Board of Building Standards

EDUCATION COMMITTEE MEETING
AGENDA (AMENDED 6/23/2021)

DATE: JUNE 24, 2021
TIME: 10:00 AM
LOCATION: **VIDEOCONFERENCE**
DIAL IN 614-721-2972,
CONFERENCE ID 381 283 161#

Staff and Guest 'Check-In'

Call to Order

Consent Agenda

Course Applications

ER-1 2021 IRC Update (International Code Council)
All certifications except ESI (3.5 hours)
Staff Notes: Not based on current code, and code adoption process delayed due to regulatory restrictions and market conditions. Not recommended for approval.
Committee Recommendation:

ER-2 2021 OBC Update (International Code Council)
All certifications except ESI (3.5 hours)
Staff Notes: Not based on current code, and code adoption process delayed due to regulatory restrictions and market conditions. Not recommended for approval.
Committee Recommendation:

ER-3 Backflow Tester (International Association of Plumbing and Mechanical Officials
BO, BI, FPI, MI, PI, NRIUI, RBO, RMI (40 hours)
Staff Notes:
Committee Recommendation:

ER-4 Introduction to Automatic Sprinkler Systems (National Fire Sprinkler Association)
BO, MPE, BPE, FPPE, BI, FPI (3 hours)
Staff Notes: Ohio-specific slides are gathered at the front (pp, 4-6). Instructor bio is at the very end.
Committee Recommendation:

ER-5 Cincinnati Inspector Cross Training Part 4 (BCFA)
Provider: Building and Fire Code Academy
RBI, RMI (four sessions, three hours each)
Staff Notes: Tabled in March for staff review: missed for May meeting: administratively approved with chair input: recommend ratification of approval.
Committee Recommendation:

ER-6 Considerations of the DWV and Storm System (Ohio Assn of Plumbing Inspectors)
All certifications (1 hour)
Staff Notes:
Committee Recommendation:

ER-7 Hangers and Restraints for Cast Iron Soil Pipe DWV Systems (Ohio Assn of Plumbing Inspectors)
All certifications (1 hour)
Staff Notes:
Committee Recommendation:

ER-8 Joining Methods for Cast Iron Soil Pipe and Fittings (Ohio Assn of Plumbing Inspectors)
All certifications (1 hour)
Staff Notes:
Committee Recommendation:

ER-9 Underground Installation Benefits of Cast Iron (Ohio Assn of Plumbing Inspectors)
All certifications (1 hour)
Staff Notes:
Committee Recommendation:

ER-10 Residential Code of Ohio (HalfMoon Education)
BO, MPE, BPE, BI, RBO, RPE (7 hours)
Staff Notes:
Committee Recommendation:

Old Business

New Business

Adjourn

EDUCATION COMMITTEE MEETING
CONSENT AGENDA

Course Applications

File Attachments for Item:

ER-1 2021 IRC Update (International Code Council)

All certifications except ESI (3.5 hours)

Staff Notes: Not based on current code, and code adoption process delayed due to regulatory restrictions and market conditions. Not recommended for approval.

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Laura Morris
(Contact Name)

Organization: International Code Council
(Organization/Company)

Address: 4051 Flossmoor Road
(Include Room Number, Suite, etc.)

City: Country Club Hills State: IL Zip: 60478

E-Mail: lmorris@iccsafe.org

Telephone: 888-422-7233 ext: 4523 Fax:

Course Sponsor: ICC

COURSE INFORMATION:

Course Title: 2021 IRC Update

New Course Submittal: ■ Update Course: ■ Prior Approval Number:

Purpose and Objective: Participants will be able to use this seminar to identify the most important changes to the 2021 International Residential Code, allowing them to apply these code requirements to design, review plan submittals and/or complete inspections.

Number of Instructional Contact Hours that can be obtained upon completion: 3.5

If Multi-Session, Number of Instructional Contact Hours Per Session:

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■ Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■

Building Plans Exam. ✓ Plumbing Inspector ■

Plumbing Plans Exam. ■ Non-Res IU Inspector ☐

Electrical Plans Exam. ■

Mechanical Plans Exam. ■

Fire Protect. Plans Exam. ✓

Res Building Official ■ Res Plans Examiner ■ Res Building Inspector ■ Res Mechanical Inspector ■ Res IU Inspector ■

Electrical Safety Inspectors ☐

Location of ESI Course: Date(s) of ESI Course(s):

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
	Organization sponsoring or requesting the program (if any)	x
Course Title:	Name of course (related to content)	x
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	x
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	x
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	x
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	x
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	x
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	x
Test Materials:		x
Completed Application:		x

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

2021 IRC Update

Based on the 2021 International Residential Code®, (IRC®)

Length:	0.5 day (3.5 Contact Hours)
Applicable Codes:	2021 IRC
Product Type/Status:	Instructor led training / webinar
Level:	All levels

Project Team:	
Instructional Designer	Sandra Hyde
Subject Matter Experts	Sandra Hyde, Buddy Showalter

Background Information

Description

It is important to have an up-to-date residential construction code addressing the design and construction of one- and two-family dwellings and townhouses to protect the health and safety of the public, as well as provide affordable housing. This seminar covers the critical changes within the *2021 International Residential Code*. Changes to building, energy, mechanical, fuel gas, plumbing and electrical requirements are discussed.

Goal

Participants will be able to use this seminar to identify the most important changes to the *2021 International Residential Cod*e, allowing them to apply these code requirements to design, review plan submittals and/or complete inspections.

Objectives

Upon completion, participants will be better able to:
1. Identify the differences between 2018 IRC and 2021 IRC.
2. Determine if the change is an addition, deletion, modification or clarification.
3. Identify changes in format and technical requirements.
4. Explain the intent and application of the changes.

Target Audience
Residential plans examiners, Residential inspectors, Building officials, Designers, Contractors

Prerequisites
Participants should be familiar with the IRC.

Instructional Concept
Participants will follow along in the handout as the instructor presents the information. They will be given some short questions to answer based on what is covered during the seminar. Examples will be given to the participants so that they can fully visualize how the code will be applied and enforced.

Instructor Preparation

Course materials: For this course, the instructor will need the following materials:
- 2021 IRC Update handout
- Slide presentation
- This course abstract with timed outline

Source documents or other resources here that will be helpful for instructors to review.
- *Significant Changes to the 2021 International Residential Code*

Timed Outline for seminar (3.5 hours, 210 minutes)

I. Welcome (10 minutes)
   A. Goal
   B. Objectives
   C. Organization of the IRC

II. Part 1: Administration, Definitions Chapters 1-2 (15 minutes)
   A. Additions, Alterations or Repairs
   B. Grade floor emergency escape opening

III. Building Provisions, Chapters 3-8 (60 minutes)
   A. Chapter 3 Building Planning
   B. Chapter 4 Foundations
   C. Chapter 5 Floors
   D. Chapter 6 Wall Construction
   E. Chapter 7 Wall Covering
   F. Chapter 8 Roof-Ceiling Construction
   G. Discussion Activity

IV. Energy Efficiency, Chapter 11 (25 minutes)

V. Mechanical, Chapters 12-23 (20 minutes)
   A. Chapter 15 Balance ventilation credit
   B. Chapter 18 Blocked vent switch

VI. Fuel Gas, Chapter 24 (20 minutes)

VII. Plumbing, Chapters 25-33 (25 minutes)
   A. Chapter 25 DWV Testing
   B. Chapter 27 Plumbing Fixtures
   C. Chapter 29 Water Supply and Distribution
   D. Chapter 30 Sanitary Drainage

VIII. Electrical, Chapters 34-43 (25 minutes)
   A. Chapter 36 Services
   B. Chapter 37 Branch Circuit Requirements
   C. Chapter 39 Power and Lighting
   D. Chapter 40 Devices and Luminaires

IX. Summary & Discussion (10 minutes)

ROGER AXEL, C.B.O.

Building Official, Retired; 12 years construction experience as self-employed contractor, 30 years inspection experience (10 years building inspector, 5 years plans examiner,15 years building official) including single and multi-family residential, educational, industrial, business and mercantile occupancies including the Mall of America; Bachelor of Science Degree in Industrial Education, University of Minnesota; Associate in Applied Science Degree in Building Inspection Technology, Inver Hills Community College; State of Minnesota Certified Building Official; Multiple International Code Council Certifications; ICC instructor; instructor for Housing and Building Inspection Institute at UW-Madison College of Engineering; instructor for MN Licensed Residential Contractor continuing education seminars; past Chairman and Executive Officer of the Association of MN Building Officials.

2021 IRC Update

Based on the 2021 International Residential Code® (IRC®)

1

Course Description

- This seminar covers the critical changes within the *2021 International Residential Code*.
- Changes to building, energy, mechanical, fuel gas, plumbing and electrical requirements are discussed.

2

Course Goal

- Identify the most important changes to the *2021 International Residential Code*.

3

Course Objectives

- Upon completion, you will be better able to:
  - Identify the differences between 2018 IRC and 2021 IRC.
  - Determine if the change is an addition, deletion, modification or clarification.
  - Identify changes in format and technical requirements.
  - Explain the intent and application of the changes.

4

Course Overview

- Chapters 1 – 2 : Admin and Definitions
- Chapters 3 – 9 : Building
- Chapter 11 : Energy
- Chapters 12 – 23 : Mechanical
- Chapter 24 : Fuel Gas
- Chapters 25 – 33 : Plumbing
- Chapters 34 – 43 : Electrical

5

Selection of Topics

- Provisions addressed based primarily on:
  - Frequency of application
  - Special significance
  - Change in application

6

Marginal Markings in the IRC

▌	solid vertical line	technical change
➔	arrow	deletion
*	single asterisk	relocated elsewhere
**	double asterisk	relocated here

7

About me

Name
Title
Company

Office Location
Telephone
Email

Pick up my business card

8

About you

- Plans examiner
- Inspector
- Building official
- Builder
- Designer
- Engineer or Architect

9

Chapter 1 – Admin
Chapter 2 - Definitions

10

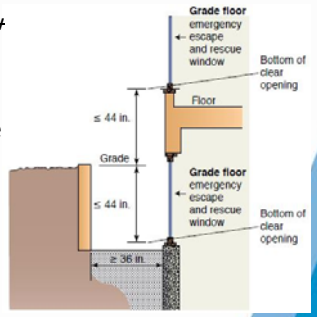
R102.7.1 Additions, Alterations or Repairs

- Not cause an existing building to be less compliant with the code
- Comply with height limits of IRC
- Where alteration causes use or occupancy to be changed to one not within the scope of IRC, the provisions of the IEBC apply.

11

R202 Grade Floor EERO

- **Grade Floor <u>Emergency Escape And Rescue</u> Opening.** ~~A window or other~~ <u>An emergency escape and rescue</u> opening located such that the ~~sill height~~ <u>bottom</u> of the <u>clear</u> opening is not more than 44 inches above or below the finished ground level adjacent to the opening.



12

Chapter 3 – Loads

13

R301.1.4 Intermodal Shipping Containers

- Provisions for construction with intermodal shipping containers are added to the IRC by referencing IBC Section 3315 and ICC G5 – *Guideline for the Safe Use of ISO Shipping Containers Repurposed as Buildings and Building Components.*

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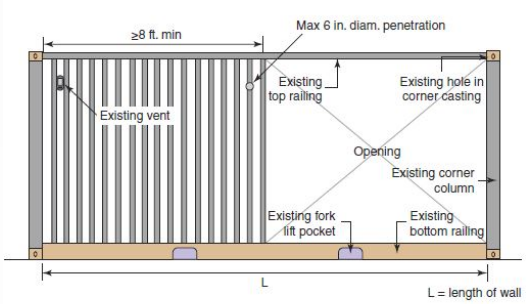
R301.1.4 Intermodal Shipping Containers



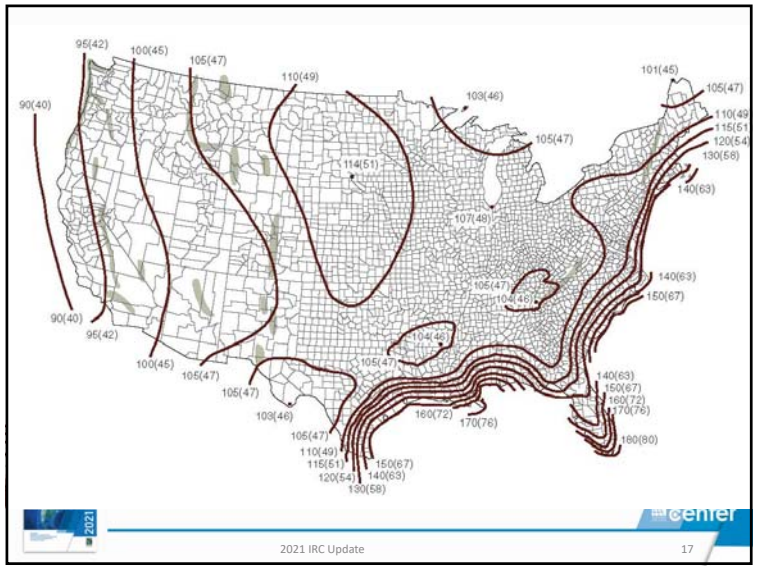
Maximum penetration size in shipping containers used for bracing

15

R301.2.1 Wind Design

- Updated Wind Speed maps match IBC and ASCE 7 maps with a large portion of the country having wind speeds less than 115 mph.

16


2021 IRC Update
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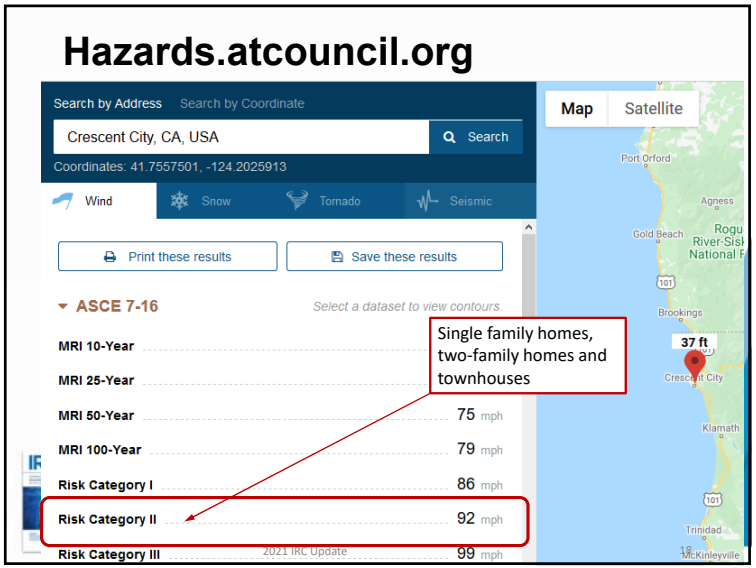
Hazards.atcouncil.org
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Satellite
Wind
Snow
Tornado
Seismic
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MRI 10-Year
MRI 25-Year
MRI 50-Year 75 mph
MRI 100-Year 79 mph
Risk Category I 86 mph
Risk Category II 92 mph
Risk Category III 99 mph
Single family homes, two-family homes and townhouses
37 ft
2021 IRC Update
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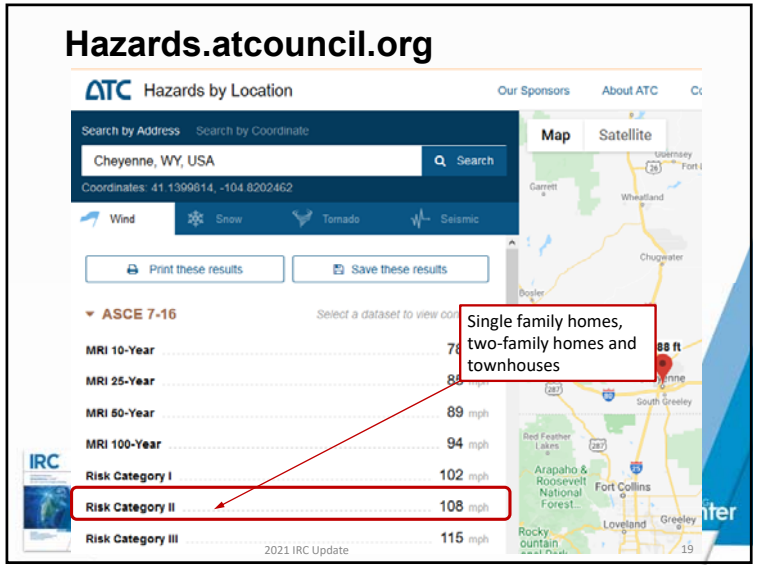
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ATC Hazards by Location
Our Sponsors
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Search by Address
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ASCE 7-16
MRI 10-Year
MRI 25-Year
MRI 50-Year 89 mph
MRI 100-Year 94 mph
Risk Category I 102 mph
Risk Category II 108 mph
Risk Category III 115 mph
Single family homes, two-family homes and townhouses
2021 IRC Update
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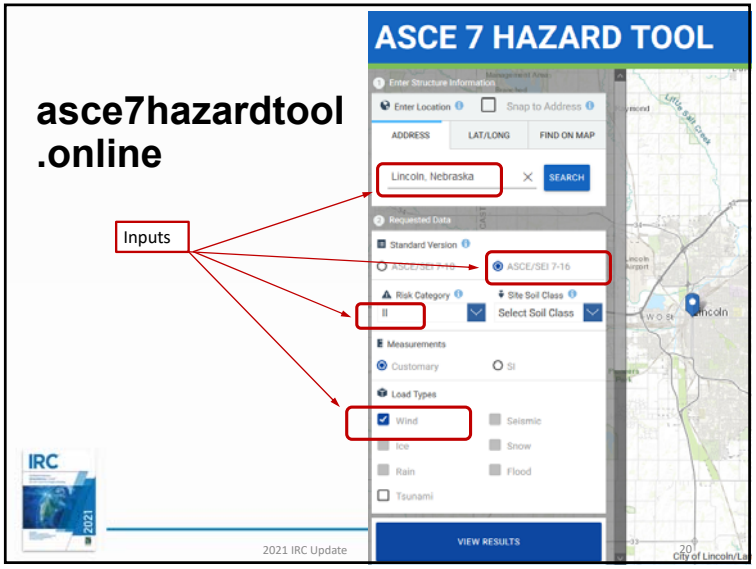
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ASCE 7 HAZARD TOOL
Inputs
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ADDRESS
LAT/LONG
FIND ON MAP
Lincoln, Nebraska
SEARCH
Requested Data
Standard Version
ASCE/SEI 7-16
Risk Category
II
Site Soil Class
Select Soil Class
Measurements
Customary
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Load Types
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Ice
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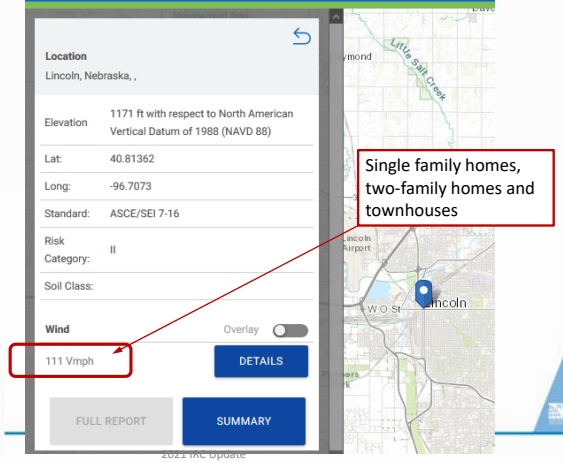
Rain
Flood
Tsunami
VIEW RESULTS
2021 IRC Update
20

20

ASCE 7 HAZARD TOOL



21

Table R301.2.1(1) Components and Cladding

- Component and cladding wind pressures in Table R301.2.1(1) are updated for new design wind speeds and hip or gable roof profiles.

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Table R301.2.1(1) Components and Cladding

	Zone	Effective Wind Areas (ft^2)	Ultimate Design Wind Speed, V_{ult}													
			90		95		100		105		110		...		180	
			Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg	Pos	Neg
Gable Roof >7 to 20 degrees	1, 2e	10	5.4	-16.2	6	-18.0	6.7	-19.9	7.4	-22	8.1	-24.1	...	...	21.6	-64.6
	1, 2e	20	4.9	-16.2	5.4	-18	6.0	-19.9	6.6	-22	7.2	-24.1	...	...	19.4	-64.6
	1, 2e	50	4.1	-9.9	4.6	-11	5.1	-12.2	5.6	-13.4	6.1	-14.7	...	...	16.4	-39.4
	1, 2e	100	3.6	-5	4	-5.6	4.4	-6.2	4.8	-6.9	5.3	-7.5	...	...	14.2	-20.2
	2n, 2r, 3e	10	5.4	-23.6	6	-26.3	6.7	-29.1	7.4	-32.1	8.1	-35.2	...	...	21.6	-94.2
	2n, 2r, 3e	20	4.9	-20.3	5.4	-22.7	6	-25.1	6.6	-27.7	7.2	-30.4	...	...	19.4	-81.4
	2n, 2r, 3e	50	4.1	-16	4.6	-17.9	5.1	-19.8	5.6	-21.8	6.1	-24	...	...	16.4	-64.2
	2n, 2r, 3e	100	3.6	-12.8	4	-14.3	4.4	-15.8	4.8	-17.4	5.3	-19.1	...	...	14.2	-51.3
	3r	10	5.4	-28	6	-30.2	6.7	-34.6	7.4	-38.1	8.1	-41.8	...	...	21.6	-112
	3r	20	4.9	-24	5.4	-26.7	6	-29.6	6.6	-32.7	7.2	-35.9	...	...	19.4	-96
	3r	50	4.1	-18.7	4.6	-20.8	5.1	-23.1	5.6	-25.4	6.1	-27.9	...	...	16.4	-74.7
	3r	100	3.6	-14.7	4	-16.3	4.4	-18.1	4.8	-20	5.3	-21.9	...	...	14.2	-58.7

23

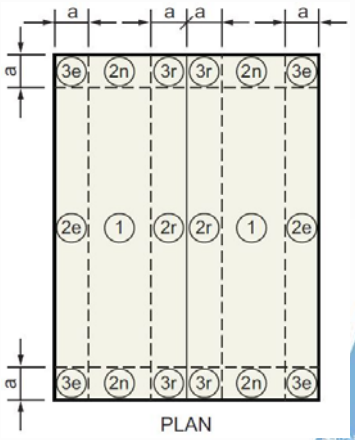
New vocabulary includes division of C&C corner and edge zones as follows:

2 – edge zones
2e – edge zone along bottom of roof above the soffit
2r – edge zone along roof peak
2n – edge zone along rake edge of gable roofs

3 – corner zones
3e – corner zone at bottom of roof above the soffit
3r – corner zone at roof peak

C&C interior zones:
1 – interior zone

a = 4 feet



24

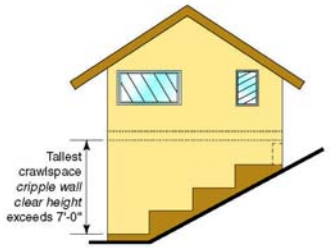
R301.2.1.1 Wind Limitations

- Engineered design requirements for special wind regions are explicitly stated in Section R301.2.1.1.
- Engineered design is required when winds are 140 mph or greater.

25

R301.2.2.6 Irregular Buildings Item 8

- Irregular building requirements for homes in high seismic regions now include limits for hillside light-frame construction.



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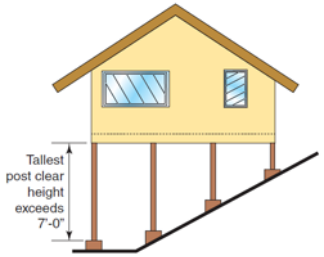
R301.2.2.6 Irregular Buildings Item 8

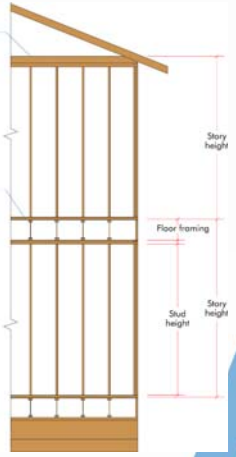
- Irregular building requirements for homes in high seismic regions now include limits for hillside light-frame construction.



27

R301.3 Story Height

- Maximum story height for wood wall framing is 13 feet 7 inches when the exception requirements are met.



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R301.3 Story Height

Load	Stud Height (feet)		
	≤ 10	10 to 12	≥ 12
Load Bearing Studs	No engineering required	Engineering required unless a Section R602.3.1 exception is met: Exc. 2 – snow load and tributary length limit Exc. 3 – snow load and span limits, only Exp B	Engineering always required
Non-loadbearing Studs	No engineering required	No engineering required for 2x4 and larger studs	Engineering required unless limits of Table R602.3(5) are met

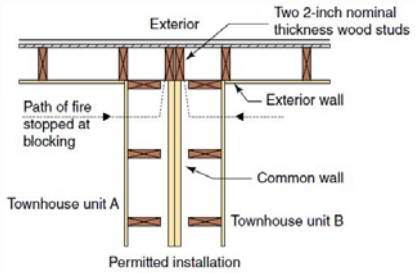
29

Chapter 3 – Life Safety

30

R302.2 Townhouse Common Wall

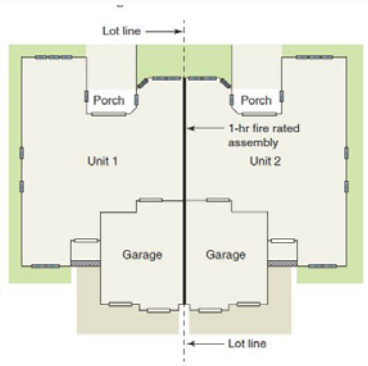
- Common walls separating townhouses can terminate at the inside of exterior walls:
  - Two 2 in. studs as fireblocking



31

R302.3 Two-Family Dwelling Separation

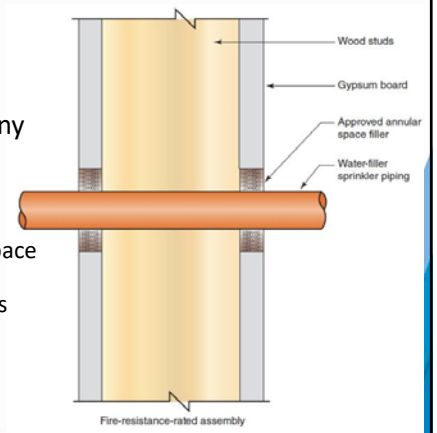
- One-hour separation whether or not a lot line exists between units



32

R302.4 Dwelling Unit Rated Penetrations

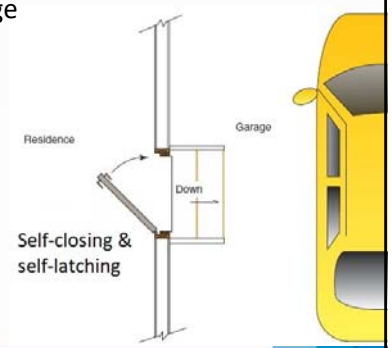
- Water-filled fire sprinkler piping of any approved material
  - does not require a firestop system
  - provided annular space is filled with the prescribed materials



33

R302.5 Dwelling-Garage Opening Protection

- Door between the garage and residence must be self-latching.



34

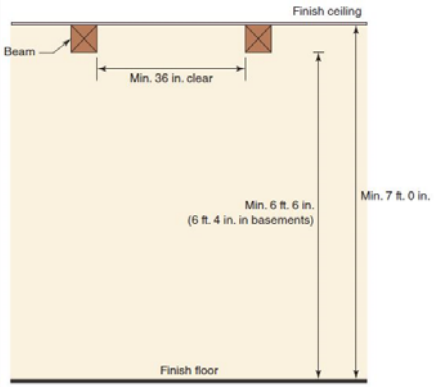
R303.1 Mechanical Ventilation

- Whole-house mechanical ventilation system <u>or a mechanical ventilation system capable of producing 0.35 ACH in habitable rooms</u>
- A local exhaust system is an acceptable substitute for natural ventilation in kitchens.

35

R305.1 Ceiling Height

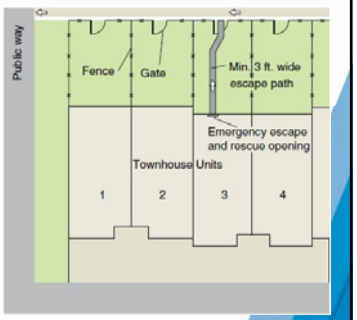
- Minimum ceiling height reduced to 6 ft. 6 in. under beams spaced at least 36 in. apart.



36

R310.1 Emergency Escape and Rescue Opening Required

- Emergency escape and rescue openings require a clear 36-inch-wide path to a public way.
- Operation requirements have been clarified.



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R310.2 Emergency Escape and Rescue Openings

- Emergency escape openings under decks, porches and cantilevers require a path not less than 36 in. in height and 36 in. in width.
- Dimensions have been clarified (placed in separate sections):
  - Minimum opening area
  - Minimum opening dimensions
  - Maximum ~~sill~~ height above floor

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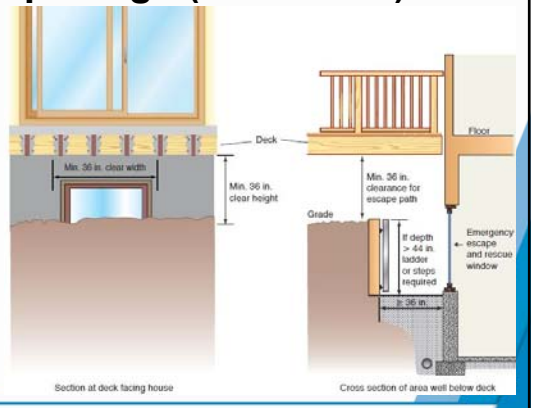
R310.2 Emergency Escape and Rescue Openings (Continued)

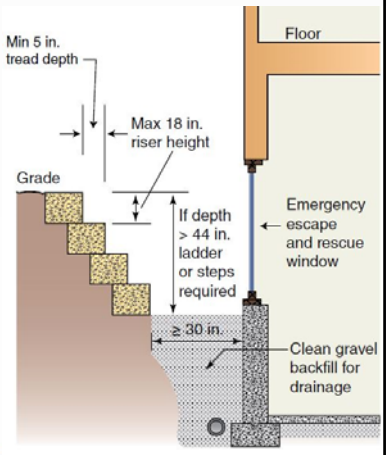
- 36 in. height
- 36 in. width



39

R310.3, R310.4 EERO Area Wells

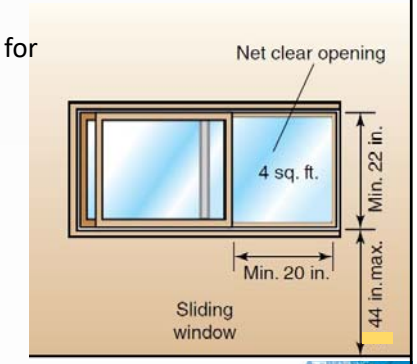
- Window wells and area wells merged into area wells.
- Dimensions are given for steps:
  - 5 in. tread
  - 18 in. rise
  - 12 in. width



40

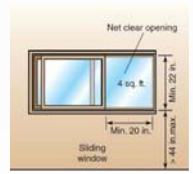
R310.5, R310.6, R310.7 EERO in Existing Buildings

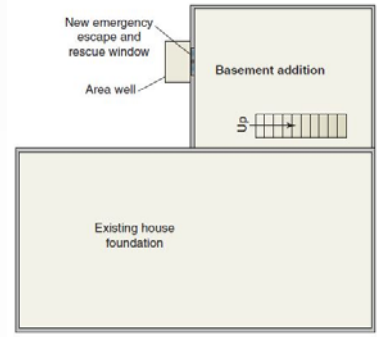
- 4 sq. ft. clear opening for EERO for:
  - Basement remodel
  - Basement addition
  - Change of occupancy



41

R310.5, R310.6, R310.7 EERO in Existing Buildings (continued)

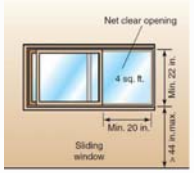


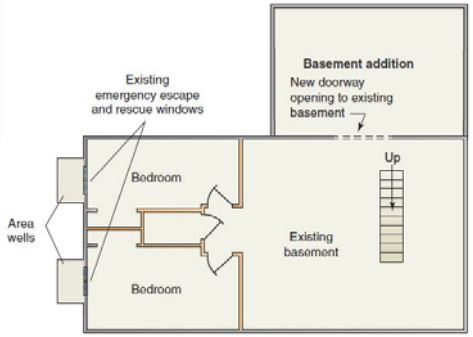


Basement addition with required emergency escape and rescue opening

42

R310.5, R310.6, R310.7 EERO in Existing Buildings (continued)



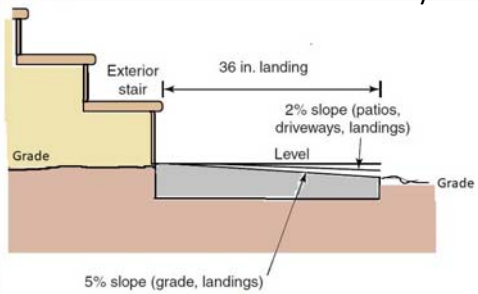


Basement addition with opening to existing basement

43

R311.7.7 Stairway and Landing Walking Surface

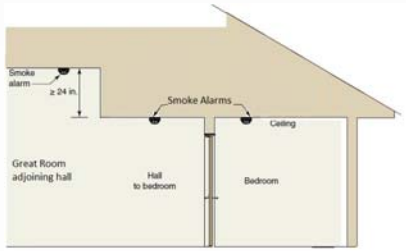
- New exception allows steeper slopes for exterior landings that also serve to drain surface water away from the building.



44

R314.3 Smoke Alarm Locations

- A new location requirement addresses high ceilings adjacent to hallways serving bedrooms.



Section drawing

45

R314.3 Smoke Alarm Locations (Continued)

- Smoke alarms identified as having resistance to common nuisance alarms from cooking sources are now permitted to be as close as 6 feet from the cooking appliance.

46

R315.2.2 Carbon Monoxide Alarms

- Repairs to an existing fuel-fired mechanical system now trigger the retroactive requirements for carbon monoxide alarms.

47

R320 Accessibility

- Clarifies accessibility provisions for live/work units and owner-occupied lodging houses (B&Bs)
  - Accessibility typically not required for IRC buildings

Live/work units

48

R323.1.1 Storm Shelters

- An engineered design is required for storm shelters.

49

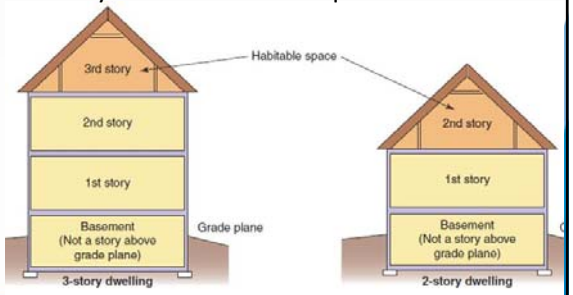
R324.6 Photovoltaic Systems

- Building-integrated photovoltaic (BIPV) systems meeting the specified criteria do not require firefighter access pathways and setbacks.

50

R326 Habitable Attics

- Habitable space above 2nd story or 1st story meets definition of story – no additional requirements



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Chapter 4 - Foundations

52

Table R403.1(1) Footing Width and Thickness

- Minimum footing size tables are revised to more accurately reflect current practice.
- A 20 psf roof live load or 25 psf ground snow load form the lowest load assumed for the footing.

53

Table R403.1(1) Footing Width and Thickness excerpt

Ground Snow Load or Roof Live Load	Story and Type of Structure with Light Frame	Load Bearing Value of Soil (psf)					
		1500	2000	2500	3000	3500	4000
20 psf Roof Live Load or 25 psf Ground Snow Load	1 story - slab on grade	12x6	12x6	12x6	12x6	12x6	12x6
	1 story - with crawl space	12x6	12x6	12x6	12x6	12x6	12x6
	1 story - plus basement	16x6 ~~18x6~~	12x6 ~~14x6~~	12x6	12x6	12x6	12x6
	2 story - slab on grade	13x6 ~~12x6~~	12x6	12x6	12x6	12x6	12x6
	2 story - with crawl space	15x6 ~~16x6~~	12x6	12x6	12x6	12x6	12x6
	2 story - plus basement	19x6 ~~22x6~~	14x6 ~~16x6~~	12x6 ~~13x6~~	12x6	12x6	12x6
30 psf	1 story - slab on grade	12x6	12x6	12x6	12x6	12x6	12x6
	1 story - with crawl space	13x6	12x6	12x6	12x6	12x6	12x6
	1 story - plus basement	16x6 ~~19x6~~	12x6 ~~14x6~~	12x6	12x6	12x6	12x6
	2 story - slab on grade	13x6 ~~12x6~~	12x6	12x6	12x6	12x6	12x6
	2 story - with crawl space	16x6 ~~17x6~~	12x6 ~~13x6~~	12x6	12x6	12x6	12x6
	2 story - plus basement	19x6 ~~23x6~~	14x6 ~~17x6~~	12x6 ~~14x6~~	12x6	12x6	12x6

54

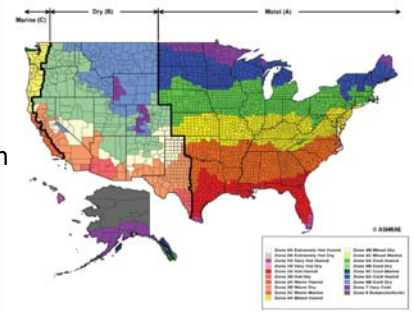
R406.2 Foundation Waterproofing

- Six-mil polyvinyl chloride and polyethylene fabrics are removed from the list of approved waterproofing materials.

55

R408.8 Under-floor Vapor Retarder

- A Class I or II vapor retarder is required on exposed air permeable insulation between floor joists in Climate Zones 1A, 2A and 3A.



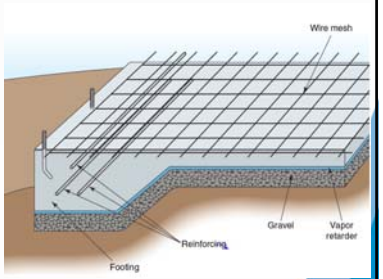
56

Chapter 5 - Floors

57

R506.2.3 Vapor Retarder

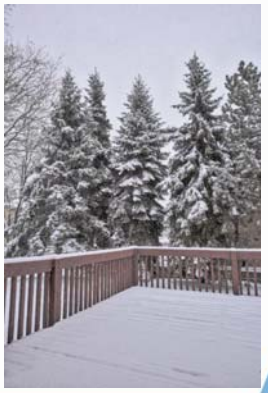
- Thicker vapor retarders are now required below slabs on grade.
- Minimum 10 mil (0.01 inch) thick



58

R507.1 Deck Loads

- Deck designs are now based on live or snow loads.



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R507.3 Deck Footings

- Footings for freestanding decks on or near the ground have been clarified.

60

Table R507.3.1 Minimum Footing Size for Decks

LIVE OR GROUND SNOW LOAD (psf)	TRIBUTARY AREA (sq. ft.)	SOIL BEARING CAPACITY 1500 psf		
		Side of a square footing (inches)	Diameter of a round footing (inches)	Thickness (inches)
40	5	7	8	6
	20	10	12	6
	40	14	16	6
50	5	7	8	6
	20	11	13	6
	40	15	17	6
60	5	7	8	6
	20	12	14	6
70	5	7	8	6
	20	12	14	6

61

R507.4 Deck Posts

- The deck post height table is expanded by adding the tributary area supported by a post and the wood species for determination of maximum post height.

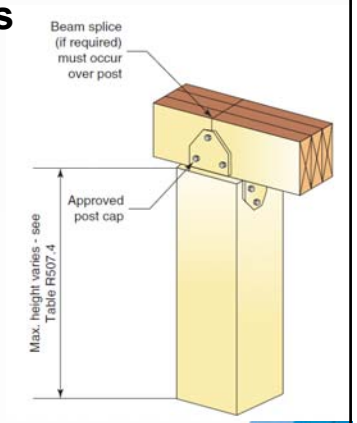

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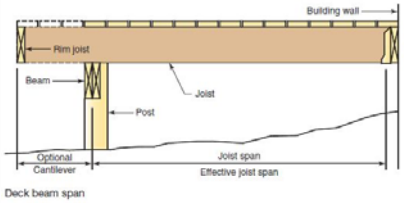
Table R507.4 Deck Post Height

Loads (psf)	Post Species	Post Size	Tributary Area (ft²) 20	40	60	80	100	120	140	160
			Maximum Deck Post Height (feet-inches)							
50 Ground Snow Load	Southern Pine	4 x 4	14-0	12-2	9-10	8-5	7-5	6-7	5-11	5-4
		4 x 6	14-0	14-0	12-6	10-9	9-6	8-7	7-10	7-3
		6 x 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	13-4
		8 x 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Douglas Fir, Hem-fir, SPF	4 x 4	14-0	12-1	9-8	8-2	7-1	6-2	5-3	4-2
		4 x 6	14-0	14-0	12-4	10-7	9-4	8-4	7-7	6-11
		6 x 6	14-0	14-0	14-0	14-0	14-0	14-0	14-0	12-10
		8 x 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0
	Redwood, W. Cedars, Pond. Pine, Red Pine	4 x 4	14-0	11-8	9-0	6-10	3-7	NP	NP	NP
		4 x 6	14-0	14-0	12-0	10-0	8-6	7-0	5-3	NP
		6 x 6	14-0	14-0	14-0	14-0	14-0	14-0	10-8	2-4
		8 x 8	14-0	14-0	14-0	14-0	14-0	14-0	14-0	14-0

63

R507.5 Deck Beams

- The deck beam span table is split into multiple tables providing spans for given deck live or snow loads. Single and multi-ply spans as well as options for cantilevered deck joists are listed.



64

Table R507.5(2) Max. Deck Beam Span – 50 psf Ground Snow Load

Beam Species	Beam Size	Effective Deck Joist Span Length (feet)						
		6	8	10	12	14	16	18
		Maximum Beam Span (feet-inches)						
Southern Pine	1-2x6	4-6	3-11	3-6	3-2	2-11	2-9	2-7
	1-2x8	5-9	4-11	4-5	4-0	3-9	3-6	3-3
	1-2x10	6-9	5-10	5-3	4-9	4-5	4-2	3-11
	1-2x12	8-0	6-11	6-2	5-8	5-3	4-11	4-7
	2-2x6	6-8	5-9	5-2	4-9	4-4	4-1	3-10
	2-2x8	8-6	7-4	6-7	6-0	5-7	5-2	4-11
	2-2x10	10-1	8-9	7-10	7-1	6-7	6-2	5-10
	2-2x12	11-11	10-3	9-2	8-5	7-9	7-3	6-10
	3-2x6	7-11	7-2	6-6	5-11	5-6	5-1	4-10
	3-2x8	10-5	9-3	8-3	7-6	6-11	6-6	6-2
	3-2x10	12-8	10-11	9-9	8-11	8-3	7-9	7-3
	3-2x12	14-11	12-11	11-6	10-6	9-9	9-1	8-7

65

Table R507.5 Deck Beam Span

- Table R507.5(5) - Joist Span Factors For Calculating Effective Deck Joist Span

C/J	Joist Span Factor
0 (no cantilever)	0.66
1/12 (0.87)	0.72
1/10 (0.10)	0.80
1/8 (0.125)	0.84
1/6 (0.167)	0.90
1/4 (0.250)	1.00

J = actual joist span length (feet)

C = actual joist cantilever length (feet)

66

Cantilever Example

- A deck with a ground snow load of 50 psf is designed using two plies of Southern Pine 2x10.
- **Joist span** is 12 feet.
  - Table R507.5(2) limits the beam to a maximum span of 7'-1".
- **Joist span** is 12 feet and there is no cantilever.
  - C = 0 feet (cantilever)
  - J = 12 feet (joist)
  - Applying the adjustment factor from footnote j in Table R507.5(2):
    - C /J= 0 and the joist span factor is 0.66
  - An effective **joist span** can be calculated as 0.66 x 12' = 8'. Look at the maximum beam length for an 8 ft joist span.
- The maximum **beam span** is 8'-9" per Table R507.5(2) because there is no cantilever.

67

R507.6 Deck Joists

- Deck joist options are added for decks with large ground snow loads. Cantilever spans are now specifically based on maximum joist spans.

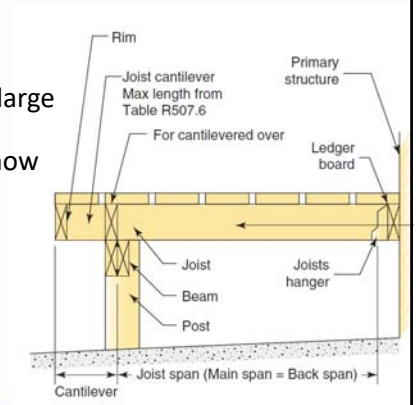


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Table R507.6 Max. Deck Joist Spans

Load[a] (psf)	Joist Species[b]	Joist Size	Allowable Joist Span (feet-inches) Joist Spacing (inches)			Maximum Cantilever (feet-inches) Joist Back Span (feet)							
			12	16	24	4	6	8	10	12	14	16	18
40 Live Load	Southern Pine	2x6	9-11	9-0	7-7	1-0	1-6	1-5	NP	NP	NP	NP	NP
		2x8	13-1	11-10	9-8	1-0	1-6	2-0	2-6	2-3	NP	NP	NP
		2x10	16-2	14-0	11-5	1-0	1-6	2-0	2-6	3-0	3-4	3-4	NP
		2x12	18-0	16-6	13-6	1-0	1-6	2-0	2-6	3-0	3-6	4-0	4-1
	Douglas Fir, Hem-fir, Spruce-Pine-Fir	2x6	9-6	8-4	6-10	1-0	1-6	1-4	NP	NP	NP	NP	NP
		2x8	12-6	11-1	9-1	1-0	1-6	2-0	2-3	2-0	NP	NP	NP
		2x10	15-8	13-7	11-1	1-0	1-6	2-0	2-6	3-0	3-3	NP	NP
		2x12	18-0	15-9	12-10	1-0	1-6	2-0	2-6	3-0	3-6	3-11	3-11
	Redwood, W. Cedars, Pond. Pine, Red Pine	2x6	8-10	8-0	6-10	1-0	1-4	1-1	NP	NP	NP	NP	NP
		2x8	11-8	10-7	8-8	1-0	1-6	2-0	1-11	NP	NP	NP	NP
		2x10	14-11	13-0	10-7	1-0	1-6	2-0	2-6	3-0	2-9	NP	NP
		2x12	17-5	15-1	12-4	1-0	1-6	2-0	2-6	3-0	3-6	3-8	NP

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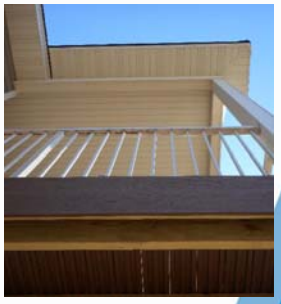
R507.10 Exterior Guards

- Requirements for deck guardrails are added.
- Provisions mirror requirements for interior stairway ramp guards.
- Two methods to connect guards – to side or top of deck framing.



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Chapter 6 - Walls

71

Table R602.3(1) – Fasteners

Item	Description of Building Elements	Number and Type of Fastener	Spacing and Location
	Roof		
1	Blocking between ceiling joists or rafters or trusses to top plate or other framing below	4-8d box (2½"x 0.113") nails 3-8d common (2½" × 0.131") nails 3-10d box (3" × 0.128") nails 3-(3" × 0.131") nails	Toenail
	Blocking between rafters or truss not at the wall top plate, to rafter or truss	2-8d common (2½" × 0.131") nails 2-(3" × 0.131") nails	Each end, toenail
		2-16d common (3½" × 0.162") nails 3-(3" × 0.131") nails	End nail
	Flat blocking to truss and web filler	16d common (3½" × 0.162") nails 3-(3" × 0.131") nails	6"o.c. face nail
	Wall		
12	Adjacent full-height stud to end of header	3-16d common (3½" × 0.162") nails 4-16d box (3 ½"x 0.135") nails 4-10d box (3" × 0.128") nails 4-(3" × 0.131") nails	End nail

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Table R602.3(1) – Fasteners

Item	Thickness	Number and Type of Fastener	Spacing of Fasteners	
			Edges (inches)	Interm. supports (inches)
Wood structural panels (WSP), subfloor, roof and interior wall sheathing to framing and particleboard wall sheathing to framing				
~~30~~ 31	⅜" – ½"	6d common or deformed (2" × 0.113" x 0.266" head) ~~(subfloor, wall)[3]~~; ~~8d common (2½" × 0.131") nail (subfloor, wall); or~~ 2 ⅜" × 0.113" x 0.266" head nail (subfloor, wall)	6[f]	~~12~~ 6[f]
		8d common (2½" × 0.131") (roof) RSRS-01 (2⅜" × 0.113") nail (roof)	6[f]	~~12~~ 6[f]
~~31~~ 32	19/32" – 1" ¾"	8d common (2½" × 0.131") (subfloor, wall) Deformed 2 3/8" × 0.113" x 0.266" head (wall or subfloor)	6	12
		8d common (2½" × 0.131") nail (roof) RSRS-01 (2⅜" × 0.113") nail (roof)	6[f]	~~12~~6[f]
~~32~~ 33	~~1⅛"~~ ⅞" – 1¼"	10d common (3" × 0.148") nail ~~8d~~ (2½" × 0.131" x 0.281" head) deformed nail	6	12

f. For wood structural panel roof sheathing attached to gable end roof framing and to intermediate supports within 48 inches of roof edges and ridges, nails shall be spaced at ~~6~~ 4 inches on center where the ultimate design wind speed is greater than 130 mph in Exposure B or greater than 110 mph in Exposure C.

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Table R602.3(2) Alternate Attachments

Nominal Material Thickness (inches)	Description of Fastener and Length (inches)	Spacing of Fasteners	
		Edges (inches)	Interm. supports (inches)
Wood structural panels subfloor, roof[g] and wall sheathing to framing and particleboard wall sheathing to framing			

g. Alternate fastening is only permitted for roof sheathing where the ultimate design wind speed is less than or equal to 110 mph, and where fasteners are installed 3 inches on center at all supports.

74

R602.9 Cripple Walls

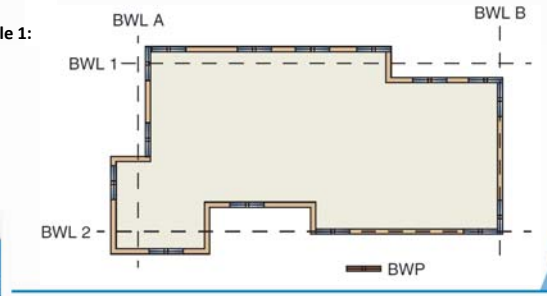
- Cripple wall requirements apply **only** to exterior cripple walls.

75

R602.10.1.2 Location of Braced Wall Lines

- Braced wall lines must be placed on a physical wall or placed between multiple walls.

Example 1:



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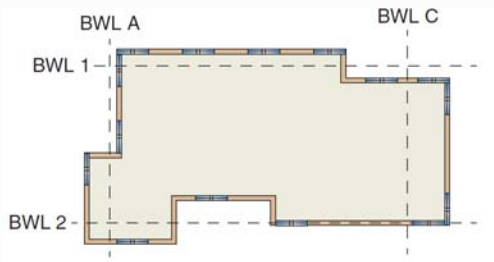
R602.10.1.2 Location of Braced Wall Lines (Continued)

Example 2:



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R602.10.2.2 Location of Braced Wall Panels

- The starting point of the first BWP when not placed at the corner of the structure is clarified.

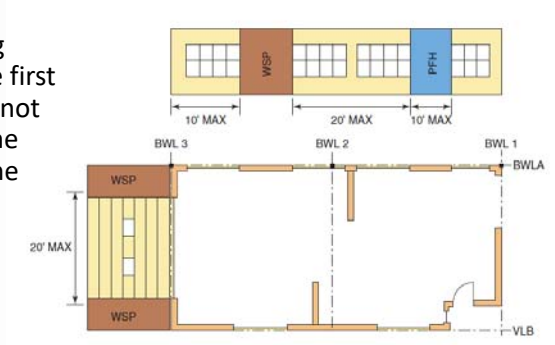

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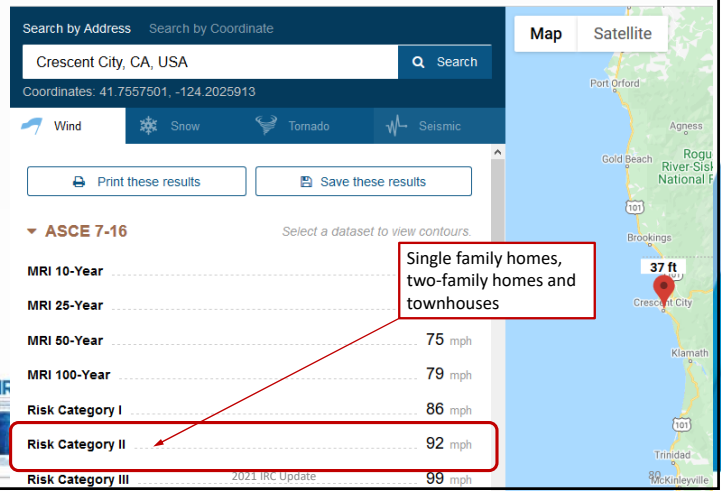
Table R602.10.3(1) Bracing based on Wind Speed

[Assumptions]			Minimum Total Length (feet) of Braced Wall Panels Required Along Each Braced Wall Line[a]		
Ultimate Design Wind Speed (mph)	Story Location	Braced Wall Line[c]	Method GB	Methods WSP, BV- WSP, ABW, PFH, PFG	Methods CS- WSP, CS- G, CS-PF
< 95 mph		10	2.5	1.5	1.5
		20	4.5	2.5	2.5
		30	6.5	4.0	3.5
		40	8.5	5.0	4.0
		50	10.5	6.0	5.0
		60	12.5	7.0	6.0
		10	5.0	3.0	2.5
		20	8.5	5.0	4.5
		30	12.5	7.0	6.0
		40	16.0	9.5	8.0
		50	20.0	11.5	10.0
		60	23.5	13.5	11.5

79

Hazards.atcouncil.org



80

Table R602.10.3(3) Bracing Based on Seismic Design Category, footnote f

f. Methods PFH, PFG and ABW are only permitted on a single story or a first of two stories.

81

R609.4.1 Garage Door Labelling

- Garage doors shall be labeled with a permanent label provided by the garage door manufacturer.
- The label shall identify the garage door:
  - manufacturer
  - model/series number
  - positive and negative design wind pressure rating
  - installation instruction drawing reference number
  - applicable test standard

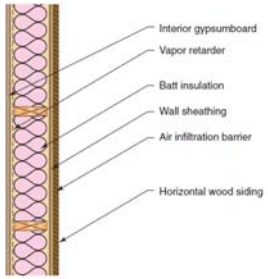
82

Chapter 7 – Wall Covering

83

R702.7 Vapor Retarders

- The vapor retarder section is reorganized for clarity and ease of use.
- Materials are listed as Class I, II or III.
- Tables offer appropriate climate zones for each class.
- Class II and III vapor retarders may be used with continuous insulation.



84

Vapor Retarders

Class I

VR < 0.1 perm
Impermeable
Foil and Polyethylene sheets

Class II

0.1 perm < VR < 1 perm
Semi-impermeable
Extruded polystyrene and Kraft fiberglass batts

Class III

1 perm < VR
Semi-impermeable
Latex paint, 30# felt and Plywood

85

R703.2, R703.7.3 Water-resistive Barriers

- WRB material options include:
  - No. 15 felt complying with ASTM D226, Type 1
  - ASTM E2556, Type I or II
  - ASTM E331
  - Other approved materials
- WRB requirements for dry climates versus wet climates are defined for stucco.

86

R704 Soffits

- Requirements for soffit material and installation are expanded in a new section.

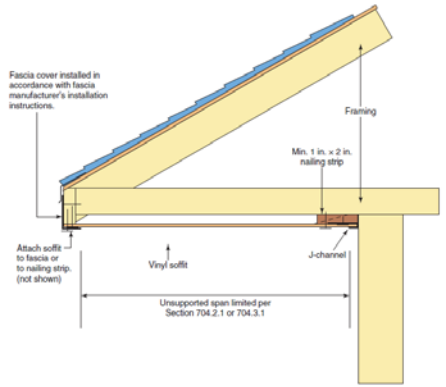
87

R704 Soffits

- R704.1 General wind limitations
- R704.2 Soffit installation where the design wind pressure is 30 psf or less
- R704.2.1 Vinyl soffit panels
- R704.2.2 Fiber-cement soffit panels
- R704.2.3 Hardboard soffit panels
- R704.2.4 Wood structural panel soffit
- R704.3 Soffit installation where the design wind pressure exceeds 30 psf
- R704.3.1 Vinyl soffit panels
- R704.3.2 Fiber-cement soffit panels
- R704.3.3 Hardboard soffit panels
- R704.3.4 Wood structural panel soffit

88

Figure R704.2.1(1) Single Span Vinyl Soffit Panel Support



89

Table R704.3.4 Prescriptive Alternative Nailing for a WSP Soffit

Maximum Design Pressure (+ or - psf)	Minimum Panel Span Rating	Minimum Panel Performance Category	Nail Type and Size	Fastener[a] Spacing Along Edges and Intermediate Supports	
				Galvanized Steel	Stainless Steel
30	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6[f]	4
40	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	6	4
50	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	4
			8d common (2½ x 0.131 x 0.281 head diameter)	6	6
60	24/0	3/8	6d box (2 x 0.099 x 0.266 head diameter)	4	3
			8d common (2½ x 0.131 x 0.281 head diameter)	6	4
70	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
80	24/16	7/16	8d common (2½ x 0.131 x 0.281 head diameter)	4	4
			10d box (3 x 0.128 x 0.312 head diameter)	6	4
90	32/16	15/32	8d common (2½ x 0.131 x 0.281 head diameter)	4	3
			10d box (3 x 0.128 x 0.312 head diameter)	6	4

90

Chapter 8 – Roof
Chapter 9 – Roof Covering

91

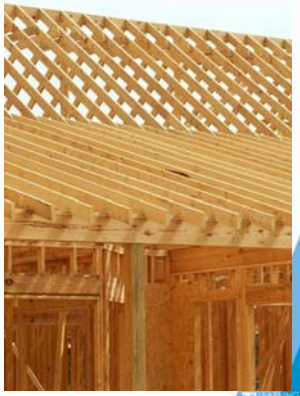
R802 Wood Roof Framing

- Revised provisions clarify ridge beam and ceiling joist requirements.

92

Table R802.5.2(1) Heel Joint Connections

- The heel joint connection table is updated for roof spans of 24 and 36 feet and a 19.2-inch rafter spacing.



93

Table R802.5.2(1) Rafter/Ceiling Joist Heel Joint Connections

RAFTER SLOPE	RAFTER SPACING (inches)	GROUND SNOW LOAD (psf)											
		20[g]			30			50			70		
		Roof span (feet)											
		12	24	36	12	24	36	12	24	36	12	24	36
		Required number of 16d common nails per heel joint splice[a,b,c,d,f]											
3:12	12	3	5	8	3	6	9	5	9	13	6	12	17
	16	4	7	10	4	8	12	6	12	17	8	15	23
	19.2	4	8	12	5	10	14	7	14	21	9	18	27
	24	5	10	15	6	12	18	9	17	26	12	23	34
4:12	12	3	4	6	3	5	7	4	7	10	5	9	13
	16	3	5	8	3	6	9	5	9	13	6	12	17
	19.2	3	6	9	4	7	11	6	11	16	7	14	21
	24	4	8	11	5	9	13	7	13	19	9	17	26
5:12	12	3	3	5	3	4	6	3	6	8	4	7	11
	16	3	4	6	3	5	7	4	7	11	5	9	14
	19.2	3	5	7	3	6	9	5	9	13	6	11	17
	24	3	6	9	4	7	11	6	11	16	7	14	21
						⋮							
12:12	12	3	3	3	3	3	3	3	3	4	3	3	5
	16	3	3	3	3	3	3	3	3	5	3	4	6
	19.2	3	3	3	3	3	4	3	4	6	3	5	7
	24	3	3	4	3	3	5	3	5	7	3	6	9

94

Table R802.5.2(1) Rafter/Ceiling Joist Heel Joint Connections Footnote a

a. 10d common (3" × 0.148") nails shall be permitted to be substituted for 16d common (3½"x 0.162") nails where the required number of nails is taken as 1.2 times the required number of 16d common nails, rounded up to the next full nail.

95

R802.6 Rafter and Ceiling Joist Bearing

Where:

1. Roof pitch is ≥ 3:12 (25% slope)
2. Ceiling joists or rafter ties are connected to rafters to provide a continuous tension tie

Vertical bearing of the top of the rafter against the ridge board shall satisfy the bearing requirement.

96

R905.4.4.1 Metal Roof Shingle Wind Resistance

- Requirements for metal shingle wind resistance are added to Section R905.4.

97

Table R905.4.4.1 Classification of Steep Slope Metal Roof Shingles Tested per ASTM D3161

MAXIMUM ULTIMATE DESIGN WIND SPEED, V_{ULT} FROM FIGURE R301.2(5)A (mph)	MAXIMUM BASIC WIND SPEED, V_{ASD} FROM TABLE R301.2.1.3 (mph)	ASTM D3161 SHINGLE CLASSIFICATION
110	85	A, D or F
116	90	A, D or F
129	100	A, D or F
142	110	F
155	120	F
168	130	F
181	140	F
194	150	F

98

Chapter 11 - Energy

99

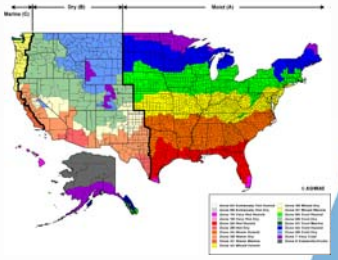
N1101.6 Definition of High-Efficacy Light Sources

- High-efficacy lighting:
  - lamps ≥ 65 lumens/W
  - luminaires ≥ 45 lumens/W
  - reflects current technology and federal standards

100

N1101.7 Climate Zones

- Comprehensively updated
- New Climate Zone 0
- Approximately 10% of US counties assigned new climate zone.



101

N1101.13 Compliance Options

- The compliance path options are revised.
- The prescriptive and mandatory labels in section titles are removed.

102

N1101.13 Compliance Options (Continued)

- Prescriptive Compliance Option
- Total Building Performance Option
- Energy Rating Index Option
- Tropical Climate Region Option

103

N1101.13.5 Additional Energy Efficiency Requirements

- Additional energy efficiency measures are required in addition to the compliance path requirements.

104

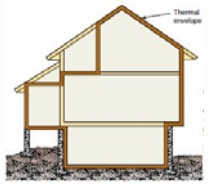
N1101.14 Permanent Energy Certificate

- Additional information:
  - Building thermal envelope
  - Solar energy
  - Energy Rating Index (ERI)
  - Code edition

105

N1102.1 Building Thermal Envelope

- The assembly *U*-Factor is established as the primary insulation metric.
- The *R*-Value approach is now an alternative method.



106

Tables N1102.1.2 and N1102.1.3 Insulation and Fenestration Requirements

- Lowered *U*-factors and increased *R*-values in the prescriptive tables

107

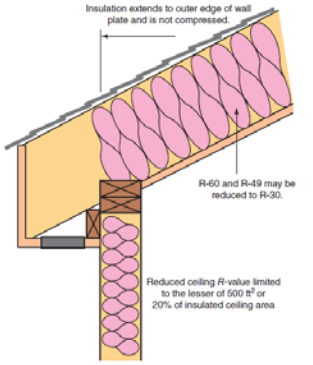
Table N1102.1.3 Insulation and Fenestration Requirements

Climate Zone	Fenestration *U*-Factor	Ceiling *R*-Value	Slab *R*-value & Depth
2	0.40	~~38~~ 49	0
3	~~0.32~~ 0.30	~~38~~ 49	~~0~~ 10ci, 2 ft
4 except Marine	~~0.32~~ 0.30	~~49~~ 60	10ci, ~~2~~ 4 ft
5 and Marine 4	0.30	~~49~~ 60	10ci, ~~2~~ 4 ft
6	0.30	~~49~~ 60	10ci, 4 ft
7 and 8	0.30	~~49~~ 60	10ci, 4 ft

108

N1102.2 Ceiling Insulation

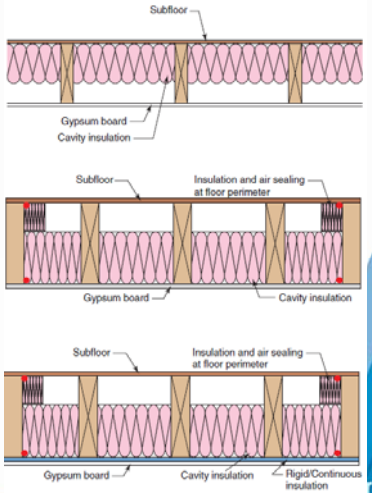
- The options for a reduction in *R*-values for both ceilings with attics and those without have been adjusted to recognize the increase in the prescriptive ceiling *R*-values in Table N1102.1.3.



109

N1102.2.7 Floor Insulation

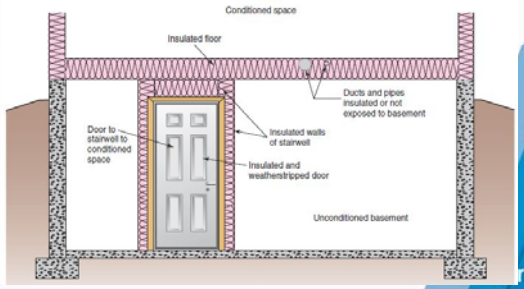
- Three separate methods of compliance:
  - Cavity insulation underside of subfloor
  - Cavity insulation top side of ceiling
  - Cavity and continuous insulation top side of ceiling



110

N1102.2.8 Unconditioned Basement

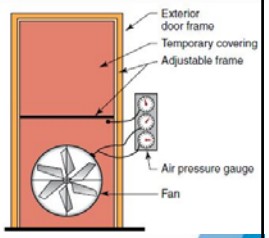
- A number of specific criteria must be met for a space to qualify as an unconditioned basement.



111

N1102.4 and Table N1102.4.1.1 Building Air Leakage and Testing

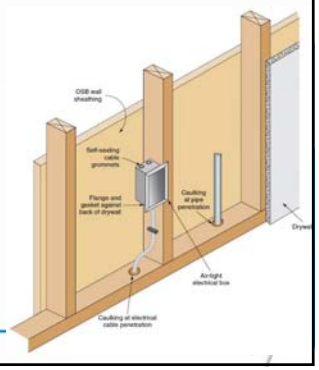
- 5 ACH for all compliance paths
- 3 ACH for prescriptive path in climate zones 3 through 8.
- Heated attached and detached garages are field verified for air barrier and insulation
- Exception to quantify air leakage in attached and small volume dwelling units
- Changes throughout Table N1102.4.1.1 Air Barrier, Air Sealing, and Insulation Installation.



112

N1102.4.6 Air-Sealed Electrical Boxes

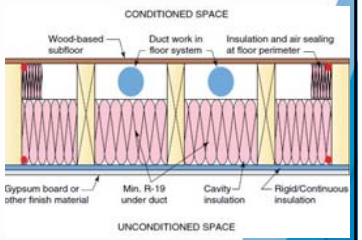
- Electrical and communication outlet boxes installed in the building thermal envelope:
  - Sealed
  - Tested NEMA OS 4
  - Marked "NEMA OS 4" or "OS 4"
  - Installed per manufacturer's instructions and NEMA OS 4



113

N1103.3 Duct Installation

- Clarifies four scenarios where ductwork qualifies as being in conditioned space:
  - Duct system completely within the continuous air barrier and building thermal envelope
  - Duct work in ventilated attic and buried within ceiling insulation
  - Duct work in floor cavities over unconditioned space
  - Duct work within exterior walls



114

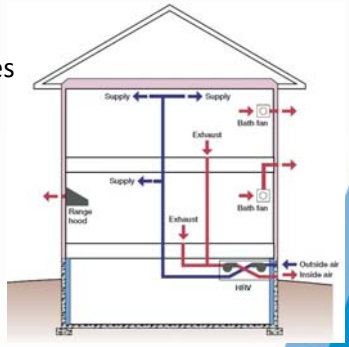
N1103.3.5 Duct Testing

- The exception for duct testing of ducts in conditioned spaces is deleted.

115

N1103.6 Mechanical Ventilation

- HRV or ERV system is required in climate zones 7 and 8.
- Mechanical ventilation systems now require testing.



116

N1104 Lighting Equipment

- High-efficacy lighting is now required in all permanent lighting fixtures.
- New provisions regulate lighting controls for interior and exterior lighting.

117

N1105 and Table N1105.2 Total Building Performance Analysis

- Section has been retitled and reorganized.
- New Table N1105.2 lists the related mandatory requirements that appear elsewhere in the code.

118

Table N1105.2 Requirements for Total Building Performance

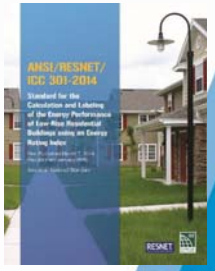
Section	Title
N1101.13.5	Additional Energy Efficiency
N1101.14	Certificate
N1102.1.1	Vapor Retarder
N1102.2.3	Eave Baffles
N1102.2.4.1	Access hatches and doors
N1102.2.10.1	Crawl space wall insulation installations
N1102.4.1.1	Installation

Excerpt

119

N1106 and Table N1106.2 Energy Rating Index Analysis

- ERI values lowered to increase energy efficiency
- Additional 5% energy reduction is applied
- New Table N1106.2 lists all of the mandatory requirements for the ERI compliance path.



120

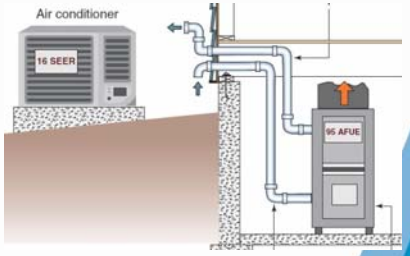
Table N1106.5 Maximum Energy Rating Index

Climate Zone	Energy Rating Index[a]
0-1	~~57~~ 52
2	~~57~~ 52
3	~~57~~ 51
4	~~62~~ 54
5	~~61~~ 55
6	~~61~~ 54
7	~~58~~ 53
8	~~58~~ 53

121

N1108 Additional Efficiency Package Options

- Additional energy efficiency package option:
  - Prescriptive
  - Total Building Performance



N1108.2.2 Item 1: More efficient HVAC equipment performance option.

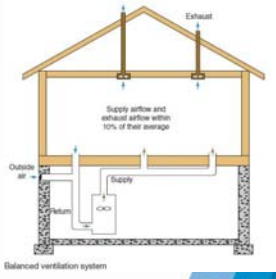
122

Chapters 12-23 – Mechanical

123

M1505 Balanced Ventilation System Credit

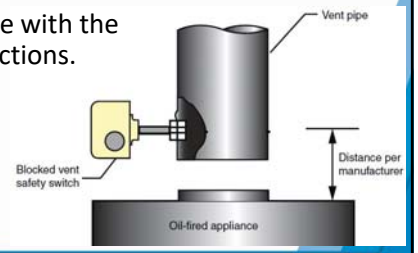
- A 30 percent reduction of airflow is permitted for balanced ventilation systems.



124

M1802.4 Blocked Vent Switch for Oil-fired Appliances

- Device will stop burner operation if venting system is obstructed.
- Requires a manual reset.
- Installed in accordance with the manufacturer's instructions.



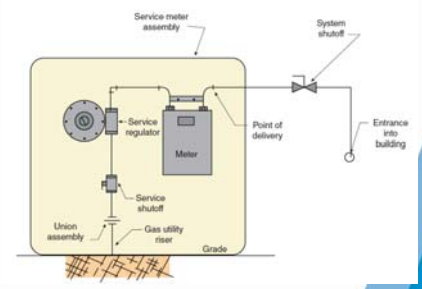
125

Chapter 24 – Fuel Gas

126

G2403 Point of Delivery and Service Meter Assembly Definitions

- Clarifies portions of piping system regulated by fuel gas provisions downstream of the point of delivery.



127

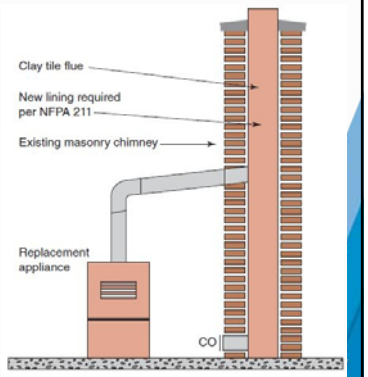
G2414.8.3 Threaded Joint Sealing

- Thread joint sealants are now required for assembling threaded joints in gas piping.

128

G2427.5.5.1 Chimney Lining

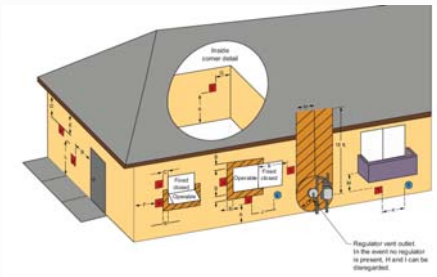
- The exception allowing an existing chimney to vent replacement appliances has been deleted.



129

G2427.8 Through-the-wall Vent Terminal Clearances

- Though-the-wall vent terminal clearance distances have been placed in a new table with a corresponding figure. (Fig.-G2427.8)



130

Table G2427.8 Through-the-wall Vent Terminal Clearances

Figure Clearance	Clearance Location	Minimum clearances for Direct- Vent Terminals	Minimum clearances for Non-Direct Vent Terminals
A	Clearance above finished grade level, veranda, porch, deck, or balcony	12 inches	
B	Clearance to window or door that is openable	6 inches: Appliances ≤ 10,000 Btu/hr 9 inches: Appliances > 10,000 Btu/hr ≤ 50,000 Btu/hr 12 inches: Appliances > 50,000 Btu/hr ≤ 150,000 Btu/hr Appliances > 150,000 Btu/hr, in accordance with the appliance manufacturer's instructions and not less than the clearances specified for nondirect-vent terminals in Row B	4 feet below or to side of opening or 1 foot above opening
C	Clearance to non-openable window	None unless otherwise specified by the appliance manufacturer	

Excerpt

131

G2447.2 Commercial Cooking Appliances Prohibited

- Commercial gas cooking appliances are prohibited.

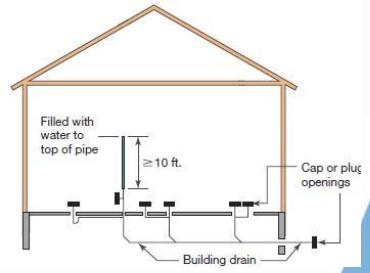
132

Chapters 25-33 – Plumbing

133

P2503.5.1 Drain, Waste and Vent Systems Testing

- The head pressure for a water test of DWV systems has increased to 10 feet.
  - Now matches the IPC.



134

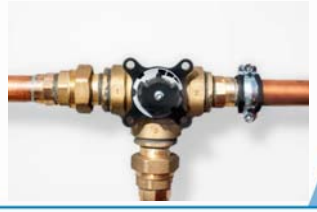
P2503.5.1 Drain, Waste and Vent Systems Testing (continued)

- Air vacuum testing is now permitted for plastic piping DWV systems.

135

P2708.4, P2713.3 Shower and Bathtub Control Valves

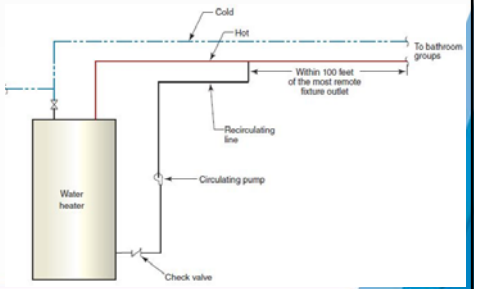
- Addresses field adjustment and access to shower control valves.
- Lower flow shower heads need to be compatible with the shower control mixing valve.



136

P2905.3 Length of Hot Water Piping to Fixtures

- Limits the length of hot water piping serving fixtures to 100 ft. (IPC = 50 ft.)



137

P3005.2.10.1 Removable Fixture Traps as Cleanouts

- Removable traps and removeable fixtures with integral traps are acceptable for use as cleanouts.

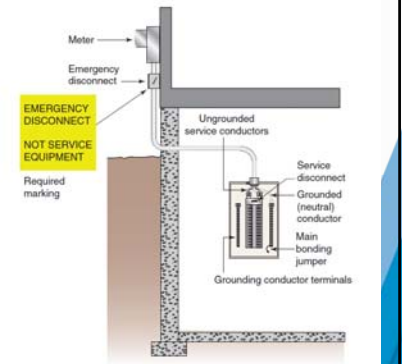
138

Chapters 34-43 – Electrical

139

E3601.8 Emergency Service Disconnects

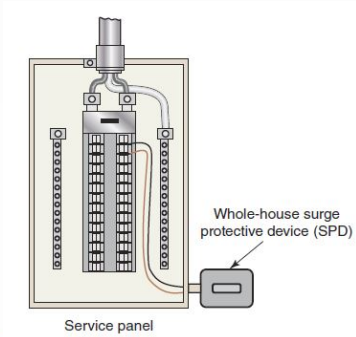
- An emergency service disconnect is required in a readily accessible outdoor location.



140

E3606.5 Service Surge-Protective Device

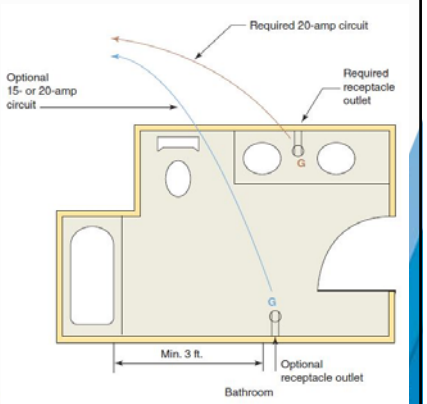
- A surge-protective device (SPD) is now required at the service panel.



141

E3703.4 Bathroom Branch Circuits

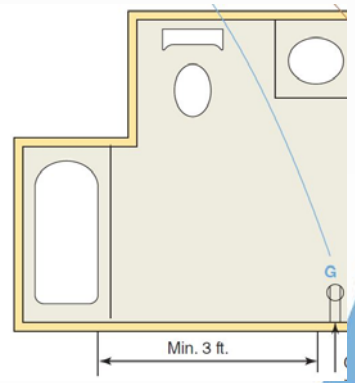
- Only the required bathroom receptacle outlets or those serving a countertop need to be on the dedicated 20-amp bathroom circuit.



142

E3703.4 Bathroom Branch Circuits

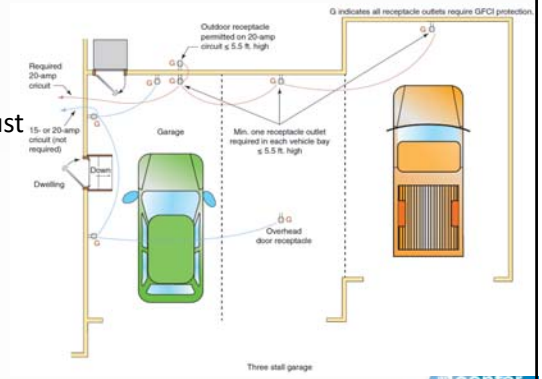
- Note new provision in E4002.11 prohibits receptacle outlets within 3 feet horizontally from bathtub rim or shower stall threshold.



143

E3703.5 Garage Branch Circuits

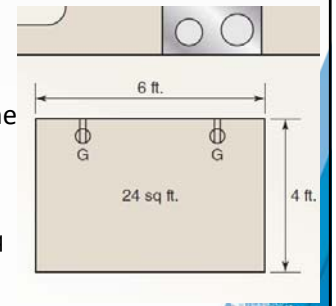
- Only the required receptacle outlets must be on the 20-amp dedicated circuit for garages.



144

E3901.4.2 Kitchen Countertop and Work Surface Receptacles

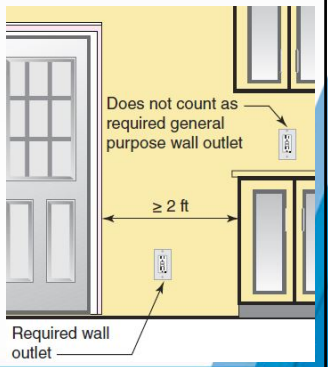
- The number of receptacle outlets required for peninsular and island countertops in kitchens is determined by the area of the countertop surface.
  - One for the first 9 sq ft or fraction thereof
  - One for every additional 18 sq ft or fraction thereof



145

E3901.4 Kitchen Countertop and Work Surface Receptacles

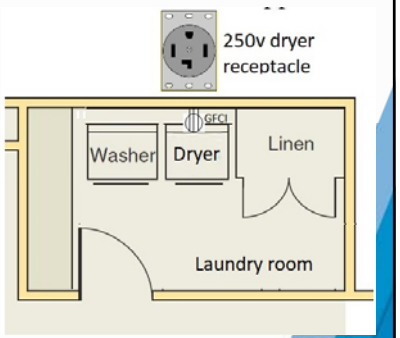
- Countertop and work surface receptacles in kitchen areas cannot be counted as a required general-purpose wall space receptacle outlet.



146

E3902 GFCI Protection for 250-Volt Receptacles

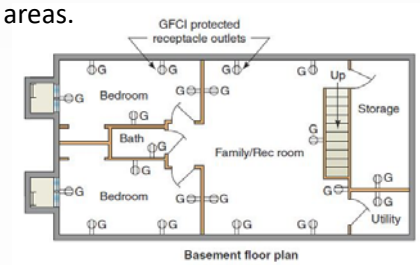
- GFCI protection is required for up to 250-volt receptacles in the identified areas.
- The 20-amp limitation has been removed.



147

E3902.5 GFCI Protection for Basement Receptacles

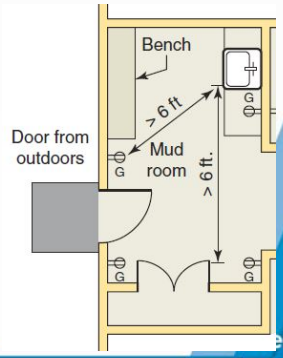
- The requirement for GFCI protection in unfinished basement areas has been expanded to include all basement areas.



148

E3902.10 GFCI Protection for Indoor Damp and Wet Locations

- GFCI protection is now required for damp and wet locations not included in the other 10 areas requiring GFCI protection.



149

Final Reflection

- What? What happened and what was observed in the training?
- So what? What did you learn? What difference did this training make?
- Now what? How will you do things differently back on the job as a result of this training?

150

IACET Accreditation

- The International Code Council has been accredited as an Authorized Provider by the International Association for Continuing Education and Training (IACET).
  - As a result of their Authorized Provider accreditation status, ICC is authorized to offer IACET CEUs for its programs that qualify under the ANSI/IACET Standard.
- You will obtain full CEUs for this course, if you actively participate in the training activities and stay for the entire session. Evidence of this will be the sign out sheet.

151

AIA Accreditation

International Code Council is a Registered Provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to CES Records for AIA members. Certificates of Completion for non-AIA members are available on request.

This program is registered with the AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

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2021 IRC Update 153

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Thank you for participating!

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The Learning Center™
1-888-ICC-SAFE (422-7233) Ext. 33821
or
E-mail: learn@iccsafe.org
Website: learn.iccsafe.org

2021 IRC Update 154

154

File Attachments for Item:

ER-2 2021 OBC Update (International Code Council)

All certifications except ESI (3.5 hours)

Staff Notes: Not based on current code, and code adoption process delayed due to regulatory restrictions and market conditions. Not recommended for approval.

Committee Recommendation:

ROGER AXEL, C.B.O.

Building Official, Retired; 12 years construction experience as self-employed contractor, 30 years inspection experience (10 years building inspector, 5 years plans examiner,15 years building official) including single and multi-family residential, educational, industrial, business and mercantile occupancies including the Mall of America; Bachelor of Science Degree in Industrial Education, University of Minnesota; Associate in Applied Science Degree in Building Inspection Technology, Inver Hills Community College; State of Minnesota Certified Building Official; Multiple International Code Council Certifications; ICC instructor; instructor for Housing and Building Inspection Institute at UW-Madison College of Engineering; instructor for MN Licensed Residential Contractor continuing education seminars; past Chairman and Executive Officer of the Association of MN Building Officials.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Laura Morris
(Contact Name)

Organization: International Code Council
(Organization/Company)

Address: 4051 Flossmoor Road
(Include Room Number, Suite, etc.)

City: Country Club Hills State: IL Zip: 60478

E-Mail: lmorris@iccsafe.org

Telephone: 888-422-7233 ext: 4523 Fax: _____

Course Sponsor: ICC

COURSE INFORMATION:

Course Title: 2021 IBC Update

New Course Submittal: ■ Update Course: ■ Prior Approval Number: _____

Purpose and Objective: This course will identify important changes in the IBC from 2018 to 2021 edition.
Participants will be presented with those changes that will most impact their use of the code when they apply the 2021 IBC. The learner will receive an overview of the most important code changes.

Number of Instructional Contact Hours that can be obtained upon completion: 3.5

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■ Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■
Building Plans Exam. ✓ Plumbing Inspector ■
Plumbing Plans Exam. ■ Non-Res IU Inspector ☐
Electrical Plans Exam. ■
Mechanical Plans Exam. ■
Fire Protect. Plans Exam. ✓

Res Building Official ■ Res Plans Examiner ■ Res Building Inspector ■ Res Mechanical Inspector ■ Res IU Inspector ■

Electrical Safety Inspectors ☐
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
	Organization sponsoring or requesting the program (if any)	x
Course Title:	Name of course (related to content)	x
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	x
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	x
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	x
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	x
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	x
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	x
Test Materials:		x
Completed Application:		x

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

2021 IBC Update

Based on the 2021 International Building Code®, (IBC®)

Length:	3.5 hours (0.35 Contact Hours)
Applicable Codes:	*2018 International Building Code®, (IBC®)* *2021 International Building Code®, (IBC®)*
Product Type/Status:	Instructor led training / webinar
Level:	Intermediate/Advanced
SKU: 2022SM18	Handout: 1000PM18

Description

The *International Building Code®* (IBC®) continues to establish minimum regulations for building systems using prescriptive and performance-related provisions. It is founded on principles that make use of new materials and new building designs.

This course will identify important changes in the IBC from 2018 to 2021 edition. Participants will be presented with those changes that will most impact their use of the code when they apply the 2021 IBC. The learner will receive an overview of the most important code changes.

Goal

Participants will be able to use this document to identify changes between the 2018 and 2021 IBC, allowing them to apply theses code requirements to design, plan submittals and/or inspection.

The lecture and activity format allows participants to discuss the changes, reasons for the changes, and answer knowledge review questions. Information presented will allow participants to apply these new code requirements to design, plan review, and/or inspection.

Objectives

Upon completion, participants will be better able to:

- Identify the most significant differences between the 2018 IBC and the 2021 IBC.
- Identify whether the code change is an addition, deletion, modification or clarification.
- Identify the purpose and intent of the code changes.
- Identify the application of the new and revised design, plan review and inspection requirements.

Target Audience

Building inspectors, building plan reviewers, building officials, architects, design professionals, fire code plan reviewers.

Prerequisites

Participants should be familiar with previous editions of the IBC.

Instructional Concept

Participants will follow along in the handout as the instructor presents the information. They will be asked some short questions at various opportunities to answer based on what is covered during the seminar. Examples will be given to the participants so that they can fully visualize how the code will be applied and enforced.

Instructor Preparation

Course materials: For this course, the instructor will need the following materials: 2021 IBC Update handout, slide presentation and this course abstract with timed outline.

Source documents or other resources here that will be helpful for instructors to review.

Timed Outline for seminar (3.5 hours, 210 minutes)

1. Overview, Objectives, (10 minutes)
    a. Background Information (5)
    b. Objectives (5)

2. Definitions Chapter 2 (15 minutes)
    a. Chapter 2 Definitions (5)

3. Building Planning Chapters 3 -6 (35 minutes)
    a. Chapter 3: 306.2,307.1.1, 311.2, 311.3 (5)
    b. Chapter 4: 404.5, 411.5, 414.2.3, 424 (5)
    c. Chapter 5: T504.3, T504.4, T506.2, 506.3.2, 508.4.4.1, 509.4.1.1, 510.2 (10)
    d. Chapter 6: T601, 602.4, (10)
    e. Activity (5)

4. Fire Protection Chapters 7 through 9 (35 minutes)
    a. Chapter 7: 703.6, 704.6.1, T705.5, 707.5, 713.12, 716.4, 717.5.2, 722.1, 722.7 (15)
    b. Chapter 9: 903.2.4, 903.2.7, 903.2.9, 903.2.10, 903.3.1.2, 907.2.10, 907.5.2.1.3, 911 (15)
    c. Activity (5)

5. Means of Egress Chapter 10 (20 minutes)
    a. Chapter 10: 1006.2.1, 1008.2.1, 1009.2.1, 1009.6.2, 1010.2.4, 1011.6, 1016.2, 1020.16 (15)
    b. Activity (5)

6. Accessibility Chapter 11
    a. Chapter 11: 1102, 1105.1.1, 1107.2, 1108.5, 1110.2 (10) (15 minutes)

7. Building Envelope, Special Inspections, and Construction Materials (50 minutes)
    a. Chapter 12: 1207.2 (5)
    b. Chapter 14: 1406.10 (5)
    c. Chapter 15: 1509.4 (5)
    d. Chapter 16: T1604.5, 1606.5 (5)
    e. Chapter 17: 1704.6, 1705.5.3, 1705.13.7, 1705.18, 1705.20, 1709.5 (10)

f. Chapter 18: 1809.5.1 (5)
g. Chapter 22: 2209, 2209.3 (5)
h. Chapter 23: 2303.4.1, 2304.11.3, 2304.11.4, 2308.5.6, 2308.6.6.2 (5)
i. Activity (5)

8. Building Services, Special Devices and Special Conditions (20 minutes)
   a. Chapter 29: 2902, 2902.3.3 (5)
   b. Chapter 31: 3103.1, 3115 (5)

9. Summary Q&A Discussion (10 minutes)

2021 IBC® Update

Based on the 2021 International Building Code® (IBC®)

1

Identify changes between the 2018 and 2021 IBC

Apply code requirements to design, plan submittals and/or inspection.

2

OBJECTIVES

- Identify the differences between 2021 IBC and the 2018 edition.
- Determine if the change is an addition, deletion, modification or clarification.
- Identify changes in format and technical requirements.
- Explain the intent and application of the changes.

3

Topics

- Administration, Chapters 1 and 2
- Building Planning, Chapters 3 through 6
- Fire Protection, Chapters 7 through 9
- Means of Egress, Chapter 10
- Accessibility, Chapter 11
- Building Envelope, Structural Systems, and Construction Materials, Chapters 12 through 26
- Building Services, Special Devices, and Special Conditions, Chapters 27 through 34

4

Selection of Topics

- Provisions addressed based primarily on:
  - Frequency of application
  - Special significance
  - Change in application
- Featured code changes have been selected from:
  - 2021 IBC Significant Nonstructural Changes seminar
  - 2021 IBC Significant Structural Changes seminar
- For additional code change commentary, see ICC publication *Significant Changes to the International Building Code, 2021 Edition*

5

Marginal Markings within the International Building Code

- **Solid vertical lines** in the margins within the body of the code indicate a technical change from the requirements of the 2018 edition.
- **Deletion indicators in the form of an arrow** are provided in the margin where an entire section, paragraph, exception or table has been deleted or an item in a list of items or a table has been deleted.
- **A single asterisk** [*] placed in the margin indicates that text or a table has been relocated within the code.
- **A double asterisk** [**] placed in the margin indicates that the text or table immediately following it has been relocated there from elsewhere in the code.

6

Letter Designations in Front of Section Numbers

- In each code development cycle, proposed changes to the code are considered at the Code Development Hearings.
- Proposed changes to a code section that has a number beginning with a letter in brackets are considered by a different code development committee.

[A]	Administrative
[E]	Energy
[EB]	Existing Building
[F]	Fire
[FG]	Fuel Gas
[M]	Mechanical
[P]	Plumbing

7

Course Icons

Addition **Deletion** **Modification** **Clarification**

8

Tips

Guide to a successful class:

- Slides contain some text and iconic images to help you learn.
- Text and commentary is in the handout.
- Follow along in the course handout.
- Ask Questions, ask questions, ASK QUESTIONS!!!!

9

Part 1 Definitions Chapter 2

10

202 Definition of Atrium

- Atrium definition has been simplified to address only two conditions:
  - Vertical space enclosed at the top, and
  - Connects three or more stories in all occupancies other than Groups I-2 and I-3 (two stories).
- Other text has been deleted or relocated to Chapter 7.
- Primary significance is increase of threshold from two to three stories for most occupancies, however no change in application will typically occur.
- Intended result is to eliminate confusion with allowance in Section 712.9 permitting two-story opening conditions without regulation as an atrium.

11

202 Definition of Change of Occupancy

- Change of occupancy now occurs where code requires a greater degree of safety, accessibility, structural strength, fire protection, means of egress, ventilation or sanitation than exists in current building.
- Applies where there is a change in:
  - Occupancy classification, or
  - Purpose or level of activity.
- Previously, a change in occupancy occurred if there was a change in application of the code requirements.
  - Did not limit the areas of code addressed or that it only applied where a higher risk to life safety or occupant welfare occurred.

12

202 Definition of Mass Timber

- Mass timber is considered as structural elements of Type IV construction primarily of solid, built-up, panelized or engineered wood products that meet minimum cross-section dimensions.
- Single term represents both:
  - Heavy-timber designated as Type IV-HT which includes various types of members where fire-resistance is based on minimum dimensions.
  - Mass timber used in new Types IV-A, IV-B and IV-C that must have a fire-resistance rating.

13

202 Definition of Mass Timber

- New definition of *noncombustible protection* addresses the passive fire protection required for mass timber.
- Depending on the building's type of construction, mass timber may have a fire-resistance rating obtained:
  - By its own fire-resistive rating, or
  - Through a combination of the inherent mass timber fire-resistance plus protection with noncombustible insulating materials, or
  - Entirely by the noncombustible protection
- The use of noncombustible protection recognizes its value in delaying the combustion of mass timber members.

14

202 Definition of Puzzle Room

- Puzzle room is a new defined term that is mostly commonly recognized as an "escape room."
- In a puzzle room, occupants are encouraged to solve a challenge to escape from a room or, more commonly, a series of rooms.
- Of particularly importance is the recognition by the definition that a puzzle room is considered as a "special amusement area" (formerly special amusement building).
  - Special amusement areas continue to be specifically regulated under provisions of Section 411.

15

Part 2
Building Planning
Chapters 3 through 6

16

306.2 Group F-1 Occupancy Classification

- Two new items added to listing of Group F-1 occupancies.
- Energy storage systems (ESS) in dedicated-use buildings.
  - Administrative/support areas without ESS permitted where ≤ 10% of floor area of the story where located
  - In mixed-occupancy buildings, ESS to be classified the same as major occupancy
  - Previously would often be classified as Group H-2, however new IFC provisions address potential hazards to allow for a reduction in occupancy classification.
- Water/sewer treatment plants
  - Typically contain materials in use that would warrant a Group H classification should MAQs be exceeded.

17

307.1.1 Uses Not Classified as Group H

- Two new items have been added to the list of uses that store, use and/or handle hazardous materials but are not to be classified as Group H.
  - Distilling or brewing of alcohol beverages
  - Storage of beer, distilled spirits and wines in barrels and casks
- Removal of Group H status applicable regardless of alcohol content and quantity of liquid.
- IFC has added additional requirements to address hazards, including automatic sprinkler systems in Group F-1 and S-1 fire areas where such liquids are located.

18

311.2, 311.3 Alcoholic Beverage Storage

- Storage of alcoholic beverages with over 16% alcohol content now classified as Group S-1 occupancy.
  - Previously not specifically addressed.
- Where alcohol content does not exceed 16%, classification continues to be Group S-2.
  - Limit that containers be only metal, glass or ceramic has been deleted to allow for wooden barrels and casks.
  - IFC safeguards no longer warrant restriction to only noncombustible containers.

19

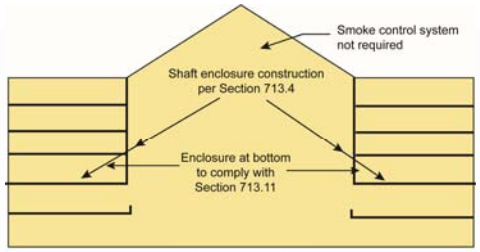
404.5 Smoke Control in Atriums

- New allowance permits a combination vertical opening condition consisting of both an atrium and a shaft enclosure without the requirement for a smoke control system.
- Smoke control system not required for atriums connecting more than two stories where:
  - Only the two lowest stories permitted to be open to the atrium, and
  - All stories above the lowest two stories to be separated from the atrium in accordance with shaft enclosure provisions.

20

404.5 Smoke Control in Atriums

- Recognizes that the combination of shaft enclosure and atrium condition provides the necessary degree of separation expected between multiple stories.



ATRIUM CONDITION

21

411.5 Puzzle Rooms

- Puzzle rooms now regulated as special amusement areas, requiring compliance with all fire- and life-safety provisions of Section 411.
- In addition, special exiting requirements have been added to solely address puzzle rooms:
  - Per Chapter 10, or
  - Alternate design approved by building official, or
  - Exit to be open and readily available upon activation by fire alarm system, sprinkler system, or manual control at constantly attended location.

22

411.5 Puzzle Rooms

- Puzzle rooms, as well as all other special amusement areas, must meet the following previously-established criteria:
  - Classified as Group A or B occupancy, based upon occupant load.
  - Fire protection systems required, including:
    - Automatic sprinkler system (with exception)
    - Automatic smoke detection system
    - Emergency voice/alarm communication system
  - Special exit marking, including approved directional marking.
  - Class A interior finishes.

23

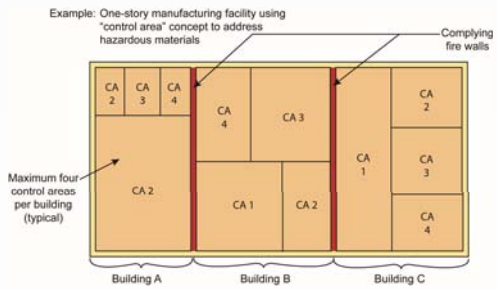
414.2.3 Fire Wall Use for Control Areas

- For purposes of determining the number of control areas in a building, each portion separated by one or more fire walls shall be considered a separate building.
  - Previously, the “separate building” allowance has been limited to allowable area, allowable height and type of construction

24

414.2.3 Fire Wall Use for Control Areas

- New allowance permits additional quantities of hazardous materials without classification as a Group H occupancy by increasing the number of control areas permitted in the structure.



25

424 Play Structures

- No longer limited to structures used solely by children, such as climbing walls.
- Additional requirements now applicable for structures more than 600 square feet in area or more than 10 feet in height:
  - Interior finishes per Table 803.13
  - Designed in accordance with Chapter 16
- Special investigation to demonstrate adequate fire safety now required where area of play structure exceeds 600 square feet.
  - Previously required when greater than 300 square feet in area.

26

Table 504.3 Allowable Height in Feet

- Limits to building height (in feet) have been developed for Types IV-A, IV-B and IV-C construction
- Sprinklered and nonsprinklered options
- Establishment of allowable height started with setting IV-B allowances equivalent to Type IB.
- No unlimited heights for Type IV-A, but typically an increase of 1.5 over Type IV-B.
- Type IV-C generally equivalent to IV-HT limits.
- No additional heights over that permitted for Type IV-HT are permitted for nonsprinklered buildings.

27

TABLE 504.3
ALLOWABLE BUILDING HEIGHT IN FEET ABOVE GRADE PLANE[a]

OCCUPANCY CLASSIFICATION	TYPE OF CONSTRUCTION												
	SEE FOOTNOTES	TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A, B, E, F, M, S, U	NS[b]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	270	180	85	85	70	60
H-1, H-2, H-3, H-5	NS[c,d]	UL	160	65	55	65	55	120	90	65	65	50	40
	S												
H-4	NS[c,d]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	140	100	85	85	70	60
I-1 Condition 1, I-3	NS[d,e]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
I-1 Condition 2, I-2	NS[d,e,f]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85									
I-4	NS[d,g]	UL	160	65	55	65	55	65	65	65	65	50	40
	S	UL	180	85	75	85	75	180	120	85	85	70	60
R[h]	NS[d]	UL	160	65	55	65	55	65	65	65	65	50	40
	S13D	60	60	60	60	60	60	60	60	60	60	50	40
	S13R	60	60	60	60	60	60	60	60	60	60	60	60
	S	UL	180	85	75	85	75	270	180	85	85	70	60

No changes to footnotes.

Sprinklered: IV-B = I-B & IV-A = 1.5 x IV-B with exceptions

28

Table 504.4 Allowable Height in Stories

- Limits to number of stories above grade plane have been established for Types IV-A, IV-B and IV-C construction.
- Rationale for story limits similar to that for height in feet.
- Where building is not sprinklered:
  - Limits on stories same as that allowed for Type IV-HT.
- Consistent with allowable height in feet and allowable floor area, each occupancy reviewed individually to address specific hazards that would warrant a variance from the established process.

29

Table 504.4 Allowable Height in Stories

- Story limits have also been modified for specific Group S-1 and S-2 occupancies.
- Height limits for Group S-1 occupancies in fully-sprinklered buildings of Type IIB and IIIB construction have been increased from three to four stories.
  - Restores story limits of 2006 IBC that were part of numerous reductions due to inconsistencies in original thresholds.
- Group S-2 story limitations for buildings of Type IV-HT construction have been increased by one story, to five stories in nonsprinklered buildings and six stories in sprinklered buildings.
  - Corrects two tabular errors that went undetected in transition from Table 503 in 2012 IBC to Table 504.4 in 2015 edition.

30

ALLOWABLE NUMBER OF STORIES ABOVE GRADE PLANE[a, b]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
		A	B	A	B	A	B	A	B	C	HT	A	B
A-1	NS	UL	5	3	2	3	2	3	3	3	3	2	1
	S	UL	6	4	3	4	3	9	6	4	4	3	2
A-2	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-3	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-4	NS	UL	11	3	2	3	2	3	3	3	3	2	1
	S	UL	12	4	3	4	3	18	12	6	4	3	2
A-5	NS	UL	UL	UL	UL	UL	UL	1	1	1	UL	UL	UL
	S	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL	UL
B	NS	UL	11	5	3	5	3	5	5	5	5	3	2
	S	UL	12	6	4	6	4	18	12	9	6	4	3
S-1	NS	UL	11	4	2	3	2	4	4	4	4	3	1
	S	UL	12	5	~~3~~4	4	~~3~~4	10	7	5	5	4	2
S-2	NS	UL	11	5	3	4	3	4	4	4	~~4~~5	4	2
	S	UL	12	6	4	5	4	12	8	5	~~5~~6	5	3

Sprinklered: IV-B = I-B & IV-A = 1.5 x IV-B with exceptions

31

Table 506.2 Allowable Building Area

- Limits to building floor areas have been developed for Types IV-A, IV-B and IV-C.
- No unlimited area permitted for any of Type IV classifications.
- Initially, allowable area factors for Type IV-HT construction were increased by following multipliers:
  - Type IV-C: x 1.25
  - Type IV-B: x 2.00
  - Type IV-A: x 3.00
- Factors then re-examined on a case-by-case basis regarding their relative hazard and occupancy classification.

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Table 506.2 Allowable Building Area

- Allowable area factor also modified for Group I-3 occupancies in one-story buildings of Type IIA construction.
  - Limit of 45,000 square feet has been increased to 60,000 square feet for single-story fully-sprinklered buildings.
  - Corrects tabular error that went undetected in transition from Table 503 in 2012 IBC to Table 504.4 in 2015 edition.

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ALLOWABLE AREA FACTOR (A_t = NS, S1, S13R, S13D OR SM, as applicable) IN SQUARE FEET[a,b]

OCCUPANCY CLASSIFICATION	SEE FOOTNOTES	TYPE OF CONSTRUCTION											
		TYPE I		TYPE II		TYPE III		TYPE IV				TYPE V	
		A	B	A	B	A	B	A 3xHT	B 2xHT	C 1.25xHT	HT	A	B
I-1	NS[f,g]	UL	55,000	19,000	10,000	16,500	10,000	54,000	36,000	18,000	18,000	10,500	4,500
	S1	UL	220,000	76,000	40,000	66,000	40,000	216,000	144,000	72,000	72,000	42,000	18,000
	SM	UL	165,000	57,000	30,000	49,500	30,000	162,000	108,000	54,000	54,000	31,500	13,500
I-2	NS[f,j]	UL	UL	15,000	11,000	12,000	NP	36,000	24,000	12,000	12,000	9,500	NP
	S1	UL	UL	60,000	44,000	48,000	NP	144,000	96,000	48,000	48,000	38,000	NP
	SM	UL	UL	45,000	33,000	36,000	NP	108,000	72,000	36,000	36,000	28,500	NP
I-3	NS[f,e]	UL	UL	15,000	10,000	10,500	7,500	36,000	24,000	12,000	12,000	7,500	5,000
	S1	UL	UL	60,000	40,000	42,000	30,000	144,000	96,000	48,000	48,000	30,000	20,000
	SM	UL	UL	45,000	30,000	31,500	22,500	108,000	72,000	36,000	36,000	22,500	15,000
I-4	NS[f,d]	UL	60,500	26,500	13,000	23,500	13,000	76,500	51,000	25,500	25,500	18,500	9,000
	S1	UL	121,000	106,000	52,000	94,000	52,000	306,000	204,000	102,000	102,000	74,000	36,000
	SM	UL	181,500	79,500	39,000	70,500	39,000	229,500	153,000	76,500	76,500	55,500	27,000
M	NS	UL	UL	21,500	12,500	18,500	12,500	61,500	41,000	25,625	20,500	14,000	9,000
	S1	UL	UL	86,000	50,000	74,000	50,000	246,000	164,000	102,500	82,000	56,000	36,000
	SM	UL	UL	64,500	37,500	55,500	37,500	184,500	123,000	76,875	61,500	42,000	27,000

General approach with exceptions.

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506.3.2 Allowable Area Frontage Increase

- Methodology for determining allowable area increase for open frontage has been simplified through use of a tabular format.
- Table 506.3.3 based on two criteria:
  - Smallest public way or open space that ≥ 20 feet, and
  - Percentage of building perimeter having ≥ 20 feet of public way and/or open space
- Allowance for weighting the open space area increase has been eliminated
  - Interpolation within Table 506.3.3 is permitted

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506.3.2 Allowable Area Frontage Increase

- Resulting frontage increase intended to be consistent with increase determined by previous method
  - In some cases, greater frontage increases are provided as compared to past methodology
- Under certain circumstance, a greater frontage increase may be available to the designer if one or more open spaces not recognized when applying Table 506.3.3 or 506.3.3.1

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TABLE 506.3.3 Frontage Increase Factor[a]

Percentage of Building Perimeter	Open Space: 0 to less than 20 Feet	20 to less than 25 Feet	25 to less than 30 Feet	30 Feet or greater
0 to less than 25	0	0	0	0
25 to less than 50	0	0.17	0.21	0.25
50 to less than 75	0	0.33	0.42	0.50
75 to 100	0	0.50	0.63	0.75

a. Interpolation is permitted.

TABLE 506.3.3.1 Section 507 Buildings[a]

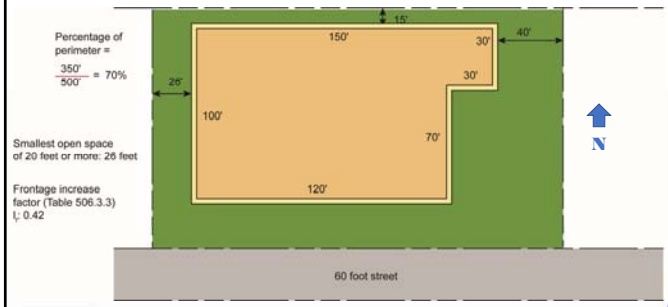
Percentage of Building Perimeter	Open Space: 30 to less than 35 feet	35 to less than 40 feet	40 to less than 45 feet	45 to less than 50 feet	50 to less than 55 feet	55 to less than 60 feet
0 to less than 25	0	0	0	0	0	0
25 to less than 50	0.29	0.33	0.38	0.42	0.46	0.50
50 to less than 75	0.58	0.67	0.75	0.83	0.92	1.00
75 to 100	0.88	1.00	1.13	1.25	1.38	1.50

a. Interpolation is permitted.

37

506.3.2 Allowable Area Frontage Increase

- EXAMPLE:



Note: If west open space is ignored, I_f would be 0.50 based on 50% of perimeter open with smallest open space of ≥ 30 feet

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508.4.4.1, 509.4.1.1 Fire Separations of Mass Timber

- Mass timber elements used as fire barriers and horizontal assemblies for separating occupancies or incidental use areas to be protected with approved thermal barrier of:
  - Minimum ½-inch gypsum board, or
  - Material tested to NFPA 275 (Temperature and Integrity Fire Tests of thermal barriers)
- Applicable only to Type IV-B and IV-C construction
- Thermal barrier only needs to cover exposed wood surfaces and does not add to fire-resistance rating of mass timber.

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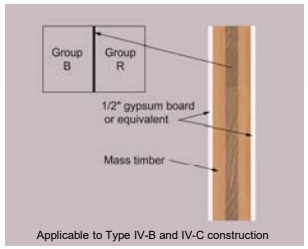
508.4.4.1, 509.4.1.1 Fire Separations of Mass Timber

- Only required on incidental use side of separation, on both sides for occupancy separation.

Example of fire separation as required by Table 508.4 for "separated occupancies"



Applicable to Type IV-B and IV-C construction

40

510.2 Stairway Construction in Podium Buildings

- Stairway construction in Type IA (lower) portion of podium buildings now permitted to be of combustible materials where two conditions exist:
  - Upper building is of Type III, IV or V construction, and
  - Stairway in lower building enclosed by minimum 3-hour fire-resistance-rated construction (shaft enclosure) with protected openings.
- Addresses confusion on how to address stairway construction that connects combustible and noncombustible portions of a podium building.
  - Section 1011.7 indicates stairways to be built of materials permitted based on building's type of construction.

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510.2 Stairway Construction in Podium Buildings

- Stairway is conceptually located totally within upper Type III, IV or V building, thus allowing for combustible stairway construction.
  - Minimum 3-hour fire-resistance-rated separation fully separates "combustible" construction from "noncombustible" construction.

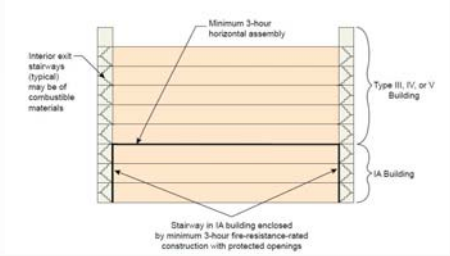

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Table 601 Type IV Fire-Resistance

- Table 601 identifying minimum fire-resistance rating for building elements based on type of construction has been expanded to include new Type IV-A, IV-B and IV-C buildings.
- General comparison with Type IA (IV-A) and Type IB (IV-B and IV-C).
- Also clarifies that heavy timber roof construction, including primary structural frame members, permitted in: Type IB, IIA, IIB, IIIA and VA buildings.
  - Allows for nonrated combustible roof construction
- In Type IV-HT construction, interior bearing walls supporting > 2 floors or > 1 floor and a roof to have minimum 1-hour fire-resistance rating

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TABLE 601 Fire-Resistance Rating Requirements for Building Elements (Hours)

	Type I		Type II		Type III		Type IV				Type V	
Building Element	A	B	A	B	A	B	A	B	C	HT	A	B
Primary structural frame[f]	3[a,b]	2[a,b,c]	1[b,c]	0[c]	1[b,c]	0	3[a]	2[a]	2[a]	HT	1[b,c]	0
Bearing walls												
Exterior[a,f]	3	2	1	0	2	2	3	2	2	2	1	0
Interior	3[a]	2[a]	1	0	1	0	3	2	2	1/HT[g]	1	0
Nonbearing walls and partitions Exterior	See Table ~~602~~ 705.5											
Nonbearing walls and partitions Interior[d]	0	0	0	0	0	0	0	0	0	See Section 2304.11.2	0	0
Floor construction and associated secondary structural members (see Section 202)	2	2	1	0	1	0	2	2	2	HT	1	0
Roof construction and associated secondary structural members (see Section 202)	1½[b]	1[b,c]	1[b,c]	0[c]	1[b,c]	0	1½	1	1	HT	1[b,c]	0

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed for roof construction, including primary structural frame members, where a 1-hour or less fire-resistance rating is required.

g. Heavy timber bearing walls supporting more than two floors or more than a floor and a roof shall have a fire-resistance rating of not less than 1 hour.

