . . R311.7.3  
 Walking surface slope . . . . . R311.7.7  
 Walkline . . . . . R311.7.4  
 Width . . . . . R311.7.1  
 Winder treads. . . . . R311.7.5.2.1
- STANDARD REFERENCE DESIGN**  
 Defined. . . . . R202  
 Requirements. . . . . N1105, Table N1105.4.2(1)
- STANDARDS** . . . . . Chapter 44, Appendix AG
- STANDPIPE (see WASTE RECEPTOR)**
- STATIONARY ENGINE GENERATORS** . . . . . R329  
 Defined. . . . . R202
- STATIONARY FUEL CELL  
 POWER SYSTEMS** . . . . . R330  
 Defined. . . . . R202
- STEEL**  
 Fireplace units . . . . . R1001.5.1  
 Floor construction. . . . . R505  
 Framing, insulation requirements . . . . . N1102.2.6  
 Roof-ceiling construction . . . . . R804  
 Walls. . . . . R603
- STOP WORK ORDER** . . . . . R114
- STORM SHELTERS** . . . . . R106.1.5, R323
- STORY**  
 Definition . . . . . R202
- STOVES**  
 Factory-built fireplace. . . . . M1414
- STRUCTURAL AND PIPING PROTECTION** . . P2603
- STRUCTURAL INSULATED PANEL (SIP)** . . . . R610
- STUDS**  
 Spacing . . . . . R602.3.1  
 Steel . . . . . R603.2, R603.3

## INDEX

Wood . . . . . R602.2, R602.3

**SUBSURFACE IRRIGATION SYSTEMS** . . . . . P3009

**SUMP PUMPS** . . . . . P3007.3.2, P3303

**SUMPS AND EJECTORS** . . . . . P3007

**SUNROOMS** . . . . . R301.2.1.1.1, R303.9.1

Defined . . . . . R202

Fenestration . . . . . N1102.3.5

Insulation . . . . . N1102.2.12

**SUPPLY**

Combustion air . . . . . Chapter 17, Chapter 24

Fuel systems . . . . . Chapter 24

Oil supply pumps and valves . . . . . M2204

Required gas . . . . . Chapter 24

Return air . . . . . M1602

Water . . . . . Chapter 29

**SUPPORT**

Of decks . . . . . R507.9.1.2

Of ducts . . . . . M1601.4.4

Of floor joists . . . . . R502.6, R505.3.2

Of masonry chimneys . . . . . R1003.2, R1003.3, R1003.4

Of pipe . . . . . M2101.9, Chapter 24, P2605

**SUPPORT REQUIREMENTS FOR**

**WIRING METHODS** . . . . . E3802.1

**SWIMMING POOLS, SPAS AND**

**HOT TUBS** . . . . . R327, N1103.10, Chapter 42, Appendix AG

**SWITCHES**

Definition . . . . . E3501

Rating and application . . . . . E4001

**SYSTEMS**

Mechanical venting . . . . . Chapter 18, Chapter 24

Plumbing, drainage, waste and venting . . . . . Chapter 25, Chapter 30, Chapter 31, Chapter 33

**T**

**TAIL PIECES, PLUMBING FIXTURE** . . . . . P2703

**TANK**

For fuel oil-burning appliances . . . . . M2201

Septic, definition . . . . . R202

**TEMPERATURE LIMITATIONS** . . . . . E3705.4

**TEMPORARY STRUCTURES** . . . . . R107

**TERMINALS** . . . . . E3406.10

**TERMINATION**

Of chimneys . . . . . R1003.9

Of vents (general) . . . . . M1804.2

**TERMITES**

Infestation probability map . . . . . Figure R318.4

Protection . . . . . R318

**TEST**

For leaks in supply piping . . . . . Chapter 24

Of backflow preventers . . . . . P2503.8

Of building sewers . . . . . P2503.4

Of plumbing systems . . . . . P2503

Of shower liner . . . . . P2503.6

**THERMAL DISTRIBUTION**

**EFFICIENCY (TDE)** . . . . . N1101.6, N1103.3.1

**THERMAL ISOLATION**

Defined . . . . . R202

Requirements . . . . . N1102.2.12

**THERMAL RESISTANCE (see R-VALUE)****THERMAL TRANSMITTANCE (see U-FACTOR)****THERMOSTAT**

Controls . . . . . N1103.1

Defined . . . . . R202

Programmable . . . . . N1103.1.1

**THICKNESS**

Of chimney walls . . . . . R1003.10

**TIES**

Veneer . . . . . R703.8.4

**TILE**

Shingles (clay and concrete) . . . . . R905.3

**TIME SWITCH, PUMPS FOR POOLS** . . . . . N1103.10.2**TOILET, BATH AND SHOWER SPACES** . . . . . R307**TOWNHOUSE**

Definition . . . . . R202

Parapet construction . . . . . R302.2.5

Scope . . . . . R101.2

Separation . . . . . R302.2

Structural independence . . . . . R302.2.6

**TRACK LIGHTING** . . . . . E4005**TRAP** . . . . . Chapter 32

Arm, definition . . . . . R202

Building . . . . . P3201.4

Seal protection . . . . . P3201.2.1

**TRENCHING AND BACKFILLING** . . . . . P2604**TRUSSES**

Steel . . . . . R505.1.3, R804.3.6

Wood . . . . . R502.11, R802.10

**TWO-FAMILY DWELLINGS** . . . . . R302.3**TYPE OF VENTING SYSTEMS**

**REQUIRED** . . . . . Chapter 18, Chapter 24

**U****U-FACTOR**

Definition . . . . . N1101.6

Maximum . . . . . Table N1102.1.2

Total UA Alternative . . . . . N1102.1.4

**UNDER FLOOR**

- Access to furnaces . . . . . M1305.1.3
- Plenums . . . . . M1601.5
- Space . . . . . R408

**UNDERGROUND INSTALLATION REQUIREMENTS**

- Duct systems . . . . . M1601.1.2
- Electrical cable . . . . . E3803
- Wiring . . . . . E4203.8

**UNDER-STAIR PROTECTION** . . . . . R302.7**UNVENTED ATTIC ASSEMBLIES** . . . . . R806.5**UTILIZATION EQUIPMENT**

- Definition . . . . . E3401

**V****VALVES**

- Backwater . . . . . P3008
- Meter . . . . . Chapter 24
- Oil-supply . . . . . M2204
- Plumbing fixture . . . . . P2903.9.3
- Relief, water heater . . . . . P2804
- Shut off, water heaters . . . . . P2903.9.2
- Shut off, water supply . . . . . P2903.9
- Shutoff, fuel-gas . . . . . Chapter 24
- Shutoff, fuel-oil . . . . . M2204.2

**VAPOR RETARDERS** . . . . . R702.7

- Definition . . . . . R202
- Under floor . . . . . R408.8

**VENEER**

- Masonry . . . . . R703.7

**VENT**

- B or BW vent . . . . . Chapter 24
- Definition . . . . . Chapter 24
- L vent . . . . . M1804.2.4, Chapter 24
- Plumbing system, definition . . . . . R202
- Termination . . . . . M1804.2, M2203.5, P3103.5

**VENTED**

- Decorative appliances . . . . . Chapter 24
- Floor furnaces . . . . . M1408
- Room heaters . . . . . M1410
- Wall furnaces . . . . . M1409

**VENTILATION**

- Adjoining rooms . . . . . R303.2
- Bathroom and kitchen . . . . . R303.3
- For hydrogen systems . . . . . M1307.4
- Habitable rooms . . . . . R303.1
- Roof . . . . . R806
- Under floor . . . . . R408.1
- Whole-house . . . . . Table N1103.6.2, M1505.4

**VENTING (MECHANICAL)**

- Chimney and vent connectors . . . . . R1006, M1803, Chapter 24
- Components . . . . . M1802, Chapter 24
- Fireplace . . . . . R1006
- General . . . . . M1801, Chapter 24
- Required . . . . . M1801, M2203.4, Chapter 24
- Systems . . . . . Chapter 18, Chapter 24
- Testing . . . . . N1103.6.3
- Whole-house . . . . . N1103.6.1

**VENTING (PLUMBING)**

- Air admittance valves . . . . . P3114
- Circuit . . . . . P3110
- Combination waste and vent system . . . . . P3111
- Common . . . . . P3107
- Connections and grades . . . . . P3104
- Fixture . . . . . P3105
- Individual . . . . . P3106
- Island fixture . . . . . P3112
- Pipe sizing . . . . . P3113
- Stacks and stack vents . . . . . P3102
- Systems . . . . . P3101
- Terminals . . . . . P3103
- Waste stack . . . . . P3109
- Wet . . . . . P3108

**VERTICAL**

- Clearances above cooking top . . . . . M1901.1
- Pipe, definition . . . . . R202

