Board of Building Standards

EDUCATION COMMITTEE MEETING
AGENDA

DATE: MAY 13, 2021
TIME: 10:00 AM
LOCATION: VIDEOCONFERENCE
DIAL-IN 614-721-2972,
CONFERENCE ID 508 285 300#

Staff and Guest 'Check-in'

Call to Order

Consent Agenda

Course Applications

ER-1 2017 NEC Grounding and Bonding (Flanik)
All Certifications (6 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-2 2017 NEC Requirements for General and Special Equipment and Special Conditions (Flanik)
All Certifications (6 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-3 2017 NEC Wiring, Equipment, and Overcurrent Protection (Flanik)
All Certifications (6 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-4 2017 NEC Wiring, Equipment, and Special Occupancies (Flanik)
All Certifications (6 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-5 2017 OBC Electrical Requirements and 2017 NEC General Equipment Installation (Flanik)
All Certifications (6 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-6 Buildings and Homes in Flood Hazard Areas (Simpson Strong-Tie)
BO, MPE, BI, RBO, RPE, RBI (1 hour)
Staff Notes: Same instructor as other course
Committee Recommendation:

ER-7 Cincinnati Cross Training, Part 5 (Building and Fire Code Academy)
RBI, RMI (two 3-hour sessions)
Staff Notes:
Committee Recommendation:

ER-8 Decks, Porches, and Boardwalks in Flood Hazard Areas (Simpson Strong-Tie)
BO, MPE, BI, RBO, RPE, RBI (1 hour)
Staff Notes:
Committee Recommendation:

ER-9 Fire Pumps (Central Ohio Code Officials Association)
ESI, BO, MPE, BPE, EPE, FPPE, BI, FPI (2 hours)
Staff Notes: Recommend approval
ESIAC Recommendation: Recommend approval
Committee Recommendation:

ER-10 Flexible Sprinkler Hose Systems (Victaulic)
ESI, BO, MPE, BPE, PPE, MechPE, FPPE, BI, FPI, RBO, RPE, RBI, RMI (2 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

Old Business

New Business

Adjourn

EDUCATION COMMITTEE MEETING
CONSENT AGENDA

Course Applications

File Attachments for Item:

ER-1 2017 NEC Grounding and Bonding (Flanik)

All Certifications (6 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend approval

Committee Recommendation:

2017 NEC Grounding and Bonding

6-Hours of Continuing Education Credit

Course Description: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar highlights key provisions of the *2017 NEC regarding Grounding and Bonding.*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- System Grounding
- Grounding Electrode System
- Service Bonding
- Bonding of Piping Systems & Structural Metal
- Bonding Jumpers

Course Outline:

1. **2017 OBC – CHAPTER 1**
   - **OBC Section 105.1 Approvals Required**
   - **OBC Section 102.10 Work Exempt From Approval**
   - **OBC Section 102.10.1 Emergency Repairs**
   - **OBC Section 102.10.2 Minor Repairs**
   - **OBC Section 106.1.1 Information on Construction Documents**

2. **2017 OBC – CHAPTER 27**

- **OBC Section 2701.1 Scope**
- **OBC Section 2701.2 Appliance and Fixture Listing**
- **OBC Section 2702 Emergency and Standby Power Systems**
- **OBC Section 2702.1 Installation**
- **OBC Section 2702.2 Where Required**
- **OBC Section 2702.3 Critical Circuits**
- **OBC Section 2702.4 Maintenance**
- **OBC Section 2703.1 Penetrations**
- **OBC Section 2703.2 Cutting, Notching, and Boring**
- **OBC Section 2704 Smoke Detection**
- **OBC Section 2704.1 Smoke Alarm Circuits**

3. **2017 NEC 5 New Articles**

- **Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment**
- **Article 691 – Large Scale PV Production Facility**
- **Article 706 – Energy Storage Systems**
- **Article 710 – Stand Alone Systems**
- **Article 712 – DC Micro Grids**