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602.4 Mass Timber Type IV Buildings

- Type IV-A, IV-B and IV-C buildings may be constructed of mass timber and noncombustible materials.
- Required fire-resistance ratings may come from mass timber, noncombustible protection, or both.
  - Protective material to be applied directly to the timber members
  - Assigned time determined per Sections 703.2 and 722.7
- For Type IV-HT construction, minimum timber member dimensions of Section 2304.11 continue to be applicable.

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602.4 Mass Timber Type IV Buildings

- In buildings of Type IV-A, IV-B and IV-C construction with an occupied floor > 75 feet above lowest level of fire department vehicle access, mass timber interior exit stairways and elevator enclosures to be additionally protected where:
  - ≤ 12 stories or 180 feet: Interior faces of mass timber to be covered with noncombustible protection
  - > 12 stories or 180 feet: Only noncombustible materials

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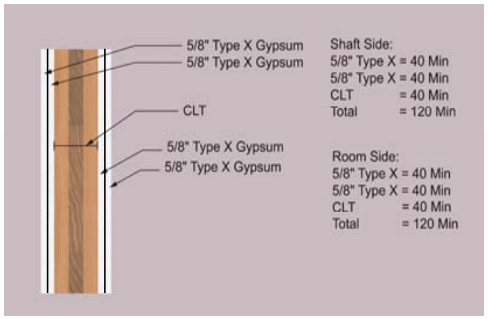
BS8

602.4 Type IV Shaft Walls



Example of interior exit stairways and elevator enclosures in Types IV-A and IV-B

- Limited to a maximum height of 12 stories or 180 ft Where height is exceeded in Type IV-A buildings, all noncombustible materials required

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602.4 Mass Timber Type IV Buildings

- Limited changes to existing heavy timber provisions now designated as Type IV-HT.
- Combustible concealed spaces permitted in all Type IV categories where in conformance with Sections 602.4.1 through 602.4.4.
- Publication "*Mass Timber Buildings and the IBC*" by ICC and AWC addresses Type IV construction in detail.

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Slide 47

BS8 new slide

Buddy Showalter, 3/2/2021

602.4.1- 602.4.3 Type IV-A, IV-B and IV-C Buildings

- Type IV-A construction mandates that faces of all timber members be protected with noncombustible materials.
  - Noncombustible wall and ceiling protection to contribute a time per Table 722.7.1(1), but not less than 80 minutes.
  - Floor assembly to be protected with noncombustible material at least 1 inch thick on top.
- Type IV-B construction mandates similar protection, but only required on an established percentage of members.
  - Some degree of exposed timber permitted
- Type IV-C construction permits all timber members to be unprotected.

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602.4.1 Type IV-A Buildings

- Type IV-A construction mandates:
  - Outside face of exterior walls of mass timber construction to have noncombustible protection with minimum assigned time of 40 minutes.
  - Interior faces of all mass timber elements, including inside faces of exterior mass timber walls and mass timber roofs, to have noncombustible protection with minimum assigned time of 80 minutes.
  - Floor assemblies to contain a noncombustible material at least 1 inch thick above mass timber with underside protected to same criteria as for other interior faces (80 minutes).
  - Interior surfaces of roof assemblies to meet same criteria as for other interior faces (80 minutes).

50

602.4.2 Type IV-B Buildings

- Type IV-B construction requires same degree of noncombustible protection as mandated for Type IV-B buildings.
- Unprotected portions of mass timber ceilings and walls permitted in Type IV-B buildings where:
  - Limited to a wall area equal to 40% of the floor area in any dwelling unit or fire area, or
  - Limited to a ceiling area equal to 20% of the floor area in any dwelling unit or fire area, or
  - A combination of unprotected wall and ceiling areas determined by applying the unity formula.

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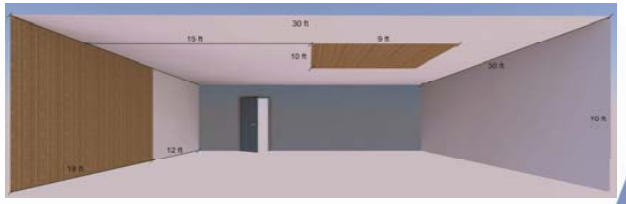
602.4.2 Type IV-B Buildings

- In each dwelling unit or fire area, unprotected portions of mass timber walls and ceilings to be $\geq$ 15 feet from other unprotected portions of other walls and ceilings.



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602.4.3 Type IV-C Buildings

- Type IV-C construction differs significantly from Types IV-A and IV-B as mass timber located on building's interior can be fully exposed, except for:
  - Concealed spaces
  - Shaft enclosures and interior exit stairways
- In addition, Type IV-C differs from Type IV-HT regarding fire-resistance-rated protection of building elements.
  - Minimum 2-hour rating required for bearing walls, floors and primary structural frame elements, however such rated elements need not be covered with noncombustible protection.

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602.4.1- 602.4.3 Type IV-A, IV-B and IV-C Buildings

- Concealed spaces in Type IV-A, IV-B and IV-C buildings shall not contain combustibles other than electrical, mechanical, fire protection and plumbing materials and equipment permitted in plenums per IMC Section 602.
  - Combustible construction forming concealed spaces to be protected with noncombustible materials with minimum assigned time of:
    - 80 minutes in Types IV-A and IV-B
    - 40 minutes in Type IV-C
- In shaft construction, both shaft and room sides of mass timber elements to be protected with noncombustible materials with minimum assigned time of:
  - 80 minutes in Types IV-A and IV-B
  - 40 minutes in Type IV-C

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602.4.4 Type IV-HT Buildings

- Type IV-HT represents the traditional heavy timber construction type where fire-resistance relies almost solely on minimum cross-sectional dimensions.
- All fire-resistance based on dimensions of timber members, prescriptive rather than performance.
- Modifications made where FRT wood is used within exterior wall assemblies:
  - Minimum 6-inch thickness deleted
  - CLT minimum thickness (4") regulated rather than wall thickness (6")

55

602.4.4 Type IV-HT Buildings

- Concealed spaces now permitted provided no combustibles other than building elements and electrical, mechanical, fire protection and plumbing materials permitted in plenums per IMC Section 602, and protected by one of following:
  - Building is sprinklered throughout, including within concealed space, or
  - Concealed space is completely filled with noncombustible insulation, or
  - Surfaces within concealed space to be fully covered with minimum 5/8" Type X gypsum board
- Exception allows concealed spaces within interior walls and partitions having minimum 1-hour rating with no additional protection.

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Part 3
Fire Protection
Chapters 7 through 9

57

703.6, 703.7 Noncombustible Protection for Mass Timber

- The time contributed to the fire-resistance rating for mass timber elements, components and assemblies by the noncombustible protection to be established through a comparison of assemblies tested per ASTM E119 or UL 263.
- Two assemblies to be tested to same criteria of structural failure with the following conditions, with noncombustible protection time contribution assigned based on time difference between the two assemblies:
  - Test Assembly 1:without protection
  - Test Assembly 2:includes representative noncombustible protection

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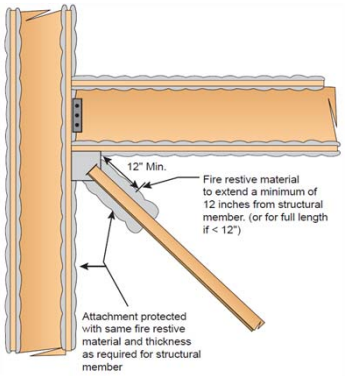
704.6.1 Secondary Attachments and Fireproofing

- Where primary and secondary structural steel members require fire protection, secondary steel attachments to have same protective material and thickness as required for primary member to address heat transfer.
- Protection to extend away from primary member:
  - At least 12 inches, or
  - Applied to entire length where attachment < 12 inches in length.
- Where attachment is hollow and ends are open, fire-resistive material and thickness to be applied to both the interior and exterior of the hollow steel attachment.

59

704.6.1 Secondary Attachments and Fireproofing



60

Table 705.5 Exterior Wall Ratings

- Previous Table 602 addressing "Fire-resistance Rating Requirements for Exterior Walls Based on Fire Separation Distance" has been relocated.
- Relocation is deemed appropriate as Chapter 7 is the primary location for establishing exterior wall requirements related to fire-resistance.
- In addition, entries have been made for new construction types IV-A, IV-B and IV-C.

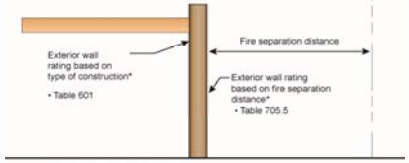


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TABLE ~~602~~ 705.5 Fire-Resistance Rating Requirements for Exterior Walls Based on Fire Separation Distance[a,d,g]

Fire Separation Distance = X (feet)	Type Of Construction	Occupancy Group H[e]	Occupancy Group F-1, M, S-1[f]	Occupancy Group A, B, E, F-2, I, R[i], S-2, U[h]
X < 5[b]	All	3	2	1
5 ≤ X < 10	IA, IV-A Others	3 2	2 1	1 1
10 ≤ X < 30	IA, IB, IV-A, IV-B IIB, VB Others	2 1 1	1 0 1	1[c] 0 1[c]
X ≥ 30	All	0	0	0

For SI: 1 foot = 304.8 mm.

(footnotes not shown)

62

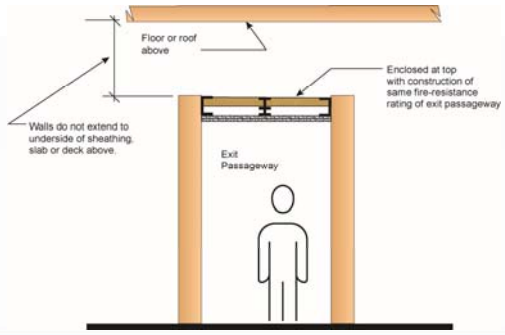
707.5 Enclosure of Exit Passageways

- Allowance now provided for fire barriers creating an exit passageway to terminate at a fire-resistance-rated lid.
  - Enclosure at top to have same fire-resistance rating as required for the exit passageway.
- This new option can be applied where fire barrier does not extend to the underside of the roof sheathing, slab or deck above.
- Permits passage of ducts, piping and conduit from one side of the exit passageway to the other without need for a horizontal shaft enclosure.

63

707.5 Enclosure of Exit Passageways

- Provision is applicable where either a floor or roof occurs above the exit passageway enclosure.



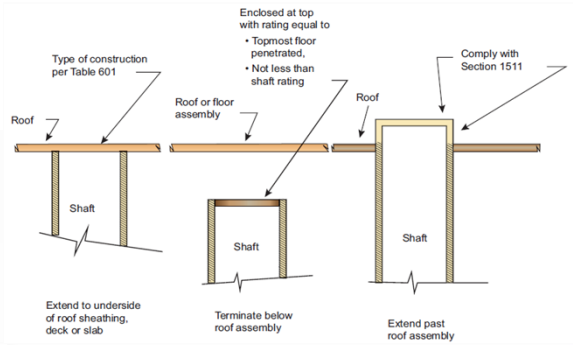
64

713.12 Top of Shaft Enclosure

- Three specific methods for terminating a shaft enclosure at the top have been established to clarify the options that are available:
  - Extend the shaft walls to the underside of the roof sheathing, deck or slab, or
  - Terminate below the roof assembly with a top enclosure having the same fire-resistance rating as the topmost floor penetrated by the shaft but not less that the required rating of the shaft enclosure, or
  - Extend past the roof assembly and comply with the provisions for rooftop structures (penthouses) in Section 1511.

65

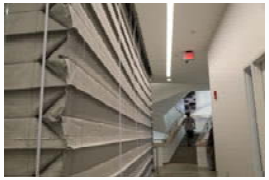
713.12 Top of Shaft Enclosure



66

716.4 Fire-Protective Curtain Assemblies

- New definition in Section 202 defining fire-protective curtain assembly as: *an assembly consisting of a fabric curtain, bottom bar, guides, coil, and an operating and closing system*
- New provisions establish guidance on how such assemblies are to be tested, labeled and installed.



67

716.4 Fire-Protective Curtain Assemblies

- Assemblies to be evaluated using UL 10D, but without hose stream test.
- IBC does not address how or where these systems are to be used or where they would be accepted.
  - It is assumed that the assemblies would typically be installed as a means of smoke and draft control.
- Their use, either vertical or horizontal, will need to be reviewed and approved by the building official under alternate methods provisions of Section 104.11.

68

717.5.2 Flex Connectors

- Under Exception 3, fire dampers may be omitted at penetrations of fire barriers in fully-ducted HVAC systems where specified conditions are met.
- New allowances permit the installation of nonmetal flexible air connectors at two locations:
  - At the duct connection to the air handling unit or equipment located within the mechanical room per IMC Section 603.9.
  - From an overhead metal duct to a ceiling diffuser within the same room per IMC Section 603.6.2.

69

722.1 Fire-Resistance Rating of Exposed Mass Timber Members

- The fire-resistance rating of mass timber members is to be in conformance with Chapter 16 of the *National Design Specification for Wood Construction* (NDS).
- NDS 16.2 addresses fire design up to 2 hours
- Applicable to beams, columns, walls, floors/roofs
- Applicable products include:
  - Sawn lumber
  - Glulam (softwood)
  - LVL
  - PSL
  - LSL
  - CLT

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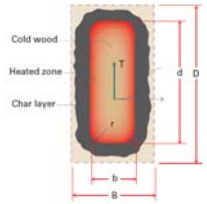
722.1 Fire-Resistance Rating of Exposed Mass Timber Members



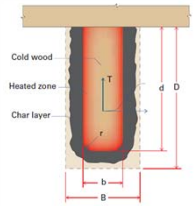


Table 16.2.1A Char Depth and Effective Char Depth (for β_n = 1.5 in./hr.)

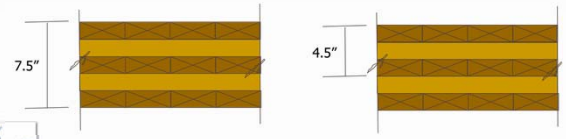
Required Fire Resistance (hr.)	Char Depth, a_{char} (in.)	Effective Char Depth, a_{eff} (in.)
1-Hour	1.5	1.8
1½-Hour	2.1	2.5
2-Hour	2.6	3.2

71

722.1 Fire-Resistance Rating of Exposed Mass Timber Members

Example of determination of effective CLT roof cross-section:

- Assume 5-layers @ 1.5” (total = 7.5”)
- Determine thickness for 1-hr FRR
- a_{char} = 1.8” (NDS Table 16.2.1B)
- d = 7.5” – 1.8” = 5.7”
- Could conservatively assume 3-layer panel for design



72

722.7 Fire-Resistance Rating of Mass Timber Assemblies

- A prescriptive approach has been provided to achieve the required fire-resistance ratings for mass timber members and assemblies.
- The fire-resistant rating to consist of the rating of the unprotected mass timber element added to the protection time of the noncombustible protection.
  - At least 2/3 of the required fire-resistance rating must come from the noncombustible protection.
- Provisions address protection on both exterior and interior surfaces.
- The fire-resistance rating of exposed mass timber members is to be in conformance with Chapter 16 of the *National Design Specification for Wood Construction* (NDS).

73

TABLE 722.7.1(1) Protection Required from Noncombustible Covering Material

Required Fire-Resistance Rating of Building Element per Tables 601 and 705.5 (hours)	Minimum Protection Required from Noncombustible Protection (minutes)
1	40
2	80
3 or more	120

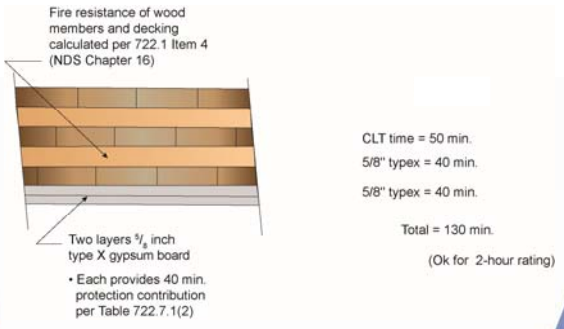
TABLE 722.7.1(2) Protection Provided by Noncombustible Covering MateriaL

Noncombustible Protection	Protection Contribution (minutes)
1/2-inch Type X gypsum board	25
5/8-inch Type X gypsum board	40

74

722.7 Fire-Resistance Rating of Mass Timber Assemblies

- Example:



75

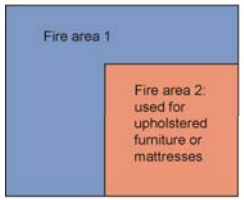
903.2.4, 903.2.7, 903.2.9 Upholstered Furniture and Mattresses

- Sprinkler requirements for Groups F-1, M and S-1 where upholstered furniture or mattresses are manufactured, sold or stored have been revised.
  - Group F-1: Area threshold (2,500 sf) now based on size of fire area where upholstered furniture or mattresses are manufactured
  - Groups M: Area threshold (5,000 sf) now based on size of floor area within fire area used for display and sales of upholstered furniture or mattresses
  - Group S-1: Area threshold (2,500 sf) now based on size of floor area within fire area used for storage of upholstered furniture or mattresses

76

903.2.4, 903.2.7, 903.2.9 Upholstered Furniture and Mattresses

- In addition, where floor area threshold exceeded, sprinkler need only be provided in fire area and not throughout building.



Separation per Table 707.3.10

Sprinkler system required throughout fire area, if:

- F-1: > 2,500 sq. ft. **fire area** for manufacture
- M: > 5,000 sq. ft. **floor area** within fire area for display and sale
- S-1: > 2,500 sq. ft **floor area** within fire area for storage

77

903.2.4, 903.2.7, 903.2.9 Upholstered Furniture and Mattresses

- In addition, new exception indicates that one-story Group S-1 self-storage facilities are exempt from 2,500 square foot sprinkler threshold where all storage spaces can be accessed directly from exterior.
  - General Group S-1 sprinkler threshold of 12,000 square feet continues to be applicable.
- Based on assumption that such facilities contain significant amount of upholstered furniture and/or mattresses.

78

903.2.4.2, 903.2.9.3 Distilled Spirits

- Automatic sprinkler protection now required in all:
  - Group F-1 fire areas used for the manufacture of distilled spirits
  - Group S-1 fire areas used for the bulk storage of distilled spirits or wine.
- Part of a series of changes in IBC and IFC to eliminate confusion in regulation of such buildings.
  - Includes allowance that Group H classification not warranted regardless of quantities of hazardous materials.

79

903.2.10 Sprinklers in Open Parking Garages

- Sprinklers now required in Group S-2 open parking garages where:
  - Any fire area exceeds 48,000 square feet, or
  - In a building having one or more stories with an occupant load ≥ 30 located ≥ 55 feet above lowest level of fire department vehicle access
- Sprinkler protection to extend throughout entire garage
- Concern based on:
  - Increased fuel load due to expanded use of plastics and lightweight materials in vehicles, as well as types of fuels being utilized
  - Recognition of a fire that occurred in a parking garage in Liverpool, England in late 2017

80

903.3.1.2 NFPA 13R Sprinkler Protection

- Scoping for the permitted use of an NFPA 13R sprinkler system in Group R occupancies has been modified such that the following conditions must all be met by the Group R to allow for use of 13R system:
  - Located no more than 4 stories above grade plane, and
  - Floor level of highest story no more than 30 feet above lowest level (or lowest story below highest level) of fire department vehicle access. (previously 60 feet above grade plane)
- In addition, the story limit of four is now to be measured from grade plane in podium buildings (Sec. 510.2 and 510.4) rather than from the horizontal assembly separating the two buildings.

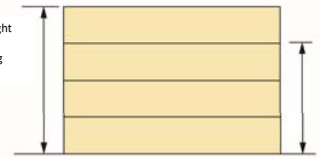
81

903.3.1.2 NFPA 13R Sprinkler Protection

Group R occupancy permitted to use NFPA 13R sprinkler system

2018

- ≤ 4 stories in height
- ≤ 60-foot building height



2021

- 4 stories above grade plane
- Highest story ≤ 30 feet above lowest level of fire dept. vehicle access
- Limit on stories also measured from grade plane when constructed using Sec. 510.2 or 510.4 (podium provisions

82

907.2.10 Manual Fire Alarms in Group S Buildings

- Manual fire alarm system now required in Group S public- and self-storage occupancies where both of following conditions occur:
  - Three stories or greater in height, and
  - Interior corridors and/or interior common areas
- Visible notification appliances not required within storage units.
- Manual fire alarms boxes not required where building is fully sprinklered and occupant notification appliances activate throughout notification zones upon sprinkler water flow.

83

907.5.2.1.3 Fire Alarm Occupant Notification

- In sleeping rooms of Group R-1 and R-2 occupancies, the audible fire alarm activated by the fire alarm system to now be a 520-Hz low-frequency signal.
  - Where smoke alarm unable to produce a 520-Hz signal, the signal to be provided by a listed notification appliance or smoke detector with an integral 520-HZ sounder.
- Low-frequency signal for smoke alarms only required if Group R-1 or R-2 occupancy is required to have a fire alarm system.

84

907.5.2.1.3 Fire Alarm Occupant Notification

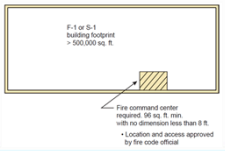
- Low frequency signals have been shown to improve the waking effectiveness for several high-risk groups, including:
  - Individuals who are over 65 who are hard of hearing
  - School-age children
  - People who are alcohol impaired
- As there are currently very few smoke alarms capable of providing the low-frequency signal, particularly in back-up mode, other methods include:
  - Fire alarm system horns and horn/strobes
  - Smoke detectors w/integral sounder bases
  - Speakers connected to an EVAC system

85

Fix S01

911 Fire Command Centers in Groups F-1 and S-1

- Fire command center now required in Group F-1 and S-1 occupancies with building footprint > 500,000 square feet.
  - Fire command centers continue to be required for high-rise buildings.
- Fire command center to be ≥ 96 square feet with a minimum dimension of 8 feet where approved by the fire code official.
  - Reduction from general requirement of ≥ 200 square feet and ≥ 10 feet minimum dimension.



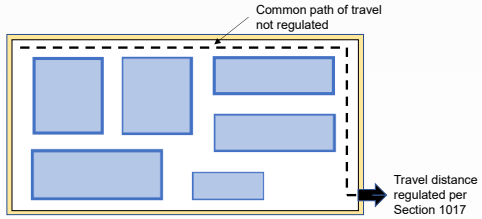
86

Part 4
Means of Egress
Chapter 10

87

1006.2.1 Egress from Mechanical Rooms and Penthouses

- Common path of travel distance limitations are no longer applicable to unoccupied mechanical rooms and penthouses.
- These limited use spaces continue to be regulated based on:
  - Occupant load (Table 1006.2.1)
  - Exit access travel distance (Table 1017.2)



88

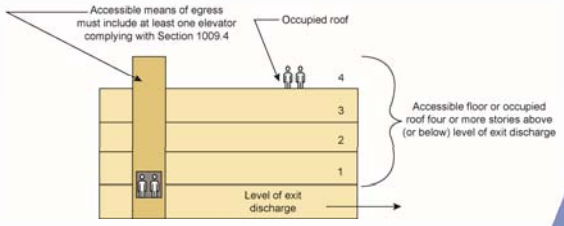
1008.2.1 Stairway Illumination

- Exit stairways, exit access stairways and their associated landings must now have an illumination level under normal power of at least 10 footcandles.
  - Measured at the walking surface
  - Not applicable to stairs in exit discharge
  - Required only when stairway is in use, allowing for occupant-sensor or daylight-responsive controls
  - Exceptions for auditoriums, theaters and similar assembly occupancies still applicable
- Considered as an easily accomplished means for improving stairway safety

89

1009.2.1 Accessible Elevators to Occupied Roofs

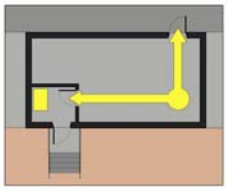
- An elevator serving a required accessible occupied roof must now be considered as one of the required accessible means of egress where the roof is located directly above the 3rd story above the level of exit discharge.



90

1009.6.2 Areas of Refuge

- An interior area of refuge no longer needs to have direct access to a complying stairway or elevator where the area of refuge:
  - Is located at the level of exit discharge, and
  - Provides direct access an exterior exit door.
- Allows for an alternative to an exterior area for assisted rescue which is typically utilized where the exit discharge is not accessible.



91

1010.2.4 Locks and Latches

- In Group I-1, Condition 2 and Group I-2 occupancies where clinical needs of care recipients require containment, or where such persons pose a security threat, locks and latches are permitted to prevent door operation where:
  - All clinical staff can readily unlock doors at all times, and
  - All such locks are keyed to keys carried by clinical staff at all times, or clinical staff have codes or other means necessary to operate the locks at all times.
- Consistent with federal healthcare regulations
- Locking devices now also permitted on doors to balconies, decks and other exterior spaces serving:
  - Private office spaces where exterior space $\geq$ 250 sf
  - Individual dwelling or sleeping units

92

1010.2.4 Locks and Latches

- Where occupants must egress from an exterior space through the building, exit access doors permitted to equipped with an approved locking device.
  - Applicable to enclosed courtyards, occupied roofs, decks and other exterior areas
  - Not applicable to egress courts
- Six conditions must be met in order for the locking devices to be permitted:

93

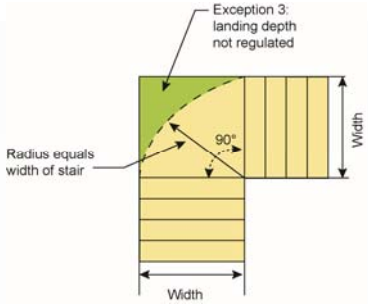
1010.2.4 Locks and Latches

- Conditions include:
  - Maximum occupant load posted per Section 1004.9 inside building adjacent to all exit access doorways
  - Weatherproof telephone or two-way communication system installed on exterior side adjacent to at least one required exit access door
  - Locking device to be key-operated and readily distinguishable as locked
  - Minimum 5 square-foot clear window or glazed door opening provided at each exit access door
  - Signage posted on interior side at each locked door stating "THIS DOOR TO REMAIN UNLOCKED WHEN THE OUTDOOR AREA IS OCCUPIED"
  - Occupant load of exterior area limited to 300

94

1011.6 Stairway Landings

- Where landing turns 90° or more, minimum landing depth not regulated where landing provided is not less than that described by an arc with a radius equal to width of the flight served.



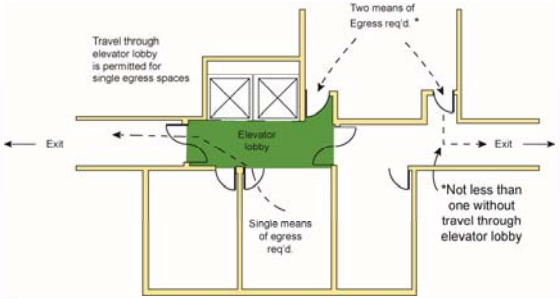
95

1016.2 Egress Through Intervening Spaces

- Egress through an enclosed elevator lobby now permitted for spaces having a single means of egress.
- Previous language mandated that access to not less than one of required exits to be provided without travel through an enclosed elevator lobby.
  - Such requirement still applicable to spaces where two or more means of egress are required
- Applicable for both nonrated and rated corridors

96

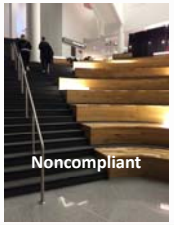
1016.2 Egress Through Intervening Spaces



97

1030.16 Handrails at Social Stairs

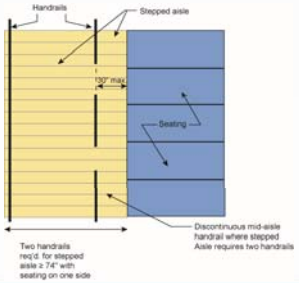
- Guidance has been provided to address handrails on those stairs, primarily in assembly and educational occupancies, that are a combination of stairway travel and assembly seating.
- Based on the assembly stepped aisle provisions, the condition is viewed as an assembly seating area with the seating platforms (without seats) located to the side of the stepped aisle.



98

1030.16 Handrails at Social Stairs

- Where the stepped aisle has seating on one side and the aisle width is at least 74 inches, two handrails are required (with at least one within 30 inches of the stepped aisle).
  - Where the stepped aisle is required to have two handrails, mid-aisle handrails to be discontinuous.



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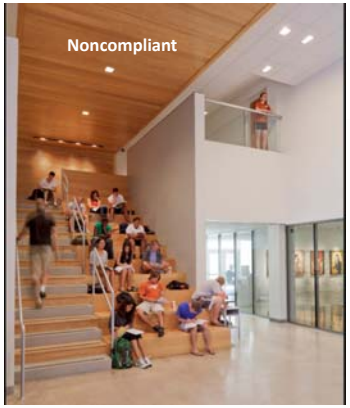
1030.16 Handrails at Social Stairs – Example



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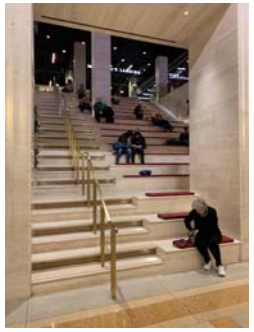
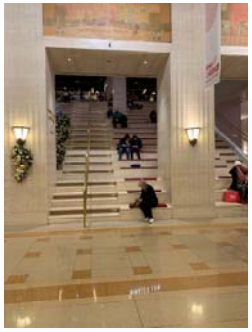
1030.16 Handrails at Social Stairs – Example

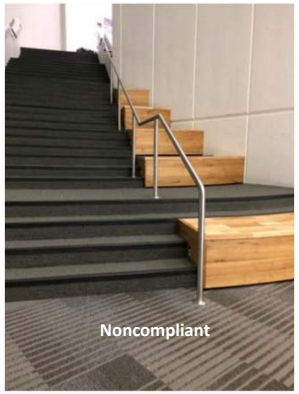




Possibly compliant

101

1030.16 Handrails at Social Stairs – Example



102

1030.16 Handrails at Social Stairs – Example

103

Part 5 Accessibility Chapter 11

104

1102 Accessible Design Compliance

- The ICC A117.1 standard as referenced by the IBC for the design and construction of accessible buildings and facilities has been updated from the 2009 edition to the 2017 edition.
- Many of the major revisions are addressed in the ICC publication *Significant Changes to the ICC A117.1 Accessibility Standard*, 2017 Edition, including:
  - Enhanced dimensions for clear floor spaces and turning spaces.
  - Modifications to exterior routes, curb cuts, blended transitions, detectable warnings, passenger drop-offs and parking facilities.

105

1105.1.1 Automatic Doors at Public Entrances

- In specified occupancies with sizable occupant loads, the accessible public entrances must now be provided with an automatic door.
  - Where an automatic door is required by Table 1105.1.1, it shall be either a full power-operated door or a low-energy power-operated door.

TABLE 1105.1.1 Public Entrance with Power-Operated Door[a]

Occupancy	Building Occupant Load Greater Than
A-1, A-2, A-3, A-4	300
B, M, R-1	500

a. In mixed-use facilities where the total sum of the building occupant load is greater than those listed, the most restrictive building occupant load shall apply.

106

1105.1.1 Automatic Doors at Public Entrances

- In mixed-occupancy buildings where total building occupant load exceeds that listed, the most restrictive building occupant load shall apply, for example:
  - Where Group B has OL of 300 and Group A-3 has OL of 100, total OL of 400, automatic door required based on Group A-3 tabular threshold.
  - Where Group B has OL of 450 and Group E has OL of 60, total OL of 510, automatic door required based on Group B tabular threshold.
- Where the public entrance includes a vestibule, at least one door into and one door out of the vestibule must comply with the requirements.

107

1107.2 Vehicle Charging Stations

- New scoping provisions now require electrical vehicle charging stations to meet limited accessibility criteria.
  - Charging stations provided to serve Group R-2, R-3 and R-4 occupancies are not required to comply.
- To be viewed as a "service" rather than a parking space
- Neither the IBC nor ICC A117.1 mandate the installation of such stations, but if they are provided they must comply with limited accessibility requirements:
  - Minimum of 5% of vehicle spaces on site, but not less than one of each type of system, shall be accessible.
  - Where charging stations are located at multiple locations on sites, accessible charging stations are not necessarily required at each location.

108

1107.2 Vehicle Charging Stations

- Accessible vehicle spaces to comply as for a van accessible parking space, with:
  - 132 inches minimum width, and
  - Minimum 60-inch-wide access aisle.
- In addition, applicable provisions of ICC A117.1 Section 502 must be met, including:
  - Access aisle
  - Floor surface
  - Vertical clearance
- A117.1 Section 502.11 specific to vehicle charging stations addresses:
  - Operable parts
  - Accessible route
  - Obstructions

109

1108.5, 1110.2 Assisted Toileting and Bathing

- Changes have been made to the provisions for nursing homes and assisted living facilities to allow some units to have toilet and bathing facilities designed for assisted use.
  - These allowances are permitted instead of the independent use facilities generally intended by the ICC A117.1 Accessible unit provisions.
- Both scoping and technical provisions are provided in IBC.
- The assisted use provisions are optional and can be applied when desired by the designer.
  - Units may be modified for toileting, bathing or both

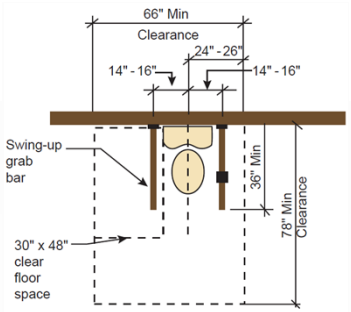
110

1108.5, 1110.2 Assisted Toileting and Bathing

- Assisted water closets and roll-in-type showers may replace like fixtures in up to **50**% of Accessible units in the following occupancies:
  - Group I-1, Conditions 1 and 2
  - Group I-2 rehabilitation facilities
- Assisted water closets and roll-in-type showers may replace like fixtures in up to **90%** of Accessible units in the following occupancies:
  - Group I-2 nursing homes

111

1108.5, 1110.2 Assisted Toileting



- Primary technical changes include:
  - Increased clearance around water closet of 66" with clearance of 24" to 26" from centerline of fixture
  - Increased clearance depth of 78" to allow for additional approach options
  - Allowance for swing-up grab bars that are typically only permitted in Type B units
  - Toilet paper dispenser to be installed on at least one of the swing-up grab bars

112

1108.5, 1110.2 Assisted Bathing

- Primary technical change is elimination of required folding seat
- Allows for use of rolling chair when necessary
- Sidewall and backwall grab bars now differ, with side-wall bar required on 'seat wall' and both grab bars starting in corners

113

Part 6
Building Envelope, Special Inspections and Tests, and Construction Materials Chapters 12-15, 17 and 25

114

1207 Enhanced Classroom Acoustics

- In Group E occupancies, enhanced classroom acoustics shall be provided in all classrooms having a volume of 20,000 cubic feet or less.
- Intended to apply to standard-sized self-contained classrooms, but not larger spaces for activities such as band or choir.
  - Also not intended to apply to ancillary spaces, such as individual tutoring rooms, corridors, or a cafeteria.
- Good acoustics are essential to support language acquisitions and learning for all children.
- Assistive technologies typically only amplify the teacher and do not amplify discussions between students or between teacher and individual student.

115

1207 Enhanced Classroom Acoustics

- Such acoustics to be in compliance with Section 808 of ICC A117.1, including regulation of:
  - Reverberation times based on either the performance method or prescriptive method
  - Ambient sound levels from sources both inside and outside of the classroom
- In addressing reverberation times, both performance and prescriptive methods are available.
- Ambient sound levels not to exceed 35 dBA and 55 dBC

116

1406.10 Metal Composite Material (MCM) Cladding

- Metal composite materials (MCM) and systems installed on buildings of Type I, II, III and IV construction are now regulated based upon one of two conditions:
  - Such installations that are over 40 feet above grade plane must comply with:
    - Surface-burning characteristics
      - Flame spread index ≤ 25
      - Smoke developed index ≤ 450
    - Thermal barrier separation
      - Minimum ½" gypsum board or test per NFPA 275
    - Acceptance criteria of NFPA 285
      - Addresses exterior nonload-bearing wall assemblies containing combustible components
  - Such installations that do not exceed 40 feet above grade plane need only comply with surface-burning characteristics and thermal barrier separation.

117

1406.10 Metal Composite Material (MCM) Cladding

- Previously, all MCM cladding on buildings of other than Type V to meet all three conditions, or meet alternative conditions of Section 1406.11
- Allowance for use of alternative conditions has been deleted, thus removing issues addressing:
  - Fire separation distance
  - MCM surface area limitation and separation
  - Sprinkler protection throughout building
- Modification addresses any confusion in the various requirements, as well as eliminating allowances previously provided where building is sprinklered.

118

1504.9 Aggregate-surfaced Roof

- Minimum parapet heights have been established for aggregate-surfaced roofs to prevent blow-off.
- New Table 1504.9 now mandates minimum heights based on:
  - Aggregate size
  - Mean roof height
  - Wind exposure
  - Basic design wind speed
- Provides engineering and scientific basis for roof design to prevent blow-off based on wind tunnel tests and subsequent field studies of hurricane damage.

119

1504.9 Aggregate-surfaced Roof

- Past provisions were not based on a quantitative analysis of observed roofing system performances on real wind events, but rather variations in surface pressure with building height
- Table 1504.8 previously either permitted or prohibited aggregate used as surfacing for roof coverings or ballast solely based on:
  - Maximum mean roof height
  - Design wind load
  - Exposure category
- Conditions where no parapets are provided are no longer allowed

120

TABLE 1504.9 Minimum Required Parapet Height (inches) for Aggregate Surfaced Roofs[a,b,c]

Aggregate Size	Mean Roof Height (ft)	Wind Exposure and Basic Design Wind Speed (mph)																	
		Exposure B									Exposure C[d]								
		≤95	100	105	110	115	120	130	140	150	≤95	100	105	110	115	120	130	140	150
ASTM D1863 [No.7 or No.67]	15	2	2	2	2	12	12	16	20	24	2	13	15	18	20	23	27	32	37
	20	2	2	2	2	12	14	18	22	26	12	15	17	19	22	24	29	34	39
	30	2	2	2	13	15	17	21	25	30	14	17	19	22	24	27	32	37	42
	50	12	12	14	16	18	21	25	30	35	17	19	22	25	28	30	36	41	47
	100	14	16	19	21	24	27	32	37	42	21	24	26	29	32	35	41	47	53
	150	17	19	22	25	27	30	36	41	46	23	26	29	32	35	38	44	50	56
ASTM D1863 [No.6]	15	2	2	2	2	12	12	12	15	18	2	2	2	13	15	17	22	26	30
	20	2	2	2	2	12	12	13	17	21	2	2	12	15	17	19	23	28	32
	30	2	2	2	2	12	12	16	20	24	2	12	14	17	19	21	26	31	35
	50	12	12	12	12	14	16	20	24	28	12	15	17	19	22	24	29	34	39
	100	12	12	14	16	19	21	26	30	35	16	18	21	24	26	29	34	39	45
	150	12	14	17	19	22	24	29	34	39	18	21	23	26	29	32	37	43	48

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 mile per hour = 0.447 m/s.

a. Interpolation shall be permitted for mean roof height and parapet height.

b. Basic design wind speed, V, and wind exposure shall be determined in accordance with Section 1609.

c. Where the minimum required parapet height is indicated to be 2 inches (51 mm), a gravel stop shall be permitted and shall extend not less than 2 inches (51 mm) from the roof surface and not less than the height of the aggregate.

d. For Exposure D, add 8 inches (203 mm) to the parapet height required for Exposure C and the parapet height shall not be less than 12 inches (305 mm).

121

Table 1604.5 Public Assembly Spaces in Risk Category III

- Risk Category III has been assigned to those buildings whose primary occupancy is not public assembly, but have one or more public assembly spaces with an occupant load exceeding 300 and a cumulative occupant load of such assembly spaces that exceeds 2,500.
  - Eliminates inconsistency in risks associated with large assembly spaces.
- Risk Category III also now applies to Group I-4 occupancies where occupant load > 250, or where combined occupant load of Groups I-4 and E > 250.

122

Table 1604.5 Public Assembly Spaces in Risk Category III

TABLE 1604.5 Risk Category of Buildings and Other Structures

Risk Category	Nature of Occupancy
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: • Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. • Buildings and other structures containing one or more public assembly spaces, each having an occupant load greater than 300 and a cumulative occupant load of the public assembly spaces of greater than 2,500. • Buildings and other structures containing Group E or Group I-4 occupancies or combination thereof, with an occupant load greater than 250. *(Other Risk Category III criteria remain unchanged)*

123

Table 1604.5 Public Assembly Spaces in Risk Category III

- Risk Category III previously only applied to public assembly condition where the assembly activity is the primary occupancy and the occupant load > 300, such as a theater.
- Example of new RC III designation:
  - 5-story hotel with conference center where hotel is building's primary occupancy
  - 2 ballrooms with 1,200 occupants each
  - 3 meeting rooms with 90 occupants each
  - Total assembly occupant load: 2,670
  - At least one assembly room with > 300 occupants, and total assembly occupant load > 2,500, thus Risk Category III

124

1606.5 Vegetative/Landscaped Roof Dead Loads

- The weight of all landscaping and hardscaping materials on roof to be considered as dead load.
- In determination of most severe load effects on structure, computed weight to consider both:
  - Fully saturated soil and drainage layer materials
  - Fully dry soil and drainage layer materials.

125

1704.6 Structural Observations

- Two new classes of structures are now required to be provided with structural observation:
  - Structures classified as Risk Category III (previously limited only to RC IV structures), and
  - Structures in SDC E that are more than two stories above grade plane (no previous requirement based upon SDC)
- Recognizes substantial hazards that may be present in facilities considered as RC III structures, as well as those structural hazards involving multi-story structures in SDC E.

126

1705.5.3 Mass Timber Special Inspection – Construction

- Applicable only to Type IV-A, IV-B and IV-C construction, special inspection requirements have been added to address the anchorage and connection of mass timber structural elements.
- Inspections are similar to requirements for other prefabricated systems, such as precast concrete and structural steel.
- Additional special inspections may be required by the building official for any work unusual in its nature.

127

TABLE 1705.5.3 Required Special Inspections of Mass Timber Construction

Type	Continuous Special Inspection	Periodic Special Inspection
1. Inspection of anchorage and connections of mass timber construction to timber deep foundation systems.		X
2. Inspect erection of mass timber construction.		X
3. Inspection of connections where installation methods are required to meet design loads.		
Threaded fasteners.		
Verify use of proper installation equipment.		X
Verify use of pre-drilled holes where required.		X
Inspect screws, including diameter, length, head type, spacing, installation angle, and depth.		X
Adhesive anchors installed in horizontal or upwardly inclined orientation to resist sustained tension loads.	X	
Adhesive anchors not defined in the preceding cell.		X
Bolted connections.		X
Concealed connections.		X

128

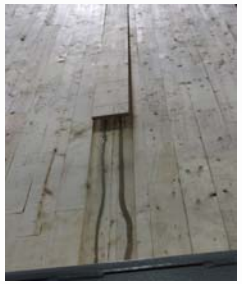
1705.20 Mass Timber Special Inspection -- Sealants

- Special inspection is also required where sealants and/or adhesives are provided in mass timber construction to resist the passage of air at abutting edges and intersections of mass timber elements required to be fire-resistant.
  - Not required where tested proprietary process to ensure there are no voids at intersections is used
- Only abutting edges and intersections in the plane and between different planes to be sealed.
- Special inspection not applicable to joints designed to accommodate building tolerances or to allow independent movement.
  - Regulated by Section 715
  - Special inspection addressed in Section 1705.18

129

1705.20 Mass Timber Special Inspection -- Sealants

- Applicable to Types IV-A, IV-B and IV-C construction
- Sealants regulated by ASTM C920
- Adhesives regulated by ASTM D3498



130

1705.13.7 Special Inspection of Steel Storage Racks

- Steel storage rack special inspection duties have been clarified with the addition of specific special inspection tasks.
  - Requirement continues to be applicable only to racks that are at least 8 feet in height and assigned to SDC D, E or F.

TABLE 1705.13.7 Required Inspections of Storage Rack Systems

Type	Periodic Inspection	Referenced Standard	IBC Reference
1. Materials used, to verify compliance with one or more of the material test reports in accordance with the approved construction documents.	X		
2. Fabricated storage rack elements.	X		1704.2.5
3. Storage rack anchorage installation.	X	ANSI/MH16.1 Section 7.3.2	
4. Completed storage rack system, to indicate compliance with the approved construction documents.	X		

131

1705.18 Firestop Inspection in Group R

- In Group R fire areas with an occupant load > 250, special inspection is now required for the installation of:
  - Firestops
  - Fire-resistant joint systems
  - Perimeter fire containment systems
- Provides greater assurance that such fire protective features are properly installed where large residential occupant loads are anticipated.

132

1709.5 Window and Door Assemblies

- Testing standards and analysis procedures are clarified for door and window assemblies, including garage doors.
- Garage doors now required to have a permanent label indicating:
  - Manufacturer
  - Model/serial number
  - Performance characteristics, including design wind pressure rating
- Provisions applicable regardless of whether building is in a hurricane-prone region.
- Provides for additional information regarding building's resilience.

133

1809.5.1 Frost Protection at Required Exits

- Frost protection to be provided at exterior landings of all required exits utilizing outward swinging doors.
  - Extent of protection need only extend enough to ensure the unobstructed opening of the required exit doors.
- Foundations to be protected by:
  - Extending foundation below frost line, or
  - Frost-protected shallow foundations, or
  - Erecting foundation on solid rock
- Protection helps prevent concrete landings from heaving and interfering with swing of exit door.

134

2209 Storage Racks

- Definition of "cantilevered steel storage rack" added to Section 202, acknowledges that such racks have different load and design requirements as a standard steel storage rack.
- In addition, a certificate of compliance is required under specified circumstances.

135

202 Definition of Storage Racks – Steel Cantilevered

- A framework or assemblage composed of cold-formed or hot-rolled steel structural members, primarily in the form of vertical columns, extended bases, horizontal arms projecting from the faces of the columns, and longitudinal bracing between columns.
  - There may be shelf beams between the arms, depending on the products being stored; this definition does not include other types of racks such as pallet storage racks, drive-in racks, drive-through racks, or racks made of materials other than steel.

136

2209.3 Storage Rack Certification

- Steel rack storage structures, including cantilevered storage racks, required to have a certificate of compliance where both:
  - ≥ 8 feet to top load level, and
  - Assigned to Design Category D, E, or F.
- After rack installation, the certificate of compliance is:
  - To be submitted to the owner or owner's authorized agent, and
  - Indicate that work was performed per approved construction documents.

137

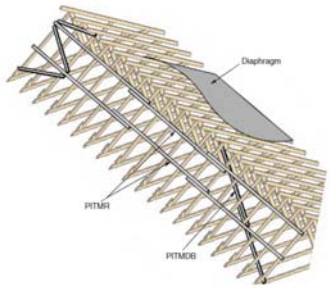
2303.4.1 Wood Truss Bracing

- Requirements have been added for permanent diagonal bracing and restraint purposes.
- In addition, new definitions are provided in Section 202 for:
  - Permanent Individual Truss Member Restraint (PITMR)
  - Permanent Individual Truss Member Diagonal Bracing (PITMDB)

138

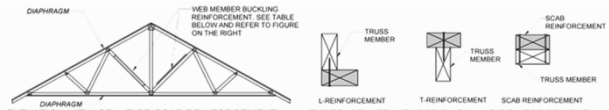
Truss Web Member Bracing

- Permanent Individual Truss Member Restraint (PITMR)
- Permanent Individual Truss Member Diagonal Bracing (PITMDB)



139

Alternative Bracing Installation



ELEVATION VIEW OF L, T OR SCAB REINFORCEMENT

TYPES OF WEB MEMBER BUCKLING REINFORCEMENT

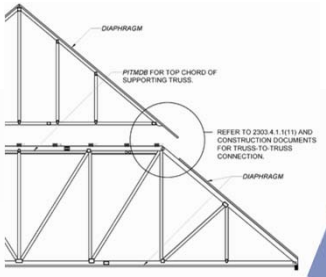
NUMBER OF ROWS OF PITMR SPECIFIED ON WEB MEMBER	SIZE OF TRUSS WEB	TYPE AND SIZE OF WEB REINFORCEMENT[a] FOR T, L OR SCAB[b]	GRADE OF WEB REINFORCEMENT	MINIMUM LENGTH OF WEB REINFORCEMENT	MINIMUM CONNECTION OF WEB REINFORCEMENT TO WEB
ONE	2x4	2x4	Same species and grade or better than web member	90% of web or extend to within 6" of end of web member, whichever is greater	(0.131" x 3") nails at 6" on-center[b]
	2x6	2x6			
	2x8	2x8			

[a]Maximum allowable web length is 14'
[b]Attach Scab reinforcement to web with two rows of minimum 0.131" x 3" nails at 6" on-center

140

Bracing Assumptions

- Compression web lateral force ~ 1-2% axial force
- 4-0.131”x3” nails = 375 lbs with SPF framing
- Top and bottom chords braced by diaphragms
- Design required if no diaphragms present



141

2304.11.3, 2304.11.4 Concealed Spaces in Type IV-HT

- Concealed spaces are now permitted in floors and roofs of Type IV-HT construction.
  - Details of limitations and protection methods set forth in Section 602.4.4.3

142

2308.5.6, 2308.6.6.2 Cripple Walls

- For buildings in Seismic Design Categories A, B and C, cripple walls that are part of an interior wall line no longer require bracing by blocking or sheathing.
- Cripple wall bracing in Seismic Design Categories D and E now limited to 14 inches in height, and must be blocked on both interior and exterior walls.

143

Part 7
Building Services, Special Devices and Special Conditions
Chapters 29 through 31, 33

144

2902 Minimum Plumbing Facilities

- When performing required number of fixtures calculations, new exceptions address both multiple-user and single-user facilities.
- In multiple-user facilities designed to serve all genders, minimum fixture count to be calculated at 100% based on total occupant load.
  - Each fixture type to meet ICC A117.1
  - Each urinal to be in a stall
  - Where single-user toilet and bathing facilities are provided, distribution and designation of facilities based on sexes is not required.
    - Single-user and family/assisted-use facilities must continue to be identified as being available for use by all persons regardless of sex

145

2902 Minimum Plumbing Facilities

MINIMUM REQUIRED NUMBER OF PLUMBING FIXTURES

Multiple-User Facility for Serving All Genders

Given: Business Classification having an Occupant Load of 60. Toilet facility design chosen to be one multiple-user facility to serve all genders.

Per Table 2902.1:

Water Closet Ratio: 1 per 25 for the first 50 and 1 per 50 for the remainder > 50
Lavatory Ratio: 1 per 40 for the first 80 and 1 per 80 for the remainder > 80

Calculations:
WCs: 50/25 + (60-50)/50 = 2.2 Round up to **3 water closets minimum.**
LAVs: 60/40 = 1.5 Round up to **2 lavatories minimum.**

Single-User Facilities

Given: Business Classification having an Occupant Load of 60. Toilet facility design chosen to be all single-user facilities.

Per Table 2902.1:

Water Closet Ratio: 1 per 25 for the first 50 and 1 per 50 for the remainder > 50
Lavatory Ratio: 1 per 40 for the first 80 and 1 per 80 for the remainder > 80

Calculations:
WCs: 50/25 + (60-50)/50 = 2.2 Round up to **3 water closets minimum.**
LAVs: 60/40 = 1.5 Round up to 2. However, because each single-user facility requires a LAV, **3 lavatories minimum.**

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2902 Minimum Plumbing Facilities

- Separate facilities are not required where rooms having both water closets and lavatory fixtures are designed for use by both sexes, and
  - Water closet privacy provided per IPC, and
  - Urinals, where provided, to be in an area visually separated from the remainder of the facility
- Where accessible urinal is required, criteria for accessible stall not provided in A117.1 or IBC
  - Should be configured to allow for presence of a wheelchair, as well as user transfer to a standing position in front of urinal

147

2902.3.3 Toilet Fixtures in Storage Facilities

- Location (within one story vertically) and distance (500 feet) limits imposed for travel limits to required toilet facilities may be exceeded in Group S occupancies.
  - Travel limits to be specifically approved by building official.
- Applicable to both public and employee facilities.
- Generally consistent with allowance for employee facilities in Group F occupancies.
- New allowance applicable to large warehouses, parking garages with attendants, self-storage facilities, etc.

148

3103.1 Special Event Structures

- Special event structures are now regulated as one of the types of temporary structures addressed in Section 3103.
- Such structures, defined in the 2018 IFC, are now similarly defined in the IBC.
  - **SPECIAL EVENT STRUCTURE.** Any ground-supported structure, platform, stage, stage scaffolding or rigging, canopy, tower or similar structure supporting entertainment-related equipment or signage.

149

3103.1 Special Event Structures

- In addition to significant IFC requirements, key criteria for all temporary structures are established in IBC, including:
  - Code conformance for structural strength, fire safety, means of egress, accessibility, light, ventilation, sanitation
  - Permits
  - Construction documents
  - Location on lot
  - Means of egress

150

3115 Intermodal Shipping Containers

- Use of intermodal shipping containers as buildings and structures now address in code.
  - **INTERMODAL SHIPPING CONTAINERS.** A six-sided steel unit originally constructed as a general cargo container used for the transport of goods and materials.
- Previously, approval based on Section 104.11 addressing alternate methods and materials.
  - ICC G5-2019 *Guideline for the Safe Use of ISO Intermodal Shipping Containers Repurposed as Buildings and Building Components*
  - Evaluation Reports

151

3115 Intermodal Shipping Containers

- New requirements designed to provide a consist set of code provisions that cover minimum safety requirements without duplicating existing code provisions.
- Mandates verification of a container's construction, condition and structural integrity to assist structural engineer in the evaluation for building construction.
- Provides for specific pointers to IBC provisions addressing protection against decay and termites, under-floor ventilation, roof assemblies and joints/voids.
- Introduces structural provisions unique to such containers.

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3115 Intermodal Shipping Containers

- Provisions intended to supplement existing applicable IBC requirements, as well as :
  - Inspection by approved agency
  - Verification of data plate
  - Method of structural design (detailed design procedure or simplified method for single-units)
- Three ISO reference standards relevant to construction of intermodal shipping containers have been added to Chapter 35.
- New provisions intended to eliminate need for patchwork of potentially conflicting or duplicative requirements.

153

Questions?

154

Final Reflection

- **What?** What happened and what was observed in the training?
- **So what?** What did you learn? What difference did this training make?
- **Now what?** How will you do things differently back on the job as a result of this training?

155

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2021 IBC Update

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2021 IBC Update

158

File Attachments for Item:

ER-3 Backflow Tester (International Association of Plumbing and Mechanical Officials

BO, BI, FPI, MI, PI, NRIUI, RBO, RMI (40 hours)

Staff Notes:

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Kim Curtis
(Contact Name)

Organization: IAPMO-BPI
(Organization/Company)

Address: 1517 Chastain Road
(Include Room Number, Suite, etc.)

City: Johns Island State: SC Zip: 29455

E-Mail: kim.curtis@iapmo.org

Telephone: 855-536-2800 Fax: 909-354-3647

Course Sponsor: N/A

COURSE INFORMATION:

Course Title: Backflow Tester 40 Hour Class and Exam

New Course Submittal: ■ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: At this forty (40) hour training class, participants will be presented with the guidelines used for acceptable practices of testing backflow prevention assemblies. The participants will also learn the principles of cross-connection control and the methods and devices used to prevent backflow of undesirable substances into water distribution and plumbing systems carrying potable water. On the last day of the training the certification examination will be administered. Presently, the initial certification candidate must demonstrate the field test procedure for a reduced pressure principle assembly, double check valve assembly, pressure vacuum breaker assembly, and spill-resistant vacuum breakers without notes or assistance.

Number of Instructional Contact Hours that can be obtained upon completion: 40

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ☐ Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■
Building Plans Exam. ☐ Plumbing Inspector ■
Plumbing Plans Exam. ☐ Non-Res IU Inspector ■
Electrical Plans Exam. ☐
Mechanical Plans Exam. ☐
Fire Protect. Plans Exam. ☐

Res Building Official ■ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ■ Res IU Inspector ☐

Electrical Safety Inspectors ☐
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

BACKFLOW PREVENTION INSTITUTE
1517 Chastain Road
Johns Island, SC 29455
Ph: 1-855-536-2800
http://www.iapmobpi.org

IAPMO BPI Backflow Tester Certification Class

Day One/Morning
Introduction and Orientation/2 hours
1-Staff and Student Introductions
2-Complete Student Paperwork, give overview of the certification process and class schedule
3-Distribute course materials
4-Go over safety procedures to be used in web lab activities
Break
Day One/Morning
Backflow Prevention History/2 hours
1- Early Water Systems
2- Federal, State, and Local Involvement
3-Safe Drinking Water Act
4-Backflow Incidents
6-Organizations and Certification History
5- Backflow History Work Sheet
Lunch
Day One/Afternoon
Hydraulics/2 hours
1-Pressure and Water Characteristics
2-Fluid in Motion
3-Backflow Hydraulics and Principles
4- Cross-Connections and How They Occur
5-Isolation and Containment
6-Thermal Expansion
7-Hydraulics Work Sheet
Break
Day One/Afternoon
Plumbing Code/2 hours
1-Adopted Plumbing Code Overview
2-State and Local AHJ Regulations
3-Degree of Hazard
4-Specific Code Sections relating to Backflow Prevention
5-Plumbing Code Work Sheet

Day Two/Morning
Backflow Prevention Methods and Devices/2 hours
1-Proper selection of cross-connection control protection
2- Air-Gaps
3-Non-Testable Devices
4-Enclosures
5-Methods and Devices Worksheet
Break
Day Two/Morning
Atmospheric Type Vacuum Breaker/1 hour
1-Operation
2-Types and Installation Requirements
3-Common mistakes
4-AVB Worksheet
Lunch
Day Two/Afternoon
Pressure Vacuum Breaker Assembly/1.5 hours
1-Operation
2-Types and Installation Requirements
3-Common mistakes
4-Testing Procedure Overview
5-PVB Worksheet
Break
Day Two/Afternoon
Spill Resistant Vacuum Breaker Assembly/1.5 hours
1-Operation
2-Types and Installation Requirements
3-Common mistakes
4-Testing Procedure Overview
SVB Worksheet
Day Two/Afternoon
Wet Lab practice testing/2 hours
1- Pressure Vacuum Breaker Assembly Testing
2- Spill-Resistant Vacuum Breaker Assembly Testing

Day Three/Morning
Double Check Valve Assembly/2 hours
1-Operation
2-Types and Installation Requirements
3-Common mistakes
4-Testing Procedures Overview
5-DCVA Worksheet
Break
Day Three/Morning
Reduced Pressure Principle Assembly/2 hours
1-Operation
2-Types and Installation Requirements
3-Common mistakes
4-Testing Procedure Overview
5-RPZ Worksheet
Lunch
Day Three/Afternoon
Test Gauges/1 hour
1-Types
2-Operation
3-ASSE 1064
4-Calibration and Recalibration
5-Adapters
6-Troubleshooting
7-Gauge Worksheet
Day Three/Afternoon
Test Procedures/1hour
1-Overveiw
2-Pre-test requirements
3-test Forms
3-Post-test requirements
Break
Day Three/Afternoon
1- Wet-Lab Testing/2 hours
2-DCVA Test Procedure
3-RPZ Test Procedure

Day Four/Morning
Fire System Backflow Prevention/1 hour
1-Fire System Types
2-NFPA Requirements
3-ASSE 5140 Requirements
4-Fire Hydrants
5-Fire System Worksheets
Cross Connection Surveys/1 hour
1-Types
2-Inspection Requirements
3- Legal Responsibilities
4-Survey Worksheet
Break
Day Four/Morning
Wet Lab Practice and Review/2 hours
Lunch
Day Four/Afternoon
Program Development/1 hour
1- Water Purveyor Responsibility
2-Tester Responsibility
3-Testing Requirements
4-Record Keeping
5-Emergency Response Plan
6-Sample Ordinances
7-Program Development Quiz
Backflow Assembly Repair and Troubleshooting/1 hour
1-Shut off Valves
2-Large Assembly Repair
3-Tools
4- Repair and Troubleshooting Worksheet.
Break
Day Four/Afternoon
Wet-Lab Practice and Review/2 hours

Day Five/Morning
Class Overview and Review/1.5 hours
Class review test/.5 hour
Break
Day/Five Morning
Wet-Lab Practice and Review/2 hours
Lunch
Day Five/Afternoon
Written and Practical Exam/4 hours

BACKFLOW PREVENTION INSTITUTE
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http://www.iapmobpi.org

IAPMO BPI Backflow Tester Class Syllabus

Class Instructor

Sean Cleary

Delivery Method

Please indicate how many hours of course time for each method below? The total number of hours should equal the total course length.

METHOD	HOURS
Classroom	20
Backflow Wet Lab	16
Computer Lab	NA
Online	NA
Practical exam	2
Written exam	2
COURSE LENGTH	**40**

Credits

Can this course be repeated for credit? ☒ Yes ☐ No
Can this course be repeated for re-certification? ☒ Yes ☐ No

Course Description

This class will allow individuals to gain the necessary skills to become backflow prevention assembly testers in accordance with the ASSE Series 5110 Professional Qualification Standard

Prerequisites

5 years of plumbing or related industry experience or be in the 4th or 5th year of an approved apprenticeship program

Learning Goals

What will students be able to accomplish after completion of this class?
1. Understand the hydraulics with water systems
2. Understand backflow and cross-connection control requirements
3. Understand federal, state, and local regulations and codes related to cross-connection control
4. Develop the proper skill level and knowledge on the use of backflow testing procedures to test and troubleshoot backflow prevention assemblies

5. Understand the methods, devices, and assemblies used to provide backflow prevention and the proper selection of the proper protection in all types of water systems.
6. Develop the knowledge and understanding of the importance of protecting the public water supply.

Objectives

What will students need to do to achieve the above learning goals?
1. Develop a basis understanding of the way liquid travels in a water system
2. Understand the actual and potential risks that exist in water systems
3. Use the lab time to develop a better understanding of how backflow prevention assemblies work
4. Use the lab time to develop the necessary skill level to test and trouble shoot backflow prevention assemblies
5. Ask questions and become engaged in the classroom discussions
6. Pass the written and practical certification exams

Grade Planning

BPI Certification requirements

Written Exam/ 100 question closed book proctored exam with a two hour maximum	70% passing score
Practical Exam/ successfully test the following assemblies	
Reduced Pressure Principle Assembly	No critical errors
Double Check Valve Assembly	No critical errors
Pressure Vacuum Breaker Assembly	No critical errors
Spill-Resistant Vacuum Breaker Assembly	No critical errors
Testing is done in a proctors exam with 1.5 hour maximum to complete all assemblies	

Course Materials

Will you be using a course packet? ☒ Yes ☐ No

Topics Covered

Basic Hydraulics, cross-connection control history, plumbing and related codes, methods, devices, and assemblies used in cross-connection protection, backflow prevention installation and testing.

Required Text Materials

IAPMO/UA 3rd Edition Backflow Prevention Reference Manual

Other Materials

Manufacturers Literature, valve cutaways, magazine articles, and on-line resources

Additional Information

Backflow Prevention Assemblies and Test Kits

1517 Chastain Road
Johns Island, SC 29455
Ph: 1-855-536-2800
http://www.iapmobpi.org

Sean Cleary is a licensed master plumber from Scranton Pennsylvania. Over the course of his 42-year career he has worked in all phases of the cross-connection, plumbing, and mechanical industries. He is a graduate of the United Association Instructor Training Program. Sean is a Past President of the American Society of Sanitary Engineering. He also served as the Chairman of the ASSE Cross-Connection Control Technical Committee for over ten years. Sean is employed by the International Association of Plumbing and Mechanical Officials (IAPMO) as the Vice President of Operations for the IAPMO Backflow Institute. The Institute is the industry leader in cross-connection control training with the United States and on an international basis. Mr. Cleary is also the Technical Editor for the Backflow Prevention Journal Magazine. He is also the co-author of the IAPMO Backflow Reference Manual and has written articles for a number of plumbing and mechanical publications. Mr. Cleary has given presentations on water and cross-connection issues for IAPMO, ASSE, ASPE, NEHA, IA, and a number of state plumbing inspector organizations.

Backflow Prevention Institute

1

Introductions

- Instructor
- Sean Cleary, Scranton, PA
- UA Apprentice, Journeyman, UA Instructor
- Licensed Master Plumber
- Past President of ASSE
- 42 years experience in the Plumbing and Mechanical Field
- IAPMO BPI Vice President of Operations

2

Vacation Photo

3

Vacation Photos

4

Who We Are

5

Mission of the Backflow Prevention Institute

- Safe water through plumbing code compliance.
- IAPMO's Backflow Prevention Institute is the industry's paramount resource for backflow prevention and cross-connection control.

6

Course Learning Objectives

- Pass the Backflow Preventer Tester Certification Examination
- Receive Certification
- Describe why backflow prevention is critically important
- Explain the theory and principles of backflow prevention and cross connection control

7

Course Learning Objectives

- Understand the plumbing, sprinkler, irrigation, and mechanical systems related to backflow prevention and cross-connection control.
- Recognize the code requirements, state and federal regulations pertaining to water systems, both public and private.
- Realize where the public system ends, and the user's system begins.

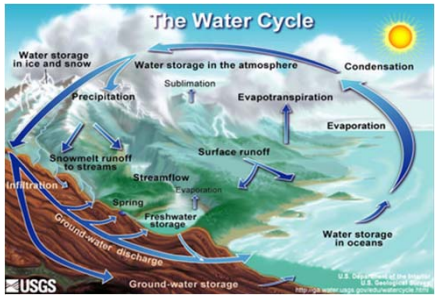
8

Course Learning Objectives

- Identify the wide variety of backflow preventers available in the industry
- Understand the differences between methods, assemblies and devices
- Understand the hydraulic principles of water and the affect pressure and temperature have on this precious resource

9

What are we trying to protect?



10

What is Potable Water

- Water that is safe to drink
- Water that is pleasing appearance and odor
- Water that has a pleasant taste
- It is not pure water
- It is not distilled water

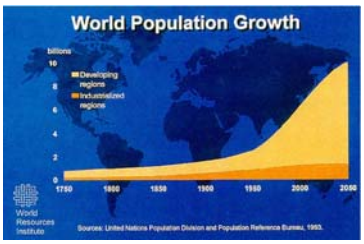
11

How Much Potable Water is Available?

- Less than three percent of the water on our planet is considered potable water that is safe to drink.
- Of that three percent, almost half in frozen into the worlds existing glaciers.

12

As the World Population Grow More Potable Water is Needed



13

United States Water Use

- As Expected, the United States at 152 gallons per person per day is the largest water using on the planet
- We are also the largest energy user on the planet

14

We Celebrate Water

15

Water is Being Wasted

- The United States suffers about 240,000 water main breaks annually and the country loses approximately 6 billion gallons a day, enough water to supply the entire state of California.

16

Recent Issues in the United States

17

Flint Michigan Water

18

Flint Michigan Water

19

Clean Safe Drinking Water is a Basic Human Right

- According to the World Health Organization the lack of access to clean water and sanitation kills children at a rate equivalent of a jumbo jet crashing every ten hours.
- Water should never be wasted.

20

Protection is needed

21

Chapter 1

BACKFLOW PREVENTION HISTORY

22

Courts in the United States have held water utilities responsible for water quality for over 100 years.

23

Federal, State, and Local agencies work to adopt standards and establish codes

24

Standard Writing Organizations

NFPA®

SANITARY ASSE ENGINEERING Prevention Rather Than Cure ®

25

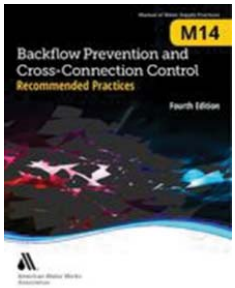
Code Writing Organizations

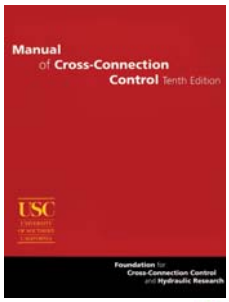
IAPMO®

ICC INTERNATIONAL CODE COUNCIL ®

26

Industry Publications





27

Professional and Labor Groups

PLUMBERS • UNION • PIPEFITTERS • SERVICE TECHS • STEAMFITTERS • SPRINKLERFITTERS ®

PHCC ® PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION

28

Who Has Jurisdiction in Requiring the Installation of Cross-Connection Protection?

- Is it the Federal Government?
- Is it the State Government?
- Is it the Local Health Department?
- Is it the Local Building Department?
- Is it another agency?
- Is it no one?

29

The Safe Drinking Water Act

- In the 1970's it became clear to many that pollution of our environment was becoming a large issue
- The US EPA was created
- The Clean Water Act was passed
- The Safe Drinking Water Act was passed
- The clean up began and awareness of the importance of pollution control was heightened

30

The Safe Drinking Water Act

- Amendments were made in 1986 which included increased monitoring for unregulated contaminants, greater enforcement standards, increased protection of wellheads, and changes to the lead-content of plumbing materials including prohibiting use of lead solders, flux and pipes in new installations and repairs of public water systems and drinking water plumbing connected to such systems. A warning was required on any solder containing more than .2 percent lead.

31

The Safe Drinking Water Act

- Originally, SDWA focused primarily on treatment as the means of providing safe drinking water at the tap. The 1996 amendments greatly enhanced the existing law by recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water. This approach ensures the quality of drinking water by protecting it from source to tap.

32

The Safe Drinking Water Act

- The United States Congress has revised the definition of "lead free" in the Safe Drinking Water Act with respect to the wetted surfaces of pipes, pipe fittings, plumbing fittings, and fixtures. As of the effective date of January 4, 2014, all pipes, pipe fittings, plumbing fitting, and fixtures must meet a 0.25% weighted average lead content. The Congressional Act was dated January 5, 2010 and was signed into law by President Barack Obama on January 4, 2011 with the effective date of January 4, 2014.

33

The Safe Drinking Water Act

- The most direct oversight of water systems is conducted by state drinking water programs. States can apply to US EPA for "primacy," the authority to implement SDWA within their jurisdictions, if they can show that they will adopt standards at least as stringent as US EPA's and make sure water systems meet these standards. All states and territories, except
- Wyoming and the District of Columbia, have received primacy.

34

Risks and Threats to Public Health

- There are varied risks associated with cross-connections and the threat to public health
- There are many cases of cross-connection problems which have compromised public health

35

Corpus Christi, Texas December 2016

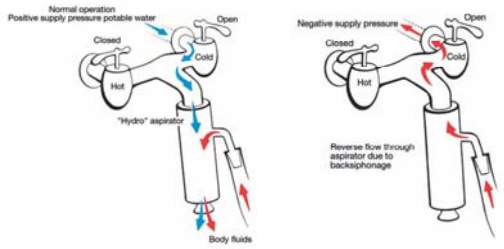
36

Corpus Christi, Texas December 2016

- Residents of Corpus Christi, Texas, were warned to avoid all contact with tap water after a corrosive industrial chemical leaked into the local water system, forcing schools to close and prompting emergency bottled water deliveries throughout the Gulf Coast City.

37

Case 1:Human Blood in the Public Water Supply



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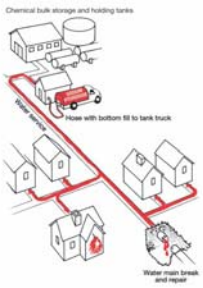
Case 2: Burned in the Shower



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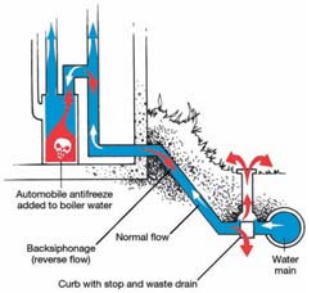
Case 3: Heating System Anti-Freeze Enters Potable Water Supply



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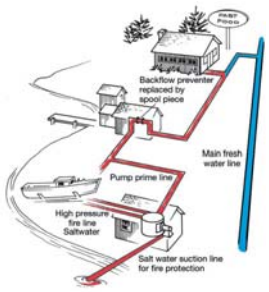
Case 4: Salty Drinks



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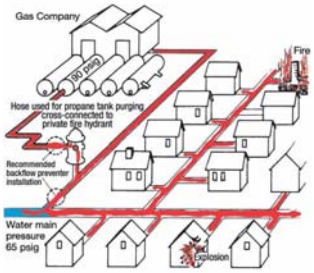
Case 5: Parquet in the Public Water Supply

42

Case 6: Propane Gas in the Water Mains



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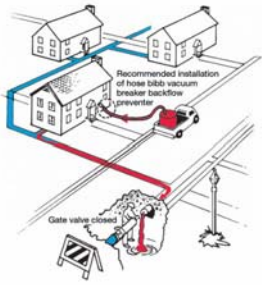
Case 7: Chlordane and Heptachlor at the Housing Authority



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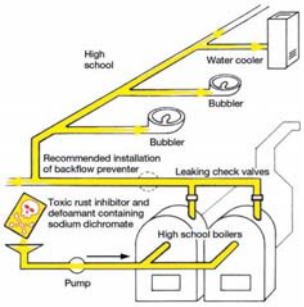
Case 8: Boiler water enters high school drinking water



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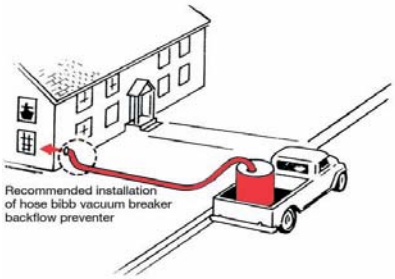
Case 9: Pesticide in the drinking



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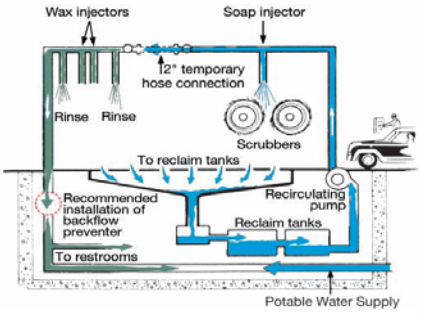
Case 10: Car wash water in the water main



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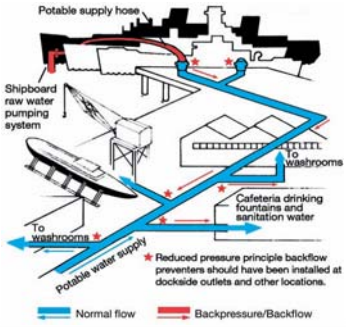
Case 11: Shipyard backflow contamination



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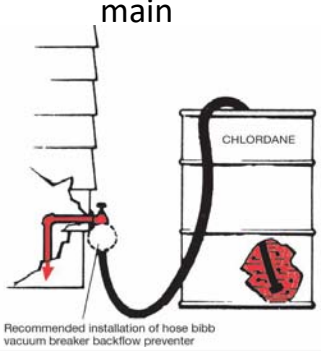
Case 12: Chlordane in the water main



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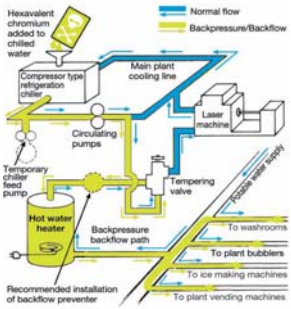
Case 13: Hexavalent chromium in the drinking water



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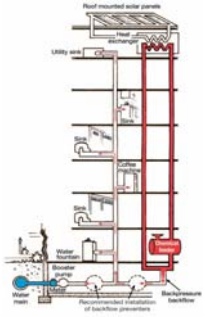
Case 14: Employee health problem due to Cross connection



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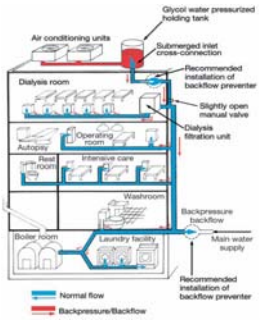
Case 15: Dialysis machine contamination



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Chapter One Question Break

53

Chapter Two

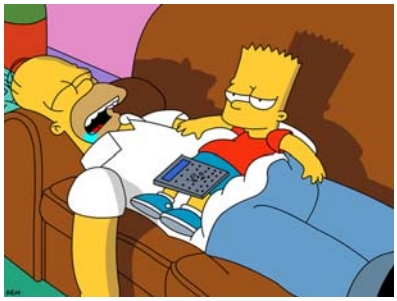
- This chapter contains Definitions and should be used along with the ASSE Series 5000, the local plumbing and mechanical codes and other industry resources
- It is important that students become familiar with the acronyms and symbols related to cross connection control

54

BACKFLOW PREVENTION HYDRAULICS

55

Water is Lazy



56

High Pressure goes to Low Pressure

- If one sentence sums up how plumbing systems work, it appears above
- The Laws of Physic's will always govern what happens in water and drainage systems
- As long as men have been putting water into piping systems backflow incidents have occurred
- Let's look at the possibilities

57

What is Backflow ?

- ***BACKFLOW*** occurs when the normal direction of flow in a piping system is reversed.
- ***BACKFLOW*** is the flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any source other than its intended source

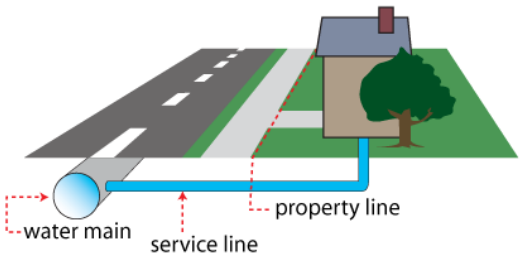
58

CROSS-CONNECTION

- A connection between the potable water supply and any material that renders or could potentially render the potable water supply non-potable is called a ***CROSS-CONNECTION***
- ***CROSS-CONNECTION CONTROL*** is the use so assemblies, devices, methods, and procedures to prevent the contamination or pollution of a potable water supply

59

The Service Connection



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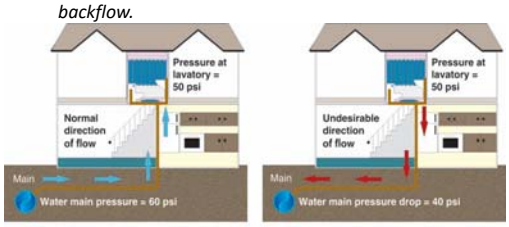
Conditions for substances to enter the potable water supply

1. A conduit must exist for fluid flow – a *cross-connection.*
2. A difference in pressure reverses the direction of flow – *backflow.*



Water flows from high to low pressure. Normal direction of flow is into the house. Backflow is the undesirable flow reversal from the house to the main in the street.

61

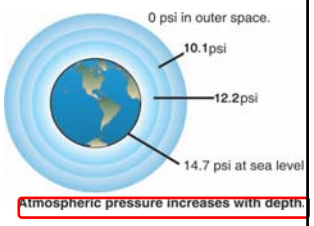
Terminology - *Pressure*

- The term pressure as it relates to backflow is the normal force exerted by a liquid or gas per unit of area, on the walls of a container
- Static pressure is the pressure of a fluid at rest
- Residual pressure is the pressure available at the fixture or water outlet after allowance is made for pressure drop due to friction loss, head pressure, or other system loss during maximum demand periods

62

Terminology – *Atmospheric Pressure*

- Atmospheric pressure is the term given to the force or weight per unit area of air around us.



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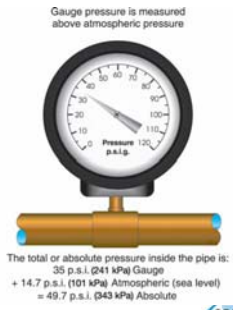
Terminology – *Absolute Pressure*

- Absolute Pressure is the total pressure; gauge pressure plus atmospheric pressure. This pressure scale is always measured as a positive value. It is not possible to have a negative absolute pressure.
- Absolute pressure is abbreviated as: PSIA.

64

Terminology – *Gauge Pressure*

- Gauge pressure is the pressure at a point in a fluid above that of the atmosphere. It used to determine the pressure within a piping system.
- Gauge pressure is abbreviated as PSIG.
- It is possible to have negative gauge pressure



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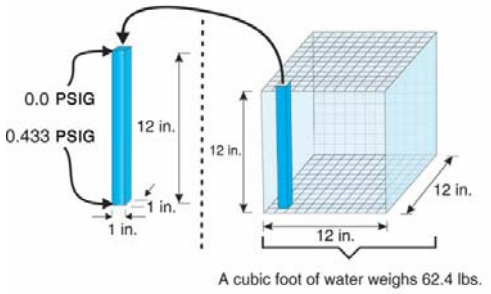
Terminology – *Excessive Water Pressure*

- Static water pressure in the water supply piping is exceeding 80 lbs. per square inch (552 kPa) is consider excessive pressure
- All three model plumbing codes used in the United States list pressures in potable water system above 80 psig as excessive

66

Water Characteristics and Pressure



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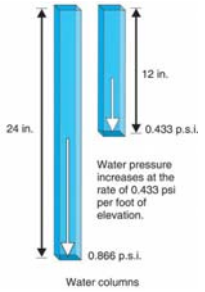
Water Characteristics and Pressure

- If several of the small water columns were stacked on top of each other, the pressure at the base would increase.
- The pressure will increase 0.433 psi for every 1-foot water column added to the stack.



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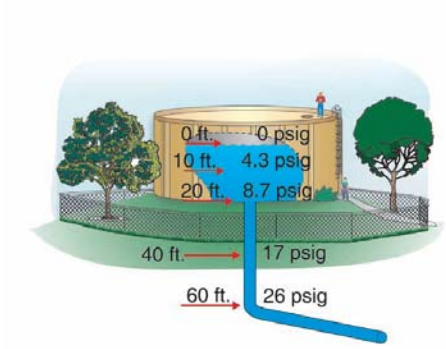
Terminology – *Head Pressure*

- Pressure head, head pressure, or static head are terms used to describe the pressure provided by a column of water. For example, a pressure of 1 PSI is equal to 2.31 feet of head.
- 27.75 Inches of Water Column Equals One PSI.

69



70

1 psi ÷ 0.433 psi per foot = 2.31

Example problem: A water column of 46 feet in height will produce a gauge pressure at base _____ psig?

46 Feet X .433 = 19.918 PSIG

71

1 psi ÷ 0.433 psi per foot = 2.31 feet

Example problem 1.5: How far will water rise in an open-ended pipe with a pressure at the base of 86.6 PSIG?

86.6 PSIG X 2.31 = 200 Feet

72

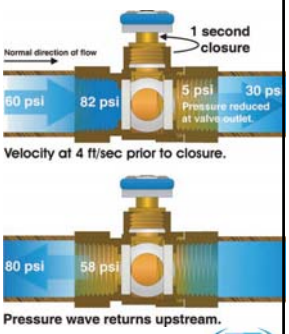
Terminology - *Hydraulic Shock*

- Hydraulic shock is commonly called Water Hammer
- Can be dangerous because the pressure increase may be severe enough to rupture the piping system or cause damage to the connected equipment.

73

Hydraulic Shock

- Sudden closure of a pipeline's valve causes the momentum of the liquid column to exert a force on the valve's disc, gate or ball.
  - The pressure on the upstream side increases and pressure on the downstream side decreases.
  - The water downstream continues to flow and creates negative pressure that may cause the pipe to collapse or implode.



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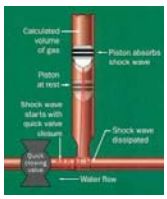
Water Hammer Arrestors

- To protect a system from hydraulic shock, water hammer arrestors are installed immediately upstream of the quick closing valve.



75

What is Backflow?

- Backflow is the reversal of the flow of water in a piping system from the normally intended direction of flow
- There are two types of Backflow
- Backpressure
- Backsiphonage

76

Terminology - ***Backpressure***

The downstream pressure becomes greater than the upstream or supply pressure as a result of either a reduction in the supply pressure or an increase in the system or downstream pressure.

– The pressure must be greater than atmospheric pressure because no vacuum is produced.

77

Backpressure Creation

78

Backpressure Creation

79

Terminology - ***Backsiphonage***

- Backsiphonage results from the creation of a siphon being formed in the piping system.
- It occurs when the system pressure is below atmospheric pressure, or a negative gauge pressure exists.

80

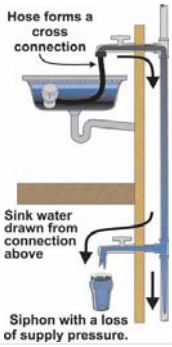
81

82

300 feet of a 42" water pipeline from Folsom Lake collapsed on itself as a vacuum was created inside it when it was being dewatered.

83

Backsiphonage



84

Daniel Bernoulli

- Daniel Bernoulli was born in Groningen, the Netherlands in February 1700. In his 82 years on Earth his work helped explained the way both liquids and gasses are affected by temperature, pressure, and velocity

85

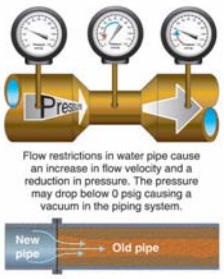
Bernoulli Theorem

- As the water velocity in a piping system increases the pressure within the system decreases
- As the water velocity in a piping system decreases the pressure within the system increases
- ALWAYS

86

Fluid Flow

- Water is essentially an incompressible fluid. This means that its density will not change much within the piping system.
- Undersized piping with high velocity flow will reduce the pressure within the system.



87

Cross Connection Types

- **Direct Connection**
  - A permanent or piped physical connection capable of allowing both backpressure and backsiphonage.
- **Indirect Connection**
  - A plumbing arrangement allowing backsiphonage only.

88

Protected Direct Cross Connection

89

Unprotected Direct Cross Connection

90

Unprotected Cross Connection

91

Indirect Connection

92

Indirect Connection

93

Dangerous Products

94

Inlet-type cross-connections

- **Under-rim** or **Submerged Inlet**
  - Allows the water to enter into the bottom side of a receptacle and is continuously immersed in a non-potable substance.

95

Protected Submerged Inlet

96

Submerged Inlet

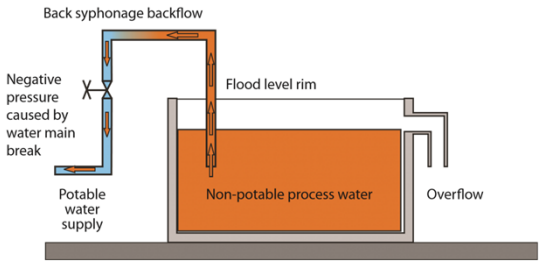
97

Inlet-type cross-connections

- **Over-rim Connection**
  - The waterline enters the receptacle over the rim and terminates at a point below the rim and, therefore, is not continuously submerged.
  - Backflow results as a siphon only.

98

Over the Rim Issues

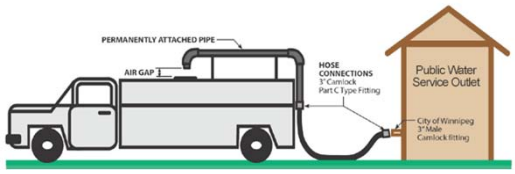


99

Over the Rim Connection

100

The Proper Way to Fill a Tank



101

Chapter Two Question Break

102

In Far Too Many Areas

103

Cross Connection Control Isolation

- Controlling a cross-connection at its point of use is a practice known as **isolation.**
- The plumbing code instructs that each cross-connection must be identified and controlled through the use of a mechanical backflow preventer or a physical air-gap separation.

104

Model Plumbing Codes

105

Isolation Protection

106

Cross Connection Control Containment

- Suppliers frequently require a backflow prevention assembly at the service connection.
- This type of protection is known as **containment.**

107

Containment Protection

108

109

Thermal Expansion Occurrence

- The creation of a closed piping system in a potable water service occurs when a non-return barrier is installed between the water heating system piping and the public supply.
- The expanded water and resultant pressures must be accounted for by relieving or containing the pressure.

110

Terminology - ***Thermal Expansion***

- The tendency of matter to increase in volume in response to a change in temperature
- Water as a liquid is almost incompressible, as a result we must consider this hydraulic condition when we install backflow prevention protection
- The three state of matter are a solid, liquid and a gas. Change of state occurs as a result of temperature changes

111

Thermal Expansion

- With a temperature increase, water immediately starts to expand in terms of volume and pressure even when heated from 40°F to room temperature. This is **thermal expansion**.

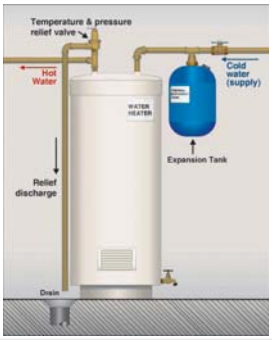
112

Uniform Plumbing Code Chapter Six Addresses Thermal Expansion

- **608.3** A water system provided with a check valve, backflow preventer, or other normally closed device that prevents dissipation of building pressure back into the water main, independent of the type of water heater used, shall be provided with an approved, listed, and adequately sized expansion tank or other approved device having a similar function to control thermal expansion. Such expansion tank or other approved device shall be installed on the building side of the check valve, backflow preventer, or other device and shall be sized and installed in accordance with the manufacturer's installation instructions.

113

Thermal Expansion Occurrence

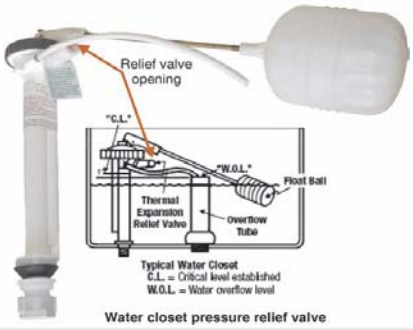


114

Thermal Expansion Occurrence

115

Watts Governor 80 Ballcock



Water closet pressure relief valve

116

Chapter Three Question Break

117

Chapter 4

CODE AND INSTALLATION CRITERIA

118

Model Plumbing Codes

119

Model Plumbing Codes

120

Model Plumbing Codes

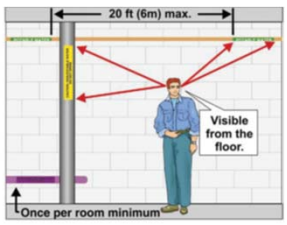
121

The Uniform Plumbing Code

- Provides us with the information we need to safely install these systems while protecting the potable supply from potential and actual cross-connections.

122

Identification of Potable and Non-Potable Water Systems



123

What are the considerations?

- The Degree of Hazard
- The Type of Backflow Which May Occur
- System Type
- Pressure Requirements
- Location
- Containment or Isolation Protection
- Installation Requirements

124

Terminology – *Degree of Hazard*

- The evaluation of the actual or potential conditions within a water system that can be classified as either a health hazard or non-health hazard.
- Health Hazard/ High Hazard/ Contaminant
- Non- Health Hazard/ Low Hazard/Pollution

125

Degree of Hazard

- **Non-Health Hazard** (Pollutant)
  - Non-Health, Aesthetic Hazard
    - Food Products
    - Non-Toxic Fluids
    - Static Water Lines
- **Health Hazard** (Contaminant)
  - Health, Toxic Hazard
    - Chemicals
    - Sewage
    - Industrial fluids

126

Terminology – *Contaminant*

- An impairment of the quality of potable water that creates an actual hazard to the public health through poisoning or though the spread of disease by sewage, industrial fluids, or other waste.

127

Terminology – *Pollution*

- An impairment of the quality of the potable water to a degree that does not create a hazard to the public heath but which does adversely and unreasonably affect the aesthetic qualities of such potable water for domestic use

128

Selection of Appropriate Backflow Prevention Product

- **Always Refer to Local Jurisdictional Authority and Prevailing Codes!**
- Possibility of Back Pressure?
  Possibility of Back-Siphonage
- Possibility of Health or of Non-Heath Hazard?
- Constant Pressure Requirement?

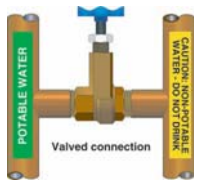
129

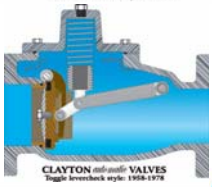
Backflow Prevention

- The installation of cross connection control affects the hydraulics of the system
- Every installation is unique
- Pressure is lost
- A closed piping system is created which may result in the need for thermal expansion protection

130

Unlawful Connections





131

UPC Section 603

- Section 603.2 discusses the fact that the devices used must be listed to an approved standard, maintained, and tested.
- Section 603.3 gives us a list of the devices and methods with a brief description of each.
- Section 603.4 covers general requirements to which all devices and/or installations must adhere.
- Section 603.5 states where and when a specific installation requires a device and which device to use along with installation parameters.

132

Backflow Prevention

- Backflow preventers include testable and non-testable methods, devices and assemblies.
- Non-testable methods are air gap separations and mechanical devices, manufactured for specific plumbing fixture and appliance applications.

133

2015 UPC Table 603.2

- Table 603.2 is an application table which includes specific installation requirements, product standard numbers, the degree of hazard protection, proper names, and the type of backflow (backpressure, backsiphonage, or both types) protection provided for backflow prevention methods, devices, and assemblies.

134

Backflow Prevention Assemblies

- The field-testable backflow prevention assemblies are:
  - Reduced pressure principle assembly (ASSE 1013)
  - Reduced pressure detector assembly (ASSE 1047)
  - Double check valve assembly (ASSE 1015)
  - Double check detector assembly (ASSE 1048)
  - Pressure vacuum breaker assembly (ASSE 1020)
  - Spill-resistant vacuum breaker (ASSE 1056)

135

2015 UPC Table 603.3.1

Table 6-3
Minimum Airgaps for Water Distribution[4]

Fixtures	When not affected by sidewalls[1]		When affected by sidewall[2]	
	Inches	(mm)	Inches	(mm)
Effective openings[3] not greater than one-half (1/2) inch (12.7 mm) in diameter	1	(25.4)	1-1/2	(38)
Effective openings[3] not greater than three-quarters (3/4) inch (19.1 mm) in diameter	1-1/2	(38)	2-1/4	(57)
Effective openings[3] not greater than one (1) inch (25.4 mm) in diameter	2	(51)	3	(76)
Effective openings[3] greater than one (1) inch (25.4 mm) in diameter	Two (2) times diameter of effective opening		Three (3) times diameter of effective opening	

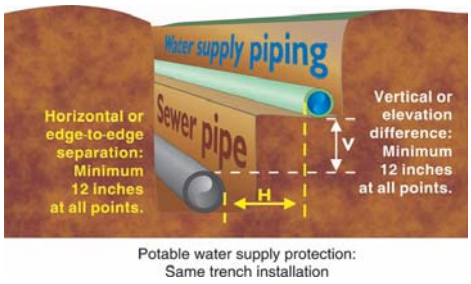
[1] Sidewalls, ribs, or similar obstructions do not affect airgaps when spaced from the inside edge of the spout opening a distance exceeding three (3) times the diameter of the effective opening for a single wall, or a distance exceeding four (4) times the effective opening for two (2) intersecting walls.
[2] Vertical walls, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening other than specified in Note 1 above. The effect of three (3) or more such vertical walls or ribs has not been determined. In such cases, the airgap shall be measured from the top of the wall.
[3] The effective opening shall be the minimum cross-sectional area at the seat of the control valve or the supply pipe or tubing that feeds the device or outlet. If two (2) or more lines supply one outlet, the effective opening shall be the sum of the cross-sectional areas of the individual supply lines or the area of the single outlet, whichever is smaller.
[4] Airgaps less than one (1) inch (25.4 mm) shall be approved only as a permanent part of a listed assembly that has been tested under actual backflow conditions with vacuums of zero (0) to twenty-five (25) inches (635 mm) of mercury.

136

Accessible?

137

Protection From Backflow In Underground Piping UPC 609.2



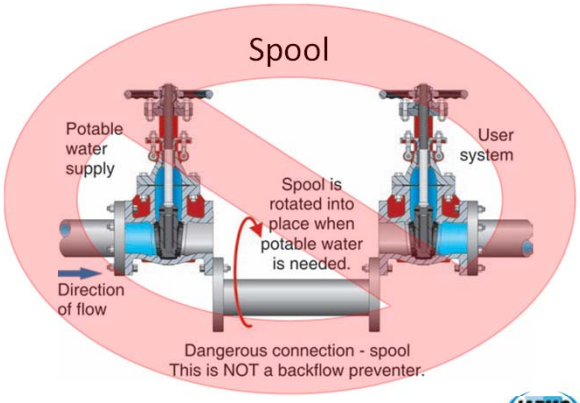
138

Changeover Connections

- The following connections are blatantly illegal and violate Section 602.0 under unlawful connections. However, they are sometimes commonly used in the water supply industry and in many manufacturing situations.

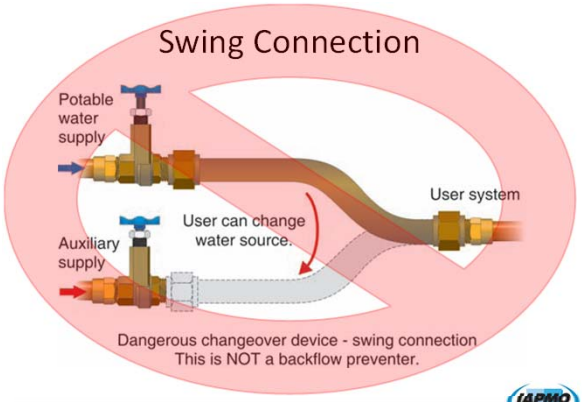
139

Spool



140

Swing Connection



141

Freeze Protection

- The model plumbing codes also address cold climate conditions. The *2015 Uniform Plumbing Code* states:
- **603.4.7 Freeze Protection.** In cold climate areas, backflow assemblies and devices shall be protected from freezing with an outdoor enclosure or by a method acceptable to the Authority Having Jurisdiction.

142

Freeze Protection ASSE 1060

143

Chapter Four Question Break

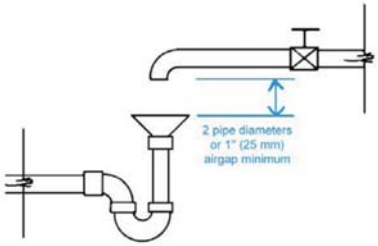
144

Chapter 5

NON-TESTABLE DEVICES OR METHODS

145

The Physical Air-Gap



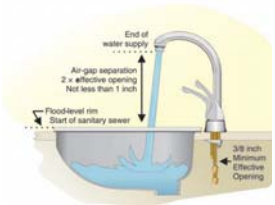
146

Air Gap Standard ASME A 112.1.2 and ASME A 112.1.3

- Low and High Hazard Protection
- Backsiphonage protection only, it is impossible to have backpressure on a properly installed air gap
- Non-testable although a yearly visual inspection is required

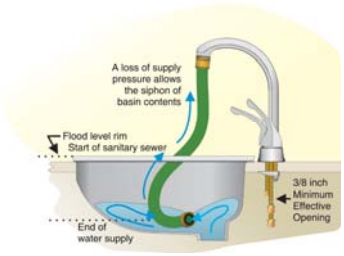
147

Air-Gap Separation



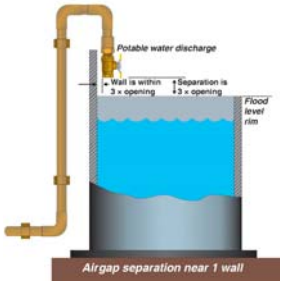
148

Air-Gap Issues



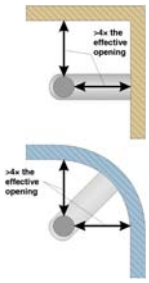
149

Single Sidewall



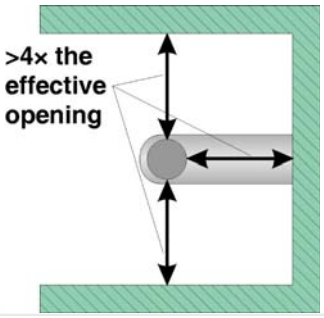
150

Two Sidewalls



151

Three Sidewalls



152

2015 UPC Chapter Six

- **603.4.4** Direct connections between potable water piping and sewer-connected wastes **shall not** be permitted to exist under any condition with or without backflow protection. Where potable water is discharged to the drainage system, it shall be by means of an approved airgap of two pipe diameters of the supply inlet, but in no case shall the gap be less than 1 inch (25.4 mm). Connection shall be permitted to be made to the inlet side of a trap provided that an approved vacuum breaker is installed not less than 6 inches (152 mm), or the distance according to the device's listing, above the flood-level rim of such trapped fixture, so that at no time will such device be subjected to backpressure.

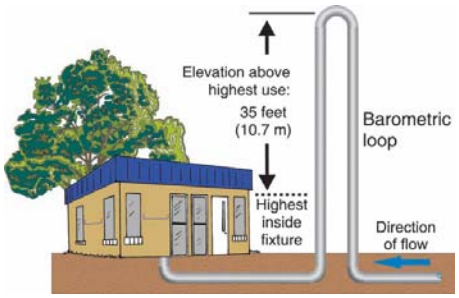
153

Barometric Loop

- A piping arrangement that extends more than 35 feet (10.7 m) at sea level is considered a ***barometric loop.***
- A barometric loop is not like a mechanical vacuum breaker because it does not admit air into the piping system.
- However, it will stop the flow of water from the downstream piping.

154

Barometric Loop



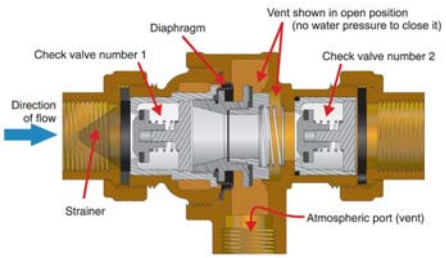
155

Barometric Loop

- There is no standard for the Barometric Loop
- They are not allowed in the Uniform Plumbing Code but are allowed in the International Plumbing code
- Backsiphonage protection only
- They are a non-testable backflow prevention method

156

Backflow Preventer with Intermediate Atmospheric Vent



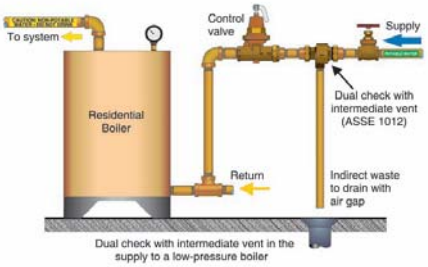
157

1012 Standard

- Low Hazard installation only
- Backpressure and backsiphonage protection
- Non- testable device
- Maximum pressure loss 25 psi during rated flow
- Horizontal or vertical installation
- Normal usage is on residential boilers in many areas

158

Backflow Preventers With Intermediate Atmospheric Vent



159

1012 Standard

- Not allowed on steam or hot water boilers in areas which have adopter the Uniform Plumbing Code
- Always check with the Local AHJ as for approval and for vertical installation approval

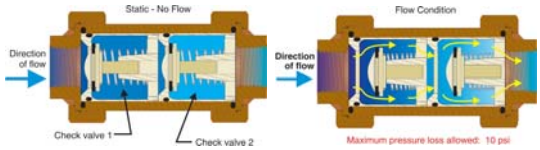
160

Dual Check Valve

- Low hazard use only
- Protects against both backpressure and backsiphonage
- Non- testable
- Maximum pressure loss 10 psi during rated flow
- Used in many areas for residential containment protection

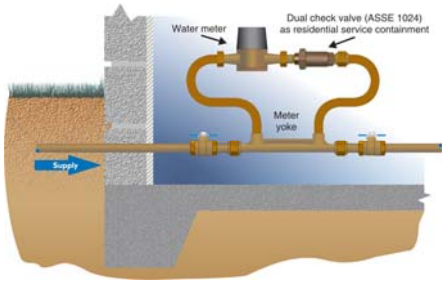
161

1024 Standard



162

Dual Check Valve



163

Fill Valve/Ballcock Standard

- Low or high hazard protection
- Backsiphonage protection
- Non-testable
- Must have a minimum air-gap of one inch above the toilet tank overflow tube

164

Flushometer Standard

- High and low hazard protection
- Backsiphonage protection
- Non-testable device
- Must be installed with the critical level of the tailpiece six inches above the fixture flood rim

165

Standard Flush Tanks

- High and low hazard protection
- Backsiphonage protection
- Non-testable device
- Must be installed in accordance with manufacturers specifications

166

Backflow Prevention Devices for Hose Connections

- Standard Hose Connection Vacuum Breaker
- Standard Hose Connection Backflow Preventer
- Standard Wall Hydrant with Backflow Prevention and Freeze Resistance, Type A, Type B, and Type C

167

Backflow Prevention Devices for Hose Connections

- Standard Dual Check Backflow Preventer Wall– Freeze Resistance Hydrant Type A and Type B
- Standard Freeze Resistant Sanitary Yard Hydrant with Backflow Protection, Type 1, Type 2, Type 3, Type 4, and Type 5

168

Hose Connection Vacuum Breaker

- High and low hazard protection
- Non-testable
- Contains one check valve

169

Hose Connection Backflow Preventer

- High and low hazard protection
- Testable using an ASSE procedure
- Contains two check valves
- Will work under low head backpressure (maximum 10 ft. head)

170

Standard Wall Hydrant with Backflow Prevention and Freeze Resistance

- Type A contains three mechanisms, an air inlet, a check valve, and a method of relieves backpressure
- Low and high hazard protection
- Non-testable
- Hose must be removed to prevent freezing

171

Standard Wall Hydrant with Backflow Prevention and Freeze Resistance

- Type B also contains three mechanisms, an air inlet, a check valve, and a method of relieves backpressure
- Low and high hazard protection
- Non-testable
- Hose does not need to be removed to prevent freezing

172

Standard Wall Hydrant with Backflow Prevention and Freeze Resistance

- Type C devices contain two mechanisms, an air inlet and a check valve for preventing backpressure
- Low and high hazard
- Non-testable
- Hose must be removed to prevent freezing

173

Standard Dual Check Backflow Preventer Wall– Freeze Resistance Hydrant

- Type A
- High and low hazard applications
- Non-testable
- Two independent check valves with an atmospheric vent
- Automatically drain if the hose is removed

174

Standard Dual Check Backflow Preventer Wall– Freeze Resistance Hydrant

- Type B
- High and low hazard applications
- Non-testable
- Two independent check valves with an atmospheric vent
- Automatically drain if the hose is attached

175

Standard Freeze Resistant Sanitary Yard Hydrant with Backflow Protection

176

Standard Freeze Resistant Sanitary Yard Hydrant with Backflow Protection

- Type 1 contains two check valves and an atmospheric vent and does not require removal of the hose for freeze protection
- Type 2 contains two check valves and an atmospheric vent and requires the removal of the hose for freeze protection
- Type 3 contains one check valve and an atmospheric vent and does not require removal of the hose for freeze protection

177

Standard Freeze Resistant Sanitary Yard Hydrant with Backflow Protection

- Type 4 contains one check valve and an atmospheric vent and requires removal of the hose for freeze protection
- Type 5 contains an air gap or removable backflow prevention device and requires removal of the backflow prevention device and hose to provide freeze protection

178

Standard Freeze Resistant Sanitary Yard Hydrant with Backflow Protection

- All five types provide high and low hazard protection
- They are non-testable
- They provide protection against backsiphonage and low hazard backpressure (less than 10 ft. of head)
- They cannot be subject to pressure for more than 12 hours in a 24-hour period

179

2015 UPC

- **603.5.17 Potable Water Outlets and Valves**. Potable water outlets, freeze-proof yard hydrants, combination stop-and-waste valves, or other fixtures that incorporate a stop and waste feature that drains into the ground shall not be installed underground.

180

Standard Backflow Prevention Devices for Hand-Held Showers

- Includes a check valve that separate from or integral with other components
- High and low hazard protection
- Non-testable
- Protects against backsiphonage and low head backpressure

181

2015 UPC

- 417.3 Handheld Showers. Handheld showers shall comply with ASME A112.18.1/ CSA B125.1. Handheld showers with integral backflow protection shall comply with ASME
- A112.18.1/CSA B125.1 or shall have a backflow prevention device that is in accordance with ASME A112.18.3.

182

Trap Seal Primer Valves

- High and low hazard protection
- Non-testable
- Backsiphonage protection only

183

2015 UPC

- **1007.1 General.** Floor drain or similar traps directly connected to the drainage system and subject to infrequent use shall be protected with a trap seal primer, except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction. Trap seal primers shall be accessible for maintenance

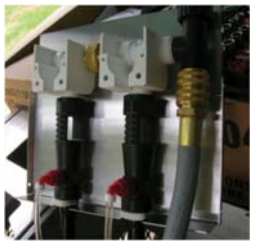
184

Laboratory Faucet Backflow Preventer

- Two independent check valves and an atmospheric vent
- High and low hazard protection
- Backsiphonage and low hazard backpressure conditions
- Non continuous pressure situations only

185

Chemical Dispensing Systems



- Type B devices do not pressure the chemicals above atmospheric pressure, the only backpressure potential comes from an elevated hose

186

Chemical Dispensing Systems

- Type A devices have the chemicals pressurized above atmospheric pressure. Currently lists no products as Type A
- Protects against both high and low hazard situations
- Backsiphonage protection with the only backpressure allow in Type B form the elevated hose.

187

Installation issues

188

Problems Everywhere

189

Side Kick Solution?

190

Side Kick in Action

191

Dual Check Valve Type Backflow Preventer

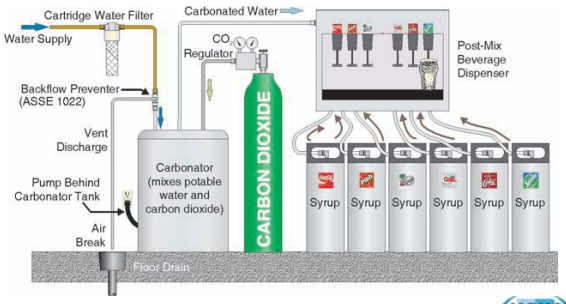
- High and low hazard protection
- Backpressure or backsiphonage protection
- Non-testable

192

Backflow Preventer for Beverage Dispensing Equipment

193

Beverage Equipment Devices



194

Backflow Preventer for Beverage Dispensing Equipment

- High and low hazard applications
- Contains two check valves with an intermediate vent
- Non-testable device
- No copper tubing or piping is allowed downstream of the device when used for carbonated beverage dispensers

195

2015 UPC

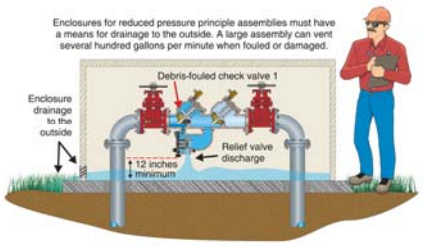
- **603.5.12 Beverage Dispensers.** Potable water supply to beverage dispensers, carbonated beverage dispensers, or coffee machines shall be protected by an airgap or a vented backflow preventer in accordance with ASSE 1022. For carbonated beverage dispensers, piping material installed downstream of the backflow preventer shall not be affected by carbon dioxide gas.

196

Outdoor Enclosures for Backflow Prevention Devices and Assemblies

- Class I enclosures are freeze protection enclosures with heat sources and insulation and must provide protection when the external temperature is -30°F (-34°C). Class II enclosures are freeze retardant enclosures with insulation only and must maintain 40°F (4°C) for a 24-hour period. Class III enclosures are non-freeze protection enclosures with no insulation or heat and should not be used for protection in freezing climates.

197



198

2015 UPC

- **603.4.7 Freeze Protection.** In cold climate areas, backflow assemblies and devices shall be protected from freezing with an outdoor enclosure in accordance with ASSE 1060, or by a method acceptable to the Authority Having Jurisdiction.

199

Chapter Five Question Break

200

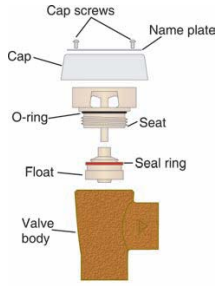
Chapter 6

ATMOSPHERIC TYPE VACUUM BREAKER

201

Atmospheric Vacuum Breaker

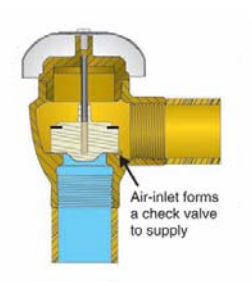
- The purpose of a vacuum breaker is to prevent backsiphonage.
- The atmospheric vacuum breaker consists of a valve that allows air into the piping system for the purpose of stopping a siphon.