**VIOLATIONS**

- And penalties . . . . . R113

**VISIBLE TRANSMITTANCE (VT)**

- Default glazed fenestration . . . . . N1101.10.3
- Defined . . . . . R202

**VOLTAGE**

- Definition . . . . . E3501

**VOLTAGE RATING (SERVICES)** . . . . . E3602.4**VOLTAGE TO GROUND**

- Definition . . . . . E3501

**VOLTAGES** . . . . . E3404.1**W****WALL FURNACE (see APPLIANCE)****WALLBOARD**

- Gypsum . . . . . R702.3

**WALLS**

- Above-grade, defined . . . . . R202
- Basement, defined . . . . . R202
- Bathtub compartments . . . . . R307.2, P2710
- Bracing, steel . . . . . R603.9

## INDEX

- Bracing, wood . . . . . R602.10  
 Construction . . . . . Chapter 6  
 Covering . . . . . Chapter 7  
 Crawl space, defined . . . . . R202  
 Cripple . . . . . R602.9  
 Deflection . . . . . R301.7  
 Exterior, defined . . . . . R202  
 Exterior covering . . . . . R703  
 Finishes . . . . . R307.2, R702  
 Fireplace . . . . . R1001.5  
 Foundation . . . . . R404  
 Insulating concrete form . . . . . R608.3, R608.4, R608.5.3  
 Shower compartments . . . . . P2710  
 Steel framing . . . . . R603  
 Structural insulated panels (SIP) . . . . . R610  
 Thickness, masonry chimneys . . . . . R1003.10  
 Wood framing . . . . . R602
- WARM-AIR FURNACES** . . . . . M1402  
 Access to . . . . . M1401.2  
 Clearance from . . . . . M1402.2
- WASTE**  
 Clear water . . . . . P2706.1  
 Continuous, definition . . . . . R202
- WASTE RECEPTOR**  
 Hub drain . . . . . P2706.1.1  
 Prohibited types . . . . . P2706.2  
 Standpipe . . . . . P2706.1.2
- WATER**  
 Distribution system, definition . . . . . R202  
 Heater, definition . . . . . R202  
 Heaters . . . . . Chapter 20, Chapter 24, Chapter 28  
 Individual supply and sewage disposal . . . . . P2602  
 Piping sizing methods . . . . . P2903  
 Pressure . . . . . P2903.3  
 Service, separation from sewer . . . . . P2604.2  
 Supply and distribution . . . . . Chapter 29  
 Supply system, definition . . . . . R202
- WATER CLOSET**  
 Carriers for wall hung . . . . . P2702.4  
 Clearances for . . . . . R307.1  
 Dual flushing . . . . . P2712.1  
 Personal hygiene devices . . . . . P2722.5  
 Seats . . . . . P2712.7  
 Standards . . . . . P2712.1
- WATER HEATER**  
 Drain water heater heat recovery units . . . . . P2903.11  
 General requirements . . . . . N1103.5.1  
 In garages . . . . . P2801.7  
 Location . . . . . P2801.3, P2801.4, P2801.5  
 Pan . . . . . P2801.6
- Plumbing requirements . . . . . Chapter 28  
 Relief valves . . . . . P2804  
 Seismic bracing . . . . . P2801.7  
 Solar thermal . . . . . P2802, P2902.5.5  
 Thermal expansion from  
 Used for space heating . . . . . P2803
- WATERTIGHT**  
 Definition applied to electrical provisions. . . . . E3501
- WATERPROOFING**  
 And dampproofing . . . . . R406  
 Of openings through roofs and walls . . . . . P2607
- WEATHERPROOF**  
 Definition applied to electrical provisions. . . . . E3501
- WELLS (see INDIVIDUAL WATER SUPPLY)**
- WHIRLPOOL BATHTUBS** . . . . . P2720
- WHOLE-HOUSE VENTILATION** . . . . . M1505.4
- WIND**  
 Design criteria . . . . . R301.2  
 Speed maps . . . . . Figure R301.2(5)A, Figure R301.2(5)B
- WINDOW** . . . . . R609  
 EERO replacement sill height . . . . . R310.5  
 Fall protection . . . . . R312.2  
 Opening limiting devices . . . . . R312.2.2
- WIRING METHODS** . . . . . Chapter 37
- WOOD**  
 Floor construction . . . . . R502  
 Foundation walls . . . . . R404.2  
 Protection against decay . . . . . R317  
 Roof-ceiling construction . . . . . R802  
 Shakes . . . . . R905.8  
 Shingles . . . . . R905.7  
 Trusses . . . . . R502.11, R802.10  
 Walls . . . . . R602
- WORKING SPACE** . . . . . E3606.2  
 Around electrical equipment . . . . . E3405.1, E3405.2
- WORKMANSHIP, PLUMBING** . . . . . P2608

## Y

## YARD

- Definition . . . . . R202

## EDITORIAL CHANGES – SECOND PRINTING

Page 2-6, definition [RE] **EXTERIOR WALL** now reads . . .

**[RB] EXTERIOR WALL.** An above-grade wall that defines the exterior boundaries of a building. Includes between-floor spandrels, peripheral edges of floors, roof and *basement* knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and *basement walls* with an average below-grade wall area that is less than 50 percent of the total opaque and nonopaque area of that enclosing side. For the definition applicable in Chapter 11, see Section N1101.6.

Page 3-3, **TABLE R301.2:** column 6, row 6 now reads . . . Summer design gains

Page 3-3, **TABLE R301.2:** Note g line 2 now reads . . . hazard areas); and the title and date of the currently effective Flood Insurance Study or other flood hazard study and maps adopted by the authority having jurisdiction, as amended.

Page 3-9, **TABLE R301.2.1(1):** column 4, row 2 now reads . . .

90.0	95.0	100.0	105.0	110.0	115.0	120.0	130.0	140.0	150.0	160.0	170.0	180.0
------	------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Page 3-32, **TABLE R301.5:** column 2, row 9 now reads . . . —

Page 3-32, **TABLE R301.5:** column 3, row 9 now reads . . . 200<sup>h</sup>

Page 3-63, **Section R322.3.7:** paragraph 2, lines 2 and 3 now read . . . enclosed with walls below the elevation required in Section R322.3.2 unless such walls are constructed in

Page 5-36, **FIGURE R507.5.1(2)** now reads as shown.

Page 6-4, **TABLE R602.3(1)—continued:** column 3, row 14 now reads . . .

3-8d box ( $2\frac{1}{2}'' \times 0.113''$ ); or  
2-8d common ( $2\frac{1}{2}'' \times 0.131''$ ); or  
2-(3''  $\times 0.131''$ ); or  
2-10d box (3''  $\times 0.128''$ )

Page 6-6, **TABLE R602.3(1)—continued:** column 3, row 9 now reads . . .

8d common ( $2\frac{1}{2}'' \times 0.131''$ ) nail; or  
Deformed ( $2\frac{1}{2}'' \times 0.131''$ ); or  
Deformed ( $2\frac{1}{2}'' \times 0.120''$ ) nail

Page 6-6, **TABLE R602.3(1)—continued:** column 3, row 10 now reads . . .

10d common (3''  $\times 0.148''$ ) nail; or  
Deformed ( $2\frac{1}{2}'' \times 0.131''$ ); or  
Deformed ( $2\frac{1}{2}'' \times 0.120''$ ) nail

6-98, **Section R606.12:** line 7 now reads . . . glass unit masonry conforming to Section R607, anchored

Page 6-132, **FIGURE R608.7.1.1(2),** column 4, Item 1 now reads . . . 1. See Table R608.7.1.1(6) for use of details.

Page 7-7, **Section R703.2:** Item 2 now reads . . . 2. ASTM E2556, Type 1 or 2.

Page 9-2, **Section R905.1.1:** Exception 1 now reads . . . 1. As an alternative, self-adhering polymer-modified bitumen underlayment bearing a label indicating compliance with ASTM D1970 and installed in accordance with both the underlayment manufacturer's and roof covering manufacturer's instructions for the deck material, roof ventilation configuration and climate exposure for the roof covering to be installed, shall be permitted.

Page 9-3, **TABLE R905.1.1(1):** column 3, row 2, line 2 now reads . . . ASTM D4696 Type I, II, III or IV



Page 11-1, **Section N1101.1 (R102.1.1)** now reads . . .

**N1101.4 (R102.1.1) Above code programs.** The *code official* or other authority having *jurisdiction* shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program shall be considered to be in compliance with this code. The requirements identified in Table N1105.2, as applicable, shall be met and the *building thermal envelope* is greater than or equal to levels of efficiency and solar heat gain coefficients (SHGC) in Tables 402.1.1 and 402.1.3 of the 2009 *International Energy Conservation Code*.