4. **Article 100: Grounded (Grounding)**

5. **Article 250 Grounding and Bonding**

- **250.4(A)(1) Electrical System Grounding**
- **250.8 Connection of Grounding and Bonding Equipment**
- **250.20(B) Alternating-Current Systems of 50 Volts to 1000 Volts**
- **250.24 Grounding Service-Supplied Alternating-Current Systems**
- **250.28 Main Bonding Jumper and System Bonding Jumper**
- **Table 250.102(C)(1)Size Main Bonding Jumpers**
- **Grounding Separately Derived Alternating-Current Systems**
- **250.30(A)(1) System Bonding Jumper**
- **250.30(A)(4) Grounding Electrode**
- **250.30(A)(5) Grounding Electrode Conductor, Single Separately Derived System**
- **250.30(A)(6) GEC, Multiple Separately Derived Systems**

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5. **Cont'd <u>Article 250 Grounding and Bonding</u>**

- **250.32 Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s)**
- **250.50 <u>All</u> Electrodes present shall be bonded together (1-7)**
- **250.52 Permitted Electrodes (1-8)**
- **250.52 Grounding Electrodes**
- **250.52(A)(2) Metal In-ground Support Structures(s)**
- **250.52(A)(3) Concrete Encased Electrode**
- **250.52(B) <u>Not</u> Permitted for Use as Grounding Electrodes**
- **250.53(A)(2) Supplemental Electrode Required**
- **250.53(A)(3)**
- **250.53(D)(2) Supplemental Electrode Required**
- **250.64(B)(4) Securing and Protection Against Physical Damage**
- **250.64(E) Raceways and Enclosures for Grounding Electrode Conductors**
- **250.66 Size of AC Grounding Electrode Conductor**
- **Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems**
- **250.66(A) Connections to a Rod, Pipe, or Plate Electrode(s)**
- **250.66(B) Connections to Concrete-Encased Electrodes**
- **250.66(C) Connections to Ground Rings**
- **250.68 Grounding Electrode Conductor and Bonding Connection to Grounding Electrodes**
- **250.68(A) Accessibility**
- **250.68(C) Grounding Electrode Conductor Connections**
- **250.92(A) Bonding at Service**
- **250.92(B) Method of Bonding at Service**
- **250.94(A) Bonding for "Communication" Systems**
- **250.94(B) Other Means**

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5. Cont'd <u>Article 250 Grounding and Bonding</u>

- **250.97 Bonding for Over 250 Volts**
- **250.100 Bonding in Hazardous (Classified) Locations**
- **250.102 Grounded Conductor, Bonding Conductors, and Jumpers**
- **250.104(B) Other Metal Piping**
- **CSST Bonding**
- **Electrical Grounding (IFGC 309.1)**
- **IFGC 310.1 Gas Pipe & Tubing other than CSST**
- **IFGC 310.2 CSST (New Requirements)**
- **IFGC 310.2.1 Bonding jumper point of connection**
- **IFGC 310.2.3 Bonding Jumper Length**
- **IFGC 310.3 ARC-RESISTANT CSST (New Section)**
- **250.122 Size of Equipment Grounding Conductors**
- **250.122(F) EGCs Installed in Parallel**
- **250.122(F)(1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays**
- **250.122(F)(2) Multiconductor Cables**
- **250.146 Connecting Receptacle Grounding Terminal to Box**
- **250.148 Continuity and Attachment of EGC to Boxes**

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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: Jerry Flanik (Contact Name)

Organization: Associated Consulting Solutions, LLC (Organization/Company)

Address: 9671 Oxford Glen Drive (Include Room Number, Suite, etc.)

City: Mentor State: Ohio Zip: 44060

E-Mail: jerry@associatedconsultingsolutions.com

Telephone: 216-256-3556 Fax: _____

Course Sponsor: Associated Consulting Solutions, LLC

COURSE INFORMATION:

Course Title: 2017 NEC Ground and Bonding

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

Purpose and Objective: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the 2017 OBC Requirements and the 2017 NEC regarding system grounding, grounding electrode system, service bonding, bonding of piping systems and structural metal, and bonding jumpers.