Atmospheric vacuum breaker exploded view

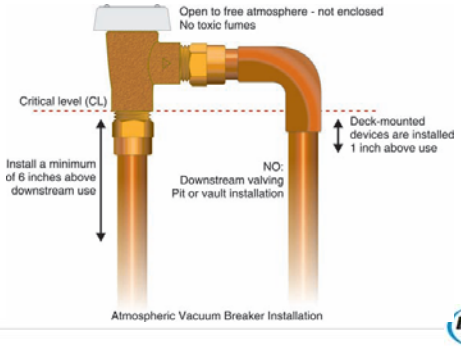
202

AVB Operation



203

AVB Code Requirements



Atmospheric Vacuum Breaker Installation

204

2015 UPC

- **603.5.13** Deck-mounted or equipment-mounted vacuum breakers shall be installed in accordance with their listing and the manufacturer's instructions, with the critical level not less than one (1) inch (25.4 mm) above the flood-level rim.

205

2015 UPC

- **603.5.1** Water closet and urinal flushometer valves shall be equipped with an atmospheric vacuum breaker. The vacuum breaker shall be installed on the discharge side of the flushometer valve with the critical level not less than six (6) inches (152 mm), or the distance according to its listing, above the overflow rim of a water closet bowl or the highest part of a urinal.

206

What's Wrong??

207

What's Wrong??

208

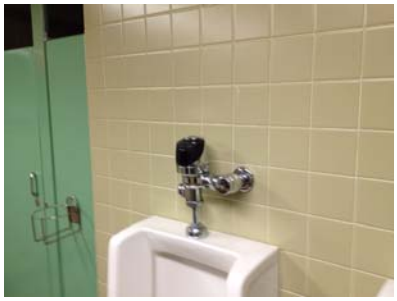
AVB Code Requirements

209

What's Wrong??

210

What's Wrong??

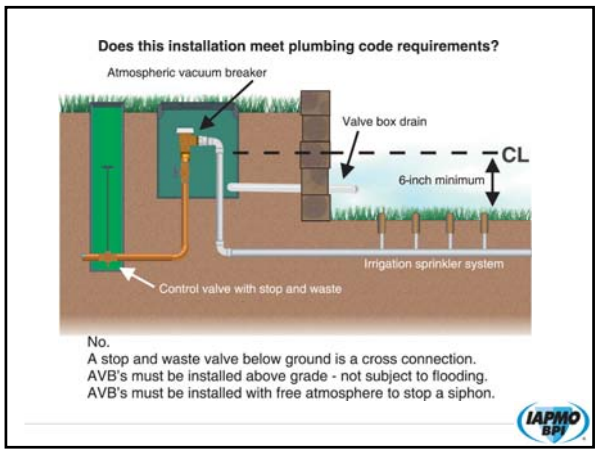


211

AVB Essential Conditions for Proper Functioning

- Must not be subjected to continuous pressure.
- No valves permitted downstream.
- Must not be subjected to backpressure.
- No installations in areas with toxic fumes.
- Need adequate air supply.

212



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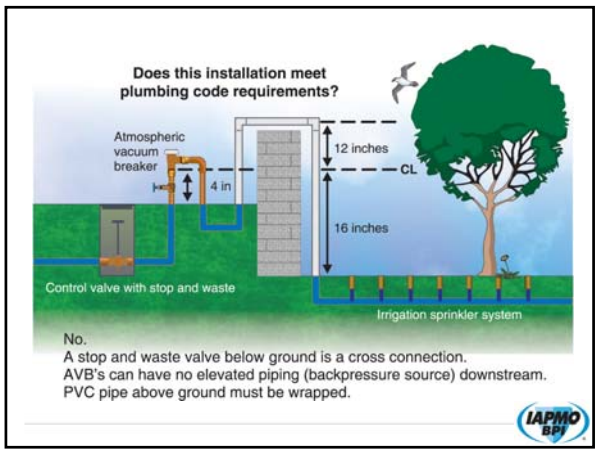


214

Chapter Six Question Break

215

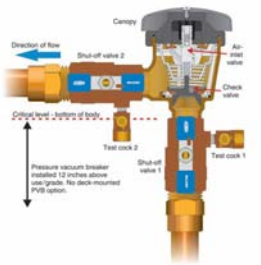
Chapter 7

PRESSURE VACUUM BREAKER ASSEMBLY

216

Pressure Vacuum Breaker (PVB)

- A testable assembly.
- Air-inlet valve is force-loaded to an open position with a minimum of 1.0 psi loading.
- Provides high-hazard or health hazard protection.



217

Pressure Vacuum Breaker Assemblies

- **2015 UPC Section 603.3.5**
- A pressure vacuum backflow prevention breaker assembly consists of a loaded air inlet valve, an internally loaded check valve, two properly located test cocks, and two isolation valves. The assembly shall be permitted to be installed indoors where provisions for spillage are provided.

218

Code Requirements

- UPC Section 603.4
- General requirements. Assemblies shall comply with listed standards and be acceptable to the Authority Having Jurisdiction over the selection and installation of backflow prevention assemblies.

219

Code Requirements

- UPC Section 603.4.2
- Testing. The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter or more often where required by the Authority Having Jurisdiction.

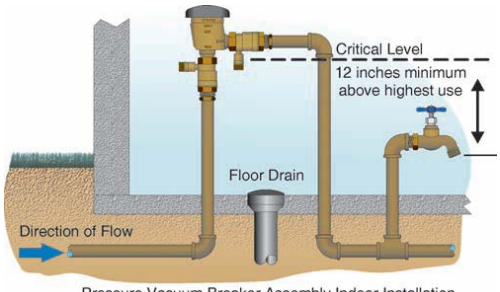
220

Code Requirements

- UPC Section 603.4.2
- Testing. The periodic testing shall be preformed in accordance with procedures referenced in the ASSE Series 5000 by a tester qualified in accordance with those standards
- Both the International and National Standard Plumbing Codes contain similar language

221

Installation Requirements



Pressure Vacuum Breaker Assembly Indoor Installation

222

Installation Requirements

PVB Must:

- Have adequate supply of air to stop siphon.
- Be upright and plumb.
- Be accessible.
- Be protected from freezing.

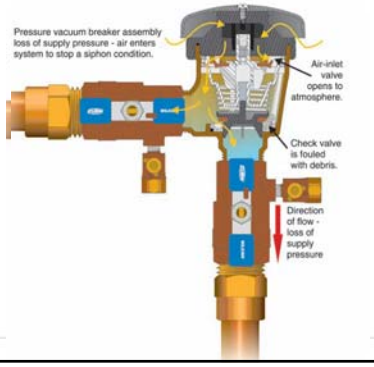
PVB Must <u>NOT</u>:

- Be subjected to backpressure.
- Be installed in areas containing toxic fumes.
- Be located in vaults or pits.

PVB may be subject to continuous pressure

223

PVB Operation



224

PVB Tester Responsibility

- Verify that the water can be shut off downstream during the test.
- Verify that the assembly is not subjected to backpressure.
- Restore the assembly to its pre-test condition.
- Prepare the test report completely:
  - Record test values for the check valve and air-inlet valve.
  - Record Shut-off valve tightness.
  - Describe any component failures with detail.

225

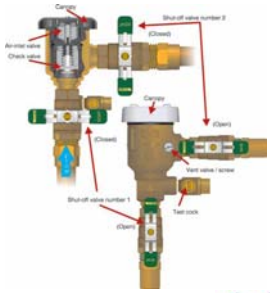
Chapter 8

SPILL-RESISTANT VACUUM BREAKER ASSEMBLY

226

Spill-Resistant Vacuum Breaker (SVB)

- Next-generation pressure type vacuum breaker that will not spill water.
- Components not required to be independent of each other.
- Field testable.



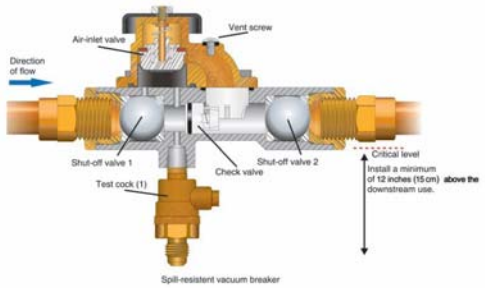
227

Spill-Resistant Pressure Vacuum Breaker Assembly

- **2015 UPC Section 603.3.6**
- A pressure- type vacuum breaker backflow prevention assembly consists of one check valve force loaded closed and an air inlet valve force loaded open to atmosphere, positioned downstream of the check valve, and located between and including two tightly closing shutoff valves and test cocks.

228

SVB Code Requirements



229

Installation Requirements

SVB Must:

- Have adequate supply of air to stop siphon.
- Be upright and plumb.
- Be accessible.
- Be protected from freezing.

SVB Must NOT:

- Be subjected to backpressure.
- Be installed in areas containing toxic fumes.
- Be located in vaults or pits.

SVB may be subject to continuous pressure.

230

Code Requirements

- UPC Section 603.4
- General requirements. Assemblies shall comply with listed standards and be acceptable to the Authority Having Jurisdiction over the selection and installation of backflow prevention assemblies.

231

Code Requirements

- UPC Section 603.4.2
- Testing. The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter or more often where required by the Authority Having Jurisdiction.

232

Code Requirements

- UPC Section 603.4.2
- Testing. The periodic testing shall be preformed in accordance with procedures referenced in the ASSE Series 5000 by a tester qualified in accordance with those standards
- Both the International and National Standard Plumbing Codes contain similar language

233

Is This Installation Correct?

234

SVB Tester Responsibility

- Verify that the water can be shut off downstream during the test.
- Verify that the assembly is not subjected to backpressure.
- Restore the assembly to its pre-test condition.
- Prepare the test report completely:
  - Record test values for the check valve and air-inlet valve.
  - Record Shut-off valve tightness.
  - Describe any component failures with detail.

235

Chapter Seven and Eight Question Break

236

Chapter 9

DOUBLE CHECK VALVE ASSEMBLY

237

Double Swing Check Valve

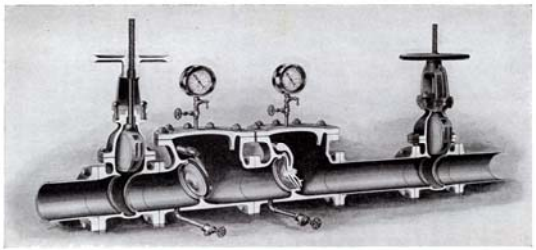
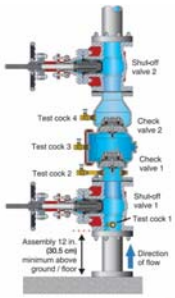


Fig. 4. — Interior of a Set of Double Check-Valves.
Showing relation of gages to clappers and to drains used for testing.

238

Double Check Valve Assembly (DCVA)

- Consists of 2 tightly closing shut-off valves.
- 2 independently acting check valves force loaded to a closed position and.
- 4 properly located test cocks.

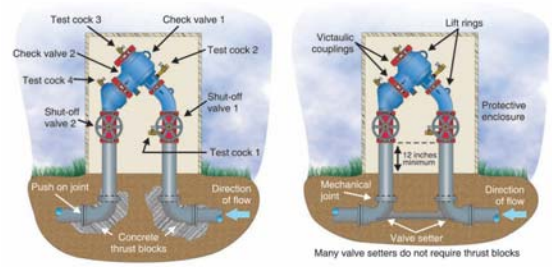


239

Proper Installation?

240

Code Requirements



Double check valve assembly above ground installation

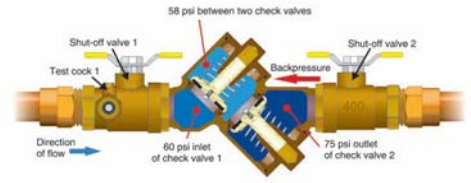
241

Code Requirements

- UPC Section 603.3.4
- Double Check Valve Backflow Prevention Assembly (DC). A double check valve backflow prevention assembly consists of two independently acting internally loaded check valves, four properly located test cocks and two isolation valves.

242

DCVA Operation



Double check valve assembly - static condition with checks closed - downstream backpressure. (Pressure values shown for example only.)

243

Code Requirements

- UPC Section 603.4
- General requirements. Assemblies shall comply with listed standards and be acceptable to the Authority Having Jurisdiction over the selection and installation of backflow prevention assemblies.

244

DCVA Tester Responsibility

- Verify that water can be shut off downstream during the test.
- Restore the assembly to its pre-test condition.
- Test the detector assembly also – verify the operation of the flow indicator and water's ability to flow through the bypass.
- Prepare the test report completely.
  - Record the test values for each check valve.
  - Record the shut-off valve tightness.
  - Describe any failures with detail.
  - Indicate whether the assembly continues to be approved or not.

245

Code Requirements

- UPC Section 603.4.2
- Testing. The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter or more often where required by the Authority Having Jurisdiction.

246

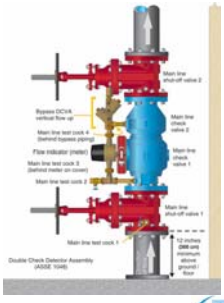
Code Requirements

- UPC Section 603.4.2
- Testing. The periodic testing shall be preformed in accordance with procedures referenced in the ASSE Series 5000 by a tester qualified in accordance with those standards
- Both the International and National Standard Plumbing Codes contain similar language

247

Double Check Detector Assembly (DCDA)

- The Double Check Detector Assembly is a hybrid backflow preventer.
- It was developed from combining the fire-sprinkler industry's single check detector (a check with a bypass meter) and a DCVA.



248

Double Check Detector Assembly (DCDA) Type Two

249

Code Requirements

- UPC Section 603.3.8
- Double Check Detector Fire Protection Backflow Prevention Assembly. A double check valve backflow prevention assembly with a parallel detector consisting of a water meter and a double check valve backflow prevention assembly

250

Dual Check vs Double Check

251

Chapter Nine Question Break

252

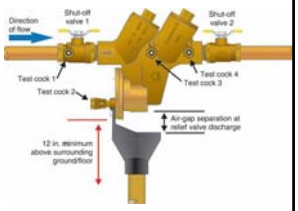
Chapter 10

REDUCED PRESSURE PRINCIPLE ASSEMBLY

253

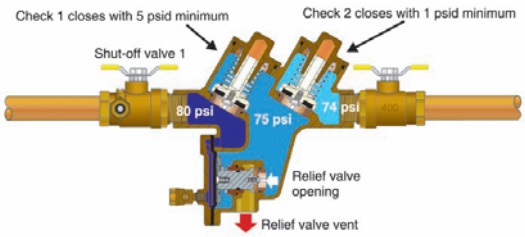
Reduced Pressure Principle Assembly (RP)

- Senses pressure at the inlet and outlet of check valve 1
- Remains closed if supply pressure is greater than zone pressure
- Opens if the difference in pressure between the supply and zone is reduced



254

RP Operation



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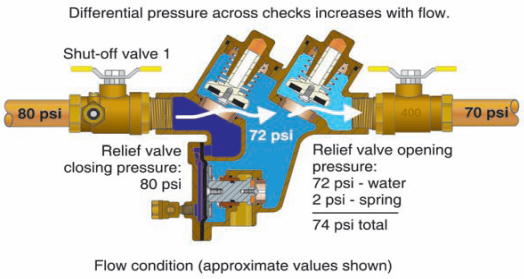

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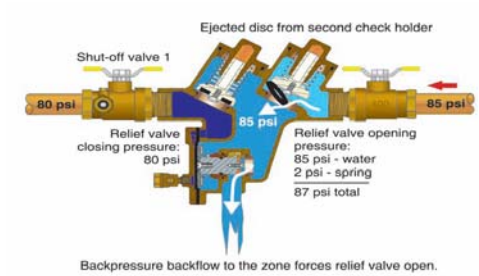

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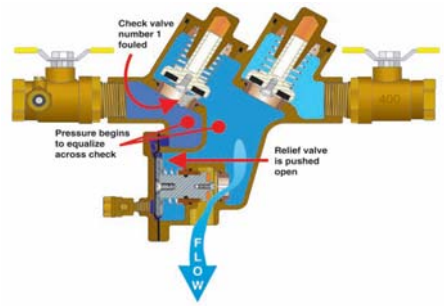


258

Code Requirements

- UPC Section 603.3.7
- Reduced-Pressure Principle Backflow Prevention Assembly (RP). A reduced-pressure principle backflow prevention assembly consists of two independently acting internally loaded check valves, a differential pressure relief valve, four properly located test cocks, and two isolation valves.

259

Code Requirements

- UPC Section 603.4
- General requirements. Assemblies shall comply with listed standards and be acceptable to the Authority Having Jurisdiction over the selection and installation of backflow prevention assemblies.

260

RP Code Requirements and Essentials Conditions for Proper Functioning

- High or low hazard application
- Provides back pressure and backsiphonage protection
- May be used as meter-service protection as containment
- Maybe used on individual fixtures and appliance protection as isolation

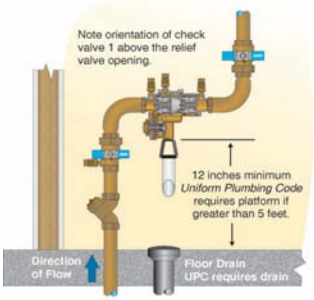
261

RP Code Requirements and Essentials Conditions for Proper Functioning

- Access and clearance requires a minimum of 1 ft. between the lowest portion of the assembly and grade
- Installation elevated exceeding 5 ft. above the grade requires a permanent platform capable of supporting a person
- NOT permitted in a vault or a pit
- Potable water system required to be protected by reduced pressure backflow preventer or reduced pressure detector assembly

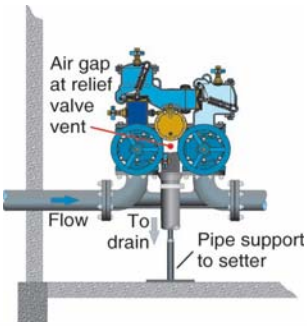
262

RP Installation



Reduced Pressure Principle Assembly Vertical Installation

263



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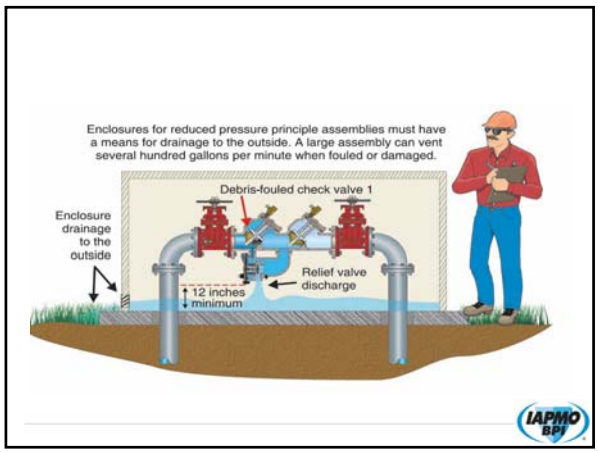

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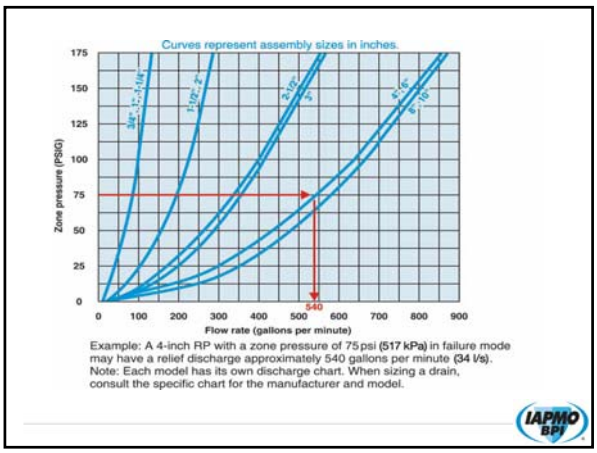

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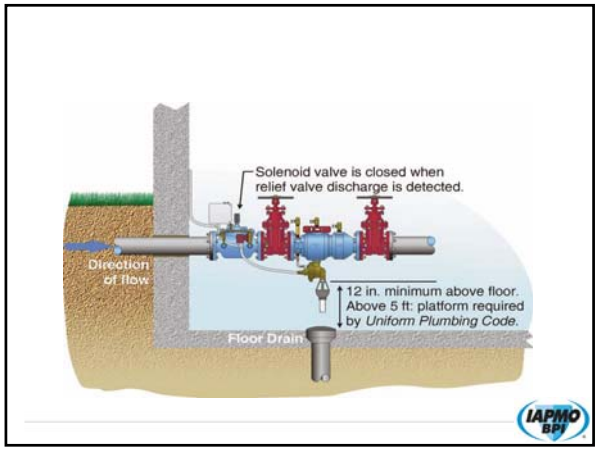
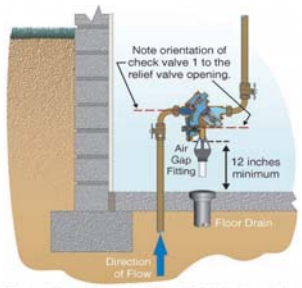


267

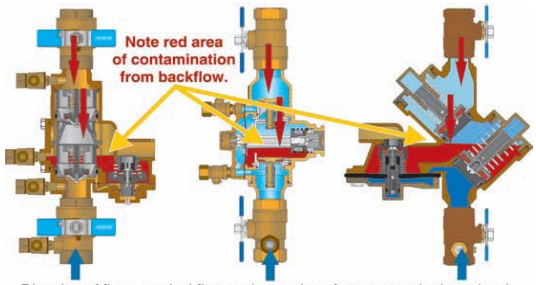
Proper Installation?

268



Reduced Pressure Principle Assembly Vertical Installation

269



Direction of flow - vertical flow up (examples of unapproved orientations)

270

What's Missing?

271

RP Tester Responsibility

- Verify that the water can be shut off downstream during the test
- Restore the assembly to its pre-test condition
- Prepare the test report completely
  - Note potential plumbing code violations
  - Record test values for each check valve
  - Describe any component failures with detail
  - Record shut-off valve tightness

272

Code Requirements

- UPC Section 603.4.2
- Testing. The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter or more often where required by the Authority Having Jurisdiction.

273

Code Requirements

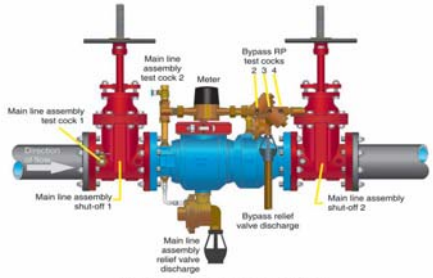
- UPC Section 603.4.2
- Testing. The periodic testing shall be preformed in accordance with procedures referenced in the ASSE Series 5000 by a tester qualified in accordance with those standards
- Both the International and National Standard Plumbing Codes contain similar language

274

Even When You Try To Do It Right

275

Reduced Pressure Detector Assembly



Reduced Pressure Detector Assembly (ASSE 1047)

276

Reduced Pressure Detector Assembly Type Two

277

Code Requirements

- UPC Section 603.3.9
- Reduced Pressure Detector Fire Protection Backflow Prevention Assembly. A reduced pressure backflow prevention assembly with a parallel detector assembly consisting of a water meter and a reduced pressure principle assembly (RP)

278

Chapter 10 Question Break

279

Chapter 11

GAUGES

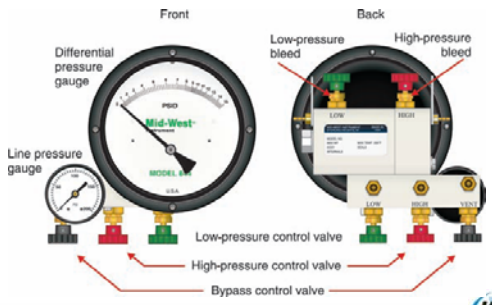
280

What Do We Test With?

- Gauges historically identified by the ASSE Series 5000 standards for testing backflow preventers include:
  - a Differential Pressure Gauge
  - a Digital Gauge or Electronic Transducer
  - a Water Column or Sight Tube
  - a Duplex Gauge

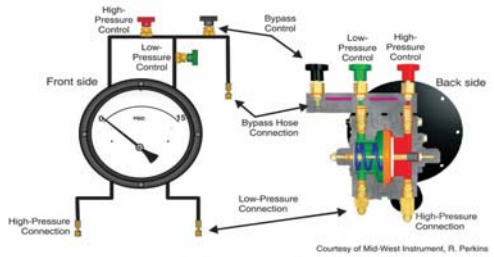
281

Differential Pressure Gauge 5 Valve Kit



282

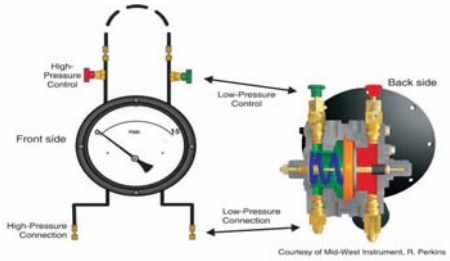
Differential Pressure Gauge 3-Valve Kit



Differential Pressure Gauge - 3-valve

283

Differential Pressure Gauge 2-Valve Kit



Differential Pressure Gauge - 2-valve

284

Digital Gauge or Electronic Transducer

285

Water Column or Sight Tube

286

Water Column or Sight Tube

- Markings should be every 2-3/4" or smaller
- Only used as a general reference tool
- More adaptable to double check valve assemblies and pressure/spill-resistant vacuum breakers

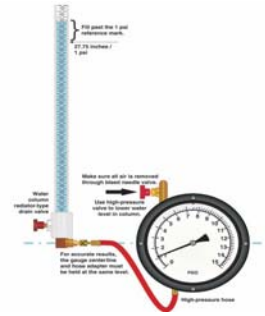
287

Basics a Tester Needs to Know

- Send a gauge for evaluation for any of these observations:
  - Water filling up the case
  - Gauge does not respond to knobs or levers turning
  - Pointer is erratic
  - Moisture under the lens
  - Gauge has been dropped or subject to water shock
  - Gauge has been outdoors at a temperature below 32°

288

Gauge Calibration



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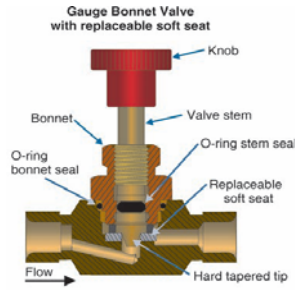
Test Kit Valves



Do not overtighten valve from knob. The valve's hard tapered tip can damage the soft seat.

290

Calibration Labs

- Should be:
  - Traceable to the National Institute of Standards and Technology (NIST)
  - Able to calibrate gauges in a descending direction

291

Reclaimed Water Gauges

- To protect the reclaimed system from contamination, backflow preventers are installed and tested against the same requirements as potable water systems
- A separate gauge should be used when performing tests on assemblies on reclaimed water systems.

292

Adaptors

293

Chapter Eleven Question Break

294

Chapter 13

FIRE-SPRINKLER SYSTEM BACKFLOW PREVENTION

295

Water Based Fire Systems

Standpipe systems are designed to provide water to fire hose connections or hose cabinets strategically installed inside a building. These systems usually are installed in large, open spaces within buildings, and in multistory buildings for the purpose of manual firefighting. Standpipe systems can provide early fire suppression in these buildings making it capable for a single individual or firefighter to offer a quick and effective response to fire.

296

Dry Standpipe Systems

297

Dry Standpipe Systems

298

Water Based Fire Systems

Automatic fire-sprinkler systems consist of an arrangement of piping installed throughout the building that is designed to supply a sufficient amount of water under pressure to an open sprinkler head. Most fire-sprinkler heads, except sprinkler heads on a deluge system, are kept closed by a heat-sensitive operating mechanism. Typically, this operating mechanism is either a fusible link or a glass bulb. Regardless of the operating mechanism, only the sprinklers that are exposed to heat will open during a fire.

299

Four Basic Types

Wet pipe systems are installed in areas where the ambient temperature is maintained at or above 40°F. When a sprinkler is activated by heat from a fire, water flows immediately from the sprinkler head. These systems have water in the pipe at all times. In situations where there is a need to provide sprinklers in an unheated area, such as a small loading dock, an antifreeze system can be used.

300

Four Basic Types

Dry pipe systems usually are installed in large, unheated areas, such as parking garages. These systems have pressurized air or nitrogen in the pipe, which keeps the main dry-pipe valve closed. When a sprinkler activates due to heat, the air is released, allowing the dry-pipe valve to open, filling the system with water, which is discharged through the open sprinkler head to suppress the fire.

301

Four Basic Types

Pre-action sprinkler systems usually are installed in areas where water could cause catastrophic damage, such as in freezers, computer rooms, and areas with electronic equipment. The piping in a pre-action system contains air or nitrogen, which can be pressurized or non-pressurized. Water to the system is held back by the pre-action valve, which is connected to a fire detection system. If a fire occurs, the detection system sends a signal that opens the pre-action valve, which then allows water into the system's piping. The water is discharged through the open sprinkler.

302

Four Basic Types

Deluge systems are designed so that all the sprinkler heads are open and the piping is not pressurized. These systems usually are installed in areas where the possibility of a severe fire condition is likely, such as aircraft hangars. Water to the system is held back by the deluge valve, which is connected to a fire detection system. If a fire occurs, the detection system sends a signal that opens the deluge valve, which then allows water to discharge from all of the sprinklers on the system.

303

Be Aware of Several Possible Situations

- A license or certification for a fire-sprinkler system may be required
- An alarm system maybe installed

304

Control Valves

All control valves must have components that visually indicate whether the valve is open or closed. This list includes some of the most common types of valves, such as:

- Outside screw and yoke valves (OS&Y)
- Butterfly valves
- Post indicator valves (PIV)
- Wall indicator valves (WIV)
- Ball valves

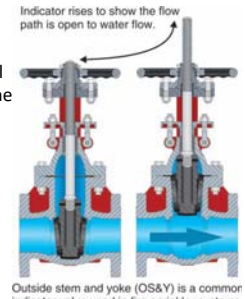
305

Post Indicator Valve

306

Valves Must Be Supervised

- Provided with indicator shutoff valves
- Valves provide an external or visual indication that the gate is open or closed.
- The majority of control valves are OS&Y (outside stem and yoke).



307

Supervised Valves Required

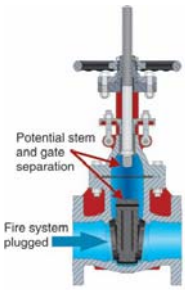
- For a fire-sprinkler system to operate, the control valve or valves must remain open and the system must be continuously monitored. Therefore, there is a device on each control valve that either prevents the valve from being closed or sends an alarm when it is closed. This device can be as simple as a locked chain through the control valve that prevents that valve from opening, or an alarm system that notifies the fire department when the valve is closed. Some systems utilize both methods. *NFPA 13* refers to all such devices as supervisory devices.

308

309

310

- A flow test is required on the system any time a water supply control valve is closed and re-opened.



A system flow test must be performed when a valve is closed and re-opened, such as after a backflow preventer test.

311

2015 Uniform Plumbing Code

603.5.14 Protection from Fire Systems.

- Except as provided under Section 603.5.14.1 and Section 603.5.13.2, potable water supplies to fire protection systems that are normally under pressure, including but not limited to standpipes and automatic sprinkler systems, except in one- or two-family or townhouse residential sprinkler systems, piped in materials approved for potable water distribution systems shall be protected from backpressure and backsiphonage by one of the following testable devices:

312

2015 Uniform Plumbing Code

(1) Double check valve backflow prevention assembly (DCVA)

(2) Double check detector fire protection backflow prevention assembly (DCDA)

(3) Reduced pressure principle backflow prevention assembly (RP)

(4) Reduced pressure detector fire protection backflow prevention assembly (RPDA)

313

2015 Uniform Plumbing Code

603.5.14.2 Chemicals. Where antifreeze, corrosion inhibitors, or other chemicals are added to a fire protection system supplied from a potable water supply, the potable water system shall be protected by one of the following:

- (1) Reduced pressure principle backflow prevention assembly (RP)
- (2) Reduced pressure detector fire protection backflow prevention assembly

314

2015 Uniform Plumbing Code

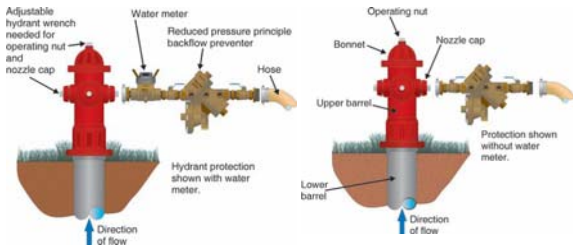
603.5.14.3 Hydraulic Design. Where a backflow device is installed in the potable water supply to a fire protection system, the hydraulic design of the system shall account for the pressure drop through the backflow device. Where such devices are retrofitted for an existing fire protection system, the hydraulics of the sprinkler system design shall be checked to verify that there will be sufficient water pressure available for satisfactory operation of the fire sprinklers.

315

Fire Hydrants

316

Fire Hydrants



317

318

319

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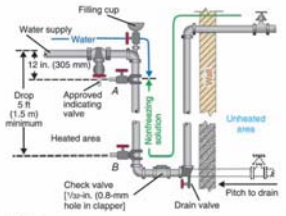
Installation: NFPA 13



Notes:
1. Check valve shall be permitted to be omitted where sprinklers are below the level of A.
2. The 1/32-in. (0.8-mm) hole in the check valve clapper is needed to allow for expansion of the solution during a temperature rise, thus preventing damage to sprinklers.

Figure 4-5.3.1 Arrangement of supply piping and valves.

321

Installation NFPA 13

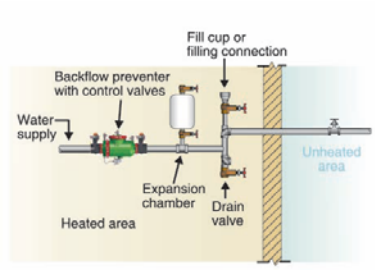


Figure 4-5.3.2 Arrangement of supply piping with backflow device.

322

NFPA 13

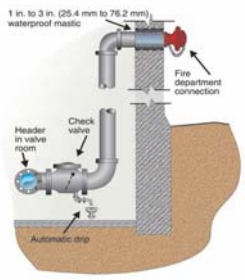


Figure A-5-15.2(a) Fire department connection.

323

2015 Uniform Plumbing Code

603.5.14.1 Fire Department Connection. Where fire protection systems supplied from a potable water system include a fire department (siamese) connection that is located less than 1700 feet (518.2 m) from a nonpotable water source that is capable of being used by the fire department as a secondary water supply, the potable water supply shall be protected by one of the following:(1) Reduced pressure principle backflow prevention assembly (RP)

- (2) Reduced pressure detector fire protection backflow prevention assembly

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NFPA Standards

Fire sprinkler systems, including the backflow prevention assemblies, must be installed per guidelines contained in *NFPA 13 – Installation of Sprinkler Systems, 2013 Edition*.

Testing and maintenance of fire-suppression backflow prevention assemblies must be performed per the guidelines contained in *NFPA 25 – Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2013 Edition.*

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Chapter 13 Question Break

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File Attachments for Item:

ER-4 Introduction to Automatic Sprinkler Systems (National Fire Sprinkler Association)

BO, MPE, BPE, FPPE, BI, FPI (3 hours)

Staff Notes: Ohio-specific slides are gathered at the front (pp, 4-6). Instructor bio is at the very end.

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Ron Ritchey
(Contact Name)

Organization: National Fire Sprinkler Association
(Organization/Company)

Address: 514 Progress Drive
(Include Room Number, Suite, etc.)

City: Linthicum Heights State: MD Zip: 21090

E-Mail: ritchey@nfsa.org and garvey@nfsa.org

Telephone: 7654126707 Fax:

Course Sponsor: National Fire Sprinkler Association

COURSE INFORMATION:

Course Title: Introduction to Automatic Sprinkler Systems

New Course Submittal: ■ Update Course: ☐ Prior Approval Number:

Purpose and Objective: All stakeholders involved in the design, selection, and installation of automatic sprinkler systems need to understand how adopted building and fire codes, NFPA standards interact with each other to ensure sprinkler systems will be meet minimum standards. This seminar will take the participant through the different scope and applications of NFPA 13, 13R, and 13 D sprinkler systems, and provide instruction on occupancy and commodity classifications, a thorough overview of the different types and characteristics of fire sprinklers and explain where to locate the minimum sprinkler obstruction rules outlined in NFPA 13.

Number of Instructional Contact Hours that can be obtained upon completion: 3.0

If Multi-Session, Number of Instructional Contact Hours Per Session:

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■ Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ☐

Building Plans Exam. ✓ Plumbing Inspector ☐

Plumbing Plans Exam. ☐ Non-Res IU Inspector ☐

Electrical Plans Exam. ☐

Mechanical Plans Exam. ☐

Fire Protect. Plans Exam. ✓

Res Building Official ☐ Res Plans Examiner ☐ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☐

Location of ESI Course: Date(s) of ESI Course(s):

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	x
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	x
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	x
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	x
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	x
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	x
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	x
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Seminar Title: Introduction to Automatic Sprinkler Systems

Seminar Description: All stakeholders involved in the design, selection, and installation of automatic sprinkler systems need to understand how adopted building and fire codes, and NFPA standards interact with each other to ensure sprinkler systems will be meet minimum standards. This seminar will take the participant through the different scope and applications of NFPA 13, 13R, and 13 D sprinkler systems, and provide instruction on occupancy and commodity classifications, a thorough overview of the different types and characteristics of fire sprinklers and explain where to locate the minimum sprinkler obstruction rules outlined in NFPA 13.

Duration: 3 hours
Number of Modules: 3
T**otal Instructional Contact Minutes:** 180 minutes

Learning Objectives:

At the conclusion of this seminar the participant will be able to:

1. Understand the differences between Codes and Standards, and their interdependent relationships.
2. Describe the difference in scope and applications of NFPA 13, 13R, and 13D Standards.
3. Identify the different occupancy and commodity classifications and apply the rules for the selection of the appropriate fire sprinkler to protect them.
4. Identify the different types of automatic sprinkler systems and their applications.
5. Understand the different types and characteristics of fire sprinklers and their various applications.
6. Understand sprinkler obstruction rules for different types of sprinklers.

Seminar Schedule

Module 1- Introduction to Automatic Sprinkler Systems	8:30 – 9:30 a.m.
Break	9:30 – 9:45 a.m.
Module 2- Introduction to Automatic Sprinkler Systems	9:45 – 10:45 a.m.
Module 3- Introduction to Automatic Sprinkler Systems	10:45 – 11:45 a.m.

Seminar Schedule Outline

Module 1- Introduction to Automatic Sprinkler Systems 60 minutes

At the conclusion of this module the participant will be able to:

1. Identify the different Ohio Building Code Occupancy Classifications
2. Understand the difference between Codes and Standards, and their relationships
3. Describe the difference between passive and active fire protection systems
4. Describe the different scope and applications of NFPA 13, 13R, and 13D Systems
5. Identify the different occupancy and commodity classifications in NFPA 13.

Module 2- Introduction to Automatic Sprinkler Systems 60 minutes

At the conclusion of this module the participant will be able to:

1. Identify the different types of sprinkler systems (Wet, Dry, Preaction, and Deluge)
2. Understand the three major classifications of sprinklers (CMDA, CMSA, and ESFR) and their proper application.
3. Understand the characteristics of sprinklers, including orientation, thermal sensitivity, temperature rating, and orifice size.
4. Identify special application sprinklers, including window sprinklers, concealed combustible, attic, institutional, and dry sprinklers.

Module 3- Introduction to Automatic Sprinkler Systems 60 minutes

At the conclusion of this module the participant will be able to:

1. Understand the overall concept of obstruction rules.
2. Identify the zones of sprinkler discharge and how the apply to obstruction rules.
3. Located the appropriate sections for the various obstruction rules (beam, 3x, 4x, partition, wide obstruction, and soffit)
4. Identify key “exceptions” to obstruction rules

Current Codes Adopted in Ohio

- **IBC 2015 Model Code**
  - 2017 Ohio Building Code (w/amendments)
    - Ohio Administrative Code 4101:1-1 to 4101:1-35
- **IFC 2015 Model Code**
  - 2017 Ohio Fire Code (w/amendments)
    - Ohio Administrative Code 1301:7-1 to 1301:7-7

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Currently adopted NFPA Referenced Standards

- **NFPA 13 (2016 Edition)** is the currently adopted standard in Ohio, and is referenced in Chapter 35 of the 2017 Ohio Building Code, including TIA 16-6, TIA 16-7, and TIA 16-8, which the Ohio Building / Fire Inspector and Plans Reviewer should be knowledgeable of and familiar with

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2

NFPA 13

- **NFPA 13, 2016 Edition** is the Fire Sprinkler standard found in the Ohio Building Code that the Ohio Building / Fire Inspector and Plans Reviewer should be knowledgeable of and familiar with.

- The definition of "Automatic Sprinkler System" is found in OBC Section 902 it is important to note that the definition includes both underground piping and interior piping.
  - **OBC 902.1 definitions**

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

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NFPA 13 CONT

- The Ohio Building Code references **NFPA 13**, **NFPA 13R** and **NFPA 13D** (The specific edition of NFPA 13 is referenced in OBC Chapter 35 as the 2016 edition) in Sections 903.3.1.1 thru 903.3.1.3 as the state's applicable fire sprinkler standard.

- There are Ohio exceptions to the base code ICC / IBC 2015 edition and NFPA 13, 13R and 13D found in Chapter 9 of the Ohio Building Code. The amendments begin at 903.1 and continue through 903.5. Many but not all of the amendments will be discussed and should be understood by Ohio building and fire officials. The amendments modify when and how fire sprinklers are required and how they must be installed in Ohio.

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Extent of Sprinkler Standards in IBC

- **NFPA 13 is applied to all occupancies (903.3.1.1)**
- **NFPA 13R, residential up to 60 ft and 4 stories (903.3.1.2)**
  - –R's and (I-1 and I-4 OBC Amendment)
- **NFPA 13D, in IBC (903.3.1.3)**:
  - –Townhouses
  - –Group R-3
  - –Group R-4 (Condition 1)Congregate Residences
  - –I-1, (Ohio Building Code Amendment)

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AGENDA

Ohio Fire Chief's Convention
Hilton Columbus at Easton
3900 Chagrin Drive
Columbus, OH 43219

Introduction to Fire Sprinklers
July 13, 2021 - 3 hours

Great Lakes
Field Service Coordinator
Ron Ritchey

ritchey@nfsa.org
(c) 765.412.6707

1

INTRODUCTION TO AUTOMATIC SPRINKLER SYSTEMS

A Program of the National Fire Sprinkler Association

2

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LEARNING OBJECTIVES

- Understand the differences between Codes and Standards, and their interdependent relationships.
- Describe the different scope and applications of NFPA 13, 13R, and 13D Standards.
- Identify the different types of automatic sprinkler systems and their applications.
- Understand the different types and characteristics of fire sprinklers and their various applications.

4

LEARNING OBJECTIVES

- Identify the different occupancy and commodity classifications and apply the rules for the selection of the appropriate fire sprinkler to protect them.
- Understand sprinkler obstruction rules for different types of sprinklers.

5

WHY SPRINKLER A BUILDING?

- Building code requirements
- Insurance requirements
- Offset a weak water supply using less water
- Cheaper to build with sprinklers trade offs in the building code
- State or local requirements
- Voluntary requirement by owner

6

CH 3- IBC Occupancy Types (26 Classifications)

- Assembly: A-1 to A-5
- Business
- Educational
- Factory and Industrial: F-1 & F-2
- High Hazard: H-1 to H-5
- Institutional: I-1 to I-4
- Mercantile
- Residential: R-1 to R-4
- Storage: S-1 to S-2
- Utility

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7

Fire Sprinkler Requirement Factors

- **Fire Sprinkler Requirements driven by these factors:**
  - General Risk Factor (based upon 26 Occupancy Types), and
  - These 4 factors
    - Size of the area ("**building area**" and/or "**fire area**")
    - Number of People ("**occupant load**')
    - Location ("upper floors" and/or "below floors")
    - Unique Building Features
      - Construction Type
      - Windowless Basements
      - Others

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8

IBC Fire Protection Schemes (Passive vs. Active)

- **Passive Fire Protection (IBC Chapter 7)**
  - Fire Walls (IBC 706)
  - Fire Barriers (IBC 707)
  - Horizontal Assemblies (IBC 711)
  - Fire Rated Doors/ Fire & Smoke Dampers, etc.
- **Active Fire Protection (IBC/IFC Chapter 9)**
  - Automatic Sprinkler Systems (IBC/IFC 903)
    - NFPA 13, NFPA 13R, and NFPA 13D
  - Standpipe Systems (IBC/IFC 905)
  - Fire Alarm Systems (IBC/IFC 907)
- **Combination Active/Passive Fire Protection (Trade ups)**
  - Next Slide

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9

9

"Active-Passive" TRADE OFFS (Incentives)

- **Partial Lists include**
  - Height Adjustments (IBC 504)
    - **NFPA 13 or 13R** (increase 1 story and/or 20 feet)
  - Area Adjustments (IBC 506)
    - **NFPA 13 ONLY**
      - 300 % for one-story
      - 200% for two or more stories
  - Reduce and/or Eliminate FRR Corridors
  - Reduce FRR for Occupancy Separations
  - Reduce FRR Stairwells
  - Eliminate or Increase size of Draft Stops (Floor/Ceilings & Attics)
  - Eliminate Fire Dampers in HVAC Ducts (still need smoke dampers)
  - Increase Travel Distance to Exit
  - Reduce Interior Wall & Ceiling Finishes
  - Eliminate Pull Alarms

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10

10

Trade Offs (Incentives)

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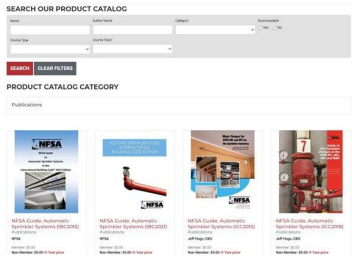

CLICK STORE

CLICK PUBLICATIONS

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12

12

Codes & Standards

What is the difference between Codes & Standards?

- **Codes (WHEN TO)**
  - Trigger installation of systems and requirements
- **Standards (HOW TO)**
  - Govern how the system is to be designed, installed, IT&M

BEWARE OF EXCEPTIONS TO THIS GENERALLY TRUE STATEMENT

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13

13

Conflicts

IBC 102.4.1 Conflicts

Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

IFC 102.7.1 Conflicts

Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

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14

Example - Conflicting Requirements

NFPA 13

- **8.16.1.1.2.1 Supervision**

  "Valves on connections to water supplies, sectional control valves, and other valves in supply pipes to sprinklers…shall be supervised by one of the following: (3) Valves locked in correct position."

IFC

- **903.4 Sprinkler System Supervision & Alarm**

  " All valves controlling the water supply for automatic sprinkler systems…and water-flow switches on all sprinkler systems shall be electrically supervised by a listed fire-alarm control unit."

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15

Fire Sprinklers Standards in the IBC

- All *automatic sprinkler systems* are required to be installed according to the specified installation standards.
- Sprinkler installation standards:
  - **NFPA 13** - All Installations
  - **NFPA 13R** - Residential up to Four Stories
  - **NFPA 13D** – One- and Two-Family Dwellings

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Standards Descriptions

	NFPA 13	NFPA 13R	NFPA 13D
Extent	Throughout	Occupied spaces	Occupied spaces
Scope	• All occupancies • Property and life safety	• Low-rise residential • Life safety	• 1&2 family • Mfg. Homes • Townhouses • Care Facilities • Life safety
Design	Density/area concept	4 sprinkler design	2 sprinkler design
Duration	30-120 minutes	30 minutes	10 minutes

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Extent of Sprinkler Standards in IBC

- **NFPA 13 is applied to all occupancies (903.3.1.1)**
- **NFPA 13R, residential up to 60 ft and 4 stories (903.3.1.2)**
- **NFPA 13D, in IBC (903.3.1.3)**:
  - Townhouses
  - Group R-3
  - Group R-4 Congregate Residences

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Current Codes Adopted in Ohio

- **IBC 2015 Model Code**
  - 2017 Ohio Building Code (w/amendments)
    - Ohio Administrative Code 4101:1-1 to 4101:1-35
- **IFC 2015 Model Code**
  - 2017 Ohio Fire Code (w/amendments)
    - Ohio Administrative Code 1301:7-1 to 1301:7-7

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Currently adopted NFPA Referenced Standards

- **NFPA 13 (2016 Edition)** is the currently adopted standard in Ohio, and is referenced in Chapter 35 of the 2017 Ohio Building Code, including TIA 16-6, TIA 16-7, and TIA 16-8, which the Ohio Building / Fire Inspector and Plans Reviewer should be knowledgeable of and familiar with

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NFPA 13

- **NFPA 13, 2016 Edition** is the Fire Sprinkler standard found in the Ohio Building Code that the Ohio Building / Fire Inspector and Plans Reviewer should be knowledgeable of and familiar with.
- The definition of "Automatic Sprinkler System" is found in OBC Section 902 it is important to note that the definition includes both underground piping and interior piping.
  - **OBC 902.1 definitions**
- **AUTOMATIC SPRINKLER SYSTEM.** An automatic sprinkler system, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The system includes a suitable water supply. The portion of the system above the ground is a network of specially sized or hydraulically designed piping installed in a structure or area, generally overhead, and to which automatic sprinklers are connected in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the fire area.

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NFPA 13 cont

- The Ohio Building Code references **NFPA 13**, **NFPA 13R** and **NFPA 13D** (The specific edition of NFPA 13 is referenced in OBC Chapter 35 as the 2016 edition) in Sections 903.3.1.1 thru 903.3.1.3 as the state's applicable fire sprinkler standard.
- There are Ohio exceptions to the base code ICC / IBC 2015 edition and NFPA 13, 13R and 13D found in Chapter 9 of the Ohio Building Code. The amendments begin at 903.1 and continue through 903.5. Many but not all of the amendments will be discussed and should be understood by Ohio building and fire officials. The amendments modify when and how fire sprinklers are required and how they must be installed in Ohio.

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Extent of Sprinkler Standards in IBC

- **NFPA 13 is applied to all occupancies (903.3.1.1)**
- **NFPA 13R, residential up to 60 ft and 4 stories (903.3.1.2)**
  - R's and (I-1 and I-4 OBC Amendment)
- **NFPA 13D, in IBC (903.3.1.3)**:
  - Townhouses
  - Group R-3
  - Group R-4 (Condition 1)Congregate Residences
  - I-1, (Ohio Building Code Amendment)

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Extent of Sprinkler Standards in IBC

- **NFPA 13 is applied to all occupancies (903.3.1.1)**
- **NFPA 13R, residential up to 60 ft and 4 stories (903.3.1.2)**
  - R's and (I-1 and I-4 OBC Amendment)
- **NFPA 13D, in IBC (903.3.1.3)**:
  - Townhouses
  - Group R-3
  - Group R-4 (Condition 1)Congregate Residences
  - I-1, (Ohio Building Code Amendment)

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HOW DO WE START? (DESIGN OR REVIEW/INSPECT)

ALL sprinkler systems are dependent upon the answer to one question:

What Are We Trying To Protect?

- Is it a warehouse
- Is it not a warehouse

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IF IT IS NOT A WAREHOUSE — IF IT IS A WAREHOUSE

Occupancy Classification (Hazard Classification)	Commodity Classification
Light hazard (LH)	Class I commodity
Ordinary Hazard Group 1 (OH1)	Class II commodity
Ordinary Hazard Group 2 (OH2)	Class III commodity ← Group C Plastic
Extra Hazard Group 1 (EH1)	Class IV commodity ← Group B Plastic
Extra hazard Group 2 (EH2)	Group A Plastic

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CLASSIFICATION OF OCCUPANCIES (HAZARD CLASSIFICATIONS)

Hazard Definition	Light Hazard	Ordinary Hazard Group One	Ordinary Hazard Group Two	Extra Hazard Group One	Extra Hazard Group Two
Product Combustibility	Low	Low	Moderate to High	Very High	Very High
Quantity of Combustibles	Low	Moderate (8' high max)	Moderate to High (12' high max)	Very High	Very High
Heat Release Rates	Low	Moderate to High	Moderate to High	High & Rapidly Developing	High & Rapidly Developing
Flammable Liquids	None	None	None (Limited)	None (Limited)	Moderate to Substantial
Shielding of Combustibles	None	None	None	None	Anticipated

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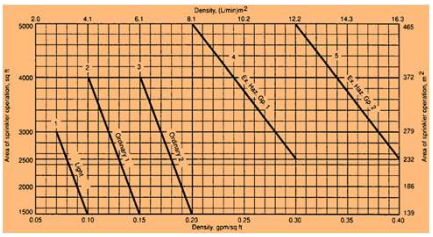
NFPA 13 – DENSITY / AREA CURVES



Examples of Hazards

LH- Office, Residential

OH 1- Restaurant Service

OH 2- Mercantile

EH 1- Plywood Mfg.

EH 2- Plastics Mfg.

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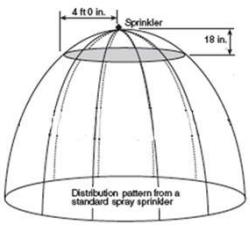
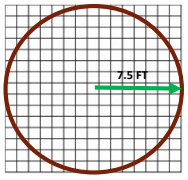
SPRINKLER SPRAY PATTERN — DENSITY PER SQ. FT.



Area of Coverage
15 x 15 = 225 s.f.



LH = 0.10/sf
OH1 = 0.15/sf
OH2 = 0.20/sf
EH1 = 0.30/sf
EH2 = 0.40/sf

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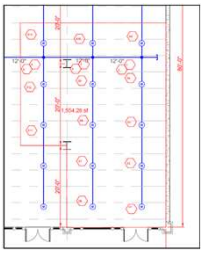
DESIGN/AREA

```
REMOTE AREA NUMBER:1
REMOTE AREA LOCATION:SPACE 5 & 6, SE CORNER
OCCUPANCY CLASSIFICATION: OH2
DENSITY:0.2/1500 gpm/sq. ft.
```



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NFPA 13 – Annex Material

Occupancy

- A.5.2- Light
- A.5.3- Ordinary
- A.5.4 – Extra Hazard

Commodity

- T-A.5.6.3 (Alphabetical Listing) p.299-306
- T-A.5.6.3.1 (Examples of Class I)
- T- A.5.6.3.2 (Examples of Class II)
- T-A.5.6.3.3 (Examples of Class III)
- T-A.5.6.3.4 (Examples of Class IV)
- T-A.5.6.4.1 (Examples of Class A)

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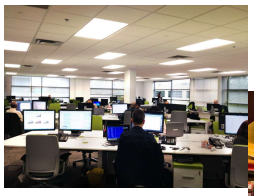
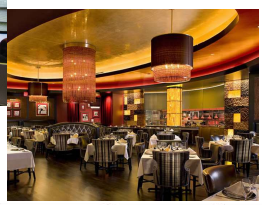
Light Hazard





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A.5.2 – Uses & Conditions similar to:

A.5.1 Occupancy examples in the listings as shown in the various hazard classifications are intended to represent the norm for those occupancy types. Unusual or abnormal fuel loadings or combustible characteristics and susceptibility for changes in these characteristics, for a particular occupancy, are considerations that should be weighed in the selection and classification.

The light hazard classification is intended to encompass residential occupancies; however, this is not intended to preclude the use of listed residential sprinklers in residential occupancies or residential portions of other occupancies.

A.5.2 Light hazard occupancies include occupancies having uses and conditions similar to the following:

(1) Animal shelters
(2) Churches
(3) Clubs
(4) Eaves and overhangs, if of combustible construction with no combustibles beneath
(5) Educational
(6) Hospitals, including animal hospitals and veterinary facilities

Animal Shelters
Churches
Clubs
Educational
Hospitals
Institutional
Nursing or convalescent homes
Offices
Residential
Restaurant Seating Areas

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Light Hazard (Residential)

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Light Hazard (Office)

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Ordinary Hazard – Group I

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Ordinary Hazard – Group II

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Ordinary Hazard

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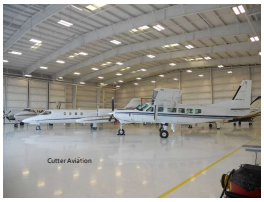
Extra Hazard – Group I & Group II



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Commodity Classification – Relative Fire Hazard

Commodity Class	Fire Hazard Ranking
Special or High-Hazards: Tires, Rolled paper, Group A plastics, Flammable/Combustible liquids, Aerosols	Highest Fire Hazard
Class IV Commodity	
Class III Commodity	
Class II Commodity	
Class I Commodity	Lowest Fire Hazard

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Classification of Commodities: "Three P's"

"A combination of *products*, primary *packaging*, and storage *pallet*."

Product: item being stored	Coffee mugs, engine blocks, plywood panels, wristwatches, toilet paper . . . .
Packing materials around the item	Cardboard boxes with dividers, steel containers, shrink wrap, boxes with foam "peanuts" . . . .
Containers: pallets, bins or storage method	Wood or plastic pallets, plastic, cardboard or paper bin boxes, crates, wooden spools . . .

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The Effect of Packaging

Frozen foods;
non-waxed or non-plastic packaging

Frozen foods:
waxed or plastic-coated paper packaging

Frozen foods:
plastic-coated packaging (including container)

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The Effect of Plastic Pallets

Commodity classification rules assume wooden or metal pallets

Plastic pallets are permitted

Unreinforced

- classification shall be increased by one class
- Must have a permanent symbol marking them

Reinforced

- Classification shall be increased by two classes

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Commodity Classifications (Storage Applications)

Non-combustible	**Class I** Glass jars in a single layer box	**Class II** Glass jars in multiple layer cardboard box
Combustible	**Class III** Paper cups in a box	**Class IV** Paper and Polystyrene cups in a box
Plastics	**Group C**	**Group B** / **Group A** Polystyrene cups in a box

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Storage- Group A Plastic

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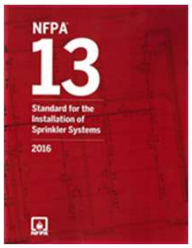
System Types – Chapter 7



7.1 Wet Pipe Systems
7.2 Dry Pipe Systems
7.3 Preaction and Deluge Systems.
7.4 Combined…Systems…Piers
7.5 Multi-Cycle Systems
7.6 Antifreeze Systems
7.7 Systems with Non-Fire Connection
7.8 Exposure Protection….
7.9 Refrigerated Spaces
7.10 Cooking Equipment
7.11 Additives and Coatings

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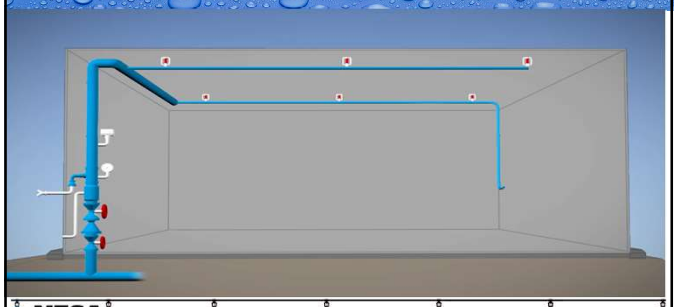
Wet Pipe System - Activation



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Dry Pipe Sprinkler System – Activation

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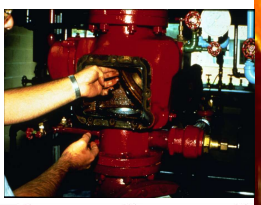
Dry Pipe Valve



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538 – Quick Opening Devices

- Installed to meet discharge times.
- Must be listed

- **Accelerators**

- **Exhausters**

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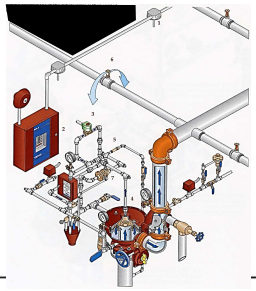
Preaction Systems

- Interlock
  - Single
  - Double
  - Non



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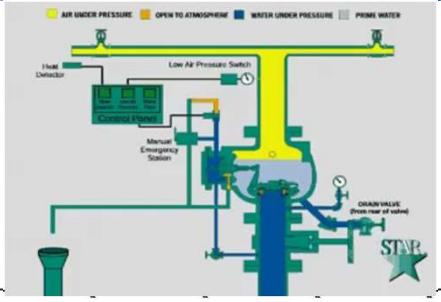
Double Interlock System Operation



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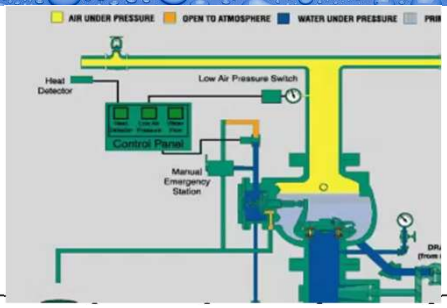
Double Interlock System False Operation



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Deluge Sprinkler System – Activation

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Deflector Style

- Sprinklers can be made to distribute water to different places with different droplet sizes.

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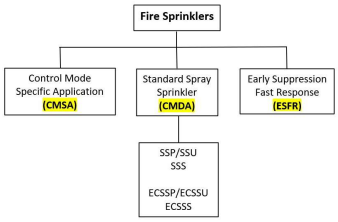
Sprinkler Types



Non-Storage Applications
CMDA
(typical)

Storage Applications
(Large Drop Sprinklers)
CMSA or ESFR
(typical)

CMDA
(usually require in-racks)

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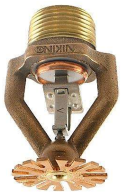
What Type of Sprinkler is Being Used?

Control Mode Density Application (CMDA)

Control Mode Special Application (CMSA)

Early Suppression-Fast Response (ESFR)



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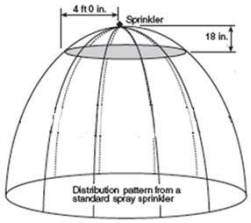
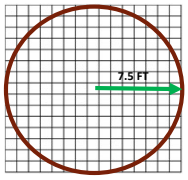
Sprinkler Spray Pattern



Area of Coverage
15 x 15 = 225 s.f.



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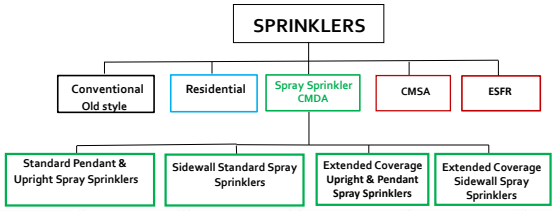
Sprinkler Categories



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Spacing and Positioning Rules

8.5 **Position, Location, Spacing and Use of Sprinklers**
8.6 Standard Spray: Up. & Pend.
8.7 Standard Spray: Sidewalls
8.8 Ex. Coverage: Up. & Pend.
8.9 Ex. Coverage: Sidewalls
8.10 Residential Sprinklers
8.11 CMSA Sprinklers
8.12 ESFR Sprinklers
8.13 In-Rack Sprinklers

8.x.1 General
8.x.2 Protection Area per Sprinkler
8.x.3 Sprinkler Spacing
8.x.3.1 Max. Distance Between
8.x.3.2 Max. Distance Walls
8.x.3.3 Min. Distance Walls
8.x.3.4 Min. Distance Between
8.x.4 Deflector Position
8.x.5 Obstructions…Pattern Dev.
8.x.6 Clearance to Storage
8.x.7 Skylights

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Spacing and Positioning Rules

8.5 **Position, Location, Spacing and Use of Sprinklers**
8.6 Standard Spray: Up. & Pend.
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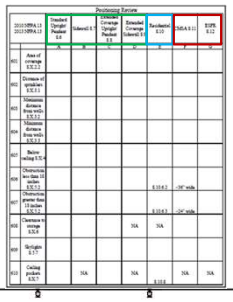
8.8 Ex. Coverage: Up. & Pend.
8.9 Ex. Coverage: Sidewalls
8.10 Residential Sprinklers
8.11 CMSA Sprinklers
8.12 ESFR Sprinklers
8.13 In-Rack Sprinklers



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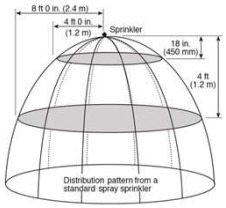
Characteristics of a Sprinkler (Which Sprinkler to Use?)

- **Water Distribution Characteristics**
  - ✓Deflector Style
- **Installation Orientation**
- **Thermal Sensitivity- RTI**
- **Temperature Rating**
- **Orifice Size**
- **Special Applications**

Sprinkler Discharge Pattern (SSP & SSU)



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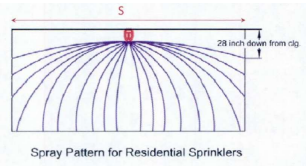
Residential Sprinkler Spray Pattern



Spray Pattern for Residential Sprinklers

Residential sprinklers are tested to **ANSI/UL Standard 1626, "Residential Sprinklers for Fire Protection Service**."

Residential sprinklers are intended to control fire growth and prevent flashover in the space where fire starts.

When they operate, residential sprinklers are designed to distribute water in a flat pattern to wet the upper 28 inches (711 mm) of the walls and to prevent flashover from the high temperatures that accumulate near the ceiling.

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Standard Spray Pendant

Residential Pendant Spray

[redacted]

[redacted]

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Standard Spray Sidewall

[redacted]

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Extended Coverage Sprinkler

[redacted]

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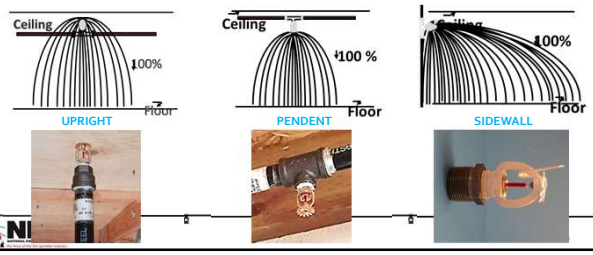
Three Basic Types of Sprinkler Orientation

It is the deflector that decides



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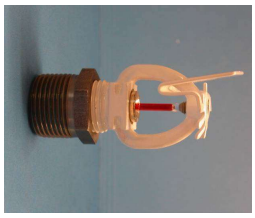
Horizontal Sidewall



Vertical Sidewall

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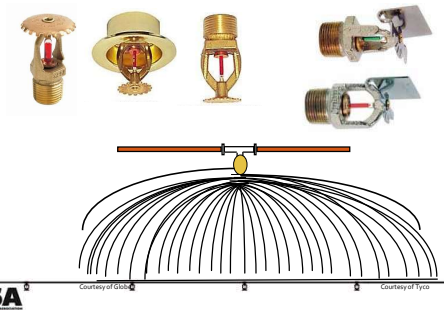
Extended Coverage Sprinklers



Courtesy of Globe

Courtesy of Tyco

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SSP & EC Spray Pattern Comparisons

[redacted]

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Are Thermal Sensitivity and Temperature Ratings the Same?

Temperature Ratings correspond with the ambient air temperatures that the sprinklers will be installed in.

Thermal Sensitivity ratings are based upon the reaction time of the fire sprinkler in fire conditions.

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Response Characteristics

- **Standard Response**
- **Fast Response**
  - Quick Response
  - Quick Response Extended Coverage
  - ESFR
  - Residential

Quick Response Sprinkler(3.6.4.8)

- A type of spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds) ½ or less and is listed as quick-response.

Residential Sprinkler (3.6.4.9)

- A type of fast-response sprinkler having a thermal element with an RTI of 50 (meter-seconds)1/2 or less and has been specifically investigated for its ability to enhance survivability in the room of fire origin, and that is listed for use in protection of dwellings.

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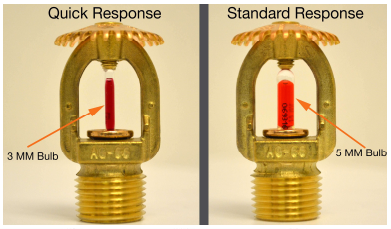
Sprinkler Characteristics- Thermal Sensitivity

Thermal sensitivity – RTI How fast is it going to go off?



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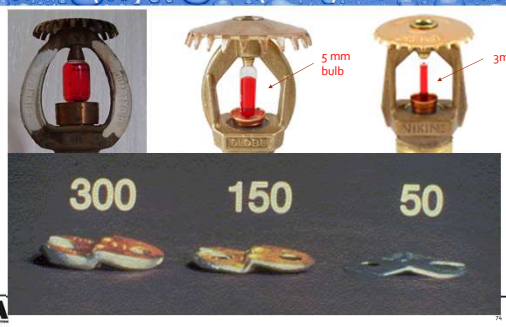
Standard Response (past) / Standard Response (present) / Fast Response



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Sprinkler Temperature Ratings

Temperature Classification	Temperature Rating	Max Ceiling Temperature	Glass Bulb Color	Frame Color (Soldered Link)
Ordinary	135 – 170	100	Orange or Red	Uncolored or Black
Intermediate	175 – 225	150	Yellow or Green	White
High	250 – 300	225	Blue	Blue
Extra High	325 – 375	300	Purple	Red
Very Extra High	400 – 475	375	Black	Green
Ultra High	500 – 575	475	Black	Orange
Ultra High	650	625	Black	Orange

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High Temperature Sprinkler (250-300 F)

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Temperature Ratings

Courtesy of Victaulic

Ordinary Temp.
(Org or Red)
135-170 F

Intermediate Temp.
(Green or Yellow)
175-225 F

Courtesy of Victaulic

High Temp.
(Blue)
250-300 F

Courtesy of Tyco

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77

High Temperature Sprinkler (250-300 F)

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Temperature Rating Rules

- Ordinary or intermediate temperature sprinklers shall be used throughout:
  - Higher temperature sprinklers are required by other sections.
- High temperature sprinklers are permitted to be used in:
  - Ordinary hazard
  - Extra hazard
  - Storage occupancies
  - As permitted by other NFPA documents

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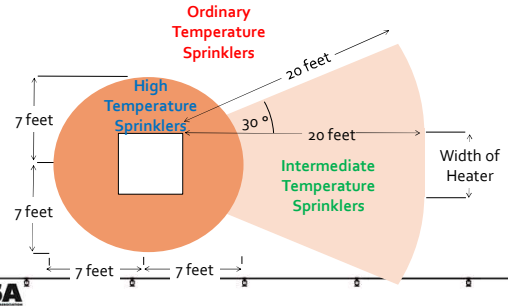
Proximity to Heat Sources

80

Horizontal Unit Heater – Plan View



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Residential Sprinklers

Courtesy of Reliable Sprinkler

Courtesy of Tyco Fire Products

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Residential Sprinklers

Residential Sprinkler Summary — Table A

Sprinkler Model	Sprinkler Identification Number (SIN)	Orientation	K-Factor gpm/psi[1/2] (lpm/bar[1/2])	Thread Size NPT or ISO7-1	Installation Options	Max. Coverage Area ft x ft (m x m)
KRes30	R3591	Pendent	3.0 (43)	1/2	Pendent or Recessed	16 x16 (4.9 x 4.9)
KRes49	R3596	Pendent	4.9 (71)	1/2	Pendent or Recessed	20 x 20 (6.1 x 6.1)
KRes58	R3593	Pendent	5.8 (84)	1/2	Pendent or Recessed	20 x 20 (6.1 x 6.1)
KRes44 HSW	RA3591	Horizontal Sidewall	4.4 (63)	1/2	Sidewall or Recessed	16 x 20 (4.9 x 6.1)
KRes58 HSW	RA3503	Horizontal Sidewall	5.8 (84)	1/2	Sidewall or Recessed	16 x 20 (4.9 x 6.1)
KRes 58 HSWX	RA3593	Horizontal Sidewall	5.8 (84)	1/2	Sidewall or Recessed	14 x 26 (4.3 x 7.9)

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Orifice Size

- Sprinklers are made in at least 13 different orifice sizes
  - See Table 6.2.3.1 in NFPA 13
- The larger the orifice, the easier it is for water to discharge from the sprinkler
- Orifice sizes are described by using the term “k-factor”

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Sample of Orifice Sizes

K 4.2 K 5.6 K 14.0 K 25.2

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Sprinkler Discharge Characteristics

Table 6.2.3.1 Sprinkler Discharge Characteristics Identification

Nominal K-factor [gpm/(psi)$^{1/2}$]	K-factor Range [gpm/(psi)$^{1/2}$]	K-factor Range [dm^3/min/(kPa)$^{1/2}$]	Percent of Nominal K-5.6 Discharge	Thread Type
1.4	1.3–1.5	1.9–2.2	25	½ in. NPT
1.9	1.8–2.0	2.6–2.9	33.3	½ in. NPT
2.8	2.6–2.9	3.8–4.2	50	½ in. NPT
4.2	4.0–4.4	5.9–6.4	75	½ in. NPT
5.6	5.3–5.8	7.6–8.4	100	½ in. NPT
8.0	7.4–8.2	10.7–11.8	140	¾ in. NPT or ½ in. NPT
11.2	11.0–11.5	15.9–16.6	200	½ in. NPT or ¾ in. NPT
14.0	13.5–14.5	19.5–20.9	250	¾ in. NPT
16.8	16.0–17.6	23.1–25.4	300	¾ in. NPT
19.6	18.6–20.6	27.2–30.1	350	1 in. NPT
22.4	21.3–23.5	31.1–34.3	400	1 in. NPT
25.2	23.9–26.5	34.9–38.7	450	1 in. NPT
28.0	26.6–29.4	38.9–43.0	500	1 in. NPT

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Pre-1999 Edition

Table A.6.2.3.1

K-factor	Orifice Size (inches)
1.4	1/4
1.9	5/16
2.8	3/8
4.2	7/16
5.6	1/2
8.0	17/32
11.2	5/8
14.0	3/4
16.8	-
19.6	-
22.4	-
25.2	-
28.0	-

1999 Edition to Present

Table 6.2.3.1

K-factor	Thread Type (NPT=inches)	Percentage of Nominal Discharge
1.4	1/2	25
1.9	1/2	33.3
2.8	1/2	50
4.2	1/2	75
5.6	1/2	100
8.0	1/2 or 3/4	140
11.2	1/2 or 3/4	200
14.0	3/4	250
16.8	3/4	300
19.6	1	350
22.4	1	400
25.2	1	450
28.0	1	500

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What does K-factor mean? Size of opening

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Application of Special Sprinklers

When evaluated and listed

- Window sprinklers
- Combustible concealed
- Attic sprinklers
- Institutional
- Conventional

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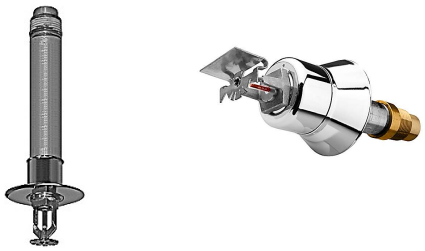
Dry Sprinklers (Dry Barrel)



Courtesy of Tyco Fire Products

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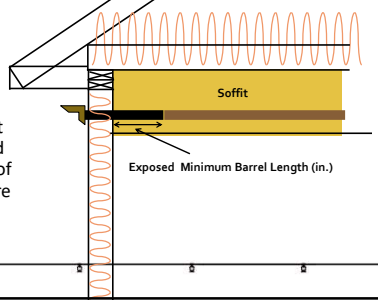
Application of Dry Barrel Sprinklers

Criteria is based on assumption of tight seal at exposed end and realistic choice of ambient temperature



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Application of Dry Barrel Sprinklers

Ambient Temp. at Discharge End of Sprinkler (°F)	EXPOSED BARREL AMBIENT TEMP (°F)		
	40°F	50°F	60°F
	Exposed Minimum Barrel Length (in.)		
40	0	0	0
30	0	0	0
20	4	0	0
10	8	1	0
0	12	3	0
-10	14	4	1
-20	14	6	3
-30	16	8	4
-40	18	8	4
-50 +	20	10	6

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Intermediate Level

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Corrosion Resistant

Wax Coated

Nickel Plated

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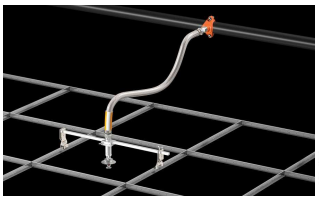
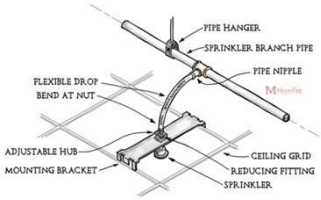
Flexible Sprinkler Drops (Flex Heads)





Flexible "Armover"

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Flexible Sprinkler Drops

FRICTION DATA LOSS & SPECIFICATIONS

FlexHead Model #	Internal I.D.	Outlet Orifice Size	Hose Assembly Length	Maximum Number of 90-degree Bends 3" – UL	8" – FM		Maximum Equivalent Length of Schedule 40, Nominal 1in. Diameter Pipe, ft		Maximum Ambient Temperature Rating F (C)	Maximum Rated Pressure psi (kPa) / psi (kPa)		Maximum K-factor
	in	in (cm)	ft (cm)		1Year	30Year	FM	UL		Standard	H-Series	
2024, 2024H	1	1/2 (1.27)	2 (0.6)	3	1	2	18.4	11	300° (148°)	175 (1205) / 300 (2068)		5.62
2036, 2036H	1	1/2 (1.27)	3 (0.9)	3	2	3	26.6	16	300° (148°)	175 (1205) / 300 (2068)		5.62
2048, 2048H	1	1/2 (1.27)	4 (1.2)	4	3	4	30.3	24	300° (148°)	175 (1205) / 300 (2068)		5.62
2060, 2060H	1	1/2 (1.27)	5 (1.5)	4	4	4	35.8	29	300° (148°)	175 (1205) / 300 (2068)		5.62
2072, 2072H	1	1/2 (1.27)	6 (1.8)	4	4	4	45.6	35	300° (148°)	175 (1205) / 300 (2068)		5.62
2036F100	1.25	1 (14)	3 (0.9)	3	-		7.1		300° (148°)	175 (1205)		22.4
2048F100	1.25	1 (14)	4 (1.2)	4	-		8.3		300° (148°)	175 (1205)		22.4
2072F100	1.25	1 (14)	6 (1.8)	4	-		10.1		300° (148°)	175 (1205)		22.4

Model Numbers: The "H" designates high pressure unit rated to 300 psig and the "E" designates elbow style unit. The "F" designates high flow rate using 1 1/4" internal hose diameter.

Flex-head products are intended for use in hydraulically designed wet, pre-action, deluge or dry pipe sprinkler connections per NFPA 13, 13R, and 13D guidelines. The hydraulic loss of the Flex-head connector needs to be included in the hydraulic design calculation the same as a valve or fitting. *Each FlexHead sprinkler drop has a* ***3" minimum bend radius per UL guidelines, and a 8" minimum bend radius per FM guidelines.***

****FM Equivalent Length Numbers include maximum "K" factor sprinkler head that is listed.****

* Equivalent lengths are shown with maximum number of 90 degree bends at the minimum bend-radius. Different values were obtained by FM and UL due to the differences in minimum bend radius, testing protocol and calculation methods. Please see individual testing standards for more information relative to friction loss (Equivalent Length of Pipe).

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Window Sprinklers -Listed or Standard Spray Sprinkler?

- **Listed Window Sprinkler**
  - IBC – Exterior Wall Protected Opening, 705.8
  - Up to a 2-hr rating as alternative means and methods
- **Standard Spray Sprinkler**
  - Atrium
  - Glazing in I-3 (jails & prisons)
  - Draft curtains at escalators

"…fire resistance rating of …assembly shall be established without the use of automatic sprinklers… incorporated as part of the assembly tested in accordance… However, this section shall not prohibit or limit the duties and powers of the building official allowed by Section 104.10 and 104.11."

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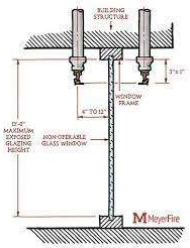
Window Sprinkler Listings

- Specific rules
  - No mullions
  - Can't be openable
  - Barrier for trash



Courtesy Joe Meyers- Meyers Fire

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NFPA 13 – Sprinkler-Protected Glazing

8.15.26* Sprinkler-Protected Glazing. Where sprinklers are used in combination with glazing as an alternative to a required fire-rated wall or window assembly, the sprinkler-protected assembly shall comply with the following:

(1) Sprinklers shall be listed as specific application window sprinklers unless the standard spray sprinklers are specifically permitted by the building code.
(2) Sprinklers shall be supplied by a wet-pipe system.
(3) Glazing shall be heat-strengthened, tempered, or glass ceramic and shall be fixed.
(4) Where the assembly is required to be protected from both sides, sprinklers shall be installed on both sides of the glazing.
(5) The use of sprinkler-protected glazing shall be limited to non-load-bearing walls.
(6) The glazed assembly shall not have any horizontal members that would interfere with uniform distribution of water over the surface of the glazing, and there shall be no obstructions between sprinklers and glazing that would obstruct water distribution.
(7) The water supply duration for the design area that includes the window sprinklers shall not be less than the required rating of the assembly

A.8.15.26 It is not the intent of this section to apply to sprinkler protection of glass atrium enclosures, pedestrian walkways, which are permitted by NFPA *101*, or model building codes to be protected by standard spray sprinklers installed in accordance with the special provisions set forth in those codes for atrium construction. In some cases, sprinkler protected assemblies as an alternative to a required fire-rated wall or window assembly could require the approval of the building official.

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IBC and Stairways

- Unenclosed openings floor openings, AND
- Sprinklers are serving as the enclosure:
  - Closely spaced sprinklers:
    - 6 ft apart
    - 6-12 inches from draft stop
  - Draft stop:
    - Adjacent to opening
    - 18 inches deep (NO TRENCHES IN CEILING)

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Factors Involved With Sprinkler Selection

- 13 different orifice sizes
- 2 different response characteristics
- 7 different temperature ratings
- 8 different deflector styles
  - ➢These deflector styles play a critical role in the delivery of water to suppress the various types of fires (HRR)
- 1456 different kinds of sprinklers!
  - – Not counting extended coverage sprinklers, recessed, semi-recessed, concealed, aesthetic coloring, etc…

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Sprinkler Identification Number (SIN)

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Sprinkler Cabinet List

A list of sprinklers installed shall be posted in sprinkler cabinet

The list to include:
- SIN or (Mfg./Model/Orifice/Deflector Type/Thermal Sensitivity)
- General Description
- Quantity of each type
- Issue or revision date of list

Sprinklers Contained in this Cabinet

Sprinkler Identification, SIN	General Description	Temperature Rating, °F	Sprinkler Quantity Maintained
TY9128	Extended Coverage, K-25, upright	155	6
VK425	Concealed pendent residential	145	6

Issued: 10/3/05 Revised:

FIGURE A.6.2.9.7.1 Sample List.

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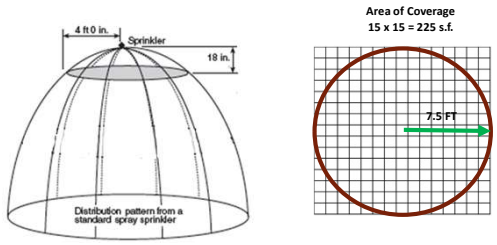
Sprinkler Spray Pattern



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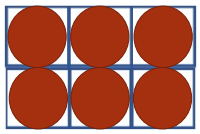
Shadow Areas



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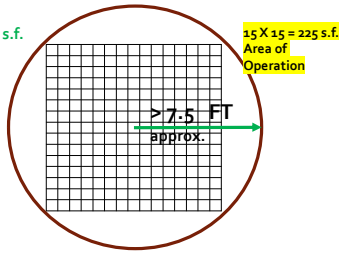
Sprinkler Spray Pattern on Floor (Actual)



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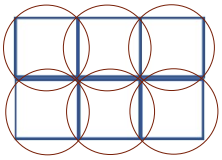
No Shadow Areas



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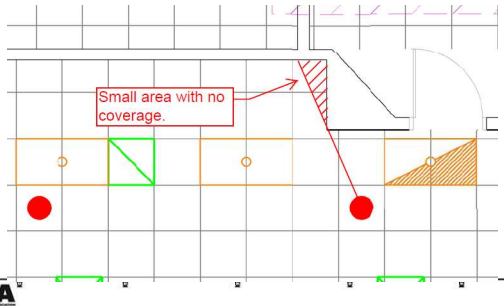
Shadow



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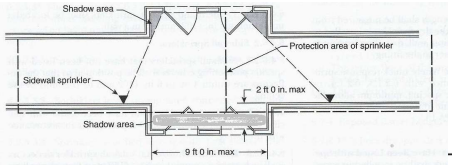
NFPA 13R & NFPA 13D Shadows

- A single sprinkler can have up to 15 sq. ft. of dry area.
- Corridors are permitted up to 2 ft in depth and 9 ft in length



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Obstruction Rules Learning Objectives

- Identify the intent of the obstruction rules.
- Identify the zones of sprinkler discharge as they apply to obstruction rules.
- Apply the "Beam Rule", "3-Times Rule", "Partition Rule", and "Wide Obstruction Rule.
- Identify key exceptions to the obstruction rules.

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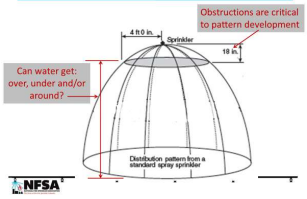
Sprinkler Pattern Development (SSP & SSU)

Pattern Development



Upper Zone (>18 inches)

- Obstructions to Sprinkler Pattern Development
  - Beam, Soffit, 3x rule

Lower Zone(>18 inches)

- Obstructions that Prevent Sprinkle Discharge from Reaching Hazard
  - Partition Rule

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Obstructions to Discharge Pattern Development

Basic Philosophy

- Throw sufficient water under the obstruction; OR
- Throw sufficient water to both sides of the obstruction; OR
- Throw sufficient water over the obstruction

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Obstruction Definitions

Continuous Obstruction:

- Located at or below sprinkler deflector and affect the discharge pattern of two or more adjacent sprinklers.

Noncontinuous Obstruction:

- Located at or below sprinkler deflector and affect the discharge pattern a single sprinkler.

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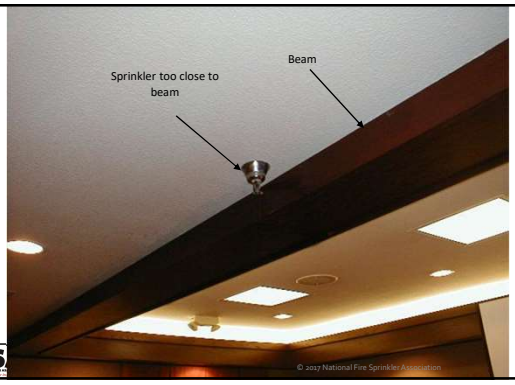

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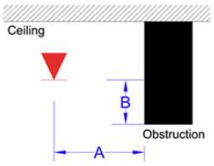
Beam Rule Table

If "A" (inches)	Maximum Allowable "B" (inches)
< 12	0
12 – 17.9	2.5
18 – 23.9	3.5
24 – 29.9	5.5
30 – 35.9	7.5
36 – 41.9	9.5
42 – 47.9	12
48 – 53.9	14
54 – 59.9	16.5
Table continues	

Beam Rule Figure



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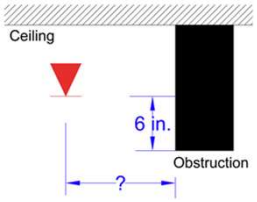
Beam Rule: Example



If deflector is 6 in above bottom of obstruction – how far does sprinkler need to be to meet the beam rule?

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Beam Rule: Example

If "A" (inches)	Maximum Allowable "B" (inches)
< 12	0
12 – 17.9	2.5
18 – 23.9	3.5
24 – 29.9	5.5
30 – 35.9	7.5
36 – 41.9	9.5
42 – 47.9	12
48 – 53.9	14
54 – 59.9	16.5
Table continues	

If deflector is 6 in above bottom of obstruction – how far does sprinkler need to be to meet the beam rule?

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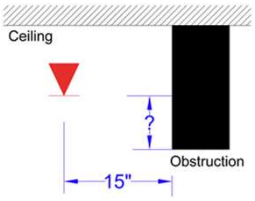
Beam Rule: Example



If sprinkler is 15 in. from the obstruction, how far is the deflector allowed to be above the bottom of the beam?

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Beam Rule: Example

If "A" (inches)	Maximum Allowable "B" (inches)
< 12	0
12 – 17.9	2.5
18 – 23.9	3.5
24 – 29.9	5.5
30 – 35.9	7.5
36 – 41.9	9.5
42 – 47.9	12
48 – 53.9	14
54 – 59.9	16.5
Table continues	

If sprinkler is 15 in. from obstruction, How far does deflector need to be above the bottom of the beam?

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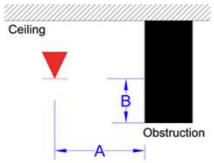
EC Beam Rule: Table 8.10.6.1.2

If "A" (inches)	Maximum Allowable "B" (inches)	SSP/SSU
< 12	0	0
12 – 17.9	0	2.5
18 – 23.9	1	3.5
24 – 29.9	1	5.5
30 – 35.9	1	7.5
36 – 41.9	3	9.5
42 – 47.9	3	12
48 – 53.9	5	14
54 – 59.9	7	16.5
Table continues		



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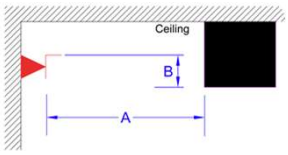
SSW Beam Rule: Table 8.7.5.1.3

If "A" (ft)	
< 4ft	Not allowed
4 to <5	1
5 to <5 ½	2
5 ½ to <6	3
6 to <6 ½	4
6 ½ to <7	6
7 to <7 ½	7
7 ½ to < 8	9
8 to < 8 ½	11
8 ½ or greater	14



Double Values of "A" for EC Sidewalls

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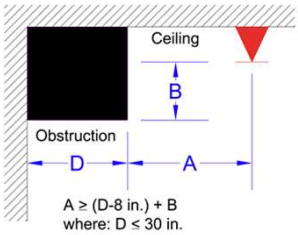
Figure 8.6.5.1.2(b) Obstructions Against Walls – Special Case of the "Beam Rule"



Same for EC

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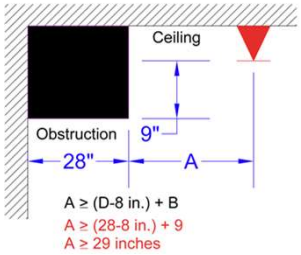
Figure 8.6.5.1.2(b) Obstructions Against Walls – Special Case of the "Beam Rule"

Example:

SOFFITS & Others



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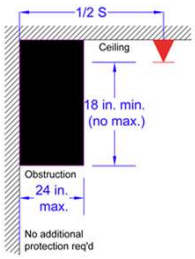
122

Figure 8.6.5.1.2(b) Obstructions Against Walls – Special Case of the "Beam Rule"



Same for EC

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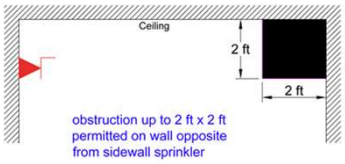
123

8.7.5.1.6* Obstructions Against Walls – Special Case of the "Beam Rule"



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124

Three Times Rule (3x Rule)

8.6.5.2.1.3* Minimum Distance from Obstructions. Unless the requirements of 8.6.5.2.1.4 through 8.6.5.2.1.9 are met, sprinklers shall be positioned away from obstructions a minimum distance of three times the maximum dimension of the obstruction (e.g., structural members, pipe, columns, and fixtures) in accordance with Figure 8.6.5.2.1.3(a) and Figure 8.6.5.2.1.3(b).

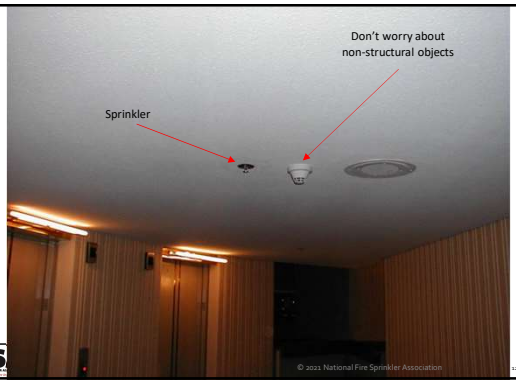
(A) The maximum clear distance required shall be 24 in. (600 mm).

(B) The maximum clear distance shall not be applied to obstructions in the vertical orientation (e.g., columns).

- Used when the obstruction is not continuous to get sufficient water to both sides or over and under
- For LH and OH consider only structural members

125

125



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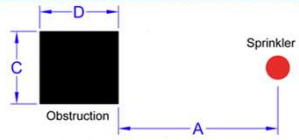
126

126

3x Rule



A ≥ 3C or 3D
A ≤ 24 in.

If C or D (whichever is greater)	Then A must be at least
1 inch	3 inches
2 inches	6 inches
4 inches	12 inches
8 inches	24 inches
12 inches	24 inches

Same for SSW

127

3x Rule

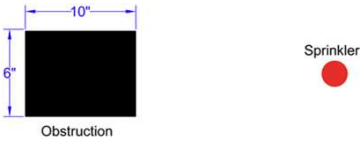
How far does the sprinkler need to be from the obstruction to meet the 3 times rule?

8 inch x 3 = 24 inch

128

3x Rule

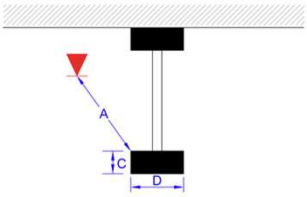
How far does the sprinkler need to be from the obstruction to meet 3 time rule?



10 inch x 3 = 30 inch
Max. Clear distance = 24 inch
Answer is 24 inches

129

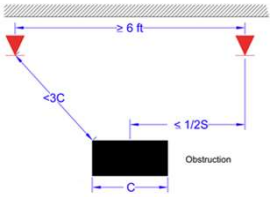
3x Rule



A ≥ 3C or 3D
up to 24 inch max.

130

Exception to 3x Rule (8.6.5.2.1.5)

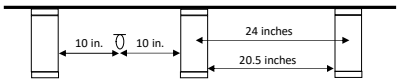


- Sprinklers on the other side of obstruction
  - Distance from centerline of obstruction to sprinkler must not exceed ½ allowable distance between sprinklers

131

Exception to 3x Rule (8.6.5.2.1.6)

- Where obstructions consist of open trusses 20 inches or greater apart (24 inches on center) sprinklers shall be permitted to be located one-half the distance between the obstructions provided that all truss members are not greater than 4 inches in width

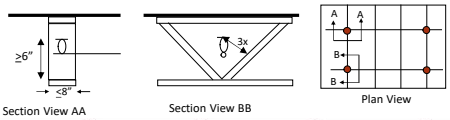


3 x 3.5 inches = 10.5 inches
situation misses three-times rule by ½ inch,
but this section says it's OK

132

Exception to 3x Rule (8.6.5.2.1.7)

- Sprinklers installed on the centerline of bar joists or a truss
  - No more than 8" wide member
  - Sprinkler must be 6" or more above bottom member
  - Sprinkler must follow 3x rule from web member



Section View AA Section View BB Plan View

NFSA

133

Exception to 3x Rule

- Piping to which an upright sprinkler is directly attached less than 3 inches in diameter
- Piping to which pendent sprinklers are directly attached
- Sprinklers positioned to meet 8.6.5.1.2, the "beam rule"

NFSA

134

Ceiling Fan

Sprinklers can be placed without regard to the blades of ceiling fan when:

- Less than 60 inches Diameter
- Plan view at least 50 % open

NFSA

135

Ceiling Fans

HIGH VOLUME LOW SPEED FANS (HVLS)

- 12.1.4
  - Max fan dia. 24 feet
  - HVLS fan centered between 4 sprinklers
  - Vertical clearance from fan to sprinkler deflector min. of 3 feet
  - Interlocked to shut down upon waterflow alarm

NFSA

136

Extended Coverage (4x Rule)

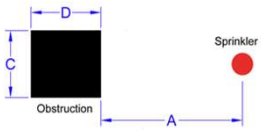
Sprinklers shall be located at a distance **Four times** greater than the maximum dimension of the obstruction

- Maximum distance from obstruction is ***36 inches***
- Used when the obstruction is not continuous to get sufficient water to both sides or over and under
- ~~For LH and OH consider only structural members~~

NFSA

137

EC 4x Rule



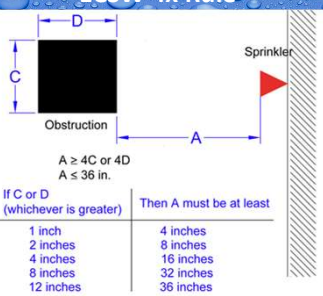
A ≥ 4C or 4D
A ≤ 36 in.

If C or D (whichever is greater)	Then A must be at least
1 inch	4 inches
2 inches	8 inches
4 inches	16 inches
8 inches	32 inches
12 inches	36 inches

NFSA

138

ECSW 4x Rule



A ≥ 4C or 4D
A ≤ 36 in.

If C or D (whichever is greater)	Then A must be at least
1 inch	4 inches
2 inches	8 inches
4 inches	16 inches
8 inches	32 inches
12 inches	36 inches

139

Floor-Mounted or Suspended Vertical Obstructions Below Sprinklers

- Light Hazard Only
- Use Figure and Table 8.6.5.2.2
- Privacy curtains, room dividers, freestanding partitions

Same for EC	Same for SSW	Same for ECSW

PARTITION RULE

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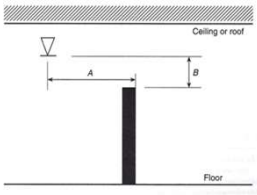
Partition Rule

A (inches)	B (inches)
≤ 6	3
6 to 9	4
9 to 12	6
12 to 15	8
15 to 18	9 1/2
18 to 24	12 1/2
24 to 30	15 1/2
> 30	18



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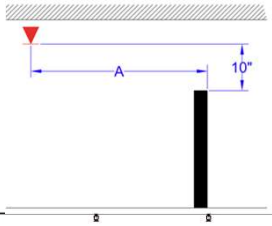
141

Partition Rule

If deflector is 10 in above partition, How far does the sprinkler need to be from the partition?



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142

Partition Rule

A (inches)	B (inches)
≤ 6	3
6 to 9	4
9 to 12	6
12 to 15	8
15 to 18	9 1/2
18 to 24	12 1/2
24 to 30	15 1/2
> 30	18

If deflector is 10 in above partition, How far away does sprinkler need to be?

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143

Round Duct Rules (8.6.5.3.7)

Sprinklers installed under **ROUND DUCTS** shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.

Intermediate-Level Sprinkler

144

Partition Rule

Privacy Curtains shall not be considered obstructions where:

(1)Curtains supported by fabric mesh on ceiling track
(2)Openings in mesh are 70% open or greater
(3)Mesh extends at least 22 inches down from ceiling.

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145

Light Hazard Only

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146

Obstructions that Prevent Sprinkler Discharge from Reaching the Hazard

- 8.6.5.3.3 Sprinklers shall be installed under obstructions which are over 4 feet wide
- 8.6.5.3.4 Sprinklers are not required under obstructions that are not fixed in place such as conference tables

Same for EC	Same for SSW	Same for ECSW

- No guidance for multiple small obstructions

147

Clearance to Storage

- Pendent and upright spray sprinklers clearance to storage is a minimum of 18 inches.
- **Storage on a shelf against a wall, the 18 inch minimum does not apply**.
- 8.6.6.2

148

Thank you!!

Any questions??

Ron Ritchey
ritchey@nfsa.org
(c) 765.412.6707

149

149

Instructor Information for Ohio Board of Building Standards

Ron Ritchey, Great Lakes Field Services Coordinator

Ron Ritchey began his career with the National Fire Sprinkler Association after retiring from the Lafayette Indiana Fire Department with 23 years of service, sixteen of those years as Assistant Chief of the Fire Prevention Bureau. He is now responsible for the oversight of membership services for the five state region in the Great Lakes area and travels throughout the United States conducting training programs to improve the understanding and implementation of the codes and standards relating to water-based fire protection systems.

Mr. Ritchey holds numerous state and national certifications, and his education includes earning an Associate's Degree in Public Safety and a Bachelor's Degree in Business Management. He has developed and presented many training seminars for code officials, code consultants, building owners, and design professionals throughout the country and has served as Co-Chairman for the Fire Inspectors Association of Indiana's (FIAI) Building and Fire Code Committees.

Ron is a member of the National Fire Protection Association, the International Code Council, numerous fire chief and fire inspector associations, and is a Certified Fire Protection Specialist and Instructor.

Mr. Ritchey has received a number of awards and recognitions from both state and local organizations and has served on and chaired various technical code committees representing the fire service.

File Attachments for Item:

ER-5 Cincinnati Inspector Cross Training Part 4 (BCFA)

Provider: Building and Fire Code Academy

RBI, RMI (four sessions, three hours each)

Staff Notes: Tabled in March for staff review: missed for May meeting: administratively approved with chair input: recommend ratification of approval.

Committee Recommendation:

CRITERIA FOR SUBMITTING CONTINUING EDUCATION COURSES FOR BOARD OF BUILDING STANDARDS CERTIFICATIONS

The Ohio Board of Building Standards approves Continuing Education Courses for building department personnel. The courses may be used for the attainment of goals that are connected with technical and professional development as they relate to enforcing and interpreting the Ohio State Building Codes. Board approval is granted only on course instruction pertaining to OBC, OMC, OPC, and RCO requirements and such other content areas directly related to the responsibilities of the certification for which credit is being requested.

Instructors: Anyone or any organization promoting an approved course, is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, certifications for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising shall not disclose improper approval information to the public.

Course sponsors/co-sponsors: provide participants a certificate of completion containing the following information: name of participant, title of approved courses, BBS approval #, BBS approved certifications, date of the continuing education program, number of approved credit hours awarded and signature of authorized sponsor or instructor.

Anyone or any organization administering an approved course shall provide the Board with advanced written information on scheduling of the course(s) (date and place) and provide to the Board a legible list of participants who completed the course with the name of course, date, and location.

Participants: Must attend the complete course as presented by the instructor to receive credit hours approved by the Board. No partial credit shall be given to any participant who failed to complete the entire course as approved. The sponsor/co-sponsor or instructor shall formulate a method to verify the individual's attendance and completion of the course.

Board approval: Remains in effect through the calendar year of approval. The course may be renewed administratively by sponsor application in subsequent years so long as it references current codes and standards Upon the Board's adoption of a new edition of the codes, course sponsors must update their course and submit to the Board for approval. The Board does not grant retroactive approval for courses presented prior to approval date.

Facility/training area: Shall be capable of comfortably and safely seating at least the number of attendees with writing surfaces for each attendee; accessible to/and usable for people with disabilities; sized and provided with audio/visual equipment adequate so that each attendee can see the instructor(s) and overhead screen and hear the content of the training programs; illuminated for writing and that the content on an overhead screen can be seen easily by all attendees; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: George Sweeney
(Contact Name)

Organization: Building and Fire Code Academy
(Organization/Company)

Address: 2420 Vantage Drive
(Include Room Number, Suite, etc.)

City: Elgin State: IL Zip: 60124

E-Mail: GSweeney@bfcacademy.com

Telephone: (847) 428-2951 Fax: (847) 428-2911

Course Sponsor: Richard A. Piccolo, Building and Fire Code Academy

COURSE INFORMATION:

Course Title: _____

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: The City will be cross training the Residential and Property Maintenance Inspectors. This class will provide an explanation

The class is based on the 2019 edition of the Residential Code of Ohio. The audience for this class is the current Residential Building Inspectors and the current property maintenance.

The class consists of lecture with a Power Point presentation with related problem-solving activities.

Number of Instructional Contact Hours that can be obtained upon completion: 12

If Multi-Session, Number of Instructional Contact Hours Per Session: 3

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐ Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐

Building Plans Exam. ☐ Plumbing Inspector ☐

Plumbing Plans Exam. ☐ Non-Res IU Inspector ☐

Electrical Plans Exam. ☐

Mechanical Plans Exam. ☐

Fire Protect. Plans Exam. ☐

Res Building Official ☐ Res Plans Examiner ☐ Res Building Inspector ☒ Res Mechanical Inspector ☒ Res IU Inspector ☐

Electrical Safety Inspectors ☐

Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

RICHARD A. PICCOLO
Master Code Professional

PRESIDENT
B & F CONSTRUCTION CODE SERVICES, INC.
BUILDING & FIRE CODE ACADEMY

CERTIFICATIONS

- Certified Building Official
- Certified Fire Official II
- Certified Fire Fighter III
- ICC® Certified Fire Inspector
- Illinois Certified Fire Inspector
- Certified Accessibility Inspector
- Certified Property Maintenance Inspector
- Certified Plans Examiner
- Certified Building Inspector
- Certified Fire Service Instructor IV
- Certified Energy Inspector
- Certified Master Code Professional

AUTHOR/ INSTRUCTOR

- Understanding the International Building Code (2000, 2003, 2006, 2009, 2012)
- Understanding the International Fire Code (2000, 2003, 2006, 2009, 2012)
- Fire Resistive Construction Requirements
- Understanding Non Structural Plan Review
- Understanding the International Mechanical Code (2006, - 2012)
- Understanding the International Plumbing Code –(2009 – 2012)
- Kitchen Hood and Duct System Plan Review
- Understanding the BOCA® National Building Code (1990 – 1999)
- Advanced Decision Making
- Managing Special Events
- Sprinkler System Plan Review
- Understanding the 1990 – 1999 BOCA® National Fire Prevention Code
- Understanding the 1996 – 1999 BOCA® National Building Code
- Understanding the 2002 – 2012 NFPA 101

INSTRUCTOR

- 1984 BOCA® Fire Prevention Code
- National Certification For Construction Code Inspectors Workshop
- Fire Prevention Principles - Levels I & II
- Principles of the 1987 BOCA® National Building Code
- Principles of the 1984 BOCA® National Building Code

ADJUNCT FACULTY

William Rainey Harper College – Palatine, IL (1984 – 1999)
- Course Title: BOCA ® National Building Code
- Course Title: Basic Code Enforcement
- Course Title: Fire Inspection Principles

BACKGROUND	Elk Grove Village Fire Department – 19 Years Public Education Office President, Illinois Institutional Fire Training, Inc. 23 Years
EDUCATION & TRAINING	Northeastern University B.A. Harper College, Palatine IL A.S. Fire Science 240 Hour Inspectors Training Course Fire Instructor Training: Levels I & II
COURT CERTIFIED CODE EXPERT	Designated Court Certified expert on Building Codes in 1995 *Provided trial testimony for the County of Kankakee, IL (Plaintiff) in County of Kankakee vs Tim Harrington, U.S. District Court No. 940 V 134* *Provided deposition for Village of Schiller Park, IL (Plaintiff), Village of Schiller Park vs SP Club, Inc. U.S. District Court No. 94 C 1422* *Deposition for Village of Addison (Defendant), Hispanics of United DuPage County vs Village of Addison, IL U.S. District Court 94 C 6075 & 95 C 3926* *Deposition for Village of Good Field, IL (Defendant), Clark v. Village of Good Field, et al., Case No. 03 L 96* *Deposition for Charles Gaston, Jr. (Plaintiff), Charles Gaston v. City of Danville, et al., Case No.06 L 35*
PROFESSIONAL AFFILIATIONS	North West Building Officials Association Suburban Building Officials National Fire Protection Association (NFPA) International Association of Continuing Education & Training (IACET) Illinois Fire Inspectors Association Chairman, Codes and Standards Committee 1983 - Current
SPECIAL TRAINING CLASSES	Florida Pennsylvania Ohio Fire Academy AIA Presentation w/National Gypsum Association Army Corps of Engineers
MILITARY SERVICE	US Army 2 years – Honorable Discharge

Education & Certification

Education (http://www.iccsafe.org/education-certification/education/training-events/)

Certification and Testing (http://www.iccsafe.org/education-certification/certification-and-testing/)

(https://shop.iccsafe.org/codes/2015-international-codes-and-references.html)

Certified Professional Information:

Last, First MI: Piccolo, Richard
Certified under this name: Richard Piccolo
Company: B & F Construction Code Services Inc
City, State Zip: Elgin, IL 60124-7867
Phone: 847-428-7010
Certification Type(s): Accessibility Inspector/Plans Examiner (expires 06/29/2018)
Building Inspector (expires 06/29/2018)
Building Plans Examiner (expires 06/29/2018)
Commercial Building Inspector (expires 06/29/2018)
Commercial Energy Inspector (expires 06/29/2018)
Commercial Energy Plans Examiner (expires 06/29/2018)
Fire Inspector I (expires 06/29/2018)
Fire Prevention I - NFPC (expires 06/29/2018)
ICC/AACE Property Maintenance & Housing Inspector (expires 06/29/2018)
Master Code Professional (expires 06/29/2018)

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Contact Information

1-888-ICC-SAFE (422-7233) ext. 5524

Contact Us (mailto:certexam@iccsafe.org

OFFICE & SHIPPING:
2420 Vantage Drive
CORRESPONDENCE:
P. X 5178
EL IL 60121-5178

CONSTRUCTION CODE SERVICES, INC.
BUILDING & FIRE PROTECTION PLAN REVIEW
TRAINING • INSPECTIONS • CODE CONSULTING

PHONE (847) 428-7010
FAX (847) 428-3151
TOLL FREE 1-800-232-5523
E-MAIL bfccs@bfccs.org

Kenneth J. Garrett

BACKGROUND

Kenneth J. Garrett has been employed by B & F Construction Code Services for 17 years as Vice President and Instructor. Ken is responsible for managing the daily operation of B & F Construction Code Services, Inc. and is positioned to provide leadership, guidance and effect teamwork for the technical staff. Ken reviews training materials, outlines and objectives for existing and new curriculum, for both internal training and classes offered externally. He develops new outlines, objectives and learning outcomes for new curriculum for company courses and serves as an instructor for Academy courses. Ken, in conjunction with the President of B & F Construction Code Services, Inc., oversees the current and future operation of training services provided by the company and shall evaluate the effectiveness and instructional technique of instructors.

Prior to working at B & F Construction Code Services, Ken was employed by the City of Zion, IL as the Assistant Director of Community Development. Ken was responsible for overseeing all functions of the building department, supervising a staff of nine employees.

EDUCATION / TRAINING

2012 Master's Degree – Public Administration, Governors State University
1995 Bachelor's Degree- Public Administration, Governors State University
1990 Code Enforcement Certificate Program, William Rainey Harper College
1983 Associate Degree- Fire Science Technology, William Rainey Harper College

CERTIFICATIONS / LICENSES / REGISTRATIONS

Certified as a Master Code Professional through the International Code Council

PREVIOUS TEACHING / TRAINING EXPERIENCE

Author and Instructor

Understanding the International Property Maintenance Code
Understanding the Basics of Code Enforcement
Management I and II
Inspection Challenges & Solutions

Instructor

Understanding the International Residential Code
Understanding the International Residential Code-Plan Review
Understanding the International Building Code – Parts I, II, III
Understanding the International Fire Code
Understanding the International Mechanical & Fuel Gas Codes
Fire Resistive Construction Requirements

Education & Certification

Education (http://www.iccsafe.org/education-certification/education/training-events/)

Certification and Testing (http://www.iccsafe.org/education-certification/certification-and-testing/)

(https://shop.iccsafe.org/codes/2015-international-codes-and-references.html)

Certified Professional Information:

Last, First MI: Garrett, Kenneth J
Certified under this name: Kenneth J Garrett
City, State Zip: Palatine, IL 60195-2089
Certification Type(s): Accessibility Inspector/Plans Examiner (expires 08/26/2017)
Building Inspector (expires 08/26/2017)
Certified Building Official (expires 08/26/2017)
Commercial Building Inspector (expires 08/26/2017)
Commercial Energy Inspector (expires 08/26/2017)
Master Code Professional (expires 08/26/2017)
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Licensed Architect with a wide variety of residential and light commercial experience. Able to create and document cost-efficient, practical designs resulting in high client satisfaction. Results-oriented, creative problem-solver.

Industry Experience

Architectural Firms, 12 years experience including:

- **Sengstock Architects**, Owner / Architect
- **OKW Architects**, Senior Architect
- **Bloodgood Sharp Buster Architects and Planners**, Project Architect
- **Nelson Associates Architects**, Job Captain

Homebuilders / Remodeling, 15 years experience including:

- **Greenscape Homes**, Director of Architecture
- **Airoom Architects and Builders**, Project Architect
- **Pinehurst Homes**, Director of Architecture and Construction
- **Town and Country Homes**, Director of Architecture
- **Pulte Home Corporation**, Assistant Director of Architecture
- **Neumann Homes**, Project Architect

Environmental Engineering and Education, 6 years experience including:

- **Building & Fire Code Academy**, Adjunct Instructor
- **Westwood College**, Adjunct Instructor
- **Law Associates**, Staff Architect
- **University of Illinois**, Teaching Assistant

Education

Master of Architecture, University of Illinois, May 1989

Master of Business Administration, University of Illinois, May 1989

Bachelor of Science, Architectural Studies, University of Illinois, May 1986

Continuing Education including:

Value Engineering
Sales and Construction techniques
Building Science / Quality Management
Green Building and Energy Conservation
Hiring, Teambuilding, and Supervisory skills
Code Updates

continued

Gregory D. Sengstock is a Licensed Architect in private practice with a wide variety of residential and light commercial experience. As proprietor of Sengstock Architects, Greg specializes in the design of new custom and production homes, additions, accessibility renovations, disaster remediation, and commercial build-outs. With over 30 years of experience working with large and small builders and architectural firms, he has an in-depth understanding of project program scope creation, efficient yet elegant design, construction documentation, building codes, and construction permitting. As an effective project manager and team leader, Greg has simultaneously guided multiple developments from several clients. His interest in Value Engineering reduces building costs while Green Building and Building Science techniques have reduced operational and maintenance costs for his clients. Greg has been responsible for dozens of Key Award winning projects.