Page 11-3, Definition **HIGH-EFFICACY LIGHT SOURCES** now reads . . .

**HIGH-EFFICACY LIGHT SOURCES.** Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.

Page 11-23, **TABLE N1101.7 (R301.1)—continued:** column 1, row 41 now reads . . . 4B Catron

Page 11-40, **Section N1101.13.5 (R401.2.5):** Item 2.2, line 2 now reads . . . under Section N1105.2 shall have an

Page 11-42, **Section N1102.2.1 (R402.2.1)** now reads . . .

**N1102.2.1 (R402.2.1) Ceilings with attics.** Where Section N1102.1.3 requires R-49 insulation in the ceiling or attic, installing R-38 insulation over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. Where Section N1102.1.2 requires R-60 insulation in the ceiling or attic, installing R-49 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the insulation and fenestration criteria in Section N1102.1.2 and the Total UA alternative in Section N1102.1.5.

Page 11-42, **TABLE R1102.1.2 (R402.1.2):** column 4, line 7 now reads . . . 0.40

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 2 now reads . . . 13 or 0&10ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 3 now reads . . . 13 or 0&10ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 4 now reads . . . 13 or 0&10ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 5 now reads . . . 20 or 13&10ci<sup>h</sup> or 0&15ci<sup>h</sup>

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 6 now reads . . . 30 or 20&5ci<sup>h</sup> or 13&10ci<sup>h</sup> or 0&20ci<sup>h</sup>

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 7 now reads . . . 30 or 20&5ci<sup>h</sup> or 13&10ci<sup>h</sup> or 0&20ci<sup>h</sup>

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 8 now reads . . . 30 or 20&5ci<sup>h</sup> or 13&10ci<sup>h</sup> or 0&20ci<sup>h</sup>

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 6, line 9 now reads . . . 30 or 20&5ci<sup>h</sup> or 13&10ci<sup>h</sup> or 0&20ci<sup>h</sup>

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 9, row 7, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 11, row 7, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 9, row 8, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 11, row 8, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 9, row 9, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** column 11, row 9, line 3 now reads . . . 13&5ci

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** Note c, line 3 now reads . . . 19 or 13&5ci” means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall;

Page 11-43, **TABLE N1102.1.3 (R402.1.3):** Note g, line 1 now reads . . . g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, “13&5” means R-13 cavity insulation plus R-5

Page 11-44, **Section N1102.2.4.1 (R402.2.4.1):** line 8 now reads . . . tion is installed, a wood-framed or equivalent baffle,

Page 11-44, **Section N1102.2.4.1 (R402.2.4.1):** line 10 now reads . . . insulation from spilling into living space from higher

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1):** column 1, row 8, line 1 now reads . . . Basement, crawl

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1):** column 2, row 8, paragraph 1, line 3 now reads . . . with Section N1102.2.10.

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1):** column 3, row 8, paragraph 1, line 3 now reads . . . N1102.2.10.

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1):** column 3, row 8, paragraph 2, line 2 now reads . . . be installed in accordance with Section N1102.2.8.1.

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1):** column 3, row 8, paragraph 3, line 2 now reads . . . dance with Section N1102.2.10.

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1)**: column 2, row 9, paragraph 1 now reads . . . Duct and flue shafts and other similar penetrations to exterior or unconditioned space shall be sealed.

Page 11-47, **TABLE N1102.4.1.1 (R402.4.1.1)**: column 3, row 11, lines 3 and 4 now read . . . shall be installed in accordance with Sections N1101.10–N1101.12 and N1102.2.7.

Page 11-48, **TABLE N1102.4.1.1 (R402.4.1.1)—continued**: column 2, row 2, line 3 now reads . . . N1102.4.5.

Page 11-51, **Section N1103.6 (R403.6)** now reads . . .

**N1103.6 (R403.6) Mechanical ventilation.** The *buildings* complying with Section N1102.4.1 shall be provided with mechanical *ventilation* that complies with the requirements of Section M1505 or with other *approved* means of *ventilation*. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the *ventilation* system is not operating.

Page 11-53, **Section N1105.2 (R405.2)**: Item 2, line 1 reads . . . 2. The building thermal envelope shall be greater than

Page 11-54, **Section N1105.3.2 (R405.3.2)**: paragraph 2, line 2 now reads . . . dance with Sections N1105.3.2.1 and N1105.3.2.2.

Page 11-54, **Section N1105.5.1 (R405.5.1)**: Item 2, line 4 now reads . . . with Section N1103.7.

Page 11-56, **TABLE N1105.4.2(1) [R405.4.2(1)]—continued**: column 2, row 4, line 7 now reads . . .  $e_f$  = the minimum fan efficacy, as specified in Table

Page 11-57, **TABLE N1105.4.2(1) [R405.4.2(1)]—continued**: column 2, row 2, line 2 now reads . . . Use, in units of gal/day =  $25.5 + (8.5 \times N_{br})$

Page 11-57, **TABLE N1105.4.2(1) [R405.4.2(1)]—continued**: column 3, row 9, now reads . . .

Duct location: as proposed

Duct insulation: as proposed.

As tested or, where not tested, as specified in Table N1105.4.2(2).

Page 11-59, **Section N1106.3.2 (R406.3.2)**: line 6 now reads . . . or Table R402.1.4 of the 2018 *International Energy*

Page 11-62, **Section N1108.2.3 (R408.2.3)**: Item 1, line 1 now reads . . . 1. Greater than or equal to 0.82 EF fossil fuel service

Page 13-1, **Section M1301.1.1**: line 2 now reads . . . areas as established by Table R301.2, mechanical *appli-*

Page 29-4, **Section P2902.5.4.1**: line 9 now reads . . . added to only a portion of an automatic sprinkler or

Page 29-8, **Section P2904.1**: line 2 now reads . . . automatic sprinkler systems shall be in accordance with

Page 39-3, **Section E3901.7**: lines 6 and 7 now read . . . porches that are accessible from inside within 4 inches (102 mm) horizontally of the dwelling unit shall have at least one

Page 39-4, new sections have been added and now read . . .

**E3902.15 Crawl space lighting outlets.** Lighting outlets not exceeding 120 volts installed in crawl spaces shall have ground-fault circuit-interrupter protection for personnel. [210.8(C)]

**E3902.16 Equipment requiring servicing.** Receptacles installed in accordance with Section E3901.12 shall have ground-fault circuit-interrupter protection. [210.8(E)]

**E3902.17 Outdoor outlets.** All outdoor outlets, other than those covered in the exception to Section E3902.3, that are supplied by single-phase branch circuits rated 150 volts to ground or less, 50 amperes or less, shall have ground-fault circuit-interrupter protection for personnel. [210.8(F)]

**Exception:** Ground-fault circuit-interrupter protection shall not be required on lighting outlets other than those covered in Section E3902.15. [210.8(F) Exception]

Page 39-4, **Section E3902.15 Location of ground-fault circuit interrupters** has been renumbered and now reads . . .

**E3902.18 Location of ground-fault circuit interrupters.**

Page 39-5, **Section E3902.16 Location of arc-fault circuit interrupters** has been renumbered and now reads . . .

**E3902.19 Location of arc-fault circuit interrupters**

Page 39-5, **Section E3902.17 Arc-fault circuit interrupter protection** has been renumbered and now reads . . .

**E3902.20 Arc-fault circuit interrupter protection**

Page 39-5, **Section E3902.18 Arc-fault circuit-interrupter protection for branch circuit extensions or modifications** has been renumbered and now reads . . .

**E3902.21 Arc-fault circuit-interrupter protection for branch circuit extensions or modifications**

Page 39-5, **Section E3902.18:** line 4 now reads . . . areas specified in Section E3902.20, the branch circuit shall

Page 44-1, Referenced Standard **AAMA 714—20** now reads . . .

**714—19: Voluntary Specification for Liquid-Applied Flashing Used to Create a Water-Resistive Seal around Exterior Wall Openings in Buildings**

Page 44-1, Referenced Standard **AAMA AAMA/NSA 2100—20** now reads . . .

**AAMA/NSA 2100—19: Specifications for Sunrooms**

Page 44-2, Referenced Standard **AISI AISI S230—18** now reads . . .

**AISI S230—19: Standard for Cold-Formed Steel Framing—Prescriptive Method for One- and Two-Family Dwellings, 2019**

Page 44-2, Referenced Standard **ANSI A108.5—19** now reads . . .

**A108.5—20: Installation of Ceramic Tile with Dry-set Portland Cement Mortar or Latex-Portland Cement Mortar**

Page 44-3, Referenced Standard **ANSI A108.6—19** now reads . . .

**A108.6—99 (Reaffirmed 2019): Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy**

Page 44-3, Referenced Standard **ANSI A118.3—20** now reads . . .