Number of Instructional Contact Hours that can be obtained upon completion: 6 hours

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

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■
Building Plans Exam. ■
Plumbing Plans Exam. ■
Electrical Plans Exam. ■
Mechanical Plans Exam. ■
Fire Protect. Plans Exam. ■

Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■
Plumbing Inspector ■
Non-Res IU Inspector ■

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

Electrical Safety Inspectors ■
Location of ESI Course: TBD Date(s) of ESI Course(s): TBD

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:		x

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

ACS ASSOCIATED CONSULTING SOLUTIONS

2017 NEC Grounding and Bonding

Based on the 2017 National Electrical Code (NEC)

Welcome

- Meet the instructor
- Participant introductions

ACS ASSOCIATED CONSULTING SOLUTIONS

Meet the Instructor

ICC PREFERRED EDUCATION PROVIDER

- Gerald C. Flanik is an ICC-Certified Master Code Professional (MCP), and holds over 40 various licenses and certifications. He is also a LEED BD+C Accredited Professional, Certified Floodplain Manager (CFM).
- Mr. Flanik is President of Associated Consulting Solutions, LLC (ACS) in Cleveland, Ohio. ACS provides plan review services, pre and post design analysis services for architectural and engineering firms, and code consulting services throughout the United States. ACS is also an ICC Preferred Education Provider, providing education throughout the United States. Previously, Gerald served as the Chief Building Official for Lake County, Ohio for 16 years. Prior to working as a code official, he owned and operated a design build contracting company.
- Gerald holds a Bachelor of Science Degree in Mechanical Engineering and a Bachelor of Science Degree in Electrical Engineering from Cleveland State University; as well as, a degree in Civil Engineering Technology. He is also an adjunct faculty instructor at Lakeland College in the Civil and Electrical Engineering Departments.
- Jerry is a professional consultant for corporations and government agencies throughout the United States, and for the International Code Council throughout the world.

Associated Consulting Solutions, LLC
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ACS ASSOCIATED CONSULTING SOLUTIONS

2017 NEC Grounding and Bonding

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- System Grounding
- Grounding Electrode System
- Service Bonding
- Bonding of Piping Systems & Structural Metal
- Bonding Jumpers

ACS ASSOCIATED CONSULTING SOLUTIONS

Description

This seminar highlights key provisions of the *2017 NEC regarding Grounding and Bonding.*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

ACS ASSOCIATED CONSULTING SOLUTIONS

OBC Chapter 1

- This chapter is largely concerned with maintaining "due process of law" in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.

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OBC Section 105.1

105.1 Approvals Required

Any owner or owner's representative who intends to construct, enlarge, alter, repair, move, or change the occupancy of a building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required approval.

However, OBC 102.10 contains additional information.

OBC Section 102.10

102.10 Work Exempt From Approval

Approval shall not be required for the following work; however, this work shall comply with all applicable provisions of the rules of the board:

Electrical:

1. Minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
2. Electrical equipment used for radio and television transmissions except equipment and wiring for power supply, and the installations of towers and antennas.
3. The installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.
4. Electrical wiring, devices, appliances, apparatus or equipment operating at less than twenty-five volts and not capable of supplying more than fifty watts of energy, unless specifically addressed in this code.
5. Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
6. Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70 as referenced in Chapter 35.

OBC Section 102.10.1

102.10.1 Emergency Repairs

Where equipment replacements and repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Provide some examples of electrical emergency situations???

OBC Section 102.10.2

102.10.2 Minor Repairs

Minor repairs to structures may be made without application or notice to the building official. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall minor repairs include addition to, alteration of, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Provide some examples of minor repairs???

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

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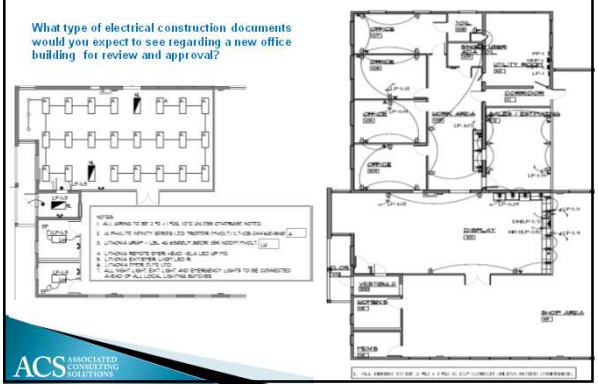
OBC Section 106.1.1

What type of electrical construction documents would you expect to see regarding a new office building for review and approval?