Greg earned his Bachelor of Science, Architectural Studies as well as Master of Architecture and Master of Business Administration degrees from the University of Illinois. He is an Adjunct Instructor at the Building & Fire Code Academy and has taught courses in the Construction Management program at Westwood College. He has been a Professional Member of the Association of Licensed Architects and the International Code Council. Greg lives in St. Charles, IL with his wife and two children.

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CITY OF CINCINNATI INSPECTION CROSS TRAINING PROGRAM INTERNATIONAL PROPERTY MAINTENANCE CODE & RESIDENTIAL CODE OF OHIO

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UNDERSTANDING THE

2019 RESIDENTIAL CODE OF OHIO

MECHANICAL

INTRODUCTION

This workbook, including all illustrations, is designed to enhance general knowledge and understanding and is not intended as a substitute for the code. Neither this text nor the course are endorsed by the International Code Council and represent the sole project of the author.

The text, including illustrations and course content, represent the opinion of the author and instruct based on accepted industry practices, formal interpretations, research and analysis as to the application, intent and rationale. It is not intended as a design manual but rather to serve as an educational guide.

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Course Description

Mechanical requirements of the 2019 Residential Code of Ohio ® are notated and defined, illustrating code requirements for the proper installation of mechanical systems. Instructors identify and discuss code requirements for furnaces, combustion air, gas piping, and proper installation of different types of residential appliances. Additional components include venting and fuel gas requirements for residential mechanical systems.

Learning Objectives

Students will demonstrate problem solving by utilizing given calculations to determine code compliance for residential mechanical systems.

Students will recognize and employ the venting and fuel gas requirements for residential mechanical systems demonstrated by calculating given examples and defending the decision.

Students will determine confined and unconfined areas, utilizing given examples and situations.

CHAPTER 12 – ADMINISTRATION

* Administrative provision of Chapter 12 apply to mechanical requirements of Chapters 13-24
* Non-gas fired appliances Chapters 13-23
* Gas fired appliances Chapter 24
* Covers permanently installed mechanical systems installed to regulate environmental conditions within buildings, including:
    - Design
    - Installation
    - Maintenance
    - Alteration and inspection
* Administrative Sections in Chapter 1 apply
* Regulates system specifically addressed in code
    - Items not covered – official must use other methods
    - Experience referenced standards, other codes

♦ Existing systems 1202

* Additions, alterations, etc. shall comply as if new
    - Not to be detrimental to existing equipment
* Existing systems can remain – lawfully installed
* Maintenance required
    - Kept in proper operating condition in accordance with the original design, including safety devices
* Make a list of fuels for Chapters 13 – 23
* Make a list of fuels for Chapter 24

CHAPTER 13 – GENERAL MECHANICAL SYSTEM REQUIREMENTS

* Refer to 2018 IFGC and 2018 IMC for items not covered
* General 1301
* Identification 1301.2
    - Pipe, tubing and fittings
    - Each length of pipe shall bear the identification of the manufacturer
* Installation of materials 1301.3
    - Materials installed per standard
    - No standard instruction – follow manufacturer's instructions
    - If manufacturer or standard does meet code – follow code
    - Plastic pipe per NSF14 (National Sanitary Foundation) 1301.3
* Third party testing or certification 1301.4
    - Pipe, tubing and fitting – tested or certified

♦ Approval 1302

* All appliances listed and labeled for application and use or approved per 104.11

♦ Labeling of Appliances 1303

* All appliances shall be labeled 1303.1
    - Label requirements
        - Manufacturer's name and trademark
        - Model and serial number / Testing agency identification
        - Electrical information / BTU/h ratings for absorption units
        - Input BTU/h ratings – fuel type / clearances
        - Electric comfort heating – maintenance instructions

♦ Type of Fuel 1304

* Fuel types 1304.1

- Appliance designed for type of fuel to be used
- Design for high altitude when applicable
- No increase or decrease beyond rating

♦ Appliance Access 1305

* Appliance access for inspection, service, repair and replacement 1305.1

- Sufficient size for service, repair, maintenance, replacement, and inspection without removal of permanent construction
- 30” x 30” working space in front of control side for service
- Appliances in rooms 1305.1.1
  - Access via minimum 24” wide door
  - Large enough to permit removal of appliance
  - 30” deep working space and height of appliance
- Appliances in attics 1305.1.2
  - Access openings (30”h x 20”w) and passageway (30”h x 22”w) large enough to allow removal after disassembly minimum
  - Not more than 20’ from attic access
  - Solid flooring from access to appliance and at service space 24” wide
  - Level service space front and/or side 30” x 30”
  - Illumination via switched light at opening, service outlet required per Chapter 38
  - Exception #2 – Passageway increased to 50’ when unobstructed 6’ in height and minimum 22” clear width
- Appliances under floors 1305.1.3
  - Same access requirements as attic
  - Protect walls if greater than 12” below grade
  - Supported level on concrete slab or approved material or suspended from structure

- 6” clearance to grade
- Illumination via switched light at openings, service outlet required
- Not more than 20’ from crawlspace access
- Exception: passageway unlimited in length when unobstructed 6’ height and minimum 22” in clear width

♦ Clearance from Combustible Construction 1306

* Appliance clearance 1306.1
  - Per appliance manufacturer
  - Clearance reduction per Table 1306.2
  - Not permitted for solid fuel appliances with listed clearance of 12” or less
  - Table differs from IMC Table 308.6
  - When ventilated air space is required – 1” clearance on all sides of assembly
* Reduce Clearance to Combustibles Table 1306.2
  - See Figure 1306.1

♦ Appliance Installation 1307

* Per manufacturer’s installation instructions
* Attached to appliance
* Anchored in an approved manner – seismic considerations
* Ignition source elevated minimum 18” in garages
* Protected from vehicular impact
  - Elevation or see International Fire Code
* Hydrogen Generating and Refueling 1307.4
  - Maximum floor area 850 square feet
  - Communicate directly to the outdoors
  - 2 openings in garage, within 12” top and bottom, directly to outdoors

- Minimum free openings 0.5 sq. ft. per 1,000 Cu Ft. of garage volume
- Louvers or grills- net free area – 25% or 75%
- Mechanical ventilation per the IMC

♦ Mechanical Systems Installation 1308

* Drilling and notching per Sections 502.8, 602.6, 602.6.1, 802.7, 505.3.5, 603.3.4, 804.3.5

* Drilling and Notching of Studs – Cut or Notched Studs 602.6

  - Notching bearing = < 25% of width
  - Non-bearing = < 40% of single stud width
  - Drilling non-bearing = < 60% and no closer than 5/8” from edge
  - Drilling on bearing = < 40% and no closer than 5/8” from edge
  - Double the stud when the stud is located on an exterior wall, bearing partition, drilled ≥ 40% and up to 60%. Not in double successive studs
  - Use a fastener across the top plate to each side of the opening
  - Use not less than eight 10d nails at each side or equivalent

* Exterior Walls or Bearing Partitions can cut/notch 25% or less

* Equivalent allowable bearing wall stud width cutting / notching (25% or less)

  - 2” x 4” nominal stud size = 7/8”
  - 2” x 6” nominal stud size = 1-3/8”

* Equivalent allowable non-bearing partitions stud width cutting / notching (40% or less)

  - 2” x 4” nominal stud size = 1-3/8”
  - 2” x 6” nominal stud size = 2-3/16”

    IF: Exterior wall or bearing studs are doubled

    AND IF: Not more than 2 successive studs are bored

AND IF: Approved stud shoes are used

THEN: OK to bore or drill 60% of stud width

- 2” x 4” nominal stud size = 2 1/8” maximum hole
- 2” x 6” nominal stud size = 3-3/8” maximum hole

* Exterior wall or bearing interior wall

IF: Notched or bored > 50% width of top plate

THEN: Install a 0.054” thick galvanized metal strap

* Min 6” past the opening with min
* Use 8 – 10 D nails (minimum 1 ½ “long) and 0.148” dia.) each side
  - 2” x 4” top plate = 1-7/8”
  - 2” x 6” top plate = 2 ¾ “
* Engineered wood products 502.8.2
  - Cuts, notches, and bored holes not permitted unless allowed by the manufacturer’s installation instructions or by registered design professional

* Protection from physical damage 1308.2
  - Concealed piping shall be protected
  - Piping less than 1 ½ inch from edge protected
  - Width of pipe and inches past framing member
    - Stud – above bottom plate and below top plate
    - Shield plate not less than 0.0575 inches (No. 16 gage)

CHAPTER 14 – HEATING AND COOLING EQUIPMENT

- General 1401
  - Installation 1401.1
    - Per the manufacturer and this code installation instructions
  - Access 1401.2
    - Located to provide access for service, replacement, cleaning, and maintenance
    - Equipment size based on Air Conditioning Contractors of America (ACCA) manual, J&S calculation
  - Equipment and appliance size 1401.3
    - Must be sized per ACCA Manual S or other approved methodologies
      - Except: Multi-stage unit or variable refrigerant flow w/loads properly calculated are within manufacturer's published capacities
    - Specified equipment cannot satisfy published total and sensible heat gains properly calculated, thus next larger standard size is specified
  - Outdoor equipment listed and labeled for outdoor installation 1401.4
  - Supports level, prevent settlement and vibration 1401.4
  - Flood hazards per Section 1401.5 and 322.1.6
  - Note: General requirements in Chapter 12 apply
- Central Furnace 1402
  - Maintain listed clearances
  - Provide combustion air – minimum 6" in front of openings
- Heat Pumps 1403
  - UL 1995
  - Minimum 6 square in of return duct per 1,000 BTU/h output rating – removed in 2018
  - Outdoor support raised 3" above grade – removed in 2018
- Electric Baseboard Convectors 1405

* Shall be installed per Chapters 33-42 and manufacturer's instructions

♦ Radiant Heat 1406

* Installed per Chapters 33-43, manufacturer's instructions 1406.1
* Panels installed parallel to framing members 1406.3
* No field cutting of panels – unless listed
* Fastened in place through unheated portions of panels
* Concrete and masonry installations 1406.4
* Labeled for concrete/masonry installation
* Not installed across expansion joints
* On gypsum panels – operating temps not to exceed 125° F
* Finish materials installed per installation instructions 1406.5
* Fasteners shall not pierce heating element

♦ Duct Heaters 1407

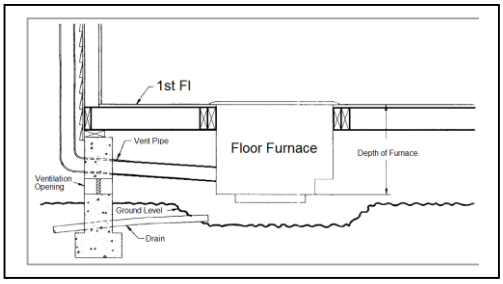
* Not create fire hazard 1407.2
* Class 1 ducts, covers, and liners interrupted at heater to provide clearances
* Fan shall be listed and labeled when within 4' of a heat pump or air conditioner 1407.3
* Accessible for maintenance 1407.4
* Fan interlock required to prevent heater operation when fan is not operating 1407.5

♦ Vented Floor Furnaces 1408

* Clearance per manufacturer 1408.2
* Location 1408.3

- Registers and burner assemblies
- Wall registers minimum 6” from corner
- Floor register minimum 6” from wall
- 12” from door and combustibles
- 5’ below projecting combustibles
- Burner assembly shall not project into an occupied under-floor area
- Not installed in concrete slab on grade
- No door swing within 12” of grill

* Access opening 1408.4



- 18” x 24” in foundation wall
- 22” x 30” in floor (trap door)
- Large enough to replace any part

* General installation requirements 1408.5

- Thermostats located in the same room
- Furnace supported independently of the register
- 6 inches above ground – 2 inches if sealed unit
- Maintain 30” service clearance area – 12 inches on other sides
- Not supported from ground

- Vented Wall Furnaces 1409
  - * Location 1409.2
    - Located not to cause fire hazard
    - Not circulate air from bathrooms to other parts of building
    - Not located within 12” of a door swing
  - * Installation 1409.3
    - Wall thickness per manufacturer
    - No ducts attached
    - Manual shut off required
  - * Access required 1409.4
- Vented Room Heaters 1410
  - * Fuel – pellet, oil, solid
  - * Installed on non-combustible floors – minimum clearances required

    Exception:

    - Listed appliances per installation instructions
- Heating and Cooling Equipment 1411
  - * Coils in warm air furnace 1411.2
    - Blower rated 0.5” water column static pressure
    - Labeled for use upstream of heat exchanger
    - Condensate disposal
      - Drain to approved location in an approved manner
      - Not create a hazard nuisance
    - Approved material: Cast iron, galvanized steel, copper, polybutylene, polyethylene, ABS, CPVC, PVC
    - Based on temperature and pressure rating

- Minimum ¾” pipe
- Horizontal pipe at uniform alignment and pitch not less than 1/8 unit vertical in 12 units horizontal 1% slope
- Installed so it can be maintained
- Trapped when required by manufacturer – no double traps

* Auxiliary or secondary system required where damage to structure is likely 1411.3

- Minimum ¾ inch pipe
- Method 1
  - Auxiliary and secondary drain systems 1411.3.1
  - Discharge to a conspicuous location
  - Minimum depth 1.5”
  - Minimum 3” larger than unit or coils
  - Corrosion resistant materials
  - Metallic pan minimum – 0.0276”
  - Non-metallic pan minimum – 0.0625”
- Method 2
  - Separate overflow from unit drain pan with equipment 1411.3.1
  - Discharge to a conspicuous location – alert occupants
  - Connected higher than the primary drain
- Method 3
  - Auxiliary pan without separate drain line
  - Detection and shut off device required conforming to UL 508
  - Constructed same as Method 1
- Method 4
  - Water level detection device conforming to UL 508 that will shut off the equipment served in the event that the primary drain is blocked
  - Device in the primary drain line, overflow drain line, or the equipment supplied drain pan

- Device located at a point higher than the primary drain line connection and below the overflow rim of pan

- Down flow furnaces
  - Only method allowed is an overflow device installed in the drain pan

* Condensate pumps 1411.4
  - IF: In uninhabitable spaces
  - THEN: Connected so that appliance or equipment served is prevented from operating if pump fails
  - Install per manufacturer's instructions

* Refrigeration piping 1411.6 – 1411.8
  - Piping and fittings for refrigerant vapor lines shall be insulated minimum R-4
  - Within 1½ inches of roof deck – protected from nails
  - Access port caps secured in outside or not protected

♦ Absorption Cooling Equipment 1412

* Condensation drain to approved location in an approved manner
* Refrigerant piping insulated
* Pressure relief device required, located as not to create hazard
* Per UL 1995

♦ Evaporative Cooling Equipment 1413

* Install in accordance with manufacturer's instructions
* Level platform 3" above grade
* Water for cooling
  - Backflow protection of potable water per Section 2902
* Exterior wall openings sealed

- Air intake openings per Chapter 3

♦ Fireplace Stoves Section 1414

- Per manufacturer
- Hearth extensions per listing 1414.2
  - Supports same level as hearth
  - Distinguishable from surrounding floor

CHAPTER 15 – EXHAUST SYSTEMS

Definition:

* Means of transferring fumes, moisture, and products from the interior of the building

♦ General 1501

* Mechanical exhaust cannot discharge air to attic, soffit, ridge vent, or crawl space
    - Except:
        - Whole house ventilation type fans for private attics

♦ Clothes Dryer Exhaust 1502

* Independent of all other systems
* Exhaust duct terminate outdoors
* Per manufacturer
* If no instructions are available, terminate a minimum of 3’ from building opening 1502.3
* Back draft damper installed
* Dryer exhaust ducts 1502.4
    - Smooth duct construction and installation
    - Minimum 4 inch duct
    - No screens in duct or termination
    - Back draft damper required
    - No sheet metal screw which protrude more than 1/8 inch
        - Section 2439.7.2 allows screws not to exceed 1/8” into duct
    - Minimum thickness of exhaust duct – 0.0157” rigid metal
    - Smooth interior finish
    - Joints running in direction of flow 1502.4.2
    - Supported at 12’ intervals
    - Transitions duct maximum 8’ – listed per UL 2158A M1502.4.3

- When concealed shall not deform duct

2 x 4 stud – 4 inch duct

Correct?

- Dryer exhaust duct power ventilators 1502.4.4
  - Conform to UL 705
  - Install per manufacturer's directions
- Duct length 1502.4.5
  - Maximum length 35' or manufacturer's instruction 1502.4.5.1
  - Does not include the transition fitting
  - Fitting length per Table 1502.4.5.1
  - Duct length and size can conform to manufacturer
  - Catalog cut available at concealment inspection
  - Equivalent length of concealed duct permanently identified within 6' of dryer vent connection 1502.4.6
  - Length of duct with power exhaust per manufacturer
- Duct to be provided at every dryer space 1502.4.7

♦ Domestic Cooking Exhaust Equipment 1503

* Domestic kitchen equipment 1503.2

- Required when exhaust equipment is provided 1503.2
- Applies to range hoods and down draft appliances
  - When not integral to appliance – UL 507

- Integral equipment shall comply – UL 507
- Integral downdraft – ANSI Z21.1 or UL858
- Microwave over cooking with exhaust – UL 923

- Open-top broilers 1503.2.1
  - Metal exhaust
  - Minimum thickness 0.0157 inches thick (No. 28 gage)
  - ¼ inch clearance around hood
  - 24 inch clearance above cook top
  - Hood width equal to unit and extend over entire cook top

* Exhaust discharge 1503.3
  - Discharge to the outdoors (not attic, crawl space or inside building)
  - Smooth interior finish and air tight
  - Back draft damper required
  - Independent of all other systems
* Duct material 1503.4
  - Duct material can be: galvanized steel, stainless steel, aluminum, or copper
    - Some down drafts can use PVC – 4 criteria
* Kitchen exhaust rates 1503.5
  - Per Table 1504.2
* Make-up air required 1503.6
  - Equipment not direct vent or mechanical draft venting
  - When exhausting > 400 CFM
  - Passive or mechanical make up required
  - Rate equal the exhaust rate
  - Location 1503.6.1

- Air shall discharge into room with exhaust or
- Rooms that connect with permanent openings

- Dampers 1503.6.2
  - Damper to be gravity or electrically operated
  - Damper to automatically open when exhaust hood operates
  - Access for inspection without removing permanent construction
  - Gravity or barometric damper not used
  - Provide airflow at a pressure differential of 0.01” of w.c.

♦ Exhaust Ducts and Exhaust Openings 1504

* Follow this Chapter or Chapter 16
* Duct length per Table 1504.2

  Exception: Per manufacturer or flow rate verified
* Termination:
  - > 3’ from property line
  - > 3’ from operable or non-operable openings
  - > 10’ from mechanical air intakes – or 3” above

♦ Mechanical Ventilation 1505

* Where local or whole house mechanical is proved follow this chapter
* Exhaust air from bathrooms and toilet rooms not to be re-circulated
* Exhaust air from bathrooms and toilet rooms not to be exhausted into attic, crawl space, or other area inside the building
* Not prohibit ductless range hoods
* Equipment per ANSI/AMCA 210 – ANSI/ASHRAE 51
* Whole-house mechanical ventilation system M1505.4
  - One or more supply or exhaust fans
  - Outdoor air ducts connected to the returns can be the supply
  - Manual controls required
  - Mechanical ventilation rates 1505.4.3

- Rates per Table 1505,4,3(1) or
- Per calculation of equation #1
- Ventilation rate in cubic feet minute = (0.01 x total square foot area of house) + [7.5x (number of bedrooms + 1)]
- Exception: Operate intermittently with controls for 25% for each 4 hour segment with a rate per Table M 1505.4.3(1) adjusted per Table M 1505.4.3(2)

- Local exhaust systems designed per Table 1505.4.4

CHAPTER 16 – DUCT SYSTEMS

- Duct Construction 1601
  - Duct design 1601.1
    - Per ACCA Manual D or
    - Manufacturer's instruction
    - Other approved methods
    - Above-ground duct systems 1601.1.1
      - Temperature limit 250°F
      - Factory made ducts comply with UL 181 and installed per manufacturer's instructions
      - Fibrous ducts conform to SMACNA or NAIMA
      - Field or shop fabricated per SMACNA except as allowed by Table 1601.1.1
      - Gypsum return air ducts limited to 125°F and not subject to condensation
      - Maximum flame spread of 200
      - Stud cavity and joist space plenums

        Not permitted as plenum for supply air

        Not part of rated assembly

        Not to convey air from more than one floor

        Fire-blocking per the building code

        Stud space in outside walls not as a plenum

        All dampers and controls require access

    - Underground duct systems
      - Approved concrete, clay, metal or plastic

- Plastic duct – maximum temperature 150 degrees F
- Metal duct – protected from corrosion or encased in concrete – 2”
- Slope to drainage point with access
- Sealed or taped before encased and tested
- Tightness per 1103.3
- Metal duct with approved coatings or non-metallic per manufacturer

* Duct insulation material 1601.3

  - Maximum flame spread 25, smoke developed < 50 per ASTM E 84
  - Not flame, glow, smolder or smoke at operating temperatures
  - External reflective insulation labeled every 36”
  - Spray insulation with special criteria
  - Maximum flame spread 25, smoke developed 450
  - Ignition barrier
  - Comply with 316 (Foam Plastics)

* Installation 1601.4

  - Joints and seams per SMACNA HVAC Duct standards – Metal and Flexible, and NAIMA Fibrous Glass Duct Construction Standards
    - Longitudinal, transvers and connections
    - Per UL 1 A-P based on the type of system
  - Duct lap
    - Round and oval – minimum of one inch in direction of flow
      Plastic joint per the manufacturer
    - Supported per manufacturer’s instructions
    - Field fabricated ducts supported per SMACNA Fibrous Glass Duct Construction Standards, and NAIMA Fibrous Glass Duct Construction Standards

- Fire-blocking 1601.4.5 per section R602.8
- Insulated when installed in non-conditioned spaces 1601.4.6
- Insulation not penetrate fire blocked wall or floor
- 4” separation from earth 1601.4.8
- When penetrate garage, 26 gauge, no openings 1601.4.9 and 302.5.2

* Under Floor Plenums 1601.5
  - Prohibited in new construction
  - Modification to existing must comply with current code
  - Loose combustible scrap removed – tightly enclosed
  - Ground covered with moisture barrier – Minimum 4 mils 1601.5.1
  - Plumbing waste cleanouts and gas pipe not permitted in space
  - Maximum flame spread 200 1601.5.2
  - Furnace duct to extend 6” below combustibles
  - Access via 18” x 24” opening
  - Start fan when reach 150°F max
  - Furnace outlet temp limit switch at 200°F max 1601.5.5
* Systems that supply living space shall not supply or return to garage M1601.6

♦ Return Air Section 1602

* Outdoor air openings 1602.1
  - Located per 303.5.1 and protected per 303.6
* Return air openings 1602.2
  - Not closer than 10’ from appliance in room
  - Return not greater than supply
  - Return and supply sized per manual D

- Not from closets, bathrooms, kitchens, garages, mechanical and furnace rooms, other dwelling units
- Not from a swimming pool area
- Cannot discharge into another dwelling unit
- Return air taken from any room or space shall be not greater than the flow rate of supply air
- Direct vent – OK
- Outdoor air inlets screened – ¼” to ½ “ Per 303.6 (Outside opening protection)

CHAPTER 17 – COMBUSTION AIR

- General 1701
  - Solid fuel appliances per manufacturers' installation instructions
  - Combustion air for gas fired appliances 2407
  - Oil appliances per NFPA 31
    - Lowest floor minimum 1' above base foot elevation 1701.2, 322.2.2.1 and 322.3.2

    Note: This chapter does not apply to fireplaces, fire place stoves, and direct vent appliances

- Effects of Inadequate Combustion Air
  - Produces poisonous, corrosive, and combustible by-products when combustion is incomplete
  - Creates environment that leads to oxygen depletion
  - Inadequate cooling of appliance causes appliance to work harder, leading to shorter appliance life
  - Incomplete combustion causes soot, increased levels of carbon monoxide, appliance malfunction, and risk of fire
  - Appliances shall be installed to allow the free circulation of air within the space
  - Simultaneous operation of all appliances shall be considered when determining combustion air
  - Avoid "going negative" due to excessive exhaust CFM with inadequate makeup air

CHAPTER 18 – CHIMNEY AND VENTS

- General 1801
  - Fuel burning appliances to be vented per manufacturer
  - Listed unvented appliances can be used
  - Gas fired per Chapter 24
  - Draft requirements 1801.2
    - Create a positive flow to convey combustion products to outside
  - Existing Chimneys 1801.3
    - Resizing required when adding or removing an appliance
    - Free of obstructions, cracks, perforations, gaps, other damage, and cleaned
    - Masonry requires a cleanout per 1003.17
      - Clearances per manufacturer

        Except: Chimney lining systems listed and labeled for contact with combustibles
    - Using existing masonry chimney as raceway for DVSCC appliance vents
  - Space around flue cannot be used to vent other appliances 1801.4
  - Masonry chimneys and factory built fireplaces constructed per the International Building Code, International Residential Code
  - Mechanical draft only for appliances listed for mechanical draft 1801.5
  - Vent system adequately supported 1801.7
  - Not through a return, supply, duct or plenum 1801.8
  - Properly fire-blocked 1801.9
  - Unused openings to be closed or capped 1801.10
  - Natural gas burning appliance vent connection to double-wall Type “B” gas vent
  - Multiple appliance venting system 1801.11
    - Appliances on the same floor

- Inlets offset
- Natural draft appliance shall be connected to mechanical draft system under positive pressure

* Solid fuel-burning vent cannot connect to a vent for another appliance 1801.12

♦ Vent Components 1802

* Draft hoods in the same room as appliance 1802.1
  - Manually operated dampers permitted on solid fuel appliances only 1802.2.1
  - Automatic dampers per UL 17 1802.2.2
    - Interlocked with burner

♦ Chimney and Vent Connectors 1803

* Connectors - connect appliance to vertical chimney or vent
* Thickness per Table 1803.2
* Within space where appliance located
* Installation per manufacturer 1803.3
* Connectors sloped ¼” per foot
* Short and straight as possible
* Properly supported and fastened with screws or rivets
* Connector shall not pass through a floor or ceiling
* Connector shall not pass through wall or partition unless a listed device is used

  - Length 1803.3.2
    - Uninsulated horizontal connector shall not exceed 75% of height of the vertical portion of vent above the connector
  - Connector at least the size of appliance flue collar 1803.3.3
  - Clearance to combustibles per Table 1803.3.4

- Connector accessible entire length 1803.3.5

* Connection to fireplace flue 1803.4

- Non-combustible seal below point of connection 1803.4.1
- Access for inspection and cleaning
- Listed appliance connected to the flue 1803.4.2
- Connector from appliance to flue 1805.3.1
  - Minimum size of flue
  - Maximum 3 times the area

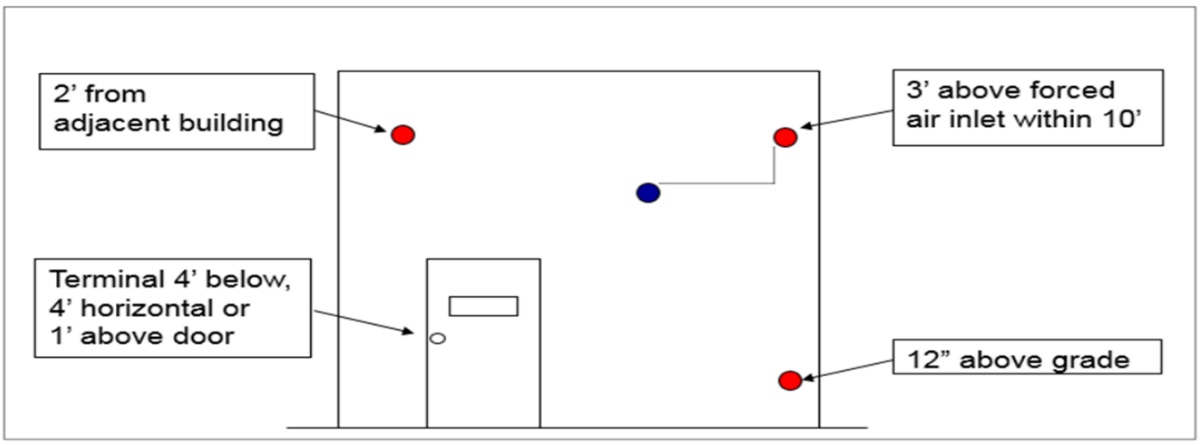
♦ Vents 1804

* Listed and labeled venting systems required per Table M804.1
* Termination per manufacturer
* Termination 1804.2

- Decorative shrouds at termination of vents listed and installed per manufacturer 18043.2.2
- Natural draft appliances 5’ above highest connected appliance 1804.2.3
- Natural draft gas vented wall furnaces 12’ above bottom of furnace 1804.2.3
- Type L vents 2-10 rule 1804.2.4
  - Minimum 2’ above highest point

- Direct vent appliances 1804.2.5
  - Per manufacturers’ specifications

- Mechanical draft 1804.2.6



* Installation Type L and pallet vents 1804.3

  - Individual vent equal to the size of the connector not less than 7 square inches

* Door swing 1804.4

  - Appliance and equipment vent terminals placed so that doors cannot swing within 12" of vent terminal

♦ Masonry and Factory Built Chimneys 1805

* Installed per Section 1003 and Section 1005

* Chimney connector enter masonry chimney 6" above lowest part of flue

* Sized not less than largest connector plus 50% of remaining chimney connectors

  Exception: Oil-fired appliances per NFPA 31

CHAPTER 19 – SPECIAL APPLIANCES, EQUIPMENT AND SYSTEMS

- Ranges and Ovens 1901
  - Clearances 1901.1
    - 30” vertical clearance to combustibles over cooking appliances
      - Reduced per listing

  - Ranges and ovens listed and labeled for household use 1901.2
    - Installed not to interfere with combustion air and servicing
    - Commercial cooking equipment installed in a dwelling unit
- Sauna Heaters 1902
  - Protected against accidental contact – not effect operation of heater
  - Installed per manufacturers’ installation instructions
  - Provide combustion air
  - Room temperature limit 194°F
  - Sensor when not integral within 6” of ceiling
  - Comply with UL 875
- Stationary Fuel Cell Power Plants 1903
  - Power output less than 1,000 KW per NFPA 853 & ANSI fc-1Z21.83
- Gaseous Hydrogen Systems 1904
  - Installed per 1307.4, 1903.1, IFC, IFGC, IBC
- Engine and Gas-Turbine Powered Equipment and Appliances 1905
  - Engine Driven equipment and appliance
    - Powered by engine driven

- Permanently installed
- Per manufacturer's installation instructions
- Per NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines

* Fuel tanks
  - Engine mounted
  - Located inside buildings
  - Outside the building
  - On a roof

* Engine mounted
  - Vented per NFPA 30
  - Adequate clearance
    - Fillings, maintenance, testing
    - Protected from public access and impact
  - Other tanks similar requirements

CHAPTER 20 – BOILERS AND WATER HEATERS

- Boilers 2001
  - Per manufacturer's installation instruction 2001.1
    - Label Information
      - Rating data
      - Operating instructions
      - Nameplate permanently attached
    - Flood zone per 322.1.6
    - Provide combustion air
    - Shutoff valve in supply & return
    - Clearance per listing and label
    - Control diagram and operating instructions on site
- Operating and Safety Controls 2002
  - Safety controls listed and labeled 2002.1
    - Hot water and steam boilers
  - Pressure and temperature gauges required; must operate in normal range of boiler 2002.2 and M2002.3
  - Steam boiler water gauge and pressure gauge 2002.3
    - Pressure relief valve required
  - Discharge by gravity within 18" of floor or receptor 2002.4
  - Low water cut-off required 2002.5
  - Operation 2002.6
    - Low water and flow sensing control automatically stop combustion
- Expansion Tanks 2003
  - Hot water boilers expansion take required 2003.1
    - Fastened to structure or boiler

- Support the twice the weight of the tank filled
- Drain non-pressurized tanks without emptying the system
- Capacity requirements in code per Table 2003.2

♦ Water Heaters Used for Space Heating 2004

* Used for both, comply with both
* Installed per chapters 24, 28, and manufacturer's installation requirements

♦ Water Heaters 2005

* Various listings – UL
* In attics per 1305.1.3
* Fuel fired water heaters locations
  - Not in storage closets
  - When in bedroom or baths – with sealed enclosure – outside combustion air
  - Not applicable to direct vent heaters
  - Provide service access and combustion air

♦ Pool Heaters 2006

* Per manufacturers' installation instructions
* Oil per UL 726, Electric per UL 1261
* Clearances not interfere with combustion air, draft hood service access, or flue terminal relief
* Temperature and pressure relief valves required
* Bypass line and valve required

CHAPTER 21 – HYDRONIC PIPING

♦ General 2101

* Definition: Hydronic piping includes piping, fitting, and valves used in building space conditioning systems

* Allowable hydronic piping materials Table 2101

* Valves, fittings, and connection approved, listed for use, and installed per manufacturer

* Provide system drain down 2101.2
* Backflow protection M2101.3 per 2902
* Openings through concrete or masonry sleeved 2101.4
* Protected against corrosion and physical damage 2101.5
* Drilling and notching per other code sections 2101.6
* Use of tee fittings 2101.7

* Provisions for expansion, contraction, shrinkage, and settlement 2101.8

* Piping support per Table 2101.9

* Systems hydrostatically tested at 100 psi not < 15 minutes 2101.10

♦ Floor Heating Requirements 2103

* Embedment of pipe in concrete or gypsum products

* Materials

- Steel, copper, cross-linked polybutylene, PCVC, cross-linked polyethylene, polypropylene
- Rated 100 psi at 180°F
- Steel piping joints welded
- Copper tubing brazed, melting point > 1,000°F
- Polybutylene socket type heat fused fittings
- Must be tested at 100 psi for 30 minutes

♦ Low Temperature Piping 2104

* Approved materials per Table 2101.1

♦ Ground-Source Heat-Pump System Loop Piping 2105

* Used materials prohibited 2105.2
* Piping, tubing, and fittings rated for operating temperatures 2105.3
* Piping and tubing materials per Table 2105.4
  - Fitting materials per Table M2105.5
    - 2105.4 – 2105.14 – information on different pipe types
* Shut offs required 2105.15
  - Supply and return for heat exchangers
  - Supply and return central utility system
  - Connection to a pressure vessel
  - Both side of a pressure reducing valve
  - Connection to mechanical equipment
  - Connection to non-diaphragm-type expansion tanks
* Installation per manufacturer's instructions 2105.17
* Protection of potable water 2105.18
  - Backflow protection per Section 2902
* Pipe penetrations must be sleeved 2105.19

- Protect annular space per 2606.1

* Clearance from combustibles

  IF: Exterior of piping > 250° F

  THEN: Provide minimum 1” clearance to combustibles

- Protect from corrosion and degradation of material
- Protect from stress, strains, expansion and contraction

* Pipe properly supported per section 2101.9

- Water velocity based on type of pipe

* Label and mark piping: “Ground-Source Heat Pump Loop System” 2105.25

- Label whether antifreeze is in system
  - Label all chemicals in system
- Testing – 100 psi for 15 minutes – no leaks
- Embedded pipe pressurized before and during concrete placement

CHAPTER 22 – SPECIAL PIPING AND STORAGE SYSTEMS

♦ Oil Tanks 2201

* Fuel il and diesel storage piping systems

* Above ground tanks – 2201.2

- Fuel supply tanks labeled per UL 58 and UL 80 2201.1
- Maximum fuel storage inside or above ground: 660 gallons
  - For space or water heating sized per NFPA 31
  - Greater than 660 gallons per NFPA 37
- Tanks supported on rigid non-combustible
- Tanks inside sized to be removable without cutting 2201.2.1
- Larger than 10 gallons at least 5’ from flame
- Outdoor above-ground tanks minimum 5’ from property line 2201.2.2

* Underground tanks 2201.3
    - Not undermine footing or foundation
    - Underground tanks minimum 1’ from property line, basement or wall
    - Minimum cover 1’ of inert material
    - Corrosion protection required
* Maximum 2 tanks cross connected 660 gallon total per 2201.4 and 2203.6
* Oil gauge required on indoor tank – no glass – unbreakable 2201.5
* Tank abandonment 2201.7 and removal per IFC

♦ Oil Piping, Fittings, and Connections 2202

* Steel pipe, copper piping or tubing listed for oil piping 2201.1
* Compatible fittings – no cast iron 2202.2
    - Not allowed:
        - Unions requiring gaskets, right or left couplings, solder melting point less than 1,000°F
        - Listed and labeled flexible connections – UL 536

♦ Installation 2203

* Pipe size and type 2203.2
    - 3/8” pipe, tubing 3/8” outside diameter
    - Copper pipe and tubing type L or heavier
* Fill piping terminal at least 2’ from openings 2203.3
    - Vent pipe minimum 1 ¼ “
        - Drain back to tank
        - Not cross connected to fill
        - Enter tank at top
    - Corrosion-resistant coatings

♦ Oil Pumps and Valves 2204

* Positive displacement pumps with automatic shut-offs 2204.1

* Manual shut-off between tank and burner with ready access 2204.2
* Pressure relief valve when shut-off in discharge
* Maximum inlet pressure – 3 psi 2204.3
* Fuel oil lines with heaters require relief valves back to return line piping when excess pressure exists 2204.4

CHAPTER 23 – SOLAR THERMAL ENERGY SYSTEMS

- Solar Thermal Energy Systems 2301
  - Solar energy for space heating or cooling, hot water heating and swimming pool heating 2301.1
  - Design and installation 2301.2
    - Accessible 2301.2.1
      - Not obstruct doors or windows or other roof mounted equipment
      - Roof to be constructed to support imposed loads 2301.2.2.1

        Collectors as roof covering – comply as a roof

        Above the roof – noncombustible or fire retardant treated

        Protected from degradation per ICC900/SRCC 300
    - Systems with fluid – pressure, temperature, and vacuum relief required 2301.2.3
    - Piping insulation
      - Per Chapter 11
      - Protected from ultraviolet degradation
      - Insulate entire loop
    - Protect from freezing 2301.2.6
    - Provide drain back in areas subject to freezing
    - Drain back not create a hazard
    - Penetrations to be properly sealed 2301.2.9
    - Solar loops 2301.2.11
      - Isolation valves required
      - Drain and fill valves labeled
      - Warning sign for a discharge at high temperature or pressure
      - Maximum water temperature 180°F 2301.2.12
  - Collectors and panels must be listed and labeled 2301.3
  - Heat transfer gases or liquids and heat exchangers 3201.4
    - Flammable gas and liquids not used

- Heat exchangers to comply with Section 2902.5.2 and SRCC 100 or SRCC 901600
- Flash point not less than 50° F above system operating temperature

* Backflow protection required 2301.5

CHAPTER 24 – FUEL GAS

- General 2401 (101)
  - Fuel gas piping, utilization equipment and related accessories, venting systems, and combustion air configurations commonly encountered in the construction of one and two family dwellings 2401.1 (101.2)
  - Piping system: All fuel piping, valves, and fittings from the outlet of the point of delivery to the outlets of the appliance shut-off valves
  - Point of delivery to appliance shutoff
- General Definitions 2403 (202)
  - Terms not defined in this code shall have meanings as ascribed in other codes 2403.3 (201.3) This chapter has its own definitions
- General G2404 (301)
  - Listed and labeled equipment 2404.3 (301.3)
  - Vibration isolation 2404.1 (301.8)
  - Repairs to maintain original listing or approval requirements 2404.5 (301.9)
  - Installed to meet expected wind loads 2404.6 (301.10)
  - Flood zones 2404.7 (301.11)
  - Seismic resistance 2404.8 (301.12)
  - Rodent proofing 2404.9 (301.14)
  - Category IV condensation appliances shall be provided with an auxiliary drain pan 2404.10 (307.5)
    - Exception: Appliances that have auto shut down operation in the event of a stoppage in the drain system
  - Condensate pump failure will prevent operation of connected appliance or equipment 2404.11 (307.6)
- Structural Safety 2405 (302)
  - Building not to be weakened by installation of gas piping

* Truss members not to be cut, drilled, notched, or spliced
* No additional loads without verification of being capable of supporting the load
* Prohibits cuts, holes, notches, in engineered wood products, including: trusses, glue-laminated members, I-joists, and structural composite components
    - Exceptions permitted by manufacturer or engineer design

♦ Appliance Location 2406 (303)

* Per code and listing
* Prohibited locations 2406.2 (303.3)
    - Sleeping rooms, bathrooms, toilet rooms
    - Storage closets, surgical rooms or a space that opens only into the room
    - Exceptions as apply
* Outdoor locations 2406.3 (303.6)
    - Listed or provided adequate protection

♦ Combustion, Ventilation, and Dilution Air 2407 (304)

* Provide adequate combustion air
* Appliance not interfere with air flow
* Draft hoods in same room as appliance 2407.3 (304.3)
* Make-up air 2407.4 (304.4)
    - Exhaust fans shall be considered in calculations
    - Kitchen ventilation, exhaust fans, dryers, fireplaces
* Indoor combustion air 2407.5 (304.5)
    - Total required sum of all appliances in area
    - Rooms communicating directly with doors to be counted
    - Standard method for minimum require volume
        - 50 Cu Ft. per 1,000 BTU input rating
        - Provides the minimum volume without outside air

- Typical appliance information tag use input BTU

☞ Class Exercise: What is the maximum minimum square footage without outside combustion air?

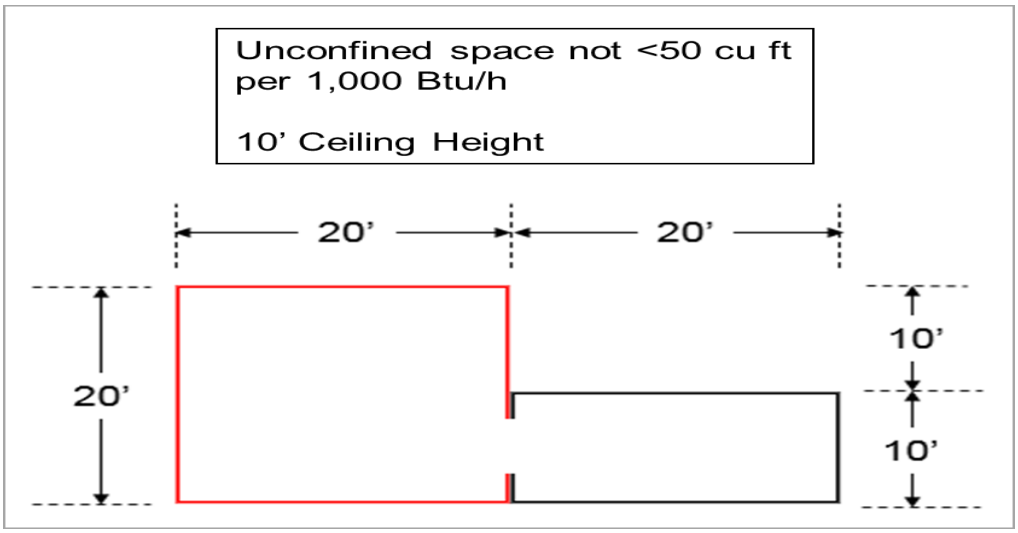
Equipment 80,000 BTU water heater / 120,000 BTU furnace

10 foot ceiling

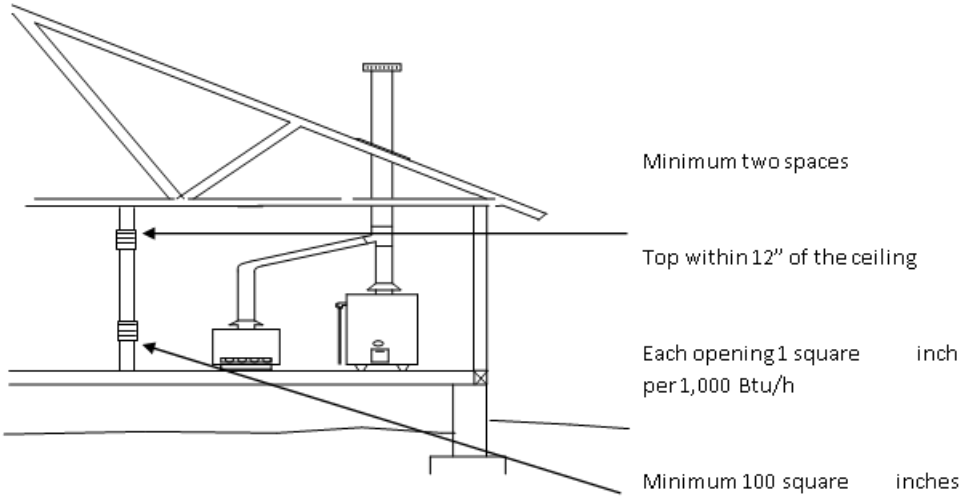
Calculation

Water heater BTU	_____	
Furnace BTU	_____	
Total BTU	_____	
Divide by 1,000	_____	
Dividend times 50	_____	cubic feet
Cubic feet ÷ ceiling height	_____	- Minimum required square footage

☞ Class Exercise: What is the maximum allowable Btu/h for each area before outdoor air is required?



* Known air infiltration method allows a performance based proof of sufficient air 2407.5.2 (304.5.2)
    - Method for fan assisted and non-assisted units
    - Not used when air infiltration rate is > 0.60.ACH (ACH = Air Changes per Hour)
* Indoor opening size and location 2407.5.3 (304.5.3)
* Combing spaces on the same story 2407.5.3.1 (304.5.3.1)
    - Free area of 1 square inch per 1,000 Btu not less than 100 square inch
        - For each opening
    - Two openings – 12” from top / 12” from bottom
    - Minimum size not less than 3”



* Combining spaces on different stories 2407.5.3 (304.5.3)
* One or more permanent openings in doors or floors
* From other stories – openings 2 square inch per 1.000 Btu
* 2 openings commencing with 12” of ceiling and floor
* Outdoor combustion air 2407.6 (304.6)
    - Two permanent openings
        - 12” top and bottom
        - Calculates net free area for each opening

- Direct to outdoors vertically 1 square inch per 4,000 Btu/h
- Communicate directly or by ducts
- Horizontal ducts 1 square inch per 2,000 Btu/h
- Calculate the total BTU being supplied

* One opening method 2407.6.2 (304.6.2)
  - 12” within the top of the enclosure
  - Appliance clearances
    - 1 inches from sides and back
    - 6 inches from the front
  - Direct to outdoors or through a duct
  - 1 square inch per 3,000 BTU
  - Duct not less than the sum of all vent connectors

☞ Class Exercise

* 2 – 34,000 Btu/h water heaters
* 1 – 120,000 Btu/h furnace
* Calculate combustion air opening sizes using the 2 opening method for outdoor air with the openings on an outdoor wall

☞ Class Exercise

* 2 – 34,000 Btu/h water heaters
* 1 – 120,000 Btu/h furnace
* Calculate combustion air opening sizes using the 2 opening method for outdoor air supplied by a horizontal duct

☞ Class Exercise

* 2 – 34,000 Btu/h water heaters
* 1 – 120,000 Btu/h furnace
* Calculate combustion air opening sizes using the one opening method

* Combination indoor and outdoor 2407.7 (304.7)
    - Indoor openings as per indoor air
    - Outdoor openings as per outdoor combustion air
    - Indoor spaces
        - Ratio of available volume of all communicating spaces divided by required volume
        - Reduction factor = 1 minus ratio of interior spaces
        - Minimum outdoor size = full size of openings calculated x reduction factor
        - Minimum dimension or air openings < 3”
* Example 2407.7 (304.7)
    - 160,000 Btu input requires 8,000 cu. Ft. for “indoor air only”
    - 240 square feet adjacent space with 8’ ceiling (8 x 240) = 1920 cu. Ft.
    - 1,920 = .24
    - 8,000
    - Reduction factor 1 - .24 = .76
    - Outdoor air required
    - 1” per 4,000 Btu/h
    - 160,000 = 40 square inch
    - 4,000
    - Outdoor air required 76 x 40 = 30.4 square inch
* Engineered combustion air 2407.8 (304.8)

* Mechanical combustion air 2407.9 (304.9)
    - 0.35 cu. Ft. per 1,000 Btu/h of total input rating all appliances
    - Appliance interlock

    IF: Mechanically supplied combustion air

THEN: System must also supply required ventilation air

* Louvers and grills G2407.10 (304.10)
  - Ventilation based on net-free opening
    - Wood louvers 25%
    - Metal 75%
  - Manufacturer's specifications
  - Motorized grills interlocked with equipment

* Combustion air ducts 2407.11 (304.11)
  - Duct must use galvanized steel for the ducts or material having equivalent corrosion resistance, strength, and rigidity
  - Terminate in obstructed space
  - Serve a single enclosure
  - Separate upper and lower duct – not screened in attic area
  - Not as part of the masonry, metal or factory built chimney assembly
  - Except direct vent appliances
  - Low opening – bottom not less than 12" above grade
  - Protected from fumes and vapors
  - Disperse fumes
  - Installed per manufacturer

♦ Installation 2408 (305)

* Listings or manufacturer's instructions
* Available on job site

* Follow stricter code or manufacturer's instruction
* Many sections same as mechanical Part V
* Ignition source 18" above grade in garage
* Installation 6' or higher in private garage unless protected from vehicle impact
* Equipment installed at grade on a level pad or suspended 6" above grade
* Clearance to combustibles be maintained
* Consider temporary items such as drawers or doors

♦ Clearance Reduction 2409 (308)

* Reductions only per Table 2409.2 unless prohibited by listing
* Includes distance to drywall
* Reductions only per Table 2409.2 unless prohibited by listing
* Clearance to indoor air conditioning 2409.3 (308.3)
* Per manufacturer
* Can use clearance Table 2409.2
* Clearance from supply ducts 2409.3.4 (308.3.4)

♦ Electrical 2410 (309)

* Gas piping not to be used as a grounding electrode

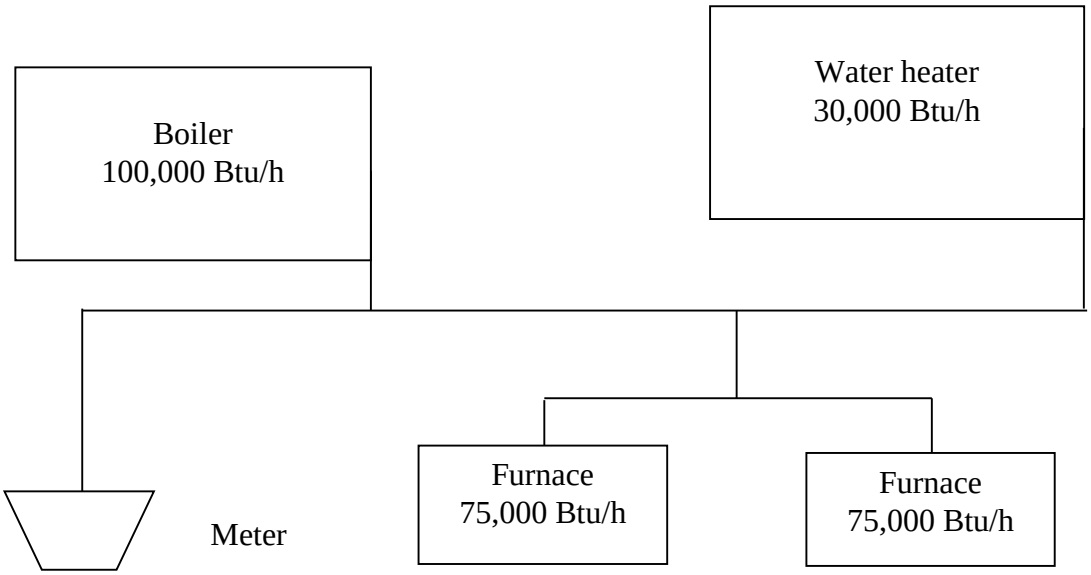
♦ Electrical Bonding 2411 (310)

* Gas pipe likely to become energized shall be bonded
* Exception: connection to equipment that is part of an electrical circuit shall be considered bonded
* Corrugated Stainless Steel Tubing (CSST) 2411.1.1 (310.1.1)
    - Bonded to electric service grounding electrode system
    - Bonded to metallic pipe or fitting
    - Bonding jumper not smaller than 6 AWG
    - All segments of system bonded

- General 2412 (401)
  - Point of delivery to connection to equipment
  - LP gas per Fire Code
  - Modification to gas pipe system requires resizing
  - Yellow identifying color with black lettering unless black metallic pipe – every 5'
  - 2 meters not to be interconnected
  - Meter labeled indicating area served
  - Pipe sized to serve all connected appliances
  - All pipe identified
    - Exceptions
      - Pipe length less than 2 feet and from same pipe
      - Steel fitting 2 inches and less
      - On product packaging
      - Other approved documentation
  - All pipe 3rd party tested or certified

- Pipe Sizing 2413 (402)
  - Based on appliance input rating
  - When rating is unknown, the manufacturer shall be consulted
  - Assume all appliances operating simultaneously
  - 1 cube foot of natural gas = 1,000 Btu
  - Maximum capacity of pipe in feet of gas per hour for gas pressure less than 2 psi. and a pressure drop of 0.5" water column Table 2413.4(1)
  - Tables are based on pressure, type of piping or tubing, pressure drop

* Table 2413.4(1) – maximum capacity of pipe in feet of gas per hour for gas pressure less than 2 psi. and a pressure drop of 0.5” water column – schedule 40 metallic pipe



* Longest length method 2413.4.1, (402.4.1)

* **Step One:** Determine the length of pipe from the point of delivery to the most remote appliance.

  - *Example:* Furthest appliance is 50’ from the meter.

* **Step Two:** Enter the table in the 50’ row.
  Entire system will be sized based on the values in this row.

* **Step Three:** Size the branch feeding the most remote appliance

  - *Example:* 30,000 Btu/h water heater requires ½” pipe. If the actual demand falls between tabular values, use the larger pipe size.

* **Step Four:** Working towards the meter, size the branch feeding the two furnaces.

- *Example:* 75,000 Btu/h furnace requires ¾" pipe to each appliance. Since the total demand upstream of the tee is less than 151, the portion of the branch that serves both appliances is permitted to be ¾"

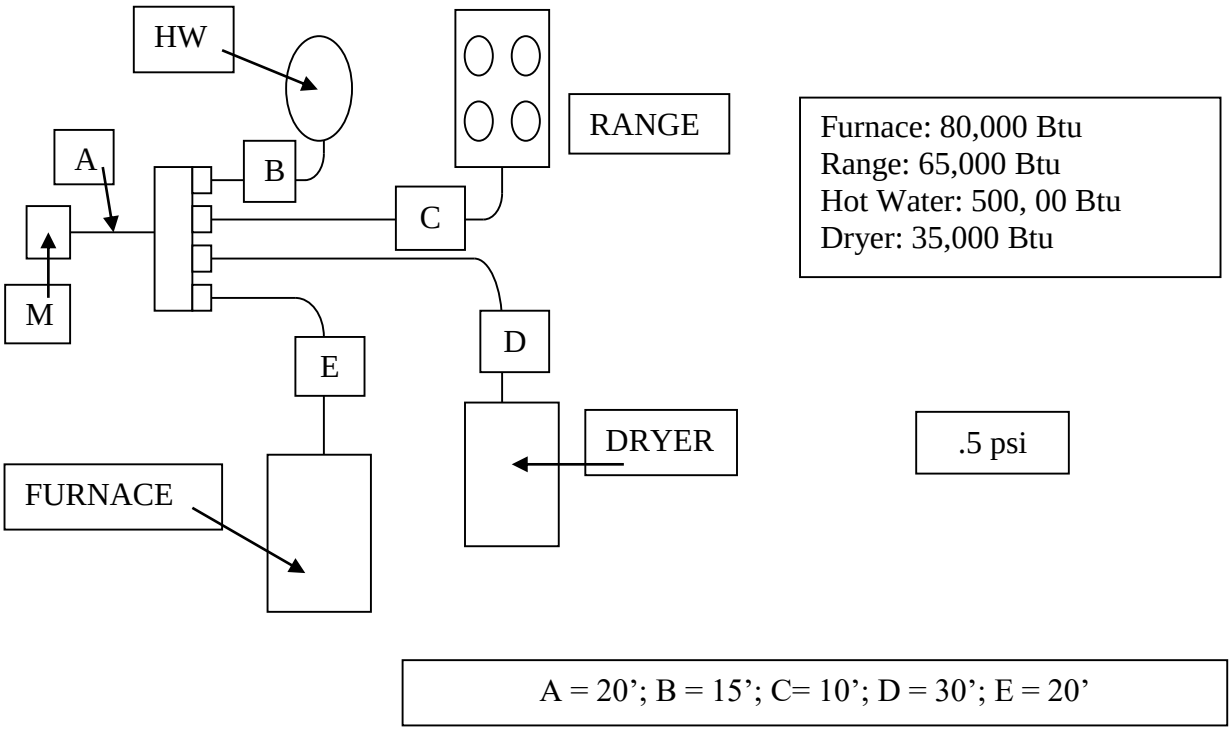
* **Step Five:** Size the main from the unit heater branch to the dual furnace branch

- *Example*: The total demand on this portion of the main is 180,000 Btu/h; required pipe size is 1".

* **Step Six:** Size the branch serving the boiler.

- *Example:* Demand on branch is 100,000 Btu/h; required pipe size is ¾"

* **Step Seven:** Size the remainder of the main.



Copper Tubing

Calculate the tubing sizes

- *Example:* Total system demand is 280,000 Btu/h; required pipe size is 1"

☞ Class Exercise – Branch length method – Calculate tubing sizes

* Solve the problem for TYPE "K" copper

1. Find the longest branch line:

2. Total input:

3. Line A is to be:

4. B, C, D, and E are sized from manifold

B= 20’ + 15’ =____’ Size ____” C= 20’ + 10’=____’ Size ____”

D= 20’ + 30’ =____’ Size____” E= 20’ + 20’=____’ Size____”

- Pipe Materials 2414 (403)
  - Used materials evaluated prior to re-use 2414.2 (403.2)
  - Other materials 2414.3 (403.3)
  - Metallic pipe 2414.4 (403.4)
    - Cast iron / Steel
  - Metallic tubing 2414.5 (403.5)
    - Copper / Aluminum / Steel
    - Corrugated stainless
  - Plastic pipe, tubing and fittings 2414.6 (403.6)
  - Workmanship and defects G2414.7 (403.7)
    - Free of burrs and defects
    - Thoroughly brushed and chip-free
  - Protected from corrosion 42414.8 (403.8)
  - Metallic pipe threads 2414.9 (403.9)
    - Stripped or damaged threads not used
    - 10-11 threads cut
    - Table G2414.9.2 (403.9.2)
    - Threaded, flanged, brazed, or welded joints permitted 2414.10.1 (403.10.1)
- Piping System Installation 2415 (404)
  - Installed per the standards or the manufacturer's installation instructions 2415.1 (404.1)
  - Not in or through air duct, clothes chute, chimney, vent or elevator shaft 2415.3 (404.3)
    - Not in solid partitions or walls unless in a chase
  - Fitting in concealed locations – no unions, tubing fittings, right and left couplings G2415.5 (404.5)
    - Allowed threaded, brazed welded, listed to ANSI LC-1-1CSA 26

* Sleeved through foundations – annular space to be filled 2415.6 (404.6)

* Protection from physical damage 2415.7 (404.7)

    - Shield plate on all piping other than black or galvanized steel at notches or holes 2415.7.1 (404.7.1)

* Piping in solid floors 2415.8 (404.8)

    - Ends extend into space

        - Open ends

        - Inside extend minimum 2”

        - Outside extend a minimum of 6”

* Above ground piping 2415.9 (404.9)

    - Protected when installed above ground and outdoors

        - 3 ½” minimum height clearance – roof

        - Protected from corrosion

* Protected from corrosion 2415.11 (404.11)

    - Exposed piping protection

    - Galvanizing not adequate

    - Protection methods 2415.11.2

        - Corrosion resistant material based on soil condition

        - Factory applied, electrically insulated coating

        - Monitored cathodic protection

    - Dissimilar metals require insulated couplings or fittings

    - Protection of risers 2415.11.4 (404.11.4)

        - Steel risers to plastic pipe – cathodically protected with an anode

    - Prohibited – uncoated threaded or socket welded joints

* Minimal burial depth 2415.12 (404.12)

    - 12” burial depth

- - Exceptions: grills, lights at 8” G2415.12.1
- Trenches 2415.13 (404.13)
  - Graded for a firm continuous bearing bottom

* Piping underground or beneath building 2415.14
  - Prohibited unless encased in a listed product
  - Ends extend into space
  - Open ends
    - Inside extend minimum 2”
    - Outside extend a minimum 6”
* Unused outlets closed 2415.15 (404.15)
* Location 2414.16 (404.16)
  - Outlets to extend 1” beyond walls and ceilings and 2” above floors
  - Not to be installed behind doors
  - Located in the room or space where appliance is installed
* Plastic pipe 2415.17 (404.17)
  - Outside underground only
  - Not within or under buildings
  - Proper metallic to plastic fittings 2415.17.2 (404.17.2)
  - Tracer wire required with non-metallic piping, yellow insulated copper, minimum 18 AWG 2415.17.2 (404.17.3

♦ Inspection, Testing, and Purging Section 2417 (406)

* Prior to acceptance to be inspected and tested 2417.1 (406.1)
  - Repair and new branches require testing
  - Permitted to be tested in sections 2417.1.4 (406.1.4)
  - Regulators and valves assemblies can be tested independently

- Oxygen is a prohibited test medium

* Test preparation 2417.3 (496.3)

- Pipe joints and welds exposed for testing
- Appliances and equipment – disconnected a test blank
  - Required when test pressure higher than allowable for the equipment

* Test pressure measurement 2147.4 (406.4)

- Device ability to measure loss
- Source isolated before test
- Gauge upper pressure 5 times less than test pressure
  - Pressure to be not less than 1 ½ times the maximum working pressure, but not less than 3 psi. G2417.4.1 (406.4.1)
  - Duration not less than 10 minutes

* Detection of leaks and defects 2417.5 (406.5)

- Reduction in pressure indicates a leak
- Detection by gas detector, noncorrosive fluid or other approved means
- Affected portions repaired or replaced

* Piping system and equipment leakage 2417.6 (406.6)

- System properly tested
- Check for open valves or pipes
- No appliances in operation before system checked and purged

* Purging 2417.7 (406.7)

- Required to be purged outdoors when system meets either of the following:
  - Pressure greater than 2 psi OR
  - Contains in excess of Table 2417.7.1.1
- Removed from service
  - Gas piping isolated and filled with inert gas

- When placed in operation displace with inert air and then gas
- Purge to outside
  - Controlled by a valve
  - 10 feet from ignition source, building openings, 25 feet from intakes
  - Open end monitored
  - Terminated when gas 90% by volume
  - All other persons 10 feet away
- Listed combustible gas indicator
- Can be purged indoors when system meets either of the following:
  - Pressure less than 2 psi OR
  - Contains less than Table 2417.7.1.1
- Purging procedure
  - Discharge to outside
  - Indoors or outdoors through an appliance burner with continuous source
  - Equipment designed for purpose
  - Monitored by a gas detector, stopped when gas detected
  - Follow written procedure
- Listed combustible gas indicator
- Appliances purged before being placed in service

♦ Piping Support 2418 (407)

* Components suitable for the piping material
* Spaced per Section 2424
* Allow pipe to expand and contract
* Underground plastic gas line with yellow #18 AWG tracer line

* Residential clothes dryer gas line with shutoff valve, capped
* 1” black iron residential gas line hanging from floor joists

♦ Drips and Sloped Piping 2419 (408)

* ¼” in 15’
* Sediment traps or drips required near appliance inlet as close as possible – with ready access
* Not required for illuminating appliances, ranges, clothes dryers, decorative vented appliances within fireplaces or outdoor grills

♦ Shutoff Valves 2420 (409)

* Not in furnace plenums or concealed locations
* Accessible / shutoff side of each meter
* Each building / permanently identified
* At each MP regulator
* Appliance shutoff valve 2420.5
    - At each appliance
        - In same room – maximum 6’ away
        - Vented decorated fireplaces per manufacturer
        - Serve no other appliance
        - Can be in a remote room if readily accessible
        - Permanently identified

♦ Flow Controls 2421 (409)

* Line pressure regulators required when appliances operate at pressure lower than the supply system
* Accessible
* Protected from physical damage
* Vent regulators to the outside
* Excess flow valves listed, sized and installed per manufacturer
* Listed flash back arrestor when used with oxygen 2421.5 (410.5)

- Appliance Connectors 2422 (411)
  - Listed and labeled
  - Protected from damage
  - Dryers and ranges 6’
  - Not concealed in or through walls
  - Shut off valve before connector
- Piping Support Intervals 2424 (415)
  - Table 2424.1 for interval
- General 2425 (501)
  - Chimneys, liners, vents, and connectors
  - Vent to the outside
  - Abandoned outlets to be sealed
  - Positive pressure or induce draft designed for positive pressure
  - Unvented appliances allowed 2425.8 (501.8)
    - When aggregate amount exceeds 20 Btu per hour per cu. Ft. of room volume, needs to be vented
    - Adjacent rooms permitted to count
    - Masonry chimney minimum 12” above lowest point
- Fuel Gas Appliance Definitions 2403 (202)
  - Category I
    - DEFINTION:
      - An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensation production in the vent
    - EXAMPLES:
      - Water Heaters / room heaters
      - Furnaces / Unit heaters
      - Boilers

* Category II
    - DEFINITION:
        - An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensation production in the vent
    - EXAMPLE
        - Forced draft or induced draft heaters
* Category III
    - DEFINITION:
        - An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent
    - EXAMPLE:
        - Direct vent furnace
* Category IV
    - DEFINITION:
        - An appliance that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent
    - EXAMPLE:
        - Sealed draft units with draft temperatures low enough to permit condensation
* Existing chimneys or vents 2425.15 (501.15)
    - Resizing required to control condensation and provide proper draft
    - Passageway free from obstructions, cracks etc.
    - Masonry chimney requires cleanout 2425.15.3 (501.15.3)
    - Clearance from combustibles as per Chapter 10 2425.15.1 (501.14.4)

♦ Vents Section 2426 (502)

* Listings required
    - B and BW – UL 441
    - L – UL 641
    - Category II and III vents – UL 1738
* Connectors required – connect appliance to vertical chimney or vent 2426.2 (502.2)

* Insulation shield required
* Adequate support 2426.6 (502.6)
* Shield plates required

♦ Venting of Appliances 2427 (503)

* All equipment to be vented 2427.2 (503.2)
* Direct and integral vent equipment per manufacturer
* Design and construction 2427.3 (503.3)
    - Designed to prevent leakage of fumes into building
    - Mechanical draft per listing
* Not to be combined with natural draft appliances
* Exit terminal 7’ above grade at public walkways
* No portion extend into or through ducts or furnace plenums
* Types of venting to be used 2427.4 (503.4)
    - See Table 2427.4 (503.4)
    - Plastic piping – used for venting equipment listed for use with such venting materials shall be approved
    - Special gas vent – shall be listed and installed in accordance with the terms of the special gas vent listing and the manufacturer’s instructions
* Chimney termination 2427.5.3 (503.5.4)
    - 3’ above roof penetration
    - 2’ higher than any portion of building within 10’
    - 5’ above highest connected draft hood
* Size of chimneys 2427.5.4 (503.5.5)
    - Per Section 2428 (504)
    - Single appliance not less than appliance flue collar greater than 7 times the draft hood outlet
    - 2 or more – not less than the largest draft hood plus 50% of the smaller, or greater than 7 times the outlet

* Inspection of masonry chimney before connecting a new appliance shall be made 2427.5.5 (503.5.6)
    - Unsafe chimneys to be repaired, rebuilt, relined, or replaced
    - Lining 2427.5.5.1 (503.5.6.1)
    - Cleanouts secured
    - Gas and solid fuel not to be interconnected 2427.5.6.1 (503.7.1)
    - Combination equipment requires certain safeguards
* Gas vents 2427.6 (503.6)
    - Installed per listing and manufacturer's instructions
    - Roof penetrations – flashed, listed termination cap
    - One 60° offset allowed, balance not to exceed 45° - single wall vent connectors not more than 75% of vertical height of vent
    - Gas vent termination 2427.6.4 (503.6.5)
        - Figure 2427.6.4 for vents under 12" with listed caps – vent 8' from wall
        - All other 2' above roof penetration and 2' above building portion within 10'
        - Decorative shrouds only with listing
* Minimum vent height 2427.6.4 (503.6.5)
    - Type B or L – 5' above draft hood or flue collar G2427.6.4 (503.6.5)
    - Type B-W vent 12' above bottom of wall furnace
    - Not to terminate adjacent to wall or below eaves or parapets except as provided G2427.6.7 (503.6.8)
* Size of gas vents 2427.6.8 (503.6.9)
    - Category I with Type B gas vent
        - Provisions of Section 2428 (504)
        - Individual appliance – not less than area of draft hood or greater than 7 times draft hood outlet area

- 2 or more appliances – area of draft hood plus 50% area of smaller hood not greater than 7 times smaller hood

- Category II, III, IV – sizing in accordance with manufacturer's instructions G2427.6.8.3 (503.6.9.3)
  - Supported per listing
  - Special signage at vent – could be required by code official
  - Example:

    "This gas vent is for appliances that burn gas. Do NOT connect to solid or liquid fuel-burning appliances or incinerators."

* Single wall pipe 2427.7 (503.7)
  - Not to be used in cold climates for venting gas utilization equipment
  - Terminate 5' above highest connected draft hood outlet
  - 2' above roof and 2' within a horizontal distance of 10' with an approved cap
  - Limited to runs direct from roof or exterior wall to the outdoor atmosphere 2427.7.4 (503.7.4)
  - Penetrations to be protected 2427.7.5 (503.7.5)
  - Thimble 18" above / 6" below roof
  - Not in concealed spaces
  - Same sizing requirements
* Vent system termination 2427.8 (503.8)
  - See Appendix C for illustration
  - Mechanical draft system 3' above any forced air within 10'
* Vent connectors for Category I appliance 2427.10 (503.10)
  - Non-combustible corrosion resistant material 2427.10.2.1 (503.10.2.1)
  - Unconditioned spaces require B or L listed material 2427.10.2.2 (503.10.2.1)
  - Approved connection material for conditioned spaces

- B or L vent material
- Single-wall pipe
  - Aluminum / Stainless Steel / Galvanized pipe
  - Smooth interior / corrosion resistant
  - Listed vent connector
  - Thickness per 2427.10.2.4 (503.10.2.4)

* Size of vent connector 2427.10.3 (503.10.3)
  - Single draft hood and fan assisted section
  - Multiple hoods – engineering methods or combined area of flue collars or draft hood outlets, minimum rise 1’
  - Common connector 2427.10.3.4 (503.10.3.4)
  - Highest level consistent with headroom and required clearance
  - Size increase at draft hood outlet 2427.10.3.5 (503.10.3.5)

* Joints 2427.10.6 (503.10.6)
  - Screws or other connectors as listed per listing sheet
  - Slope
    - Without dips, rise ¼” per foot
  - Length – as short as possible 2427.10.8 (503.10.8)
  - 75% of chimney or vent height maximum
    - Type B double wall permitted – 100% height of chimney or vent

* Properly supported 2427.10.9 (503.10.9)

* Draft Hoods 2427.12 (503.12)
  - Vented equipment to have draft hoods
  - Installed exactly as furnished
  - Dampers

* Manually operated dampers not part of approved installation 2427.13 (503.13)
  - Devices that obstruct flow of flue gas not to be installed

- Sizing of Category I Appliance Venting Systems Section 2428 (504)

  * DEFINTIONS:

    - Appliance categorized vent diameter / area – minimum vent area / diameter permissible for Category I appliances to maintain a non-positive vent static pressure when tested in accordance with nationally recognized standards.

    - Fan assisted combustion system / Fan Min / Fan Max / Nat Max / Fan + Fan / Fan + Nat / NA / Nat + Nat

  * Type B Double-wall vent

    - Single Category I appliance connected directly to vent Table 2428.2(1) (504.2.1)

  * Type B Double-wall vent Table G2428.2(2) (504.2.2)

    - Single Category I appliance with single-wall metal connector

  * Connection to a masonry chimney shall meet the requirements of the 2015 International Fuel Gas Code (IFGC) Tables per Appendix B

  * IFGC TABLE 504.2(3) Masonry Chimney

    - Single Category I appliance with Type B double-wall connector

  * IFGC TABLE 504.2(4) Masonry Chimney

    - Single Category I appliance with single-wall connector

  * IFGC Table 504.2(5) Single-wall metal pipe or Type B asbestos cement pipe

    - Single draft hood equipped connected directly to pipe or vent

  * Vent offsets 2428.2.3 (504.2.3)

    - Zero lateral length – no elbows
    - Tables include 2, 90° as part of numbers
    - Each elbow to 45° reduces vent table 5%
    - Each elbow to 90° reduces tables 10%

  * Zero lateral only to straight vertical vent attached directly to draft hood or flue collar 2428.2.4

  * Multiple rate appliances need to meet both minimum and maximum numbers 2428.2.6 (504.2.6)

* Vent connectors not more than 2 sizes greater than listed appliance categorized vent diameter, draft hood or flue collar 2428.2.11 (504.2.11)

* Multiple Appliance Vent Tables 2428.3 (504.3)

    - Comply with 2428.3.1 – 2428.3.23
    - No obstruction installed in system
    - Connector length per Table 504.3.2 or 1 ½ feet per inch of connector
    - Reduce vent capacity 10% for each multiple length of connector
    - Each elbow to 45° reduces vent table 5% 2428.3.6 (504.3.6)
    - Each elbow to 90° reduces tables 10%

* Common vent – equal to or greater than largest connector 2428.3.8 (504.3.8)

* Connector rise from the appliance connector to the centerline of vent gas streams G428.3.11 (504.3.11)

* Vent height measure from highest draft hood outlet

* Vent height size not more than 7 times smallest listed vent area 2428.3.13 (504.3.17)

* Vent extends more than 5’ above roof – additional enclosure requirements 2428.3.16 (504.3.20)

    - Where the actual height of a vent falls between entries in the height column, either interpolation must be used or the lower input rating must be used for the FAN MAX and NAT MAX G2428.3.22 (504.2.25)

* Type B Double-wall vent Table 2428.3(1)

    - 2 or more Category I appliances with Type B double-wall pipe

* Type B Double-wall vent Table 2428.3(2)

    - 2 or more Category I appliances with single-wall connector

* Masonry Chimney Table 2428.3.(3)

    - 2 or more Category I appliances with Type B double-wall pipe

* Masonry Chimney IFGC Table 504.3.(4)

    - 2 or more Category I appliances with single-wall metal connector

* Single-wall metal pipe or Type B asbestos cement vent IFGC Table 504.3(5)
    - 2 or more draft hood equipped direct to pipe or vent
* Exterior Masonry Chimney IFGC Table 504.3(7a)
    - 2 or more appliances NAT + NAT Type B double-wall connector
* Exterior Masonry Chimney IFGC Table 504.3(7b)
    - 2 or more appliances NAT + NAT Type B double-wall connector
* Exterior Masonry Chimney Table 504.3(8a)
    - 2 or more appliances FAN + NAT Type B double-wall connector
* Exterior Masonry Chimney IFGC Table 504.3(8b)
    - 2 or more appliances FAN + NAT Type B double-wall connector

♦ Vents and Connectors – Definitions 202

* Vent is defined:
    - "A passageway for conveying flue gases from fuel-fired appliances or their vent connectors to the outside atmosphere."
* Vent connector is defined:
    - "That portion of a venting system that connects the flue collar or draft hood of an appliance to a vent."
* Draft is defined:
        - "The pressure difference existing between the appliance or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the appliance to the atmosphere." Section R202
        - Mechanical or induced draft is the pressure difference by the action of a fan blower or ejector between the appliance and the chimney or vent termination.
        - Natural draft is created by the vent or chimney because of height and temperature difference between the flue gas and atmosphere.

☞ Class Exercise - Vent sizing for natural draft pool heater

* Determine Btu/h input rating from appliance label
* When rating is unknown, the manufacturer shall be consulted
* 1,000 Btu = 1 cube foot of natural gas
* Reference Type B double-wall vent system serving a single appliance with Type B double-wall vent
* Table G2428.2(2)
    - Category I Natural Draft Pool Heater
    - 225,000 Btu input – 1’ lateral / 20’ height
    - Other appliances

☞ Class Exercise – Maximum and minimum vent sizing

* What is the maximum effective vent area allowed?
* Not greater than 7x draft hood outlet area
* Fan assisted 100,00 Btu/h furnace – 15’ lateral / 30’ height
* What is the maximum vent size allowed?
* What is the minimum size allowed?

☞ Determining minimum capacity of a vertical Type B vent larger than a single vent size connecting to it

* Size of chimneys Type B vents 2427.5.4 (503.5.5)

- "For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue collar or draft hood outlet, nor greater than 7 times the draft hood outlet area."

* Where do we start?

* Type B double-wall gas vent TABLE 2428.2(1)

* 100,000 Btu/h / 1,000 = appliance input rating in thousands
* Fan assisted 100,000 Btu/h furnace – 15' lateral / 30' height

* What is the maximum vent size allowed?

* What is the minimum vent size allowed? (Not greater than 7x draft hood outlet area)

☞ Sizing an individual chimney venting system for a single appliance with a draft hood 2427.5.4

* The effective areas of the vent connector and chimney flue shall be:

  - Not less than the area of the appliance flue collar or draft hood outlet

  - Nor greater than 7 times the draft hood outlet area

* Where:

  - Area of circle: $A = \pi r^2$

  - π = 3.14

  - Vent connector = 4" diameter

* Thus:

- 4” diameter = 2” radius
- Radius squared 2” x 2” = 4”
- Flow area of vent connector = 3.14 x 4”, or 12.56 square inch

* Check for 7 times the size limit
  - 12.56 square inch x 7 = 87.96 square inch
  - 87.96 square inch / 3.14 – 28 square inch
  - Square root of 28 square inch = 5.29”
* Answer: Vertical vent maximum size = 5” diameter

☞ Class Exercise – Determine 2 single-wall connector vent sizes and Type B double-wall vent size accepting the 2 single-wall vents

* Reference TABLE 2428.3(1) vent system serving 2 or more appliances with a Type B double-wall common vent and single-wall vent connectors
* Equipment common-vented into a 20’ high Type B vent chimney:
  - 100,000 Btu/h Fan assisted furnace
    - 10’ lateral / 2’ rise
  - 50,000 Btu/h Water heater
    - 4’ lateral / 3’ rise

♦ STEP ONE:

* Determine size of single-wall vents from each appliance
* Type B double-wall vent TABLE 2428.3(2)
* 100,000 Btu/h Fan assisted furnace, lateral 2’ rise / 20’ chimney

* Type B double-wall vent TABLE 2428.3(1)

* 50,000 Btu/h Water heater, lateral 2’ rise / 20’ chimney

* Type B double-wall vent TABLE 2428.3(1)

* Common vent diameter requirement for Type B double-walled vent

* Size of Type B double-wall common vent is 5”

Specific Appliances 2431 – 2453

- Decorative Appliances For Installation In Fireplaces 2432 (602)
  - Flame safeguard device, pilot flame or ignition
- Log Lighters 2433 (603)
  - Per CSA 8
- Vented Gas Fireplace Heaters 2435 (605)
  - Access panels not to be attached to building
    Vented gas fireplace heaters per ANSI Z21.88
  - Natural gas log lighter
  - Gas shutoff valve within 6’ 2420.5.1 (409.5.1)
- Vented Wall Furnaces 2436 (607)
  - Not circulate air from or between bathrooms
  - 12” clearance for doors; doorstops and door closer not allowed as clearance device
  - Not ducted
  - Access for cleaning and service
- Floor Furnaces 2437 (609)
  - Specific clearance requirements
  - Thermostats in same room
  - Protection if suspended into habitable spaces
- Clothes Dryers and Exhaust 2438 - 2439 (613-614)
  - Fire resistance rating of construction to be maintained
  - Access for cleaning of all vertical ducts
  - Exhausted outside of the building
  - Many same requirements as mechanical section
- Sauna Heaters 2440 (615)
  - 194° – room temperature

* One hour maximum timer – required

- Forced Warm Air Furnaces 2442 (618)
  * Outside and return air ducts not less than 2 sq. in. per 1,000 Btu or as manufacturer's instructions
  * Many same requirements as mechanical section
- Unit Heaters 2444 (620)
  * Properly supported
  * No duct work unless listed
  * Clearance to combustibles
- Unvented Room Heaters 2445 (621)
  * Not sole source of heat
  * Aggregate total 20 Btu per cube foot – venting required
  * Oxygen depletion service
- Vented Room Heaters 2446 (622)
  * Per ANSI Z21.86 / CSA 2.32
- Cooking Appliances 2247 (623)
  * Commercial cooking appliances not to be installed in dwelling units or areas where domestic cooking will occur
  * Domestic appliances to be listed and labeled for use
- Water Heaters 2448
  * Safety devices per code
  * Listed accordingly if supplying space heating and domestic
- Air Conditioning Appliances 2449 (627)
- Illuminating Appliances 2450 (628)
- Infrared Radiant Heaters 2451 (630)
- Chimney Damper Opening Area 2453 (634)

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Understanding the 2019 Residential Code of Ohio Mechanical©

Chapter 12 Administration

Building Better With Our Greatest Resource…Education®

Course Description

Mechanical requirements of the 2019 Residential Code® of Ohio are notated and defined, illustrating code requirements for the proper installation of mechanical systems. Instructors identify and discuss code requirements for furnaces, combustion air, gas piping, and proper installation of different types of residential appliances. Additional components include venting and fuel gas requirements for residential mechanical systems.

Learning Objectives / Learning Outcomes

<u>Students successfully completing this course will be able to:</u>

Students will demonstrate problem solving by utilizing given calculations to determine code compliance for residential mechanical systems.

Students will recognize and employ the venting and fuel gas requirements for residential mechanical systems demonstrated by calculating given examples and defending the decision.

Students will determine confined and unconfined areas, utilizing given examples and situations.

- Chapter 12 Administration
  - Administrative provisions of Chapter 12 apply to mechanical requirements of Chapters 13 - 24
  - Non-gas fired appliances Chapters 13 – 23
  - Gas fired appliances Chapter 24

Chapter 12 Administration

- Covers permanently installed mechanical systems installed to regulate environmental conditions within buildings, including:
  - Design
  - Installation
  - Maintenance
  - Alteration and inspection
- Administrative sections in Chapter 1 apply
- Regulates systems specifically addressed in code
  - Items not covered — official must use other methods
  - Experience, referenced standards, other codes

Existing Systems 1202

- Additions, alterations or repairs 1202.1
  - Shall comply as if new
  - Not to be detrimental to existing equipment
- Existing installations 1202.2
  - Systems can remain – lawfully installed
- Maintenance 1202.3
  - Kept in proper operating condition in accordance with the original design, including safety devices

* Make a list of fuels for Chapters 13 – 23

* Make a list of fuels for Chapter 24

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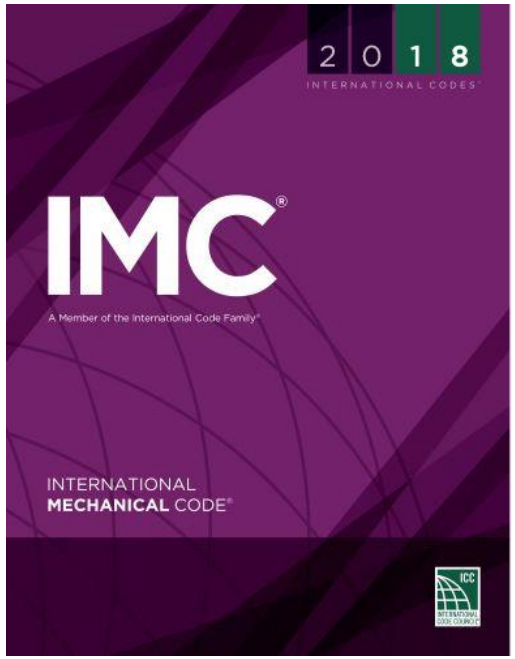
Understanding the 2019 Residential Code of Ohio Mechanical©

Chapter 13
General Mechanical System Requirements

* Refer to 2018 International Fuel Gas Code and 2018 International Mechanical Code for installation of mechanical appliances, equipment, and systems not addressed by this code

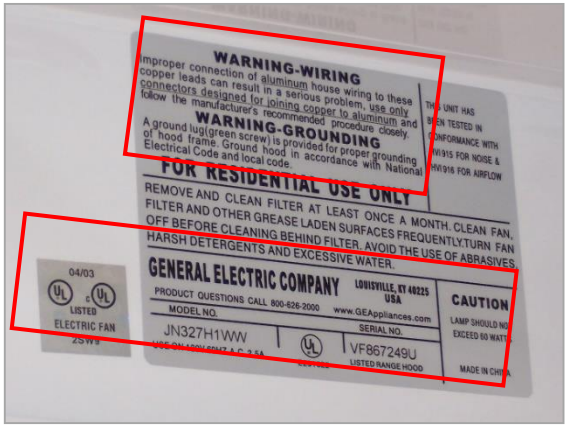


- General 1301
  - Identification 1301.2
    - Pipe, tubing, fittings
    - Each length of pipe shall bear the identification of the manufacturer
  - Installation of materials 1301.3
    - Materials installed per standard
    - No standard instructions – follow manufacturer's instructions
    - If manufacturer or standard does not meet code – follow code

- General 1301 *(continued)*
  - Installation of materials 1301.3
    - Plastic pipe per NSF14 (National Sanitary Foundation)
  - Third party testing or certification 1301.4
    - Pipe, tubing and fitting – tested or certified
- Approval 1302
  - All appliances listed and labeled for application and use or approved per 104.11

Labeling of Appliances 1303

- All appliances shall be labeled M1303.1
  - Label requirements
    - Manufacturer's name and trademark
    - Model and serial numbers
    - Testing agency identification
    - Electrical information
    - Btu/h ratings for absorption units
    - Input BTU/h ratings fuel type/clearances
    - Electric comfort heating maintenance instructions



Type of Fuel 1304

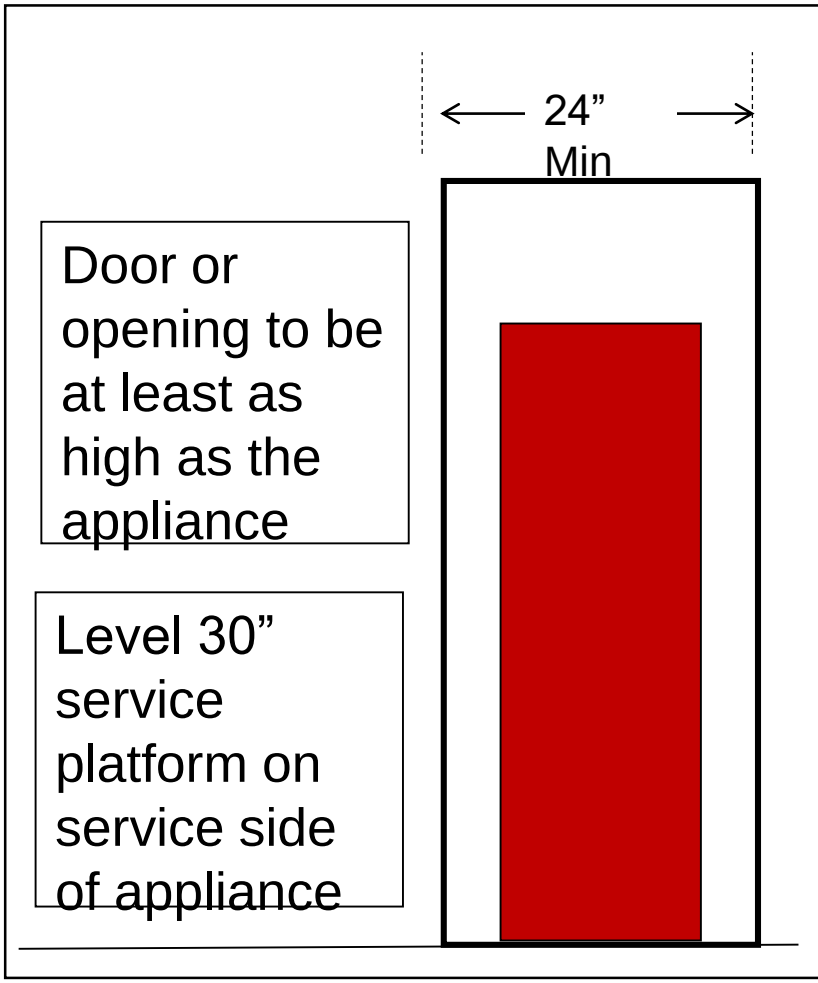
- Fuel types 1304.1
  - Appliance designed for type of fuel to be used
  - Design for high altitude when applicable
  - No increase or decrease beyond rating

Appliance Access 1305

* Appliance access for inspection, service, repair and replacement 1305.1
  - Sufficient size for service, repair, maintenance, replacement, and inspection without removal of permanent construction
  - 30” x 30” working space in front of control side for service

Appliance Access 1305

- Appliance access for inspection, service, repair and replacement 1305.1
  - Appliances in rooms 1305.1.1
    - Access via minimum 24” wide door
    - Large enough to permit removal of appliance
    - 30” deep working space and height of appliance



Appliance Access 1305

- Appliance access for inspection, service, repair and replacement 1305.1
  - Appliances in attics M305.1.2
    - Access opening (30”h x 20”w) and passageway (30”h x 22”w) large enough to allow removal after disassembly minimum
    - Not more than 20’ from attic access
    - Solid flooring from access to appliance and at service space 24” wide
    - Level service space front and/or side 30” x 30”
    - Illumination via switched light at opening, service outlet required per Chapter 38
    - Exception # 2 – Passageway increased to 50’ when unobstructed 6’ in height and minimum 22” clear width

Appliance Access 1305 *(continued)*

- Appliance access for inspection, service, repair and replacement 1305.1
  - Appliances under floors 1305.1.3
    - Same access requirements as attic
    - Protect walls if greater than 12” below grade
    - Supported level on concrete slab or approved material or suspended from structure
    - 6” clearance to grade
    - Illumination via switched light at opening, service outlet required
    - Not more than 20’ from crawlspace access
    - Exception: Passageway unlimited in length when unobstructed 6’ height and minimum 22” in clear width

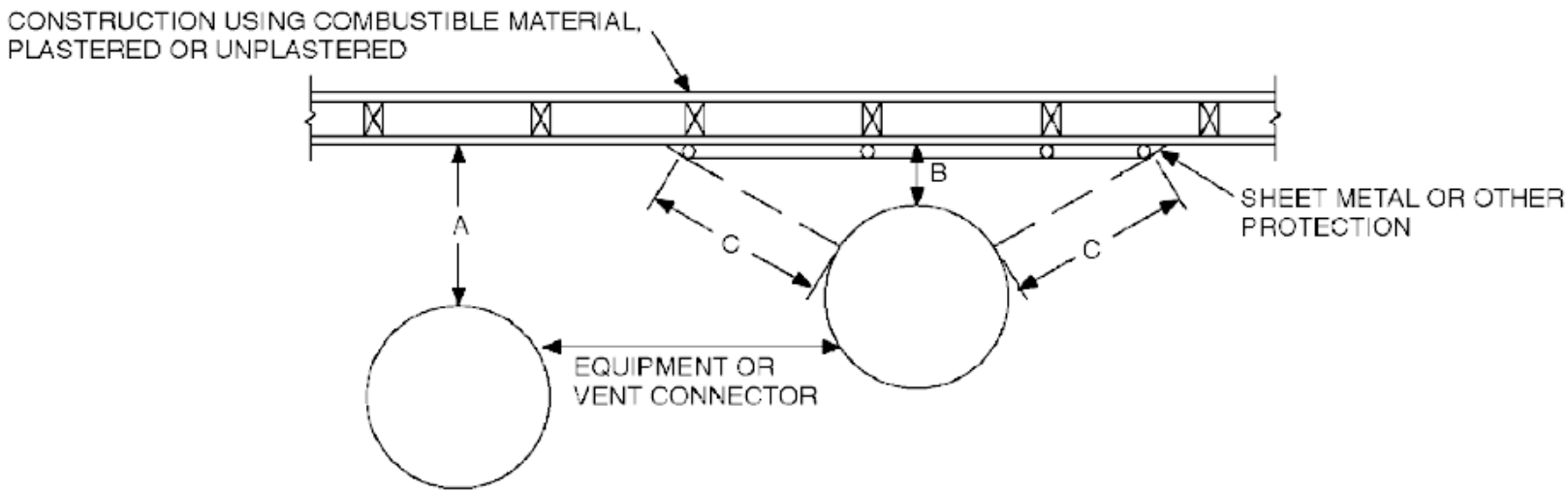
Clearance from Combustible Construction M1306

- Appliance clearance 1306.1
  - Per appliance manufacturer
  - Clearance reduction per Table 1306.2
  - Not permitted for solid fuel appliances with listed clearance of 12” or less
  - Table differs from IMC Table 308.6
  - When ventilated air space is required – 1” clearance on all sides of assembly
  - Reduce clearance to combustibles Table 1306.2
    - See Figure M1306.1

TABLE 1306.2
REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION[a, c, d, e, f, g, h, i, j, k, l]

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION (See Figures M1306.1 and M1306.2)	WHERE THE REQUIRED CLEARANCE WITHOUT PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE WALL METAL PIPE IS:									
	36 inches		18 inches		12 inches		9 inches		6 inches	
	Allowable clearances with specified protection (Inches)[b]									
	Use column 1 for clearances above an appliance or horizontal connector. Use column 2 for clearances from an appliance, vertical connector and single-wall metal pipe.									
	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2	Above column 1	Sides and rear column 2
$3^1/_2$-inch-thick masonry wall without ventilated air space	—	24	—	12	—	9	—	6	—	5
$^1/_2$-inch insulation board over 1-inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) over 1-inch glass fiber or mineral wool batts reinforced with wire or rear face with a ventilated air space	18	12	9	6	6	4	5	3	3	3
$3^1/_2$-inch-thick masonry wall with ventilated air space	—	12	—	6	—	6	—	6	—	6
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space 1-inch off the combustible assembly	18	12	9	6	6	4	5	3	3	2
$^1/_2$-inch-thick insulation board with ventilated air space	18	12	9	6	6	4	5	3	3	3
Galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with ventilated air space over 24 gage sheet steel with a ventilated space	18	12	9	6	6	4	5	3	3	3
1-inch glass fiber or mineral wool batts sandwiched between two sheets of galvanized sheet steel having a minimum thickness of 0.0236-inch (No. 24 gage) with a ventilated air space	18	12	9	6	6	4	5	3	3	3

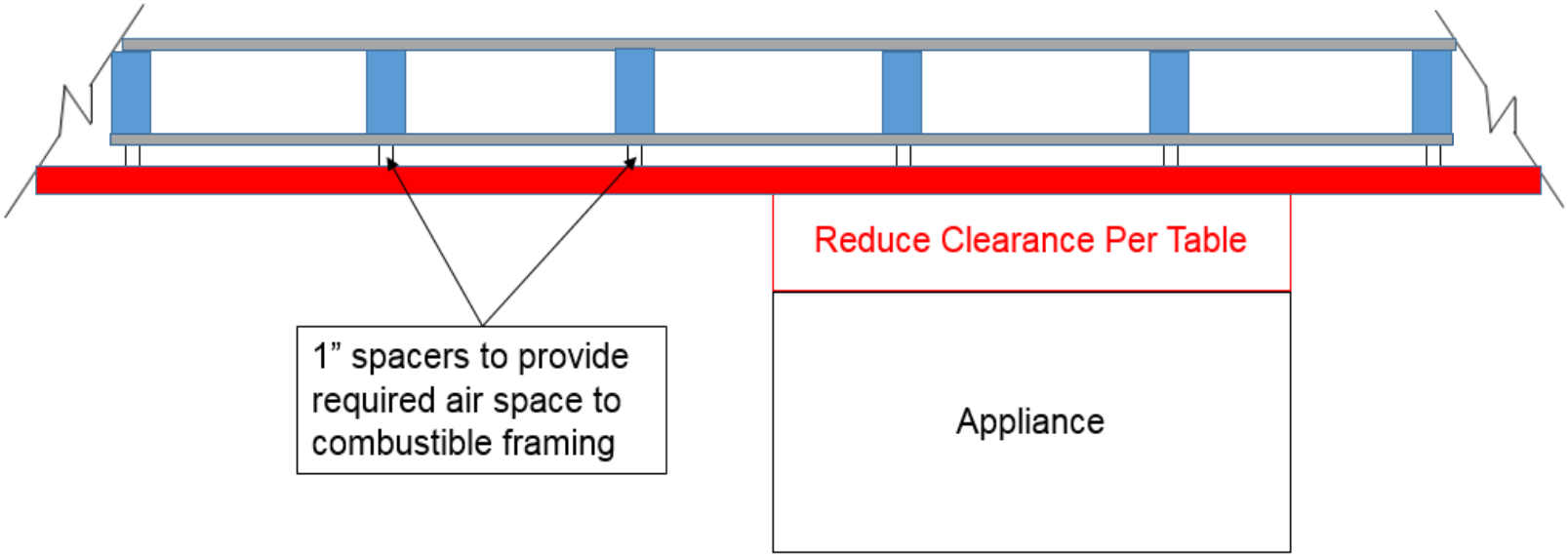
* Figure 1306.1



Note: "A" equals the required clearance with no protection. "B" equals the reduced clearance permitted in accordance with Table M1306.2. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

FIGURE 1306.1
REDUCED CLEARANCE DIAGRAM

* Reduce clearance to combustibles Table 1306.2



Horizontal Section Through Clearance Reduction Protection Attachment To Combustible Framing - *NTS*

Appliance Installation 1307

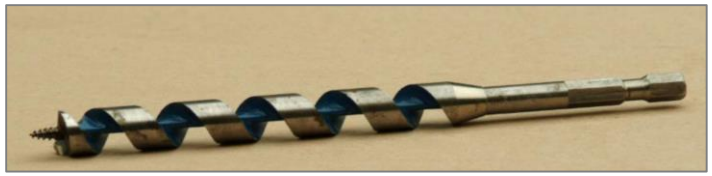
- Per manufacturer's installation instructions
- Attached to appliance
- Anchored in an approved manner – seismic considerations
- Ignition source elevated minimum 18" in garages
- Protected from vehicular impact
  - Elevation or see International Fire Code

Appliance Installation 1307

- Hydrogen generating and refueling M1307.4
  - Maximum floor area 850 square feet
  - Communicate directly to the outdoors
  - 2 openings in garage, within 12” top and bottom, directly to outdoors
  - Minimum free opening 0.5 square feet per 1,000 cu ft of garage volume
  - Louvers or grilles – net free area – 25% or 75%
  - Mechanical ventilation per the IMC

Mechanical Systems Installation 1308

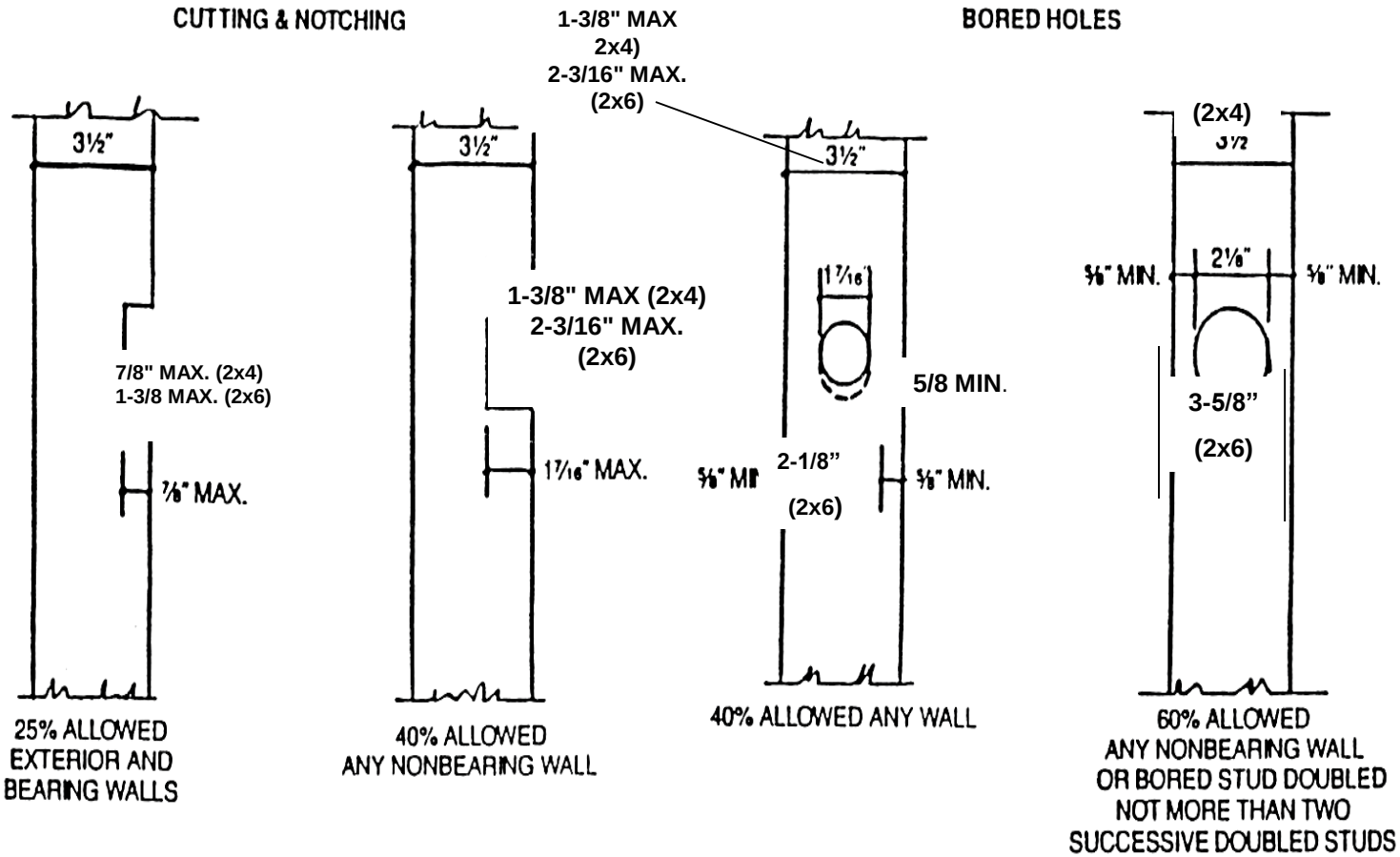
- Drilling and notching per sections 502.8, 602.6, 602.6.1, 802.7, 505.3.5, 603.3.4, 804.3.5



Drilling and Notching of Studs – Cut or Notched Studs 602.6

- Notching bearing = < 25% of width
- Non-bearing = < 40% of single stud width
- Drilling non-bearing = < 60% and no closer than 5/8” from edge
- Drilling on bearing = < 40% and no closer than 5/8” from edge, or
- Double the stud when the stud is located on an exterior wall, bearing partition, drilled ≥ 40% and up to 60%. Not in double successive studs
- Use a fastener across the top plate to each side of the opening
- Use not less than eight 10d nails at each side or equivalent

* Sample Stud Notching Sketch



MAXIMUM ALLOWED NOTCHING AND DRILLING
FOR NORMAL CONSTRUCTION WITH
2 × 4 STUD

* Drilling and notching of studs 602.6

♦ Drilling and Notching of Studs 602.6

* Exterior walls or bearing partitions can cut/notch 25% or less
  - Equivalent allowable <u>bearing</u> wall stud width cutting/notching (25%or less)
    - 2”x 4” nominal stud size = 7/8”
    - 2”x 6” nominal stud size = 1-3/8”
* Equivalent allowable <u>non-bearing</u> partitions stud width cutting/notching (40% or less)
  - 2”x 4” nominal stud size = 1-3/8”
  - 2”x 6” nominal stud size = 2-3/16”

* Drilling and notching of studs 602.6

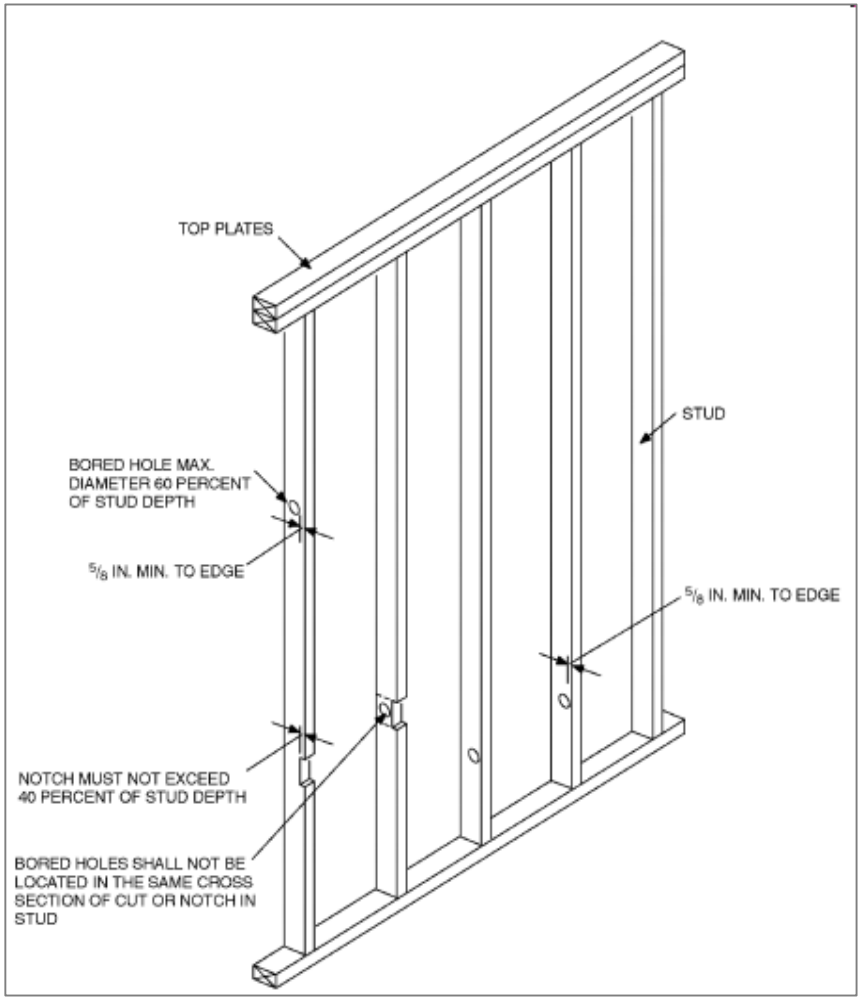


FIGURE R602.6(2)
NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR NONBEARING WALLS

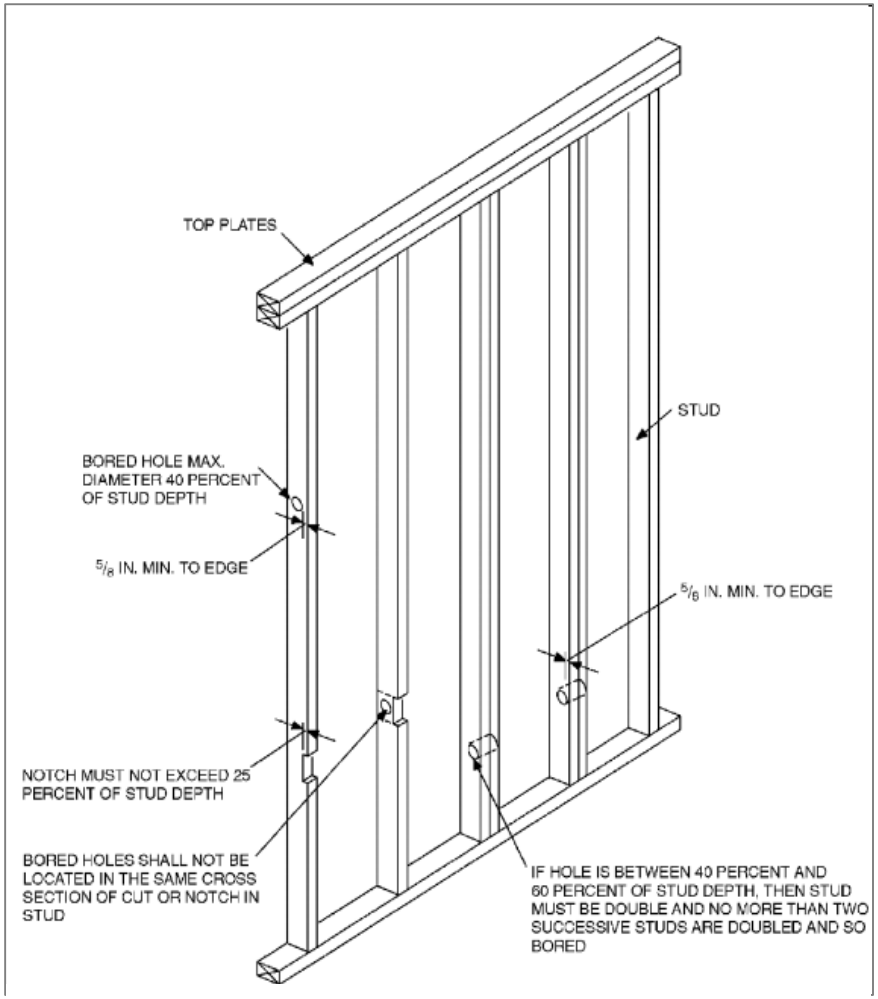


FIGURE R602.6(1)
NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS

* Drilling and notching of studs 602.6

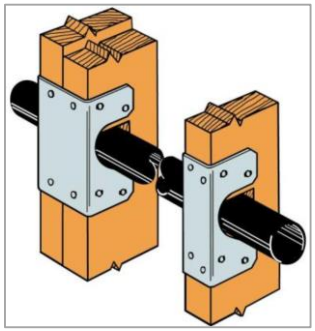
♦ Drilling and Notching of Studs 602.6

IF: Exterior wall or bearing studs are doubled

AND IF: Not more than 2 successive studs are bored

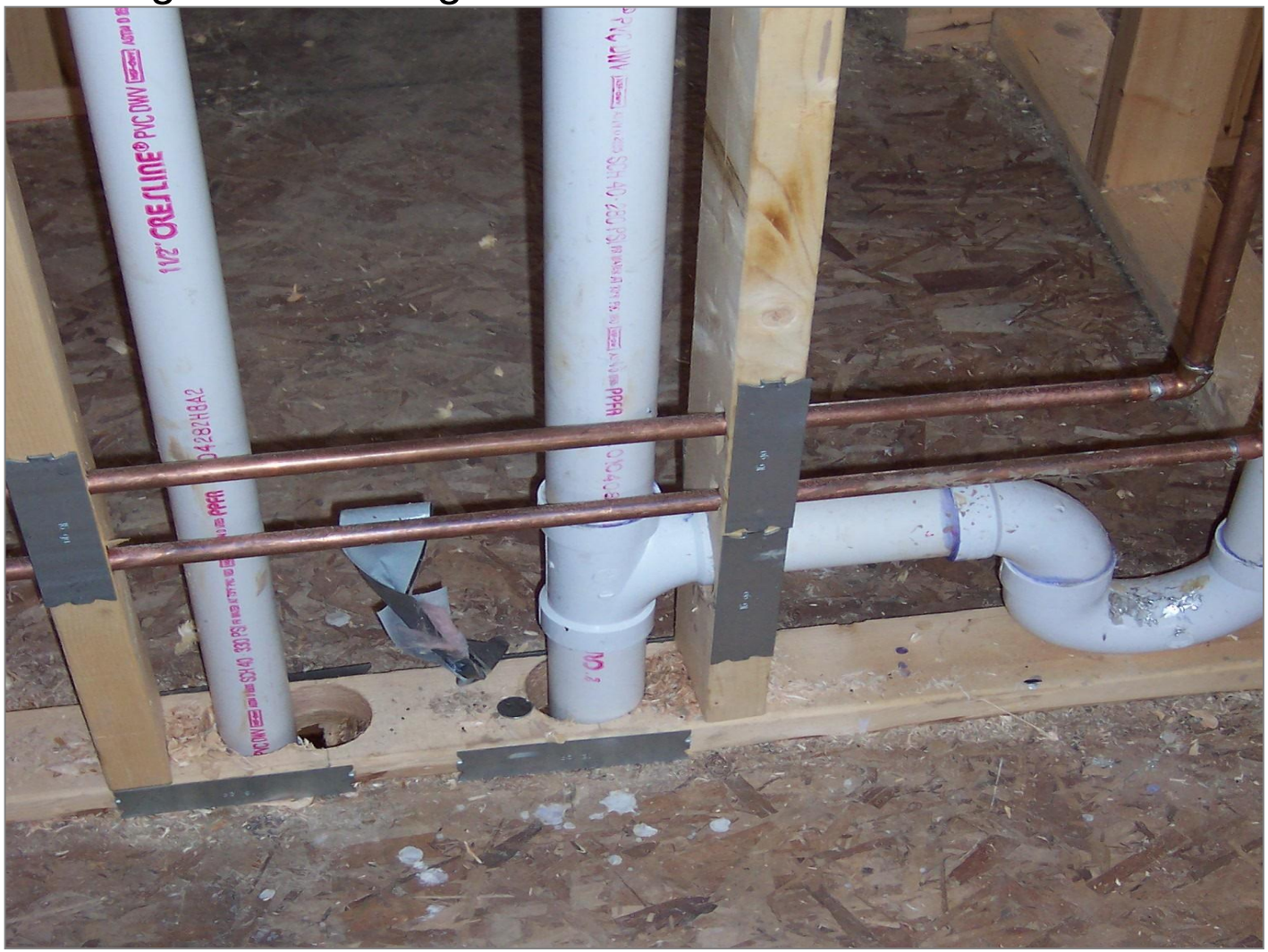
AND IF: Approved stud shoes are used

THEN: OK to bore or drill 60% of stud width



- 2”x 4” nominal stud size = 2-1/8” maximum hole
- 2”x 6” nominal stud size = 3-3/8” maximum hole