**A118.3—13: American National Standard Specifications for Chemical-resistant, Water-cleanable Tile-setting and -grouting Epoxy and Water Cleanable Tile-setting Epoxy Adhesive**

Page 44-3, Referenced Standard **ANSI A136.1—19** now reads . . .

**A136.1—20: American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile**

Page 44-3, Referenced Standard **LC1/CSA 6.26—2016** now reads . . .

**ANSI LC 1—2018/CSA 6.26—2016: Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST)**

Page 44-3, Referenced Standard **ANSI Z21.8—94(R2012)** now reads . . .

**ANSI Z21.8—1994 (R2017): Installation of Domestic Gas Conversion Burners**

Page 44-3, Referenced Standard **ANSI Z21.10.1/CSA 4.1—2012** now reads . . .

**ANSI Z21.10.1—2017/CSA 4.1—2017: Gas Water Heaters, Volume I, Storage**

Page 44-3, Referenced Standard **ANSI Z21.22—99(R2003)** now reads . . .

**ANSI Z21.22—2015: Relief Valves for Hot Water Supply Systems**

Page 44-4, Referenced Standard **ANSI Z21.58—95/CSA 1.6—2015** now reads . . .

**ANSI Z21.58—2018/CSA 1.6—2018: Outdoor Cooking Gas Appliances**

Page 44-4, Referenced Standard **ANSI Z21.97—2014** now reads . . .

**ANSI Z21.97—2017/CSA 2.41—2017: Outdoor Decorative Gas Appliances**

Page 44-4, Referenced Standard **ANSI Z83.19—2009 (R2014)** now reads . . .

**ANSI Z83.19—2017/CSA 2.35—2017: Gas-Fired High-Intensity Infrared Heaters**

Page 44-4, Referenced Standard **ANSI Z83.20—08** now reads . . .

**ANSI Z83.20—2016/CSA 2.34—2016: Gas-Fired Tubular and Low-Intensity Infrared Heaters**

Page 44-4, Referenced Standard **ANSI Z97.1—2014** now reads . . .

**Z97.1—2017: Safety Glazing Materials Used in Buildings—Safety Performance Specifications and Methods of Test**

Page 44-5, Referenced Standard **ASHRAE—2021** now reads . . .

**ASHRAE—2017: ASHRAE Handbook of Fundamentals**

Page 44-6, Referenced Standard **ASME A112.1.2—2012(R2022)** now reads . . .

**A112.1.2—2012(R2017): Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water Connected Receptors)**

Page 44-6, Referenced Standard **ASME A112.1.3—2000 (Reaffirmed 2020)** now reads . . .

**A112.1.3—2000 (R2019): Air Gap Fittings for Fixtures, Appliances and Appurtenances**

Page 44-6, Referenced Standard **ASME A112.3.1—2007(R2022)** now reads . . .

**A112.3.1—2007(R2017): Stainless Steel Drainage Systems for Sanitary, DWV, Storm and Vacuum Applications Above and Below Ground**

Page 44-6, Referenced Standard **ASME A112.3.4—2020/CSA B45.9—20** now reads . . .

**A112.3.4—2018/CSA B45.9—2018: Macerating Toilet Systems and Related Components**

Page 44-6, Referenced Standard **ASME A112.4.14—2004(R2019)** now reads . . .

**A112.4.14—2019/CSA B125.14—19: Manually Operated Valves for Use in Plumbing Systems**

Page 44-6, Referenced Standard **ASME A112.6.2—2022** now reads . . .

**A112.6.2—2017: Framing-affixed Supports for Off-the-floor Water Closets with Concealed Tanks**

Page 44-6, Referenced Standard **ASME A112.14.1—03(2022)** now reads . . .

**A112.14.1—03(2017): Backwater Valves**

Page 44-6, Referenced Standard **ASME A112.18.1—2020/CSA B125.1—2020** now reads . . .

**A112.18.1—2018/CSA B125.1—2018: Plumbing Supply Fittings**

Page 44-6, Referenced Standard **ASME A112.18.2—2019/CSA B125.2—2019** now reads . . .

**A112.18.2—2020/CSA B125.2—2020: Plumbing Waste Fittings**

Page 44-6, Referenced Standard **ASME A112.18.3M—2002(R2020)** now reads . . .

**A112.18.3M—2002(R2017): Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings**

Page 44-6, Referenced Standard **ASME A112.18.6—2021/CSA B125.6—21** now reads . . .

**A112.18.6—2017/CSA B125.6—2017: Flexible Water Connectors**

Page 44-6, Referenced Standard **ASME A112.19.1—2020/CSA B45.2—2020** now reads . . .

**A112.19.1—2018/CSA B45.2—2018: Enameled Cast-iron and Enameled Steel Plumbing Fixtures**

Page 44-6, Referenced Standard **ASME A112.19.2—2020/CSA B45.1—2020** now reads . . .

**A112.19.2—2018/CSA B45.1—2018: Ceramic Plumbing Fixtures**

Page 44-6, Referenced Standard **ASME A112.19.3—2021/CSA B45.4—08(R2021)** now reads . . .

**A112.19.3—2017/CSA B45.4—2017: Stainless Steel Plumbing Fixtures**

Page 44-6, Referenced Standard **ASME A112.19.5—2021/CSA B45.15—2021** now reads . . .

**A112.19.5—2017/CSA B45.15—2017: Flush Valves and Spuds for Water-closets, Urinals and Tanks**

Page 44-6, Referenced Standard **ASME A112.19.7—2012/CSA B45.10—2012(R2021)** now reads . . .

**A112.19.7—2012/CSA B45.10—2012(2017): Hydromassage Bathtub Systems**

Page 44-6, Referenced Standard **ASME A112.19.12—2019** now reads . . .

**A112.19.12—2014(R2019): Wall-mounted and Pedestal-mounted, Adjustable, Elevating, Tilting, and Pivoting Lavatory and Sink, and Shampoo Bowl Carrier Systems and Drain Waste Systems**

Page 44-7, Referenced Standard **ASME ASSE 1016—2020/ASME 112.1016—2020/CSA B125.16—20** now reads . . .

**ASME A112.4.2—2015/CSA B45.16—2015(R2020): Water-closet Personal Hygiene Devices**

Page 44-7, Referenced Standard **ASME ASSE 1016—2020/ASME 112.1016—2020/CSA B125.16—2020** now reads . . .

**ASSE 1016—2017/ASME A112.1016—2017/CSA B125.16—2017: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations**

Page 44-7, Referenced Standard **ASME B1.20.1—2019** now reads . . .

**B1.20.1—2013(R2018): Pipe Threads, General-purpose (Inch)**

Page 44-7, Referenced Standard **ASME B16.3—2021** now reads . . .

**B16.3—2016: Malleable-iron-threaded Fittings, 150 and 300**

Page 44-7, Referenced Standard **ASME B16.4—2021** now reads . . .

**B16.4—2016: Gray-iron-threaded Fittings**

Page 44-7, Referenced Standard ASME B16.11—2021 now reads . . .

**B16.11—2016: Forged Fittings, Socket-welding and Threaded**

Page 44-7, Referenced Standard ASME B16.12—2009(R2019) now reads . . .

**B16.12—2009(R2014): Cast-iron-threaded Drainage Fittings**

Page 44-7, Referenced Standard ASME B16.23—2021 now reads . . .

**B16.23—2016: Cast-copper-alloy Solder Joint Drainage Fittings (DWV)**

Page 44-7, Referenced Standard ASME B16.34—2020 now reads . . .

**B16.34—2017: Valves—Flanged, Threaded and Welding End**

Page 44-8, Referenced Standard ASME CSD-1—2021 now reads . . .

**CSD-1—2018: Controls and Safety Devices for Automatically Fired Boilers**

Page 44-8, Referenced Standard ASSE 1003—2011 now reads . . .

**1003—2009: Performance Requirements for Water-pressure-reducing Valves for Domestic Water Distribution Systems**

Page 44-8, Referenced Standard ASSE 1011—2016 now reads . . .

**1011—2017: Performance Requirements for Hose Connection Vacuum Breakers**

Page 44-8, Referenced Standard ASSE 1013—2017 now reads . . .

**1013—2011: Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers**

Page 44-8, Referenced Standard ASSE 1015—2017 now reads . . .

**1015—2011: Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies**

Page 44-9, Referenced Standard ASSE 1060—2016 now reads . . .

**1060—2017: Performance Requirements for Outdoor Enclosures for Fluid-conveying Components**

Page 44-9, Referenced Standard ASSE ASSE 1016—2020/ASME 112.1016—2020/CSA B125.16—2020 now reads . . .