OBC Chapter 27

2701.1 Scope

This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment, and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

2701.2 Appliance and Fixture Listing

Electrical appliances and fixtures within the scope of this code shall be tested and listed in published reports of inspected electrical equipment by an approved agency and installed in accordance with all instructions included as part of such listing.

UL LISTED

OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

OBC Chapter 27

Section 2703 Penetrations

2703.1 Penetrations
Penetrations of walls, floors, ceilings and assemblies required to have a fire-resistance rating, shall be protected in accordance with Chapter 7. Where cables, conductors and raceways penetrate fireblocking or draftstopping, such penetrations shall be protected by filling the annular space with an approved fireblocking material.

2703.2 Cutting, Notching, and Boring
The cutting, notching and boring of wood and steel framing members, structural members and engineered wood products shall be in accordance with this code and as prescribed by the registered design professional.

Section 2704 Smoke Detection

2704.1 Smoke Alarm Circuits
Smoke detectors required by this code and installed within dwelling units shall not be connected as the only load on a branch circuit. Such detectors shall be supplied by branch circuits having lighting loads consisting of lighting outlets in habitable spaces.

Why do we need codes and standards?

IKEA Rooftop PV Install (Illinois)

1.124 MW System

Bolingbrook (05.12.2018)

4,784 Panels

No Injuries Reported

Lake County; Fair Painesville, Ohio

Bumper Car Ride - Electrocution

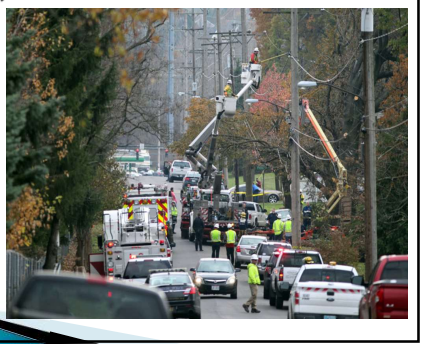
08.12.2003

- Boy 8 Years old
- 22 Safety Violations
- Grounding & Bonding
- 2 Mil. Settlement

11.15.2017 Tree trimmer fatality in Akron, Ohio

Electrocution: 23kv Line bucket lift accident; 1 died, 1 in serious condition

Update: **2 deaths**



2017 NEC "Features"

The 2017 NEC edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new.

"5" New 2017 NEC Articles

Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment

Article 691 – Large Scale PV Production Facility

Article 706 – Energy Storage Systems

Article 710 – Stand Alone Systems

Article 712 – DC Micro Grids

Article 250 Grounding and Bonding

Grounding and Bonding

Grounding

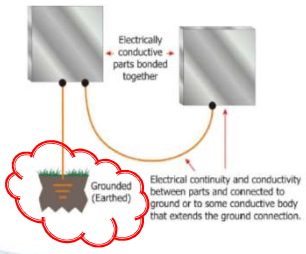
- Limit the voltages due to lightning, line surges or unintentional contact with higher voltage lines.
- Stabilize voltage to ground during normal operation.

Bonding

- Bonding (connecting non–current carrying conductive materials together) shall be provided where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed. The earth shall not be considered as an effective ground-fault current path.

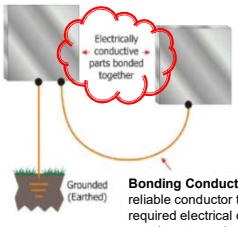
Article 100: Grounded (Grounding)

Grounded (Grounding). Connected (connecting) to ground or to a conductive body that extends the ground connection.



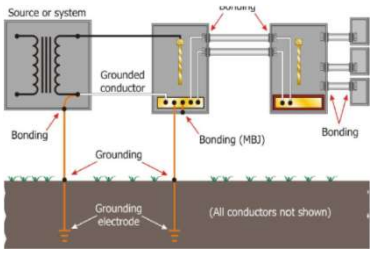
Article 100: Bonded (Bonding)

Bonded (Bonding). Connected to establish electrical continuity and conductivity.



Bonding Conductor or Jumper. A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected.

Grounding vs. Bonding



250.4(A)(1) Electrical System Grounding

The Intent / Purpose of Grounding

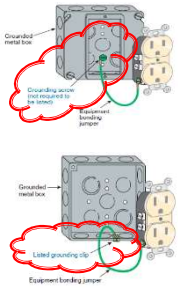
Electrical systems that are grounded ***shall*** be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.