* Drilling and notching of studs 602.6



Drilling and Notching of Studs 602.6

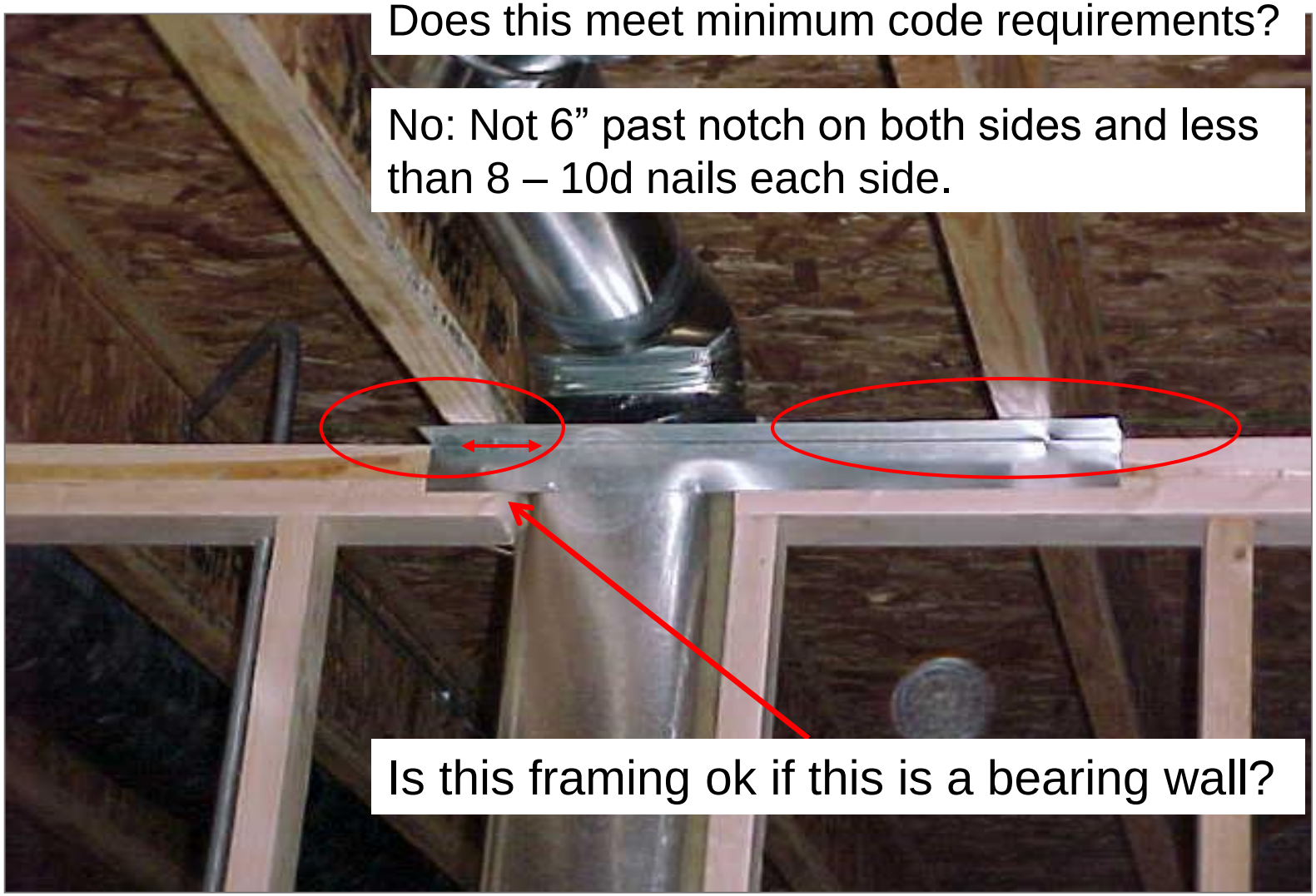
* Drilling and notching top plate 602.6.1
  - Exterior wall or bearing interior wall

    IF: Notched or bored >50% width of top plate

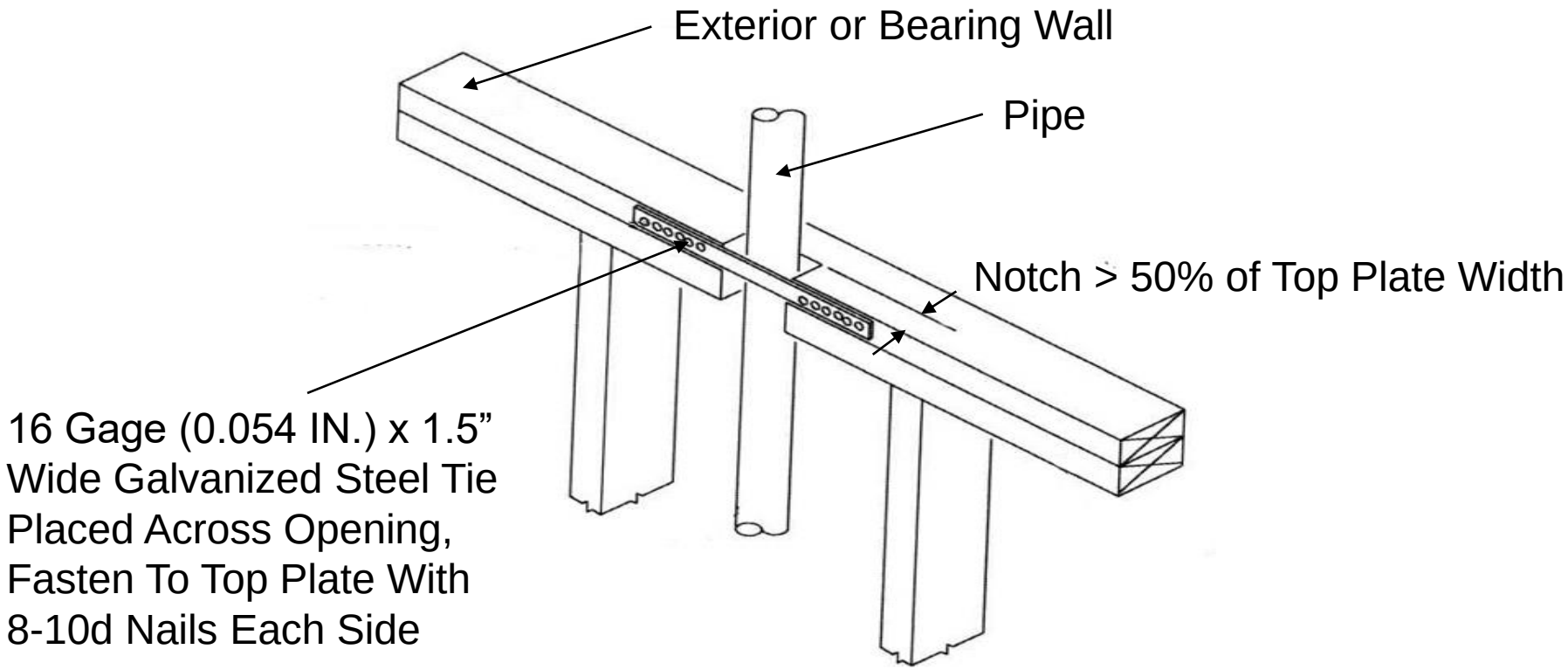
    THEN: Install a 0.054” thick galvanized metal strap
  - Min 6” past the opening with min
  - Use 8 – 10d nails (min 1 ½” long) and 0.148” dia) each side
    - 2”x 4” top plate = 1-7/8”
    - 2”x 6” top plate = 2-3/4”

* Drilling and notching top plate 602.6.1

* Drilling and notching top plate 602.6.1



* Drilling and notching top plate 602.6.1



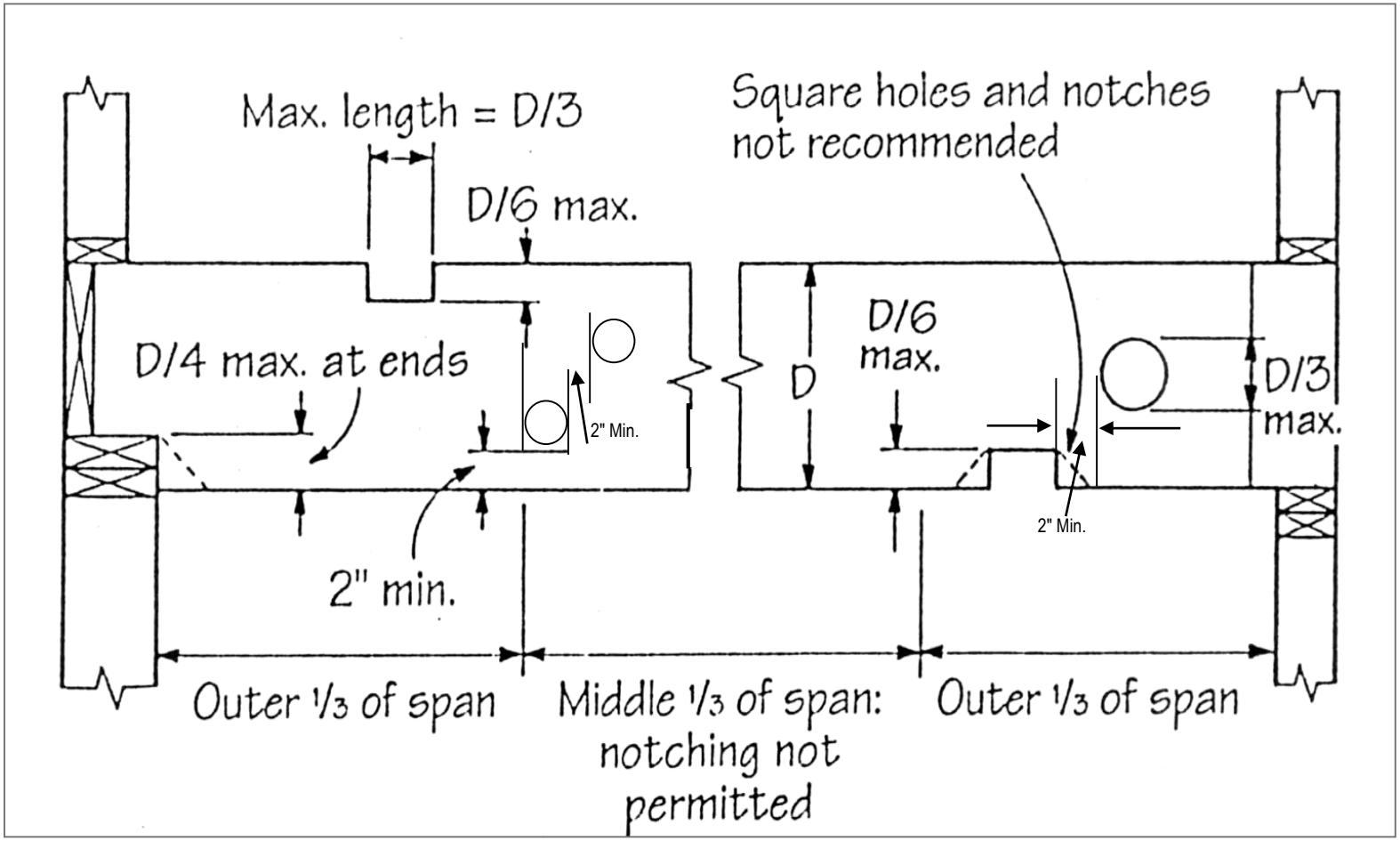
* Drilling and notching top plate 602.6.1

* Bridging 502.7.1
* When joists exceed 2x12

♦ Cutting, Drilling and Notching 502.8

GUIDE FOR CUTTING, NOTCHING AND BORING JOISTS			
Joist Size	Maximum Hole	Maximum Notch Depth	Maximum End Notch
2x4	None	None	None
2x6	1-13/16”	7/8”	1-3/8”
2x8	2-1/2”	1-1/4”	1-7/8”
2x10	3-1/8”	1-9/16”	2-3/8”
2x12	3-13/16”	1-7/8”	2-7/8”

* Cutting, drilling and notching 502.8



* Cutting, drilling and notching 502.8

* Cutting, drilling and notching 502.8

Cutting, Drilling and Notching 502.8

- Engineered wood products 502.8.2
  - Cuts, notches and bored holes not permitted unless allowed by the manufacturer's installation instructions or by registered design professional

Mechanical Systems Installation 1308

- Protection from physical damage 1308.2
  - Concealed piping shall be protected
  - Piping less than 1 ½ inch from edge protected
  - Width of pipe and inches past framing member
    - Stud – above bottom plate and below top plate
    - Shield plate not less than 0.0575 inches (No. 16 gage)

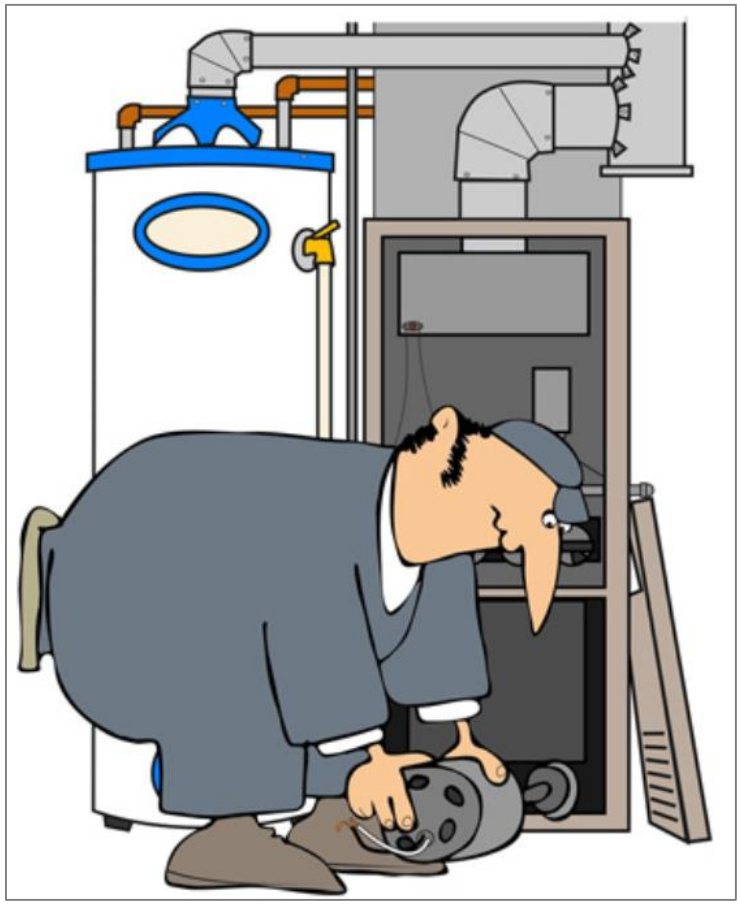
BFCA®

Building & Fire Code Academy

Understanding the 2019 Residential Code of Ohio Mechanical©

Chapter 14 – Heating and Cooling Equipment and Appliances

- General 1401
  - Installation 1401.1
    - Per the manufacturer and this code
  - Access 1401.2
    - Located to provide access for service, replacement, cleaning and maintenance
  - Equipment and appliance sizing 1401.3
    - Equipment size based on Air Conditioning Contractors of America (ACCA) Manual, J & S calculation



General 1401

- Equipment and appliance sizing 1401.3
  - Must be sized per ACCA Manual S or other approved methodologies
    - Except:

      Multi-stage unit or variable refrigerant flow w/loads properly calculated are within manufacturer's published capacities
  - Specified equipment cannot satisfy published total and sensible heat gains properly calculated, thus next larger standard size is specified

General 1401 *(continued)*

- Outdoor equipment listed for outdoor installation 1401.4
- Supports level, prevent settlement and vibration 1401.4
- Flood hazards per section 1401.5 and 322.1.6
- Listed and labeled for outdoor installation 1401.4
- Note: General requirements in Chapter 12 apply

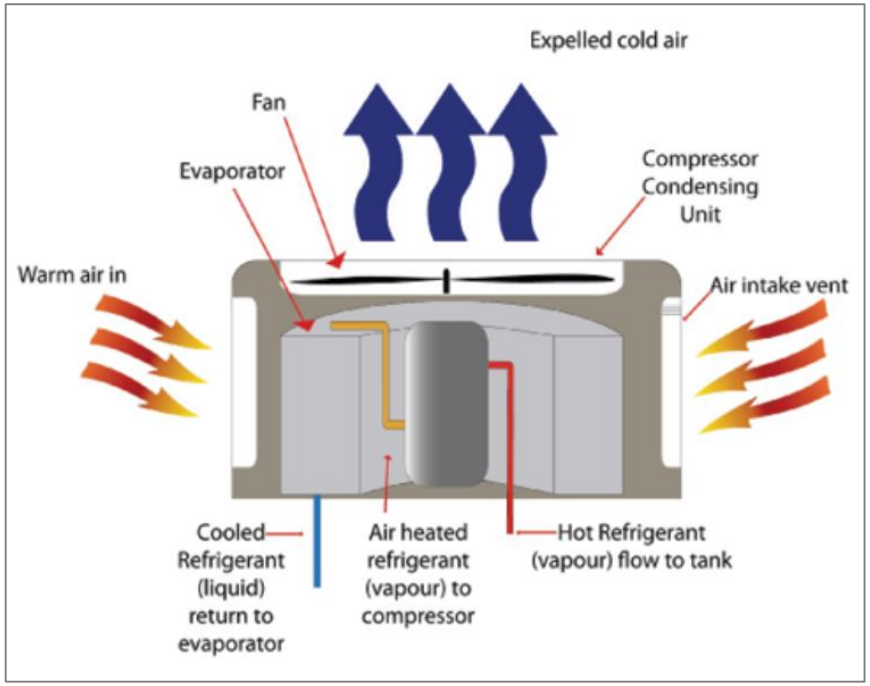
Equipment	Standard/Listing
Electric Furnaces	UL 1995
Oil Fired Central Furnaces	ANSI/UL 727
Heat pumps	UL 1995
Duct heaters	UL 1995
Vented floor furnaces	ANSI/UL 729
Vented wall furnaces	ANSI/UL 730
Vented room heaters	UL 1482 or UL 896
Refrigeration equipment	ANSI/ASHRAE34
Fireplace stoves	UL 737

Central Furnaces 1402

- Maintain listed clearances
- Provide combustion air – minimum 6” in front of openings

Heat Pump Equipment 1403

- UL 1995
- Minimum 6 square in of return duct per 1,000 Btu/h output rating – removed in 2018
- Outdoor support raised 3” above grade – removed in 2018



- Electric Baseboard Convectors 1405
  - Shall be installed per Chapters 33-42 and manufacturer's instructions

- Radiant Heat 1406
  - Installed per Chapters 33-43, manufacturer's installation Instructions 1406.1
  - Panels installed parallel to framing members 1406.3
  - No field cutting of panels – unless listed
  - Fastened in place through unheated portions of panels

Radiant Heat 1406

- Concrete and masonry installations 1406.4
- Labeled for concrete/masonry installation

- Not installed across expansion joints
- On gypsum panels – operating temps not to exceed 125° F
- Finish materials installed per installation instructions 1406.5
- Fasteners shall not pierce heating element

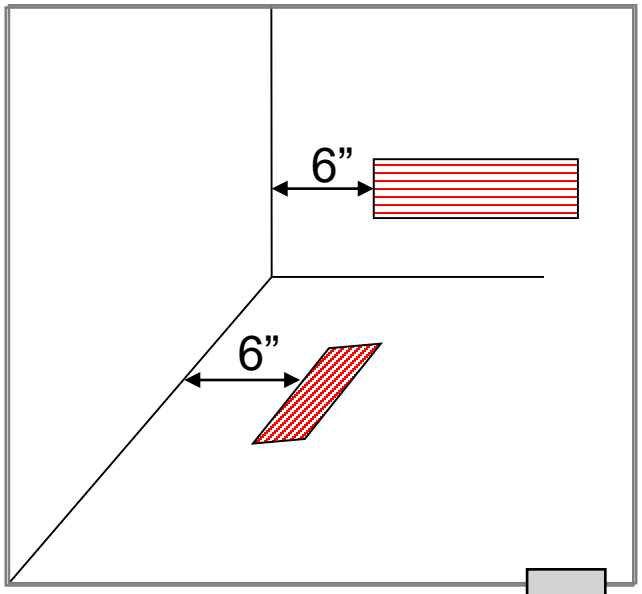
Duct Heaters 1407

- Shall not create fire hazard

- Class 1 ducts, covers, and liners interrupted at heater to provide clearances
- Fan shall be listed and labeled when within 4’ of a heat pump or air conditioner 1407.3
- Accessible for maintenance 1407.4
- Fan interlock required to prevent heater operation when fan is not operating 1407.5

Vented Floor Furnaces 1408

- Clearances per manufacturer 1408.2
- Location 1408.3
  - Registers and burner assemblies
  - Wall registers minimum 6” from corner
  - Floor register minimum 6” from wall
  - 12” from door and combustibles
  - 5’ below projecting combustibles

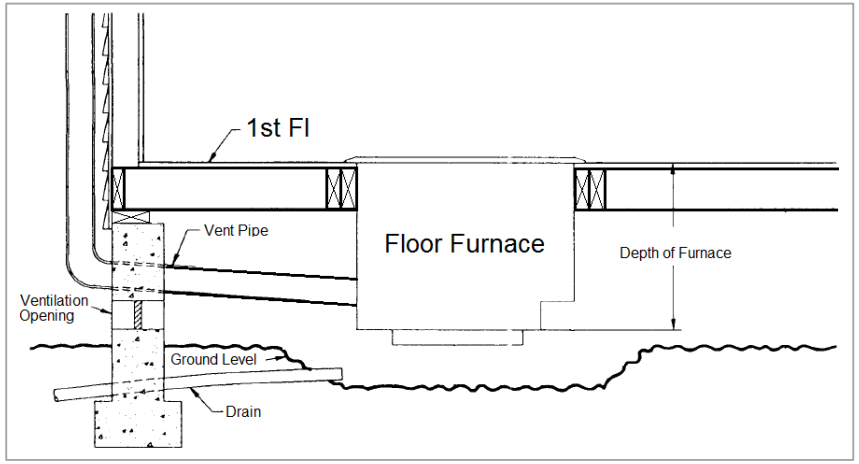


Vented Floor Furnaces 1408

- Location 1408.3
  - Burner assembly shall not project into an occupied under-floor area
  - Not installed in concrete slab on grade
  - No door swing within 12” of grill
- Access 1408.4
  - 18” x 24” in foundation wall
  - 22” x 30” in floor (trap door)
  - Large enough to replace any part

Vented Floor Furnaces 1408

* General installation requirements 1408.5
  - Thermostats located in the same room
  - Furnace supported independently of the register
  - 6 inches above ground – 2 inches if sealed unit
  - Maintain 30” service clearance area – 12 inches on other side
  - Not supported from ground

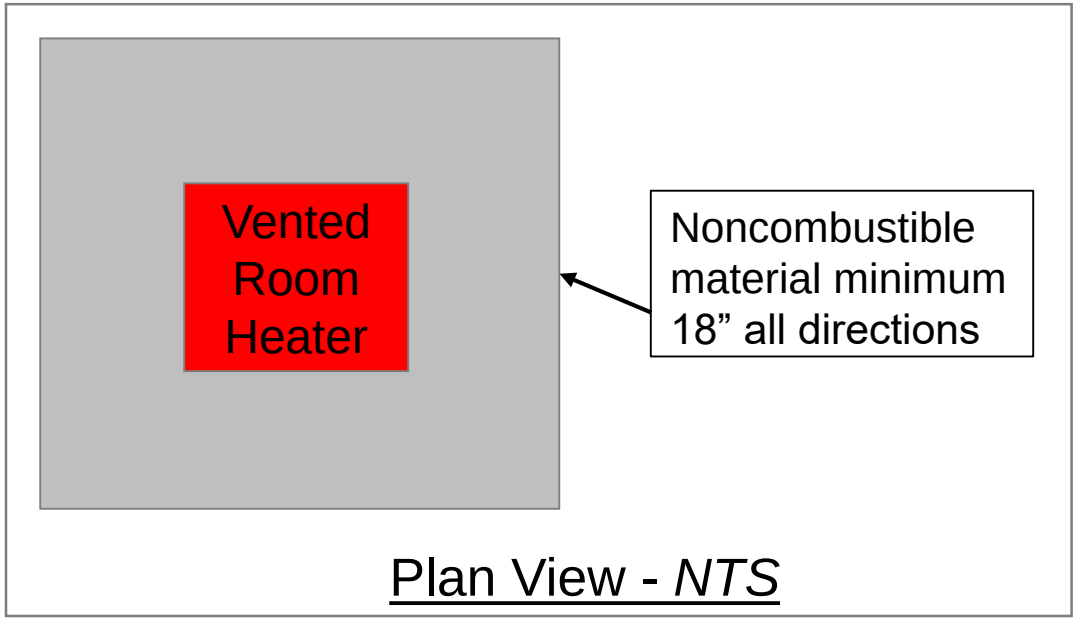


Vented Wall Furnaces 1409

- Location 1409.2
  - Located not to cause fire hazard 1409.2
  - Not circulate air from bathrooms to other parts of building
  - Not located within 12” of a door swing
- Installation 1409.3
  - Wall thickness per manufacturer
  - No ducts attached
  - Manual shut off required
- Access required 1409.4

Vented Room Heaters 1410

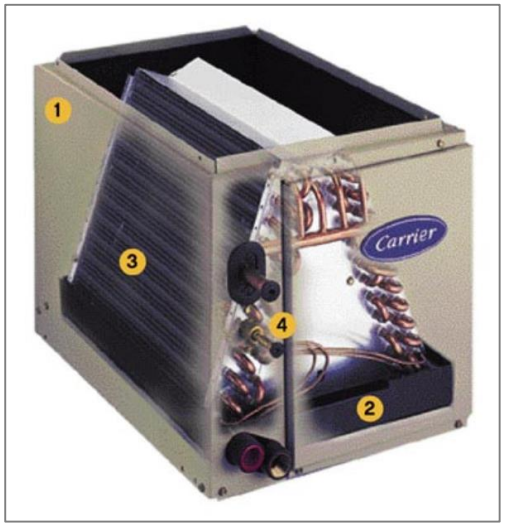
* General 1410.1
  - Fuel – pellet, oil, solid
  - Installed on non-combustible floors – minimum clearances required



  - Exception:
    - Listed appliances per installation instructions

Heating And Cooling Equipment 1411

- Coils in warm air furnace 1411.2
  - Blower rated 0.5” water column static pressure
  - Labeled for use upstream of heat exchanger
  - Condensation drain to approved location in an approved manner
    - Not create a hazard nuisance



Heating And Cooling Equipment 1411

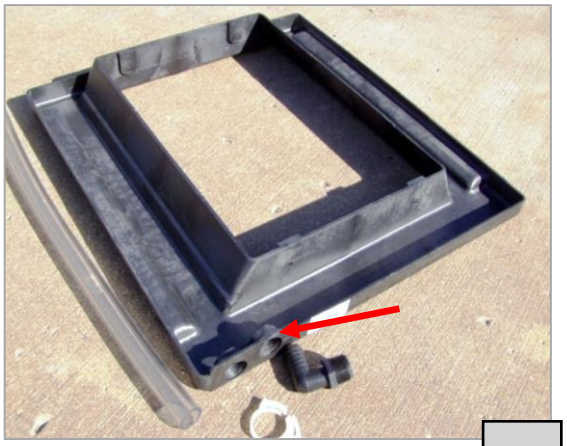
- Condensate disposal 1411.3
  - Drain to an approved location in an approved manner
  - Not create a hazard
  - Approved material: Cast iron / galvanized steel / copper / polybutylene / polyethylene / ABS / CPVC / PVC
  - Based on temperature and pressure rating
  - Minimum 3/4” pipe
  - Horizontal pipe at uniform alignment and pitch not less than 1/8 unit vertical in 12 units horizontal 1% slope
  - Installed so it can be maintained

Heating And Cooling Equipment 1411

- Auxiliary or secondary system required where damage to structure is likely – 4 methods
  - Minimum ¾ inch pipe
  - Method 1
    - Auxiliary and secondary drain systems 1411.3.1
    - Discharge to a conspicuous location
    - Minimum depth 1.5”
    - Minimum 3” larger than unit or coils
    - Corrosion resistant materials
    - Metallic pan minimum – .0276”
    - Non-metallic pan minimum – .0625”

Heating And Cooling Equipment 1411

- Auxiliary or secondary system required where damage to structure is likely – 4 methods
  - Method 2
    - Separate overflow from unit drain pan with equipment 1411.3.1
    - Discharge to a conspicuous location – alert occupants
    - Connected higher than the primary drain



Heating And Cooling Equipment 1411

- Condensate disposal 1411.3
- Auxiliary or secondary system required where damage to structure is likely – 4 methods
  - Method 3
    - Auxiliary pan without separate drain line

      Detection and shut off device required conforming to UL 508
    - Constructed same as Method 1

Heating And Cooling Equipment 1411

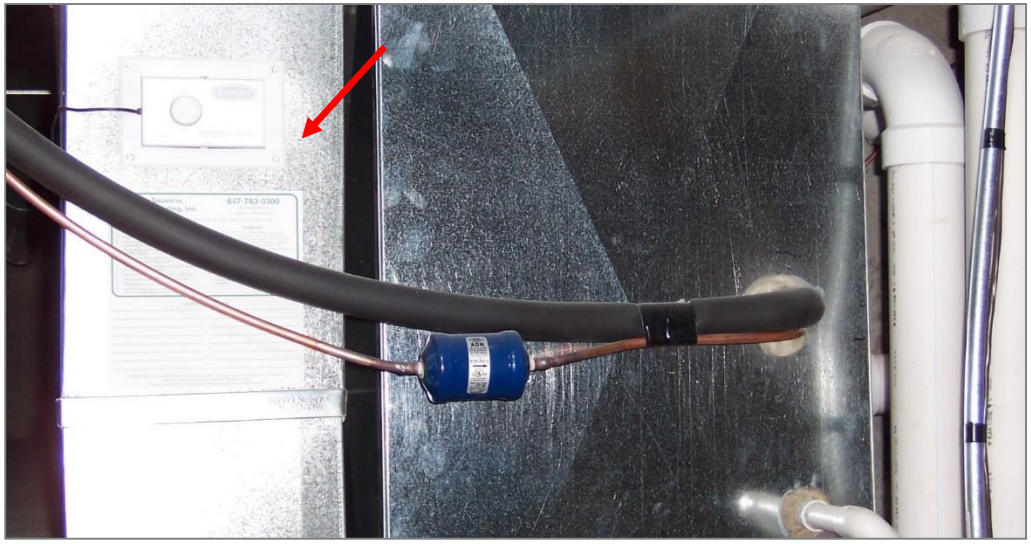
- Condensate disposal 1411.3
- Auxiliary or secondary system required where damage to structure is likely – 4 methods
  - Method 4
    - Water level detection device conforming to UL 508 that will shut off the equipment served in the event that the primary drain is blocked
    - Device in the primary drain line, overflow drain line or the equipment-supplied drain pan
    - Device located at a point higher than the primary drain line connection and below the overflow rim of pan
  - Down flow furnaces – only method allowed is an overflow detector installed in the drain pan

♦ Heating And Cooling Equipment 1411 (

* Condensate pumps 1411.4
  - IF: In uninhabitable spaces
  - THEN: Connected so that appliance or equipment served is prevented from operating if pump fails
  - Install per manufacturer's instructions

Heating And Cooling Equipment 1411

- Refrigeration piping 1411.6 – 1411.8
  - Piping and fittings for refrigerant vapor lines shall be insulated minimum R-4 1411.6
  - Within 1½ inches from roof deck – protected from nails
  - Access port caps secured if outside or not protected



- Absorption Cooling Equipment 1412
  - Condensation drain to approved location in an approved manner
  - Refrigerant piping insulated to prevent condensation
  - Pressure relief device required, located as not to create hazard
  - Per UL 1995

Evaporative Cooling Equipment 1413

- Install in accordance with manufacturer's instructions
- Level platform 3" above grade
- Water for cooling
  - Backflow protection of potable water per Section 2902
- Exterior wall openings sealed
- Air intake openings per Chapter 3

Fireplace Stoves 1414

- General 1414.1
  - Per manufacturer
- Hearth extensions per listing M414.2
  - Supports same level as hearth
  - Distinguishable from surrounding floor

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Understanding the 2019 Residential Code of Ohio Mechanical©

Chapter 15
Exhaust Systems

Building Better With Our Greatest Resource…Education®

General 1501

- Exhaust system: Means of transferring – fumes, moisture, products – from the interior of the building
- Outdoor discharge 1501.1
  - Mechanical exhaust cannot discharge air to attic, soffit, ridge vent or crawl space.
    - Except: Whole house ventilation-type fans for private attics

Clothes Dryer Exhaust 1502

- Independent of all other systems
- Exhaust duct terminate outdoors
- Per manufacturer
- If no instructions are available terminate a minimum of 3’ from building opening 1502.3
- Back draft damper installed

Clothes Dryer Exhaust 1502

- Dryer exhaust ducts 1502.4
  - Smooth duct construction and installation
  - Minimum 4 inch duct
  - No screens in duct or termination
  - Back draft damper required
  - No sheet metal screw which protrude more than 1/8 inch
    - Section 2439.7.2 allows screws not to exceed 1/8” into duct work
  - Minimum thickness of exhaust duct – .0157” rigid metal

Clothes Dryer Exhaust 1502

- Dryer exhaust ducts 1502.4
  - Smooth interior finish
  - Joints running in direction of flow 1502.4.2
  - Supported at 12' intervals
  - Transitions duct maximum 8' – listed per UL 2158A 1502.4.3
  - When installed concealed will not deform duct

2 x 4 stud – 4 inch duct

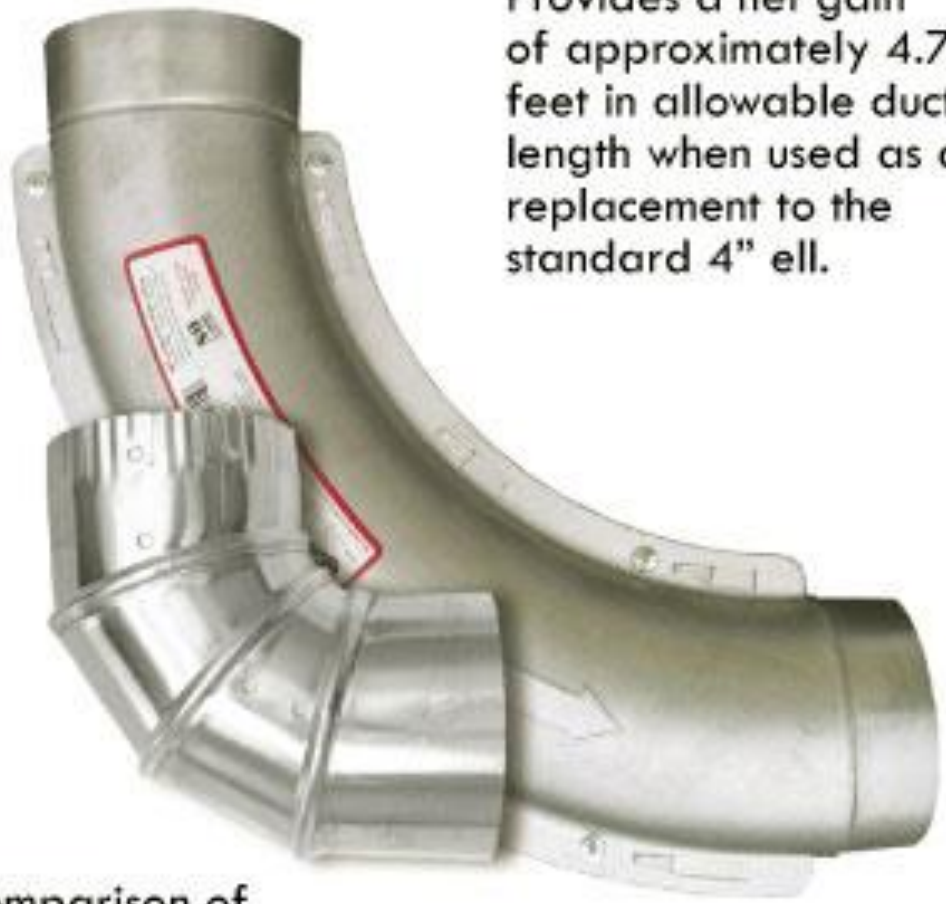
Correct?

Clothes Dryer Exhaust 1502

- Dryer exhaust ducts 1502.4
  - Dryer exhaust duct power ventilators 1502.4.4
    - Conform to UL 705
    - Install per manufacturer's directions

Clothes Dryer Exhaust 1502

- Dryer exhaust ducts 1502.4
  - Duct length 1502.4.5
  - Maximum length 35’ or manufacturer’s instruction 1502.4.5.1
    - Does not include the transition fitting
    - Fitting length per Table 1502.4.5.1
    - Duct length and size can conform to the manufacturer
    - Catalog cut available at the concealment inspection
    - Equivalent length of concealed duct permanently identified within 6’ of dryer vent connection 1502.4.6
    - Length of duct with power exhaust per manufacturer



Provides a net gain of approximately 4.7 feet in allowable duct length when used as a replacement to the standard 4" ell.

comparison of two ells

* Duct to be provided at every dryer space 1502.4.7

ZIGGY...
by Tom Wilson & TOM II
TRUST ME! YOU SHOULD NEVER LET DRYER LINT BUILD UP LIKE THAT!
REPAIR

Domestic Cooking Exhaust Equipment 1503

- Domestic kitchen equipment 1503.2
  - Required when exhaust equipment is provided
  - Applies to range hoods and down-draft appliances
    - When not integral with appliance – UL 507
    - Integral equipment shall comply – UL 507
    - Integral downdraft – ANSI Z 21.1 or UL 858
    - Microwave over cooktop with exhaust – UL 923

Domestic Cooking Exhaust Equipment 1503

- Domestic kitchen equipment 1503.2
  - Open-top broilers 1503.2.1
    - Metal exhaust
    - Minimum thickness 0.0157 inches thick (No. 28 gage)
    - ¼ inch clearance around hood
    - 24 inch clearance above cook top
    - Hood width equal to unit and extend over entire cook top

Domestic Cooking Exhaust Equipment 1503 *(continued)*

- Exhaust discharge 1503.3
  - Discharge to the outdoors (not attic, crawl space or inside building)
  - Smooth interior finish and air tight
  - Backdraft damper required
  - Independent of all other systems

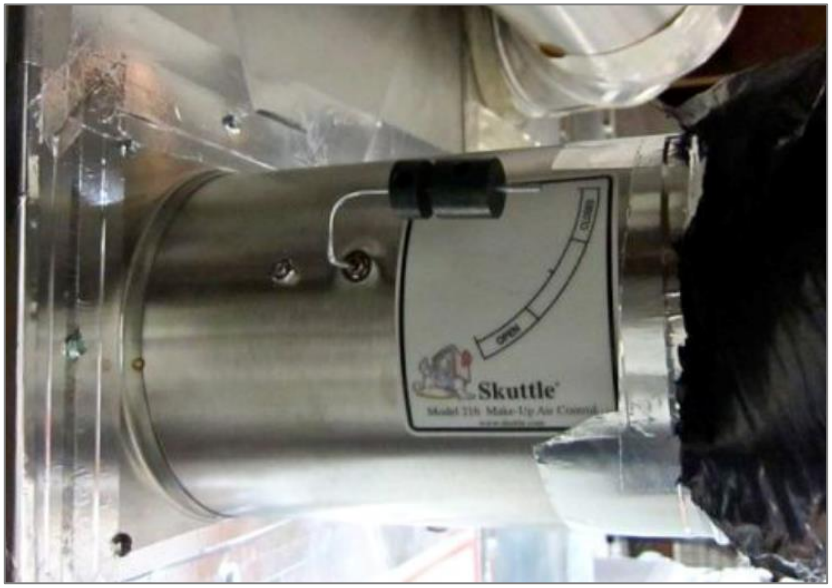
Domestic Cooking Exhaust Equipment 1503

- Duct material 1503.4
  - Duct material can be galvanized steel, stainless steel, aluminum or copper
    - Some down drafts can use PVC – 4 criteria
- Kitchen exhaust rates 1503.5
  - Per Table 1504.2

TABLE 1504.2
DUCT LENGTH

DUCT TYPE	FLEX DUCT								SMOOTH-WALL DUCT							
Fan airflow rating (CFM @ 0.25 inch wc[a])	50	80	100	125	150	200	250	300	50	80	100	125	150	200	250	300
Diameter[b] (inches)	Maximum length[c, d, e] (feet)															
3	X	X	X	X	X	X	X	X	5	X	X	X	X	X	X	X
4	56	4	X	X	X	X	X	X	114	31	10	X	X	X	X	X
5	NL	81	42	16	2	X	X	X	NL	152	91	51	28	4	X	X
6	NL	NL	158	91	55	18	1	X	NL	NL	NL	168	112	53	25	9
7	NL	NL	NL	NL	161	78	40	19	NL	NL	NL	NL	NL	148	88	54
8 and above	NL	NL	NL	NL	NL	189	111	69	NL	NL	NL	NL	NL	NL	198	133

- Domestic Cooking Exhaust Equipment 1503
- Make-up air required 1503.6
  - Equipment not direct vent or mechanical draft venting
  - When exhausting > 400 CFM
  - Passive or mechanical make up required
  - Rate equal the exhaust rate



Domestic Cooking Exhaust Equipment 1503

- Make-up air required 1503.6
  - Location 1503.6.1
    - Air shall discharge into room with exhaust or
    - Rooms that connect with permanent openings
  - Dampers 1503.6.2
    - Damper to be gravity or electrically operated
    - Damper to automatically open when exhaust hood operate
    - Access for inspection without removing permanent construction
    - Gravity or barometric damper not used
    - Provide air flow at a pressure differential of 0.01” of wc

- Exhaust Ducts and Exhaust Openings 1504
  - Follow this Chapter or Chapter 16
  - Duct length per Table 1504.2
    - Exception: Per manufacturer or flow rate verified
  - Termination:
    - > 3’ from property line
    - > 3’ from operable or non-operable openings
    - > 10’ from mechanical air intakes – or 3” above

Mechanical Ventilation 1505

- Where local or whole house mechanical is provided follow this chapter
- Exhaust air from bathrooms and toilet rooms not to be re-circulated

- Exhaust air from bathrooms and toilet rooms not to be exhausted into attic, crawl space or other area inside the building
- Not prohibit ductless range hoods
- Equipment per ANSI/AMCA 210 – ANSI/ASHARE 51

Mechanical Ventilation 1505

- Whole-house mechanical ventilation system 1505.4
  - One or more supply or exhaust fan
  - Outdoor air ducts connected to the returns can be the supply
  - Manual controls required

Mechanical Ventilation 1505

- Whole-house mechanical ventilation system 1505.4 *(continued)*
  - Mechanical ventilation rates 1505.4.3
    - Rates per Table 1505.4.3(1) or
    - Per calculation of equation #1

      Ventilation rate in cubic feet minute =
      (0.01 x total square foot area of house) +
      [7.5x (number of bedrooms + 1)]

      Exception: Operate intermittently with controls for 25% for each 4 hour segment with a rate per Table M 1505.4.3(1) adjusted per Table M 1505.4.3(2)

Mechanical Ventilation 1505

- Whole-house mechanical ventilation system 1505.4
  - Local exhaust systems deigned per Table 1505.4.4
  - Table 1505.4.4
    - Minimum Required Local Exhaust Rates for One- and Two-Family Dwellings

AREA TO BE EXHAUSTED	EXHAUST RATES
Kitchens	100 cfm intermittent or 25 cfm continuous
Bathrooms --- Toilet Rooms	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous

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Chapter 16
Duct Systems

- Duct Construction 1601
  - Duct design 1601.1
    - Per ACCA Manual D, or
    - Manufacturer's instruction or
    - Other approved methods
    - Above-ground duct systems 1601.1.1
      - Temperature limit 250º F
      - Factory made ducts comply with UL 181 and installed per manufacturer's instructions

Duct Construction 1601

- Duct design M1601.1
  - Above-ground duct systems M1601.1.1
    - Fibrous ducts conform to SMACNA or NAIMA
    - Field or shop fabricated per SMACNA except as allowed by Table 1601.1.1
    - Gypsum return air ducts limited to 125° F and not subject to condensation
    - Maximum flame spread of 200

* Table 1601.1.1 Duct Construction Minimum Sheet Metal Thickness for Single Dwelling Units

ROUND DUCT DIAMETER (inches)	STATIC PRESSURE			
	$^1/_2$ inch water gage		1 inch water gage	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
≤ 12	0.013	0.018	0.013	0.018
12 to 14	0.013	0.018	0.016	0.023
15 to 17	0.016	0.023	0.019	0.027
18	0.016	0.023	0.024	0.034
19 to 20	0.019	0.027	0.024	0.034

RECTANGULAR DUCT DIMENSION (inches)	STATIC PRESSURE			
	$^1/_2$ inch water gage		1 inch water gage	
	Thickness (inches)		Thickness (inches)	
	Galvanized	Aluminum	Galvanized	Aluminum
≤ 8	0.013	0.018	0.013	0.018
9 to 10	0.013	0.018	0.016	0.023
11 to 12	0.016	0.023	0.019	0.027
13 to 16	0.019	0.027	0.019	0.027
17 to 18	0.019	0.027	0.024	0.034
19 to 20	0.024	0.034	0.024	0.034

Duct Construction 1601

- Duct design 1601.1
  - Above-ground duct systems 1601.1.1
    - Stud cavity and joist space plenums

      Not permitted for supply air

      Not part of rated assembly

      Not to convey air from more than one floor

      Fire-blocking per the building code

      Stud space in outside walls not as a plenum

      All dampers and controls require access

Duct Construction 1601

- Duct design 1601.1
  - Underground duct systems
    - Approved concrete, clay, metal or plastic
    - Plastic duct – maximum temperature 150 degrees F
    - Metal duct – protected from corrosion or encased in concrete – 2”
    - Slope to drainage point with access
    - Sealed or taped before encased and tested
    - Tightness per 1103.3
    - Metal duct with approved coatings or non metallic per manufacturer

Duct Construction 1601

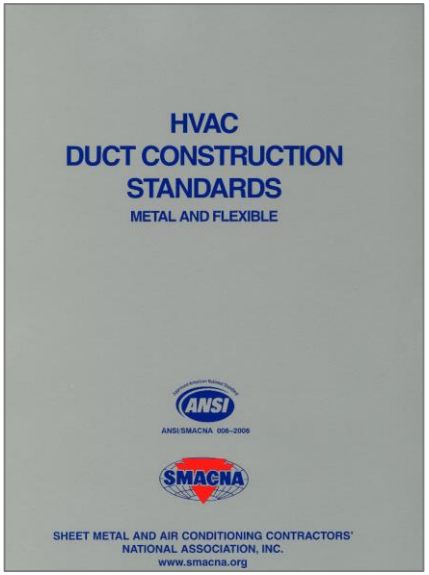
- Duct in1601.3
  - Maximum flame spread 25, smoke developed <50 per ASTM E 84
  - Not flame. Smolder or smoke at operating temperature
  - External reflective insulation labeled every 36”
  - Spray applied polyurethane foam in attics and crawl spaces permitted with conditions

Duct Construction 1601

- Duct insulation material 1601.3
  - Maximum flame spread 25, smoke developed 450
  - Ignition barrier
  - Complies with Section 316 (Foam Plastics)

Duct Construction 1601

- Installation 1601.4
  - Joints and seams per SMACNA HVAC Duct Construction Standards – Metal and Flexible, and NAIMA Fibrous Glass Duct Construction Standards
    - Longitudinal, transvers, connections
    - Per UL 181 A-P based on type of system



Duct Construction 1601

- Installation 1601.4
  - Duct lap 1601.4.2
    - Round and oval – minimum of one inch in direction of flow

      Plastic joint per manufacturer
    - Supported per manufacturer's instructions
    - Field fabricated ducts supported per SMACNA Fibrous Glass Duct Construction Standards, and NAIMA Fibrous Glass Duct Construction Standards

Duct Construction 1601

- Installation 1601.4
  - Fire-blocking 1601.4.5 per Section 602.8
  - Insulated when installed in non-conditioned spaces 1601.4.6
  - Insulation not penetrate fire blocked wall or floor
  - 4” separation from earth 1601.4.8
  - When penetrate garage, 26 gage, no openings 1601.4.9 and 302.5.2

Duct Construction 1601

- Under floor plenums 1601.5
  - Prohibited in new construction
  - Modification to existing – comply with current code
  - Loose combustible scrap removed / tightly enclosed
  - Ground covered with moisture barrier / Min. 4 mils 1601.5.1
  - Plumbing waste cleanouts and gas pipe not permitted in space
  - Maximum flame spread 200 1601.5.2

Duct Construction1601

- Under floor plenums 1601.5
  - Furnace duct to extend 6” below combustibles
  - Access via 18” x 24” opening
  - Start fan when reach 150°F max
  - Furnace outlet temp limit switch at 200°F max 1601.5.5
- Systems that supply living space shall not supply or return to garage 1601.6

Return Air 1602

- Outdoor air openings 1602.1
  - Located per 303.5.1 and protected per 303.6
- Return air openings 1602.2
  - Not closer than 10’ from appliance in room
  - Return not greater than supply
  - Return and supply per manual D
  - Flammable vapors present or located within 10’ of public way, driveway or sidewalk

Return Air 1602

- Return air openings 1602.2
  - Not from closets, bathrooms, kitchens, garages, mechanical and furnace rooms, other dwelling units
  - Not from a swimming pool area
  - Cannot discharge into another dwelling unit
  - Return air taken from any room or space shall be not greater than the flow rate of supply air
  - Direct vent OK
  - Outdoor air inlets screened – ¼” to ½” per 303.6

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Chapter 17
Combustion Air

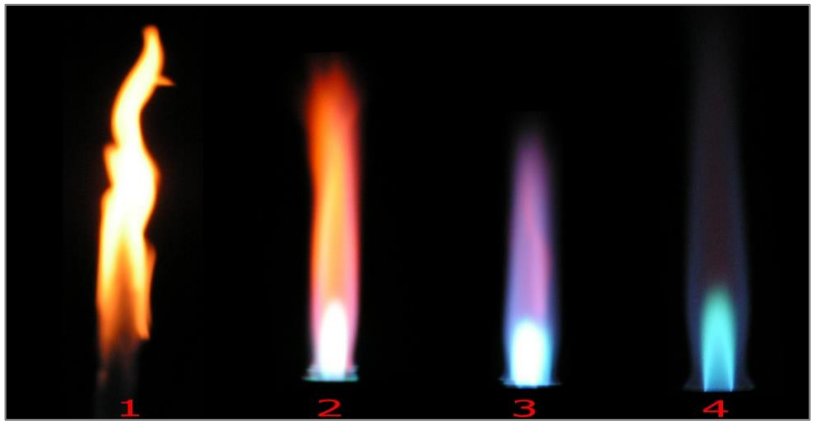
General 1701

- Solid fuel appliances per manufacturers' installation instructions
- Combustion air for gas fired appliances 2407
- Oil appliances per NFPA 31
  - Air in flood hazard areas
  - Lowest floor minimum 1' above base foot elevation 1701.2, 322.2.2.1 and 322.3.2

Note: This chapter does not apply to fireplaces, fire place stoves and direct vent appliances

♦ Effects of Inadequate Combustion Air

- Produces poisonous, corrosive and combustible by-products when combustion is incomplete
- Creates environment that leads to oxygen depletion
- Inadequate cooling of appliance causes appliance to work harder, leading to shorter appliance life

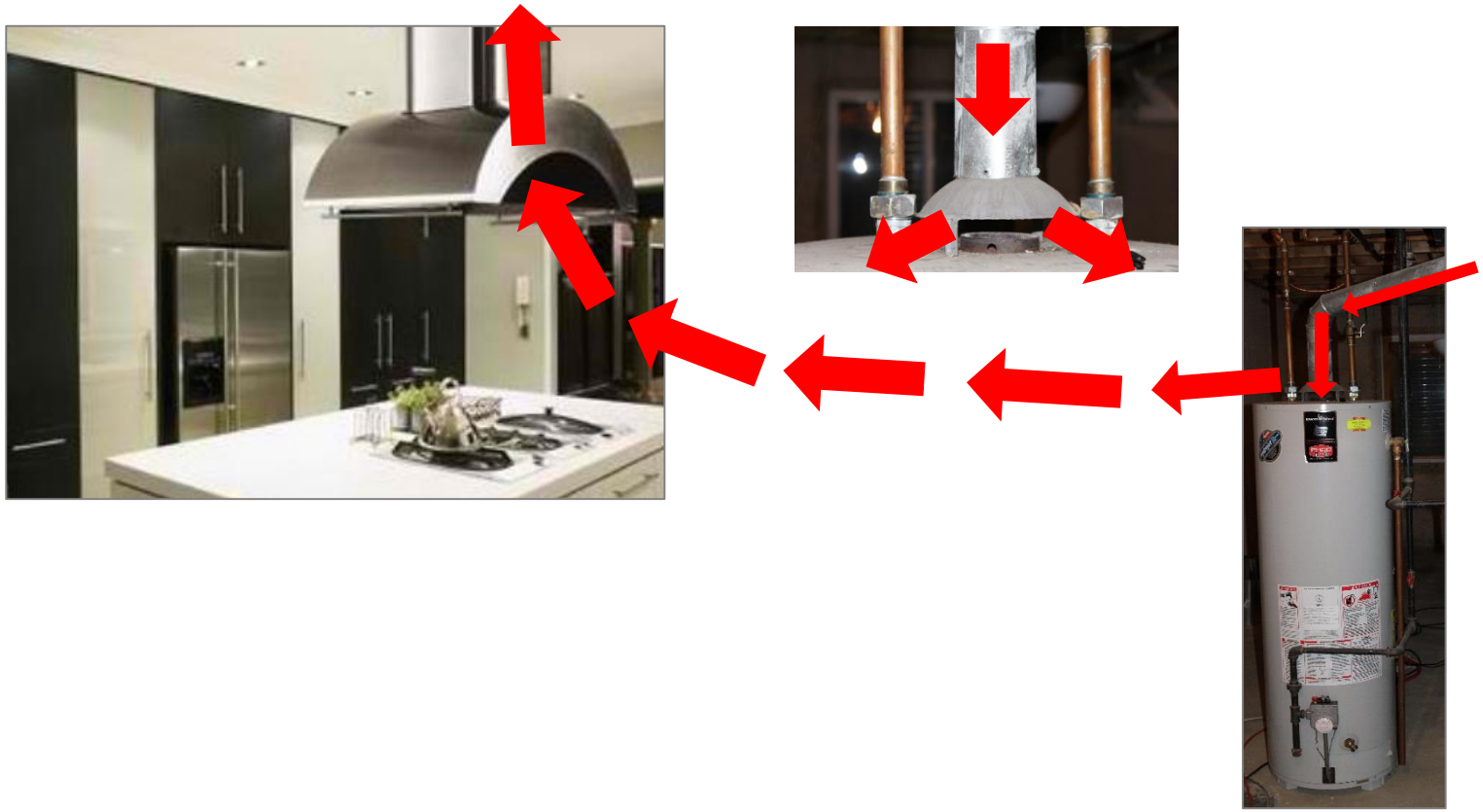


Low Combustion Air → Adequate Combustion Air

Effects of Inadequate Combustion Air *(continued)*

- Incomplete combustion causes soot, increased levels of carbon monoxide, appliance malfunction and risk of fire
- Appliances shall be installed to allow the free circulation of air within the space
- Simultaneous operation of all appliances shall be considered when determining combustion air

* Avoid “going negative” due to excessive exhaust CFM with inadequate makeup air



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Chapter 18
Chimneys and Vents

- General 1801
  - Fuel burning appliances to be vented per manufacturer
  - Listed unvented appliances can be used
  - Gas fired per Chapter 24
  - Draft requirements 1801.2
    - Create a positive flow to convey combustion products to outside

General 1801

- Existing chimneys 1801.3
  - Resizing required when adding or removing an appliance
  - Free of obstructions, cracks, perforations, gaps and other damage and cleaned
  - Masonry requires a cleanout per 1003.17
    - Clearances per manufacturer

      Except: Chimney lining systems listed and labeled for contact with combustibles

General 1801

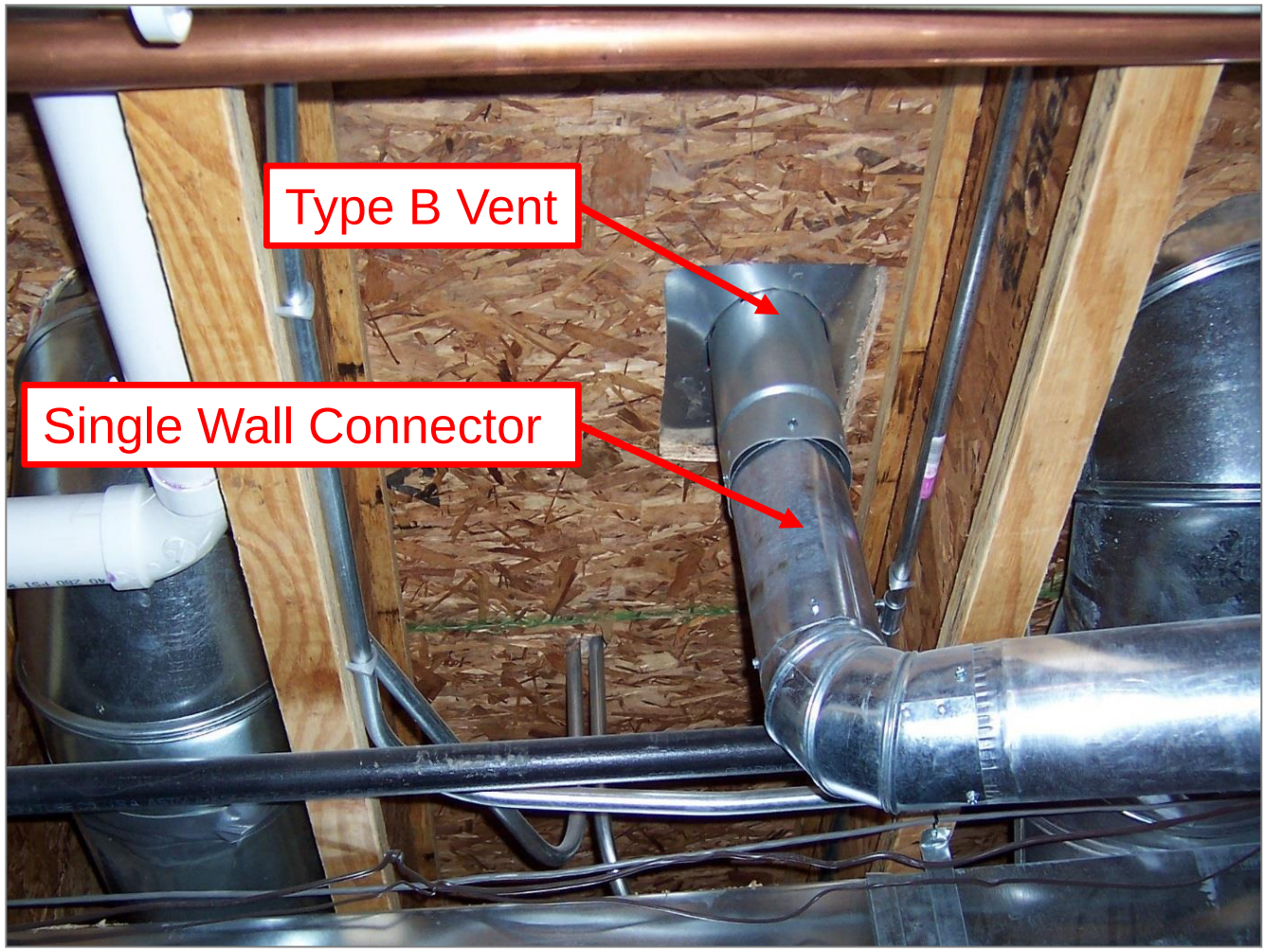
- Existing chimneys 1801.3
  - Using existing masonry chimney as raceway for DVSCC appliance vents
- Space around flue cannot be used to vent other appliances 1801.4

- General 1801
  - Masonry chimneys and factory-built fireplaces constructed per the International Building Code / International Residential Code

General 1801

- Mechanical draft only for appliances listed for mechanical draft 1801.5
- Vent system adequately supported 1801.7
- Not through a return or supply / duct or plenum 1801.8
- Properly fire-blocked 1801.9
- Unused openings to be closed or capped 801.10
  - Solid-fuel burning vent cannot connect to a vent for another appliance 1801.12

* Natural gas burning appliance vent connection to double-wall Type “B” gas vent



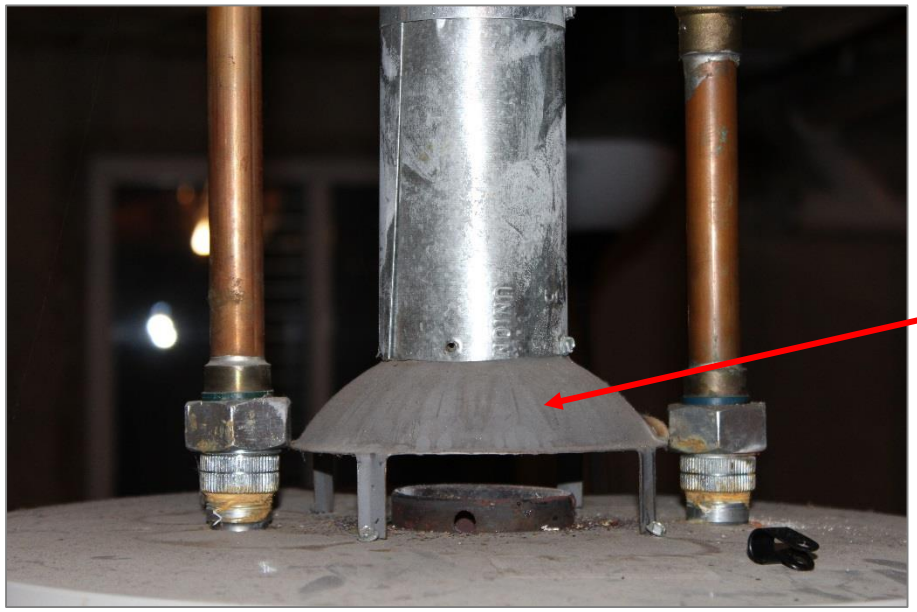
General 1801

- Multiple appliance venting system 1801.11
  - Appliances on the same floor
  - Inlets offset
  - Natural draft appliance shall not be connected to mechanical draft system under positive pressure

- Solid fuel-burning vent cannot connect to a vent for another appliance 1801.12

Vent Components 1802

- Draft hoods in the same room as appliance 1802.1
  - Manually operated dampers permitted on solid fuel appliances only 1802.2.1
  - Automatic dampers per UL 17 1802.2.2
    - Interlocked with burner



Draft hood on natural gas water heater

Chimney and Vent Connectors 1803

- Connectors – connect appliance to vertical chimney or vent
- Thickness per Table 1803.2
- Within space where appliance located
- Installation per manufacturer 1803.3
- Connectors sloped 1/4” per foot
- Short and straight as possible
- Properly supported and fastened with screws or rivets
- Connector shall not pass through floor or ceiling
- Connector shall not pass through wall or partition unless a listed device is used

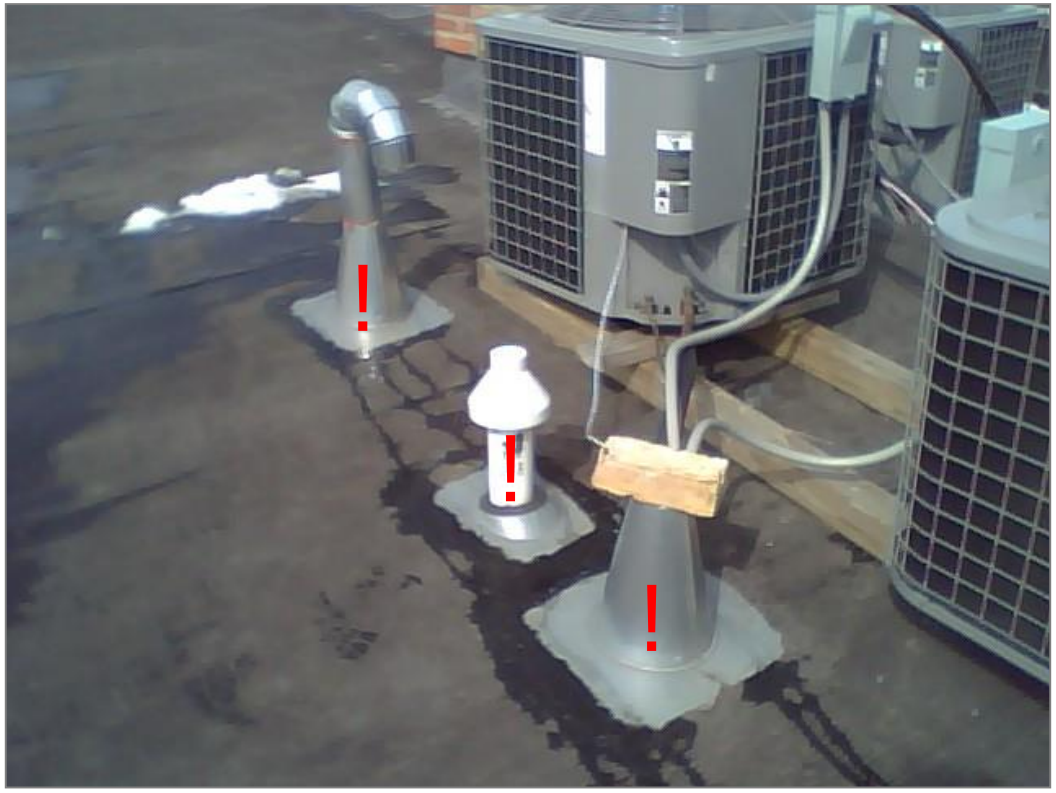
Chimney and Vent Connectors 1803

- Installation 1803.3
  - Length 1803.3.2
    - Uninsulated horizontal connector shall not exceed 75% of the height of the vertical portion of vent above the connector
  - Connector at least the size of appliance flue collar 1803.3.3
  - Clearance to combustibles per Table 1803.3.4
  - Connector accessible entire length 1803.3.5

Chimney and Vent Connectors 1803

- Connection to fireplace flue 1803.4
  - Non-combustible seal below point of connection 1803.4.1
  - Access for inspection and cleaning
  - Listed appliance connected to the flue 1803.4.2
  - Connector from appliance to flue 1805.3.1
    - Minimum size of flue
    - Maximum 3 times the area

- Vents 1804
  - Listed and labeled venting systems required per Table 1804.1
  - Termination per manufacturer

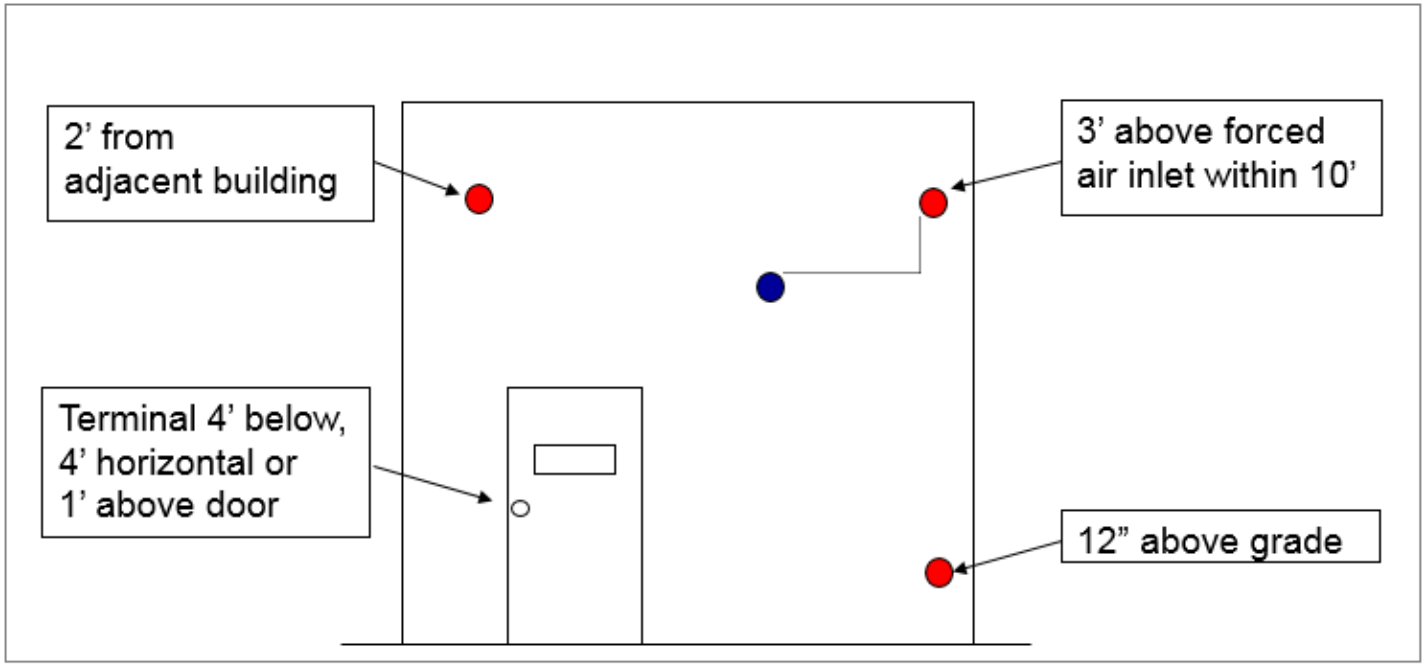


Vents 1804

* Termination 1804.2
  - Decorative shrouds at termination of vents listed and installed per manufacturer 1804.2.2
  - Natural draft appliances 5’ above highest connected appliance 1804.2.3
  - Natural draft gas vented wall furnaces 12’ above bottom of furnace 1804.2.3
  - Type L vents 2-10 rule 1804.2.4
    - Minimum 2’ above highest point

Vents 1804

- Termination 1804.2
  - Direct vent appliances 1804.2.5
    - Per manufacturer's specifications
  - Mechanical draft 1804.2.6



- Vents 1804
  - Installation Type L and pellet vents 1804.3
    - Individual vent equal to the size of the connector not less than 7 square inches
  - Door swing 1804.4
    - Appliance and equipment vent terminals placed so that doors cannot swing with 12”
- Masonry and Factory Built Chimneys 1805
  - Installed per Section 1003 and Section 1005
  - Chimney connector enter masonry chimney 6” above lowest part of flue
  - Sized not less than largest connector plus 50% of remaining chimney connectors
    - Exception: Oil-fired appliances per NFPA 31

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Chapter 19
Special Appliances, Equipment and Systems

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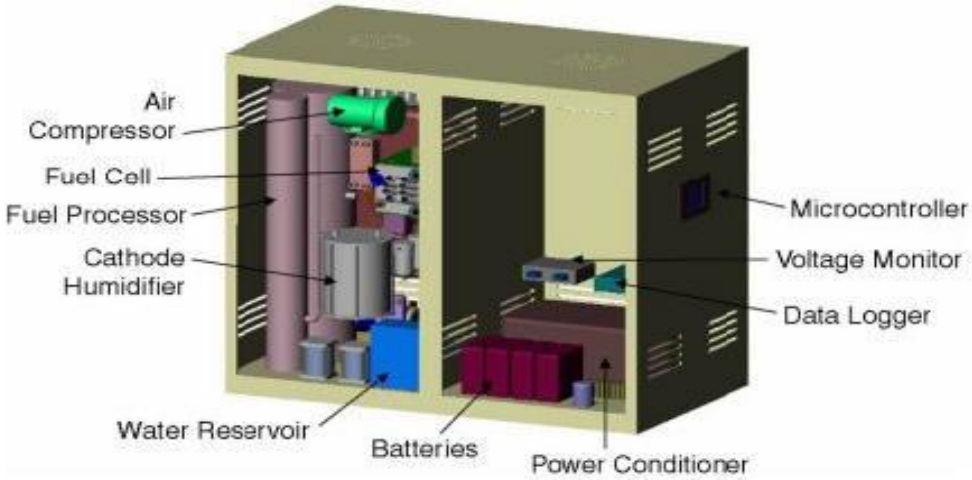
Ranges and Ovens 1901

- Clearances 1901.1
  - 30” vertical clearance to combustibles over cooking appliances
    - Reduce per listing
- Ranges and ovens listed and labeled for household use 1901.2
  - Installed to not to interfere with combustion air and servicing
  - Commercial cooking equipment not installed in a dwelling unit

- Sauna Heaters 1902
  - Protected against accidental contact
  - Not affect operation of heater
  - Installed per manufacturer's installation instructions
  - Provide combustion air
  - Room temperature limit 194º F
  - Sensor when not integral within 6" of ceiling
  - Comply with UL 875

- Stationary Fuel Cell Power Plants 1903
  - General 1903.1
    - Power output less than 1000kW per NFPA 853 & ANSI fc-1Z21.83
- Gaseous Hydrogen Systems M1904
  - Installation 1904.1
    - Installed per 1307.4; 1903.1; IFC; IFGC; IBC



Engine and Gas-Turbine Powered Equipment and Appliances 1905

- Engine Driven equipment and appliance
  - Powered by engine driven
  - Permanently installed
  - Per manufacturer's installation instructions
  - Per NFPA 37 – Installation and Use of Stationary Combustion Engines and Gas Turbines

* Fuel tanks
  - Engine mounted
  - Located inside buildings
  - Outside the building
  - On a roof
* Engine mounted
  - Vented per NFPA 30
  - Adequate clearance
    - Fillings, maintenance, testing
    - Protected from public access and impact
  - Other tanks similar requirements

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Chapter 20
Boilers and Water Heaters

Boilers 2001

* Per manufacturer's installation instructions 2001.1
  - Label information
    - Rating data
    - Operating instructions
    - Nameplate permanently attached
  - Flood zone per 322.1.6
  - Provide combustion air
  - Shut off valve in supply & return
  - Clearance per listing and label
  - Control diagram and operating instructions on site

Operating and Safety Controls 2002

- Safety controls listed and labeled 2002.1
  - Hot water and steam boilers
- Pressure and temperature gages required; must operate in normal range of boiler 2002.2 and 2002.3
- Steam boiler water gauge glass and pressure gauge 2002.3
  - Pressure relief valve required
- Discharge by gravity to within 18” of floor or receptor 2002.4
- Low water cut-off required 2002.5
- Operation 2002.6
  - Low water and flow sensing controls automatically stop combustion process

Expansion Tanks 2003

- Hot water boilers expansion tank required 2003.1
  - Fastened to structure or boiler
  - Support twice the weight of the tank filled
  - Drain non-pressurized tanks without emptying system
  - Capacity requirements in code
  - Per Table 2003.2

- Water Heaters Used for Space Heating 2004
  - Used for both, comply with both
  - Installed per Chapter 24, Chapter 28, and manufacturer's installation requirements
- Water Heaters 2005
  - Various listings – UL
  - In attics per 1305.1.3
  - Fuel fired water heaters locations
    - Not in storage closets
    - When in bedroom or baths – with sealed enclosure – outside combustion air
    - Not applicable to direct vent heaters
    - Provide service access and combustion air

Pool Heaters 2006

- Per manufacturer's installation instructions
- Oil per UL 726, Electric per UL 1261
- Clearances not interfere with combustion air, draft hood service access or flue terminal relief
- Temperature and pressure relief valves required
- Bypass line and valve required

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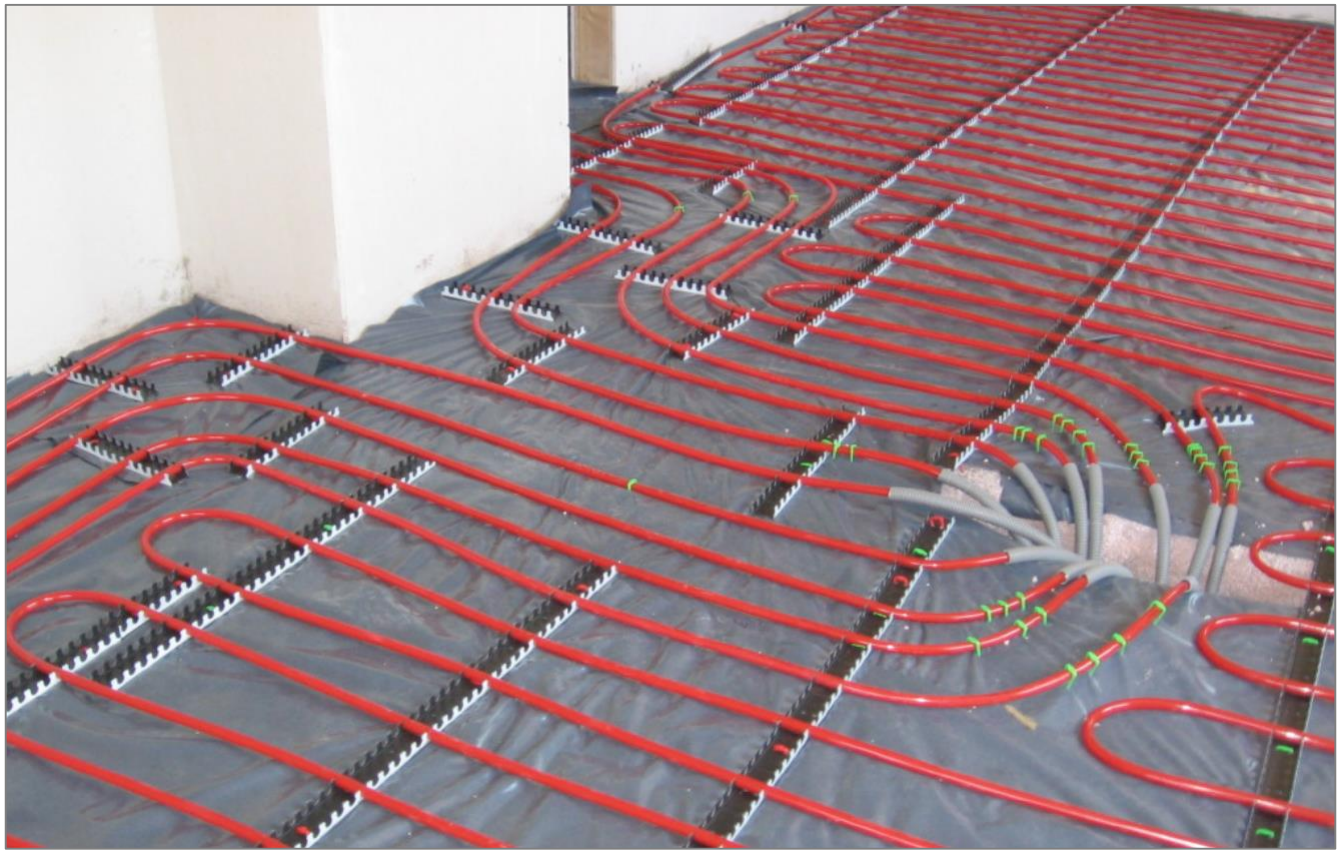
Chapter 21
Hydronic Piping

* Hydronic piping includes piping, fitting and valves used in building space conditioning systems



* Allowable hydronic piping materials Table Fuel tanks

TABLE 2101.1
HYDRONIC PIPING AND FITTING MATERIALS

MATERIAL	USE CODE[a]	STANDARD[b]	JOINTS	NOTES
Acrylonitrile butadiene styrene (ABS) plastic pipe	1, 5	ASTM D1527 ASTM F2806 ASTM F2969	Solvent cement joints	—
Chlorinated poly (vinyl chloride) (CPVC) pipe and tubing	1, 2, 3	ASTM D2846	Solvent cement joints, compression joints and threaded adapters	—
Copper and copper-alloy pipe	1	ASTM B42, B43, B302	Brazed, soldered and mechanical fittings threaded, welded and flanged	—
Copper and copper-alloy tubing (Type K, L or M)	1, 2	ASME B16.51, ASTM B75, B88, B135, B251, B306	Brazed, soldered, press-connected and flared mechanical fittings	Joints embedded in concrete shall be brazed
Cross-linked polyethylene (PEX)	1, 2, 3	ASTM F876	(See PEX fittings)	Install in accordance with manufacturer's instructions
Cross-linked polyethylene/ aluminum/cross-linked polyethylene (PEX-AL-PEX) pressure pipe	1, 2	ASTM F1281 or CAN/ CSA B137.10	Mechanical, crimp/insert	Install in accordance with manufacturer's instructions
PEX fittings		ASTM F877 ASTM F1807 ASTM F1960 ASTM F2098 ASTM F2159 ASTM F2735	Copper crimp/insert fittings, cold expansion fittings, stainless steel clamp, insert fittings	Install in accordance with manufacturer's instructions

General 2101

- Valves, fittings and connection approved, listed for use and installed per manufacturer 2101.1
- Provide system drain down 2101.2
- Backflow protection 2101.3 per 2902
- Openings through concrete or masonry sleeved 2101.4
- Protected against corrosion and physical damage 2101.5
- Drilling and notching per other code sections 2101.6
- Use of tee fittings 2101.7

General 2101

- Provisions for expansion, contraction, shrinkage and settlement 2101.8
- Piping support per Table 2101.9

TABLE 2101.9
HANGER SPACING INTERVALS

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS	4	10[a]
CPVC ≤ 1-inch pipe or tubing	3	5[a]
CPVC ≥ $1\frac{1}{4}$ inches	4	10[a]
Copper or copper alloy pipe	12	10
Copper or copper alloy tubing	6	10
PB pipe or tubing	2.67	4
PE pipe or tubing	2.67	4

- Systems hydrostatically tested at 100 psi not <15 minutes 2101.10

Floor Heating Requirements 2103

- Embedment of pipe in concrete or gypsum products
- Materials
  - Steel, copper, crossed linked polybutylene, CPVC, cross-linked polyethylene, polypropylene
  - Rated 100 psi at 180° F
  - Steel pipe joints welded
  - Copper tubing brazed, melting point >1,000° F
  - Polybutylene socket type heat fused fittings
  - Must be tested at 100 psi for 30 minutes

- Low Temperature Piping 2104
  - Approved materials per table
- Ground-Source Heat-Pump System Loop Piping 2105
  - Used materials prohibited M2105.2
  - Piping, tubing and fittings rated for operating temperatures 2105.3
  - Piping and tubing materials per Table 2105.4
    - Fitting materials per Table 2105.5
      - 2105.4 – 2105.14 info on different pipe type

TABLE 2105.4
GROUND-SOURCE LOOP PIPE

MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC)	ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F441; ASTM F442; CSA B137.6
Cross-linked polyethylene (PEX)	ASTM F876; CSA B137.5
High-density polyethylene (HDPE)	ASTM D2737; ASTM D3035; ASTM F714; AWWA C901; CSA B137.1; CSA C448; NSF 358-1
Polyethylene/aluminum/polyethylene (PE-AL-PE) pressure pipe	ASTM F1282; AWWA C 903; CSA B137.9
Polypropylene (PP-R)	ASTM F2389; CSA B137.11, NSF 358-2
Polyvinyl chloride (PVC)	ASTM D1785; ASTM D2241; CSA 137.3
Raised temperature polyethylene (PE-RT)	ASTM F2623; ASTM F2769, CSA B137.18

TABLE 2105.5
GROUND-SOURCE LOOP PIPE FITTINGS

PIPE MATERIAL	STANDARD
Chlorinated polyvinyl chloride (CPVC)	ASTM D2846; ASTM F437; ASTM F438; ASTM F439; ASTM F1970; CSA B137.6
Cross-linked polyethylene (PEX)	ASTM F877; ASTM F1807; ASTM F1960; ASTM F2080; ASTM F2159; ASTM F2434; CSA B137.5
High-density polyethylene (HDPE)	ASTM D2683; ASTM D3261; ASTM F1055; CSA B137.1; CSA C448; NSF 358-1
Polyethylene/aluminum/polyethylene (PE-AL-PE)	ASTM F1282; ASTM F2434; CSA B137.9
Polypropylene (PP-R)	ASTM F2389; CSA B137.11; NSF 358-2
Polyvinyl chloride (PVC)	ASTM D2464; ASTM D2466; ASTM D2467; ASTM F1970, CSA B137.2; CSA B137.3
Raised temperature polyethylene (PE-RT)	ASTM D2683; ASTM D3261; ASTM F1055; ASTM F1807; ASTM F2098; ASTM F2159; ASTM F2735; ASTM F2769; CSA B137.1; CSA B137.18

Ground-Source Heat-Pump System Loop Piping 2105

- Shut offs required 2105.15
  - Supply and return for heat exchangers
  - Supply and return central utility system
  - Connection to a pressure vessel
  - Both side of a pressure reducing valve
  - Connection to mechanical equipment
  - Connection to non-diaphragm-type expansion tanks

Ground-Source Heat-Pump System Loop Piping 2105

- Installation per manufacturer's instructions 2105.17
- Protection of potable water 2105.18 per 2606.1
- Pipe penetrations must be sleeved 2105.19
  - Protect annular space per 2606.1
- Clearance from combustibles

  IF: Exterior of piping >250° F

  THEN: Provide minimum 1" clearance to combustibles
  - Protect from corrosion and degradation of material
  - Protect pipe from stress, strains, expansion and contraction

Ground-Source Heat-Pump System Loop Piping 2105

- Pipe properly supported per Section 2101.9
  - Water velocity based on type of pipe
- Label and mark piping: “Ground-Source Heat Pump Loop System” 2105.25
  - Label whether antifreeze is in system
    - Label all chemicals in system
  - Testing 100 psi for 15 minutes – no leaks
  - Embedded pipe pressurized before and during placement of concrete

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Chapter 22
Special Piping and Storage Systems

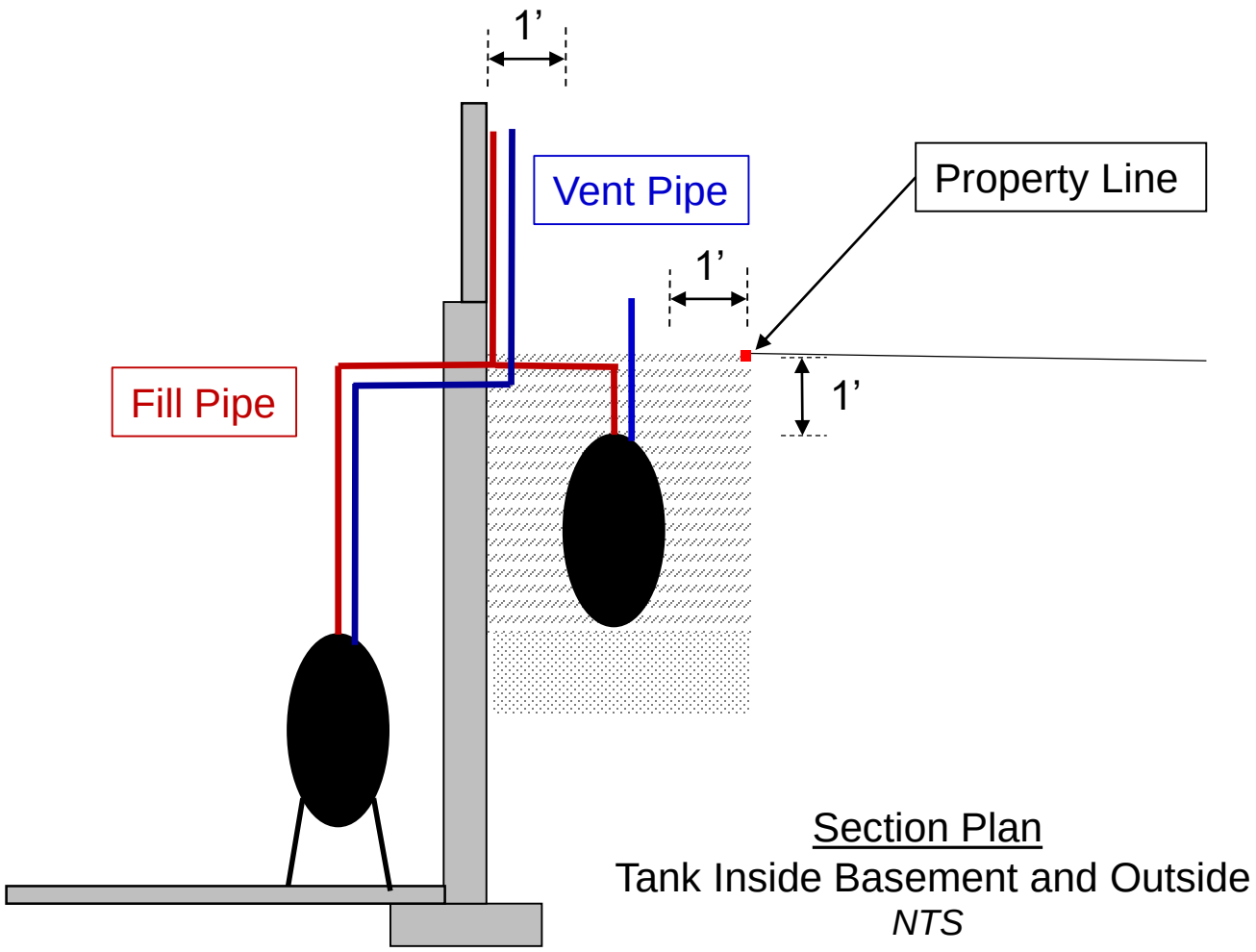
Oil Tanks M2201

- Fuel oil and diesel storage and piping systems
- Above ground tanks 2201.2
  - Fuel supply tanks labeled per UL 58 and UL 80 2201.1
  - Maximum fuel storage inside or above ground: 660 gallons
    - For space or water heating sized per NFPA 31
    - Greater than 660 gallons per NFPA 37
  - Tanks supported on rigid non-combustible
  - Tanks inside sized to be removable without cutting 2201.2.1
  - Larger than 10 gallons at least 5’ from flame
  - Outdoor above-ground tanks minimum 5’ from property line 2201.2.2

Oil Tanks 2201

* Underground tanks 2201.3
  - Not undermine footing foundation
  - Underground tanks minimum 1’ from property line, basement or wall
  - Set on and surrounded by inert material
  - Minimum cover 1 foot of inert material
  - Set on and surrounded by inert material
  - Corrosion protection required

* Tanks within buildings and underground tanks 2201.2.1 and 2201.3



Section Plan
Tank Inside Basement and Outside
NTS

Oil Tanks 2201

- Oil gauge required on indoor tank – no glass – unbreakable 2201.5
- Maximum 2 tanks cross connected 660 gal total per 2201.4 and 2201.4.6
- Tank abandonment 2201.7 and removal per IFC

Oil Piping, Fittings and Connections 2202

- Steel pipe, copper piping or tubing listed for oil piping 2201.1
- Compatible fittings – no cast iron 2202.2
  - Not allowed:
    - Unions requiring gaskets, right or left couplings, solder melting point less than 1,000°F
    - Listed and labeled flexible connections – UL 536

Installation 2203

- Pipe size and type 2203.2
  - 3/8” pipe, tubing 3/8” outside diameter
  - Copper pipe and tubing type L or heavier
- Fill piping terminal at least 2’ from openings 2203.3
  - Vent pipe min 1¼”
    - Drain back to tank
    - Not cross connected to fill
    - Enter tank at top
  - Corrosion-resistant coatings

Oil Pumps and Valves 2204

- Positive displacement pumps with automatic shut-offs 2204.1
- Manual shut-off between tank and burner with ready access 2204.2
- Pressure relief valve when shut-off in discharge
- Maximum inlet pressure – 3 psi 2204.3
- Fuel oil lines with heaters require relief valves back to return line piping – when excess pressure exists 2204.4

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Chapter 23
Solar Thermal Energy Systems

Solar Thermal Energy Systems 2301

- Solar energy for space heating or cooling, hot water heating and swimming pool heating 2301.1
- Design and installation 2301.2
  - Accessible 2301.2.1
    - Not obstruct doors or windows or other roof mounted equipment

Solar Thermal Energy Systems 2301

- Design and installation 2301.2
  - Accessible 2301.2.1
    - Not obstruct doors or windows or other roof mounted equipment
    - Roof to be constructed to support imposed loads 2301.2.2.1

      Collectors as roof covering – comply as a roof

      Above the roof – noncombustible or fire retardant treated

      Protected from degradation per ICC 900 / SRCC 300

- Solar Thermal Energy Systems 2301
  - Design and installation 2301.2
    - Piping insulation 2301.2.5
      - Per Chapter 11
      - Protected from ultraviolet degradation
      - Insulate entire loop
    - Protect from freezing 2301.2.6

Solar Thermal Energy Systems 2301

- Design and installation 2301.2
  - Drain back not create hazard
  - Expansion tanks
    - Installed per section 2003 if contain fluid
    - Per ICC 900/ SRCC 300
  - Penetrations to be properly sealed 2301.2.9
  - Systems with fluid – pressure, temperature, and vacuum relief required 2301.2.3

Solar Thermal Energy Systems 2301

- Design and installation 2301.2
  - Solar loops 2301.2.11
    - Isolation valves required
    - Drain and fill valves labeled
    - Warning sign for a discharge at high temperature or pressure
    - Maximum water temperature 180° 2301.2.12
- Collectors and panels must be listed and labeled 2301.3

Solar Thermal Energy Systems 2301

- Heat transfer gases or liquids and heat exchangers 3201.4
  - Flammable gas and liquids shall not be used
  - Heat exchangers to comply with Section 2902.5.2 and SRCC 100 or SRCC 901600
  - Flash point not less than 50° F above system operating temperature
- Backflow protection required 2301.5

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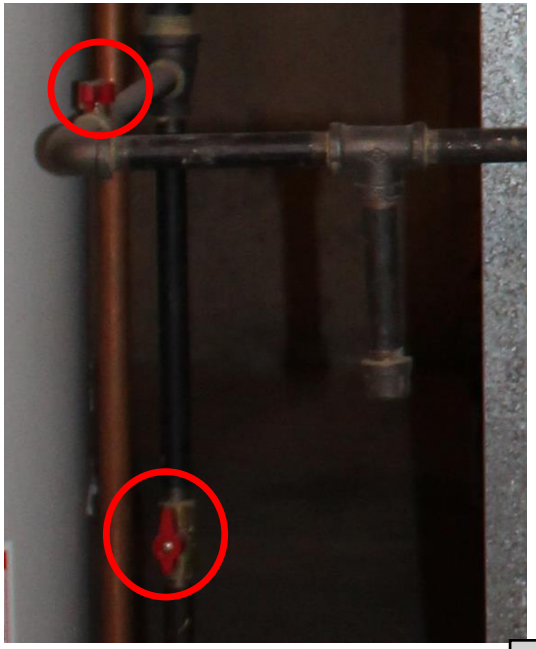
Understanding the 2019 Residential Code of Ohio Mechanical©

Chapter 24
Fuel Gas

General 2401

- Fuel gas piping, utilization equipment and related accessories, venting systems, and combustion air configurations commonly encountered in the construction of one and two family dwellings 2401.1
- Piping system: All fuel piping, valves and fittings from the outlet of the point of delivery to the outlets of the appliance shutoff valves
- Point of delivery to appliance shut off



- General Definitions 2403
  - Terms not defined in this code shall have meanings as ascribed in other codes 2403.3
  - This chapter has its own definitions
- General 2404
  - Listed and labeled equipment 2404.3
  - Vibration isolation 2404.4 (
  - Repairs to maintain original listing or approval requirements 2404.5
  - Installed to meet expected wind loads 2404.6
  - Flood zones 2404.7

- General 2404
  - Seismic resistance 2404.8
  - Rodent proofing 2404.9
  - Category IV condensation appliances shall be provided with an auxiliary drain pan 2404.10
    - Exception: Appliances that have auto shut down operation in the event of a stoppage in the drain system
  - Condensate pump failure will prevent operation of connected appliance or equipment 2404.11

Structural Safety 2405

- Building not to be weakened by installation of gas piping
- Truss members not to be cut, drilled, notched or spliced
- No additional loads without verification of being capable of supporting the load
- Prohibits cuts, holes, notches, in engineered wood products including: trusses, glue-laminated members, I-joists and structural composite components
  - Exceptions permitted by manufacturer or engineer design

Appliance Location 2406

- Per code and listing
- Prohibited locations 2406.2
  - Sleeping rooms / Bathrooms / Toilet rooms
  - Storage closets / Surgical rooms / A space that opens only into the room
  - Exceptions as apply
- Outdoor locations 2406.3
  - Listed or provided adequate protection

Combustion, Ventilation and Dilution Air 2407

- Provide adequate combustion air
- Appliance not interfere with air flow
- Draft hoods in same room as appliance 2407.3
- Make-up air 2407.4
  - Exhaust fans shall be considered in calculations
  - Kitchen ventilation / exhaust fans / dryers / fireplaces

Combustion, Ventilation and Dilution Air 2407

- Indoor combustion air 2407.5
  - Total required sum of all appliances in area
  - Rooms communicating directly without doors to be counted
  - Standard method for minimum required volume
    - 50 cu ft. per 1,000 Btu input rating
    - Provides minimum volume without outside air
    - Typical appliance information tag – Use input BTU

* Class Exercise What is the maximum allowable Btu/h for each area before outside air is required?

10’ Ceiling Height

<u>80,000</u> BTU/hr
Water Heater

<u>120,000</u> BTU/hr
Furnace

80,000 Btu/h
+ <u>120,000 Btu/h</u>
200,000 Btu/h Total

Thus:

200,000 Btu/h ÷ 1,000 = 200

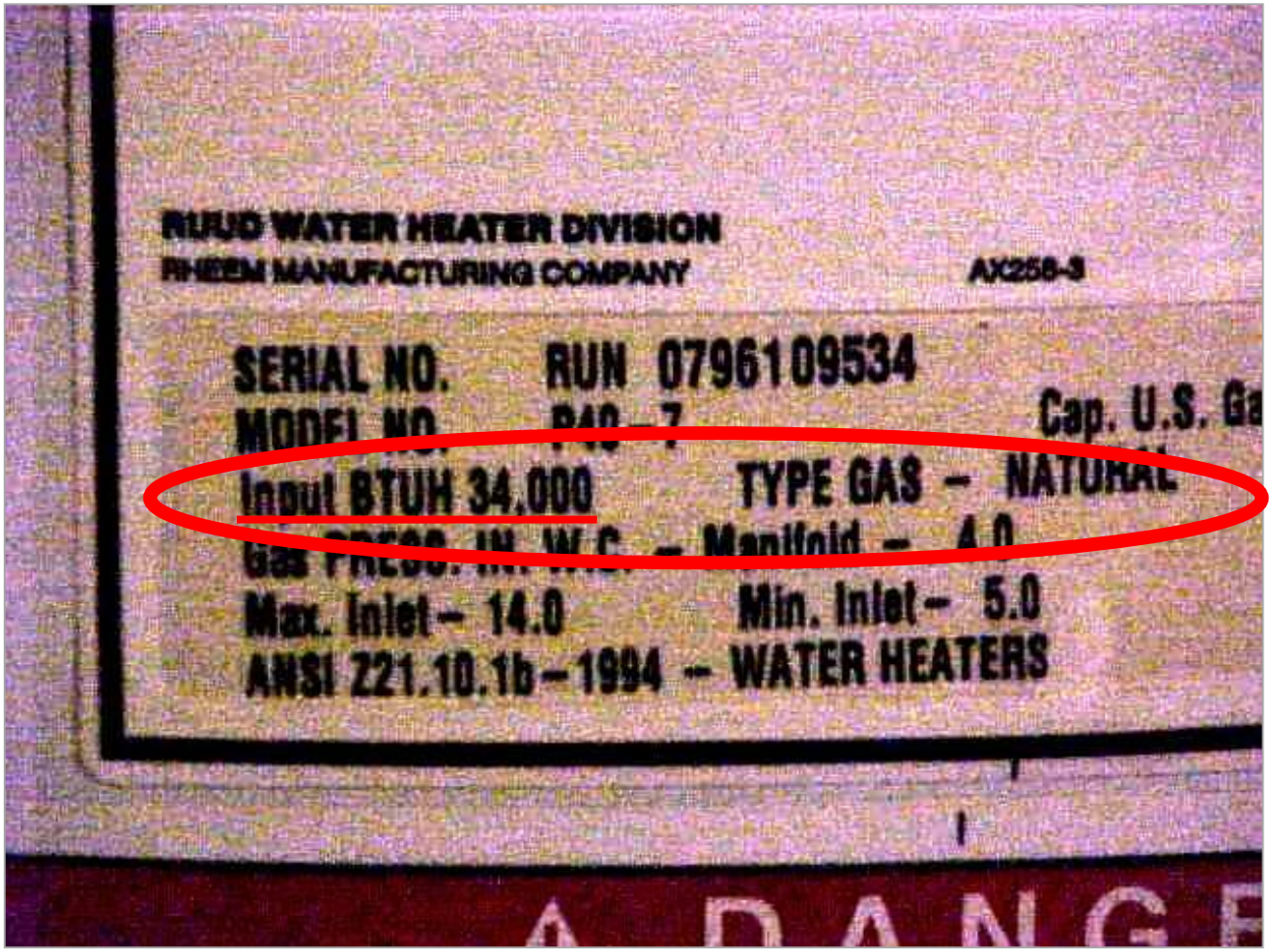
200 x 50 cu ft = **<u>10,000 cu ft</u>**

10’ High Ceiling

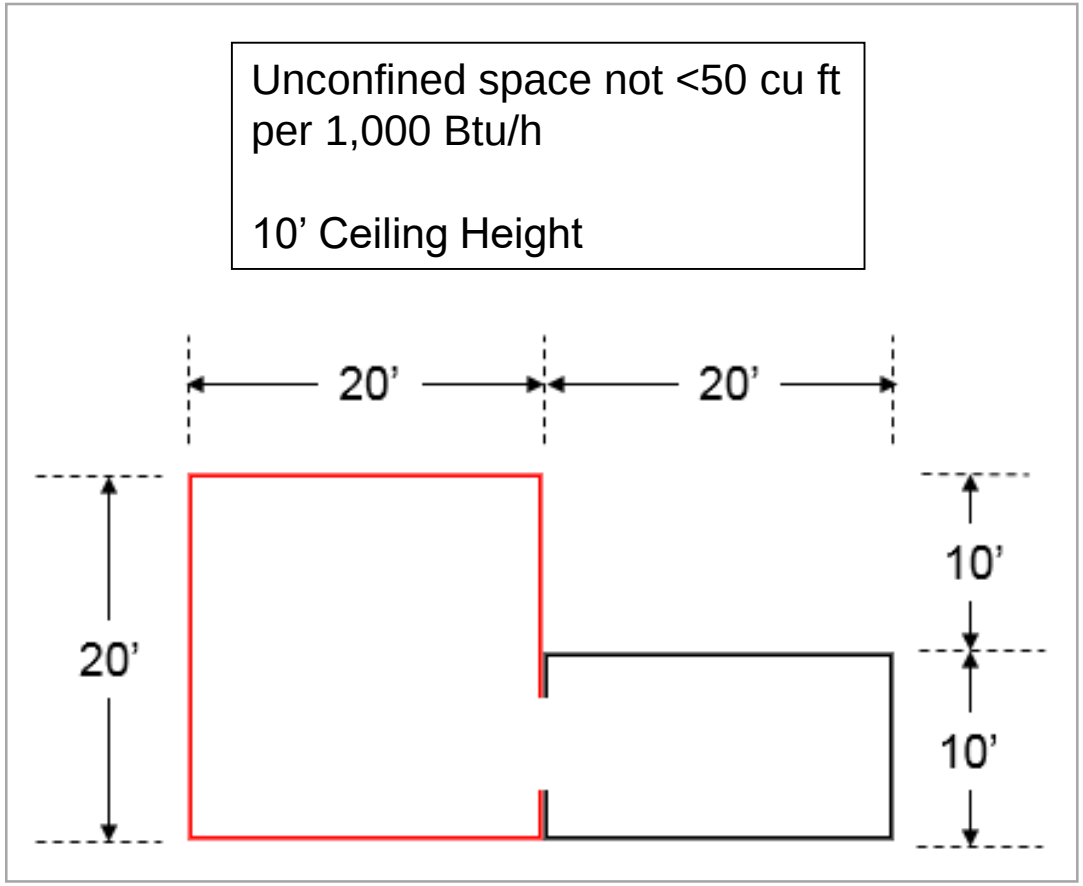
10,000 cu ft ÷ 10 = ?

<u>1,000 sq ft Minimum Req’d</u>

* Typical appliance information tag



* Class Exercise – What is maximum allowable Btu/h for each area before outdoor air is required?