**ASSE 1016—2017/ASSE 112.1016—2017/CSA B125.16—2017: Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations**

Page 44-11, Referenced Standard ASTM B280—13 now reads . . .

**B280—2018: Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service**

Page 44-11, Referenced Standard ASTM C35/C35M—(2014) now reads . . .

**C35/C35M—01(2014): Specification for Inorganic Aggregates for Use in Gypsum Plaster**

Page 44-12, Referenced Standard ASTM C91/C91M—2018A now reads . . .

**C91/C91M—2018: Specification for Masonry Cement**

Page 44-15, Referenced Standard ASTM C1280—18 now reads . . .

**C1280—13a: Specification for Application of Exterior Gypsum Panel Products for Use as Sheathing**

Page 44-18, Referenced Standard ASTM D3138—04(2011) now reads . . .

**D3138—04(2016): Standard Specification for Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Non-Pressure Piping Components**

Page 44-18, Referenced Standard ASTM D3462/D3462M—10A now reads . . .

**D3462/D3462M—2016: Specification for Asphalt Shingles Made from Glass Felt and Surfaced with Mineral Granules**

Page 44-20, Referenced Standard ASTM D6694/D6694M—2015 now reads . . .

**D6694/D6694M—08(2013)E1: Standard Specification for Liquid-applied Silicone Coating Used in Spray Polyurethane Foam Roofing Systems**

Page 44-21, Referenced Standard ASTM E2556/E2556M—10 now reads . . .

**E2556/E2556M—2010(2016): Standard Specification for Vapor Permeable Flexible Sheet Water-resistive Barriers Intended for Mechanical Attachment**

Page 44-26, Referenced Standard CSA A112.18.6—2021/CSA B125.6—2021 now reads . . .

**A112.18.6—2017/CSA B125.6—2017: Flexible Water Connectors**



Page 44-26, Referenced Standard CSA A112.19.7—2012/CSA B45.10—2012(R2021) now reads . . .

**A112.19.7—2012/CSA B45.10—2012(R2017): Hydromassage Bathtub Systems**

Page 44-26, Referenced Standard CSA ASME A112.3.4—2013/CSA B45.9—18 now reads . . .

**ASME A112.3.4—2018/CSA B45.9—2018: Macerating Toilet Systems and Related Components**

Page 44-26, Referenced Standard CSA ASME A112.4.2—2015/CSA B45.16—15 now reads . . .

**ASME A112.4.2—2015/CSA B45.16—2015(2020): Water-closet Personal Hygiene Device**

Page 44-26, Referenced Standard CSA ASME A112.18.2—2019/CSA B125.2—2019 now reads . . .

**ASME A112.18.2—2020/CSA B125.2—2020: Plumbing Waste Fittings**

Page 44-26, Referenced Standard CSA ASSE 1070—2015/ASME A112.1070—2015/CSA B125.70—15 now reads . . .

**ASSE 1070—2020/ASME A112.1070—2020/CSA B125.70—2020: Performance Requirements for Water-temperature-limiting Devices**

Page 44-28, Referenced Standard CSA B356—10(R2015) now reads . . .

**B356—10(R2020): Water Pressure Reducing Valves for Domestic Water Supply Systems**

Page 44-31, Referenced Standard MSS SP-58—2018 now reads . . .

**SP-58—2009: Pipe Hangers and Supports—Materials, Design, Manufacture, Selection, Application, and Installation**

Page 44-31, Referenced Standard MSS SP-67—2017 now reads . . .

**SP-67—2011: Butterfly Valves**

Page 44-31, Referenced Standard MSS SP-71—2018 now reads . . .

**SP-71—2011: Gray Iron Swing Check Valves, Flanged and Threaded Ends**

Page 44-31, Referenced Standard MSS SP-80—2013 now reads . . .

**SP-80—2019: Bronze Gate, Globe, Angle and Check Valves**

Page 44-32, Referenced Standard MSS SP-122—2017 now reads . . .

**SP-122—2012: Plastic Industrial Ball Valves**

Page 44-33, Referenced Standard NSF 358-4—2017 now reads . . .

**358-4—2018: Polyethylene of Raised Temperature (PE-RT) Tubing and Fittings for Water-Based Ground-Source (Geothermal) Heat Pump Systems**

Page 44-33, Referenced Standard NSF 359—2011(R2016) now reads . . .

**359—2016: Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems**

Page 44-34, Referenced Standard SMACNA SMACNA/ANSI—2016 now reads . . .

**ANSI/SMACNA 006—2020: HVAC Duct Construction Standards—Metal and Flexible 4th Edition**

Page 44-38, Referenced Standard WDMA I.S. 11—16 now reads . . .

**I.S. 11—18: Industry Standard Analytical Method for Design Pressure (DP) Ratings of Fenestration Products**

Page APPENDIX AJ-1, **Section AJ102.4.3:** line 5 now reads . . . R310.2 and R310.4.4 provided that the replacement

Page APPENDIX AJ-2, **Section AJ102.5:** line 3 now reads . . . Table R301.2 shall be subject to the provisions of Section

Page APPENDIX AJ-4, **Section AJ110.1.1:** line 3 now reads . . . Section R303.7.

Page APPENDIX AU-1, disclaimer now reads . . . *The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

## APPENDIX AX

# ZERO ENERGY RESIDENTIAL BUILDING PROVISIONS

*The provisions contained in this appendix are not mandatory unless specifically referenced in the adopting ordinance.*

### User Note:

**About this appendix:** This appendix provides requirements for residential buildings intended to result in net zero energy consumption over the course of a year. Where adopted by ordinance as a requirement, Section AX101 language is intended to replace Section N1101.13.

### SECTION AX 101(RC101) COMPLIANCE

**AX101.1 (RC101.1) Compliance.** Existing *residential buildings* shall comply with Sections N1109 through N113. New *residential buildings* shall comply with Section AX102.

### SECTION AX 102 (RC102) ZERO ENERGY RESIDENTIAL BUILDINGS

**AX102.1 (RC102.1) General.** New *residential buildings* shall comply with Section AX102.2.

**AX102.2 (RC102.2) Energy Rating Index zero energy score.** Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table AX102.2 when compared to the *ERI reference design* determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation AX-1.

Adjusted OPP = OPP + CREF + REPC

**(Equation AX-1)**

where:

**CREF (Community Renewable Energy Facility power production):** The yearly energy, in kilowatt hour equivalent (kWh<sub>eq</sub>), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

**REPC (Renewable Energy Purchase Contract power production):** The yearly energy, in kilowatt hour equivalent (kWh<sub>eq</sub>), contracted from an energy facility that generates energy with photovoltaic, solar thermal, *geothermal energy*, or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

**TABLE AX102.2 (RC102.2)  
MAXIMUM ENERGY RATING INDEX<sup>a</sup>**

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
1	43	0
2	45	0
3	47	0
4	47	0
5	47	0
6	46	0
7	46	0
8	46	0

a. The building shall meet the mandatory requirements of Section N1106.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table N1102.1.2 or Table N1102.1.4 of the 2015 *International Residential Code*.

For the complete errata history of this code, please visit: <https://www.iccsafe.org/errata-central/>



## RESOURCE A

# RECOMMENDED PRACTICES FOR REMOTE VIRTUAL INSPECTIONS (RVI)

---

### User note:

**About this resource:** *The typical process of inspecting projects by inspectors driving to job sites and performing on-site inspections has certain challenges that impacts timeliness and resource efficiencies both for building construction and safety industry and regulating jurisdictions. The time spent driving to job sites, particularly in larger cities with busy traffic patterns, takes up a substantial part of the day, reducing the number of inspections possible to complete and creating a backlog of requested inspections.*

*To address some of the challenges, many jurisdictions have implemented remote virtual inspections (RVI) for more routine and simpler inspections such as water heater replacements or other similar items. RVI is an alternative to on-site inspections using a video call with the inspector. With advances in technology and availability of sophisticated smart phones and tablets, RVI has become more common, and some jurisdictions plan to implement it for more complicated and larger inspection items or projects.*

*To assist the building construction industry and member jurisdictions in adoption of an RVI program, in May 2020, the International Code Council® (ICC®) published the Recommended Practices for Remote Virtual Inspections (RVI). This publication offers a comprehensive framework for both local jurisdictions and building industry professionals that desire to implement a remote inspection program.*

---





# Recommended Practices for Remote Virtual Inspections (RVI)



## **Recommended Practices for Remote Virtual Inspections (RVI)**

Second Printing: September 2020

ISBN: 978-1-952468-23-0

COPYRIGHT © 2020  
by  
INTERNATIONAL CODE COUNCIL, INC.