250.8 Connection of Grounding and Bonding Equipment

250.8 Connection of Grounding and Bonding Equipment.

(A) **Permitted Methods.** Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:

(1) Listed pressure connectors
(2) Terminal bars
(3) Pressure connectors listed as grounding and bonding equipment
(4) Exothermic welding process
(5) Machine screw-type fasteners that engage not less than two threads or are secured with a nut
(6) Thread-forming machine screws that engage not less than two threads in the enclosure
(7) Connections that are part of a listed assembly
(8) Other listed means

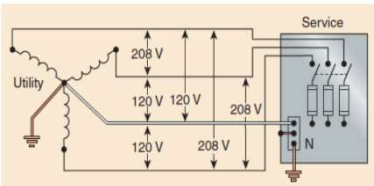


System Grounding 250.20(B) Alternating-Current Systems of 50 Volts to 1000 Volts

(B) Alternating-Current Systems of 50 Volts to 1000 Volts. Alternating-current systems of 50 volts to 1000 volts that supply premises wiring and premises wiring systems shall be grounded under any of the following conditions:
(1) Where the system can be grounded so that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts
(2) Where the system is 3-phase, 4-wire, wye connected in which the neutral conductor is used as a circuit conductor
(3) Where the system is 3-phase, 4-wire, delta connected in which the midpoint of one phase winding is used as a circuit conductor

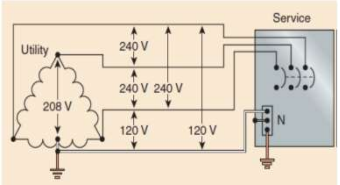
Alternating-Current Systems of 50 Volts to 1000 Volts

(2) Where the system is 3-phase, 4-wire, wye connected in which the neutral conductor is used as a circuit conductor



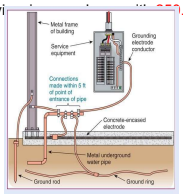
Alternating-Current Systems of 50 Volts to 1000 Volts

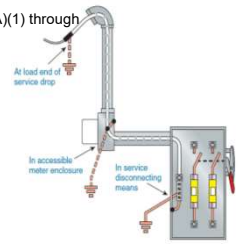
(3) Where the system is 3-phase, 4-wire, delta connected in which the midpoint of one phase winding is used as a circuit conductor



250.24 Grounding Service-Supplied Alternating-Current Systems

(A) System Grounding Connections. A premises wiring system supplied by a grounded ac service shall have a grounding electrode conductor connected to the grounded service conductor, at each servi .24(A)(1) through (A)(5).

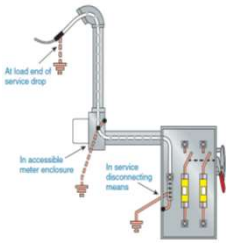




250.24 Grounding Service-Supplied Alternating-Current Systems

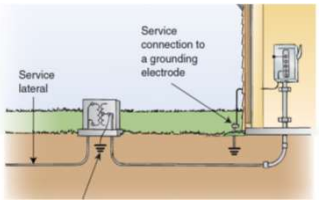
(1) General. The grounding electrode conductor connection shall be made at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to, including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.

Note: The accessibility of a point of connection has to be determined by the AHJ based on local conditions such as locked meter socket enclosures.



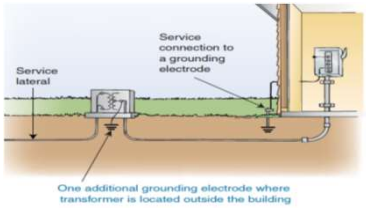
250.24 Grounding Service-Supplied Alternating-Current Systems

(2) Outdoor Transformer. Where the transformer supplying the service is located outside the building, at least one additional



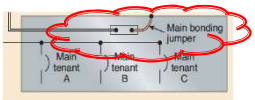
250.24 Grounding Service-Supplied Alternating-Current Systems

(2) Outdoor Transformer. Where the transformer supplying the service is located outside the building, at least one additional grounding connection shall be made from the grounded service conductor to a grounding electrode, either at the transformer or elsewhere outside the building.