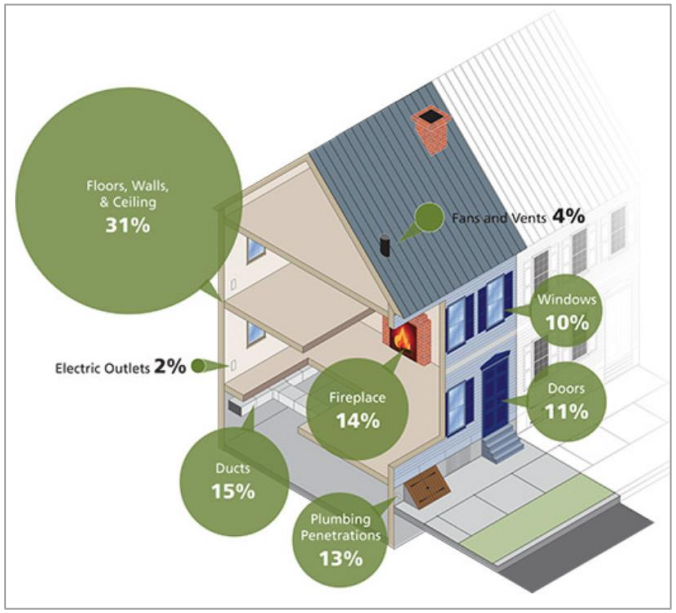


Area 1
20' X 20' X 10' = 4,000 cu ft
4,000 / 50 = 80
1,000 X 80 = **<u>80,000 Btu/h</u>**

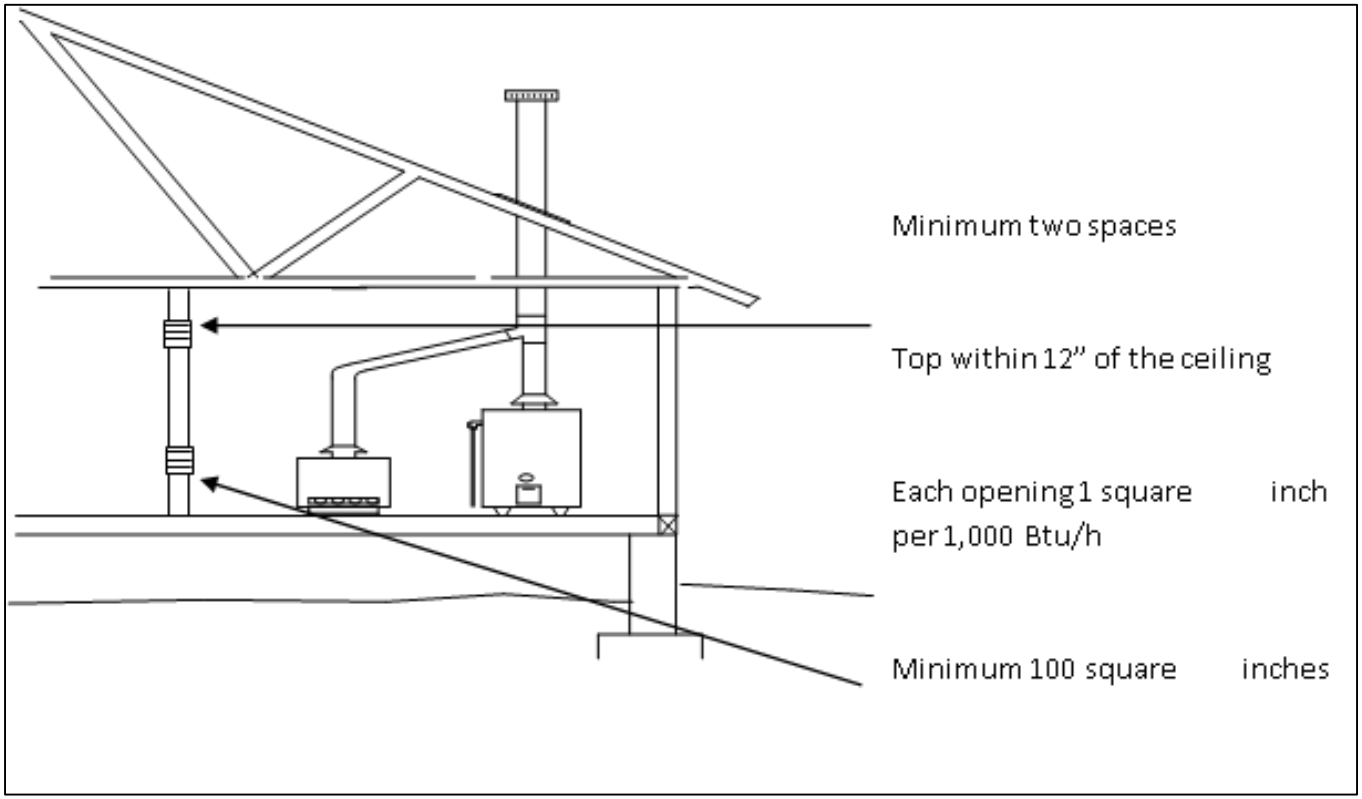
Area 2
20' X 10' X 10' = 2,000 cu ft
2,000 / 50 = 40
1,000 X 40 = **<u>40,000 Btu/h</u>**

Combustion, Ventilation and Dilution Air 2407

- Known air infiltration method allows a performance-based proof of sufficient air 2407.5.2
  - Method for fan assisted and non-assisted units
  - Not used when air infiltration rate is >0.60 ACH (ACH = Air Changes per Hour)



- Combustion, Ventilation and Dilution Air 2407
  - Indoor openings size and location 2407.5.3
  - Combing spaces on the same story 2407.5.3.1
    - Free area of 1 square inch per 1,000 Btu not less than 100 square inch
      - For each opening
    - Two openings – 12 inches from top / 12 inches from bottom
    - Minimum size not less than 3 inches


Minimum two spaces
Top within 12" of the ceiling
Each opening 1 square inch per 1,000 Btu/h
Minimum 100 square inches

- Combustion, Ventilation and Dilution Air 2407
  - Indoor openings size and location 2407.5.3
    - Combining spaces on different stor
    - One or more permanent openings in doors or floors
    - From other stories – openings 2 square inch per 1,000
    - 2 openings commencing within 12” of ceiling and floor

* Figure 2407.6.1

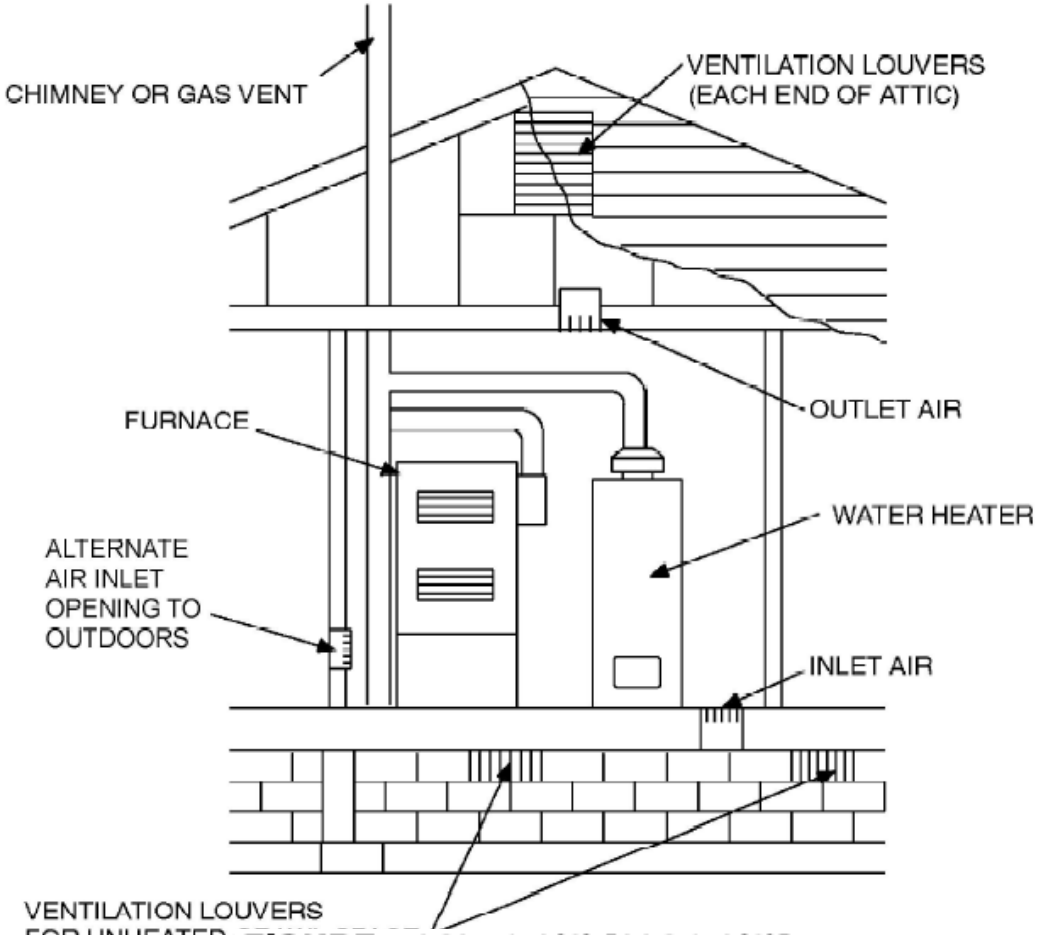


FIGURE 2407.6.1(1) [304.6.1(1)]

ALL AIR FROM OUTDOORS—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC

Combustion, Ventilation and Dilution Air 2407

- Outdoor combustion air 2407.6
  - Two permanent openings
    - 12” top and bottom
    - Calculates net free area for each opening
    - Direct to outdoors vertically 1 square inch per 4,000 Btu/h
    - Communicate directly or by ducts
    - Horizontal ducts 1 square inch per 2,000 Btu/h
    - Calculate the total BTU being supplied

* Figure 2407.6.1(2)

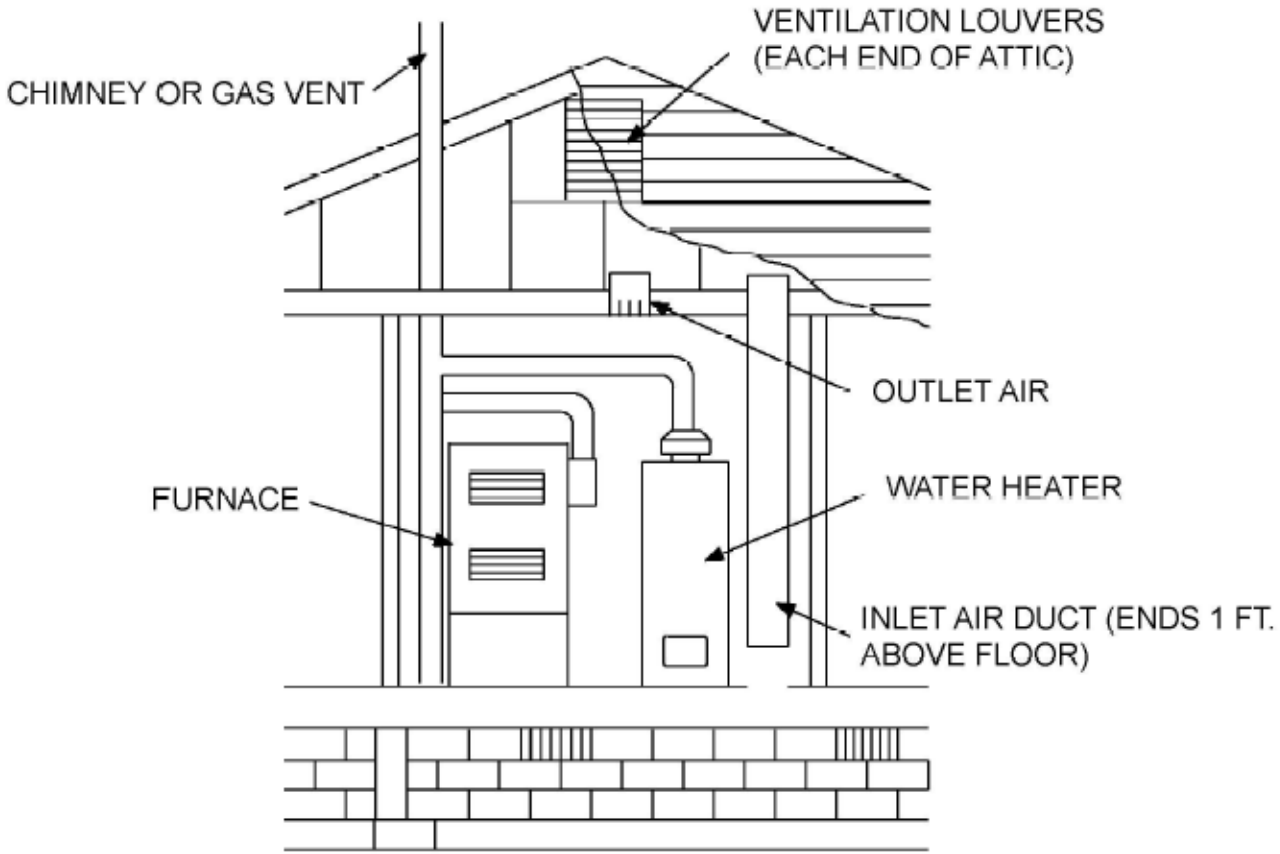


FIGURE 2407.6.1(2) [304.6.1(2)]
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC (see Section G2407.6.1)

* Figure G2407.6.1(3)

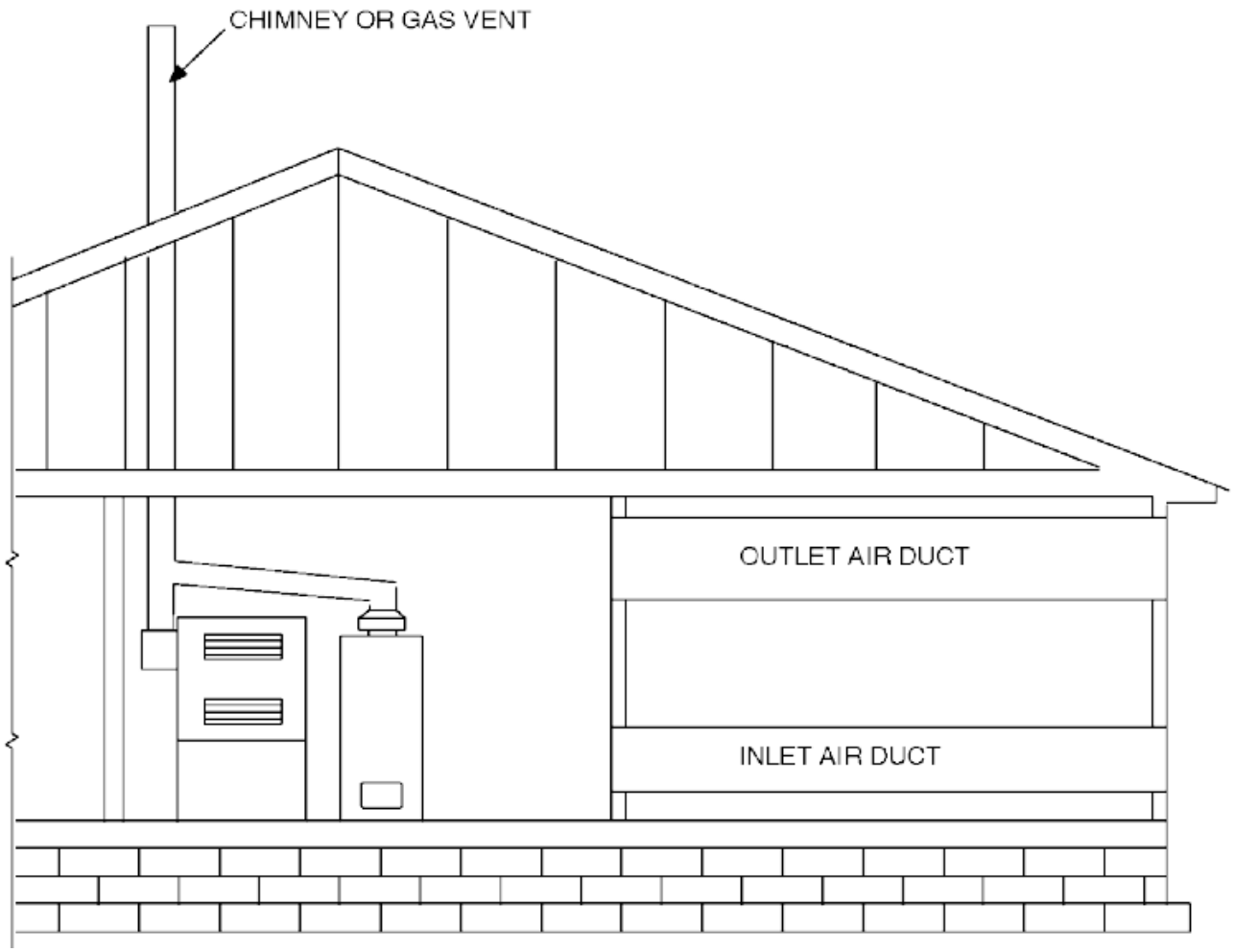


FIGURE G2407.6.1(3) [304.6.1(3)]
ALL AIR FROM OUTDOORS (see Section G2407.6.1)

Combustion, Ventilation and Dilution Air G2407 (304) *(continued)*

- One opening method G2407.6.2
  - 12” within the top of the enclosure
  - Appliance clearances
    - 1 inches from sides and back
    - 6 inches from the front
  - Direct to outdoors or through a duct
  - 1 square inch per 3,000 BTU
  - Duct not less than the sum of all vent connectors

* Figure G2407.6.2 page 548

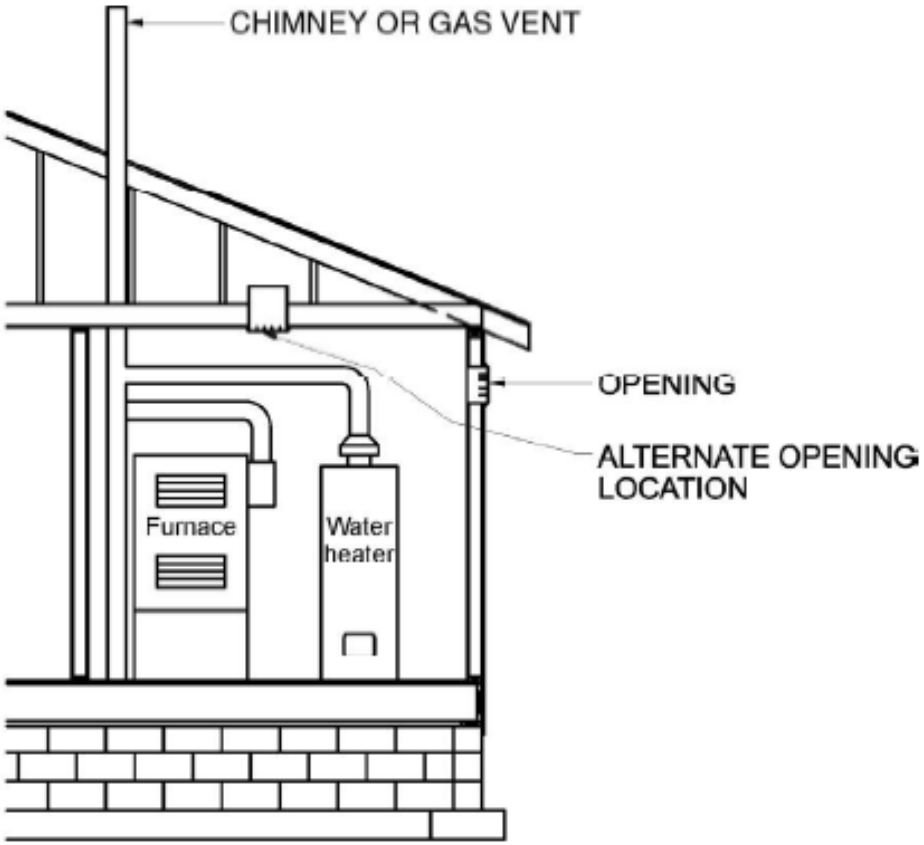


FIGURE G2407.6.2 (304.6.2)
SINGLE COMBUSTION AIR OPENING,
ALL AIR FROM OUTDOORS

* Class Exercise
  - 2- 34,000 Btu/h water heaters
  - 1- 120,000 Btu/h furnace
* Calculate combustion air opening sizes using the 2 opening method for outdoor air with the openings on an outdoor wall

34,000
34,000
120,000
188,000 Btu/h appliance load

188,000/2,000 = 94 sq in net free for each opening

* Class Exercise
  - 2- 34,000 Btu/h water heaters
  - 1- 120,000 Btu/h furnace
  - Calculate combustion air opening sizes using the 2 opening method for outdoor air supplied by a horizontal duct

34,000
34,000
120,000
188,000 Btu/h appliance load

188,000/2,000 = 94 sq in net free for the one opening

* Class Exercise
  - 2- 34,000 Btu/h water heaters
  - 1- 120,000 Btu/h furnace
* Calculate combustion air opening sizes using the one opening method

34,000
34,000
120,000
188,000 Btu/h appliance load

188,000/3,000 =
62.67 sq in net free
for each opening

Combustion, Ventilation and Dilution Air 2407

- Combination indoor and outdoor 2407.7
  - Indoor openings as per indoor air
  - Outdoor openings as per outdoor combustion air
  - Indoor Spaces
    - Ratio of available volume of all communicating spaces divided by required volume
    - Reduction factor = 1 minus ratio of interior spaces
    - Minimum outdoor size = full size of openings calculated x reduction factor
    - Minimum dimension of air openings not < 3”

- Example 2407.7
  - 160,000 Btu input requires 8,000 cube foot for “Indoor Air only”
  - 240 square feet adjacent space with 8’ ceiling (8 x 240) = 1920 cube foot
  - 1,920 = .24
  - 8,000
  - Reduction Factor 1 - .24 = .76
  - Outdoor air required
  - 1” per 4,000 Btu/h
  - 160,000 = 40 square inch
  - 4,000
  - Outdoor air required: .76 x 40 = 30.4 square inch

Combustion, Ventilation and Dilution Air 2407

- Engineered combustion air 2407.8
- Mechanical combustion air 2407.9,
  - 0.35 cu ft. per 1,000 Btu/h of total input rating all appliances
  - Appliance interlock

IF: Mechanically supplied combustion air

THEN: System must also supply required ventilation air

Combustion, Ventilation and Dilution Air 2407

* Louvers and grills 2407.10
  - Ventilation based on net free opening
    - Wood louvers 25%
    - Metal 75%
  - Manufacturer's specifications
  - Motorized grills interlocked with equipment

Combustion, Ventilation and Dilution Air 2407

- Combustion air ducts 2407.11
  - Duct must use galvanized steel for the ducts or material having equivalent corrosion resistance, strength, and rigidity
  - Terminate in unobstructed space
  - Serve a single enclosure
  - Separate upper and lower duct – not screened in attic area
  - Not as part of the masonry, metal or factory built chimney assembly
  - Except direct vent appliances

- Combustion, Ventilation and Dilution Air 2407
  - Combustion air ducts 2407.11
    - Low opening – bottom not less than 12”above grade
    - Protected from fumes and vapors
    - Disperse fumes
    - Installed per manufacturer
- Installation 2408
  - Listings or manufacturer’s instructions
  - Available on the job site
  - Follow stricter code or manufacturer
  - Many sections same as mechanical Part V

Installation 2408

- Ignition source 18” above grade in garage
- Installation 6’ or higher in private garage unless protected from vehicle impact
- Equipment installed at grade on a level pad or suspended 6” above grade
- Clearance to combustibles to be maintained
- Consider temporary items such as drawers or doors

Clearance Reduction 2409

- Reductions only per Table 2409.2 unless prohibited by listing
- Includes distance to drywall
- Reductions allowed only per Table 2409.2 unless prohibited by listing
- Clearance to indoor air conditioning 2409.3
- Per manufacture
- Can use clearance Table 2409.2
- Clearance from supply ducts 2409.3.4

- Electrical 2410
  - Gas piping not to be used as a grounding electrode
- Electrical Bonding 2411
  - Pipe and tubing other than CSST 21411.1
    - Gas pipe likely to become energized shall be bonded
      - Exception: Connection to equipment that is part of an electrical circuit shall be considered bonded

Electrical Bonding 2411

- Corrugated stainless steel tubing (CSST) 2411.1.1 (310.1.1)
  - Bonded to electric service grounding electrode system
  - Bonded to metallic pipe or fitting
  - Bonding jumper not smaller than 6 AWG
  - All segments of system bonded

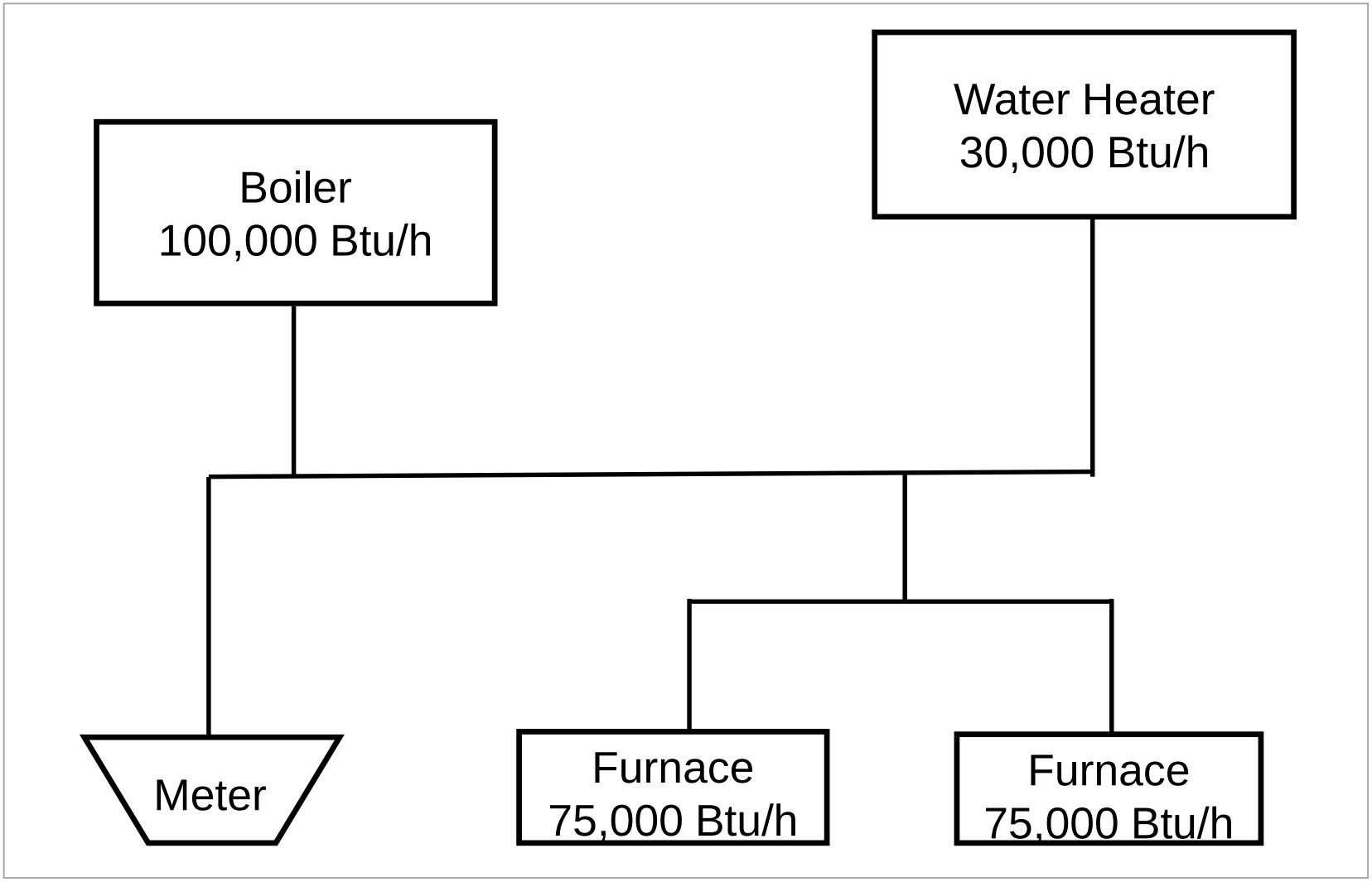
- General 2412
  - Point of delivery to connection to equipment
  - LP gas per Fire Code
  - Modification to gas pipe system requires resizing
  - Yellow identifying color with black lettering unless black metallic pipe – every 5’
  - 2 meters not to be interconnected
  - Meter labeled indicating area served
  - Pipe sized to serve all connected appliances

General 2412

- Meter labeled indicating area served
- Pipe sized to serve all connected appliances
- All pipe identified
  - Exceptions:
    - Pipe length less than 2 feet and from same pipe
    - Steel fitting 2 inches and less
    - On product packaging
    - Other approved documentation
- All pipe third party tested or certified

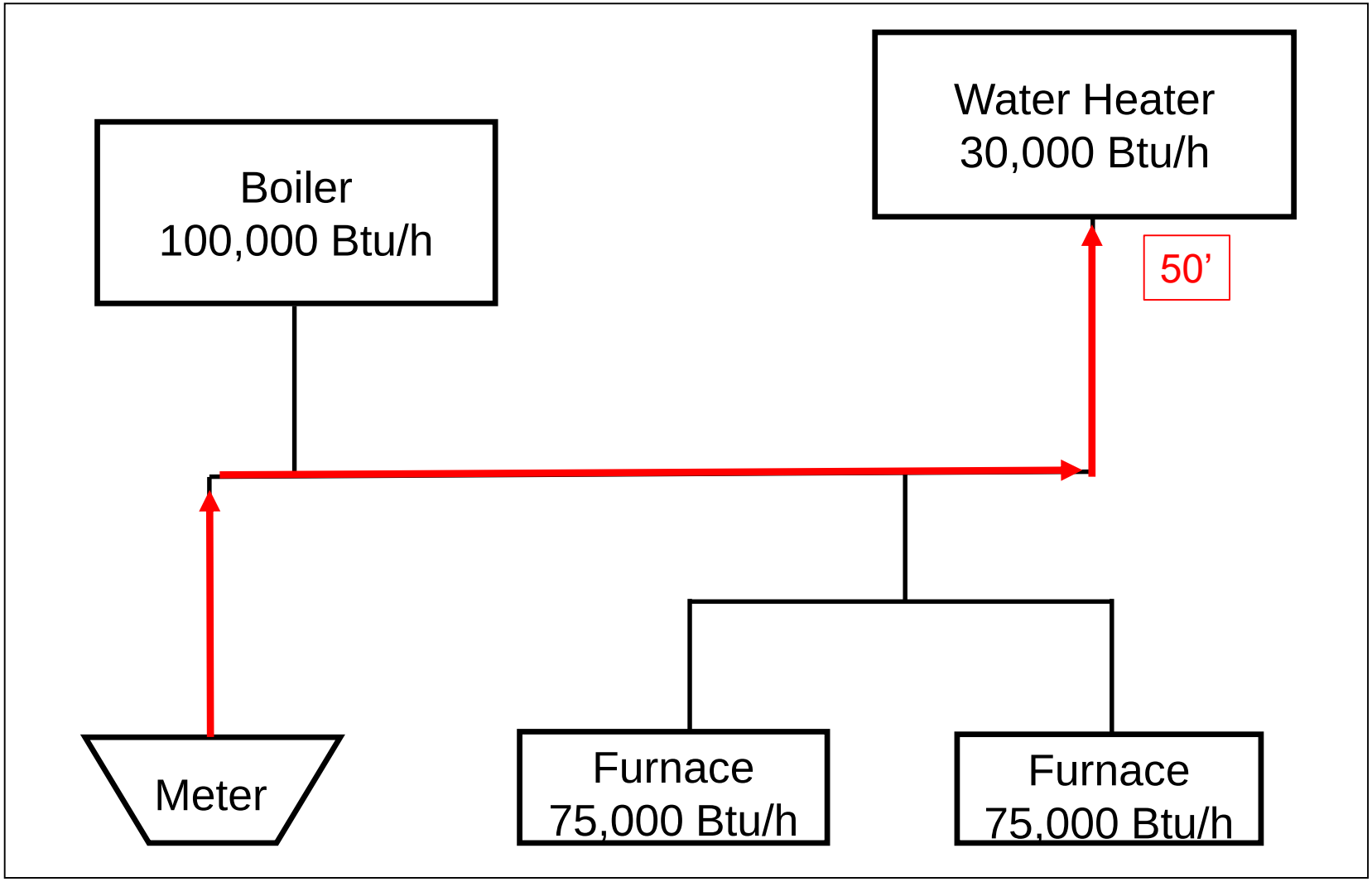
Pipe Sizing 2413

- Based on appliance input rating
- When rating is unknown, the manufacturer shall be consulted
- Assume all appliances operating simultaneously
- 1 cube foot of natural gas = 1,000 Btu
- Maximum design pressure 5 psig or exceptions
- Size is per code tables
- Tables are based on pressure, type of pipe or tubing, pressure drop
- Maximum capacity of pipe in feet of gas per hour for gas pressure less than 2 psi and a pressure drop of 0.5” water column Table 2413.4(1)


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

Pipe Sizing 2413

- Longest length method 2413.4.1
- **Step One**
  - Determine the length of pipe from the point of delivery to the most remote appliance
    - Example: Furthest appliance is 50’ from the meter
- **Step Two**
  - Enter the table in the 50’ row
  - Entire system will be sized based on the values in this column


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
50’
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

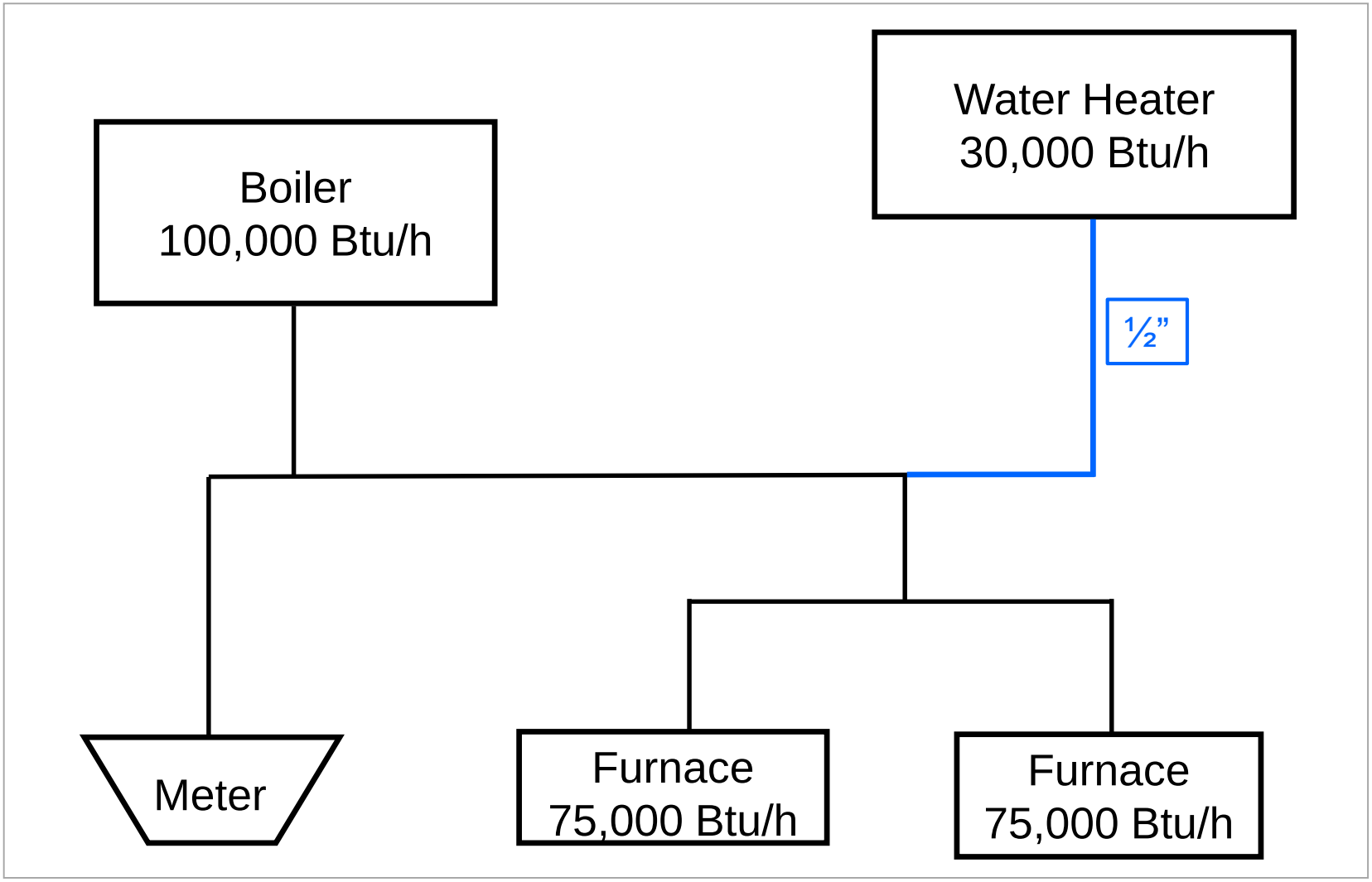
Pipe Sizing 2413

* **Step Three**
  - Size the branch feeding the most remote appliance
  - Example: 30,000 Btu/h water heater
    - Divide 30,000 Btu/h/1,000 Btu/h per cu ft of gas
    - equals 30 cube foot of natural gas required by this water heater
    - Look in Table G2413.4(1) on 50’ length row
    - Find cube foot of gas equal to or higher than 30
    - ½” pipe delivers 72 cube foot of gas per hour
    - Answer: ½” pipe required
  - If the actual demand falls between tabular values, use the larger pipe size

* Schedule 40 Metallic Pipe Table 2413.4(1)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 inch WC
Specific Gravity	0.60

PIPE SIZE (inches)						
Nominal	1/2	3/4	1	1 1/4	1 1/2	2
Actual ID	[illegible]	0.824	1.049	1.380	1.610	2.067
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour					
10	[illegible]	360	678	1,390	2,090	4,020
20	[illegible]	247	466	957	1,430	2,760
30	[illegible]	199	374	768	1,150	2,220
40	[illegible]	170	320	657	985	1,900
50	72	151	284	583	873	1,680
60	65	137	257	528	791	1,520


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
½”
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

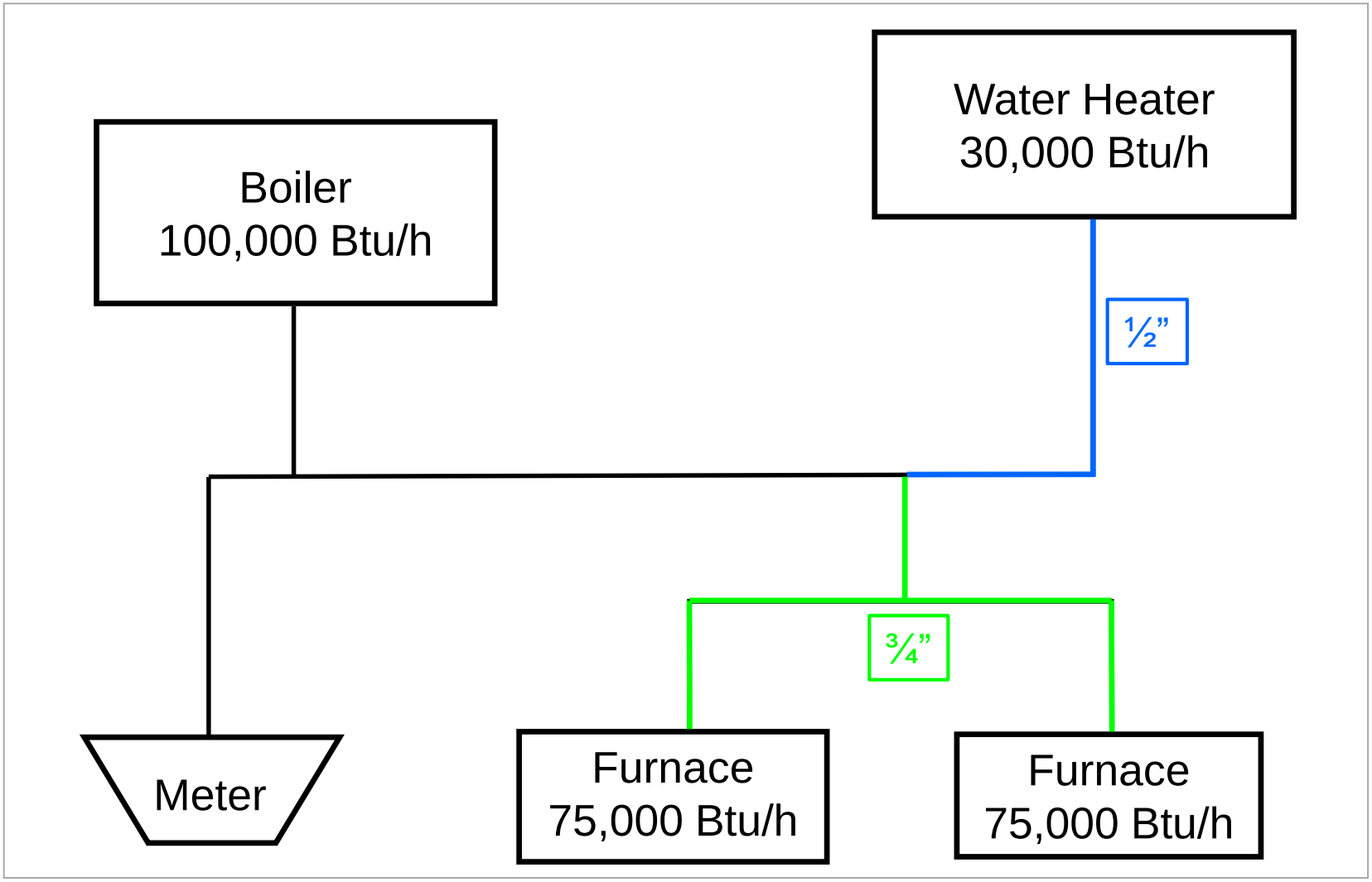
Pipe Sizing 2413

* **Step Four**
  - Working towards the meter, size the branch feeding the 2 furnaces
  - Example:
    - 75,000 Btu/h furnace requires 3/4” pipe to each appliance
    - Since the total demand upstream of the tee is less than 151, the portion of the branch that serves both appliances is permitted to be 3/4”

* Schedule 40 Metallic Pipe Table 2413.4(1)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 inch WC
Specific Gravity	0.60

PIPE SIZE (inches)						
Nominal	1/2	3/4	1	1 1/4	1 1/2	2
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour					
10	172	350	678	1,390	2,090	4,020
20	118	241	466	957	1,430	2,760
30	95	189	374	768	1,150	2,220
40	81	170	320	657	985	1,900
50	72	151	284	583	873	1,680
60	65	137	257	528	791	1,520


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
½”
¾”
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

Pipe Sizing 2413

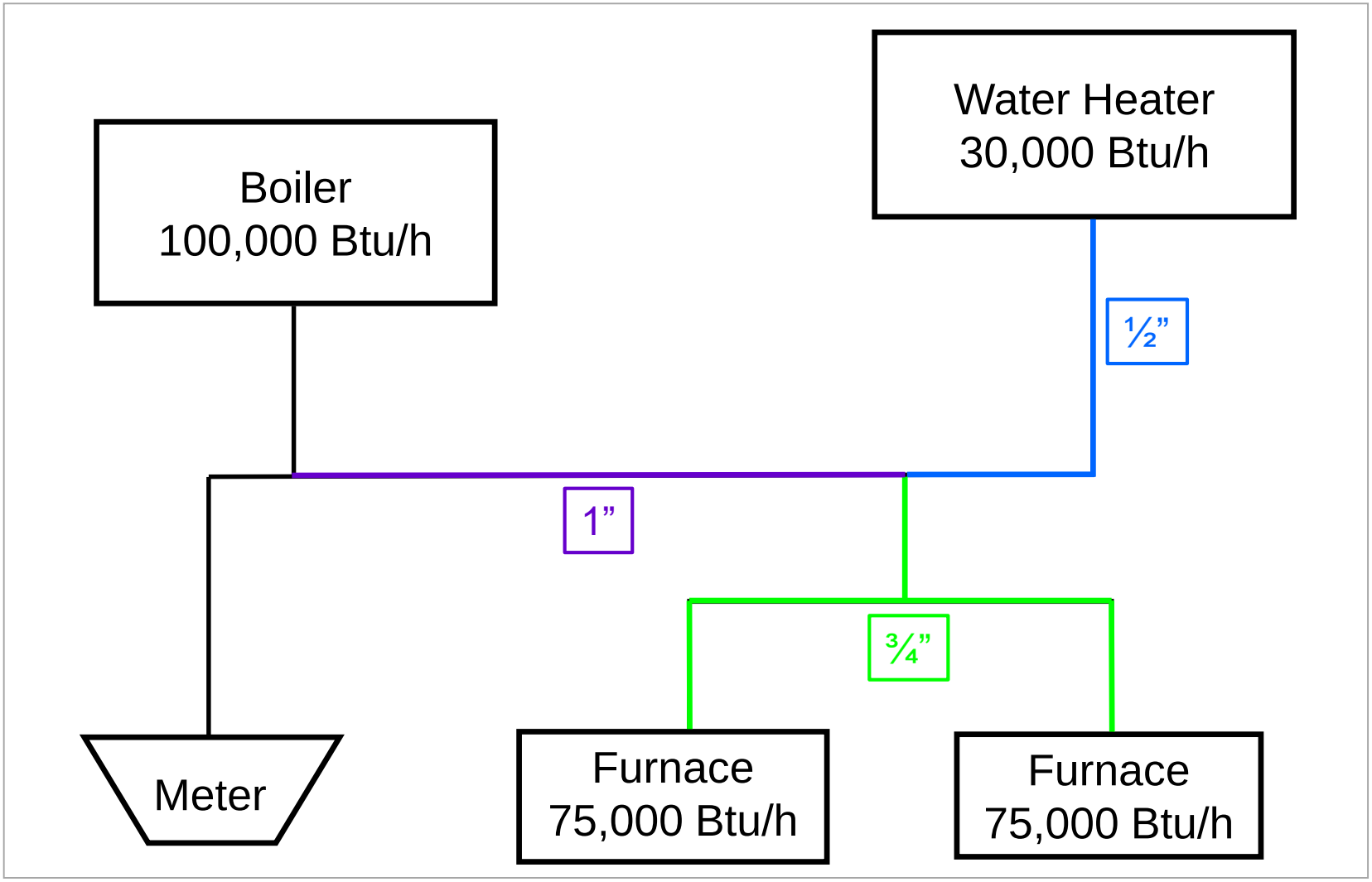
* **Step Five**
  - Size the main from the unit heater branch to the dual furnace branch
  - Example:
    - The total demand on this portion of the main is 180,000 Btu/h

      Required pipe size is 1”

* Schedule 40 Metallic Pipe Table 2413.4(1)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 inch WC
Specific Gravity	0.60

PIPE SIZE (inches)						
Nominal	1/2	3/4	1	1 1/4	1 1/2	2
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour					
10	172	360	[illegible]	1,390	2,090	4,020
20	118	247	[illegible]	957	1,430	2,760
30	95	199	[illegible]	768	1,150	2,220
40	81	170	320	657	985	1,900
50	72	151	284	583	873	1,680
60	65	137	257	528	791	1,520


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
½”
1”
¾”
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

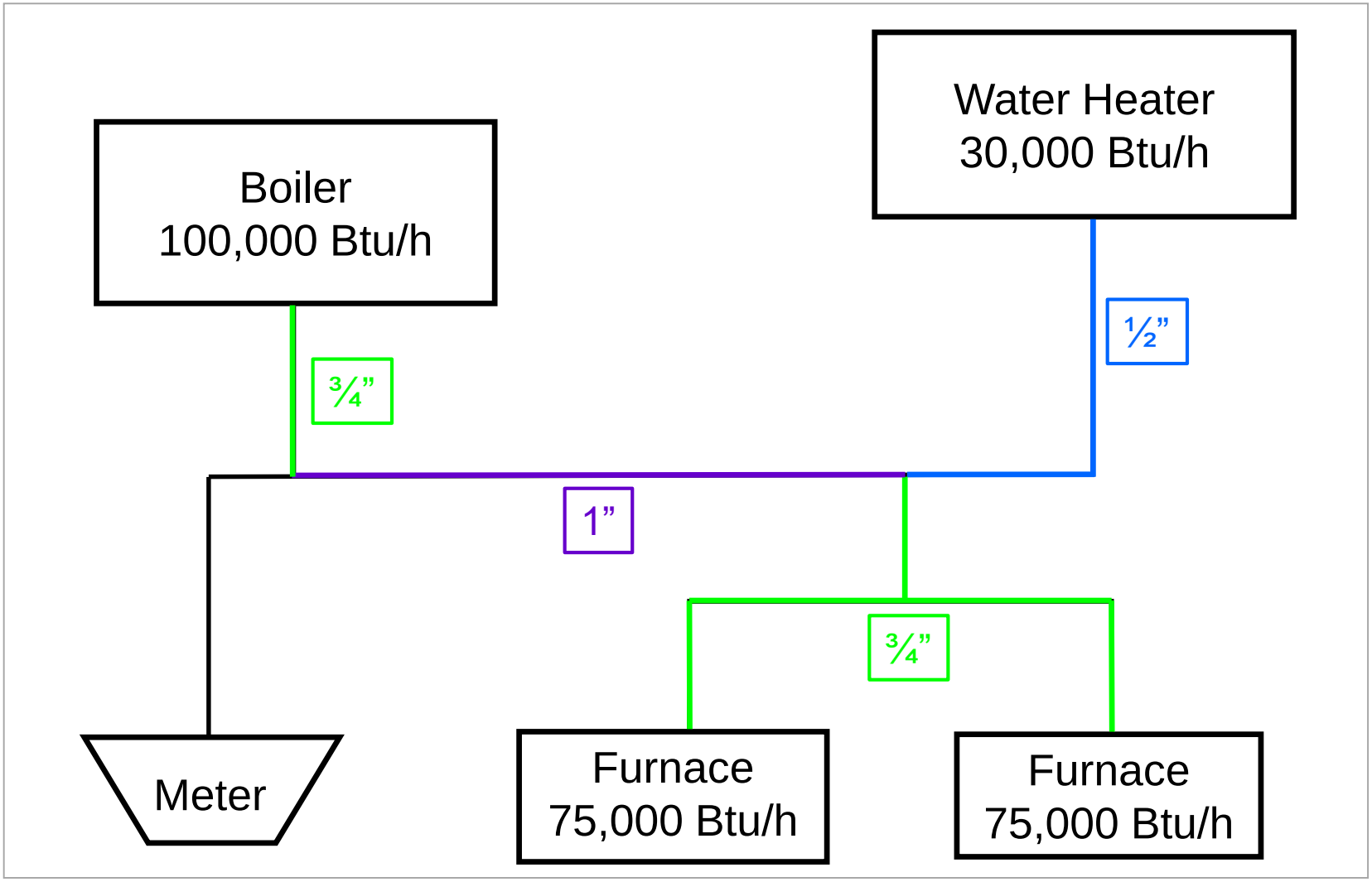
Pipe Sizing 2413

- Step Six
  - Size the branch serving the boiler
  - Example
    - Demand on branch is 100,000 Btu/h
    - Required size is 3/4”

Schedule 40 Metallic Pipe
Table G2413.4(1)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 inch WC
Specific Gravity	0.60

PIPE SIZE (inches)						
Nominal	1/2	3/4	1	1 1/4	1 1/2	2
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour					
10	172	360	678	1,390	2,090	4,020
20	118	247	466	957	1,430	2,760
30	95	199	374	768	1,150	2,220
40	81	170	320	657	985	1,900
50	72	151	284	583	873	1,680
60	65	137	257	528	791	1,520


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
½”
¾”
1”
¾”
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

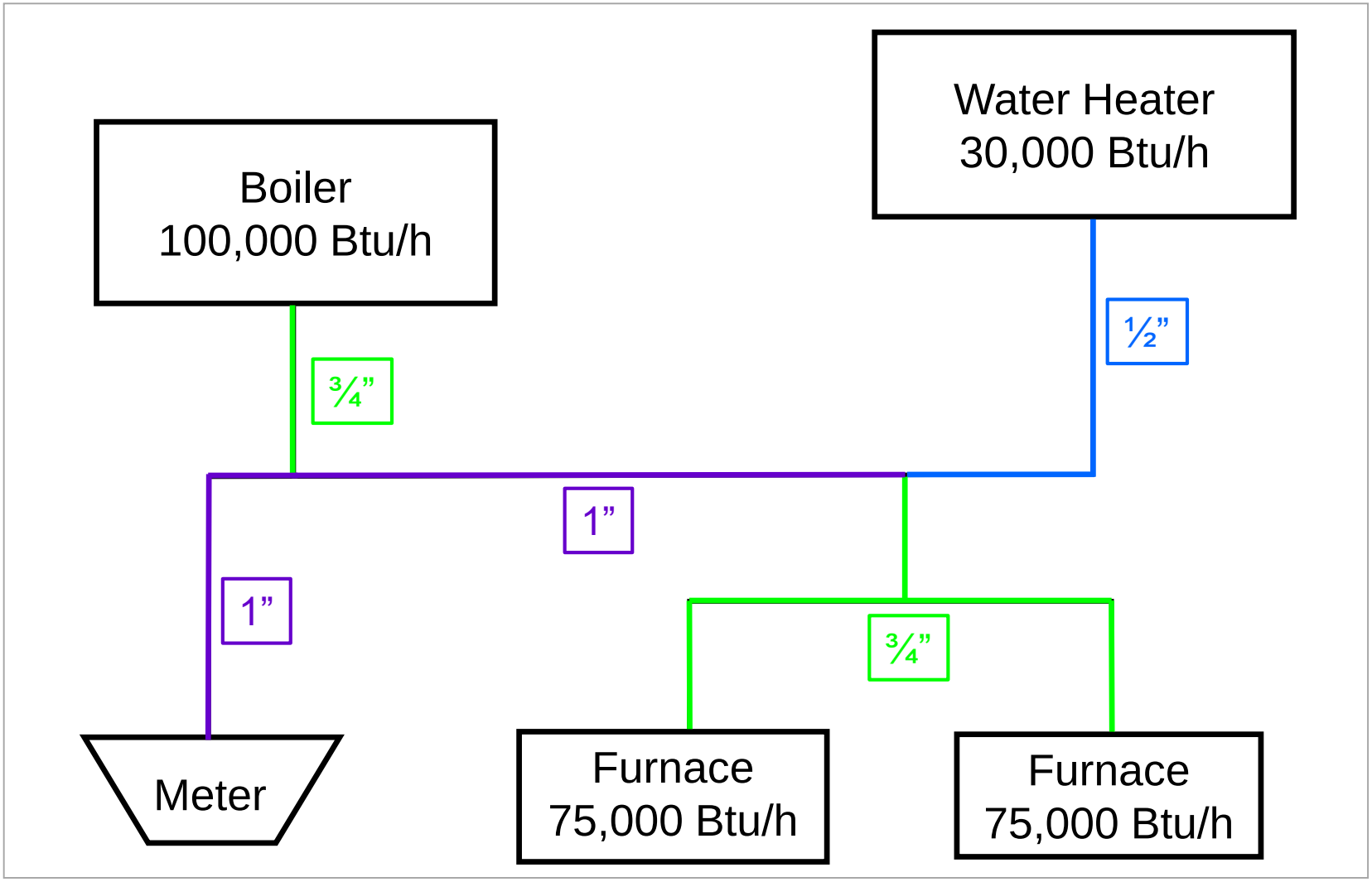
Pipe Sizing 2413

- Step Seven
  - Size the remainder of the main
  - Example
    - Total system demand is 280,000 Btu/h
    - Pipe size required is 1”

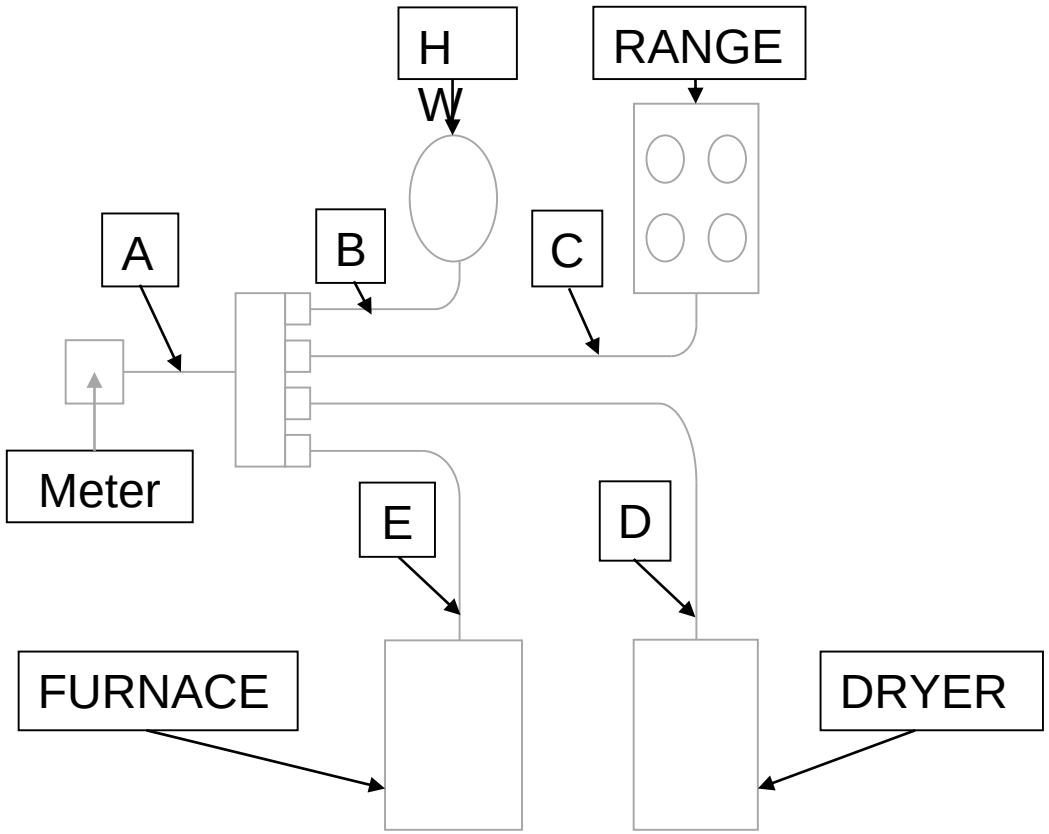
Schedule 40 Metallic Pipe
Table G2413.4(1)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 inch WC
Specific Gravity	0.60

PIPE SIZE (inches)						
Nominal	1/2	3/4	1	1 1/4	1 1/2	2
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour					
10	172	360	[illegible]	1,390	2,090	4,020
20	118	247	[illegible]	957	1,430	2,760
30	95	199	[illegible]	768	1,150	2,220
40	81	170	[illegible]	657	985	1,900
50	72	151	284	583	873	1,680
60	65	137	257	528	791	1,520


Water Heater
30,000 Btu/h
Boiler
100,000 Btu/h
½”
¾”
1”
1”
¾”
Meter
Furnace
75,000 Btu/h
Furnace
75,000 Btu/h

* Class Exercise – Branch length method – Calculate tubing sizes



A = 20’
B = 15’
C = 10’
D = 30’
E = 20’

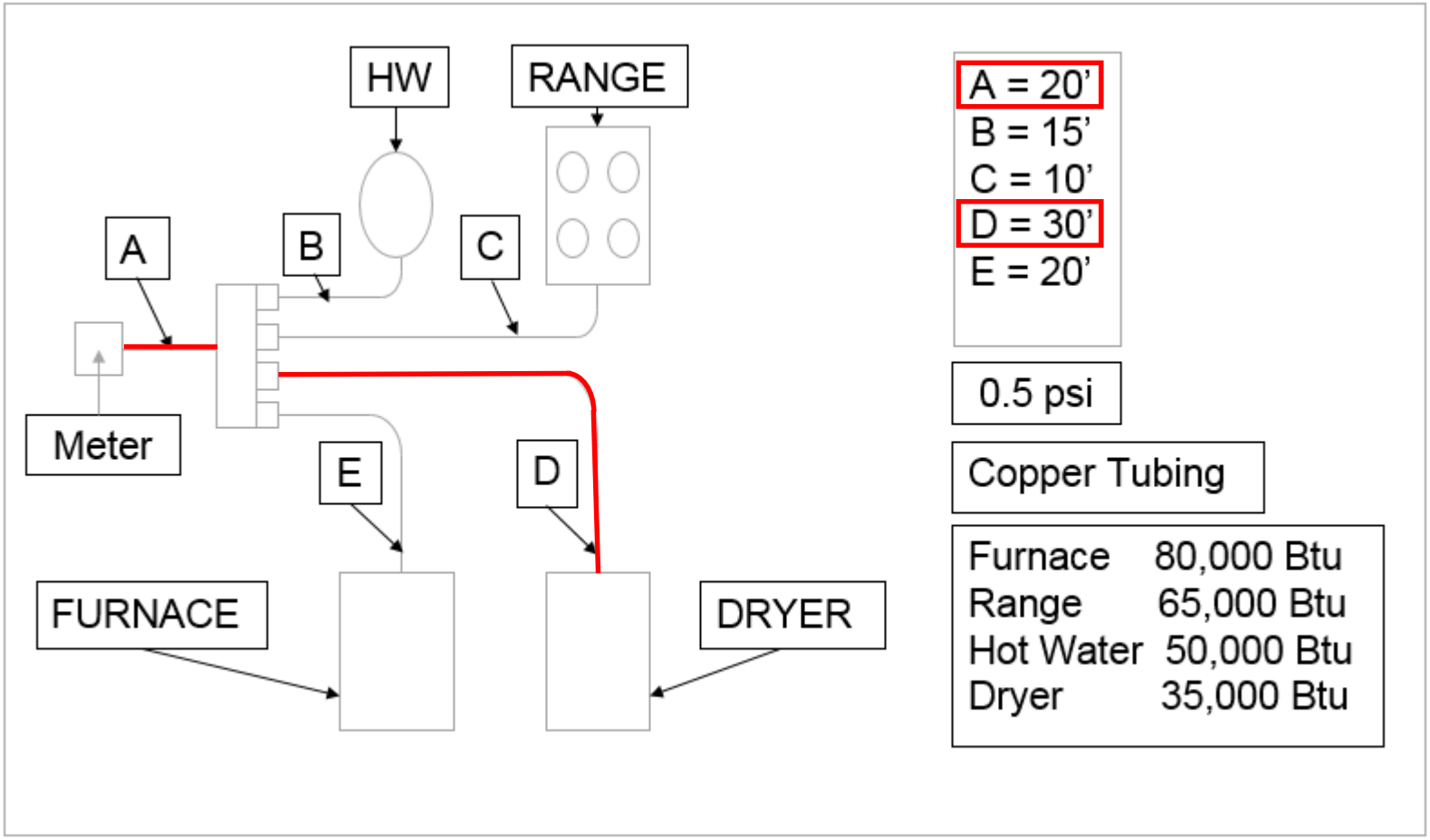
0.5 psi

Copper Tubing

Furnace 80,000 Btu
Range 65,000 Btu
Hot Water 50,000 Btu
Dryer 35,000 Btu

* Class Exercise - Solve the problem for Type K copper

1. Find longest branch line:



* Class Exercise - Solve the problem for Type K copper

2. Total input:

Furnace	80,000 Btu
Range	65,000 Btu
Hot Water	50,000 Btu
Dryer	35,000 Btu
	230,000 Btu

Use expected 230,000 Btu/h

* Class Exercise - Solve the problem for Type K copper

3. Line A is to be: 1”

Semirigid Copper Tubing
Table 2413.4(3)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

TUBE SIZE (inches)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	[illegible]	1 3/8	—	—
Outside		0.375	0.500	0.625	0.750	0.875	1.[illegible]5	1.375	1.625	2.125
Inside		0.305	0.402	0.527	0.652	0.745	0.[illegible]5	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of G[illegible] per Hour								
10		27	55	111	195	276	[illegible]	1,060	1,680	3,490
20		18	38	77	134	190	[illegible]	730	1,150	2,400
30		15	30	61	107	152	[illegible]	586	925	1,930
40		13	26	53	92	131	[illegible]	502	791	1,650
50		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

* Class Exercise - Solve the problem for Type K copper

3. Line A 20’ + Line B 15’ = 35’ Line B is to be: ½”

Semirigid Copper Tubing
Table 2413.4(3)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

TUBE SIZE (inches)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
Outside		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		27	55	[illegible]	195	276	590	1,060	1,680	3,490
20		18	38	[illegible]	134	190	406	730	1,150	2,400
30		15	30	[illegible]	107	152	326	586	925	1,930
40		[illegible]	[illegible]	53	92	131	279	502	791	1,650
50		11	23	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

* Class Exercise - Solve the problem for Type K copper

3. Line A 20’ + Line C 10’ = 30’ Line C is to be: ½”

Semirigid Copper Tubing
Table 2413.4(3)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

TUBE SIZE (inches)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
Outside		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		27	55	[illegible]	195	276	590	1,060	1,680	3,490
20		18	38	[illegible]	134	190	406	730	1,150	2,400
30		[illegible]	[illegible]	61	107	152	326	586	925	1,930
40		13	26	53	92	131	279	502	791	1,650
50		11	23	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

* Class Exercise - Solve the problem for Type K copper

3. Line A 20’ + Line D 30’ = 50’ Line D is to be: ½”

Semirigid Copper Tubing
Table 2413.4(3)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

TUBE SIZE (inches)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	—	—
Outside		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125
Inside		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity in Cubic Feet of Gas per Hour								
10		27	55	[illegible]	195	276	590	1,060	1,680	3,490
20		18	38	[illegible]	134	190	406	730	1,150	2,400
30		15	30	[illegible]	107	152	326	586	925	1,930
40		13	26	[illegible]	92	131	279	502	791	1,650
50		[illegible]	[illegible]	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

* Class Exercise - Solve the problem for Type K copper

3. Line A 20’ + Line E 20’ = 40’ Line E is to be: 5/8”

Semirigid Copper Tubing
Table 2413.4(3)

Gas	Natural
Inlet Pressure	Less than 2 psi
Pressure Drop	0.5 in. w.c.
Specific Gravity	0.60

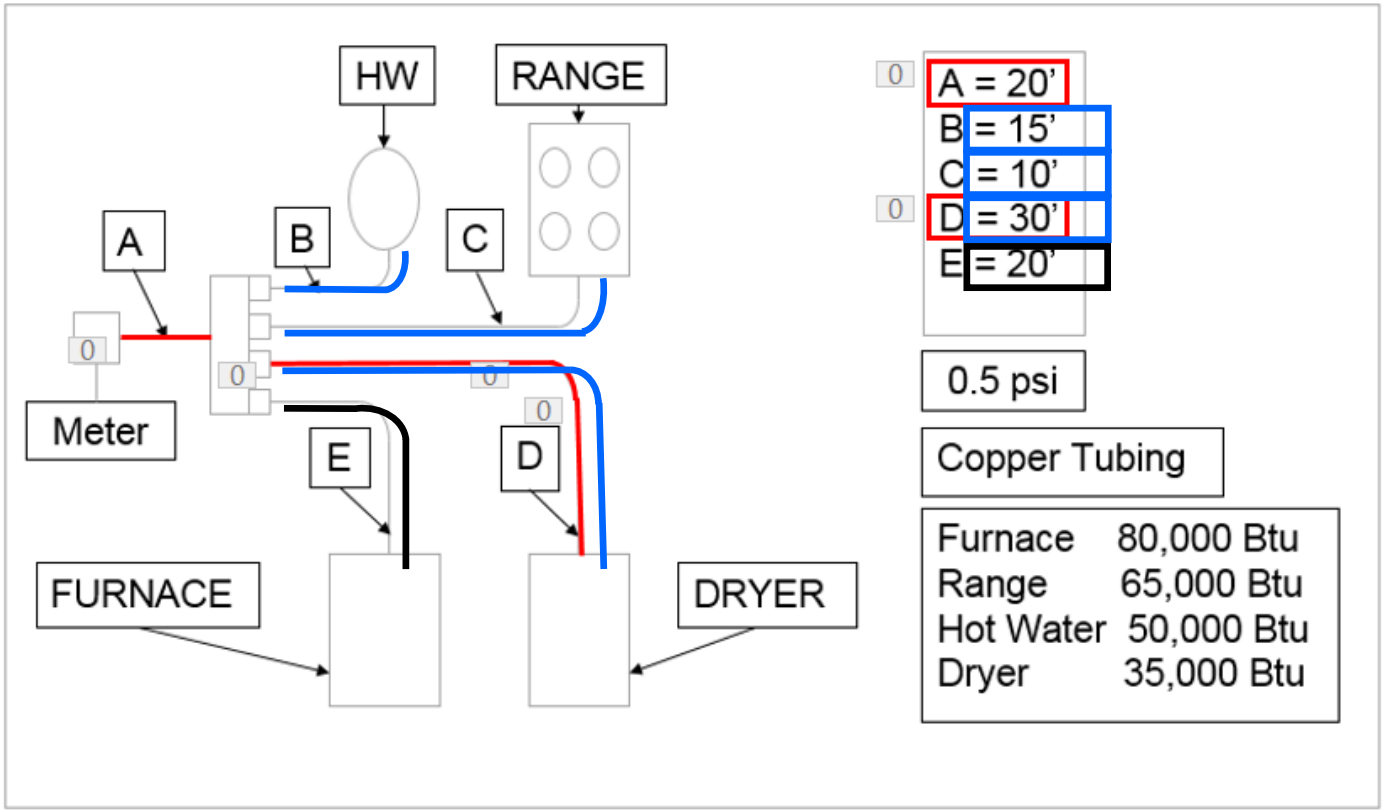
TUBE SIZE (inches)										
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2
	ACR	3/8	1/2	5/8	[illegible]	7/8	1 1/8	1 3/8	—	—
Outside		0.375	0.500	0.625	[illegible]	0.875	1.125	1.375	1.625	2.125
Inside		0.305	0.402	0.527	[illegible]	0.745	0.995	1.245	1.481	1.959
Length (ft)		Capacity Cubic Feet of Gas per Hour								
10		27	55	111	[illegible]	276	590	1,060	1,680	3,490
20		18	38	77	[illegible]	190	406	730	1,150	2,400
30		15	30	61	107	152	326	586	925	1,930
40		[illegible]	[illegible]	[illegible]	92	131	279	502	791	1,650
50		11	23	47	82	116	247	445	701	1,460
60		10	21	42	74	105	224	403	635	1,320

* Class Exercise - Solve the problem for Type K copper

4. B, C, D and E are sized from manifold

B = 1/2 D = 1/2

C = 1/2 E = 5/8



Pipe Materials 2414

- Used materials evaluated prior to re-use 2414.2
- Other materials 2414.3
- Metallic pipe 2414.4
  - Cast iron / Steel
- Metallic tubing 2414.5
  - Copper / Aluminum / Steel
  - Corrugated stainless
- Plastic pipe, tubing and fittings 2414.6

Pipe Materials 2414

- Workmanship and defects 2414.7
  - Free of burrs and defects
  - Thoroughly brushed and chip-free
- Protected from corrosion 2414.8
- Metallic pipe threads 2414.9
  - Stripped and damaged threads not used
  - 10 - 11 threads cut
  - Table 2414.9.2
  - Threaded, flanged, brazed or welded joints permitted 2414.10.1

Piping System Installation 2415

- Installed per the standards or the manufacturer's installation instructions 2415.1
- Not in or through air duct, clothes chute, chimney, vent or elevator shaft 2415.3
  - Not in solid partitions or walls unless in a chase
- Fitting in concealed locations – no unions, tubing fittings, right and left couplings 2415.5 (
  - Allowed threads, brazed, welded listed to ANSI LC-1 CSA26
- Sleeved through foundations – annular space to be filled 2415.6

Piping System Installation 2415

- Protection from physical damage 2415.7
  - Shield plate on all piping other than black or galvanized steel at notches or holes 2415.7.1
- Piping in solid floors 2415.8
  - Accessible in solid floors
  - Ends extend into space
    - Open ends
    - Inside - extend a minimum 2 inches
    - Outside – extend a minimum of 4 inches

Piping System Installation 2415

- Above ground piping 2415.9
  - Protected when installed above ground and outdoors
    - 3 1/2” minimum height clearance – roof
    - Protected from corrosion 2415.9
- Protected from corrosion 2415.11
  - Exposed piping protection
  - Galvanizing not adequate

Piping System Installation 2415

- Protected from corrosion 2415.11
  - Protection methods
    - Corrosion resistant material based on soil condition
    - Factory applied, electrically insulated coating
    - Monitored cathodic protection
  - Dissimilar metals require insulated couplings or fittings
  - Protection of risers 2415.11.4
    - Steel risers to plastic pipe – cathodically protected with an anode
  - Prohibited – uncoated threaded or socket welded joints

Piping System Installation 2415

- Minimum burial depth 2415.12
  - 12” burial depth-see exceptions
    - Exceptions: grills, lights at 8”
  - Trenches 2415.13
    - Graded for a firm continuous bearing bottom
- Piping underground or beneath buildings 2415.14
  - Prohibited unless encased in a listed product
  - Ends extend into space
  - Open ends
    - Inside – extend minimum 2 inches
    - Outside – extend a minimum of 6 inches

Piping System Installation 2415

- Unused outlets closed 2415.15
- Location 2414.16
  - Outlets to extend 1” beyond walls and ceilings and 2” above floors
  - Not to be installed behind doors
  - Located in the room or space where appliance is installed

Piping System Installation 2415

- Plastic pipe 2415.17
  - Outside underground only
  - Not within or under buildings
  - Proper metallic to plastic fittings 2415.17.2
  - Tracer wire required with non-metallic piping, yellow insulated copper, minimum 18 AWG 2415.17.3

Inspection, Testing and Purging 2417

- Prior to acceptance to be inspected and tested 2417.1
  - Repair and new branches require testing
  - Permitted to be tested in sections 2417.1.4
  - Regulators and valve assemblies tested independently
  - Oxygen is a prohibited test medium
- Test preparation 2417.3
  - Pipe joints and welds exposed for the testing
  - Appliances and equipment – disconnected or a test blank
    - Required when test pressure higher than allowed for equipment

Inspection, Testing and PurgingG2417

- Test pressure measurement 2417.4
  - Device ability to measure loss
  - Source isolated before test
  - Gauge upper pressure 5 times less than test pressure
    - Pressure to be not less than 1 ½ times the maximum working pressure, but not less than 3 psig 2417.4.1
    - Duration not less than 10 minutes
- Detection of leaks and defects 2417.5
  - Reduction in pressure indicates a leak
  - Detection by gas detector, noncorrosive leak detection fluid or other approved means
  - Affected portions repaired or replaced

Inspection, Testing and Purging 2417

- Piping system and equipment leakage 2417.6
  - System properly tested
  - Check for open valves or pipes
  - No appliances in operation before system checked and purged
- Purging 2417.7
  - Required to be purged outdoors when system meets either of the following:
    - Pressure greater than 2 psi, OR
    - Contains in excess of Table 2417.7.1.1
  - Removed from service
    - Gas piping isolated and filled with inert gas

Inspection, Testing and Purging 2417

- Purging 2417.7
  - When placed in operation displace with inert air and then gas
  - Purge to outside
    - Controlled by a valve
    - 10 feet from ignition source, building openings, 25 feet from intakes
    - Open end monitored
    - Terminated when gas 90% by volume
    - All other persons 10 feet away
  - Listed combustible gas indicator

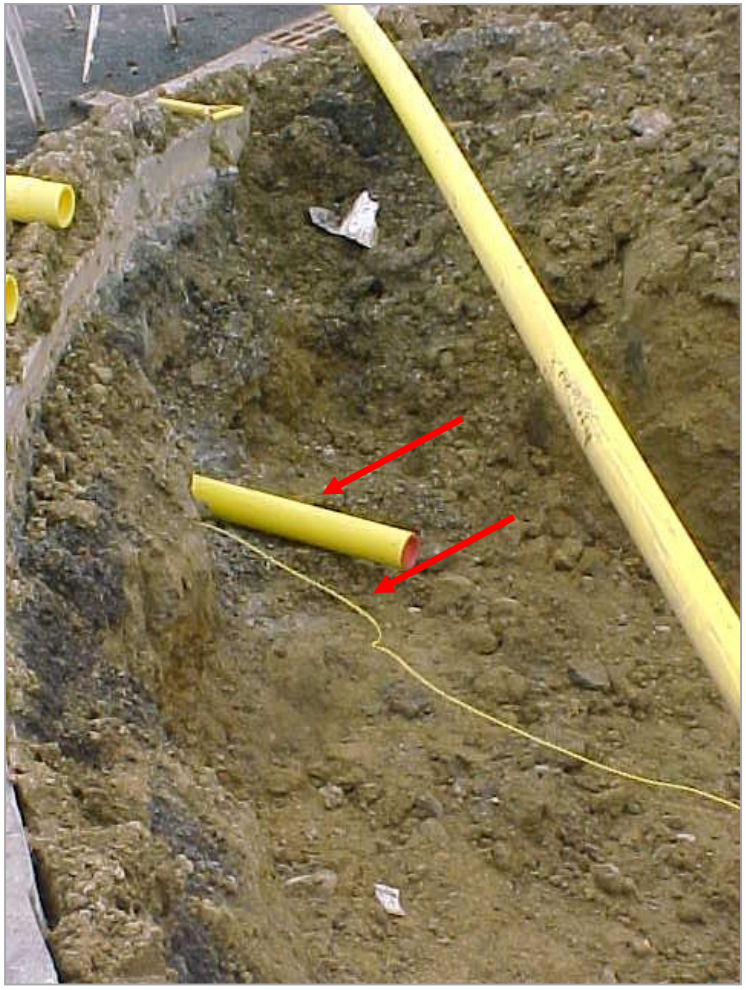
Inspection, Testing and Purging 2417

- Purging 2417.7
  - Can be purged indoors when system meets either of the following:
    - Pressure less than 2 psi, OR
    - Contains less than Table 2417.7.1.1
  - Purging procedure
    - Discharge to outside
    - Indoors or outdoors through an appliance burner with continuous source
    - Equipment designed for purpose
    - Monitored by a gas detector, stopped when gas detected
    - Follow written procedure

- Inspection, Testing and Purging 2417
  - Purging 2417.7
    - Listed combustible gas indicator
    - Appliances purged before being placed in service

- Piping Support 2418
  - Components suitable for the piping material
  - Spaced per Section 2424
  - Allow pipe to expand and contract

* Underground plastic gas line with yellow #18 AWG tracer line



* Residential clothes dryer gas line with shut off valve, capped

* 1” Black iron residential natural gas line hanging from floor joists

Drips and Sloped Piping 2419

- ¼” in 15’
- Sediment traps or drips required near appliance inlet as close as possible
- Not required for illuminating appliances, ranges, clothes dryers, decorative vented appliances within fireplaces or outdoor grills

Shutoff Valves 2420

- Not in furnace plenums or concealed locations
- Accessible
- Shut off side of each meter
- Each building
- At each MP regulator

- Shutoff Valves 2420
  - Appliance shutoff valve 2420.5
    - At each appliance
      - In same room – maximum 6’ away
      - Vented decorative fireplaces per manufacturer
      - Serve no other appliance
      - Can be in a remote room if readily accessible
      - Permanently identified

- Flow Controls 2421
  - Line pressure regulators required when appliances operate at pressure lower than supply system
  - Accessible
  - Protected from physical damage
  - Vent regulators to the outside
  - Excess flow valves listed, sized and installed per manufacturer
  - Listed flash back arrestor when used with oxygen 2421.5

- Appliance Connectors 2422
  - Listed and labeled
  - Protected from damage
  - Dryers and ranges 6’
  - Not concealed in or through walls
  - Shut off valve before connector
- Piping Support Intervals 2424
  - Table 2424.1 for interval

- General 2425
  - Chimneys, liners, vents and connectors
  - Vent to outside
  - Abandoned outlets to be sealed
  - Positive pressure or induce draft designed for positive pressure
  - Unvented appliances allowed 2425.8
    - When aggregate amount exceeds 20 Btu per hour per cu ft. of room volume, need to be vented
    - Adjacent rooms permitted to count
    - Masonry chimney minimum 12” above lowest point

* Fuel Gas Appliance Definitions 2403

Category 1

- Flue negative pressure
- Flue gas >140° F

Example: Regular atmospheric draft appliances

Vent Pipe >140° F

Category 3

- Flue positive pressure
- Flue gas >140° F

Example: Sealed combustion chamber appliances

Vent Pipe Negative

Vent Pipe Positive

Category 2

- Flue negative pressure
- Flue gas <140° F
- Some condensing of flue gasses

Vent Pipe < 140° F

Category 4

- Flue positive pressure
- Flue gas <140° F
- Condensing of flue gasses

Example: 90%+ Condensing Units

Fuel Gas Appliance Definitions 2403

- Category I
  - DEFINITION: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent
  - EXAMPLES:
    - Water heaters
    - Room heaters
    - Furnaces
    - Unit heaters
    - Boilers

Fuel Gas Appliance Definitions 2403

- Category II
  - DEFINITION: An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent
  - EXAMPLE: Forced draft or induced draft heaters

Fuel Gas Appliance Definitions 2403

- Category III
  - DEFINITION: An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent
  - EXAMPLE: Direct vent furnace

Fuel Gas Appliance Definitions 2403

- Category IV
  - DEFINITION: An appliance that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent
  - EXAMPLE: Sealed draft units with draft temperatures low enough to permit condensation

General 2425

- Existing chimneys or vents 2425.15
  - Resizing required to control condensation and provide proper draft
  - Passageway free from obstructions; cracks etc.
  - Masonry chimney requires cleanout 2425.15.3
  - Clearance from combustibles as per Chapter 10 2425.15.4

- Vents 2426
  - Listings required
    - B and BW – UL 441
    - L – UL 641
    - Category II and III Vents – UL 1738
  - Connectors required – connect appliance to vertical chimney or vent 2426.2
  - Insulation shield required
  - Adequate support 2426.6
  - Shield plates required

- Venting of Appliances 2427
  - All equipment to be vented 2427.2
  - Direct and integral vent equipment per manufacturer
  - Design and construction 2427.3
    - Designed to prevent leakage of fumes into building
    - Mechanical draft listing

Venting of Appliances 2427

- Not to be combined with natural draft appliances
- Exit terminal 7’ above grade at public walkways
- No portion extend into or through ducts or plenums
- Table 2427.4 provides for type of venting to be used

TABLE 2427.4 (503.4)
TYPE OF VENTING SYSTEM TO BE USED

APPLIANCES	TYPE OF VENTING SYSTEM
Listed Category I *appliances* *Listed appliances* equipped with draft hood *Appliances* listed for use with Type B gas vent	Type B gas *vent* (Section G2427.6) *Chimney* (Section G2427.5) Single-wall metal pipe (Section G2427.7) *Listed* chimney lining system for gas venting (Section G2427.5.2) Special gas *vent* listed for these appliances (Section G2427.4.2)
Listed vented wall furnaces	Type B-W gas vent (Sections G2427.6, G2436)
Category II, Category III and Category IV *appliances*	As specified or furnished by manufacturers of *listed appliances* (Sections G2427.4.1, G2427.4.2)

Venting of Appliances 2427

- Type of venting system to be used 2427.4
  - Plastic piping – used for venting equipment listed for use with such venting materials shall be approved
  - Special gas vent – shall be listed and installed in accordance with the terms of the special gas vent listing and the manufacturer's instructions

- Venting of Appliances 2427
  - Chimney termination 2427.5.3
    - 3’ above roof penetration
    - 2’ higher than any portion of building within 10’
    - 5’ above highest connected draft hood
  - Size of chimneys 2427.5.4
    - Per Section 2428
    - Single appliance not less than appliance flue collar or greater than 7 times the draft hood outlet
    - 2 or more – not less than the largest draft hood plus 50% of the smaller or greater than 7 times the outlet

Venting of Appliances 2427

* Inspection of masonry chimney before connecting a new appliance shall be made 2427.5.5
  - Unsafe chimneys to be repaired, rebuilt, relined or replaced
  - Lining 2427.5.5.1
  - Cleanouts secured
  - Gas and solid fuel not to be interconnected 2427.5.6.1
  - Combination equipment requires certain safeguards

- Venting of Appliances 2427
  - Gas vents 2427.6
    - Installed per listing and manufacturer's instructions
    - Roof penetrations – flashed, listed termination cap
    - One 60° offset allowed, balance not to exceed 45° – single-wall vent connectors not more then 75% of vertical height of vent
    - Gas vent termination 2427.6.4
      - Figure 2427.6.4 for vents under 12" with listed caps – vent 8' from wall
      - All other 2' above roof penetration and 2' above building portion within 10'
      - Decorative shrouds only with listing

- Venting of Appliances 2427
  - Minimum vent height 2427.6.4
    - Type B or L - 5’ above draft hood or flue collar 2427.6.4
    - Type B-W Vent 12’ above bottom of wall furnace
    - Not to terminate adjacent to wall or below eaves or parapets except as provided 2427.6.7

Venting of Appliances 2427

- Size of gas vents G2427.6.8 (503.6.9)
  - Category I with Type B gas vent
    - Provisions of Section 2428
    - Individual appliance – not less then area of draft hood or greater then 7 times draft hood outlet area
    - 2 or more appliances – area of larger draft hood plus 50% area of smaller hood not greater then 7 times smaller hood

- Venting of Appliances 2427
  - Size of gas vents 2427.6.8
    - Category II, III, IV – Sizing in accordance with manufacturer's instructions 2427.6.8.3
      - Supported per listing
      - Special signage at vent – could be required by code official

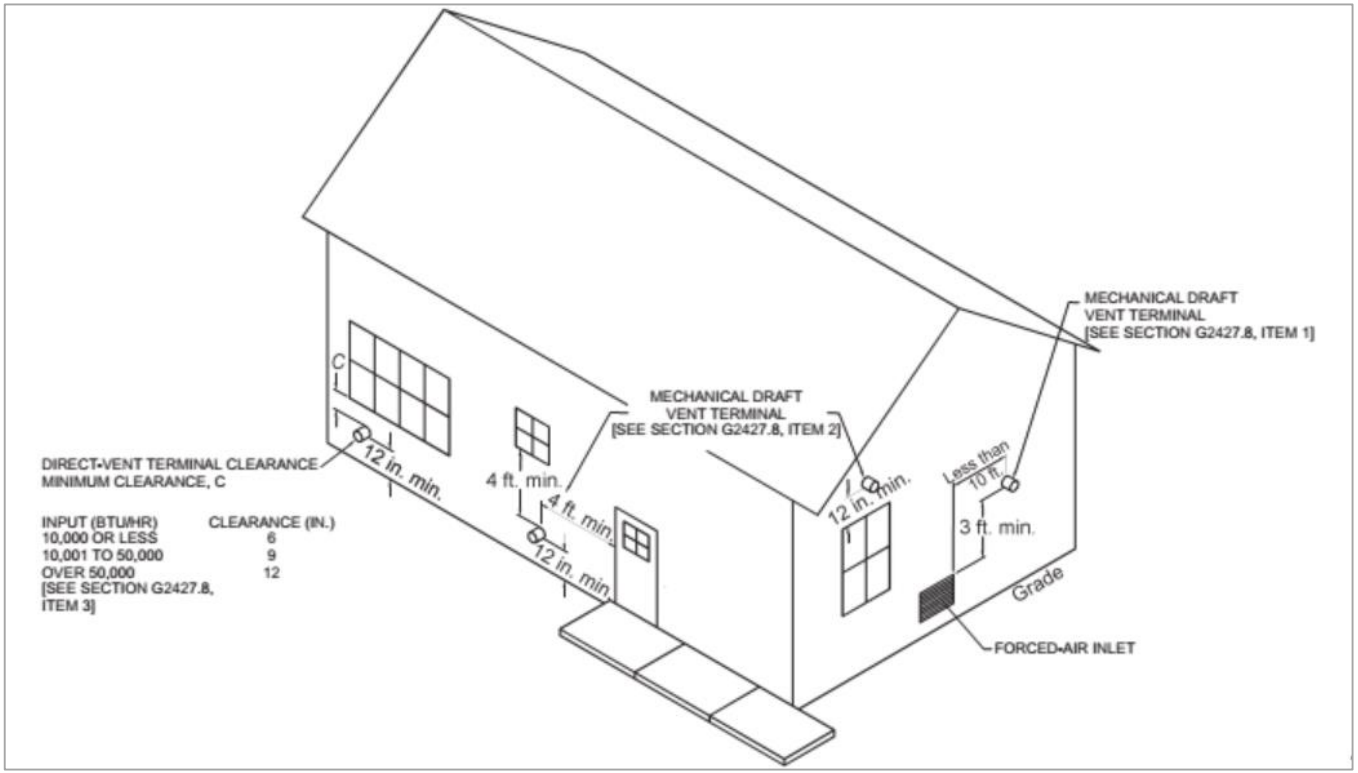
        Example:

        "This gas vent is for appliances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators."

- Venting of Appliances 2427
  - Single wall pipe 2427.7
    - Not to be used in cold climates for venting gas utilization equipment
    - Terminate 5’ above highest connected draft hood outlet
    - 2’ above roof and 2’ within a horizontal distance of 10’ with an approved cap
    - Limited to runs direct from roof or exterior wall to the outdoor atmosphere 2427.7.4
    - Penetrations to be protected 2427.7.5
    - Thimble 18” above / 6” below roof
    - Not in concealed spaces
    - Same sizing requirements

Venting of Appliances 2427

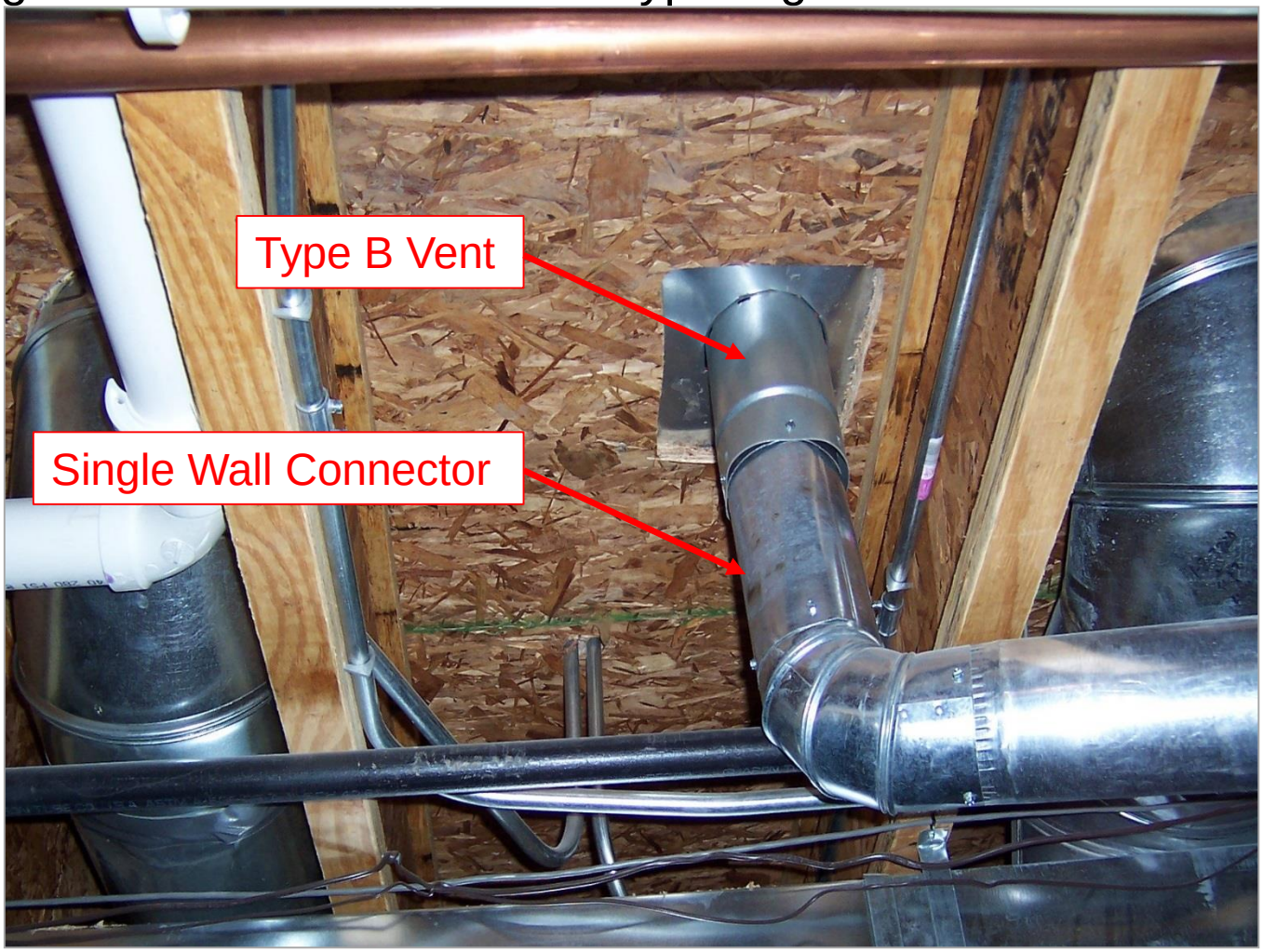
* Vent system termination 2427.8
  - See Appendix C for illustration
  - Mechanical draft system 3’ above any forced air within 10’



Venting of Appliances 2427

- Vent connectors for Category I appliance 2427.10
  - Non-combustible corrosion resistant material 2427.10.2.1
  - Unconditioned spaces require B or L listed material 2427.10.2.2
  - Approved connection material for conditioned spaces
  - B or L vent material
  - Single-wall pipe
    - Aluminum / Stainless steel / Galvanized pipe
    - Smooth interior / corrosion resistant
    - Listed vent connector
    - Thickness per 2427.10.2.4

* Single wall vent connector into Type B gas vent



- Venting of Appliances 2427
  - Size of vent connector 2427.10.3
    - Single draft hood and fan assisted Section 2428
    - Multiple hoods – engineering methods or combined area of flue collars or draft hood outlets; minimum rise 1’
    - Common connector 2427.10.3.4
    - Highest level consistent with headroom and required clearance
    - Size increase at draft hood outlet 2427.10.3.5

- Venting of Appliances 2427
  - Joints 2427.10.6
    - Screws or other connectors as listed per listing sheet
    - Slope
      - Without dips; rise ¼” per foot
    - Length – as short as possible 2427.10.8
    - 75% of chimney or vent height maximum
      - Type B double wall permitted 100% height of chimney or vent
  - Properly supported 2427.10.9

Venting of Appliances 2427

- Draft hoods 2427.12
  - Vented equipment to have draft hoods
  - Installed exactly as furnished
  - Dampers
- Manually operated dampers not part of approved installation 2427.13
  - Devices that obstruct flow of flue gas not to be installed
  - Exception: Draft control 2427.15

- Sizing of Category I Appliance Venting Systems 2428
  - DEFINITIONS: Appliance categorized vent diameter/area – Minimum vent area/diameter permissible for Category I appliances to maintain a non-positive vent static pressure when tested in accordance with nationally recognized standards
  - Fan assisted combustion system / Fan Min / Fan Max / Nat Max / Fan + Fan / Fan + Nat / NA / Nat + Nat

- Sizing of Category I Appliance Venting Systems 2428
  - Type B Double-Wall Vent Table 2428.2(1)
    - Single Category 1 appliance connected directly to vent
  - Type B Double-Wall Vent Table 2428.2(2)
    - Single Category 1 appliance with single-wall metal connector
  - Connection to a masonry chimney shall meet the requirements of the 2018 International Fuel Gas Code (IFGC) Tables per Appendix B

- Sizing of Category I Appliance Venting Systems 2428
  - IFGC Table 504.2(3) Masonry Chimney
    - Single Category 1 appliance with Type B double-wall connector
  - IFGC Table 504.2(4) Masonry Chimney
    - Single Category 1 appliance with single-wall connector
  - IFGC Table 504.2(5) Single-Wall Metal Pipe or Type B Asbestos Cement Pipe
    - Single draft hood equipped connected directly to pipe or vent

Sizing of Category I Appliance Venting Systems 2428

- Vent offsets 2428.2.3
  - Zero lateral length – no elbows
  - Tables include 2, 90° as part of numbers
  - Each elbow to 45° reduces vent table 5%
  - Each elbow to 90° reduces tables 10%
- Zero lateral only to straight vertical vent attached directly to draft hood or flue collar 2424.2.4
- Multiple rate appliances need to meet both minimum and maximum numbers 2428.2.6

- Sizing of Category I Appliance Venting Systems 2428
  - Vent connectors not more than 2 sizes greater than listed appliance categorized vent diameter, draft hood or flue collar 2428.2.11
  - Multiple Appliance Vent Tables 2428.3
    - Comply with 2428.3.1 – 2428.3.23
    - No obstructions in system
    - Connector length per Table 504.3.2 or 1 ½ feet per inch of connector
    - Reduce vent capacity 10% for each multiple length of connector

- Sizing of Category I Appliance Venting Systems 2428
  - Multiple Appliance Vent TablesG2428.3
    - Each elbow to 45° reduces vent table 5% G2428.3.6 (504.3.6)
    - Each elbow to 90° reduces tables 10%
    - Elbows in connectors 2428.3.7
    - Each elbow to 45° reduces vent table 5%
    - Each elbow to 90° reduces tables 10%

- Sizing of Category I Appliance Venting Systems 2428
  - Common vent – equal to or greater than largest connector 2428.3.8
  - Connector rise from the appliance connector to the centerline of vent gas streams 2428.3.11
  - Vent height measure from highest draft hood outlet
  - Vent height size not more than 7 times smallest listed vent area 2428.3.13

- Sizing of Category I Appliance Venting Systems 2428
  - Vent extends more than 5’ above roof additional enclosure requirements 2428.3.16
    - Where the actual height of a vent falls between entries in the height column either interpolation must be used of the lower input rating must be used for the FAN MAX and NAT MAX 2428.3.22

- Sizing of Category I Appliance Venting Systems 2428
  - Type B Double-Wall Vent Table 2428.3(1)
    - 2 or more Category I appliances with Type B double-wall pipe
  - Type B Double-Wall Vent Table 2428.3(2)
    - 2 or more Category I appliances with single-wall connector
  - Masonry Chimney Table 2428.3(3)
    - 2 or more Category I appliances with Type B double-wall pipe

- Sizing of Category I Appliance Venting Systems 2428
  - Masonry Chimney IFGC Table 504.3(4) 2 or more Category I appliances with single wall metal connector
  - Single-Wall Metal Pipe or Type B Asbestos Cement Vent IFGC Table 504.3(5)
    - 2 or more draft hood equipped direct to pipe or vent
  - Exterior Masonry Chimney IFGC Table 504.3(7a)
    - 2 or more appliances Nat + Nat Type B double-wall connector

- Sizing of Category I Appliance Venting Systems 2428
  - Exterior Masonry Chimney Table 504.3(7b)
    - 2 or more appliances Nat + Nat Type B double-wall connector
  - Exterior Masonry Chimney Table 504.3(8a)
    - 2 or more appliances fan + Nat Type B double-wall connector
  - Exterior Masonry Chimney Table 504.3(8b)
    - 2 or more appliances Fan + Nat Type B double-wall connector

Vents and Connectors – Definitions 202

- Vent is defined:
  - "A passageway for conveying flue gases from fuel-fired appliances or their vent connectors to the outside atmosphere."
- Vent connector is defined:
  - "That portion of a venting system that connects the flue collar or draft hood of an appliance to a vent."

Vents and Connectors – Definitions 202

- Draft is defined:
  - "The pressure difference existing between the appliance or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the appliance to the atmosphere." Section R202

    Mechanical or induced draft is the pressure difference by the action of a fan blower or ejector between the appliance and the chimney or vent termination

    Natural draft is created by the vent or chimney because of height and temperature difference between the flue gas and atmosphere

Class Exercise – Vent sizing for natural draft pool heater

* Determine Btu/h input rating from appliance label
* When rating is unknown, the manufacturer shall be consulted
* 1,000 Btu = 1 cube foot of natural gas
* Reference Type B double-wall vent system serving a single appliance with Type B double-wall vent
* Table G2428.2(2)
    - Category I Natural Draft Pool Heater
    - 225,000 Btu input – 1’ lateral – 20’ height
    - Other Appliances

* Type B Double-Wall Gas Vent Table 2428.2(2)

What size vent is allowed? 6”

HEIGHT (H) (feet)	LATERAL (L) (feet)	3			4			5			6			VENT
		APPLIANCE INPU												
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165
	2	39	51	36	60	96	66	85	156	104	123	231	156	159
	4	NA	NA	33	74	92	63	102	152	102	146	225	152	187
	6	NA	NA	31	83	89	60	114	147	99	163	220	148	207
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161
	2	39	56	39	59	108	75	83	176	119	121	261	179	155
	5	NA	NA	37	77	102	69	107	168	114	151	252	171	193
	8	NA	NA	33	90	95	64	122	161	107	175	243	163	223
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158
	2	39	61	41	59	117	80	82	193	128	119	287	194	153
	5	52	56	39	76	111	76	105	185	122	148	277	186	190
	10	NA	NA	34	97	100	68	132	171	112	188	261	171	237
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153
	2	38	69	47	57	136	93	80	225	149	115	337	224	148
	5	51	63	44	75	128	86	102	216	140	144	326	217	182
	10	NA	NA	39	95	116	79	128	201	131	182	308	203	228
	15	NA	NA	NA	NA	NA	72	158	186	124	220	290	192	272
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149
	2	37	74	50	56	148	99	78	248	165	113	375	248	144
	5	50	68	47	73	140	94	100	239	158	141	363	239	178
	10	NA	NA	41	93	129	86	125	223	146	177	344	224	222
	15	NA	NA	NA	NA	NA	80	155	208	136	216	325	210	264

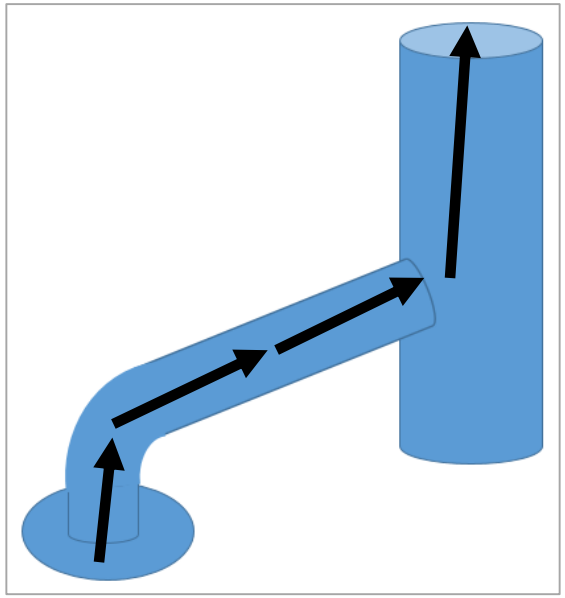
* Class Exercise – Maximum and minimum vent sizing
  * What is the maximum effective vent area allowed?
  * Not greater than 7x draft hood outlet area
  * Fan Assisted 100,000 Btu/h Furnace – 15 feet lateral – 30 feet height
  * What is the maximum vent size allowed? 4”
  * What is the minimum vent size allowed? 4”

* Determining minimum capacity of a vertical Type B vent larger than a single vent size connecting to it
  - Size of chimneys Type B vents 2427.5.4
    - “For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue shall be not less than the area of the appliance flue collar or draft hood outlet, nor greater than seven times the draft hood outlet area.”

- Where do we start?
- Type B Double-Wall Gas Vent Table 2428.2(1)
- 100,000 Btu/h/1,000 = Appliance input rating in thousands
  - Fan Assisted 100,000 Btu/h Furnace – 15 feet lateral, 30 feet height
  - What is the maximum vent size allowed?
  - What is the minimum vent size allowed? (Not greater than 7x draft hood outlet area) Please see next slide

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches											
		3			4			5			6		
		APPLIANCE INPUT RATING IN THOUSANDS											
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
30	0	0	100	64	0	213	128	0	374	220	0	587	336
	2	9	81	56	13	166	112	14	283	185	18	432	280
	5	21	77	54	28	160	108	36	275	176	45	421	273
	10	27	70	50	37	150	102	48	262	171	59	405	261
	15	33	64	NA	44	141	96	57	249	163	70	389	249
	20	56	58	NA	53	132	90	66	237	154	80	374	237
	30	NA	NA	NA	73	113	NA	88	214	NA	104	346	219

* Sizing an individual chimney venting system for a single appliance with a draft hood 2427.5.4
* The effective areas of the vent connector and chimney flue shall be:
  - Not less than the area of the appliance flue collar or draft hood outlet
  - Not greater than seven times the draft hood outlet area



* Where:
  - Area of circle: $A=\pi r2$
  - π = 3.14
  - Vent connector = 4” diameter
  - Thus:
  - 4” diameter = 2” radius
  - Radius squared 2” x 2” = 4”
  - Flow area of vent connector = 3.14 x 4”, or
    - 12.56 square inch
* Check for 7 times size limit
  - 12.56 square inch x 7 = 87.96 square inch
  - 87.96 square inch /3.14 = 28 square inch”
  - Square root of 28 square inch = 5.29”
* Answer: Vertical vent maximum size = 5” diameter

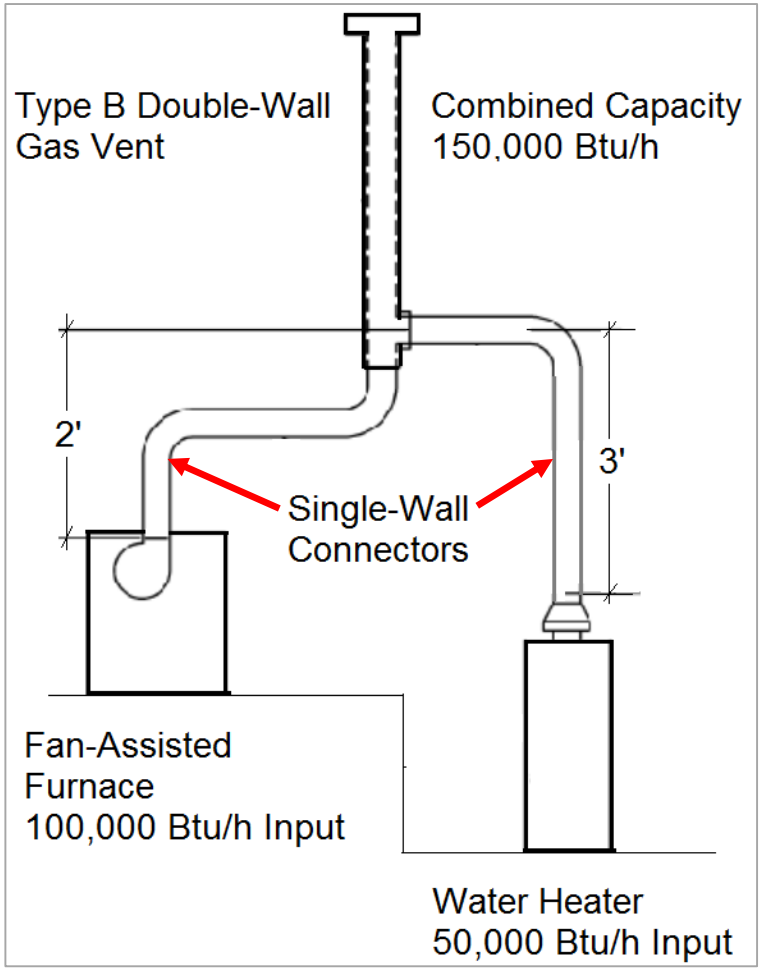
Class Exercise – Determine 2 single wall connector vent sizes and Type B double wall vent size accepting the 2 single wall vents

- Reference Table 2428.3(1) vent system serving 2 or more appliances with a Type B double-wall common vent and single-wall vent connectors
- Equipment common-vented into a 20’ high Type B vent chimney:
  - 100,000 Btu/h Fan assisted furnace

    10’ lateral – 2’ rise
  - 50,000 Btu/h Water heater

    4’ lateral - 3’ rise

* Step One
  - Determine size of single wall vents from each appliance



* Type B Double-Wall Vent Table 2428.3(2)

- 100,000 Btu/h Fan assisted furnace, lateral 2’ rise – 20’ chimney

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	VENT CO SINGLE-W APPLIA 3			4			5		
		FAN		NAT	FAN		NAT	FAN		NAT
		Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	NA	NA	26	NA	NA	46	NA	NA	71
	2	NA	NA	31	NA	NA	55	NA	NA	85
	3	NA	NA	34	NA	NA	62	121	131	95
8	1	NA	NA	27	NA	NA	48	NA	NA	75
	2	NA	NA	32	NA	NA	57	125	126	89
	3	NA	NA	35	NA	NA	64	130	138	100
10	1	NA	NA	28	NA	NA	50	119	121	77
	2	NA	NA	33	84	85	59	124	134	91
	3	NA	NA	36	89	91	67	129	144	102
15	1	NA	NA	29	79	87	52	116	138	81
	2	NA	NA	34	83	94	62	121	150	97
	3	NA	NA	39	87	100	70	127	160	109
20	1	49	56	30	78	97	54	115	152	84
	2	52	59	36	82	103	64	120	163	101
	3	55	62	40	87	107	72	125	172	113
	1	47	60	21	77	110	57	112	175	80

* Type B Double-Wall Vent Table 2428.3(1)
* 50,000 Btu/h Water heater, lateral 3’ rise – 20’ chimney

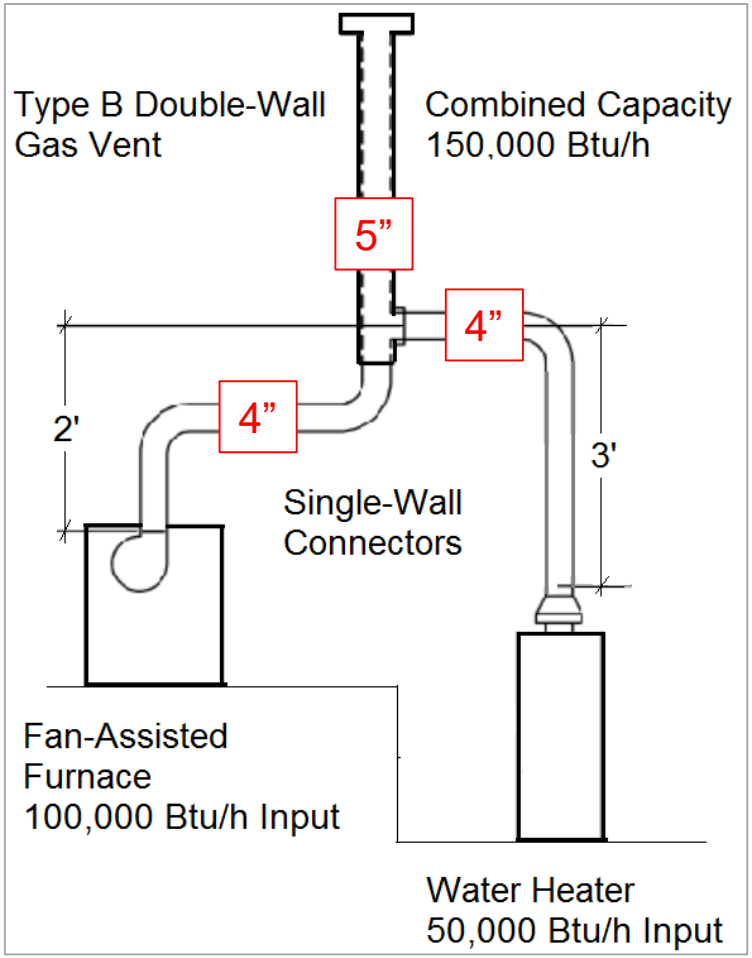
VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	3			4			
		FAN		NAT	FAN		NAT	
		Min	Max	Max	Min	Max	Max	M
6	1	NA	NA	26	NA	NA	46	N
	2	NA	NA	31	NA	NA	55	N
	3	NA	NA	34	NA	NA	62	12
8	1	NA	NA	27	NA	NA	48	N
	2	NA	NA	32	NA	NA	57	12
	3	NA	NA	35	NA	NA	64	13
10	1	NA	NA	28	NA	NA	50	11
	2	NA	NA	33	84	85	59	12
	3	NA	NA	36	89	91	67	12
15	1	NA	NA	29	79	87	52	11
	2	NA	NA	34	83	94	62	12
	3	NA	NA	39	87	100	70	12
20	1	49	56	30	78	97	54	11
	2	52	59	36	82	103	64	12
	3	55	62	40	87	107	72	12

* Type B Double-Wall Vent Table 2428.3(1)
* Common vent diameter requirement for Type B double-walled vent

COMMON VENT CAPACITY

VENT HEIGHT (H) (feet)	TYPE B DOU								
	4			5			6		
	COMBINED A								
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	
6	NA	78	64	NA	113	99	200	158	
8	NA	87	71	NA	126	111	218	173	
10	NA	94	76	163	137	120	237	189	
15	121	108	88	189	159	140	275	221	
20	131	118	98	208	177	156	305	247	
30	145	132	113	236	202	180	350	286	
50	159	145	128	268	233	208	406	337	

* Size of Type B Double-Wall common vent is 5”

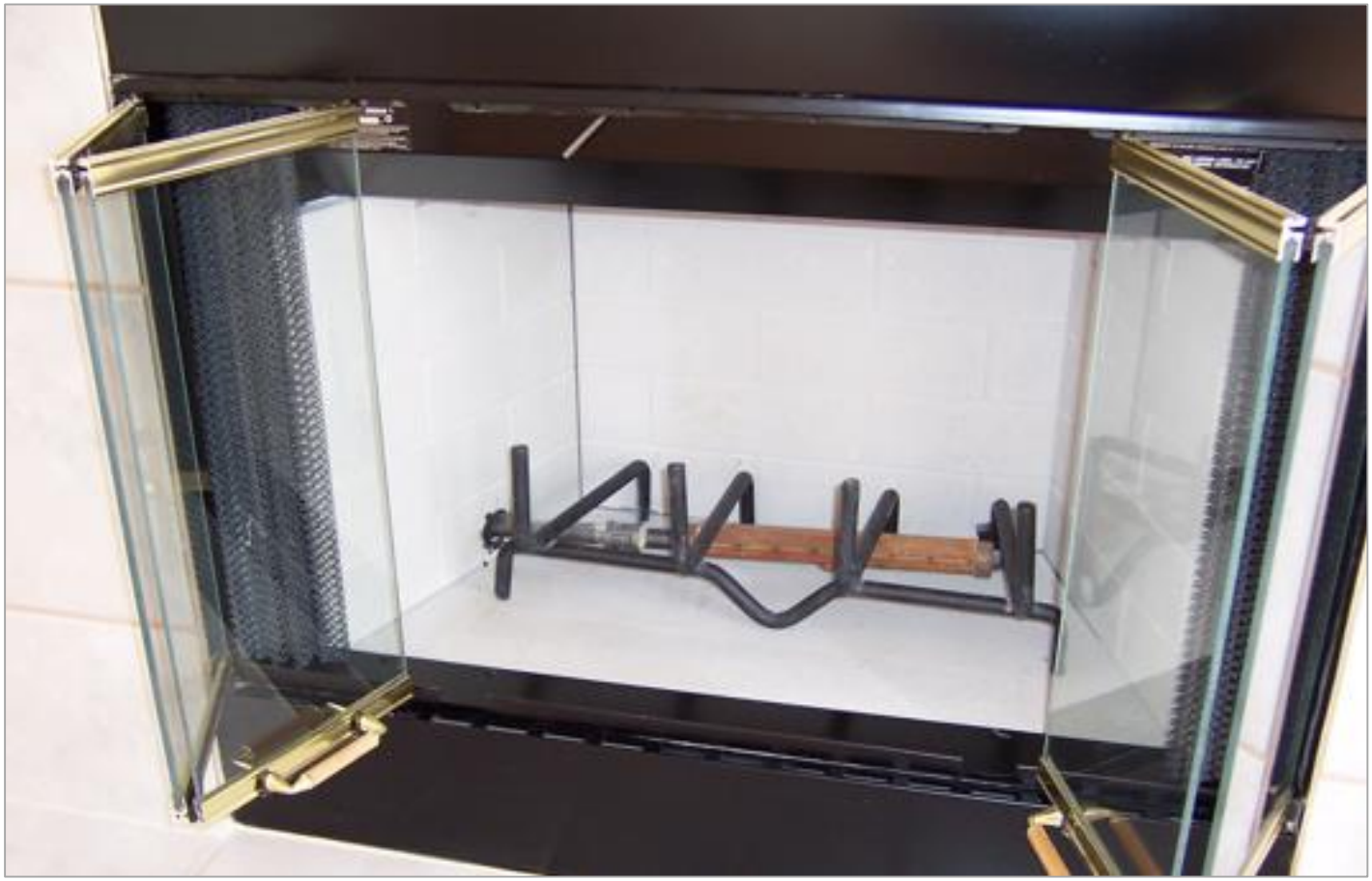


Connector Diameters	
150,000 Btu/h Furnace	4”
50,000 Btu/h Water Heater	4”
Combined Type B Vent	5”

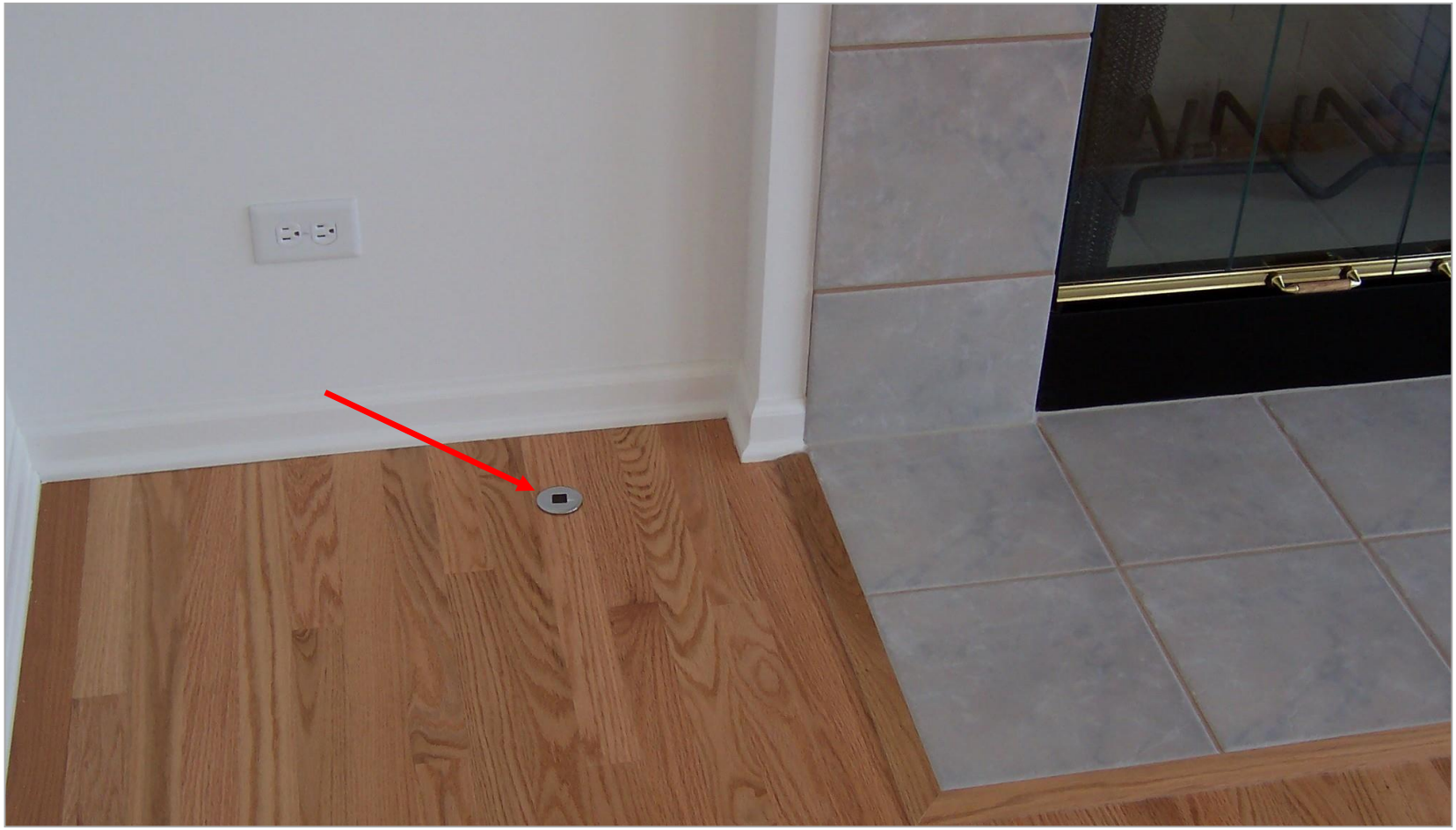
Specific Appliances 2431 – G2453

- Decorative Appliances for Installation in Fireplaces 2432
  - Flame safeguard device, pilot flame or ignition
- Log Lighters
  - Per CSA 8
- Vented Gas Fireplace Heaters 2435
  - Access panels not to be attached to building
  - Vented gas fireplace heaters per ANSI Z21.88

* Natural gas log lighter



* Gas shutoff valve within 6’ 2420.5.1



- Vented Wall Furnaces 2436
  - Not circulate air from or between bathrooms
  - 12” clearance for doors; doorstops and door closers not allowed as clearance device
  - Not ducted
  - Access for cleaning and service
- Floor Furnaces 2437
  - Specific clearance requirements
  - Thermostats in same room
  - Protection if suspended into habitable spaces

- Clothes Dryers and Exhaust Sections 2438-2439
  - Fire resistance rating of construction to be maintained
  - Access for cleaning of all vertical ducts
  - Exhausted outside the building
  - Many same requirements as mechanical section
- Sauna Heaters 2440
  - 194° – room temperature
  - One hour maximum timer – required

- Forced Warm Air 2442
  - Outside and return air ducts not less then 2 sq. in per 1,000 Btu or as per manufacturer's instructions
  - Many same requirements as mechanical section
- Unit Heaters 2444
  - Properly supported
  - No duct work unless listed
  - Clearance to combustibles

- Unvented Room Heaters 2445
  - Not sole source of heat
  - Aggregate total 20 Btu per cube foot – venting required
  - Oxygen depletion device
- Vented Room Heaters 2446
  - Per ANSI Z21.86 / CSA 2.32
- Cooking Appliances 2447
  - Commercial cooking appliances not to be installed in dwelling units or areas where domestic cooking will occur
  - Domestic appliances to be listed and labeled for use

- Water Heaters 2448
  - Safety devices per code
  - Listed accordingly if supplying space heating and domestic
- Air Conditioning Appliances 2449
- Illuminating Appliances 2450
- Infrared Radiant Heaters 2451
- Boilers Section 2452
- Chimney Damper Opening Area 2453

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Questions?