ALL RIGHTS RESERVED. This publication is a copyrighted work owned by the International Code Council, Inc. (“ICC”). Without advance written permission from the ICC, no part of this publication may be reproduced, distributed or transmitted in any form or by any means, including, without limitation, electronic, optical or mechanical means (by way of example and not limitation, photocopying, or recording by or in an information storage and retrieval system). For information on use rights and permissions, please contact: ICC Publications, 4051 Flossmoor Road, Country Club Hills, Illinois 60478. Phone: 1-888-ICC-SAFE (422-7233).

The information contained in this document is believed to be accurate; however, it is being provided for informational purposes only and is intended for use only as a reference for recommended practices. Publication of this document by the ICC should not be construed as the ICC engaging in or rendering engineering, legal or other professional services. Use of the information contained in this publication should not be considered by the user as a substitute for the advice of a registered professional engineer, attorney or other professional. If such advice is required, it should be sought through the services of a registered professional engineer, licensed attorney or other professional. This Recommended Practices document does not intend to overrule national building codes or local practices, but to provide a reference for minimum levels of quality to safeguard health, property and general welfare.

Trademarks: “International Code Council,” the “International Code Council” logo, “ICC,” the “ICC” logo and other names and trademarks appearing in this book are registered trademarks of the International Code Council, Inc., and/or its licensors (as applicable), and may not be used without permission. Errata on various ICC publications may be available at [www.iccsafe.org/errata](http://www.iccsafe.org/errata).

PRINTED IN THE USA

## Table of Contents

Table of Contents . . . . .	i
Preface . . . . .	1
About the International Code Council® . . . . .	2
1.0 Introduction. . . . .	3
Purpose and Scope . . . . .	3
2.0 Definitions and Acronyms . . . . .	3
3.0 Remote Virtual Inspection Process . . . . .	3
Customer: Requesting a Remote Virtual Inspection . . . . .	4
AHJ: Scheduling Remote Virtual Inspection . . . . .	5
Customer: Prepare for Remote Virtual Inspection . . . . .	6
Customer: Prepare to Receive Remote Virtual Inspection Call . . . . .	6
What to Expect During the Inspection . . . . .	7
Inspection Results . . . . .	7
Maintaining Records of Inspections . . . . .	8
4.0 Training and Communication . . . . .	8
Staff Training. . . . .	8
Customer/Applicant. . . . .	9
Additional Considerations. . . . .	9
5.0 Appendix A (Examples of Potential Activities). . . . .	10





## Preface

Technological advances have created enormous possibilities in all aspects of life, including the building construction and safety industry. Digital and online tools for building design, construction and administrative functions, such as permit application, plan review, inspection and commissioning, have drastically increased the efficiency and accuracy of achieving safe and resilient communities. Local, state and national governments have taken advantage of advancing technologies and have incorporated various levels of digitization into their processes in order to save time and reduce costs. Examples of such efforts include online offering of permit applications, payment of permit fees, submittal of plans and digital plan review.

The speed of adoption and implementation of technology, however, varies by geographic region and depends on a number of factors, including the availability of financial resources and the infrastructure needed to support the technology. Many Authorities Having Jurisdiction (AHJs) have implemented technology at various levels with good success and have embraced greater reliance on digitization as time goes by.

The 2020 global coronavirus pandemic created an impetus in speeding the implementation of modern technologies and taking advantage of new ideas in a much shorter time frame. The spread of COVID-19 and the closing of most businesses and social activities in many parts of the world to create social distancing resulted in many sectors of the economy searching to find new solutions for conducting business.

Many AHJs needed to come up with solutions to perform all aspects of codes and standards administration from remote locations and/or home offices. One such solution using available technology is Remote Virtual Inspections (RVI).

RVI is a method of inspection that allows the needed inspections to proceed in a timely manner by the owner or contractor located on the jobsite and the inspector or inspection teams performing the inspection remotely. While this practice gained good acceptance and implementation during the weeks and months of COVID-19 social distancing, its advantages are so great that it will likely become a popular and routine tool for the foreseeable future.



The advantages and opportunities created by RVI locally, nationally and globally are enormous, allowing those with technical expertise in their specific subjects to offer their services across the globe. Building code specialists, inspectors and consultants will be able to provide services and consulting from far distances and to help building safety and resiliency anywhere needed at the local, national or global level.

*Recommended Practices for Remote Virtual Inspections* (RVI) was developed based on study, research, and discussions related to items that should be considered and addressed for an effective and consistent RVI program and to assist AHJs in implementing the readily available technologies in the adoption and implementation of their own RVI program.

ICC welcomes your comments and feedback to improve future editions of this Recommended Practices publication. Submit feedback at [www.iccsafe.org/RVI](http://www.iccsafe.org/RVI).

## About the International Code Council®

The International Code Council is a nonprofit association that provides a wide range of building safety solutions including product evaluation, accreditation, certification, codification and training. It develops model codes and standards used worldwide to construct safe, sustainable, affordable and resilient structures. The mission of the Code Council is to provide the highest quality codes, standards, products and services for all concerned with the safety and performance of the built environment. ICC Evaluation Service (ICC-ES) is the industry leader in performing technical evaluations for code compliance fostering safe and sustainable design and construction.

### Washington DC Headquarters:

500 New Jersey Avenue, NW, 6th Floor  
Washington, DC 20001-2070

### Regional Offices:

- Eastern Regional Office (BIR)
- Central Regional Office (CH)
- Western Regional Office (LA)
- Distribution Center (Lenexa, KS)

888-ICC-SAFE (888-422-7233)

[www.iccsafe.org](http://www.iccsafe.org)

### Family of Solutions:



## 1.0 Introduction

Hand-held devices such as smartphones and tablets have capabilities for real time, online communication of videos and photos. Use of advanced tools and technologies, combined with the power of such hand-held devices, has made it possible for anyone to observe the construction activities of a jobsite from any location, near or thousands of miles away. Using Remote Virtual Inspection (RVI) allows construction projects to continue without impediment and allows the Authority Having Jurisdiction (AHJ) to continue to provide the vital services needed for construction of safe buildings.

### Purpose and Scope

The purpose and scope of these Recommended Practices is to provide guidance to the Authority Having Jurisdiction (AHJ) when implementing a Remote Virtual Inspection (RVI) program as well as to the construction industry user. This document specifically addresses implementation and administration of RVI. These procedures are organized in a fashion that can be readily implemented by the AHJ as part of their inspection procedures. This document also provides recommended practices to construction industry professionals submitting to an RVI.

Until recently, Remote Virtual Inspections have been conducted only by a few AHJs at varying levels. As a result, there has not been a standardized program that addresses how to prepare for, conduct and participate in these types of inspections.

## 2.0 Definitions and Acronyms

1. **RVI: Remote Virtual Inspection:** Remote Virtual Inspection, also known as RVI, is a form of visual inspection which uses visual or electronic aids to allow an inspector or team of inspectors to observe products and/or materials from a distance because the objects are inaccessible or are in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.
2. **AHJ: Authority Having Jurisdiction.**

## 3.0 Remote Virtual Inspection Process

Remote Virtual Inspections (RVI) may provide benefits to AHJs and customers alike. In certain circumstances, an RVI may provide a better quality inspection with an increase in efficiency and cost savings. It will increase the efficiency of the inspection process utilizing modern technology. Depending on the location and complexity of a project, some limitations may impact its use. In cases where an RVI is not suitable or technology fails to provide sufficient visual clarity (i.e., poor/no service or Wi-Fi, poor lighting, etc.), an onsite inspection may be required. Subject to local approval, the AHJ may choose to use an approved third-party inspection agency or utilize staff inspectors. Where Wi-Fi and/or cellular recep-

tion are poor or not available, some AHJs may consider allowing the contractor to provide an acceptable electronic documentation of the area that needs an inspection for review by the assigned inspector or team of inspectors.

A clear understanding of the RVI requirements and communication throughout the process by both parties is paramount to the completion of a successful inspection. The inspector will check all aspects of the permitted construction project to the adopted codes and other applicable laws and regulations no differently than if it were an onsite inspection. Identification of the project jobsite location, posted address and its location within the building will be a critical part of the process.

The applicable Codes and Standards to be used for RVI are the same as the adopted codes and referenced standards of the AHJ. The implementation of the RVI is intended to achieve the same results as the typical in-person site inspection by applying the provisions of adopted codes such as the IBC®, IRC®, IPC®, IFC® and other applicable and adopted International Codes.



### Customer: Requesting a Remote Virtual Inspection

1. Ensure there is an active permit issued or certificate application filed or obtain the appropriate one prior to attempting to schedule an inspection for the project in question.
2. Electronically sign a notice indicating that the permit holder of record or representative:
  - 2.1. Consents to the use of the remote inspections.
  - 2.2. Is responsible for their own safety during the remote inspection.
  - 2.3. Allows the complete use of the videos and photos of the remote inspection by the AHJ.
  - 2.4. Certifies they are making available the site and inspection items truthfully and to the best of their ability.
  - 2.5. Is responsible for compliance with all codes and standards applicable to the project.
  - 2.6. Acknowledges that participation in the remote inspection program is voluntary (if not a mandatory program within the AHJ's jurisdiction).
  - 2.7. Acknowledges that the decision to perform an RVI is at the sole discretion of the AHJ.