250.24 Grounding Service-Supplied Alternating-Current Systems

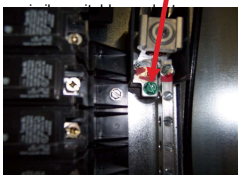
(4) Main Bonding Jumper as Wire or Busbar. Where the main bonding jumper specified in 250.28 is a wire or busbar and is installed from the grounded conductor terminal bar or bus to the equipment grounding terminal bar or bus in the service equipment, the grounding electrode conductor shall be permitted to be connected to the equipment grounding terminal, bar, or bus to which the main bonding jumper is connected.

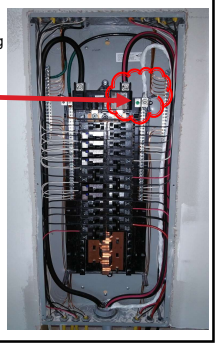


(B) Main Bonding Jumper. For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28.

250.28 Main Bonding Jumper and System Bonding Jumper.

(A) Material. Main bonding jumpers and system bonding jumpers shall be of copper or other corrosion-resistant material.
A main bonding jumper and a system bonding jumper shall be
a wire, bus, screw,



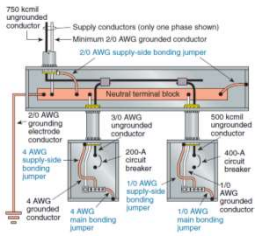


250.28 Main Bonding Jumper and System Bonding Jumper.

(D) Size. Main bonding jumpers and system bonding jumpers shall be sized in accordance with 250.28(D)(1) through (D)(3).

(1) General. Main bonding jumpers and system bonding jumpers shall not be smaller than specified in Table 250.102(C)(1).

(2) Main Bonding Jumper for Service with More Than One Enclosure. Where a service consists of more than a single enclosure as permitted in 230.71(A), the main bonding jumper for each enclosure shall be sized in accordance with 250.28(D)(1) based on the largest ungrounded service conductor serving that enclosure.



Size Main Bonding Jumpers

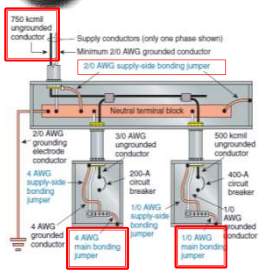


TABLE 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper[a] (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Grounding Separately Derived Alternating-Current Systems.

250.30(A)(1) System Bonding Jumper

(1) System Bonding Jumper. An unspliced system bonding jumper shall comply with 250.28(A) through (D). This connection shall be made at any single point on the separately derived system from the source to the first system disconnecting means or overcurrent device, or it shall be made at the source of a separately derived system that has no disconnecting means or overcurrent devices, in accordance with 250.30(A)(1)(a) or (b). The system bonding jumper shall remain within the enclosure where it originates. If the source is located outside the building or structure supplied, a system bonding jumper shall be installed at the grounding electrode connection in compliance with 250.30(C).

250.30(A)(4) Grounding Electrode

Separately Derived Systems

(4) Grounding Electrode. The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C).

Exception: If a separately derived system originates in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

As described in 250.52(A)(1) through (A)(7), all electrodes that are present are required to be bonded together to form the grounding electrode system for the building or structure. Separately derived systems are required to utilize the entire building or structure grounding electrode system as the grounding electrode.

250.30(A)(4) continued

Any of the other electrodes identified in 250.52(A) shall be used if the electrodes specified by 250.30(A)(4) are not available.

You are now required to utilize the grounding electrode for the building.

480V to 208/120V Transformer

250.30(A)(5) Grounding Electrode Conductor, Single Separately Derived System

Separately Derived Systems

(5) Grounding Electrode Conductor, Single Separately Derived System. A grounding electrode conductor for a single separately derived system shall be sized in accordance with 250.66 for the derived ungrounded conductors. It shall be used to connect the grounded conductor of the derived system to the grounding electrode in accordance with 250.30(A)(4), or as permitted in 250.68(C)(1) and (2). This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

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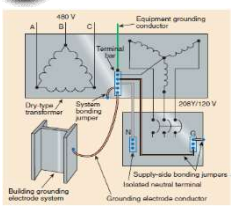
FOR EXAMPLE

Single Separately Derived System



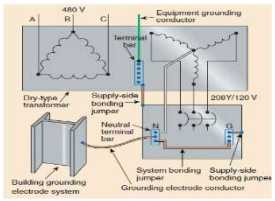


Figure 1 and Figure 2 illustrate two acceptable locations for connecting the GEC to the grounded conductor of a separately derived system. These figures depict typical wiring arrangements for dry-type transformers supplied from a 480-volt,
3-phase feeder to derive a 208Y/120-volt or 480Y/277-volt secondary.