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Thank You For Your Time

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File Attachments for Item:

ER-6 Considerations of the DWV and Storm System (Ohio Assn of Plumbing Inspectors)

All certifications (1 hour)

Staff Notes:

Committee Recommendation:

1

Considerations of the DWV and Storm System:
What to know about Plenums and Firestopping

2 **Learning objectives**

- Plenum Spaces
  - Acceptable materials for use in DWV Systems
  - ASTM E 84 testing
  - Plenum wrap insulation
- Firestopping
  - Concerns
  - Through and Membrane Penetrations
  - Details
  - Exemptions
  - Complexities
  - Engineered Judgements
  - Issues
  - Melting Points of Piping Products
- Toxicity of piping materials
- Question and Answer
-

3 **Plenum Spaces**

4 **Acceptable Piping in Plenum Spaces**

- Criteria for acceptable piping in plenum spaces
  - Must meet 25/50 Flame and Smoke spread tested to ASTM E 84
  - Be an exempt Non-Combustible
  - Be acceptable for use as DWV pipe
  -
  - Cast Iron Soil Pipe and Fittings are acceptable

5 **ASTM E 84**

- "Standard Test Method for Surface Burning Characteristics of Building Materials"
- 10 Minute Test
- The "Thermometer" to scale and compare materials for Flame and Smoke Spread
- 25 Flame Spread and 50 Smoke Developed Index is determined by the code, not the standard

6 **Wrap Insulation**

- Misconceptions
  - Only exposed item needs to meet 25/ 50
  - Wrap Insulation can be used to cover plastic pipe in plenums
  -
- Facts
  - Many wrap insulations are tested and listed using a MODIFIED ASTM E 84 test
  - Typically they have not been tested as a composite (wrap, pipe, tapes, etc.)

- Test Labs modify tests, but ASTM E 84 does not specifically allow these modifications

7 **Firestopping**

8 **Firestop Concerns**

"Understanding what a firestop is as well as where and why it is required helps ensure that it is correctly installed.
It is important to remember that firestopping is designed to perform as tested only once in its lifetime, and to do so, it must be properly installed."

Source: Plumbing Systems & Design Nov. 2010 "Fire in its Tracks" Author: Riley Archer – National Technical Manager for RectorSeal

9 **What is firestopping? Through and Membrane Penetrations**

- It is a system, consisting of:
- Penetrating item
- Opening in resistive member
- Construction component
  - Type- wall, floor, ceiling, or floor/ ceiling
  - Material
  - Hour rating
- Material or materials used for firestopping
- Listed system detail for installing and inspection
-

10 **Exemptions**

- 6" and smaller nominal metallic pipe in penetration openings under 144 square inches may be protected by use of grout or concrete, in concrete or masonry walls, floors, or ceilings.
-
- This does not require a listed system
-
- Non-metallic pipe can not be protected in as simple a manner
-
- Combustible piping can leave a void in a fire barrier when it burns or melts away, non-combustible piping materials do not, making protection for metallic, non-combustible pipes much simpler.
-

11 **Complexities of Firestopping**

- What type of barrier is being penetrated?
- What is it made of?
- What material is penetrating the barrier?
- How big is the opening?
- What manufacturer is being used?
- What listed system fits the above criteria?
- What materials are needed?

- How is it to be installed?
- What are the inspection requirements?
-

12 **The Firestop System Listing**

- The parameters for the opening, annular space, penetrating materials and barrier type and materials
- Which manufacturer- Listings are manufacturer specific and material from manufacturer A can not be mixed with manufacturer B's materials
- What materials are need, quantities, etc.
- How it is to be applied, secured, backed, the thickness of materials, and specialty items, such as: screws, washers, anchors, tapes, wire, metal sheeting, etc.
- What the hour rating of protection is…
- Remember- mixing or exchanging one material or manufacturer for another in a listed system, makes it no longer listed, therefore not protected!!!
-

13 **Engineered Judgements**

- Should only be used where and when a listed system does not exist (Check all listings, even if under a different manufacturer)
- This is only an opinion that a certain material(s) applied and installed a certain way SHOULD work.
- May not be acceptable to Administrative Authority Having Jurisdiction
- This is not the same as a listed system, because it has not be installed and tested to rate the performance
- Provided by Firestopping Manufacturers Engineers Only

14 **Firestopping Installation Issue-**
Not a Listed system

15 **Firestop Installation issue**

16 **Firestop Installation issue**

17

18

19 **Melting Points of Common Materials**

Temperature at 10 minutes = 1300 °F

Melting Points (approximate):

- Aluminum - 1220 °F[1]
-
- PVC plastic pipe - 413 °F[2]
-
- Fiberglas® insulation - 1100 °F[3]

➢

Sources:

1. NFPA Fire Protection Handbook, 18th Ed. Table 4-16A. Pg 4-183.
2. SFPE Handbook of Fire Protection Engineering, 1st Ed. Table 1-12.1. Pg. 1-166.
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•

20 ☐

Product Data Sheet (From a manufacturer)

• 4. Performance & Typical Physical Properties
Color: Gray with Red Liner
Fire Resistance: 1-3 Hours (wall- or floor-rating dependent)
Activation Temperature: 550° F (288° C)
Expansion Volume: 100x

ISSUE: PVC MELTS AWAY 137 degrees F BEFORE the intumescent even begins to react!!!

21 ☐ **Firestop Test Failure**

22 ☐ **Firestop Test Failure**

23 ☐ **Toxicity of Piping Materials**

24 ☐ **Toxicity**

Many combustible products give of toxic gasses and chemicals when burned. Some items are far worse and have a higher toxicity than others. This needs to be looked at when assessing materials for piping in the DWV system.

• Resources:
• US EPA on Vinyl Chloride
• Evaluation of Fire Stop Burn Test Polyvinyl Chloride (PVC)
• Living Building Challenge
•
• Many other resources are available

25 ☐ **From the EPA**

Epa.gov
75-01-4
Hazard Summary-Created in April 1992; Revised in January 2000

Most vinyl chloride is used to make polyvinyl chloride (PVC) plastic and vinyl products. Acute (short-term) exposure to high levels of vinyl chloride in air has resulted in central nervous system effects (CNS), such as dizziness, drowsiness, and headaches in humans. Chronic (long-term) exposure to vinyl chloride through inhalation and oral exposure in humans has resulted in liver damage. Cancer is a major concern from exposure to vinyl chloride via inhalation, as vinyl chloride exposure has been shown to increase the risk of a rare form of liver cancer in humans. EPA has classified vinyl chloride as a Group A, human carcinogen.

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Air inside new cars may contain vinyl chloride at higher levels than detected in ambient air because vinyl chloride may outgas into the air from the new plastic parts.

Drinking water may contain vinyl chloride released from contact with polyvinyl pipes.

26 **PVC is a "Red List Material" for Living Building Challenge**

- Red List Materials from Living Building Challenge:
- Polyvinyl Chloride (PVC)
  - PVC's vinyl chloride monomer building block is a known human carcinogen, according to the US Department of Health and Human Services. In addition, PVC is a Persistent Organic Pollutant Source Material. Due to its chlorine content, PVC manufacture often contains other substances of concern, such as cadmium, lead, and phthalates, and can result in the production of dioxins during production and disposal phases. Dioxins, specifically TCDD, accumulate in human and animal tissue and are associated with immune system impairment, damage to developing nervous systems, and damage to the endocrine and reproductive systems. TCDD is listed as a "known human carcinogen" by the International Agency for Research on Cancer.
- REF: (dioxins): http://www.who.int/mediacentre/factsheets/fs225/en/index.html
- REF: (vinyl chloride): http://www.atsdr.cdc.gov/tfacts20.html

27 **Questions?**

Laura Loziuk

Technical Services Regional Manager

McWane Plumbing Group (Tyler, AB&I, Wade & Husky)

www.mcwaneplumbingtechservices.com

laura.loziuk@mcwaneplbgrp.com

Laura Loziuk is a Strategic Codes & Standards Specialist for McWane Plumbing Technical Services who works with plumbing industry design professionals and enforcement agencies to provide the education and technical expertise to solve technical design issues with innovative materials/solutions.

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PLUMBING TECHNICAL SERVICES

Considerations of the DWV and Storm System:

What to know about Plenums and Firestopping

Laura Loziuk
Technical Services Manager

PLUMBING TECHNICAL SERVICES

Learning objectives

- Plenum Spaces
  - Acceptable materials for use in DWV Systems
  - ASTM E 84 testing
  - Plenum wrap insulation
- Firestopping
  - Concerns
  - Through and Membrane Penetrations
  - Details
  - Exemptions
  - Complexities
  - Engineered Judgements
  - Issues
  - Melting Points of Piping Products
- Toxicity of piping materials
- Question and Answer

PLUMBING TECHNICAL SERVICES

Plenum Spaces

PLUMBING TECHNICAL SERVICES

Acceptable Piping in Plenum Spaces

- Criteria for acceptable piping in plenum spaces
  - Must meet 25/50 Flame and Smoke spread tested to ASTM E 84
  - Be an exempt Non-Combustible
  - Be acceptable for use as DWV pipe
  - Cast Iron Soil Pipe and Fittings are acceptable

PLUMBING TECHNICAL SERVICES

ASTM E 84

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- The "Thermometer" to scale and compare materials for Flame and Smoke Spread
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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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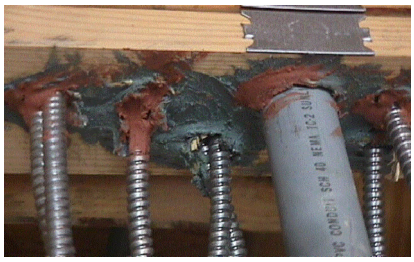
PLUMBING TECHNICAL SERVICES

Firestopping Installation Issue- Not a Listed system



Multiple Products and not installed per listing

PLUMBING TECHNICAL SERVICES

Firestop Installation issue

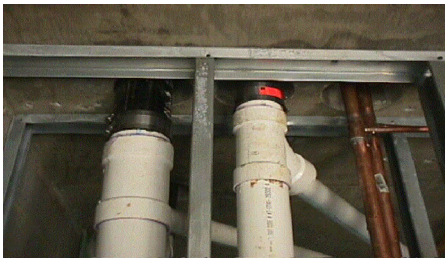
PLUMBING TECHNICAL SERVICES

Firestop Installation issue

No protection provided by firestop device if the annular space is too large…like this one

PLUMBING TECHNICAL SERVICES

Firestop Installation issue



The plastic will melt away, allowing the fire to melt away the plastic above…no protection provided in this installation resulting in a chimney effect.

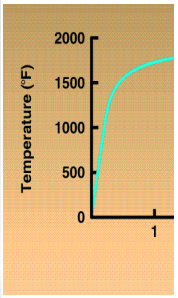
PLUMBING TECHNICAL SERVICES

Firestop Installation issue

Left- Not tooled to ensure proper seal
Right- Tooled, but the seal has pulled away

PLUMBING TECHNICAL SERVICES

Melting Points of Common Materials



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PLUMBING TECHNICAL SERVICES

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Activation of Some Intumescent Materials

Product Data Sheet (From a manufacturer)

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ISSUE: PVC MELTS AWAY 137 degrees F **BEFORE** the intumescent even begins to react!!!

PLUMBING TECHNICAL SERVICES

Firestop Test Failure

PLUMBING TECHNICAL SERVICES

Firestop Test Failure

Intumescent did not expand enough to fill the hole exposed by the melting plastic…this would allow smoke and flame to travel

PLUMBING TECHNICAL SERVICES

Toxicity of Piping Materials

PLUMBING TECHNICAL SERVICES

Toxicity

Many combustible products give of toxic gasses and chemicals when burned. Some items are far worse and have a higher toxicity than others. This needs to be looked at when assessing materials for piping in the DWV system.

- Resources:
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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

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PLUMBING TECHNICAL SERVICES

Questions?

Laura Loziuk
Technical Services Manager
903-941-4541
Laura.Loziuk@mcwaneplbgrp.com

CRITERIA FOR SUBMITTING CONTINUING EDUCATION COURSES FOR BOARD OF BUILDING STANDARDS CERTIFICATIONS

The Ohio Board of Building Standards approves Continuing Education Courses for building department personnel. The courses may be used for the attainment of goals that are connected with technical and professional development as they relate to enforcing and interpreting the Ohio State Building Codes. Board approval is granted only on course instruction pertaining to OBC, OMC, OPC, and RCO requirements and such other content areas directly related to the responsibilities of the certification for which credit is being requested.

Instructors: Anyone or any organization promoting an approved course, is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, certifications for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising shall not disclose improper approval information to the public.

Course sponsors/co-sponsors: proved participants a certificate of completion containing the following information: name of participant, title of approved courses, BBS approval #, BBS approved certifications, date of the continuing education program, number of approved credit hours awarded and signature of authorized sponsor or instructor.

Anyone or any organization administering an approved course shall provide the Board with advanced written information on scheduling of the course(s) (date and place) and provide to the Board a legible list of participants who completed the course with the name of course, date, and location.

Participants: Must attend the complete course as presented by the instructor to receive credit hours approved by the Board. No partial credit shall be given to any participant who failed to complete the entire course as approved. The sponsor/co-sponsor or instructor shall formulate a method to verify the individual's attendance and completion of the course.

Board approval: Remains in effect during the current code edition. Upon the Board's adoption of a new edition of the codes, course sponsors must update their course and submit to the Board for approval. The Board does not grant retroactive approval for courses presented prior to approval date.

Facility/training area: Shall be capable of comfortably and safely seating at least the number of attendees with writing surfaces for each attendee; accessible to/and usable for people with disabilities; sized and provided with audio/visual equipment adequate so that each attendee can see the instructor(s) and overhead screen and hear the content of the training programs; illuminated for writing and that the content on an overhead screen can be seen easily by all attendees; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: James A Richardson Jr
(Contact Name)

Organization: OAPI
(Organization/Company)

Address: 111 N. Front St.
(Include Room Number, Suite, etc.)

City: Columbus State: OH Zip: 43215

E-Mail: jarichardson@columbus.gov

Telephone: 6147744855 Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: Considerations of the DWV and Storm System: What to know about Plenums and Firestopping

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: This course is designed to give the participant working knowledge regarding acceptable firestopping methods. The course covers plenum spaces, ASTM E 84, plenum wrap, through penetrations, membrane penetrations, exemptions, engineered judgements, and toxicity of materials.

Presenter will be Laura Loziuk - BIO sent with application

Number of Instructional Contact Hours that can be obtained upon completion: 1

If Multi-Session, Number of Instructional Contact Hours Per Session: 1

Program Applicable for the Following Participants:

Building Official ☒ Master Plans Examiner ☒ Building Inspector ☒ Fire Protection Inspector ☒ Mechanical Inspector ☒
Plumbing Plans Exam. ☒ Plumbing Inspector ☒
Electrical Plans Exam. ☒ Non-Res IU Inspector ☒
Mechanical Plans Exam. ☒

Res Building Official ☒ Res Plans Examiner ☒ Res Building Inspector ☒ Res Mechanical Inspector ☒ Res IU Inspector ☒

Electrical Safety Inspectors ☒
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	✔
Course Sponsor:	Organization sponsoring or requesting the program (if any)	✔
Course Title:	Name of course (related to content)	✔
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	✔
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	✔
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	✔
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	✔
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	✔
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	✔
Test Materials:	Copy of quizzes or tests to be given	✔
Completed Application:		✔

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

File Attachments for Item:

ER-7 Hangers and Restraints for Cast Iron Soil Pipe DWV Systems (Ohio Assn of Plumbing Inspectors)

All certifications (1 hour)

Staff Notes:

Committee Recommendation:

1 **Hangers and Restraint for Cast Iron Soil Pipe DWV Systems**

Laura Loziuk
Technical Services Manager
McWane Plumbing Group

2 **Learning Objectives**

3 **Hangers**

4 **Hangers**

5 **Hangers**

6 **Hangers**

7 **Hanger Spacing**

- Code also provides the intervals that hangers must be placed at.
- This is done by material type.
- 2018 IPC Table 308.5 provides this information.

8 **Hanger Spacing**

- Cast iron hanger requirements are 5 feet or 10 feet where 10 foot lengths of pipe are used (see footnote a. in IPC table)
  - Stainless Steel requirements are 10 feet.
- 2018 UPC uses Table 313.3

9 **Hanger Spacing**

PVC requirements vary by pipe size in DWV applications

-
-

10 **Hanger Spacing**

PVC requirements become even more complex in pressure applications

11 **Hanger Spacing**

Examples:

- PVC requirements start at 3 feet (depending on the pipe diameter)
- Cast Iron requirements are 5 feet or 10 feet where 10 foot lengths of pipe are used (see footnote a. in IPC table)
- Stainless Steel requirements are 10 feet.
- 2018 UPC uses Table 313.3

12 **CISPI Handbook**

- Provides guidance on hanging, specific to cast iron soil pipe and fittings.
- From the CISPI Handbook: *"(1) Cast iron soil pipe installed in the horizontal position shall be supported at every hub (hub and spigot) or coupling (hubless). The hanger shall be placed within 18" of the hub or coupling. Joints used for connecting cast iron soil pipe possess sufficient shear strength to require one hanger per joint or hub."*
-

13 **Alternative Materials**

- Rigid piping materials, like cast iron require less hangers for support.
- Flexible piping materials, like ABS or PVC require more design consideration and hangers for support.
- Steel, copper and stainless steel are similar to cast iron, as they can support their length, when used in a DWV system.
-

14 **Restraints**

15 **Types of Restraint**

- Thrust Restraint
- Sway Bracing
- Seismic Restraint
-
- All 3 fall under Chapter 3 General Regulations of the IPC and UPC
-

16 **Types of Restraint**

Thrust Restraint - bracing, blocks, rodding, and other suitable methods to resist thrust forces in a piping system

17 **Types of Restraint**

Sway Bracing - rigid bracing or other rigid support arrangements installed to resist movement of the upstream pipe in the direction of flow (2018 IPC)

-
-

18 **Types of Restraint**

Seismic Restraint - Piping Seismic Supports- plumbing piping supports designed and installed for the seismic forces in accordance with the International Building Code. (2018 IPC)

-
-

19 **Thrust Restraint**

- 2018 IPC Chapter 3, section 308.7.1 describes thrust restraint, and states "For pipe sizes greater than 4 inches (102 mm), restraints shall be provided for drain pipes at all changes of in direction and at all changes in diameter greater than two pipe sizes."

20 **Thrust Restraint**

Thrust Forces - The Reason for the Restraints!

21 **Thrust Restraint**

Case Study: MGM National Harbor Casino

22 **CISPI Thrust Restraint Example**

23 **Manufacturer's Installation Instructions**

- Manufacturers of cast iron soil pipe and fittings include similar language as CISPI for thrust

restraint. It is applicable to both Hub and Spigot and Hubless (No-Hub) pipe and fittings.

- Simply stated:

ALL HORIZONTAL PIPE AND FITTINGS, 5 INCH AND LARGER. SHOULD BE BRACED TO PREVENT MOVEMENT AT EVERY BRANCH OR CHANGE OF DIRECTION,

24 **Sway Bracing**

25 **CISPI Handbook- Sway Bracing**

26 **Seismic Restraint System**

- An engineering system to resist seismic movement.
- As each installation is different, so must be the system used for restraint.
- Building Codes and plumbing codes require that seismic movement be restrained.
- Consult with the engineer for specific installation and design to meet this requirement.

27 **Example**

28 **Example**

29 **Items to Remember**

- Hangers and their requirements are defined by the plumbing code.
- Hanging support intervals vary by piping material.
- Thrust forces and restraint of those forces are keys to a properly installed system.
- The plumbing codes address restraint (thrust, sway and seismic).
- Manufacturers of cast iron soil pipe and fittings, CISPI, and the codes have similar language to deal with restraint.

30 **Questions?**

31 **Knowledge Assessment**

Laura Loziuk

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Hangers and Restraint for Cast Iron Soil Pipe DWV Systems

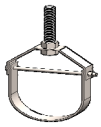
Laura Loziuk
Technical Services Manager
McWane Plumbing Group

Learning Objectives

- Types of Hangers
- Hanging Requirements
- Types of restraint
  - Thrust Restraint
  - Sway Bracing
  - Seismic Restraint (Bracing)

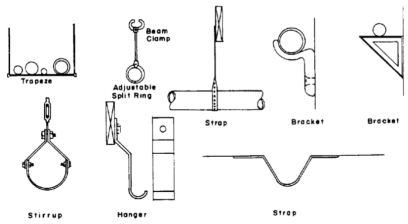
Hangers

Example of a clevis hanger which is commonly used to suspend cast iron soil pipe and fittings



Hangers

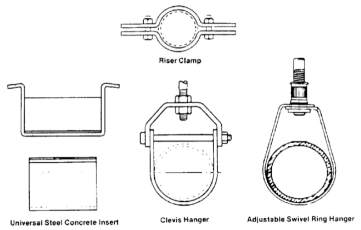
A Multitude of Other Hanger Types are Used



Source: CISPI Handbook

Hangers

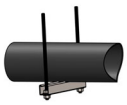
A Multitude of Other Hanger Types are Used



Source: CISPI Handbook

Hangers

- All-Thread Rod is used to suspend many of these hangers from beams by use of beam clamps or other devices directly into concrete structures or beams.
- The 2018 UPC section 313.6 and Table 313.6 provides guidance on hanger rod sizes



Hanger Spacing

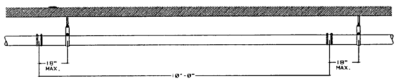
- Code also provides the intervals that hangers must be placed at.
- This is done by material type.
- 2018 IPC Table 308.5 provides this information.

TABLE 308.5
HANGER SPACING

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
Acrylonitrile butadiene styrene (ABS) pipe	4	10[b]
Aluminum tubing	10	15
Brass pipe	10	10
Cast-iron pipe	5[a]	15
Chlorinated polyvinyl chloride (CPVC) pipe and tubing, 1 inch and smaller	3	10[b]
Chlorinated polyvinyl chloride (CPVC) pipe and tubing, 1 1/4 inches and larger	4	10[b]
Copper or copper-alloy pipe	12	10

Hanger Spacing

- Cast iron hanger requirements are 5 feet or 10 feet where 10 foot lengths of pipe are used (see footnote a. in IPC table)
  - Stainless Steel requirements are 10 feet.
- 2018 UPC uses Table 313.3



Source: CISPI Handbook

Hanger Spacing

PVC requirements vary by pipe size in DWV applications

Table 8-B: PVC-DWV Pipe Support Spacing

SIZE (in)	MAXIMUM SPACING (ft)
1¼ - 2	3
3 - 4	4
6 - 8	5
10 - 12	6

Source: PPFA website

Hanger Spacing

PVC requirements become even more complex in pressure applications

Table 8-C: PVC Pressure Pipe Support Spacing (ft)

Pipe Size (in)	Schedule 40 Temperature (°F)					Schedule 80 Temperature (°F)				
	60	80	100	120	140	60	80	100	120	140
¼	4	3½	3½	2	2	4	4	3½	2½	2
½	4	4	3½	2½	2½	4½	4½	4	2½	2½
½	4½	4½	4	2½	2½	5	4½	4½	3	2½
¾	5	4½	4	2½	2½	5½	5	4½	3	2½
1	5½	5	4½	3	2½	6	5½	5	3½	3
1¼	5½	5½	5	3	3	6	6	5½	3½	3
1½	6	5½	5	3½	3	6½	6	5½	3½	3½
2	6	5½	5	3½	3	7	6½	6	4	3½
2½	7	6½	6	4	3½	7½	7½	6½	4½	4
3	7	7	6	4	3½	8	7½	7	4½	4
3½	7½	7	6½	4	4	8½	8	7½	5	4½
4	7½	7	6½	4½	4	9	8½	7½	5	4½
6	8½	8	7½	5	4½	10	9½	9	6	5
8	9	8½	8	5	4½	11	10½	9½	6½	5½
10	10	9	8½	5½	5	12	11	10	7	6
12	11½	10½	9½	6½	5½	13	12	10½	7½	6½
14	12	11	10	7	6	13½	13	11	8	7
16	12½	11½	10½	7½	6½	14	13½	11½	8½	7½
18	13½	12	11	8	7	14½	14	12	11	9
20	14	12½	11½	10	8½	15½	14½	12½	11½	9½

Source: PPFA website

Hanger Spacing

Examples:

- PVC requirements start at 3 feet (depending on the pipe diameter)
- Cast Iron requirements are 5 feet or 10 feet where 10 foot lengths of pipe are used (see footnote a. in IPC table)
- Stainless Steel requirements are 10 feet.

- 2018 UPC uses Table 313.3

CISPI Handbook

- Provides guidance on hanging, specific to cast iron soil pipe and fittings.
- From the CISPI Handbook: *"(1) Cast iron soil pipe installed in the horizontal position shall be supported at every hub (hub and spigot) or coupling (hubless). The hanger shall be placed within 18" of the hub or coupling. Joints used for connecting cast iron soil pipe possess sufficient shear strength to require one hanger per joint or hub."*

Alternative Materials

- Rigid piping materials, like cast iron require less hangers for support.
- Flexible piping materials, like ABS or PVC require more design consideration and hangers for support.
- Steel, copper and stainless steel are similar to cast iron, as they can support their length, when used in a DWV system.

Restraints

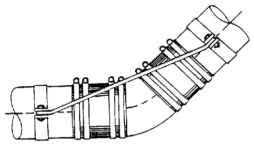
Types of Restraint

- Thrust Restraint
- Sway Bracing
- Seismic Restraint

- All 3 fall under Chapter 3 General Regulations of the IPC and UPC

Types of Restraint

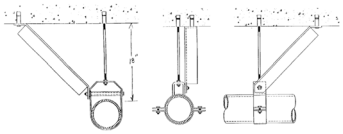
Thrust Restraint - bracing, blocks, rodding, and other suitable methods to resist thrust forces in a piping system



Source: CISPI Handboook

Types of Restraint

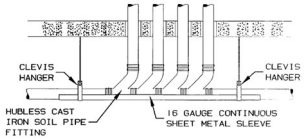
Sway Bracing - rigid bracing or other rigid support arrangements installed to resist movement of the upstream pipe in the direction of flow (2018 IPC)



Source: CISPI Handboook

Types of Restraint

Seismic Restraint - Piping Seismic Supports- plumbing piping supports designed and installed for the seismic forces in accordance with the International Building Code. (2018 IPC)



Note: Seismic braces may be installed at either hanger; braces at both hangers are not required.

Source: CISPI Handboook, Figure 16—Method of Supporting "Multi-Fitting" Installations (Hanger Spacing 10 Ft. Max.).

Thrust Restraint

- 2018 IPC Chapter 3, section 308.7.1 describes thrust restraint, and states "For pipe sizes greater than 4 inches (102 mm), restraints shall be provided for drain pipes at all changes of in direction and at all changes in diameter greater than two pipe sizes."

Thrust Restraint

Thrust Forces - The Reason for the Restraints!

Thrust or Displacement Forces Encountered in Hydrostatic Testing of Cast Iron Soil Pipe

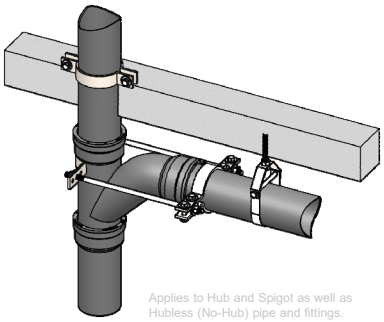
Pipe Size		1.5"	2"	3"	4"	5"	6"	8"	10"	12"	15"
Head, Feet of Water	Pressure PSI	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.	Thrust lb.
10	4.3	12	19	38	65	95	134	237	377	538	847
20	8.7	25	38	77	131	192	271	480	762	1088	1714
30	13.0	37	56	115	196	287	405	717	1139	1626	2562
40	17.3	49	75	152	261	382	539	954	1515	2164	3409
50	21.7	62	94	191	327	479	676	1197	1900	2714	4276
60	26.0	74	113	229	392	574	810	1434	2277	3252	5124
70	30.3	86	132	267	457	668	944	1671	2654	3790	5971
80	34.7	99	151	306	523	765	1082	1914	3039	4341	6838
90	39.0	111	169	344	588	860	1216	2151	3416	4879	7685
100	43.4	123	188	382	654	957	1353	2394	3801	5429	8552
110	47.7	135	207	420	719	1052	1487	2631	4178	5967	9400
120	52.0	148	226	458	784	1147	1621	2868	4554	6505	10247
Area, OD		2.84	4.34	8.81	15.07	22.06	31.17	55.15	87.58	125.09	197.06

Source: CISPI Handboook

Thrust Restraint

Case Study: MGM National Harbor Casino

CISPI Thrust Restraint Example



Applies to Hub and Spigot as well as Hubless (No-Hub) pipe and fittings.

Manufacturer's Installation Instructions

- Manufacturers of cast iron soil pipe and fittings include similar language as CISPI for thrust restraint. It is applicable to both Hub and Spigot and Hubless (No-Hub) pipe and fittings.
- Simply stated:

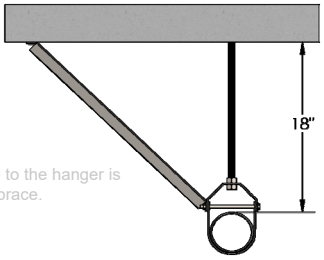
ALL HORIZONTAL PIPE AND FITTINGS, 5 INCH AND LARGER. SHOULD BE BRACED TO PREVENT MOVEMENT AT EVERY BRANCH OR CHANGE OF DIRECTION,

Sway Bracing

308.6 Sway bracing. Where horizontal pipes 4 inches (102 mm) and larger convey drainage or waste, and where a pipe fitting in that piping changes the flow direction greater than 45 degrees (0.79 rad), rigid bracing or other rigid support arrangements shall be installed to resist movement of the upstream pipe in the direction of pipe flow. A change of flow direction into a vertical pipe shall not require the upstream pipe to be braced.

Source: 2018 IPC Section 308.6

CISPI Handbook-Sway Bracing

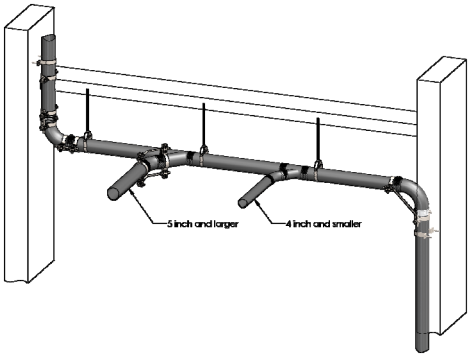


The brace to the hanger is the sway brace.

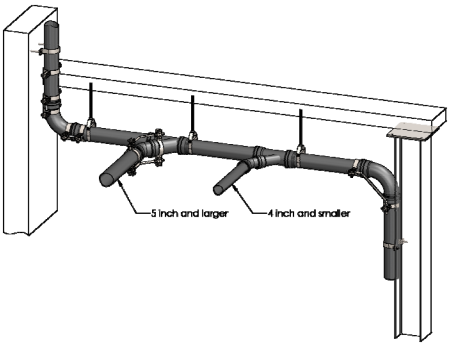
Seismic Restraint System

- An engineering system to resist seismic movement.
- As each installation is different, so must be the system used for restraint.
- Building Codes and plumbing codes require that seismic movement be restrained.
- Consult with the engineer for specific installation and design to meet this requirement.

Example



Example



Items to Remember

- Hangers and their requirements are defined by the plumbing code.
- Hanging support intervals vary by piping material.
- Thrust forces and restraint of those forces are keys to a properly installed system.
- The plumbing codes address restraint (thrust, sway and seismic).
- Manufacturers of cast iron soil pipe and fittings, CISPI, and the codes have similar language to deal with restraint.

Questions?

Knowledge Assessment

Laura Loziuk
Technical Services Manager
903-941-4541
Laura.Loziuk@mcwaneplbgrp.com

CRITERIA FOR SUBMITTING CONTINUING EDUCATION COURSES FOR BOARD OF BUILDING STANDARDS CERTIFICATIONS

The Ohio Board of Building Standards approves Continuing Education Courses for building department personnel. The courses may be used for the attainment of goals that are connected with technical and professional development as they relate to enforcing and interpreting the Ohio State Building Codes. Board approval is granted only on course instruction pertaining to OBC, OMC, OPC, and RCO requirements and such other content areas directly related to the responsibilities of the certification for which credit is being requested.

Instructors: Anyone or any organization promoting an approved course, is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, certifications for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising shall not disclose improper approval information to the public.

Course sponsors/co-sponsors: proved participants a certificate of completion containing the following information: name of participant, title of approved courses, BBS approval #, BBS approved certifications, date of the continuing education program, number of approved credit hours awarded and signature of authorized sponsor or instructor.

Anyone or any organization administering an approved course shall provide the Board with advanced written information on scheduling of the course(s) (date and place) and provide to the Board a legible list of participants who completed the course with the name of course, date, and location.

Participants: Must attend the complete course as presented by the instructor to receive credit hours approved by the Board. No partial credit shall be given to any participant who failed to complete the entire course as approved. The sponsor/co-sponsor or instructor shall formulate a method to verify the individual's attendance and completion of the course.

Board approval: Remains in effect during the current code edition. Upon the Board's adoption of a new edition of the codes, course sponsors must update their course and submit to the Board for approval. The Board does not grant retroactive approval for courses presented prior to approval date.

Facility/training area: Shall be capable of comfortably and safely seating at least the number of attendees with writing surfaces for each attendee; accessible to/and usable for people with disabilities; sized and provided with audio/visual equipment adequate so that each attendee can see the instructor(s) and overhead screen and hear the content of the training programs; illuminated for writing and that the content on an overhead screen can be seen easily by all attendees; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: James A Richardson Jr
(Contact Name)

Organization: OAPI
(Organization/Company)

Address: 111 N. Front St.
(Include Room Number, Suite, etc.)

City: Columbus State: OH Zip: 43215

E-Mail: jarichardson@columbus.gov

Telephone: 6147744855 Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: Hangers and Restraints for Cast Iron Soil Pipe DWV Systems

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: This course is designed to give the participant an understanding of the hanger and restraint requirements for the varying materials used in piping systems. Specifics covered will be - types of hangers, hanger spacing requirements, and types of restraints.

Presenter will be Laura Loziuk - BIO sent with application

Number of Instructional Contact Hours that can be obtained upon completion: 1

If Multi-Session, Number of Instructional Contact Hours Per Session: 1

Program Applicable for the Following Participants:

Building Official ☒ Master Plans Examiner ☒ Building Inspector ☒ Fire Protection Inspector ☒ Mechanical Inspector ☒
Plumbing Plans Exam. ☒ Plumbing Inspector ☒
Electrical Plans Exam. ☒ Non-Res IU Inspector ☒
Mechanical Plans Exam. ☒

Res Building Official ☒ Res Plans Examiner ☒ Res Building Inspector ☒ Res Mechanical Inspector ☒ Res IU Inspector ☒

Electrical Safety Inspectors ☒
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	✔
Course Sponsor:	Organization sponsoring or requesting the program (if any)	✔
Course Title:	Name of course (related to content)	✔
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	✔
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	✔
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	✔
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	✔
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	✔
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	✔
Test Materials:	Copy of quizzes or tests to be given	✔
Completed Application:		✔

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

File Attachments for Item:

ER-8 Joining Methods for Cast Iron Soil Pipe and Fittings (Ohio Assn of Plumbing Inspectors)

All certifications (1 hour)

Staff Notes:

Committee Recommendation:

1 **Joining Methods for Cast Iron Soil Pipe and Fittings**

Laura Loziuk
Technical Services Regional Manager
McWane Plumbing Group

2 **Learning Objectives**

3 **Hub and Spigot**
Joining Methods

4 **Code Sections for Hub and Spigot Joints- IPC**

- The 2018 International Plumbing Code (IPC) sections are:
  - 705.3.1 Caulked Joints (Lead and Oakum)
  - Section is prescriptive- explains what is to be done
  - 705.3.2 Compression Gasket Joints
  - This section cites ASTM C 564 for gasket material and ASTM C 1563 for testing of the gasket.

5 **Code Sections for Hub and Spigot Joints- UPC**

- The 2018 Uniform Plumbing Code (UPC) sections are:
  - 705.2.1 Caulked Joints (Lead and Oakum)
  - Section is prescriptive- explains what is to be done
  - 705.2.2 Mechanical Joints and Compression Joints
  - This sections combines couplings for hubless and gaskets for hub and spigot, cites both ASTM C 564 and ASTM C 1563, along with prescriptive language for both types of joints
-

6 **Lead and Oakum**

- Can be used for Service Weight and Extra Heavy Pipe and Fittings.
- Still used today for repair and some new construction
- Completed by “packing” Oakum into the hub and around the pipe
- Then pouring the proper amount of lead for the joint, based on pipe size
- “Caulking” the lead into the hub and around the spigot of the pipe
-
-

7 **Compression Gaskets**

- Available for both Service Weight and Extra Heavy Pipe and Fittings
- Material standard- ASTM C 564 for elastomer and ASTM C 1563 for the test method
- Uses either a lubricant or an adhesive lubricant for installation, based on pipe size.
- Used above and below grade all over the US

-

8 **Code Sections for Transitions of Dissimilar Materials- IPC**

- The 2018 IPC section 705.16 Joints Between Different Materials addresses the different standards that apply and how to transition between materials.

- Sections 705.16.1, 705.16.2, 705.16.3, 705.16.4, 705.16.5, 705.16.6, 705.16.7 all address different, specific transitions of dissimilar materials.

9 **Code Sections for Transitions of Dissimilar Materials- UPC**

- The 2018 UPC section 705.10 Joints Between Various Materials address the different standards that apply and how to transition between materials.
- Sections 705.10.1, 705.10.2, 705.10.3, and 705.10.4 all address specific transitions of dissimilar materials.
-

10 **Transitions between Dissimilar Materials**

- Transitions from Hub and Spigot to other materials, by code, should be completed using an approved transition
- Lead and Oakum is effective as a transition method as it conforms to each joint specifically
- Temperatures, as it applies to the "other" materials will need to be considered.
- There are compression gaskets that are available for transitioning between materials.

11 **Hubless**
Joining Methods

12 **Code Sections for Hub and Spigot Joints- IPC**

- The 2018 International Plumbing Code (IPC) sections are:
  - 705.3.3 Mechanical Joint Coupling this section specifically cites CISPI 310, ASTM C 1277, and ASTM C 1540. It also cites ASTM C 564 and CSA B 602 for the elastomeric sleeve of the coupling.

13 **Code Sections for Hub and Spigot Joints- UPC**

- The 2018 Uniform Plumbing Code (UPC) sections are:
  - 705.2.2 Mechanical Joints and Compression Joints
  - This sections combines couplings for hubless and gaskets for hub and spigot, cites ASTM A 1056, ASTM C 1277, ASTM C 1540, or CISPI 310 for the coupling and ASTM C 564 for elastomeric sleeve of the coupling. This section also provides prescriptive installation information of the couplings.

14 **Standard Couplings**

- Standards that cover these couplings are:
  - CISPI 310 (The Original)
  - ASTM C 1277
- Require ASTM C 564 elastomer gaskets, stainless steel shields, etc
- Both standards are listed in the codes as an approved joining method for hubless pipe and fittings
- Does not cover transitions of dissimilar materials
- Basis for NSF-CISPI 310 program and other listings
-
  -
-

15 **Heavy Duty Couplings**

- ASTM C 1540- Standard that covers Heavy Duty Couplings

- Written AFTER the couplings were being produced
- Allows for a wide variation in permissible designs and configurations
- Cited by all major plumbing codes
- Not for Transition of dissimilar materials
- Sub-categories (not defined by the standard) are Mid-Duty and Heavy Duty.

16 **Other Couplings**

- Other coupling configurations exist
- Must meet the standards that are applicable to them
- Shield materials can vary…even cast iron shielded couplings exist with the ASTM A 1056 standard
- While there are many options, Standard and Heavy Duty couplings are the vast majority in use

17 **Code Sections for Transitions of Dissimilar Materials- IPC**

- The 2018 IPC section 705.16 Joints Between Different Materials addresses the different standards that apply and how to transition between materials. It lists ASTM C1173, C 1460, C 1461 for the product and ASTM C 425, C 443, c 564, C 1440, , F 477, CSA A 257.3M or B 602 for the elastomer seal.
- Sections 705.16.1, 705.16.2, 705.16.3, 705.16.4, 705.16.5, 705.16.6, 705.16.7 all address different, specific transitions of dissimilar materials.

18 **Code Sections for Transitions of Dissimilar Materials- UPC**

- The 2018 UPC section 705.10 Joints Between Various Materials address the different standards that apply and how to transition between materials. It lists ASTM C 1173 for below ground use, ASTM C 1460 for above ground use, or ASTM C 1461 for above and below ground use.
- Sections 705.10.1, 705.10.2, 705.10.3, and 705.10.4 all address specific transitions of dissimilar materials.
-

19 **Hubless Transitions of Dissimilar Materials**

- Code refers to products being listed to multiple standards for transition purposes
- Shielded and unshielded varieties exist, depending on standard
- Gasket materials may or may not be ASTM C 564 compliant, depending on standard.
- Some may be configured similar to Standard Couplings, Heavy Duty Couplings, or something entirely different
- Dependent on piping materials, location of use (above or below grade), and even size differentials

20 **Installation Considerations**

21 **Applications by Joining Method**

- A few questions can lead to the best choice of joining method available for the application.
  - What occupancy is the structure?
    - Healthcare typically use Heavy Duty couplings, like the Husky SD 4000 (orange shield) as the joining method of choice.
  - What does code allow?
  - What parameters does the structure have?
    - Deflection issues?
    - Pipe Type- Hub and Spigot or Hubless
    - Storm Water systems with large floor spacing

- Extra protection or security desired or needed
- By asking and considering these questions and other specifics, joining methods can be chosen to best suite each project's specific needs.

22 **Installation**

- The 2018 UPC has prescriptive language for installation of a standard hubless coupling.
- CISPI 310 contains an annex detailing installation of standard hubless couplings.
- The CISPI Cast Iron Soil Pipe and Fittings Handbook provides installation information of lead and oakum, compression gaskets, and standard couplings.
- Manufacturers of all of these joining methods have specific installation instructions that should be followed.

23 **Manufacturer's Installation Instructions**

- Regardless of joining method employed, the manufacturers of cast iron soil pipe and fittings all suggest similar language to the below. The plumbing codes of our country all state similar requirements as well.
- Simply stated:

ALL HORIZONTAL PIPE AND FITTINGS, 5 INCH AND LARGER. SHOULD BE BRACED TO PREVENT MOVEMENT AT EVERY BRANCH OR CHANGE OF DIRECTION,

- This is regardless of joining method employed!!!

24 **Conclusion**

- There are multiple methods for joining cast iron soil pipe and fittings. It is based on:
  - Type of cast iron pipe and fittings
  - Method of joining specified or employed
  - Code allowable methods
  - Plumber Preference
- Both the 2018 IPC and UPC Codes cite allowable standards and methods in various sections
- ASTM C 1540 Heavy Duty Couplings vary a great deal by manufacturer and model.
- Other couplings exist, but not in as much use as Standard and Heavy Duty Couplings

25 **Conclusion Continued**

- Transitions of dissimilar materials to cast iron is governed by the codes and standards and is dependent upon the dissimilar material.
  - There are many methods and products that can be employed, but they must be code listed for the purpose.
- Regardless of joining method employed, proper installation like restraint and hangers still need to be followed, per pipe and fittings manufacturer installation instructions and the code sections applicable.
-

26 **Questions?**

Joining Methods for Cast Iron Soil Pipe and Fittings

Laura Loziuk
Technical Services Regional Manager
McWane Plumbing Group

Learning Objectives

- Hub and Spigot Joining Methods
  - Lead and Oakum
  - Compression Gaskets
  - Transitions for Dissimilar Materials
- Hubless Joining Methods
  - Standard Couplings
  - Heavy Duty Couplings
  - Other Types of Couplings
  - Transitions for Dissimilar Materials
- Installations Considerations
- Conclusion

Hub and Spigot Joining Methods

Code Sections for Hub and Spigot Joints- IPC

- The **2018 International Plumbing Code (IPC)** sections are:
  - **705.3.1 Caulked Joints** (Lead and Oakum)
  - Section is prescriptive- explains what is to be done
  - **705.3.2 Compression Gasket Joints**
  - This section cites ASTM C 564 for gasket material and ASTM C 1563 for testing of the gasket.

Code Sections for Hub and Spigot Joints- UPC

- The **2018 Uniform Plumbing Code (UPC)** sections are:
  - **705.2.1 Caulked Joints** (Lead and Oakum)
  - Section is prescriptive- explains what is to be done
  - **705.2.2 Mechanical Joints and Compression Joints**
  - This sections combines couplings for hubless and gaskets for hub and spigot, cites both ASTM C 564 and ASTM C 1563, along with prescriptive language for both types of joints

Lead and Oakum

- Can be used for Service Weight and Extra Heavy Pipe and Fittings.
- Still used today for repair and some new construction
- Completed by "packing" Oakum into the hub and around the pipe
- Then pouring the proper amount of lead for the joint, based on pipe size
- "Caulking" the lead into the hub and around the spigot of the pipe

Compression Gaskets

- Available for both Service Weight and Extra Heavy Pipe and Fittings
- Material standard- ASTM C 564 for elastomer and ASTM C 1563 for the test method
- Uses either a lubricant or an adhesive lubricant for installation, based on pipe size.
- Used above and below grade all over the US

Code Sections for Transitions of Dissimilar Materials- IPC

- **The 2018 IPC section 705.16 Joints Between Different Materials** addresses the different standards that apply and how to transition between materials.
- Sections **705.16.1, 705.16.2, 705.16.3, 705.16.4, 705.16.5, 705.16.6, 705.16.7** all address different, specific transitions of dissimilar materials.

Code Sections for Transitions of Dissimilar Materials- UPC

- **The 2018 UPC section 705.10 Joints Between Various Materials** address the different standards that apply and how to transition between materials.
- Sections **705.10.1, 705.10.2, 705.10.3, and 705.10.4** all address specific transitions of dissimilar materials.

Transitions between Dissimilar Materials

- Transitions from Hub and Spigot to other materials, by code, should be completed using an approved transition
- Lead and Oakum is effective as a transition method as it conforms to each joint specifically
- Temperatures, as it applies to the "other" materials will need to be considered.
- There are compression gaskets that are available for transitioning between materials.

Hubless Joining Methods

Code Sections for Hub and Spigot Joints- IPC

- The **2018 International Plumbing Code (IPC)** sections are:
  - **705.3.3 Mechanical Joint Coupling** this section specifically cites CISPI 310, ASTM C 1277, and ASTM C 1540. It also cites ASTM C 564 and CSA B 602 for the elastomeric sleeve of the coupling.

Code Sections for Hub and Spigot Joints- UPC

- The **2018 Uniform Plumbing Code (UPC)** sections are:
  - **705.2.2 Mechanical Joints and Compression Joints**
  - This sections combines couplings for hubless and gaskets for hub and spigot, cites ASTM A 1056, ASTM C 1277, ASTM C 1540, or CISPI 310 for the coupling and ASTM C 564 for elastomeric sleeve of the coupling. This section also provides prescriptive installation information of the couplings.

Standard Couplings

- Standards that cover these couplings are:
  - CISPI 310 (The Original)
  - ASTM C 1277
- Require ASTM C 564 elastomer gaskets, stainless steel shields, etc
- Both standards are listed in the codes as an approved joining method for hubless pipe and fittings
- Does not cover transitions of dissimilar materials
- Basis for NSF-CISPI 310 program and other listings

Heavy Duty Couplings

- ASTM C 1540- Standard that covers Heavy Duty Couplings
- Written AFTER the couplings were being produced
- Allows for a wide variation in permissible designs and configurations
- Cited by all major plumbing codes
- Not for Transition of dissimilar materials
- Sub-categories (not defined by the standard) are Mid-Duty and Heavy Duty.

Other Couplings

- Other coupling configurations exist
- Must meet the standards that are applicable to them
- Shield materials can vary…even cast iron shielded couplings exist with the ASTM A 1056 standard
- While there are many options, Standard and Heavy Duty couplings are the vast majority in use

Code Sections for Transitions of Dissimilar Materials- IPC

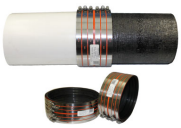
- **The 2018 IPC section 705.16 Joints Between Different Materials** addresses the different standards that apply and how to transition between materials. It lists ASTM C1173, C 1460, C 1461 for the product and ASTM C 425, C 443, c 564, C 1440, , F 477, CSA A 257.3M or B 602 for the elastomer seal.
- Sections **705.16.1, 705.16.2, 705.16.3, 705.16.4, 705.16.5, 705.16.6, 705.16.7** all address different, specific transitions of dissimilar materials.

Code Sections for Transitions of Dissimilar Materials- UPC

- **The 2018 UPC section 705.10 Joints Between Various Materials** address the different standards that apply and how to transition between materials. It lists ASTM C 1173 for below ground use, ASTM C 1460 for above ground use, or ASTM C 1461 for above and below ground use.
- Sections **705.10.1, 705.10.2, 705.10.3, and 705.10.4** all address specific transitions of dissimilar materials.

Hubless Transitions of Dissimilar Materials

- Code refers to products being listed to multiple standards for transition purposes
- Shielded and unshielded varieties exist, depending on standard
- Gasket materials may or may not be ASTM C 564 compliant, depending on standard.
- Some may be configured similar to Standard Couplings, Heavy Duty Couplings, or something entirely different
- Dependent on piping materials, location of use (above or below grade), and even size differentials



Installation Considerations

Applications by Joining Method

- A few questions can lead to the best choice of joining method available for the application.
  - What occupancy is the structure?
    - Healthcare typically use Heavy Duty couplings, like the Husky SD 4000 (orange shield) as the joining method of choice.
  - What does code allow?
  - What parameters does the structure have?
    - Deflection issues?
    - Pipe Type- Hub and Spigot or Hubless
    - Storm Water systems with large floor spacing
    - Extra protection or security desired or needed
  - By asking and considering these questions and other specifics, joining methods can be chosen to best suite each project's specific needs.

Installation

- The 2018 UPC has prescriptive language for installation of a standard hubless coupling.
- CISPI 310 contains an annex detailing installation of standard hubless couplings.
- The CISPI Cast Iron Soil Pipe and Fittings Handbook provides installation information of lead and oakum, compression gaskets, and standard couplings.
- Manufacturers of all of these joining methods have specific installation instructions that should be followed.

Manufacturer's Installation Instructions

- Regardless of joining method employed, the manufacturers of cast iron soil pipe and fittings all suggest similar language to the below. The plumbing codes of our country all state similar requirements as well.
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  - There are many methods and products that can be employed, but they must be code listed for the purpose.
- Regardless of joining method employed, proper installation like restraint and hangers still need to be followed, per pipe and fittings manufacturer installation instructions and the code sections applicable.

Questions?

Laura Loziuk

Technical Services Regional Manager

McWane Plumbing Group (Tyler, AB&I, Wade & Husky)

www.mcwaneplumbingtechservices.com

laura.loziuk@mcwaneplbgrp.com

Laura Loziuk is a Strategic Codes & Standards Specialist for McWane Plumbing Technical Services who works with plumbing industry design professionals and enforcement agencies to provide the education and technical expertise to solve technical design issues with innovative materials/solutions.

Laura believes providing the technical education needs of the industry is essential to ensuring buildings are constructed/designed to be safe and sanitary for the occupants.Laura is an active member of Women of ASPE, IAPMO, ICC, and ASTM. She is also a Board member of the Philadelphia chapter of ASPE.

Laura has a Bachelor's degree in Civil Engineering from Florida Atlantic University and has been active in the construction industry for over 12 years.

CRITERIA FOR SUBMITTING CONTINUING EDUCATION COURSES FOR BOARD OF BUILDING STANDARDS CERTIFICATIONS

The Ohio Board of Building Standards approves Continuing Education Courses for building department personnel. The courses may be used for the attainment of goals that are connected with technical and professional development as they relate to enforcing and interpreting the Ohio State Building Codes. Board approval is granted only on course instruction pertaining to OBC, OMC, OPC, and RCO requirements and such other content areas directly related to the responsibilities of the certification for which credit is being requested.

Instructors: Anyone or any organization promoting an approved course, is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, certifications for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising shall not disclose improper approval information to the public.

Course sponsors/co-sponsors: proved participants a certificate of completion containing the following information: name of participant, title of approved courses, BBS approval #, BBS approved certifications, date of the continuing education program, number of approved credit hours awarded and signature of authorized sponsor or instructor.

Anyone or any organization administering an approved course shall provide the Board with advanced written information on scheduling of the course(s) (date and place) and provide to the Board a legible list of participants who completed the course with the name of course, date, and location.

Participants: Must attend the complete course as presented by the instructor to receive credit hours approved by the Board. No partial credit shall be given to any participant who failed to complete the entire course as approved. The sponsor/co-sponsor or instructor shall formulate a method to verify the individual's attendance and completion of the course.

Board approval: Remains in effect during the current code edition. Upon the Board's adoption of a new edition of the codes, course sponsors must update their course and submit to the Board for approval. The Board does not grant retroactive approval for courses presented prior to approval date.

Facility/training area: Shall be capable of comfortably and safely seating at least the number of attendees with writing surfaces for each attendee; accessible to/and usable for people with disabilities; sized and provided with audio/visual equipment adequate so that each attendee can see the instructor(s) and overhead screen and hear the content of the training programs; illuminated for writing and that the content on an overhead screen can be seen easily by all attendees; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: James A Richardson Jr
(Contact Name)

Organization: OAPI
(Organization/Company)

Address: 111 N. Front St.
(Include Room Number, Suite, etc.)

City: Columbus State: OH Zip: 43215

E-Mail: jarichardson@columbus.gov

Telephone: 6147744855 Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: Joining Methods for Cast Iron Soil Pipe and Fittings

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: This course is designed to give the participant an understanding of various joining methods for cast iron pipe and fittings. Joining methods for hub and spigot including - lead and oakum, compression gaskets, and transitions for dis-similar materials. Joining methods for hubless cast iron including - standard couplings, heavy duty couplings, and transitions for dis-similar materials.

Presenter will be Laura Loziuk - BIO sent with application

Number of Instructional Contact Hours that can be obtained upon completion: 1

If Multi-Session, Number of Instructional Contact Hours Per Session: 1

Program Applicable for the Following Participants:

Building Official ☒ Master Plans Examiner ☒ Building Inspector ☒ Fire Protection Inspector ☒ Mechanical Inspector ☒
Plumbing Plans Exam. ☒ Plumbing Inspector ☒
Electrical Plans Exam. ☒ Non-Res IU Inspector ☒
Mechanical Plans Exam. ☒

Res Building Official ☒ Res Plans Examiner ☒ Res Building Inspector ☒ Res Mechanical Inspector ☒ Res IU Inspector ☒

Electrical Safety Inspectors ☒
Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	✔
Course Sponsor:	Organization sponsoring or requesting the program (if any)	✔
Course Title:	Name of course (related to content)	✔
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	✔
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	✔
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	✔
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	✔
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	✔
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	✔
Test Materials:	Copy of quizzes or tests to be given	✔
Completed Application:		✔

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

File Attachments for Item:

ER-9 Underground Installation Benefits of Cast Iron (Ohio Assn of Plumbing Inspectors)

All certifications (1 hour)

Staff Notes:

Committee Recommendation:

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APPLICATION

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COURSE SUBMITTER:

Course Submitter: James A Richardson Jr
(Contact Name)

Organization: OAPI
(Organization/Company)

Address: 111 N. Front St.
(Include Room Number, Suite, etc.)

City: Columbus State: OH Zip: 43215

E-Mail: jarichardson@columbus.gov

Telephone: 6147744855 Fax: _____

Course Sponsor: _____

COURSE INFORMATION:

Course Title: Underground Installation Benefits of Cast Iron

New Course Submittal: ☒ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: This course is designed to give the participant an understanding of the differing requirements for specific materials used in underground sanitary and storm piping systems, trenching requirements for each material, bedding and compaction requirements for each material, and how soil conditions can affect the installation and the most proper material to use for the condition.

Presenter will be Laura Loziuk - BIO sent with application

Number of Instructional Contact Hours that can be obtained upon completion: 1

If Multi-Session, Number of Instructional Contact Hours Per Session: 1

Program Applicable for the Following Participants:

Building Official ☒ Master Plans Examiner ☒ Building Inspector ☒ Fire Protection Inspector ☒ Mechanical Inspector ☒
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Mechanical Plans Exam. ☒

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Electrical Safety Inspectors ☒
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Test Materials:	Copy of quizzes or tests to be given	✔
Completed Application:		✔

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1 **Underground Installation Benefits of Cast Iron**

2 **You Will Learn About:**

- The Benefits of Cast Iron in an Underground Application
- Types of Piping Materials
- Code Requirements
- Trenching Comparisons
- Bedding, Compaction and Soil Conditions

3 **Benefits of Cast Iron Underground Installation**

Flexible vs. Rigid Piping Materials

4 **Benefits of Cast Iron Underground Installation**

- Define flexible and rigid piping
- Trenching
- Loading recommendations
- Compaction, bedding & soil types
- Water control / special conditions
- Testing procedures

5 **Typical Piping Materials Used for Underground DWV Installations**

Plastic

6 **Flexible DWV Piping (Plastics)**

Flexible Piping:

- Type of piping / fittings that rely on the side-fill stiffness of trench construction and compaction to limit outward deflection which contributes to failure
- Considered failed at 3-5% deflection

7 **Flexible DWV Piping Materials**

Flexible Piping Materials:

8 **Rigid DWV Piping**

Rigid Piping:

- Type of piping / fittings expected to support the anticipated earth and live loads with little to no deflection
- Failure occurs when pipe and fittings are loaded to the point where they crush

9 **Rigid DWV Piping Materials**

Rigid Piping:

10 **Code Requirements Indicate Approved Underground Materials**

Plumbing Codes:

- Sanitary Drainage
- Storm Drainage

IPC Table 702.2
UPC Table 701.2

UPC- 314.4.1 for
Installation of Thermoplastic Pipe and Fittings

11 **Codes, Standards & Manufacturer Installation Instructions**

PLUMBING CODES:
Chapter 3
(General Regulations)

12 **Codes, Standards & Manufacturer Installation Instructions**

Material Standards with Recommended Installation Instructions:

- ASTM D2321
  Dominant standard for plastic underground installations
- CISPI 301
  Recommended installation procedures for cast iron
-
- Check Manufacturer's Installation Instructions

13 **Benefits of Cast Iron Underground Installation**

Trenching Recommendations

14 **Underground Trenching Comparison**

15 **Underground Trenching**
Benefits of Cast Iron

1 Cast Iron

2
- Burial of cast iron soil pipe is often regarded as a simple task due to its inherent strength. Failure determined when pipe fractures
- Trench Width Cast Iron Pipe:
  As narrow as installer needs to make joint connections
- Trench Bottom: Pipe should be continuously supported, with hub / coupling holes excavated

3 Plastic

4
- Plastic piping failure is considered at 3-5% deflection
- Trench Width: Determined by soil type, depth of trench and the excavation equipment used
- Trench Width Flexible Pipe: Must be wide enough to allow for compaction to limit pipe defection. Per ASTM D2321, 3-5% deflection is considered failure
-

16 **Trenching for Thermo-**
plastic Piping Per ASTM D2321

1 OPTION 1:

2 Pipe Outside Diameter,
plus 16"
Pipe OD + 16" = Trench Width

Example:
4" PVC-4.50 (OD) + 16 = 20.5" trench width

▪

3 OPTION 2:

4 Pipe Outside Diameter multiplied by 1.25, plus 12"
(Pipe OD x 1.25) + 12" = Trench Width

Example:
4" PVC - (4.50 OD x 1.25) = 5.625 + 12 = 17.625" trench width
•

17 **Types of Loads on Underground DWV Pipe Materials**

- Non-pressure, underground DWV pipe materials are subjected to external loads - Earth and Live Loads
- Earth Load = Backfill Weight
- Live Load (Truck Load) = Traffic and Impact
- Total Load = Earth Load + Live Load (external)

18 **Benefits of Cast Iron Underground Installation**

Bedding, Compaction & Soil Conditions

19 **Bedding of Plastic Pipe**

- Minimum 4" bedding material required
- Engineer or soil conditions could require more
- If "quick" soil conditions exist, extensive items and steps maybe required
- Soil conditions is first step in bedding and backfilling
- Identification of native soil and if additional soils must be brought on site to satisfy ASTM D 2321 requirements
- Soil types and installations are indicated in Tables 1 and 2 of ASTM D 2321
- Soil materials must be brought on site to satisfy and installations are indicated in Tables 1 and 2 of ASTM D2321

20 **ASTM D2321 Table 1**

Classes of Embedment and Backfill Materials

21 **ASTM D2321 Table 2**

Recommendations for Installation and Use of Soils and Aggregates for Foundations, Embedment and Backfill

22 **Compaction – ASTM D 2321 for Plastic Pipe**

- Based on Tables 1 and 2 of ASTM D2321
- Bedding: Continuous Support, Graded and Compacted
- Haunch (sides) area of pipe backfilled and compacted
- Lifts of backfill to be installed and compacted in lifts not exceeding 6"
- No heavy duty equipment used until suitably backfilled

23 **Stainless Steel Piping**

- 316L are suitable for direct burial, not 304 material
- Soil conditions could pose issues, that soil tests would identify
- 2"- 4" leveling course, free of frozen material
- No large or sharp stones, properly graded, continuous support
- End of pipe and change of directions must be braced

- 4″ Sand or crushed stone surrounding pipe
- Fill material carefully applied and compacted to 93 proctor density

24 **Cast Iron Soil Pipe Underground**

- No special bedding required
- Pipe should be continuously supported, with hub / coupling holes excavated
- Backfill should be clean earth free of large rocks (greater than 1.5″), stones, and frozen fill material
- Normal compaction to be done to appropriate levels. No special process is required as it is for flexible materials

25

26 **Benefits of Cast Iron Underground Installation**

Water Control

27 **Water Control for**
ASTM D2321 of Plastic Pipe

ASTM D2321 Requires water control measures if these two conditions exist, because plastic pipe is flexible and will move or shift, floatation, washout, or disturbances of the pipe and embedment

- Ground Water Conditions
- Running Water Conditions

28 **Water Control for**
ASTM D2321 of Plastic Pipe

Ground Water

- Water must be kept below bottom of trench
- Use of pumps, well points, and other suitable means
- Until trench is dug, bedding installed, pipe installed and compacted with sufficient bedding installation to prevent floatation of the pipe

29 **Water Control for**
ASTM D2321 of Plastic Pipe

Running Water

- All running, ground, drainage and surface water must be controlled
- Dams, cutoffs or other barriers during installation of pipe, bedding, backfill through compaction to prevent disturbance of the pipe and embedment

30 **Benefits of Cast Iron Underground Installation**

Differences in Testing Methods

31 **Ground Preparation**

1 Cast Iron

- No sampling of soil needed
- No special leveling of the ground needed
- No specific compaction methods

32 **Ground Preparation**

Stainless Steel Tubing

- No sampling needed
- Soil conditions could pose issues, that soil tests would identify

- 2″- 4″ leveling course, free of frozen material
- No large or sharp stones, properly graded, continuous support
- Must verify the product is installed/buried per the engineers specification

33 **Ground Preparation**

Plastic (PVC / ABS)

- Soil must be sampled for compaction levels
- Must inspect bedding to meet engineers specification
- Per ASTM D2321 the engineer should inspect the following at necessary intervals:
  trench depth
  water conditions
  foundations
  embedment / backfill materials

-
-

34 **Joining Methods**

Cast Iron

- Can verify the materials used without removal
- Can verify the correct torque on couplings without removal
- Can remove sections without damaging the product to test by floor/section, etc.
- Any defective items can be removed and replaced without disturbing the installation
- Additional methods: standard couplings, medium duty and heavy duty

35 **Joining Methods**

Stainless Steel

- No way to verify the strength of the joint
- No way to verify if the pipe was damaged/distorted before assembly
- Only one joining method

36 **Joining Methods**

Plastic (PVC / ABS)

- No way to verify cements used for joints once assembled
- Must inspect bedding to meet engineers specification
- Defective products cannot be removed without destroying the joint

37 **Why Cast Iron Soil Pipe is a great choice for underground DWV piping?**

1 • Strength & durability
- No infiltration or exfiltration
- Ease of installation
- Design of compatibility
- Meets or exceeds codes

2 • Easy to verify proper installation
- Corrosion resistance
- Nonflammable
-

38 **What You Learned**

1 As a flexible material, PVC is dependent on side-fill stiffness and compaction to limit deflection. ASTM D2321 recommends a trench width of the pipe outside diameter plus 16″ or pipe outside diameter multiplied by 1.25 plus 12″

•

2 The rigid material of cast iron pipe does not depend on sidefill stiffness, so the trench can be as narrow as the installer needs to make joint connections

•

3 • Cast Iron Soil Pipe

4 • PVC Soil Pipe

Laura Loziuk

Technical Services Regional Manager

McWane Plumbing Group (Tyler, AB&I, Wade & Husky)

www.mcwaneplumbingtechservices.com

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Laura Loziuk is a Strategic Codes & Standards Specialist for McWane Plumbing Technical Services who works with plumbing industry design professionals and enforcement agencies to provide the education and technical expertise to solve technical design issues with innovative materials/solutions.

Laura believes providing the technical education needs of the industry is essential to ensuring buildings are constructed/designed to be safe and sanitary for the occupants.Laura is an active member of Women of ASPE, IAPMO, ICC, and ASTM. She is also a Board member of the Philadelphia chapter of ASPE.

Laura has a Bachelor's degree in Civil Engineering from Florida Atlantic University and has been active in the construction industry for over 12 years.

Underground Installation Benefits of Cast Iron

Laura Loziuk
Technical Services Manager
McWane Plumbing Group

You Will Learn About:

- The Benefits of Cast Iron in an Underground Application
- Types of Piping Materials
- Code Requirements
- Trenching Comparisons
- Bedding, Compaction and Soil Conditions

Benefits of Cast Iron Underground Installation

Flexible vs. Rigid Piping Materials

Benefits of Cast Iron Underground Installation

- Define flexible and rigid piping
- Trenching
- Loading recommendations
- Compaction, bedding & soil types
- Water control / special conditions
- Testing procedures

Typical Piping Materials Used for Underground DWV Installations

Plastic

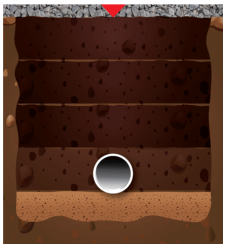
Cast Iron

Stainless Steel Tubing

Flexible DWV Piping (Plastics)

Flexible Piping:

- Type of piping / fittings that rely on the side-fill stiffness of trench construction and compaction to limit outward deflection which contributes to failure
- Considered failed at 3-5% deflection



Flexible DWV Piping Materials

Flexible Piping Materials:

Plastic

Stainless Steel Tubing

Rigid DWV Piping

Rigid Piping:

- Type of piping / fittings expected to support the anticipated earth and live loads with little to no deflection
- Failure occurs when pipe and fittings are loaded to the point where they crush

Rigid DWV Piping Materials

Rigid Piping:

Cast Iron

Vitrified Clay

Concrete

Code Requirements Indicate Approved Underground Materials

Plumbing Codes:

- Sanitary Drainage
- Storm Drainage

IPC Table 702.2
UPC Table 701.2

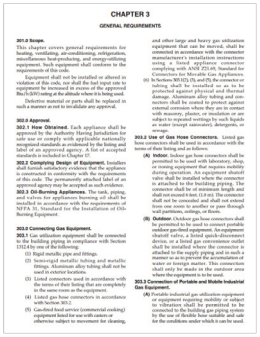
UPC- 314.4.1 for Installation of Thermoplastic Pipe and Fittings

Codes, Standards & Manufacturer Installation Instructions

PLUMBING CODES:

Chapter 3
(General Regulations)

- Covers General Requirements of trenching and backfilling.
- 2018 UPC section 314.4.1 covers the Underground installation requirements for Thermoplastic Pipe and fittings.
- UPC Table 701.2 and IPC Table 702.2 provides approved materials for underground installation.
- Storm Drainage chapters for underground materials refer back to these tables.



CHAPTER 3

GENERAL REQUIREMENTS

301.0 Scope.

This chapter covers general requirements for heating, ventilating, air-conditioning, refrigeration, miscellaneous heat-producing, and energy-utilizing equipment. Such equipment shall conform to the requirements of this code.

Equipment shall not be installed or altered in violation of the terms of its listing. Such equipment shall be increased in excess of the approved Btu/h/kW rating at the altitude where it is being used.

Defective material or parts shall be replaced in such a manner as not to invalidate any approval.

302.0 Approval.

302.1 How Obtained. Each appliance shall be approved by the Authority Having Jurisdiction for use and installation in accordance with generally recognized standards as evidenced by the listing and label of an approved agency. A list of accepted standards is included in Chapter 17.

302.2 Complying Design of Equipment. Installers shall furnish satisfactory evidence that the appliance is constructed in conformity with the requirements of this code. Such evidence shall consist of an approved agency may be accepted as such evidence.

303.3 Oil-Burning Appliances. The tank, piping, and valves for appliances burning oil shall be installed in accordance with the requirements of NFPA 31, Standard for the Installation of Oil-Burning Equipment.

303.0 Connecting Gas Equipment.

303.1 Gas utilization equipment shall be connected to the building piping in compliance with Section 1312.4 by one of the following:

(1) Rigid metallic pipe and fittings.
(2) Semi-rigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.
(3) Listed gas hose connectors in accordance with the terms of their listing that are completely in the same room as the equipment.
(4) Listed gas hose connectors in accordance with Section 303.2.
(5) Gas-fired food service (commercial cooking) equipment listed for use with casters or otherwise subject to movement for cleaning, and other large and heavy gas utilization equipment that can be moved, shall be connected in accordance with the connector manufacturer's installation instructions using a listed appliance connector complying with ANSI Z21.69, Standard for Connectors for Movable Gas Appliances.
(6) In Sections 303.3(2), (3), and (5), the connector or tubing shall be installed so as to be protected against physical and thermal damage. Connectors and tubing in concealed sections shall be coated to protect against external corrosion where they are in contact with masonry, plaster, or insulation or are subject to repeated settings by such liquids as water (except rainwater), detergents, or sewage.

303.2 Use of Gas Hose Connectors. Listed gas hose connectors shall be used in accordance with the terms of their listing and as follows:

(A) Indoor. Indoor gas hose connectors shall be permitted to be used with laboratory, shop, or similar equipment where the equipment is moved during operation. An equipment shutoff valve shall be installed where the connector is attached to the building piping. The connector shall be of minimum length and shall not exceed 6 feet (1829 mm). The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors.
(B) Outdoor. Outdoor gas hose connectors shall be permitted to be used to connect portable outdoor gas-fired equipment. An equipment shutoff valve, a fixed gas connection vent device, or a listed gas convenience outlet shall be installed where the connector is attached to the supply piping and in such a manner as to prevent the accumulation of water in the connector. The connection shall only be made in the outdoor area where the equipment is to be used.

303.3 Connection of Portable and Mobile Industrial Gas Equipment.

(A) Portable industrial gas utilization equipment or equipment requiring mobility, or subject to movement for cleaning, maintenance, shall be connected to the building gas piping system by the use of flexible hose suitable and safe for the conditions under which it can be used.

Codes, Standards & Manufacturer Installation Instructions

Material Standards with Recommended Installation Instructions:

- ASTM D2321
  Dominant standard for plastic underground installations
- CISPI 301
  Recommended installation procedures for cast iron
- Check Manufacturer's Installation Instructions

Benefits of Cast Iron Underground Installation

Trenching Recommendations

Underground Trenching Comparison

Underground Installations	CISP	PVC ASTM D2321
Failure Mode	Rigid-Crush	Flexible
		5% Deflection
		Infiltration / Exfiltration
		Dependent upon side fill
Trench Width	Minimum width	O.D. + 16" or O.D. x 1.25 + 12"
		6" pipe – 20" trench
Trench Bottom	Flat w/ hub or coupling holes	Dependent upon soil type
	Uniform support	4" bedding standard
	No special bedding	6" in rock
Compaction	No special requirements	6" layers to spring line
		Hand compact around pipe
		85% - 95% compaction

Underground Trenching Benefits of Cast Iron

Cast Iron

- Burial of cast iron soil pipe is often regarded as a simple task due to its inherent strength. Failure determined when pipe fractures
- Trench Width Cast Iron Pipe: As narrow as installer needs to make joint connections
- Trench Bottom: Pipe should be continuously supported, with hub / coupling holes excavated

Plastic

- Plastic piping failure is considered at 3-5% deflection
- Trench Width: Determined by soil type, depth of trench and the excavation equipment used
- Trench Width Flexible Pipe: Must be wide enough to allow for compaction to limit pipe defection. Per ASTM D2321, 3-5% deflection is considered failure

Trenching for Thermo-plastic Piping Per ASTM D2321

OPTION 1:

Pipe Outside Diameter, plus 16"
Pipe OD + 16" = Trench Width

Example:
4" PVC-4.50 (OD) + 16 = 20.5" trench width

OPTION 2:

Pipe Outside Diameter multiplied by 1.25, plus 12"
(Pipe OD x 1.25) + 12" = Trench Width

Example:
4" PVC - (4.50 OD x 1.25) = 5.625 + 12 = 17.625" trench width

Types of Loads on Underground DWV Pipe Materials

- Non-pressure, underground DWV pipe materials are subjected to external loads - Earth and Live Loads
- Earth Load = Backfill Weight
- Live Load (Truck Load) = Traffic and Impact
- Total Load = Earth Load + Live Load (external)

Benefits of Cast Iron Underground Installation

Bedding, Compaction & Soil Conditions

Bedding of Plastic Pipe

- Minimum 4" bedding material required
- Engineer or soil conditions could require more
- If "quick" soil conditions exist, extensive items and steps maybe required
- Soil conditions is first step in bedding and backfilling
- Identification of native soil and if additional soils must be brought on site to satisfy ASTM D 2321 requirements
- Soil types and installations are indicated in Tables 1 and 2 of ASTM D 2321
- Soil materials must be brought on site to satisfy and installations are indicated in Tables 1 and 2 of ASTM D2321

ASTM D2321 Table 1

Classes of Embedment and Backfill Materials

D 2321 – 05

TABLE 1 Classes of Embedment and Backfill Materials

Class	Type	Soil Group Symbol (4 Letter)	Description	Percentage Passing Sieve Sizes 1½ in. (38 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	Atterberg Limits LL	PI	Compaction Dry Density, lb/ft³	Compaction Dry Density, kg/m³
I	Manufactured Aggregates: open-graded, clean.	None	Angular, crushed stone or rock, crushed gravel, crushed slag, crushed shells, cinders or shale; large rock fragments; contain little or no fines.	100 %	<10 %	<5 %	Non Plastic			
III	Manufactured, Processed Aggregates: dense graded, clean.	None	Well graded mixtures of sand and gravel or crushed stone with a wide range in particle sizes and sufficient fines to fill voids in the coarse material and provide moderate resistance to displacement when compacted.	100 %	>50 %	<5 %	Non Plastic			
II	Coarse-Grained Soils, clean	GW	Well graded gravels and gravel-sand mixtures, little or no fines.	100 %	<50 % of "Coarse Fraction"	<5 %	Non Plastic		>4	> 1 to 3
		GP	Poorly graded gravels and gravel-sand mixtures, little or no fines.						>4	>1 or >4
		GW	Well graded sands and gravelly sands, little or no fines.		<50 % of "Coarse Fraction"				>5	> 1 to 3
		SP	Poorly graded sands and gravelly sands, little or no fines.						>5	>1 or >4
	Coarse-Grained Soils, low dense when not fine-grained	e.g. SW-SC, SP-SM	Sands and gravels which are well graded or poorly graded and with fines.	100 %	Varies	5 % to 12 %	Non Plastic		Varies by mix SW-SC, SP-SM, etc.	
IV	Coarse-Grained Soils With Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	>50 % of "Coarse Fraction"	12 % to 50 %		<4 or <0.6" Line		
		GC	Clayey gravels, gravel-sand-clay mixtures.					>7 and >0.6" Line		
		SM	Silty sands, sand-silt mixtures.		>50 % of "Coarse Fraction"			<4 or <0.6" Line		
		SC	Clayey sands, sand-clay mixtures.					>7 and >0.6" Line		
GLY	Fine-Grained Soils (inorganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	>50 %	<50 %	<50	<4 or <0.6" Line		
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.					>7 and >0.6" Line		
VB	Fine-Grained Soils (inorganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	>50 %	<50 %	>50 %	>5 Below "A" Line		
		CH	Inorganic clays of high plasticity, fat clays.					>5 Below "A" Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100 %	>50 %	<50 %	<50 %	<5 or <0.6" Line		
		OH	Organic clays of medium to high plasticity, organic silts.				>50	>5 Below "A" Line		
	Highly Organic	Pt	Peat and other high organic soils.							

[A] Percolation Test Method C-1417 Sometimes classifications and soil symbols Moving on plasticity Index and liquid limits.
Note—"Coarse Fraction" as used in this table is defined as material retained on a No. 200 sieve.

ASTM D2321 Table 2

Recommendations for Installation and Use of Soils and Aggregates for Foundations, Embedment and Backfill

D 2321 – 05

TABLE 2 Recommendations for Installation and Use of Soils and Aggregates for Foundation, Embedment and Backfill

	Not Class (see Table 1)[A]				
	Class IA	Class IB	Class II	Class III	Class IVA
General Recommendations and Restrictions	Do not use where conditions may cause migration of pipe from proper line and grade of pipe support. Suitable for use as a foundation material, compaction is not required. Suitable for use where material is suitably graded (see 7.1.3).	Pressure compaction required to obtain pipe deflection which will minimize soil stress. Use of open materials (see 7.1.3). Suitable for use as a foundation material and cushion.	When compaction is required, dent easily (track goodation to minimize compaction). Use groups suitable for use as drainage materials or cushion.	Do not use where water conditions in trench may cause instability.	Only after detailed evaluation of proposed materials under high earth fills, surface applied wheel loads, or other heavy vibratory compaction. Do not use where conditions in trench may cause instability.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6-in. maximum layers.	Suitable as foundation and for replacing over-excavated and unstable trench bottom. Install and compact in 6-in. maximum layers.	Suitable as a foundation and for replacing over-excavated and unstable trench bottom as restricted above. Install and compact in 6-in. maximum layers.	Suitable as foundation and for replacing over-excavated trench bottom as restricted above. Do not use in thickness greater than 6 in. Install and compact in 6-in. maximum layers.	Suitable only in undisturbed condition and where trench is dry. Provide firm, stable, uniform bottom to prevent pipe movement.
Bedding	Suitable as restricted above. Install in 6-in. maximum layers. Level final grade by hand to provide uniform support. Work in shaped pipe by hand to provide uniform support.	Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable as restricted above. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable as restricted above. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).	Suitable only in dry trench conditions and where trench is dry. Provide firm, stable, uniform bottom to prevent pipe movement. Install and compact in 6-in. maximum layers. Level final grade by hand. Minimum depth 4 in. (6 in. in rock cuts).
Haunching	Suitable as restricted above. Install in 6-in. maximum layers. Work in shaped pipe by hand to provide uniform support.	Install and compact in 6-in. maximum layers. Work in shaped pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6-in. maximum layers. Work in shaped pipe by hand to provide uniform support.	Suitable as restricted above. Install and compact in 6-in. maximum layers. Work in shaped pipe by hand to provide uniform support.	Suitable only in dry trench conditions and where trench is dry. Provide firm, stable, uniform bottom to prevent pipe movement. Install and compact in 6-in. maximum layers. Work in shaped pipe by hand to provide uniform support.
Initial Backfill	Suitable as restricted above. Install by a minimum of 6 in. above pipe crown.	Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.	Suitable as restricted above. Install and compact to a minimum of 6 in. above pipe crown.
Embedment Compaction[B]	Place and work by hand to insure all excavated voids and haunch areas are filled. Use high densities as a tolerably compactible.	Minimum density 85 % Std. Proctor.[C] Use hand tampers or a tractors compactors.	Minimum density 85 % Std. Proctor.[C] Use hand tampers or a tractors compactors.	Minimum density 85 % Std. Proctor.[C] Use hand tampers or an tractors compactors. Maintain moisture content within 2 % to minimize compaction.	Minimum density 85 % Std. Proctor.[C] Use hand tampers or an tractors compactors. Maintain moisture content within 2 % to minimize compaction.
Final Backfill	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.	Compact as required by the engineer.

[A] Does IVB (MH-CH) and Class V (OL, OH, PT) Materials are unsuitable as embedment. They may be used as final backfill as permitted by the engineer.

[B] Compaction requirements are based on Class I, II, and III materials placed at the indicated moisture content and compacted to a minimum of 6 in. cover when using small mechanical compactors. When using larger compactors maintain minimum depths as required by the engineer (See 6.1.1).

[C] The minimum densities given in the table are intended as the compaction requirements for obtaining satisfactory embedment stiffness in most installation conditions (see 7.1.1).

Compaction – ASTM D 2321 for Plastic Pipe

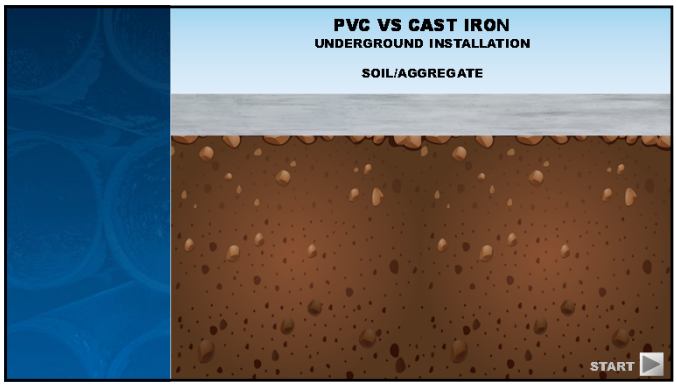
- Based on Tables 1 and 2 of ASTM D2321
- Bedding: Continuous Support, Graded and Compacted
- Haunch (sides) area of pipe backfilled and compacted
- Lifts of backfill to be installed and compacted in lifts not exceeding 6"
- No heavy duty equipment used until suitably backfilled

Stainless Steel Piping

- 316L are suitable for direct burial, not 304 material
- Soil conditions could pose issues, that soil tests would identify
- 2"- 4" leveling course, free of frozen material
- No large or sharp stones, properly graded, continuous support
- End of pipe and change of directions must be braced
- 4" Sand or crushed stone surrounding pipe
- Fill material carefully applied and compacted to 93 proctor density

Cast Iron Soil Pipe Underground

- No special bedding required
- Pipe should be continuously supported, with hub / coupling holes excavated
- Backfill should be clean earth free of large rocks (greater than 1.5"), stones, and frozen fill material
- Normal compaction to be done to appropriate levels. No special process is required as it is for flexible materials



Benefits of Cast Iron Underground Installation

Water Control

Water Control for ASTM D2321 of Plastic Pipe

ASTM D2321 Requires water control measures if these two conditions exist, because plastic pipe is flexible and will move or shift, floatation, washout, or disturbances of the pipe and embedment

- Ground Water Conditions
- Running Water Conditions

Water Control for ASTM D2321 of Plastic Pipe

Ground Water

- Water must be kept below bottom of trench
- Use of pumps, well points, and other suitable means
- Until trench is dug, bedding installed, pipe installed and compacted with sufficient bedding installation to prevent floatation of the pipe

Water Control for ASTM D2321 of Plastic Pipe

Running Water

- All running, ground, drainage and surface water must be controlled
- Dams, cutoffs or other barriers during installation of pipe, bedding, backfill through compaction to prevent disturbance of the pipe and embedment

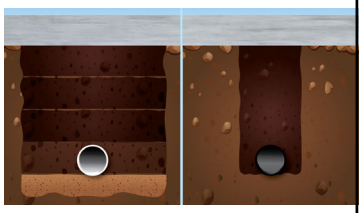
Benefits of Cast Iron Underground Installation

Differences in Testing Methods

Ground Preparation

Cast Iron

- No sampling of soil needed
- No special leveling of the ground needed
- No specific compaction methods



Ground Preparation

Stainless Steel Tubing

- No sampling needed
- Soil conditions could pose issues, that soil tests would identify
- 2”- 4” leveling course, free of frozen material
- No large or sharp stones, properly graded, continuous support
- Must verify the product is installed/buried per the engineers specification

Ground Preparation

Plastic (PVC / ABS)

- Soil must be sampled for compaction levels
- Must inspect bedding to meet engineers specification
- Per ASTM D2321 the engineer should inspect the following at necessary intervals:
  - trench depth
  - water conditions
  - foundations
  - embedment / backfill materials

Joining Methods

Cast Iron

- Can verify the materials used without removal
- Can verify the correct torque on couplings without removal
- Can remove sections without damaging the product to test by floor/section, etc.
- Any defective items can be removed and replaced without disturbing the installation
- Additional methods: standard couplings, medium duty and heavy duty

Joining Methods

Stainless Steel

- No way to verify the strength of the joint
- No way to verify if the pipe was damaged/distorted before assembly
- Only one joining method

Joining Methods

Plastic (PVC / ABS)

- No way to verify cements used for joints once assembled
- Must inspect bedding to meet engineers specification
- Defective products cannot be removed without destroying the joint

Why Cast Iron Soil Pipe is a great choice for underground DWV piping?

- Strength & durability
- No infiltration or exfiltration
- Ease of installation
- Design of compatibility
- Meets or exceeds codes
- Easy to verify proper installation
- Corrosion resistance
- Nonflammable

What You Learned

- PVC Soil Pipe

As a flexible material, PVC is dependent on side-fill stiffness and compaction to limit deflection. ASTM D2321 recommends a trench width of the pipe outside diameter plus 16" or pipe outside diameter multiplied by 1.25 plus 12"

- Cast Iron Soil Pipe

The rigid material of cast iron pipe does not depend on sidefill stiffness, so the trench can be as narrow as the installer needs to make joint connections

File Attachments for Item:

ER-10 Residential Code of Ohio (HalfMoon Education)

BO, MPE, BPE, BI, RBO, RPE (7 hours)

Staff Notes:

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER:

Course Submitter: Tim Case (Contact Name)

Organization: HalfMoon Education Inc. (Organization/Company)

Address: PO Box 278 (Include Room Number, Suite, etc.)

City: Altoona State: WI Zip: 54720

E-Mail: halfmoonce@halfmoonseminars.org

Telephone: 715-835-5900 x2035 Fax: 715-835-6066

Course Sponsor: HalfMoon Education Inc.

COURSE INFORMATION:

Course Title: Residential Code of Ohio

New Course Submittal: ■ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: The purpose and objective of this course is to instruct learners on specific code requirements of the Residential Code of Ohio. Mr. Schutz will provide an historical overview of the development and enforcement of the RCO, including any recent and anticipated amendments. The course will cover code provisions for building planning and shell construction, energy efficiency requirements, and provisions for mechanical, fuel plumbing and electrical systems.

Number of Instructional Contact Hours that can be obtained upon completion: 7.0

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■ Building Inspector ■ Fire Protection Inspector ☐ Mechanical Inspector ☐

Building Plans Exam. ✔ Plumbing Inspector ☐

Plumbing Plans Exam. ☐ Non-Res IU Inspector ☐

Electrical Plans Exam. ☐

Mechanical Plans Exam. ☐

Fire Protect. Plans Exam. ☐

Res Building Official ■ Res Plans Examiner ■ Res Building Inspector ☐ Res Mechanical Inspector ☐ Res IU Inspector ☐

Electrical Safety Inspectors ☐

Location of ESI Course: _____ Date(s) of ESI Course(s): _____

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
	Organization sponsoring or requesting the program (if any)	x
Course Title:	Name of course (related to content)	x
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	x
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	x
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	x
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	x
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	x
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	x
Test Materials:		x
Completed Application:		x

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Residential Code of Ohio

Seminar Agenda

September 2, 2021 – Akron, OH

Presented by Robert J. Schutz

8:30-9:30 **Development and Enforcement of the Residential Code of Ohio (RCO)**

History of the International Residential Code (IRC)
Adoption and enforcement of the Residential Code of Ohio
Recent and anticipated code amendments
Future of the code

9:30-9:45 **Break**

9:45-11:45 **Building Planning and Shell Construction (Chapters 2-10)**

Definitions
Alternative provisions and design criteria
Wind effects and protection of openings
Seismic provisions
Story height and live loads Snow loads
Fire-resistant construction and exterior walls
Dwelling unit separations and garage separation
Ceiling heights Glazing
Garages and carports Ingress, egress and stairways
Fire and carbon monoxide safety and detection
Foam plastic
Wood and wood-based products Accessibility
Floods, storms and drainage
Soils and foundations Framing and fastening
Walls and wall covering Roof/ceiling construction
Roof assemblies Fireplaces and chimneys

11:45-12:45 **Lunch**

12:45-2:00 **Energy Efficiency (Chapter 11)**

Compliance Building thermal envelope
Climate classifications Permanent energy certificate
Insulation and fenestration
Building systems Lighting

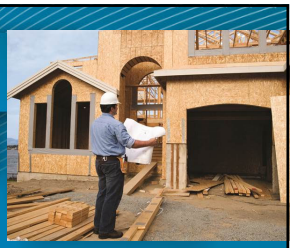
2:00-2:15 **Break**

2:15-5:00 **Mechanical, Fuel, Plumbing and Electrical Systems**

Appliance installation and exhaust systems
Ventilation Hydronic systems
Fuel gas systems and appliances
Plumbing fixtures Drains
Backflow preventers, venting, sumps and ejectors
Fire sprinkler systems
Electrical system grounding
Intersystem bonding termination
Overcurrent devices Electrical outlets
Luminaires Pools, spas and hot tubs

Instructor Information: **Robert J. Schutz, PE, PS, CPO**
Consulting Engineer & Code Instructor
PO Box 1381
Columbus, OH 43216-1381

Instructor Biography: **Robert J. Schutz** is a recently retired building official with the City of Columbus, Ohio. He was previously a senior staff engineer with the International Code Council in product development after several years as their manager of instructors in the ICC Training & Education Department. He has also served as an assistant architect administrator at the Ohio Board of Building Standards. While with the State of Ohio, he oversaw the new Residential Code of Ohio program, including certification of local residential code departments and personnel. His varied previous experiences include active military service during the 1980s as an Army Corps of Engineers (ACE) officer; building code enforcement for several central Ohio jurisdictions, including ten years as chief building official (CBO) for the City of Powell where he also served as city engineer and director of public services; and chief engineer for the Ohio Department of Health, where he chaired the state's plumbing advisory board, was chief of plumbing and was a voting member on the Ohio Board of Building Standards.



RESIDENTIAL CODE OF OHIO FOR ONE-, TWO-, AND THREE-FAMILY DWELLINGS

(Effective – July 1, 2019)

Code Administration –

The Residential Code of Ohio uses the 2018 IRC as its base document; however Chapter 1, Administration of the IRC is deleted in its entirety and replaced by a unique, specific Ohio administrative chapter.

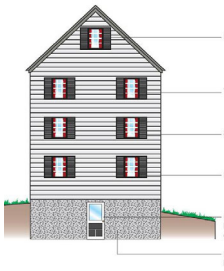
RCO - Residential Code of Ohio

- Regulates of 1-, 2-, and 3-family dwellings
- Applies to accessory structures
- Contains building, energy and fuel gas codes
- References OMC, OPC and NEC (2017)
- May be used for other residential occupancies as referenced in the OBC (310.)

Single-family dwelling

Other OBC residential

Dwellings



Habitable attic is not considered a story

Maximum 3 stories above grade plane

Allows a full basement in addition to 3 stories

Dwelling – (202)

- Any building that exclusively contains one, two , or three dwelling units each of which may be occupied by a family and no more than 5 lodgers or boarders, intended, or designed to be built to be used, rented, leased, let or hired out to be occupied or is occupied for living purposes, physically separated from adjacent structures and with an independent exit from each dwelling unit.

Dwellings

- Separate means of egress to the outdoors for each dwelling unit
  - 1 exterior exit door
  - Egress travel distance is not regulated
- No limit on size of dwellings
- 2- & 3- family dwellings require fire-resistant separations

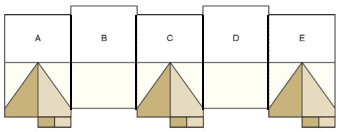
Townhouse (202, OBC)

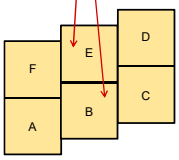
- RCO deletes the definition (although still exists in the OBC) – usually refers to "multiple single-family dwelling structures"
- A single-family dwelling unit constructed in a group of three or more attached units in which each unit extends from foundation to roof and with a yard or public way on not less that two sides.

Townhouses

Units are not open on 2 sides; cannot be constructed under the IRC

- Minimum of 3 townhouses
- No maximum on the number of townhouses
- Fire-resistant separations between townhouses
- Townhouses open on front and back





Accessory Structures (101.2, 202)

- The RCO regulates accessory buildings
  - Use incidental and accessory to dwelling
  - On same lot as dwelling
  - Unlimited area
  - ≤ 3 stories above grade plane (AGP)

Existing Buildings

- Existing buildings permitted to continue without change
  - Maintained per code under which they were constructed
- The RCO regulates additions, alterations and repairs to an existing building
- Chapter 34 offers compliance alternatives for construction on existing buildings
  - Work categorized as repair, renovation, alteration or reconstruction

Development of the IRC

2000 International Residential Code (IRC) was the first edition developed by an ICC – committee from BOCA, ICBO and SBCCI with NAHB. The result is a stand-alone document for one- and two- family dwelling design and construction -

- includes energy, plumbing, mechanical, fuel gas and electrical codes
- Appendices on radon, swimming pools, others.
- intended for statewide uniformity with local amendments or local adoption

Appendices in the IRC

- Developed in the same manner as the main body of code
- May provide some guidelines or examples of recommended practices
- May assist in the determination of alternative materials or methods
- Have no legal status until specifically recognized in the adopted ordinance or legislation
- Examples – Pools / Gas Venting / Radon / Patio Covers / Tiny Homes

Building Official Authority and Duties

- Building Official is authorized and directed to:
  - Enforce provisions of code
  - Make interpretations
  - Adopt policies and procedures
  - Approve modifications and alternatives

  Within intent and purpose of code
- Limits on authority:
  - Not authorized to waive code requirements
  - Not authorized to require more than the code

Administrative Sections (Chapter 1)

- 105 – Approvals
- 106 – Construction Documents
- 107 – Plan Approval Process
- 108 – Inspection Process
- 109 – Orders, Violations, Unsafe
- 110 – Appeals
- 111 – Certificate of Occupancy / Certificate of Completion (new)
- 113 – Existing Structures
- 114 – Products and Materials

Alternative Methods and Materials (106.4)

- The RCO does not exclude any material or method
- Alternatives subject to approval by the Building Official based on performance or Section 114
- The Building Official has an obligation to approve alternatives that meet the intent of the RCO
  - Reports issued by the ICC Evaluation Service (ICC-ES) are valuable resources in verifying performance equal to the code requirements (www.icc-es.org)
- Reason for disapproval in writing
- Alternative engineered designs also permitted (106.5)

Approvals(Permits) - (105)

- Construction requires approval before work begins, including application and construction documents
- Exempt work:
  - 1-story tool sheds, playhouses, and similar ≤ 200 ft^2
  - Decks
    - ≤ 200 ft^2
    - ≤ 30 in. above grade
    - not attached to a dwelling **and**
    - do not serve the required exit door
  - Fences ≤ 6 feet in height
  - (there are 16 exemptions)

Fees

- Jurisdiction may charge fees to offset costs of providing associated services to the public
  - Administration costs
  - Plan review costs
  - Inspection costs
- Building Official / Jurisdiction develops equitable and consistent procedures for establishing fees

Required Inspections (108)

- Foundation
- Floodplain
- Plumbing, Mechanical, Fuel Gas and Electrical
- Frame and Masonry
- Fire-Resistance-Rated Construction (FRRC)
- Other inspections as deemed necessary
  (Site / Energy / Solar / Thermal / Radon)
- Final Inspection – Certificate of Occupancy

Board of Appeals

- Public has the right of due process to appeal an order, decision or determination of the building official.
- Basis for appeal:
  - Code has been interpreted incorrectly
  - Code does not apply
  - Equivalent alternative was not accepted (requires written reason for disapproval)
- The Board of Appeals has no authority to waive code requirements

Definitions (Chapter 2)

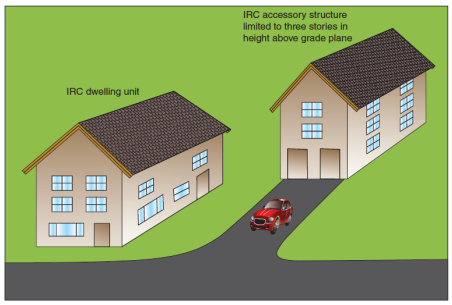
Definitions (202)

- Access (to) / Ready Access (to)
- Accessible and Type A, B, or C (sec 1101.6) or Readily Accessible (section 1101.6 (Energy))
- Air Barrier (1101.6) / Vapor Retarder (702.7)
  - Class I: less/= 0.10 Perm (Sheet PE)
  - Class II: 0.10 – 1.0 Perm (Kraft-faced FG batts)
  - Class III: 1.0 – 10 Perm (Latex / Enamel paint)
- Contamination / Pollution
- Conductor / Leader & Stack Vent / Vent Stack
- Treated Lumber (Nominal) / Riser

Accessory Structures

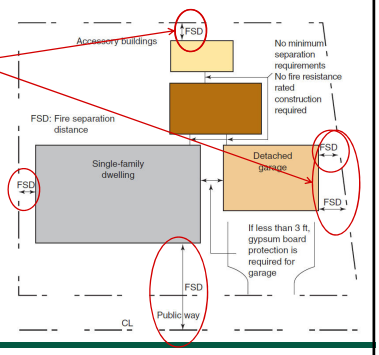
- *A building, the use of which is incidental to that of the dwelling(s) and that is located on the same lot.* (202)
- the limiting height of an RCO structure accessory to a dwelling unit has increased from 2 stories to 3 stories above grade plane (AGP).
- Accessory structure size is not regulated so long as it is subsidiary to the dwelling (height limited to 3 stories)

Accessory Structures

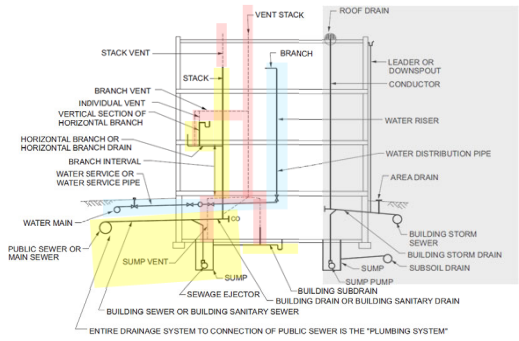


Fire Separation Distance

- Measured perpendicular <u>from</u> the exterior wall
- Measured from the building face to:
  - Lot lines
  - Centerline of a street or alley
  - Imaginary line



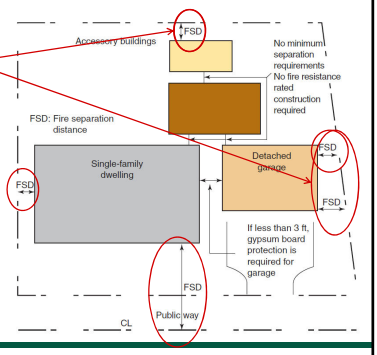
Parts of a plumbing system



Site Development

Fire Separation Distance

- Measured perpendicular from the exterior wall
- Measured from the building to:
  - Lot lines
  - Centerline of a street or alley
  - Imaginary Line



Site Preparation

- Basic provisions:
  - Site plan submittal and approval (soil tests / loads)
  - Soil characteristics as they relate to the support and stability of foundations (401.2)
  - Grading to provide surface drainage away from foundations (401.3)

General Requirements

- Exterior footings
  - Minimum of 12” below the undisturbed ground level
  - Protected against frost
- All footings must bear on:
  - Undisturbed natural soil; or
  - Compacted engineered fill

Presumptive Load-bearing Values & Properties of Soils

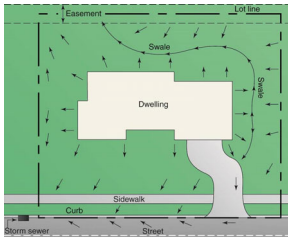
Unified Soil Classification System Symbol	Soil Description	Load Bearing Pressure (psf)	Drainage Characteristics	Frost Heave Potential	Volume Change Potential Expansion
GW	Well-graded gravels, gravel sand mixtures, little or no fines	3000	Good	Low	Low
GP	Poorly graded gravels or gravel sand mixtures, little or no fines	3000	Good	Low	Low
SW	Well-graded sands, gravelly sands, little or no fines	2000	Good	Low	Low
SP	Poorly graded sands or gravelly sands, little or no fines	2000	Good	Low	Low
GM	Silty gravels, gravel-sand-silt mixtures	2000	Good	Medium	Low
SM	Silty sand, sand-silt mixtures	2000	Good	Medium	Low
GC	Clayey gravels, gravel-sand-clay mixtures	2000	Medium	Medium	Low
SC	Clayey sands, sand-clay mixture	2000	Medium	Medium	Low
ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	1500	Medium	High	Low
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	1500	Medium	Medium	Medium to Low
CH	Inorganic clays of high plasticity, fat clays	1500	Poor	Medium	High
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	1500	Poor	High	High

Fill

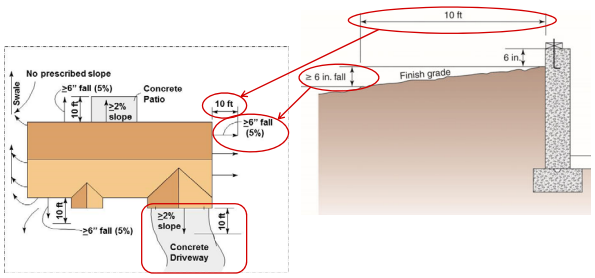
- Engineered fill is required for:
  - Over-excavation to remove unsuitable soils
  - Additional material to raise the elevation of the footings above the existing undisturbed soil
- Engineered fill must be:
  - Designed by a registered design professional
  - Installed as specified in design requirements
  - Tested as specified in design requirements

Storm Drainage

- Final grade
  - Minimum fall 6” within 10’ of foundation
  - Exception for local site conditions
    - Water can be directed to swales or drains
  - Concrete surfaces within 10’ of the foundation need 2% slope



Storm Drainage



Chapter 3

Climatic & Geographic Design Criteria and Loads

Table R301.2(1)

Climatic and Geographic Design Criteria

- RCO adoption: jurisdiction completes table with data applicable to the jurisdiction – for example:

Ground Snow Load	Wind Design				Seismic Design Category
	Speed (mph) V_{ult}	Topographic Effects	Special Wind Region	Wind-borne Debris Zone	
30 psf	115 mph	Deleted	Deleted	Deleted	B

Table R301.2(1) (Continued)

Climatic and Geographic Design Criteria

- RCO adoption: jurisdiction completes table with data applicable to the jurisdiction – for example:

Subject to Damage from			Ice Barrier Underlayment Required
Weathering	Frost Line Depth	Termite	
Negligible or Moderate or Severe	42 in.	Yes or No	Yes or No

Table R301.2(1) (Continued) **
Climatic and Geographic Design Criteria

Winter Design Temp	Flood Hazards	Air Freezing Index	Mean Annual Temp
2º F	Date NFIP, Etc.	1197	51º F

Prescriptive and Performance

- Prescriptive requirements
  - A specific set of rules to follow

    Ex: Wall frame of 2 X 4's @ 16" o/c with . . .
- Performance requirements
  - Expectation that the system will function certain way
  - For structural requirements, performance is achieved through engineering

  Ex: Two-family dwelling units must be separated by two 1-hour fire-resistance-rated walls, or . . .

Prescriptive and Performance

- Conventional construction
  - Engineered design can be used for structural elements that:
    - Exceed the limits in the code; or
    - Are not included in the code
- Alternative to wood framing provisions
  - Wood Frame Construction Manual published by the American Wood Council
    - WFCM addresses wind speeds up to 150 mph
    - IRC wind speeds are less than 110 mph

For example, the sizing of wide flange steel beams

Live Loads

IRC Table R301.5

Minimum Uniformly Distributed Live Loads

USE	LIVE LOAD (psf)
Uninhabitable attics without storage	10
Uninhabitable attics with limited storage	20
Habitable attics and attics served with fixed stairs	30
Balconies (exterior) and decks	40
Fire escapes	40
Rooms other than sleeping rooms	40
Sleeping rooms	30

Live Loads (Continued)

RCO Table R301.5

Minimum Uniformly Distributed Live Loads

USE	LIVE LOAD (psf)	
Guardrails and handrails	200	Single concentrated load applied in any direction along the top.
Guardrail in-fill components	50	Horizontally applied normal load of 50 lb. on area of 1 sq. ft.
Passenger vehicle garages	50	2,000-lb concentrated load / 20-sq. in. area.
Stairs	40	300-lb concentrated load / 4 sq. in. of tread

Dead Loads

- Average dead loads are included in the prescriptive tables for:
  - Footings
  - Floors
  - Walls
  - Roofs
  - RE: 301.4 and Figure 301.4 Code Commentary

For example, spread footing sizes for conventional frame construction assume average weights for the construction materials being supported

Deflection

- Allowable deflection in structural framing members:
  - Studs
  - Joists
  - Beams
  - Rafters
- Table 301.7
  - L = span length
  - H = span heigh

Structural Member	Allowable Deflection
Rafters having slopes greater than 3:12 with no finished ceiling attached to rafters	*L*/180
Interior walls and partitions	*H*/180
Floors/ceilings with plaster or stucco finish	*L*/360
All other structural members	*L*/240
Exterior walls—wind loads with plaster or stucco finish	*H*/360
Exterior walls with other brittle finishes	*H*/240
Exterior walls with flexible finishes	*H*/120
Lintels supporting masonry veneer walls	*L*/600

Example 4-1 Floor Joist Deflection

- Floor joist span is 14’
- Allowable deflection from Table R301.7 is L/360

  L = 14’ x 12” = 168”

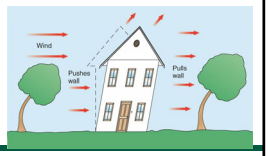
  168 ÷ 360 = 0.47

  Allowable deflection is 0.47”

Note: a 14’ span rafter with 4:12 slope and no ceiling attached has an allowable deflection of L/180, which is twice the deflection allowed for floor joists

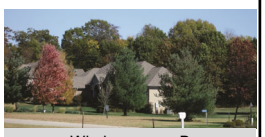
Wind Loads

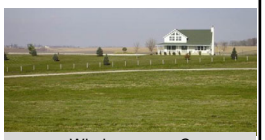
- Wind forces acting on buildings
  - IRC conventional framing limits wind speed to 140 mph V_{ult} (130 in hurricane prone areas)
  - AWC – *Wood Framing Construction Manual* (WFCM)
  - ICC 600 – *Standard for Residential Construction in High-Wind Regions*
  - ICC – *International Building Code*
  - ASCE 7 – *Minimum Design Loads for Buildings and Other Structures*



Wind Exposure Category

- Exposure B
  - Some wind protection with trees and buildings
  - Default
- Exposure C
  - Open terrain with scattered obstructions
- Exposure D
  - Flat, unobstructed areas exposed to open water, smooth mud flats, salt flats and unbroken ice for ≥ 5,000 ft


Wind exposure B


Wind exposure C

Hurricane-prone regions

- **Hurricane-prone regions.** Areas vulnerable to hurricanes, defined as the U.S. Atlantic Ocean and Gulf of Mexico coasts where the ultimate design wind speed, Vult, is greater than 115 miles per hour , and Hawaii, Puerto Rico, Guam, Virgin Islands and America Samoa.
- **Windborne debris region.** Areas within hurricane-prone regions located in accordance with one of the following:
  - Within 1 mile of the coastal mean high water line where the ultimate design wind speed, Vult, is 130 mph or greater.
  - OR
  - In areas where the ultimate design wind speed, Vult, is 140 mph or greater; or Hawaii.