3. Prior to contacting the department to schedule the inspection, confirm that the minimum criteria for a remote inspection are met. See Appendix A for examples of qualified inspection activities.
  - 3.1. Note that some types of inspections may be too complex or otherwise not compatible for remote inspections.
4. Call or go online to schedule an appointment for inspection with the AHJ.
5. Must be at least 18 years old or with an adult to perform the virtual inspection.
6. When scheduling the inspection, provide the address, permit number, and type and number of requested inspections.

### AHJ: Scheduling Remote Virtual Inspection

1. Schedule Inspection Time.
  - 1.1. All remote inspections scheduled should be requested by the customer a minimum of one business day prior to the desired inspection date.
  - 1.2. Schedule inspection either online or by telephone.
  - 1.3. Schedule sufficient time for the type of inspection requested.
  - 1.4. AHJ to send an inspection confirmation email or text to the customer with the date, approximate time of RVI and name of inspector.
  - 1.5. Send notice of customer consent and acknowledgment for electronic signature. Must be returned by customer prior to inspection scheduled time.
2. Time slots for inspections.
  - 2.1. Anticipated length of inspections per type (i.e., water heater installation, HVAC replacement, etc.) needs to be established.
  - 2.2. Each customer will be given an approximate time window for inspection.
3. Post the earliest available time for remote inspections and the latest time of the day a remote inspection may be scheduled Monday through Friday or other days selected by the AHJ.
4. Schedule after-hours or emergency inspections on a case-by-case basis.
5. Determine the types of inspections allowed for remote inspections. See Appendix A for examples of qualified inspection activities.
  - 5.1. All inspections may qualify for an RVI, depending on the AHJ's resources and policies.
6. Determine which type of videotelephony is available for use and is compatible with the AHJ's permitting software and videotelephony equipment.
  - 6.1. Videotelephony platform examples: FaceTime, Google Duo, Zoom, WhatsApp, Skype, Tango, WebEx, Microsoft Teams, GoTo-Meeting, etc.





## Customer: Prepare for Remote Virtual Inspection

1. Prior to the inspection, ensure that:
  - 1.1. The jobsite is safe at all times for the individual(s) using the device during the remote inspection including health safety.
  - 1.2. The device (smartphone, tablet, drone, etc.) is fully charged and has a suitably charged additional power supply (battery pack).
  - 1.3. The use of a noise-canceling headset is recommended.
  - 1.4. The jobsite has high-speed Wi-Fi connectivity or minimum 4G cellular service with a strong signal.
  - 1.5. The necessary tools based on type of inspection are readily available.
    - 1.5.1. For example, carry a flashlight, tape measure, level, step ladder (for close ups of ceiling), GFCI tester, etc. An extending pole for the video device, such as selfie pole, may be very helpful in taking the smartphone or other video device closer to the point of inspection in various places such as very high ceilings.
2. Have approved plans, permit card, and other necessary construction documents available onsite.
3. Make sure good lighting is available and clear the area of any unnecessary objects.
4. All features applicable to the required inspection must be visible at the time of the remote inspection. These features must be captured sufficiently and clearly for the inspector to evaluate.
5. If at any point the inspector believes that the remote inspection process is not allowing them to properly assess compliance, they may require that a site inspection be conducted at a future date or instruct the customer to make different arrangements.
  - 5.1. In areas within the jobsite where there is no Wi-Fi or cell service, at the sole discretion of the inspector, the contractor may be allowed to provide video and/or photographic documentation of the item(s) to be inspected for review by the authorized inspector at a later time.
6. The onsite inspection may be conducted by an approved third-party inspection agency or by the AHJ's inspection staff.

## Customer: Prepare to Receive Remote Virtual Inspection Call

1. Ensure that the lens and screen of any device being used to capture images or video has been cleaned. Dust, grit, smudges, etc., might interfere with the image quality and distorting the inspector's view.
2. To minimize interruptions during the RVI and to ensure that the video feed will be uninterrupted, make sure that all notifications are turned off in the Settings of the mobile device used for the RVI. Should the video be interrupted, the inspection could be delayed or have to be rescheduled.
3. Be prepared to answer the inspector's call at any time during the scheduled timeframe. Be cooperative and closely follow the inspector's instructions.

4. As each site and inspection is different, allot the proper amount of time for the type of inspection and accessibility of the site.
5. Carefully follow the inspector's instructions for where to direct the device and for covering the site. Do not rush the inspector but allow him or her adequate time to conduct the RVI to his or her satisfaction.
6. As much as possible, minimize background noise as that can interfere with communication with the inspector.

## What to Expect During the Inspection

1. Begin inspection at the street view looking at the structure with the address or other required jobsite identification in the video display.
  - 1.1. Inspector may also verify location through GPS/Geotagging where the service is available.
2. Follow the directions of the inspector with respect to the order and direction of inspection.
3. As the inspection progresses, write down any items that the inspector finds that need to be corrected. Be sure the notes are detailed and ask questions of or seek clarification from the inspector at the time of the RVI.
4. If provided a permit card, do not write on it. During the next in-person visit, the inspector should update it then.
5. In most cases, the inspector will relay the results of the inspection before the end of the RVI of passing, failing or not ready for inspection.
6. Do not cover any work needing corrections until corrections are verified by reinspection. Reinspection fees may apply in accordance with the AHJ's policies.
7. Note: At a minimum, there must be an adult of the required legal age on site who will represent the owner/representative during the entire duration of the RVI.
8. The owner/representative must be able to verbally communicate with the remote inspector at all times during the inspection.

## Inspection Results

1. Results of the inspection will be entered into the AHJ's permit database as soon as practicable after the RVI is completed. It is important to note that the inspection was completed using the RVI process.
2. Where an approval tag for utility connections is required, the AHJ should work directly with the utility company.
3. Following the inspection:
  - 3.1. Inspection comments will be available on the AHJ's website, within the AHJ's normal timelines, indicating passing or failing with the list of corrections when applicable.
  - 3.2. In addition, the inspector may email the inspection information upon request to the customer as soon as inspection information is available.

- 3.3. The inspector will determine whether additional fee(s) for reinspection is required.
4. Scheduling a reinspection or the next inspection needed is based on availability of time slots.
5. The authorized inspector may provide an option for the owner/representative to submit electronic documentation that a deficiency or deficiencies have been corrected.
6. It is incumbent on the owner/representative to provide the address and permit number on all submitted correspondence or communications.

## Maintaining Records of Inspections

Required inspection records, including, but not limited to, correction notices, electronic media, recordings or photo documentation, shall be maintained in accordance with the AHJ's policy, laws, regulations, and applicable codes, and may be subject to disclosure.

## 4.0 Training and Communication

Training and effective communication of processes, procedures and requirements are essential and a critical part to the success of any program. This program is no different as it lends itself to new technology, new programs, and methods that are in many cases, new to the building construction and safety industry. Therefore, training of the AHJ's staff as well as the building industry on the various programs and procedures will save time and money and make the administrative and enforcement process a positive experience with minimal confusion. Training also leads to better communications between an AHJ and its customers.



## Staff Training

1. Ensure all staff are trained in the appropriate areas of responsibility.
2. Permit Technicians:
  - 2.1. Review of approved permit applications relative to RVI requirements.
  - 2.2. Required departmental approvals are complete.
  - 2.3. Fee collection process.
  - 2.4. Required documents for the project (plans, calculations, etc.).
3. Remote Inspection Staff:
  - 3.1. Inspection software and hardware.
  - 3.2. Remote inspection procedures.
  - 3.3. Types of platforms used (Facetime, Skype, etc.).
  - 3.4. Reinspection fee procedures.
  - 3.5. Recording inspection results in permit tracking system.

## Customer/Applicant

1. Ensure the owner and representative are trained in their areas of responsibility.
2. Permit applicant:
  - 2.1. Knowledge of the AHJ's departmental approvals required for the project.
  - 2.2. Knowledge of the AHJ's RVI protocol.
  - 2.3. Ensuring project meets RVI protocol.
  - 2.4. Ensure that the project is ready for the RVI at the scheduled time.
  - 2.5. Comply with the inspector's direction.
3. Owner/Contractor/Subcontractor:
  - 3.1. Requesting remote inspection process.
  - 3.2. Knowledge of remote inspections procedures.
  - 3.3. Platform required (Facetime, Skype, Google Duo, etc.).
  - 3.4. Jobsite communication requirements (Wi-Fi, 4G, etc.).
  - 3.5. Communication skills.