Snow Loads

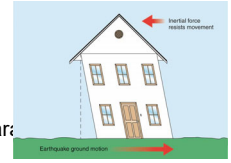
- Snow loads must be considered where applicable
- IRC and WFCM conventional framing tables are limited to snow load <70 psf

Earthquakes

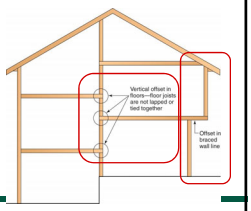
- The RCO assigns a Seismic Design Category to building sites relative to the anticipated intensity and frequency of earthquakes
- Prescriptive provisions of the RCO are adequate for SDC A and B

Seismic Design Category	1- and 2-Family Dwellings	Townhouses
A & B	No seismic requirements	No seismic requirements
C	No seismic requirements	Seismic Requirements Apply
D_0, D_1, D_2	Seismic Requirements Apply	
E	Engineered Design Required	

Earthquakes



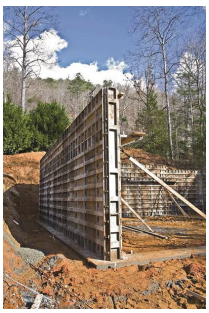
- Regularly shaped buildings
  - Uniform distribution of forces
  - More predictable response chara
- Irregularly shaped buildings
  - Force concentrations
  - Generally less effective in resisting earthquake load effects



Footings & Foundations

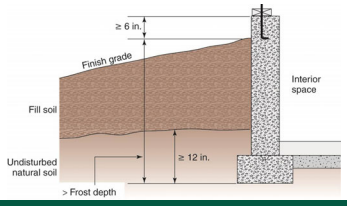
Foundation Materials

- Concrete
  - Removable forms
  - Stay-in-place insulating concrete forms (ICF)
- Precast concrete
- Masonry
- Wood
- Engineered or alternative designs



Footings

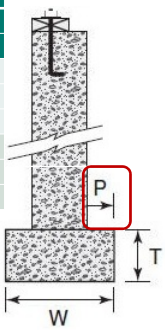
- Footings must bear on undisturbed ground
- Footings must extend below the frost depth
- Exterior footings 12” below undisturbed ground level
- Detrimental materials removed prior to placing concrete



Size of Concrete Footings

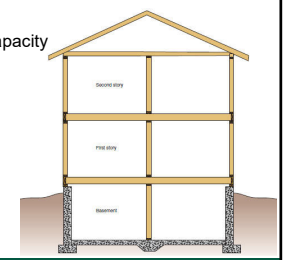
Conventional Light-Frame Construction				
Snow load	Type of foundation	Load bearing value of soil		
30 psf		1,500	2,000	2,500
1-story	Slab-on-grade	12 x 6	12 x 6	12 x 6
	With crawl space	13 x 6	12 x 6	12 x 6
	Plus basement	19 x 6	14 x 6	12 x 6
2-story	Slab-on-grade	12 x 6	12 x 6	12 x 6
	With crawl space	17 x 6	13 x 6	12 x 6
	Plus basement	23 x 6	17 x 6	14 x 6

Projection “P” ≥ 2 in. and ≤ T
Thickness “T” ≥ 6 in.
Width “W” per table



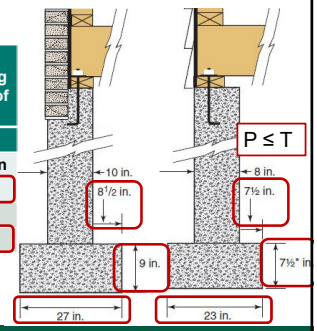
Example 5-1 Footing Size

- Determine minimum width (W), projection (P) and thickness (T) of a continuous spread footing
- Given:
  - 2-story dwelling with basement
  - 1500 psf assumed soil bearing capacity
  - 30 psf snow load
  - Conventional construction:
    - a) Light-frame construction with siding
    - b) Light-frame construction with brick veneer



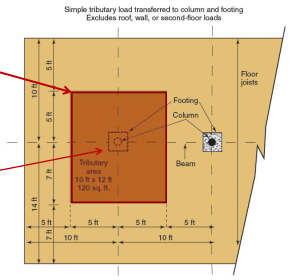
Example 5-1 Footing Size

Snow load	Type of foundation	Load bearing value of soil
30 psf		1,500
Conventional Light-Frame Construction		
2-story	Plus basement	23 x 6
With Brick Veneer		
2-story	Plus basement	27 x 9



Example 5-2
Isolated Footing Size

- Given:
  - Column supports tributary floor area of 120 ft^2 at 50 psf
  - 1,500 psf assumed soil-bearing capacity
- Determine minimum footing size

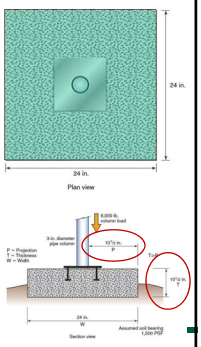


Example 5-2
Isolated Footing Size

- Soil load-bearing capacity
  - 1500 psf
- Tributary column load
  - 120 ft^2 x 50 lbs. = 6,000 lbs.

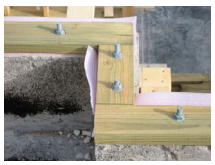
6,000 lbs. ÷ 1,500 psf = 4 ft^2

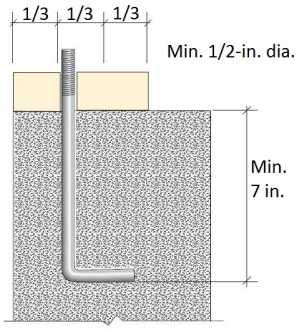
- Thickness (T) Min. 6"
- Projection (P) cannot exceed footing thickness



Foundation Anchorage

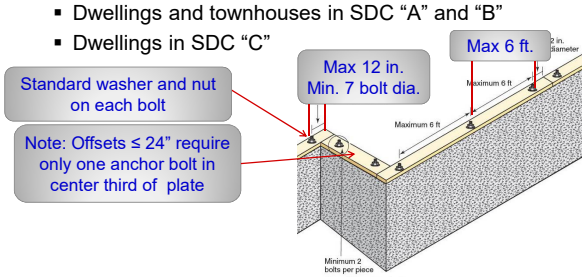
- Anchor bolts
  - ½-inch diameter
  - 7-inch embedment
  - Middle 1/3 of plate deleted from RCO





Foundation Anchorage

- Wood sill plate anchorage to foundation for
  - Dwellings and townhouses in SDC "A" and "B"
  - Dwellings in SDC "C"

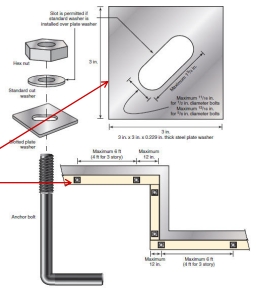


Foundation Anchorage

- Wood sill plate anchorage Seismic
  - Dwellings and townhouses in SDC D_0, D_1 and D_2
  - Townhouses in SDC C

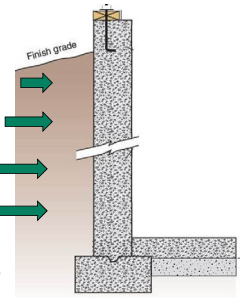
3" x 3" plate washers approximately ¼" thick

Bolt spacing ≤ 4' for anchorage of 3-story buildings



Concrete Foundation Walls

- Foundation walls must be constructed to resist lateral loads
- Thickness and vertical reinforcement determined by:
  - Soil type
  - Height of foundation
  - Height of unbalanced backfill
    - Difference in height between the exterior finish ground level and the top of the interior basement floor



Concrete Foundation Walls

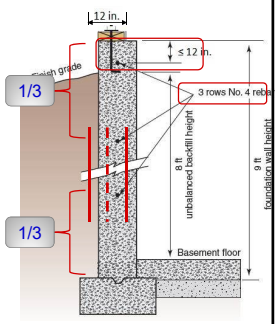
- Horizontal reinforcing required for basement walls
  - Table R404.1.2(1)

Maximum Unsupported Height of Basement Wall	Location of Horizontal Reinforcement
≤8 feet	One No. 4 bar within 12" of the top of the wall and one No. 4 bar near mid-height of the wall story
>8 feet	One No. 4 bar within 12" of the top of the wall and one No. 4 bar near third points the wall story

- Vertical reinforcing required
  - Tables R404.1.2(2) through R404.1.2(9)

Horizontal Reinforcing in Concrete Basement Wall

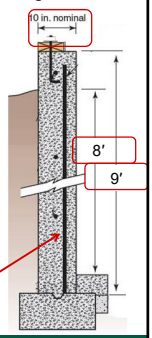
- Table R404.1.2(1)
  - Three horizontal No. 4 bars
  - One bar within 12" of top
  - Other bars at third points
  - Bars located center of wall



Vertical Reinforcing in Concrete Basement Wall

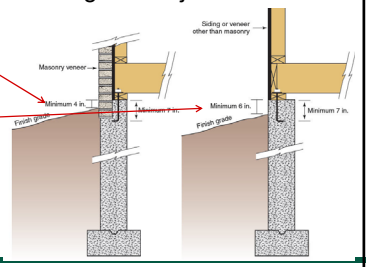
- Soil class = CL inorganic sandy clay
- 10″ nominal thickness
- Wall height = 9′
- Unbalanced backfill height = 8′
- Table R404.1.2(8) Vertical Reinforcement
  - No. 6 bars at 39 inches on center

Wall Hgt.	Unbal. backfill	Soil class			
		SC, ML-CL and inorganic CL			
		6″	8″	10″	12″
	6	6 @ 36	6 @ 39	NR	NR
9	7	6 @ 33	6 @ 38	5 @ 37	NR
	8	6 @ 24	6 @ 29	6 @ 39	4 @ 48



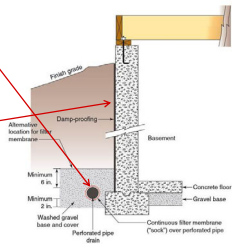
Height Above Finished Grade

- Concrete and masonry foundation walls must extend above the finished grade adjacent to the foundation
  - Minimum of 4” with masonry veneer
  - Minimum of 6” elsewhere



Moisture Protection

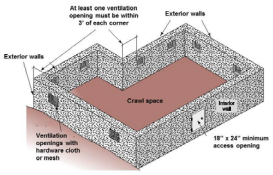
- Drainage by perforated pipe or other approved drain system
  - Installed at or below the level of the basement or crawl space floor
  - Exception for areas with well-drained soils
- Dampproofing materials applied to the exterior of the foundation
- Waterproofing in areas with a high water table or other known severe soil-water conditions
  - Flexible sealants or other impervious material



Underfloor Space

- Ventilation of crawl space required
  - Circulate air
  - Dissipate condensation
- Method of ventilation
  - Foundation openings
  - Mechanical exhaust ventilation
  - Connection to the conditioned air supply of the dwelling
- Access to underfloor spaces
  - 18” x 24” through floor
  - 16” x 24” through wall

  Dehumidification if closed



Framing - Walls, Floors & Roofs

Framing

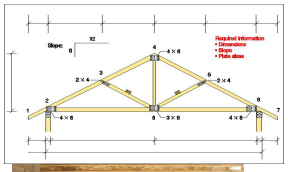
- Light-frame construction
  - Wood or cold-formed steel
- Grade mark on wood products
  - Wood structural panels
  - Load-bearing dimension lumber

Engineered Wood Products

- Plate-connected open web trusses
- I-joists
- Glued-laminated lumber
- Laminated veneer lumber (LVL)
- Other structural composite lumber (SCL)

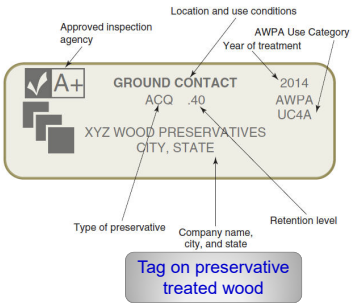
Wood Trusses

- Design submitted to building official for approval
- Include:
  - Design loads
  - Slope or depth, span and spacing
  - Required bearing widths
  - Lumber size, species and grade
  - Connection requirements
  - Required permanent bracing location
  - Other information

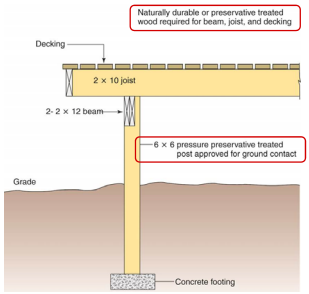


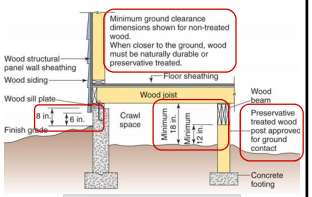
Wood Treatment

- Wood in locations subject to decay requires:
  - Wood treated with preservatives; or
  - Naturally durable wood
    - Redwood
    - Cedar
    - Black locust
    - Black walnut



Protection Against Decay

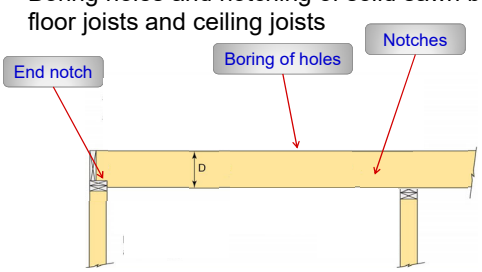




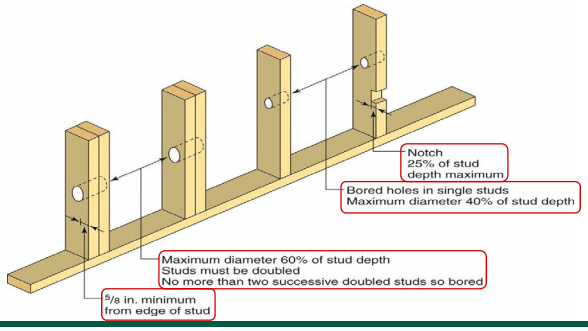
Clearance above grade

Boring and Notching Floor and Ceiling Joists

- Boring holes and notching of solid sawn beams, floor joists and ceiling joists

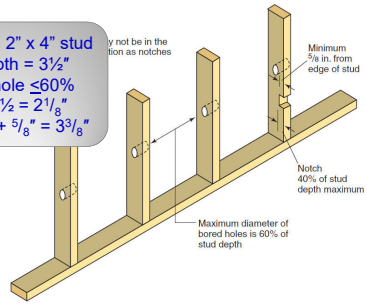


Boring and Notching Bearing Walls

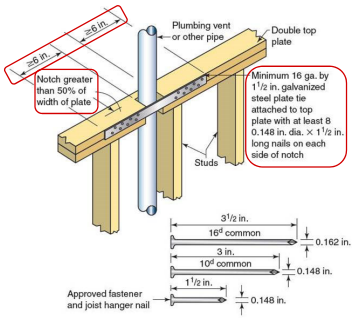


Boring and Notching Nonbearing Walls

Hole size in 2" x 4" stud
Stud depth = 3½"
Largest hole ≤60%
60% x 3½ = $2\frac{1}{8}$"
$\frac{5}{8}$" + $2\frac{1}{8}$" + $\frac{5}{8}$" = $3\frac{3}{8}$"



Repair Bearing Wall Top Plate

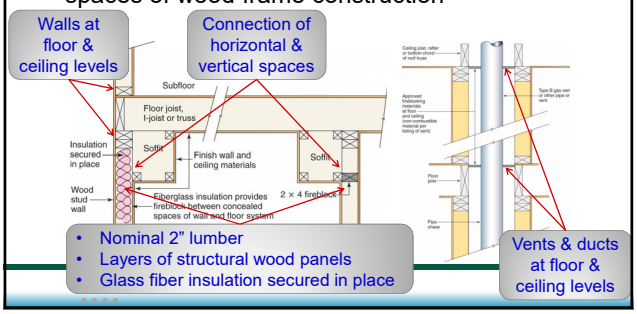


Fireblocking

- Designed to stop the spread of fire in concealed spaces of wood frame construction

Walls at floor & ceiling levels

Connection of horizontal & vertical spaces



- Nominal 2" lumber
- Layers of structural wood panels
- Glass fiber insulation secured in place

Vents & ducts at floor & ceiling levels

Draftstopping

- Divide concealed floor assembly spaces into areas of <1000 ft^2
- Materials:
  - 1/2" gypsum board
  - 3/8" wood structural panels
  - Other approved materials

Wood Floor Framing

- Prescriptive tables for:
  - Beams and girders
    - No. 2 grade Douglas fir-larch, hem-fir, southern pine and spruce-pine-fir
    - Various support conditions
  - Floor joists
    - Specific grade and species of lumber
    - Live load 30 psf or 40 psf
    - Dead load 10 pdf or 20 psf

Example 6-1
Beam Size and Bearing Support

- Determine the minimum size and bearing support requirements for an interior beam supporting 2 floors
- #2 hem-fir lumber
- Building width = 28'
- Beam span = 6'

Girder supporting	Size	Building width		
		20	28	36
		Span	Span	Span
Two floors	3-2x10	6-2	5-4	4-10
	3-2x12	7-2	6-3	5-7
	4-2x8	6-1	5-3	4-8
	4-2x10	7-2	6-2	5-6

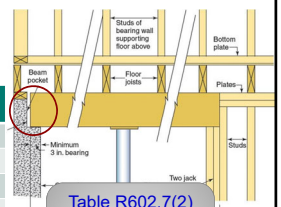


Table R602.7(2)
- Three 2 x 12
  or
- Four 2 x 10

Example 6-2
Joist Size and Spacing

- Living area = 40 psf LL
- #2 Douglas fir-larch
- Dead load = 10 psf
- Span = 14'

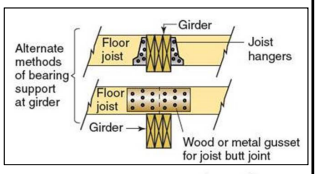
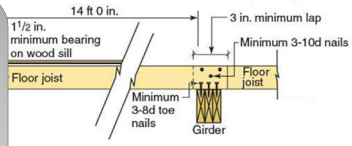


Table R502.3.1(2)

Joist Spacing	Joist Size	Span
12" O.C.	2 x 8	14 – 2
16" O.C.	2 x 10	15 – 7
19.2" O.C.	2 x 10	14 – 3
24" O.C.	2 x 12	14 – 9



Fastener Schedule for Floor Framing

- IRC Table R602.3(1)
  Fastener Schedule for Structural Members
- Common nails

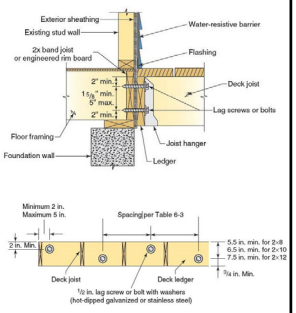
Description	Nails	Spacing
Rim joist to plate, toe nail	8d	6" O.C.
Joist to sill or girder, toe nail	3 - 8d	–
Joists lapped at bearing support, face nail	3 - 10d	IRC Section R502.6.1
Built-up girders and beams	10d	24" O.C. at top and bottom and staggered. Three nails at ends and at each splice.

Exterior Decks (507)

- 507.1 Decks = wood-frame
- 507.2 Materials
  - Wood; or
  - Plastic composite board
- Fasteners & connectors
  - Table 507.2.3
  - Flashing
  - Alternate materials (glass)
  - Footings
  - Posts
  - Beams
  - Joists

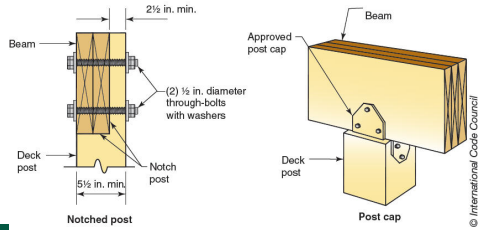
Deck Attachment (507

- Deck ledger connection to:
  - 2" band joist; or
  - 1 x 9½ Douglas Fir LVL rim board
- Fasteners
  - ≥½" diameter lag screws or bolts with washers
  - Hot-dipped galvanized or stainless steel
  - Lag screws full-depth through rim joist
  - Fasteners staggered along length of ledger



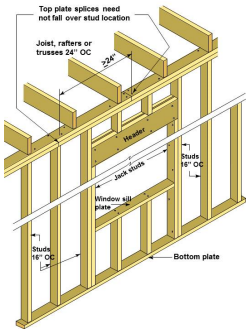
Deck Joists and Beams (507)

- Prescriptive methods for joists and beams in deck construction.
  - Spans & bearing requirements



Wall Framing (601)

- Size and spacing of studs is related to:
  - Number of floors being supported
  - With or without the additional load of the roof-ceiling assembly



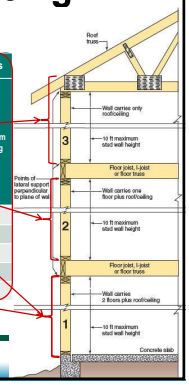
Example 6-3
Stud Size and Spacing

- Determine the minimum size, maximum height and maximum spacing of standard studs in an exterior bearing wall
- Given:
  - 3 stories of wood framing (walk-out basement plus 2 stories)
  - Standard- or stud-grade lumber

Example 6-3
Stud Size and Spacing

- Table R602.3(5)

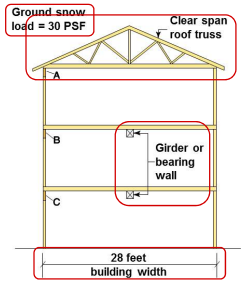
Stud Size (inches)	Bearing Walls					Nonbearing Walls	
	Laterally Unsupported Stud Height (feet)	Maximum Spacing When Supporting a Roof/Ceiling Assembly or a Habitable Attic Assembly Only	Maximum Spacing When Supporting One Floor, Plus a Roof/Ceiling Assembly or a Habitable Attic Assembly	Maximum Spacing When Supporting Two Floors Plus a Roof/Ceiling Assembly or a Habitable Attic Assembly	Maximum Spacing When Supporting One Floor Only	Laterally Unsupported Stud Height	Maximum Spacing
2 x 3	--	--	--	--	--	10'	16"
2 x 4	10 ft	24"	16"	--	24"	14'	24"
3 x 4	10 ft	24"	24"	16"	24"	14'	24"
2 x 5	10 ft	24"	24"	--	24"	16'	24"
2 x 6	10 ft	24"	24"	16"	24"	20'	24"



Stud height in bearing walls is generally limited to 10'

Example 6-4
Header Size in Exterior Walls

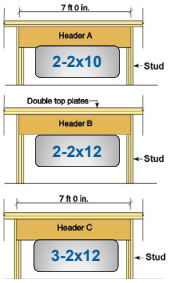
- Given:
  - Ground snow load = 30 psf
  - Clear span roof truss
  - Center bearing floor framing
  - Building width = 28'
  - Header span = 7'
  - #2 Douglas fir-larch



Example 6-4
Header Size in Exterior Walls

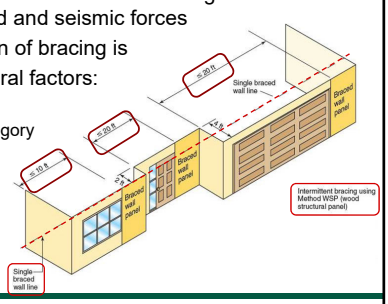
Table R602.7.1

Ground snow load = 30 psf Building width = 28 feet			
Supporting	Size	Span	Jack studs
Roof & Ceiling	2-2x10	7-3	2
	2-2x12	8-5	2
Roof, ceiling, one center-bearing floor	2-2x10	6-2	2
	2-2x12	7-1	2
Roof, ceiling, two center-bearing floors	3-2x10	6-4	2
	3-2x12	7-4	2



Wall Bracing

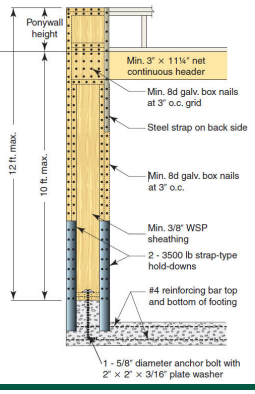
- Wall bracing provides resistance to racking from lateral loads, primarily wind and seismic forces
- Amount and location of bracing is determined by several factors:
  - Number of stories
  - Seismic design category
  - Design wind speed
  - Method of bracing



Method PFH Braced Wall Panels

Portal Frame with Hold-Downs

- Minimum hold-down capacity 3500 lbs
- Double sill plate
- 5/8-inch anchor bolt



Ceiling Joists

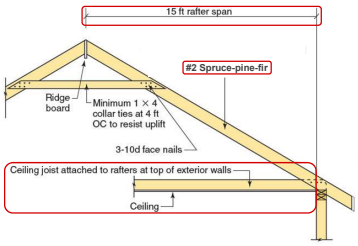
- Ceiling joists
  - Support ceiling materials
  - Serve as rafter ties to resist the outward thrust of the rafters at the top of the wall
  - Require adequate connection to the rafter and top of wall
- Ceiling joist spans for:
  - Attics without storage
  - Attics with limited storage
    - Attics with fixed stair access require joists sized as floor joists

Rafters

- Rafter spans based on:
  - Snow load of the geographic area;
  - Roof live load of 20 psf where snow load <30 psf;
  - Whether ceiling material is attached to the bottom of the rafter
- Connection to ceiling joists
  - Rafters are connected to the ceiling joists at the top plate; or
  - 2 x 4 rafter ties are required to resist the outward thrust forces of the rafters on the wall

Example 6-6
Rafter Size and Spacing

- Given:
  - #2 Spruce-pine-fir lumber
  - Span = 15'
  - Ground snow load = 30 psf
  - Dead load = 10 psf
  - Ceiling not attached to rafters

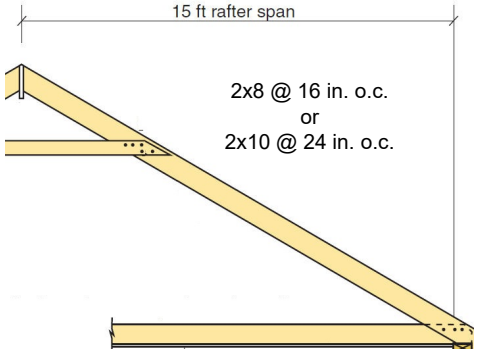


Example 6-6
Rafter Size and Spacing

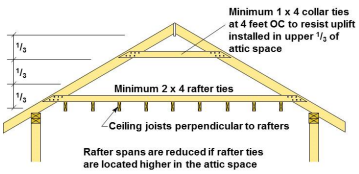
Table 802.5.1(3) - Rafter Spans

Rafter Spacing (inches)	Species and Grade	Dead Load = 10 psf		
		2 x 6	2 x 8	2 x 10
		Maximum rafter spans		
		ft - in	ft - in	ft - in
16	Douglas fir-larch #2	12-1	15-4	18-9
	Southern Pine #2	11-2	14-2	16-10
	Spruce-pine-fir #2	11-11	15-1	18-5
24	Douglas fir-larch #2	9-9	12-4	15-1
	Southern Pine #2	10-2	13-2	15-9
	Spruce-pine-fir #2	9-9	12-4	15-1

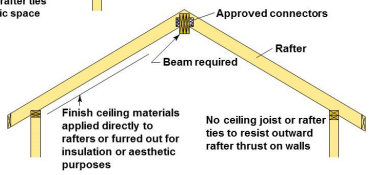
Example 6-6



Rafter Tie Alternatives



- Ridge beam



- Rafter ties

Table R602.3(1)
Fastener Schedule for Roof Framing

Description	Nails	Spacing
Rafter or roof truss to plate, toe nail	3-16d box or 3-10d common	2 toe nails on one side and 1 toe nail on opposite side
Roof rafters to ridge, valley or hip rafters	4-16d toe nail 3-16d face nail	–
Ceiling joists to plate, toe nail	3-8d common	–
Collar tie to rafter, face nail	3-10d common	–
Rafter/ceiling joist heel joint connection	Table R802.5.1(9)	–

Roof Uplift Connections

- Table provides uplift values based on:
  - Building width
  - Wind speed
  - Exposure category
  - Roof pitch
- For ≤200 lbs. uplift, toe-nail connection is OK
- For >200 lbs. uplift, a connector is required

Example
Roof Uplift Connection

- Determine uplift forces
- Given:
  - Wind speed = 115 mph
  - Wind exposure B
  - Trusses 24 in. o.c.
  - Building width = 36 ft
  - Roof slope = 5:12

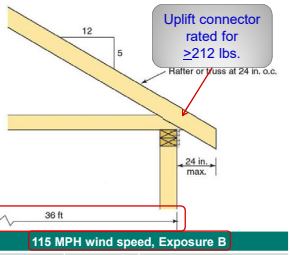


Table R802.11 – Rafter or Truss Uplift Connection Forces from Wind

115 MPH wind speed, Exposure B			
Rafter or Truss Spacing	Roof Span (feet)	Roof Pitch	
		< 5:12	≥ 5:12
24" OC	28	198	176
	32	218	194
	36	240	212

Attic Ventilation and Access

- Total net free ventilating area must be 1/150 of attic area
  - Reduced to 1/300 when 40% to 50% of ventilating area in upper portion of space
  - Unvented attics may be permitted with certain conditions
- Access to attics required when:
  - Attic area >30 ft^2, and
  - Attic height >30"
- Access
  - Minimum 22" x 30"
  - 30" headroom above the opening
  - Located in a hallway or other readily accessible location

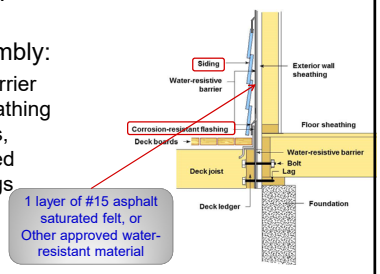
Finishes and Weather Protection

Interior Finishes

- Minimum installation requirements for:
  - Gypsum board (drywall) – ASTM Standards
  - Plaster
  - Ceramic tile
  - Wood paneling
- Inspection not required except F-R-R-C
- Vapor Retarders – R702.7 – Class I or II required interior side of frame walls – CZ 5-8
  - Exceptions – Basement / below grade / AHJ

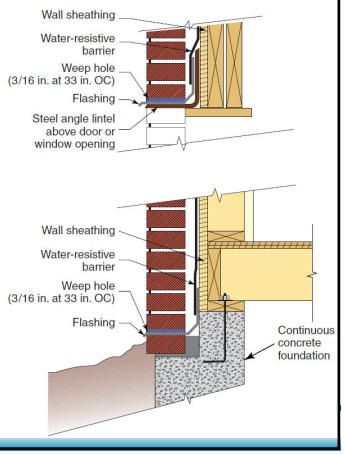
Exterior Wall Covering

- 3 components of a weather-resistant exterior wall assembly:
  - Water-resistive barrier required over sheathing of all exterior walls, except for detached accessory buildings
  - Flashing
  - Siding or veneer



Masonry and Stone Veneer

- SDC A, B or C
  - < 3 stories
  - < 30 feet above noncombustible foundations
  - Additional 8 feet for gabl end walls
  - < 5 inches thick
  - Weight < 50 psf weight
- SDC D_0, D_1, or D_2
  - Reduced height, weight and thickness limitations



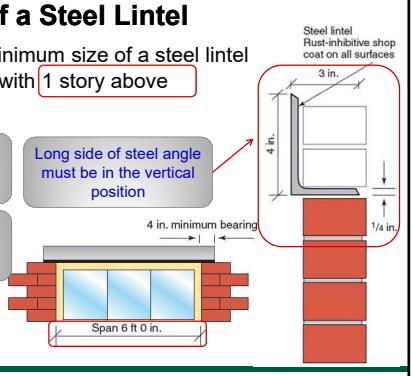
Example 7-1
Size of a Steel Lintel

- Determine the minimum size of a steel lintel masonry veneer with 1 story above

Table R703.8.3.1
Allowable Spans for Lintels
Supporting Masonry Veneer

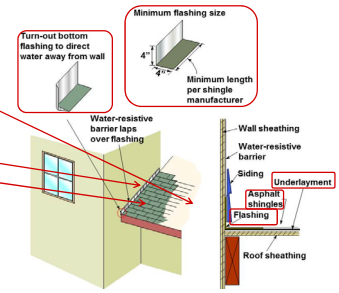
Long side of steel angle must be in the vertical position

Stories above = 1
Span = 6'0"
Steel angle = 4" x 3" x ¼"



Roof Covering

- Weather protection system:
  - Underlayment
  - Ice barriers
  - Flashing
  - Roofing material



Underlayment for Asphalt Shingles

1 layer underlayment

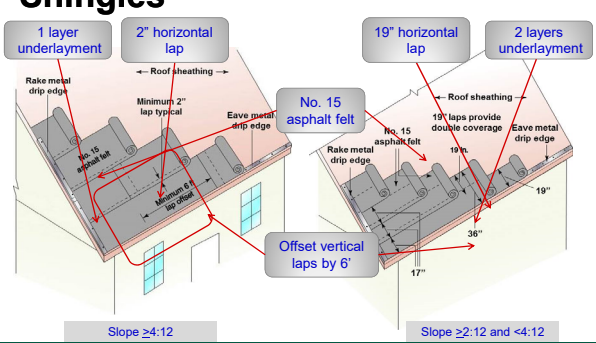
2" horizontal lap

19" horizontal lap

2 layers underlayment

No. 15 asphalt felt

Offset vertical laps by 6'

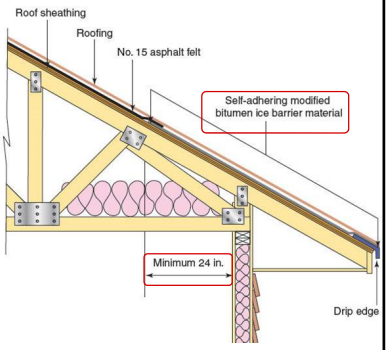


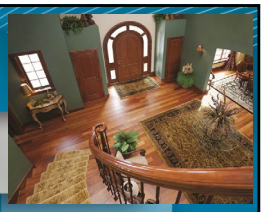
Slope ≥4:12

Slope ≥2:12 and <4:12

Ice Barriers

- Ice barrier is required in Ohio

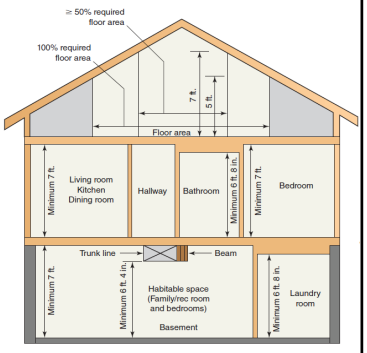




Health and Safety

Ceiling Height

- Generally 7 ft. 0 in.
- 6 ft. 8 in.:
  - Bathrooms
  - Toilet rooms
  - Laundry rooms
  - Basements w/o habitable space or hallways
- 6 ft. 4 in. basements:
  - Beams
  - Girders
  - Ducts
  - Other obstructions



Ceiling height

Means of Egress

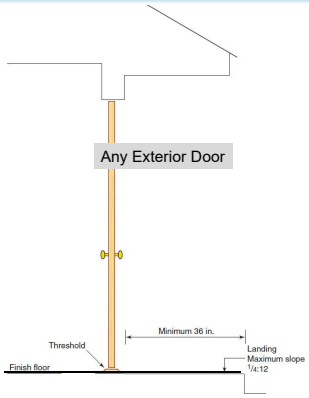
- "Means of egress" describes the path of travel from any location in the dwelling to the exterior
  - Stairways
  - Ramps
  - Hallways
  - Doors
    - One 3 - 0 × 6 - 8 side-swinging egress door to exterior
    - No size or type requirements for other doors
    - No limits on travel distance

Means of Egress

- Designed to provide a safe path to exterior
  - Does not pass through a garage
  - ½" gypsum board on enclosures under stairs
  - Egress components securely anchored to the structure
  - Required egress door can be opened without a key or special knowledge
  - Access to grade at required egress door

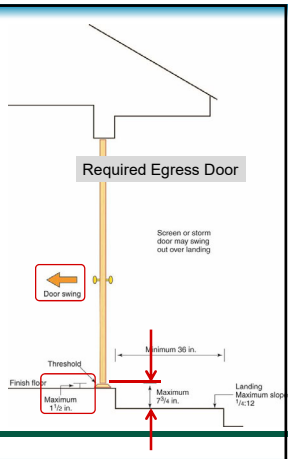
Landings at Exterior Doors

- Landing or floor on each side of exterior door
  - At least as wide as the door
  - ≥ 36 in. in the direction of travel
- Max. landing slope = ¼ / 12
- No elevation requirements in Section R311.3
- Exception for balconies



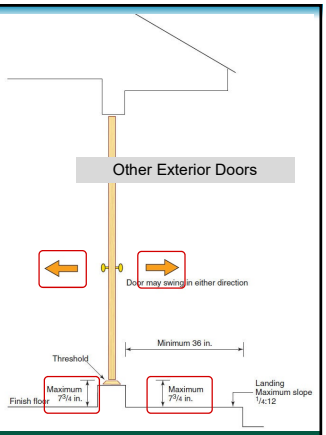
Landings at Exterior Doors

- Required egress door
- Landings or finished floors ≤ 1½ in. below top of threshold
- Exception
  - Door swings in
  - Exterior landing can be a maximum of 7¾ inches below top of the threshold
- Access to grade



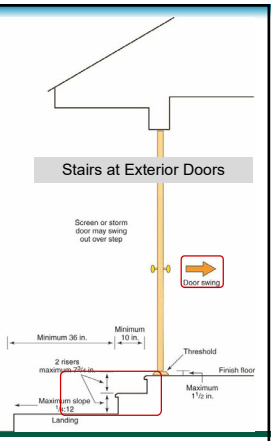
Landings at Exterior Doors

- Other than required egress door
- Landing on either side:
  - ≤ 7¾ in. below top of the threshold
- Door swings either direction



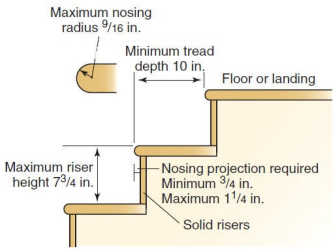
Stairs at Exterior Doors

- Door other than required egress door
- Exception
  - Stairs allowed on exterior side
    - Door cannot swing out over stairs
    - Stairs can have a maximum of 2 risers



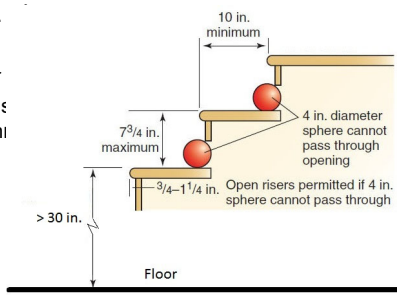
Stair treads and risers

- Riser ≤ 7¾ in.
- Tread ≥ 10 in.
- Variance ≤ ⅜ in.
- Nosing projection ¾ - 1¼ in.



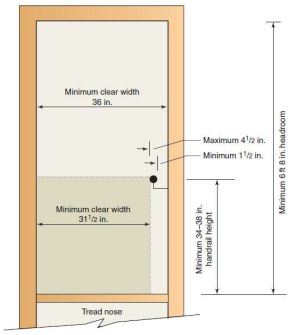
Stair treads and risers

- Treads > 30 in. floor or grade
  - Solid risers, or
  - 4-in. diameter s cannot pass thr



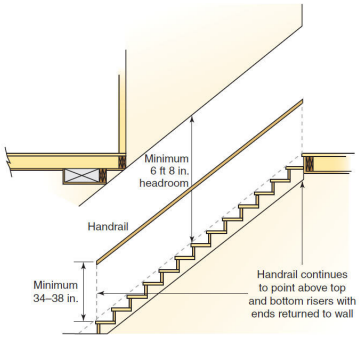
Stairway Width

- Minimum clear width of 36”
  - Required above the handrail; and
  - Below the required headroom height
  - ≤ 4½” handrail projection either side



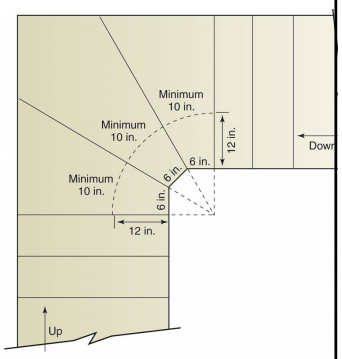
Stairway Headroom

- Minimum headroo
  - 6 ft. 8 in.
  - Above plane of tre nosings



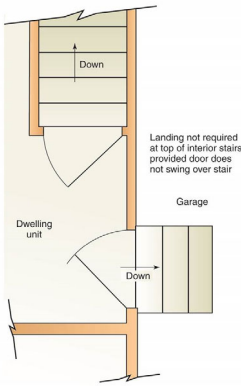
Winder Stairs

- Nonparallel edges
- Tread depth of 6” at the narrow end
- Tread depth of 10” measured at walk line



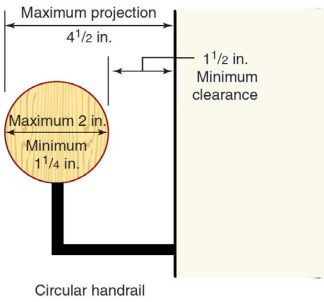
Landings

- Required at top and bottom of stairs
- Width of stairway
- Minimum 36” in direction of travel
- Maximum 147” vertically between landings **
  **(2018 IRC = 151”)
- Exception allows a door at the top of an interior flight of stairs, provided the door does not swing over the step

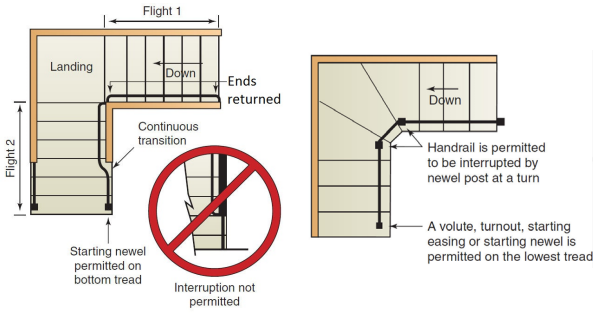


Handrail

- Max. 4½-inch projection from wall
- Min. 1 ½-inch clearance to wall
- Graspable shape

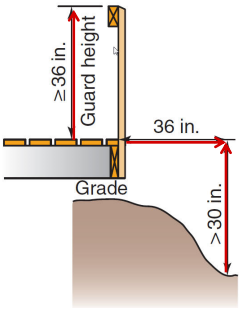


Handrail continuity



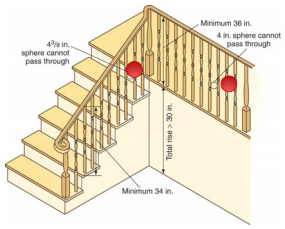
Guards

- A walking surface >30 inches above any point within 36 inches horizontally
- Min. guard height 36 in.
  - 34 in. at stairs
  - ** (2018 IRC)



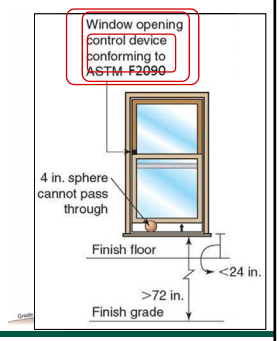
Guards

- Openings shall not allow a 4-in. sphere to pass through
  - 4 ⅜ in. along stairs
- Top rail to resist a single concentrated load of 200 lbs. applied in any direction
- Infill components to resist 50-lb. horizontal load applied to an area of 1 ft^2



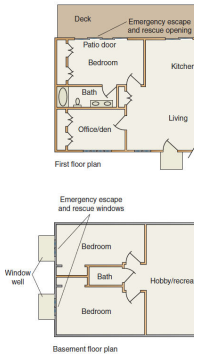
Windowsill Height

- Window openings >72" above grade must have a sill height of >24"
- Alternatives to 24" sill height
  - Window opening control device
  - Window fall prevention device
  - Fixed glazing



Emergency Escape and Rescue Openings

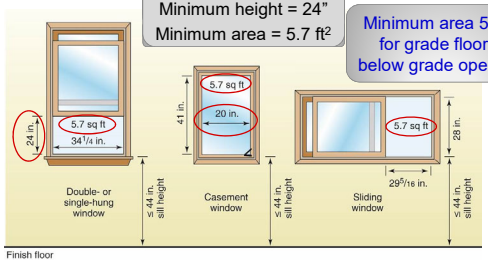
- Basements **
- Habitable attics
- Sleeping rooms
  - Exceptions:
    - Storm shelters
    - Basements ≤ 200 sq. ft. used only to house mechanical equipment



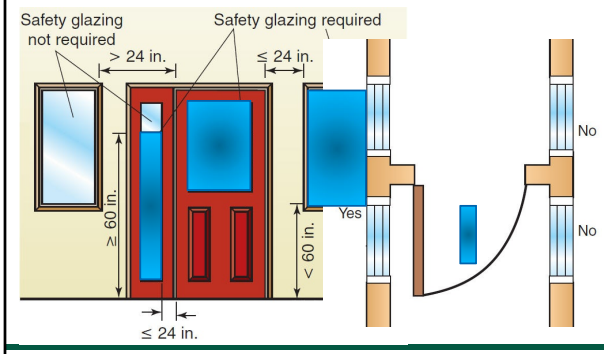
Emergency Escape and Rescue Openings

Minimum width = 20”
Minimum height = 24”
Minimum area = 5.7 ft²

Minimum area 5.0 ft² for grade floor or below grade openings

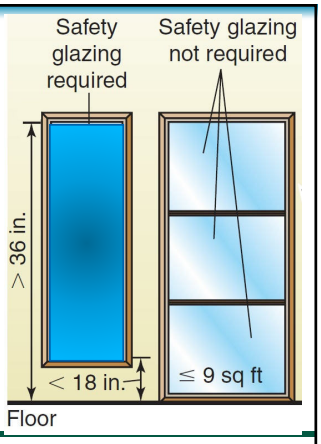


Safety Glazing–Adjacent Doors**

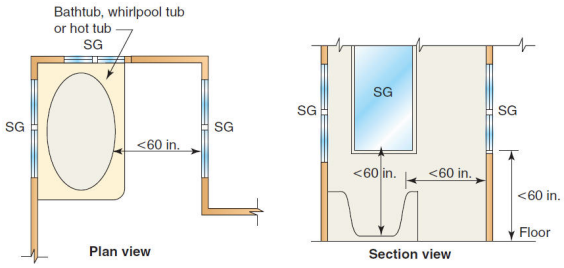


Safety Glazing – Windows

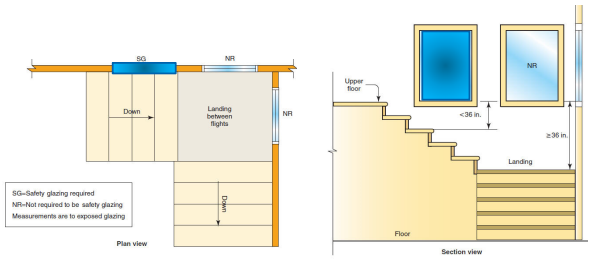
- Exposed area of an individual pane > 9 sq. ft.
- Bottom edge of glazing < 18 in. above floor
- Top edge of glazing > 36 in. above floor
  - Exception:
    - Horizontal rail installed 34 to 38 in. above walking surface



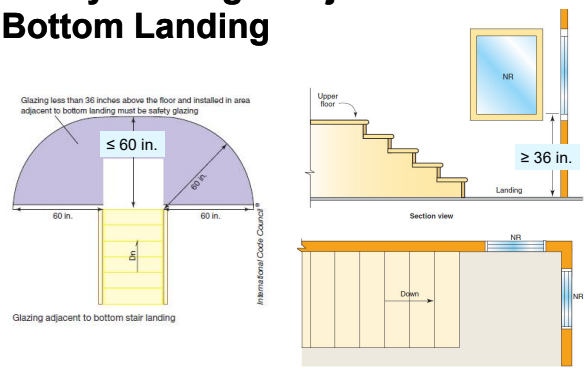
Safety Glazing – Wet Surfaces



Safety Glazing – Adjacent Stairs

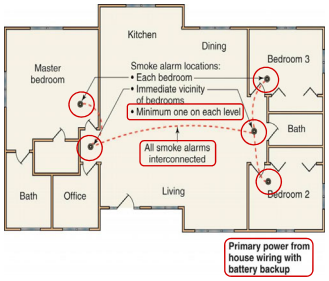


Safety Glazing – Adjacent Bottom Landing



Smoke Alarms

- In each sleeping room
- Outside each sleeping area
- On each story
- Building wiring system to provide primary power
- Battery backup
- Interconnection



Smoke Alarms in Existing Dwellings

- Retrofit smoke alarms when a permit is required:
  - Interior alterations or repairs
  - Additions
- Battery-operated smoke alarms
- Exception – provisions do not apply for:
  - Minor work that does not require a permit
  - Exterior work such as roofing or siding
  - Replacing doors or windows
  - Addition of a deck or porch

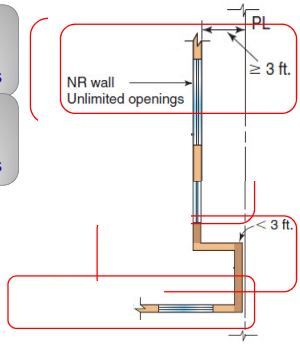
Residential Fire Sprinkler Systems

- Required in:
  - New dwellings
  - New townhouses
- Design criteria:
  - IRC Section P2904
  - NFPA 13D
  - Both designs applicable to 1- and 2-family dwellings and townhouses

Exterior Walls

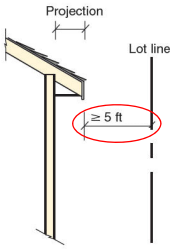
Dwelling **without** fire sprinklers

Dwelling **with** fire sprinklers



Eave Projections

Dwelling **without** fire sprinklers

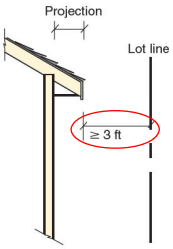


No protection required

1-HR protection

Eave Projections

Dwelling **with** fire sprinklers

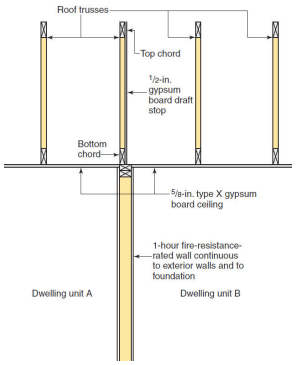


No protection required

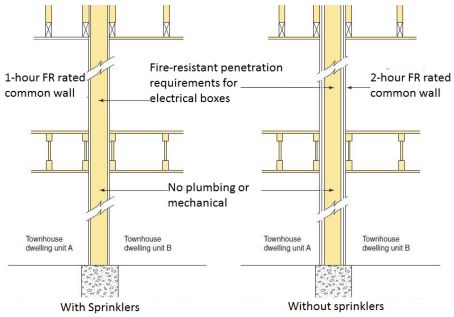
1-HR protection

Two-Family Dwelling Separation

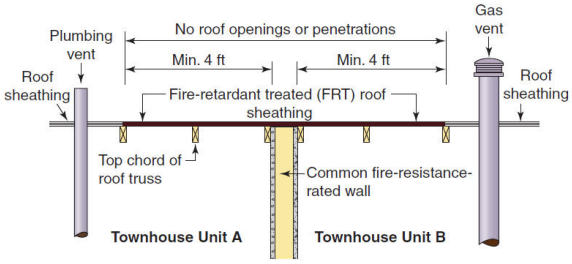
- 1-hour separation
  - Continuous foundation to roof
- Exception
  - ⅝-inch gypsum board ceiling
  - ½-inch gypsum board on bearing walls
  - Draft stop in attic



Townhouse Separation **



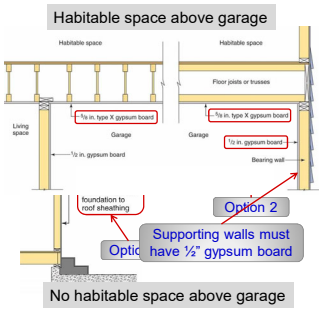
Parapet Exception



Alternatives to FRT sheathing:
- Non-combustible sheathing
- ⅝-in. type X gypsum board below sheathing

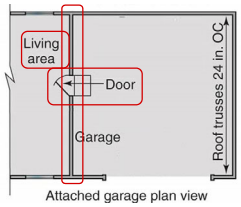
Dwelling Separation from Garage

- Not a fire-resistance-rated assembly
- ½" gypsum board on the garage side provides limited resistance to the spread of fire
- ⅝" Type X gypsum board on ceiling when habitable space above



Dwelling Separation from Garage

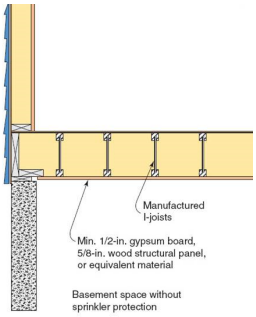
- Penetrations not rated
- No openings from garage into a sleeping room
- Self-closing door
  - 1⅜"-thick solid-core wood
  - 1 ⅜"-thick solid-core steel
  - 1 ⅜"-thick honeycomb-core steel
  - 20-minute fire-resistance-rated



Attached garage plan view

Fire Protection of Floors **

- Underside of floor assembly
  - ½" gypsum board
  - ⅝" wood structural panel
  - equivalent material
- Exceptions
  - ≥ 2 ×10 dimension or SCL
  - Sprinklers below
  - ≤ 80 ft^2 area
  - Crawl space with no storage or fuel-fired appliances

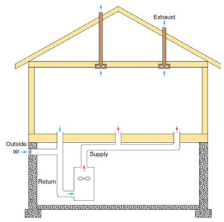


Light and Ventilation

- Habitable rooms:
  - Glazing ≥ 8% or lighting ≥ 6 footcandles
  - Openings ≥ 4% or mechanical ventilation
- Bathrooms:
  - Glazing ≥ 3 ft^2 or electric lighting
  - Openings ≥ 1.5 ft^2 or mechanical exhaust

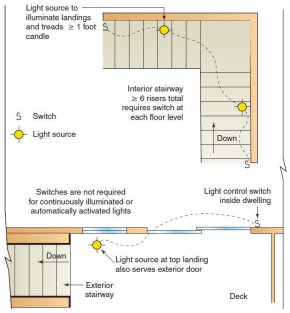
Whole-house Mechanical Ventilation System

- Required if
  - Blower door test performed and
  - Air infiltration rate ≤ 5 ACH
- Prescriptive air flow rate based on
  - Area of dwelling
  - Number of bedrooms
  - Continuous or intermittent operation
  - Visual inspection no longer acceptable



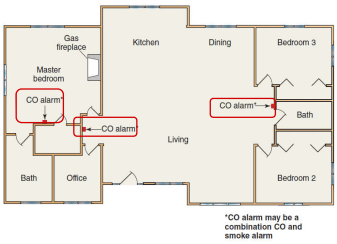
Stairway Illumination

- Interior stairways
  - Treads and landings ≥1 foot-candle
  - Wall switch at each floor level ≥ 6 risers.
- Exterior stairways
  - Light source at top landing
  - Bottom landing providing access to a basement



Carbon Monoxide (CO) Alarms **

- Required if
  - Fuel-fired appliance or
  - Attached garage communicating with dwelling unit
- Locations
  - Outside of each separate sleeping area adjacent bedrooms
  - Within bedroom with fuel-burning appliance located within bedroom or attached bathroom
- Power
  - House wiring with battery Backup (** Interconnection)



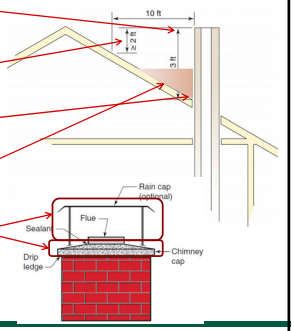
Chimneys and Fireplaces

- Masonry fireplaces
- Masonry chimneys
- Factory-built fireplaces
- Factory-built chimneys
- Exterior Air Supply

Per manufacturer's instructions

Masonry Chimney Termination

- 3 feet above roof penetration
- 2 feet higher than any portion of a building within 10 feet
- Flashing to weatherproof the chimney penetration at the roof
- Crickets required for chimneys ≥30" wide
- Chimney cap required
- Rain cap optional

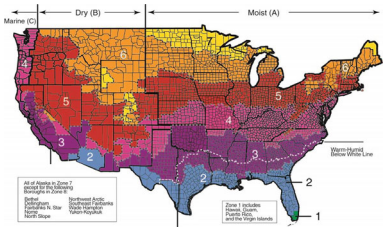


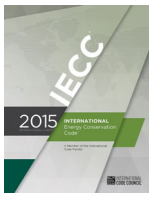
Chapter 11

Energy Efficiency

Energy Efficiency

- IRC Chapter 11 is extracted from the applicable provisions of the 2015 IECC





Compliance Paths

Projects shall comply with one of the following:

1. Sections 1101.14 through 1104.
2. Section 1105 and the provisions of Sections 1101.14 through 1104 labeled "Mandatory."
3. An energy rating index (ERI) approach in Section 1106.

Prescriptive and mandatory provisions

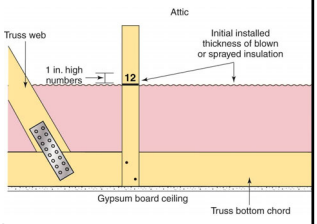
Performance and mandatory provisions

Building Insulation

- Pieces of insulation >12" in width must have:
  - Visible R-value mark; or
  - Installer certification
    - Insulation type
    - Manufacturer
    - R-value

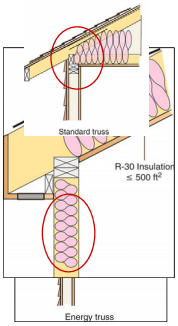
Blown-in or Sprayed Insulation

- Attic markers each 300 sq. ft.
- Certificate indicating:
  - Initial installed thickness
  - Settled thickness
  - Settled R-value
  - Installed density
  - Coverage area
  - Number of bags installed



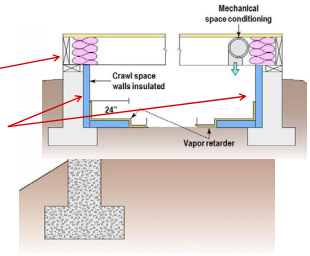
Insulation Requirements

- Minimum R-values for insulation is based on climate zone
- Exceptions:
  - Energy truss or raised-heel roof truss
  - Reduced R-values in rafter or joist space
  - Cold-formed steel framing requires higher insulation R-values and continuous insulation sheathing to provide a thermal break



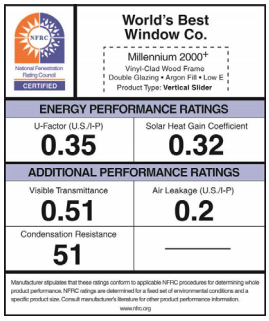
Insulation Requirements

- Slab on grade
- Crawl spaces
  - Insulation of the floor above the crawl space; or
  - Insulation of the exterior walls
    - When the crawl space is not ventilated to the outside
    - Vapor retarder on exposed earth of unventilated crawl spaces



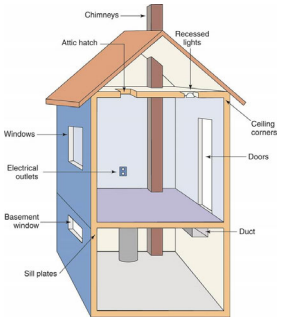
Windows and Doors

- Fenestration includes:
  - Skylights
  - Roof windows
  - Vertical windows
  - Opaque doors
  - Glazed doors
  - Glass block
- U-factor
- Solar Heat Gain Coefficient (SHGC)



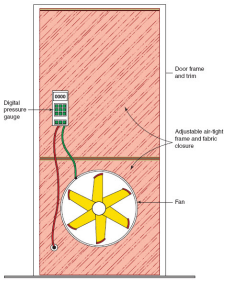
Sealing Against Air Leakage (Mandatory)

- Windows and doors
- Sill plate, rim joist, top plate
- Garage separation
- Tubs/showers
- Attic access opening
- Rim joists
- Recessed lighting
- Electrical boxes



Testing of Building Thermal Envelope (Mandatory)

- Blower door test required
- Allowable air-leakage rate:
  - Climate Zones 1 – 2: ≤ 5 ACH
  - Climate Zones 3 – 8: ≤ 3 ACH
- Test results on permanent certificate



Duct Insulation and Sealing

- Supply and return ducts in attics >R-8
- Supply and return ducts in other locations >R-6
- No insulation required for ducts within conditioned spaces
- Sealing of all ducts is required
- Air leakage test except when entire system is installed within the thermal envelope
- Building cavities cannot be used as ducts or plenums

Hot Water Pipe Insulation (Prescriptive)

- Hot water pipe insulation ≥ *R*-3 for:
  - ≥ ¾" diameter pipe
  - Water Heater to distribution manifold
  - Outside conditioned space
  - Under slab or underground
  - Piping in recirculation systems other than demand systems

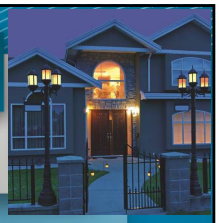
Energy Certificate (Mandatory)

- Completed by:
  - Builder; or
  - Registered design professional
- Listing of
  - Insulation
  - Fenestration
  - Type and efficiency of equipment
  - Results of air testing
- Permanent certificate posted near furnace or approved indoor location

Energy Efficiency Certificate	
Insulation Rating	
Ceiling/roof	
Walls	
Floors	
Ducts	
Air-leakage Test Results	
Blower door	Duct testing
Fenestration Rating	
Window	
Opaque door	
Skylight	
Equipment Performance	
Heating system	
Cooling system	
Water heater	
Designer/builder	

© International Code Council

Permanent energy certificate



Chapters 12 thru 41, IRC

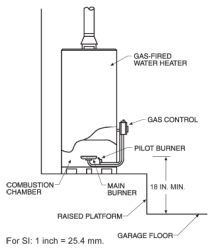
Building Utilities

(Mechanical, Fuel Gas, Plumbing, Electrical)

Mechanical Installations

- Installation instructions must be available:
  - On site
  - At time of inspection
- If the code and manufacturer's instructions disagree:
  - the most restrictive provision must prevail

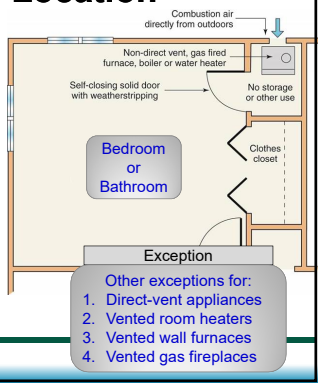
Elevation of Ignition Source



- Elevate appliances so that the ignition source is no less than 18 inches above floor in:
  - Hazardous locations.
  - Public garages.
  - Private garages.
  - Repair garages.
  - Motor fuel-dispensing facilities.
  - Parking garages.

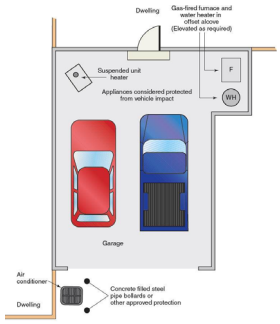
Appliances Installation and Location

- Gas-fired appliances
- Installation and clearances per the appliance listing
- Prohibited locations
  - Sleeping room
  - Bathroom
  - Toilet rooms
  - Storage closets
  - Space that opens only into such rooms or spaces



Appliances Installation and Location

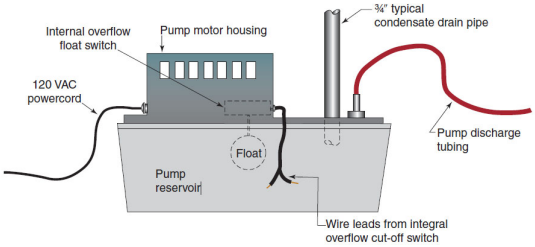
- In garages, the ignition source ≥18" above the floor
  - Unless the appliance is listed as flammable-vapor-ignition resistant
- In all locations, protected from impact by vehicles



Access to Appliances

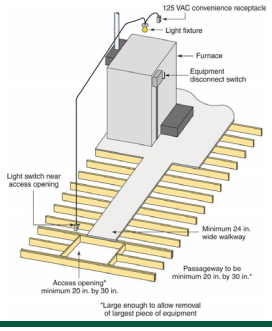
- Minimum 30" x 30" working space in front of the controls
- Access doors and passageways
  - Minimum 24" wide
  - Large enough to remove the largest appliance
- Clearance
  - Furnace compartments to be >12" inches wider than the appliance
  - Minimum 3" clearance at the sides and back

Condensate pumps



Access
Appliances in Attics

- Finish access opening ≥ 20 x 30
  - (R807.1 Rough 22 x 30)
- Passageway
  - ≥ 22 x 30 h
  - ≥ 24-in. wide flooring
  - ≤ 20-ft. length
  - Exception
    - ≤ 6-ft. high x 50 ft. long

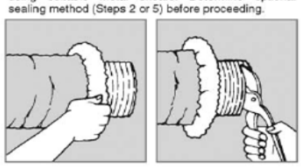


DUCTS

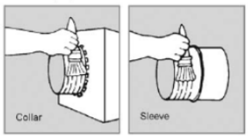
- Metal ducts per SMACNA.
- Fibrous ducts per NAIMA and UL 181a.
- Flexible air ducts per ADC and UL 181b.
- Unlisted duct tape not permitted as a sealant on metal ducts.

FLEX DUCT CONNECTIONS

1. After cutting duct to desired length, fold back jacket and insulation exposing core. Trim core ends squarely using suitable metal shears. Determine optional sealing method (Steps 2 or 5) before proceeding.



2. When mastics are required and for pressures 4" w.g. [1000 Pa] and over, seal joint with mastic applied uniformly to the outside surface of collar/sleeve. (Disregard this step when not using mastics and proceed to Step 3).



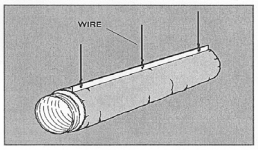


Figure 13

Flexible ducts may rest on ceiling joists or truss supports. Maximum spacing between supports shall not exceed the maximum spacing per manufacturer's installation instruction.

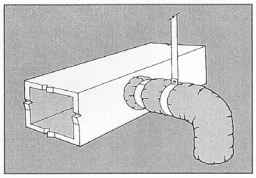


Figure 15

Vertically installed duct shall be stabilized by support straps at a max. of 6' [1.8 m] on center.

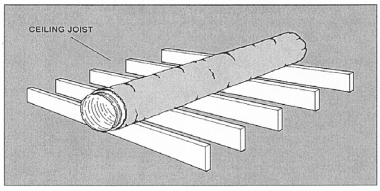


Figure 14

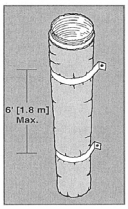
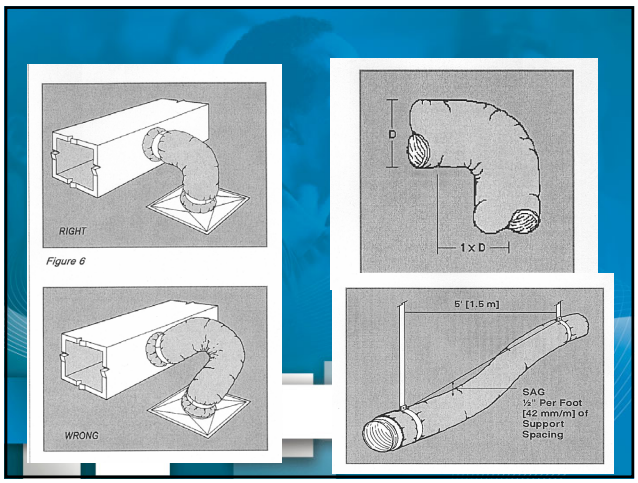


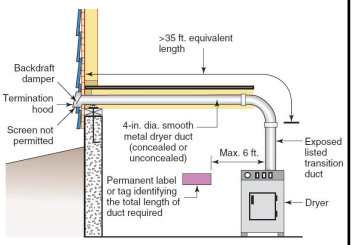
Figure 16

Note:
Factory-made air ducts may not be used for vertical risers in air duct systems serving more than two stories.



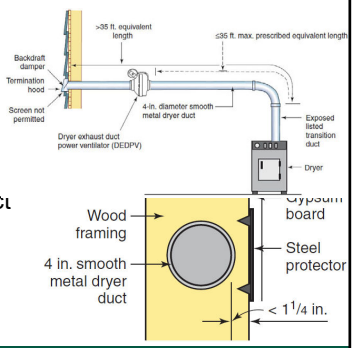
Clothes Dryer Exhaust Systems

- Termination
  - Backdraft damper
  - No screen
  - ≥ 3 ft. from openings
- Length
  - Deductions for fittings
  - 35 feet max unless approved
- Approved transition duct (8' max)



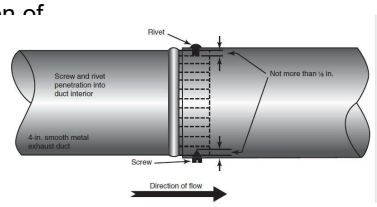
Clothes Dryer Exhaust Systems

- Dryer Exhaust Duct Power Ventilator (DEDPV)
  - Per manufacturer
- Protection of concealed dryer duct
  - < 1¼ inches
  - ≥ 2 in. above sole plates, below top plates



Dryer Exhaust Duct

- 4-in. smooth metal duct
  - Min. No. 28 gage
- Insert in direction of flow
- Max. ⅛-in. screw penetration



Whole-house Mechanical Ventilation system

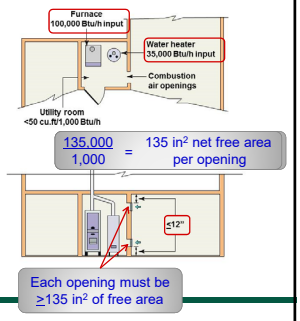
- Prescriptive airflow rate based on:
  - Floor area of dwelling unit
  - Number of bedrooms
  - Continuous or intermittent
- System design
  - One or more supply or exhaust fans, or a combination
  - Outdoor air ducts connected to the return permitted to supply ventilation.

Floor Area	Bedrooms	
	2 – 3	4 – 5
	CFM Airflow	
< 1500	45	60
1501 – 3000	60	75
3001 – 4500	75	90

Combustion Air from Inside the Building

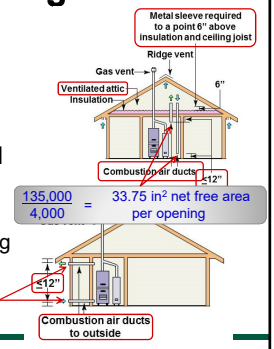
Furnace = 100,000 Btu/h
Water heater = 35,000 Btu/h
Combined input = 135,000 Btu/h

- Combustion air can draw from an adjacent room if:
  - Volume of adjacent space is >50 ft^3 per 1000 Btu/h
  - At least 2 openings provide air from the adjacent room
  - Free area of openings based on:
    - Btu/h input rating of all appliances
    - 1 in^2 per 1000 Btu/h
    - Minimum 100 in^2 per opening



Combustion Air from *Two Outdoor* Openings

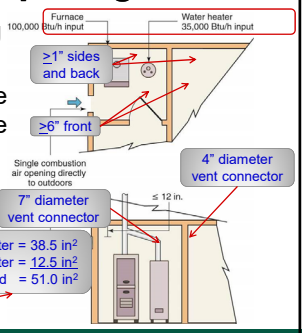
- Direct opening or vertical duct
  - Free area of ≥1 in^2 per 4000 Btu/h of total input rating
- Direct opening or horizontal ducts
  - Free area of ≥1 in^2 per 2000 Btu/h of total input rating



135,000 / 2,000 = 67.5 in^2 net free area per opening

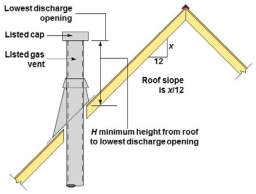
Combustion Air from *Single Outdoor* Opening

- Free area of the opening in^2 per 3000 Btu/h
- Free area must equal the sum of the areas of all ve connectors in the space
- Minimum clearances required around the



Gas Vent Roof Termination

- Termination height for gas vents with a cross section <12" and at least 8' from a vertical wall is based on the roof slope



Roof Slope	Minimum Height from Roof to Lowest Discharge Opening (feet)
≤6/12	1.0
>6/12 to ≤7/12	1.25
>7/12 to ≤8/12	1.5
>8/12 to ≤9/12	2.0
>9/12 to ≤10/12	2.5
>10/12 to ≤11/12	3.25
>11/12 to ≤12/12	4.0
>12/12 to ≤14/12	5.0
>14/12 to ≤16/12	6.0
>16/12 to ≤18/12	7.0
>18/12 to ≤20/12	7.5
>20/12 to ≤21/12	8.0

Gas Pipe Materials

- Schedule 40 steel
- Approved seamless metallic tubing
  - Gas used cannot be corrosive to the material
- Corrugated stainless steel tubing (CSST)
- Exterior underground locations only:
  - Approved plastic pipe, tubing and fittings

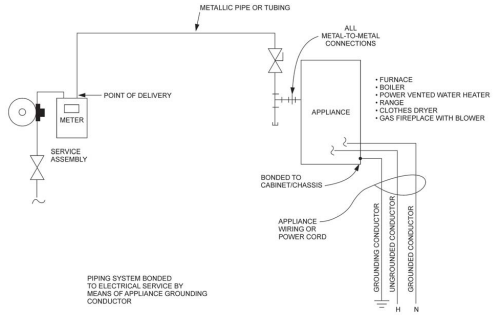
Prohibited Locations for Gas Piping

- Piping cannot be installed:
  - Within an air duct
  - Within a clothes chute
  - Within a chimney
  - Within a gas vent
  - Through any other townhouse unit
  - Entering a building below grade

Gas Piping Protection

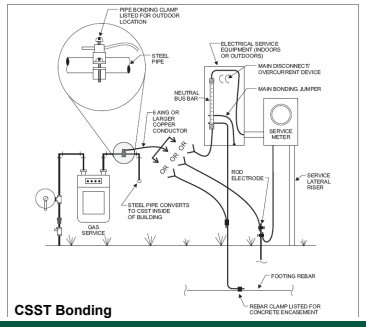
- Concealed piping installed through holes or notches in studs, joists, rafters must be:
  - >1½" from the nearest edge of the member or
  - Protected by No. 16 Gage nail shield plates
  - Except Schedule 40 black or galvanized steel gas piping
- CSST gas tubing requires protection in accordance with the code and the manufacturer's installation instructions

Electrical Bonding



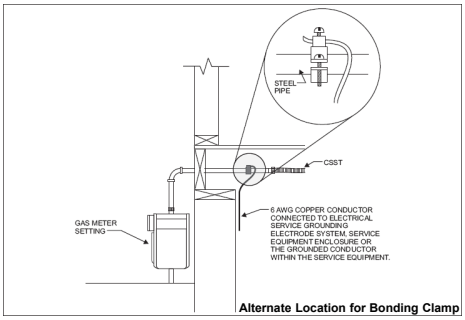
Gas Pipe Bonding by Appliance Branch Circuit

Corrugated Stainless Steel Tubing (CSST)



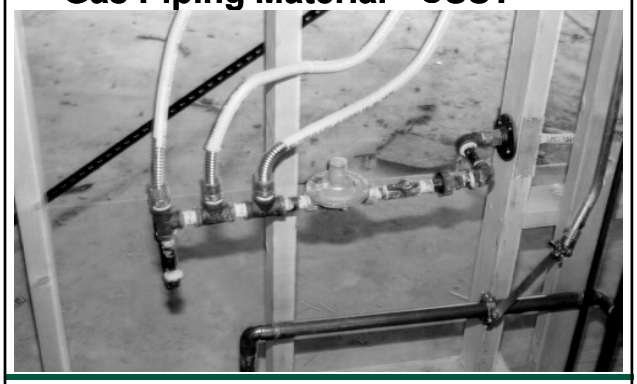
CSST Bonding

Corrugated Stainless Steel Tubing (CSST)



Alternate Location for Bonding Clamp

Gas Piping Material - CSST



Other Gas Piping Installation Requirements

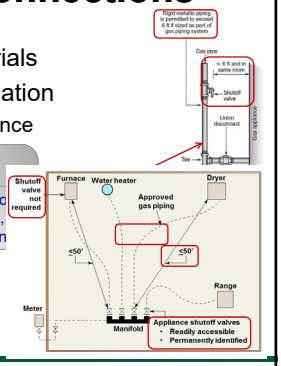
- Above-ground gas piping outdoors
  - ≥ 3½” above ground and above roof surface
  - Protection from corrosion for ferrous metal
    - Painting
    - Galvanizing
- Underground gas piping
  - Steel pipe wrapped with approved material for corrosion protection
  - Galvanizing is not approved protection from corrosion
  - Buried ≥ 12” deep

Gas Appliance Connections

- Appliance connector materials
- Appliance connector installation
  - Can pass through the appliance
- Rigid metallic piping
- CSST
- Listed and labeled
- Listed and labeled appliance connecto

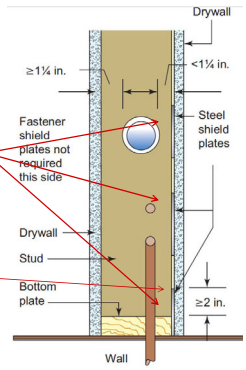
Cannot pass thro walls, floors, partitions, ceilin

- Shut-off valve
  - ≤6’, or
  - <50’ when connected to manifold



Plumbing Piping Protection from Damage

- Concealed piping installed through studs, joists or rafters
- < 1¼ in. from nearest edge
  - Shield plates ≥ 0.0575” thick steel (No. 16 Gage)
    - Covers area where the pipe passes through
    - Extends ≥ 2” above sole plates and below top plates
- Exception for cast iron and galvanized steel pipe



Protection from Freezing

- Underground water service pipe
  - Buried ≥12” deep
  - Buried ≥ 6” below the frost line
- Building sewer pipe
  - Depth determined by the Jurisdiction
  - Stipulated in the adopting ordinance

Plumbing Piping Support

- Support
  - Maintains alignment and slope
  - Prevents sagging
  - Allows for expansion and contraction
- Underground
  - Continuous support
  - Suitable bedding materials
  - Not supported on rocks or blocks
  - Backfill free of debris, rocks, concrete, and frozen material
  - Protection of footings

Aboveground Plumbing Piping Support

- Horizontal and vertical support spacing based on the pipe material
- A mid-story guide is required for vertical plastic piping ≥ 2-in. diameter

Piping Material	Maximum Horizontal Spacing (ft)	Maximum Vertical Spacing (ft)
ABS pipe	4	10
Cast-iron pipe, <10' lengths	5	15
Cast-iron pipe, 10' lengths	10	15
Copper or copper alloy pipe	12	10
PEX pipe	2.67	10
PVC pipe	4	10

Water Service

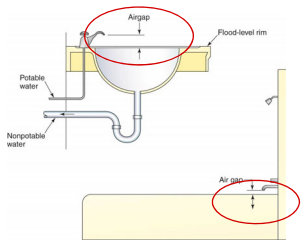
- When pipe for building sewer is listed for underground use within a building:
  - Water service pipe is permitted in the same trench with a building sewer (e.g. cast-iron or schedule 40 PVC DWV)
- For building sewer pipe not approved for underground use within a building:
  - Water service must be separated from sewer pipe:
    - ≥ 5' of horizontal separation, or
    - Installed on a ledge ≥ 12" inches above and to one side of the highest point of the building sewer

Water Supply System Design Criteria

- Water service at the building entrance
  - 40–80 psi
  - ≥ ¾" pipe size
- Distribution system pipe size based on
  - Fixture unit values
  - Developed length of piping
  - Water pressure
- Flow rates and consumption are limited for plumbing fixtures to conserve water
- Valves
  - Main shut-off valve
  - At each fixture other than showers and tubs

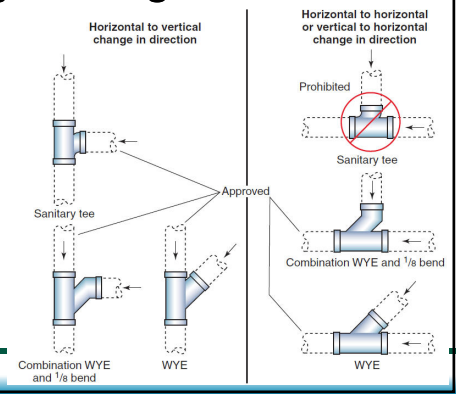
Water Supply Protection

- Backflow prevention devices suitable for the application
  - Hose connections
  - Boilers
  - Heat exchangers
  - Lawn irrigation systems
- Air gap required at
  - Sinks
  - Lavatories
  - Bathtubs



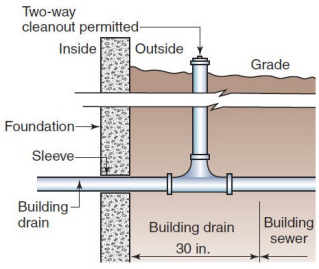
Sanitary Drainage

- Approved fittings for change in direction



Cleanouts

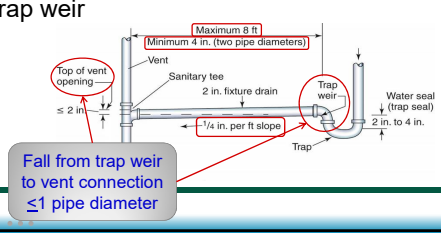
- Cleanouts required where:
  - Horizontal drain lines change direction >45°
  - Within 10 ft. of building drain / building sewer connection
- Where more than one change of direction occurs, only one cleanout is required each 40'
- A readily removable fixture (ex: water closet or sink fixture trap) may serve as a cleanout



Cleanout required near building drain/sewer connection

Fixture Vents

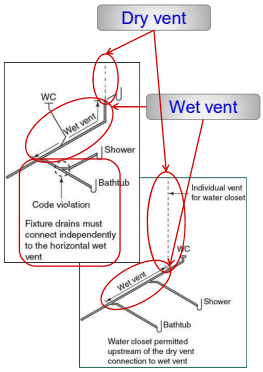
- The distance from the trap to the vent is limited
  - Self-siphoning fixtures such as water closets are not limited
- Vent connection is not permitted to be below the trap weir



Fall from trap weir to vent connection ≤1 pipe diameter

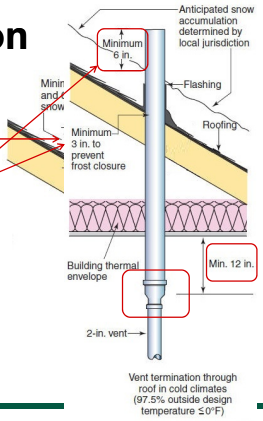
Vent Pipe

- Horizontal wet venting is permitted for fixtures of one or two bathroom groups located on the same floor
- Diameter of vent piping
  - At least ½ of the required diameter of the drain served
  - >1¼"
  - For vents >40', increase of one pipe size



Vent Termination

- Open vents
  - ≥ 6 in. above roof
  - ≥ 6 in. above anticipated snow accumulation
- Frost closure
  - 97.5% outside design temperature ≤ 0°F
  - Increase to 3 in. at point ≥ 12 in. inside building envelope



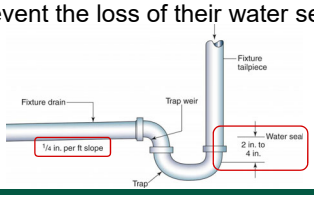
Protection Against Scalding

- Temperature control devices are required on the water outlets of bathing fixtures and bidets to prevent scalding

Fixture	Maximum Temperature	Approved Device	Standard
Shower or Tub/Shower Combination	120ºF	Pressure-balance control valve	ASSE 1016 / ASME A112.1016/CSA B125.1
		Thermostatic-mixing control valve or Combination pressure-balance/thermostatic-mixing control valve	
Bathtub or Whirlpool	120ºF	Water-temperature-limiting device	ASSE 1070 or CSA B125.3
Bidet	110ºF		

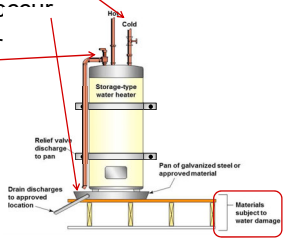
Fixture Traps

- Traps provide a water seal with a depth of 2" to 4" to prevent sewer gases from entering the building
- Floor drains require a trap-primer or deep-seal design to prevent the loss of their water seal by evaporation



Water Heaters

- Connection to the water supply
- Drain pan if damage will occur
- Temperature & pressure relief valve
- Ignition sources elevated
  - ≥18” above garage floor
- Anchorage to walls
  - SDCs D_0, D_1, and D_2
  - Townhouses in SDC C

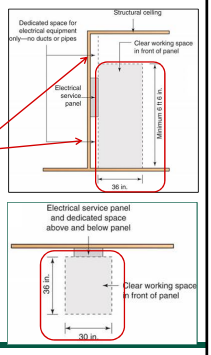


Electrical Services

- IRC covers:
  - 120/240-volt
  - Single-phase systems
  - <400 amperes
- Main service disconnect
- Service distributes electricity to the premises wiring system
- Only one service is permitted for 1- and 2-family dwellings

Equipment Location

- Readily accessible service disconnect
- Working space
- Light source nearby
- Spaces above and below the panel are dedicated to the electrical installation
- Not in clothes closets or bathrooms
  - Electrical panels
  - Service disconnects
  - Circuit breakers



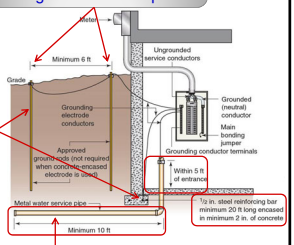
Electrical Service Size and Rating

- Service rating
  - Minimum 100 amp for single-family dwellings
  - Minimum 60 amperes for other installations
- Ampacity of ungrounded service conductors and service rating must at least match the load served in the structure

Grounding Electrode System

- Grounding options
  - Underground metal water pipe
  - Concrete-encased reinforcing bar (Ufer ground)
  - Approved ground rods

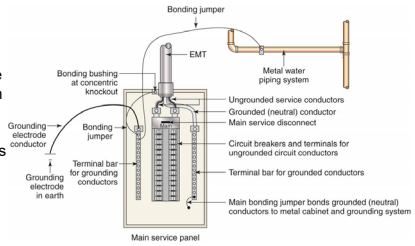
If a single ground rod has a resistance of >25 ohms, then a 2nd ground rod is required



Requires at least one additional electrode

Bonding

- Main bonding jumper at service equipment
  - Connection of the grounding system to the grounded (neutral) conductors occurs at main service disconnect
- Metal water piping must be bonded to the ground system



Conductor Sizing

- Ampacity tables are provided for all wire sizes based on the material and insulation type
- When sizing wires, several variables must be considered:
  - Temperature rating of the conductor insulation
  - Derating for bundled conductors
  - Temperature rating of the terminal

	Circuit Rating		
Conductors	15 amp	20 amp	30 amp
Min. size (AWG) circuit conductors (copper)	14	12	10
Overcurrent-protection device: max. amp rating	15	20	30
Duplex or multiple outlet receptacle rating (amps)	15 max.	15 or 20	30
Single receptacle outlet minimum rating (amps)	15	20	30
Max. load (amps)	15	20	30

Overcurrent Protection Required

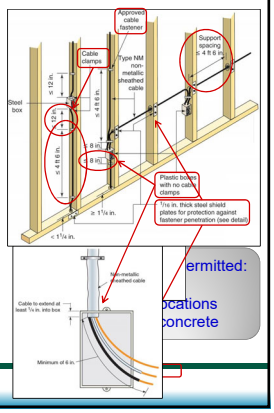
- Circuit breaker or fuse is required to protect all ungrounded branch circuit and feeder conductors
- Overcurrent protective device ratings cannot exceed the allowable ampacity of the conductor

Copper		Aluminum or Copper-Clad Aluminum	
Size (AWG)	Maximum overcurrent protection device rating (amps)	Size (AWG)	Maximum overcurrent protection device rating (amps)
14			
12			
10			

Overcurrent devices located:
1. Where the branch circuit conductors receive their supply
2. At the service panel (typically)
3. So they are readily accessible
4. Where not subject to damage
5. Not in clothes closets or bathrooms
6. Not located above a step

Wiring Methods

- Cable and conductors must be approved for the location
- Typically, above-ground wiring is Type NM non-metallic cable
- Protection from physical damage
- Fasteners
  - Approved fasteners
  - Spacing
- Cable support



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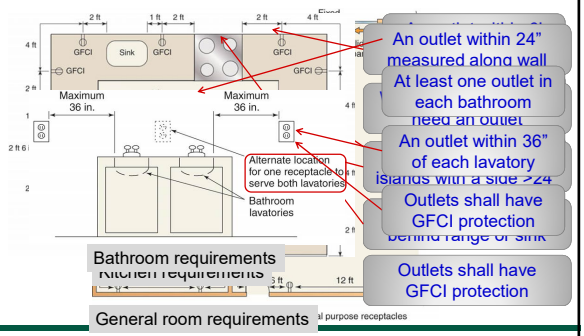
Receptacle Outlet Locations



An outlet within 24" measured along wall

At least one outlet in each bathroom

An outlet within 36" of each lavatory

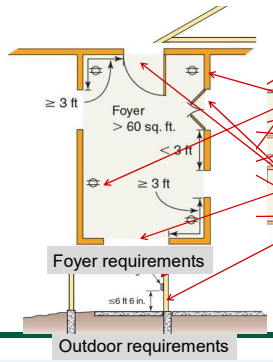
Outlets shall have GFCI protection

Bathroom requirements

Outlets shall have GFCI protection

General room requirements

Receptacle Outlet Locations



1 outlet at the front, and 1 outlet at the back of

Foyers >60 sq.ft. require an outlet on each wall ≥3' wide

Measured between:
- Doorways
- Floor-to-ceiling windows
- Similar openings

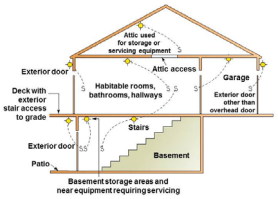
Outlets shall have GFCI protection

Foyer requirements

Outdoor requirements

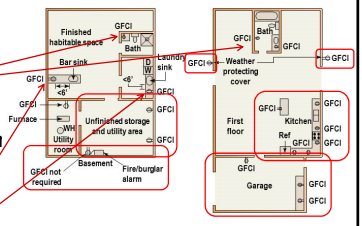
Lighting Outlets

- Wall switch–controlled lighting outlet
  - Habitable rooms
  - Bathrooms
  - Hallways
  - Storage areas
  - Garages
  - Stairways
  - Outside each exterior door



Ground-fault Circuit-Interrupter Protection (GFCI)

- GFCI protection required:
  - Bathroom
  - Kitchen counter
  - Unfinished basemen
    - Except fire/burglar alarm system
  - Garage
  - <6' from sink
  - Exterior



Arc-fault Circuit Interrupter Protection (AFCI)

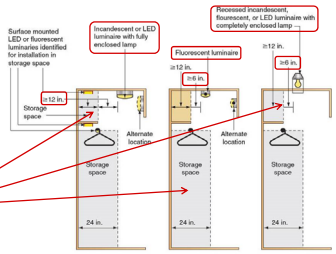
- AFCI devices
  - Detect unwanted arcing in the wiring of the branch circuit
  - Open the circuit before excessive heat buildup can cause a fire
- AFCI devices are installed in the service panel or subpanel
- AFCI protection required for:
  - Living areas
  - Hallways
  - Closets

Receptacles

- Wet locations
  - Enclosure that is weatherproof
  - when a cord is plugged in
  - Receptacles prohibited within or
  - directly over a bathtub or shower space
- Tamper-resistant receptacle required in locations accessible to children
  - Not required when:
    - >5½' above the floor
    - Part of a luminaire or appliance
    - In a dedicated space for an appliance

Luminaires in Clothes Closets

- Type of luminaires
- Minimum clearances
- Clearances are measured from the fixture to the nearest point of the defined storage space



2018 REVISIONS TO THE

2015 INTERNATIONAL RESIDENTIAL

CODE (2015 IRC)

229

R101.2 Scope

- Single-family and two-family dwellings
- Townhouses
- With Sprinklers –
  - Care Facility less than or with 5 persons
    - for Custodial Care in a dwelling unit
    - for Medical Care in a dwelling unit
    - Care Facility in a single-family home
  - Live-Work Unit (Sec 419, IBC)
  -
- Lodging House owner-occupied with 5 guest rooms maximum

230

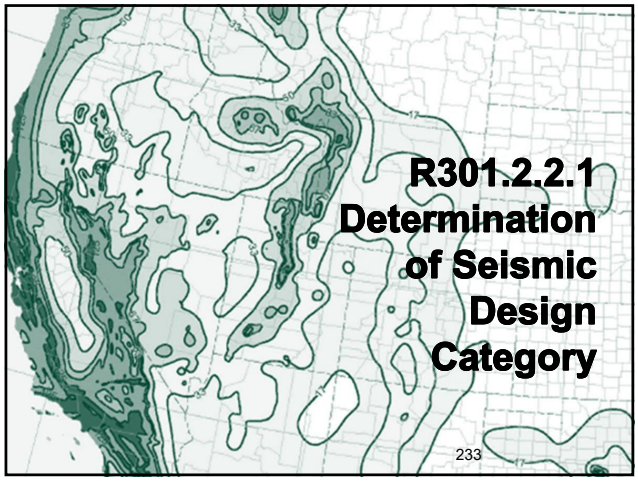
R105.1, R110.1, R202 Change of Occupancy

231

Table 301.2(1) Climate and Geographic Design Criteria

Elevation	Latitude	Winter Heating	Summer Cooling	Altitude Correction Factor	Indoor Design Temperature	Design Temperature Cooling	Heating Temperature Difference	Cooling Temperature Difference	Wind Velocity Heating	Wind Velocity Cooling	Coincident Wet Bulb
--	--	--	--	--	--	--	--	--	--	--	--
Daily Range	Winter Humidity	Summer Humidity									

232



R301.2.2.1 Determination of Seismic Design Category

233

Table R302.1(1) Exterior Walls & Table R302.1(2) Exterior Walls-Dwellings with Fire Sprinklers

234

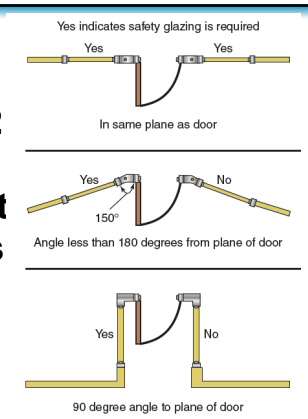
R302.2 Townhouse Separation

235

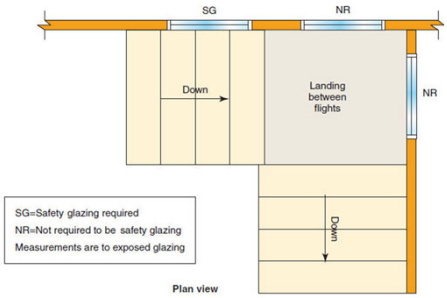
R302.13 Fire Protection of Floors

236

R308.4.2 Glazing Adjacent to Doors

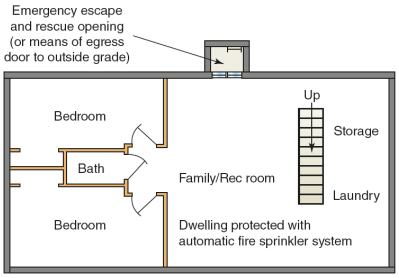


R308.4.4 Glazing in Guards and Railings



R308.4.7 Glazing Adjacent to the Bottom Stair Landing

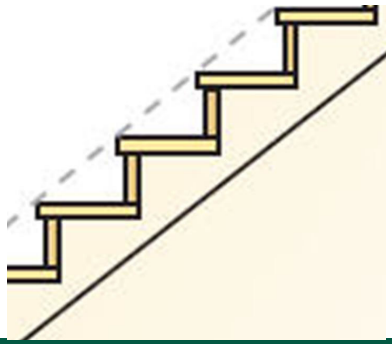
R310.1 Emergency Escape and Rescue Opening Required



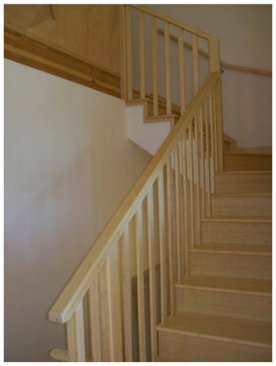
Basement floor plan

R310.3 Emergency Escape and Rescue Doors

R311.7.3 Vertical Rise

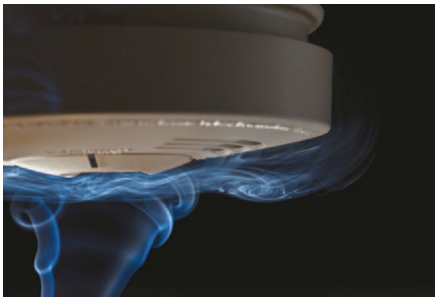


R311.7.11, R311.7.12 Maximum Stair Rise Between Landings



R312.1 Guards

R314 Smoke Alarms



INTERCONNECTION OF MULTIPLE DEVICES IS REQUIRED

245

R315 Carbon Monoxide Alarms

INTERCONNECTIN OF MULTIPLE CO ALARMS REQUIRED WITH EXCEPTION

R322.3 Coastal High-Hazard Flood Zones

GUIDANCE FOR COASTAL HIGH-HAZARD AREAS AND COASTAL 'A' ZONES

325.3 Area Limitation - Note: Mezzinine sections deleted

249

Habitable Attics (202 & 325)

DEFINITION IS ADDED; HOWEVER NEW SECTION WITH REQUIREMENTS FOR HABITABLE ATTICS IS DELETED

2018 IRC Significant Changes 251

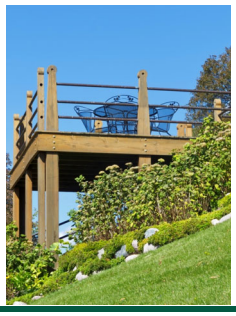
Table R403.4 Crushed Stone Footings

252

R408.3 Unvented Crawl Space

253

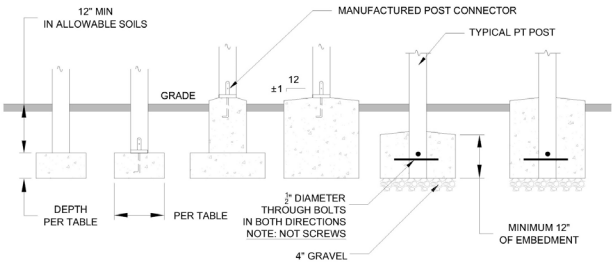
R507.2, R507.3 Deck Materials



254

255

R507.3 Deck Footings



NOTE:
POSTS MUST BE CENTERED ON OR IN FOOTING

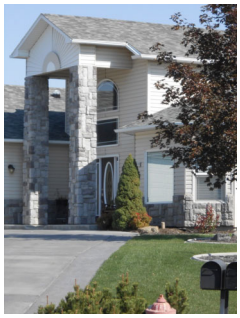
256

R507.6 Deck Joists

257

258

Table R602.3(6) Alternate Stud Heights



259

260

Table R602.7(2) Girders/ Headers Interior Walls

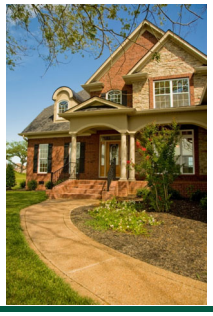
		Building Width[a] (feet)					
		12		24		36	
Header and Girder Supporting	Size	Span[b]	NJ[d]	Span[b]	NJ[d]	Span[b]	NJ[d]
One floor only	2-2 × 4	4 - 1	1	2 - 10	1	2 - 4	1
	2-2 × 6	6 - 1	1	4 - 4	1	3 - 6	1
	2-2 × 8	7 - 9	1	5 - 5	1	4 - 5	2
	2-2 × 10	9 - 2	1	6 - 6	2	5 - 3	2
	2-2 × 12	10 - 9	1	7 - 7	2	6 - 3	2
	3-2 × 8	9 - 8	1	6 - 10	1	5 - 7	1
	3-2 × 10	11 - 5	1	8 - 1	1	6 - 7	2
	3-2 × 12	13 - 6	1	9 - 6	2	7 - 9	2
	4-2 × 8	11 - 2	1	7 - 11	1	6 - 5	1
	4-2 × 10	13 - 3	1	9 - 4	1	7 - 8	1
	4-2 × 12	15 - 7	1	11 - 0	1	9 - 0	2
Two floors	2-2 × 4	2 - 7	1	1 - 11	1	1 - 7	1
	2-2 × 6	3 - 11	1	2 - 11	2	2 - 5	2
	2-2 × 8	5 - 0	1	3 - 8	2	3 - 1	2
	2-2 × 10	5 - 11	2	4 - 4	2	3 - 7	2
	2-2 × 12	6 - 11	2	5 - 2	2	4 - 3	3
	3-2 × 8	6 - 3	1	4 - 7	2	3 - 10	2
	3-2 × 10	7 - 5	1	5 - 6	2	4 - 6	2
	3-2 × 12	8 - 8	2	6 - 5	2	5 - 4	2
	4-2 × 8	7 - 2	1	5 - 4	1	4 - 5	2
	4-2 × 10	8 - 6	1	6 - 4	2	5 - 3	2
	4-2 × 12	10 - 1	1	7 - 5	2	6 - 2	2

261

Support for Headers

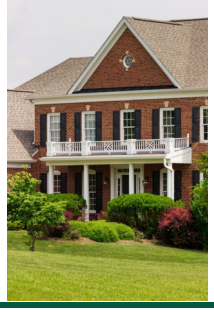
262

Table R602.10.3 (4) Seismic Adjustment Factors



263

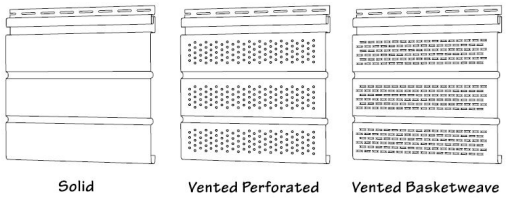
R602.10.6.5 Method BV-WSP



264

R703.2 Water-resistive Barrier

R703.3.1 Soffit Installation



R703.8.4 Veneer Anchorage Through Insulation

TABLE R703.8.4(2) REQUIRED BRICK TIE SPACING FOR DIRECT APPLICATION TO WOOD STRUCTURAL PANEL SHEATHING[a,b,c] excerpt

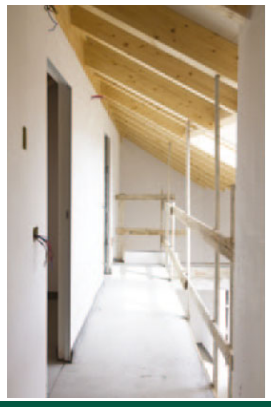
Fastener type[d]	Size (Diameter or Screw #)	110 mph V_{ult}			115 mph V_{ult}		
		Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D	Zone 5, Exposure B	Zone 5, Exposure C	Zone 5, Exposure D
Ring Shank Nails	0.091	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12x12	16/16, 16/12, 12/16, 12/12	16/12, 12/16, 12/12	12/12
	0.148	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	
Screws	#6	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	24/16, 16/24, 16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12	16/16, 16/12, 12/16, 12/12

R703.11.2 Vinyl Siding Installation Over Foam Plastic Sheathing

R802.1.5.4 Labeling

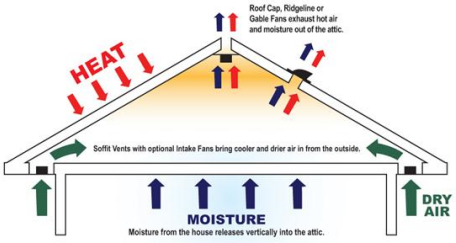
269

R802 Roof Framing



270

R806.2 Minimum Vent Area



271

272

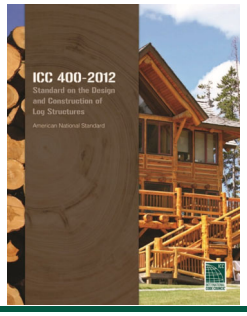
R1005.8 Chimney Insulation Shield

273

N1101.6, Tables N1101.10.3 (1) and N1101.10.3 (2)Fenestration Definitions and U-Factors

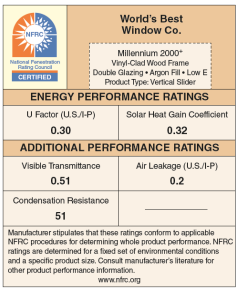
274

N1102.1 Building Thermal Envelope for Log Homes



275

N1102.1.2 and N1102.1.4 Insulation and Fenestration Requirements

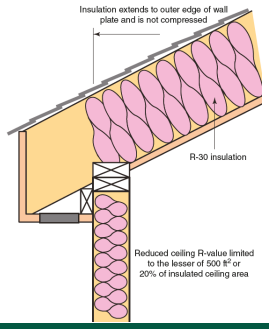


World's Best Window Co.	
Millennium 2000™ Vinyl-Clad Wood Frame Double Glazing • Argon Fill • Low E Product Type: Vertical Slider	
ENERGY PERFORMANCE RATINGS	
U Factor (U.S./I-P)	Solar Heat Gain Coefficient
0.30	0.32
ADDITIONAL PERFORMANCE RATINGS	
Visible Transmittance	Air Leakage (U.S./I-P)
0.51	0.2
Condensation Resistance	
51	_____

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.
www.nfrc.org

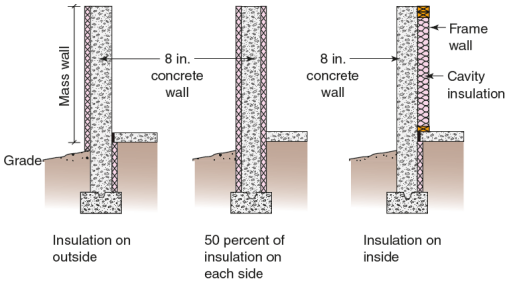
276

N1102.2.5 Reduction of Ceiling Insulation



277

N1102.2.5 Mass Walls



278

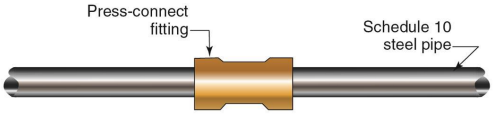
279

280

N1104.1 Lighting

281

G2414.4.2, G2414.10.1 Schedule 10 Steel Gas Piping

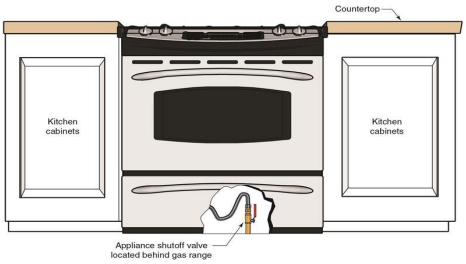


Press-connect fittings use gaskets and special equipment to join steel gas piping

SCHEDULE 10 STEEL PIPE IS ACCEPTABLE FOR FUEL GAS PIPING

282

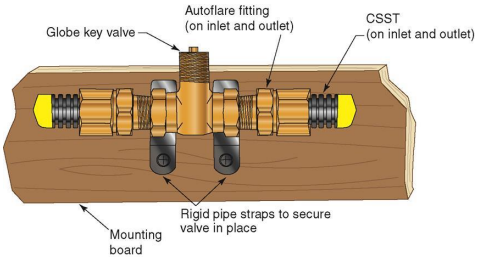
G2420.5.1 Shutoff Valve Location



SHUTOFF VALVES BEHIND MOVABLE APPLIANCES ARE CONSIDERED TO HAVE "ACCESS TO"

283

G2420.6 Support for Shutoff Valves in Tubing Systems



SHUTOFF VALVES REQUIRE SEPARATE RIGID SUPPORT

284

G2442.2 Forced Air Furnace Duct Size

PRESCRIPTIVE DUCT SIZING IS DELETED – USE METHODS SPECIFIC TO FORCED-AIR FURNACE

285

G2447.2 Commercial Cooking Appliances

2018 IRC Significant Changes

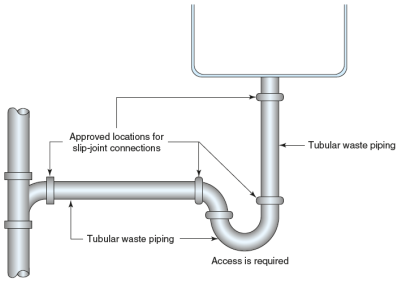
286

P2503.7 Air Testing of PEX Piping

AIR TESTING OF PEX PIPING WITH COMPRESSED AIR IS PERMITTED WHEN DONE PER MANUFACTURER'S INSTRUCTIONS

287

P2704 Slip Joint Connections



SLIP JOINT CONNECTIONS ARE PERMITTED ANYWHERE BETWEEN FIXTURE OUTLETS AND FIXTURE DRAINS

288

P2713.1 Bathtub Overflow

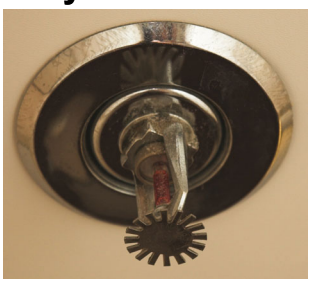
BATHTUB OVERFLOW OUTLETS ARE NOT REQUIRED 289

P2801.6 Plastic Pan for Gas-Fired Water Heaters

Photo courtesy of Lowe's

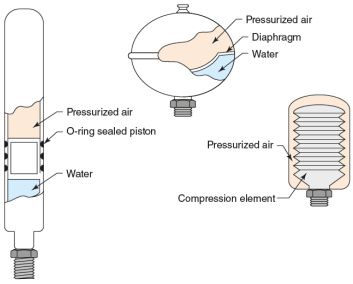
290

P2902.5.4, P2904 Backflow Protection for Fire Sprinkler Systems



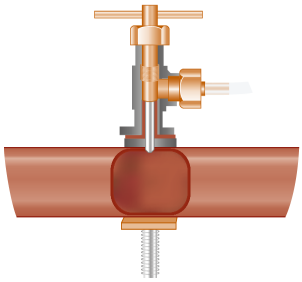
291

P2903.5 Water Hammer Arrestors



REQUIRED WITH QUICK-CLOSING VALVES 292

P2906.6.1 Saddle Tap Fittings on Water Distribution Piping



SADDLE TAP FITTINGS ARE NOT PERMITTED ON WATER DISTRIBUTION PIPING

293

P2906.18.2 Joints Between PVC and CPVC Piping

A SINGLE SOLVENT-CEMENT TRANSISTION JOINT IS ACCEPTABLE FOR CONNECTING CPVC WATER DISTRIBUTION PIPING TO PVC WATER SERVICE PIPING

294

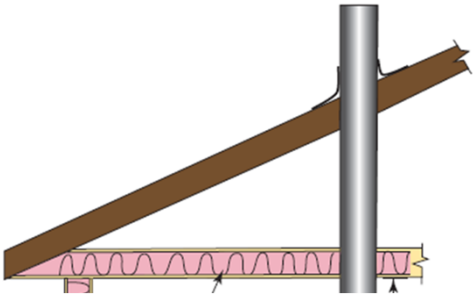
P3003.2 Prohibited Joints for Sanitary Drainage

295

P3005.1.6 Reduction in Pipe Size

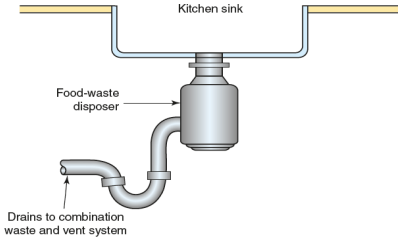
296

P3103.1 Vent Pipe Termination



297

P3111 Combination Waste and Vent System



FOOD WASTE DISPOSERS AND DRINKING FOUNTAINS MAY CONNECT TO COMBINATION WASTE AND VENT SYSTEM

298

P3114.8 Prohibited Installations for Air Admittance Valves

AAV CAN'T BE USED TO SOLVE OPEN VENT TERMINAL THAT IS TOO CLOSE TO BUILDING AIR INTAKE

299

E3703.5 Garage Branch Circuits

SEPARATE 20-AMP BRANCH CIRCUIT REQUIRED TO SERVE RECEPTACLE OUTLETS OF ATTACHED GARAGES AND DETACHED GARAGES WITH ELECTRIC POWER

300

E3901.2 Wall Space for Receptacle Distribution

CABINETS WITH COUNTERTOPS ARE NOW CONSIDERED WALL SPACE WHEN DETERMINING REQUIRED LOCATIONS FOR GENERAL PURPOSE RECEPTACLE OUTLETS

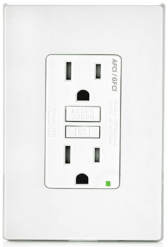
301

E3901.3 Appliances on 15 Amp Circuits

INDIVIDUAL 15-AMP BRANCH CIRCUIT PERMITTED FOR ANY SPECIFIC KITHCHEN APPLIANCE

302

E3905.2.1 GFCI Protection for Crawl Space Lighting Outlets



NOW REQUIRED FOR CRAWL SPACE LIGHTING OUTLETS

303

E3905.2.1 Nonmetallic-Sheathed Cable and Metal Boxes

Nm cable must extend into box minimum ¼-inch and past cable clamp

304

E4101.3 Cord- and-Plug-Connected Appliances

305