## Additional Considerations

1. Adopt basic online security practices. Consult with your IT department for guidance.
2. Consult with your legal counsel to ensure compliance with all federal, state and local requirements related to your RVI program. For example, you may want to consult counsel to find out whether a homeowner's release is needed to conduct an RVI.
3. Ensure that all staff have access to the codes and standards that are applicable to what they are inspecting. The Code Council's Digital Codes Library (<https://codes.iccsafe.org/>) offers online access to all ICC model codes and standards and most state codes.
4. Document lessons learned to improve your RVI program and to support potential long-term establishment of virtual inspection processes.



## 5.0 Appendix A (Examples of Potential Activities)

The following are a few examples of construction activities that may be considered to be included in a RVI Program. This list is not all-inclusive. The determination of whether an inspection can be conducted remotely is at the sole discretion of the AHJ.

- Plumbing system repairs or fixture replacements.
- Construction trailer installations.
- Swimming pool excavations.
- Gas line repairs or gas utility clearance.
- Electric utility clearances.
- HVAC direct replacement or repair.
- Minor residential electrical.
- Miscellaneous repair/exterior repair or upgrades (stucco, windows, etc.).
- Re-roofing/roof covering replacement.
- Water heater or water softener direct replacement.
- New residential plumbing rough-in.
- New residential rough framing inspections.
- Residential rooftop-mounted photovoltaic panel systems.
- HUD manufactured home installation verification.
- Any other inspection approved by the AHJ.



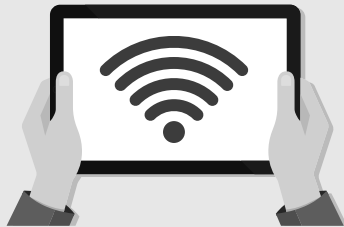




# KEYS TO SUCCESS FOR REMOTE VIRTUAL INSPECTIONS

## The Value of Communication

### WHAT ARE REMOTE VIRTUAL INSPECTIONS (RVI)?

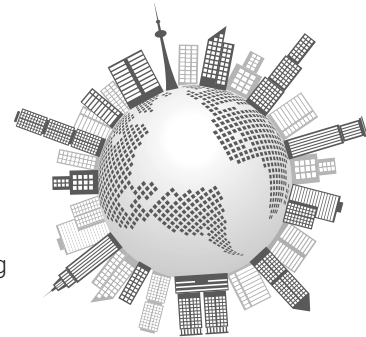


Remote Virtual Inspections, also known as RVI, are a form of inspections which use visual or electronic aids to allow an inspector or team of inspectors to observe certain types of construction, products and/or materials from a distance.

RVI are a solution to help inspectors observe construction and objects that might be inaccessible or in dangerous environments, or whereby circumstances or conditions prevent an in-person inspection.

### RVI BENEFITS

- Construction projects can continue without impediment
- Building professionals can continue providing services with minimal health risk during pandemics such as COVID-19
- Authorities Having Jurisdiction (AHJs), testing agencies, manufacturers, laboratories, home builders and contractors are able to provide the vital services needed on all levels for the construction of safe buildings
- Inspectors can continue providing services remotely while saving time and money
- Safe and resilient construction projects can continue to grow and thrive anywhere needed at the local, national or global level



### THE FOUNDATION OF SUCCESS: TRAINING AND COMMUNICATION



With the use of new technology, new programs, and methods, AHJs, testing agencies, manufacturers, laboratories, home builders and contractors can implement effective training of these programs to their staff to create a foundation for successful Remote Virtual Inspections.

A clear understanding of RVI requirements and communication throughout the process by all parties involved is paramount to the completion of successful inspections.



### Recommended Practices for Remote Virtual Inspections (RVI)

## THE KEY STEPS TO A REMOTE VIRTUAL INSPECTION



## LEARN MORE

Read the full version of our Recommended Practices for Virtual Remote Inspections [here](#).

20-13018

## Recommended Practices for Remote Virtual Inspections (RVI)



People Helping People Build a Safer World®

# Get FREE access to hundreds of ICC resources and view the largest collection of code titles

*ICC's Digital Codes Library ([codes.iccsafe.org](https://codes.iccsafe.org)) conveniently provides access to the latest code text while on the go, at home or in the office, in an easy-to-navigate format.*



Available anywhere 24/7

Use on any mobile or digital device

View over 800+ ICC titles

19-17590

Learn how to use this powerful tool at [codes.iccsafe.org](https://codes.iccsafe.org)

# Recommended Practices for Remote Virtual Inspections (RVI)

*Recommended Practices for Remote Virtual Inspections (RVI)* is the most complete source of information on remote inspections. RVI is an alternative to on-site inspections using a video call on a 4G or WiFi telephony (smartphone, tablet, etc.) in order to interact with the inspector. It is a comprehensive tool for local jurisdictions and the building industry alike that desire to implement a remote inspection program.

This publication covers the RVI process, inspection scheduling, preparation, what the owner/contractor should expect, training and communications, and recording and maintaining records. While all types of inspections may not be suitable for RVI, a list of potential construction activities suitable for remote inspections is provided.

RVI also lends itself to connect seamlessly as part of an overall online program that will allow jurisdictions to provide complete services to the public utilizing the latest technology. Online permitting and electronic plan review, together with remote virtual inspections, can provide a complete program that keeps the construction industry moving while providing a healthy environment for all participants.

ISBN 978-1-952468-23-0



9 781952 468230

Item No. 7072S1



## ICC FAMILY OF SOLUTIONS

Evaluation Service • Accreditation Service • General Code  
S. K. Ghosh Associates • ANCR • NTA • Certification  
Digital Code Library • Membership • Plan Review • Publications

[www.iccsafe.org](http://www.iccsafe.org) • 1-888-ICC-SAFE (422-7233)



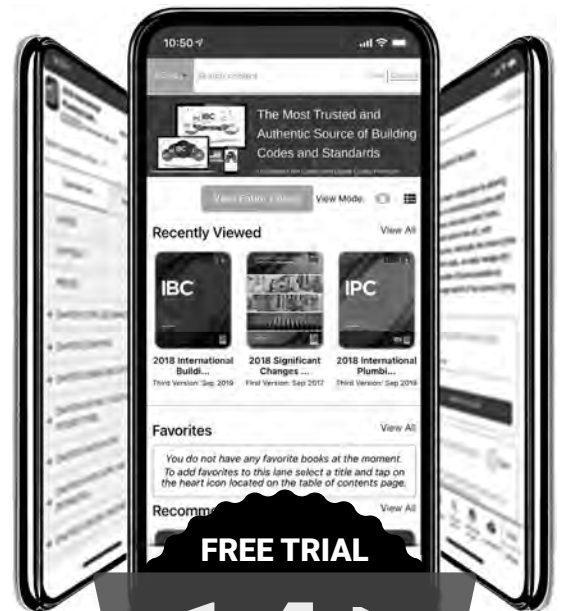
DIGITAL CODES  
**PREMIUM**

[codes.iccsafe.org](https://codes.iccsafe.org)



## Get Digitally Empowered and Enhance Your Code Experience with Premium Complete

- ✓ Search over 1,000 of the latest codes and standards
- ✓ Classify notes, files and videos into relevant code sections
- ✓ Share your access and content simultaneously
- ✓ View past committee code interpretations
- ✓ View full change history and public comments
- ✓ View real time code change proposals
- ✓ View updates and significant codes changes to I-Codes



**FREE TRIAL**

**14 DAY**

**SIGN UP**



**Enterprise pricing available.**  
Please inquire via [panthony@iccsafe.org](mailto:panthony@iccsafe.org)



**Sign up for a Free 14-Day Premium Complete trial at [codes.iccsafe.org/trial](https://codes.iccsafe.org/trial)**





# TRAINING



## LEARN. ACHIEVE. SUCCEED.

ICC Training provides training and education to building safety, fire, design, and construction professionals on how best to apply and enforce the codes and leadership topics. All training opportunities are developed and led by nationally recognized code experts with decades of experience. We offer convenient learning opportunities in a variety of formats including classroom, virtual, live web session and online courses.

TRAINING programs are designed for maximum impact and results by assisting you in developing professional skills, advancing your career, expanding your knowledge base, and/or preparing for your next certification exam. Stay on the leading edge of the industry while earning valuable CEUs.

CAREER PATHS will guide you through the training, publications, and certification recommended to enter a specific career field. Check out the career paths at [learn.iccsafe.org](https://learn.iccsafe.org)

For information about available training:  
visit **[learn.iccsafe.org](https://learn.iccsafe.org)** or call 888-422-7233, x33821

22-21809