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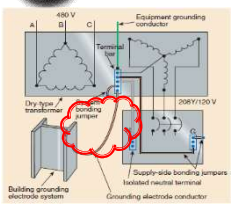
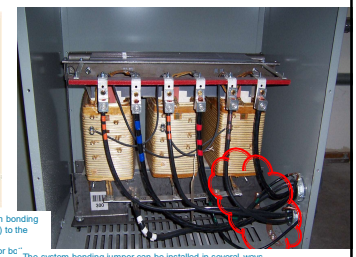
FOR EXAMPLE



Separately derived systems are required to have a system bonding jumper to connect the grounded circuit conductor (neutral) to the supply
side bonding jumper or equipment grounding conductor, or bo



The system bonding jumper can be installed in several ways.

For example, if a multi-barrel lug is connected to the XO terminal of a transformer,
the system bonding jumper, grounding electrode conductor, grounded conductor, and supply-side jumper can be connected at that connector. If a multi-barrel lug is connected to the transformer or generator enclosure, a common practice is to connect the system bonding jumper, the grounding electrode conductor, and the bonding jumper or conductor to that connector. The grounded conductor should

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250.30(A)(6) GEC, Multiple Separately Derived Systems

Common Grounding Electrode Conductor

(A) The common grounding electrode conductor shall be permitted to be one of the following:

(1) A conductor of the wire type, 3/0 CU or larger.
(2) ***A metal water pipe that complies with 250.68(C)(1)***
(3) ***The metal structural frame of the building or structure that complies with 250.68(C)(2)*** or 3/0 CU or larger wire.

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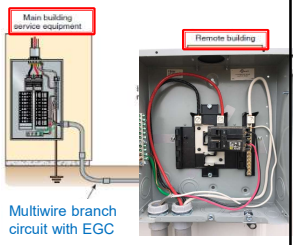
250.32 Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s)

(A) Grounding Electrode. Building(s) or structure(s) supplied by feeder(s) or branch circuit(s) shall have a grounding electrode or grounding electrode system installed in accordance with Part III of Article 250. The grounding electrode conductor(s) shall be connected in accordance with 250.32(B) or (C). Where there is no existing grounding electrode, the grounding electrode(s) required in 250.50 shall be installed.



Multiwire branch circuit with EGC

Exception: A grounding electrode shall not be required where only a single branch circuit, including a multiwire branch circuit, supplies the building or structure and the branch circuit includes an equipment grounding conductor for grounding the normally non-current-carrying metal parts of equipment.

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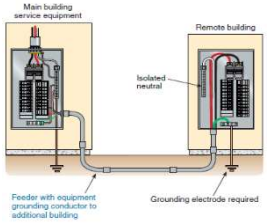
250.32 Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s)

(B) Grounded Systems.

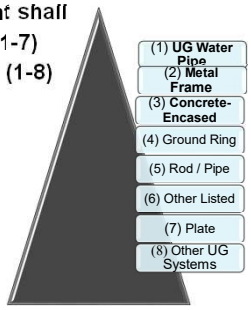
(1) Supplied by a Feeder or Branch Circuit. An equipment grounding conductor, as described in 250.118, shall be run with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. The equipment grounding conductor shall be sized in accordance with 250.122. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s).



ACS ASSOCIATED CONSULTING SOLUTIONS

Grounding

250.50 All Electrodes present shall be bonded together (1-7)
250.52 Permitted Electrodes (1-8)



250.50 Grounding Electrode System

- **250.50 Grounding Electrode System.**
- All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. Where none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) though (A)(8) shall be installed and used.
- Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system where the steel reinforcing bars or rods are not accessible for use without disturbing the concrete.

250.52 Grounding Electrodes

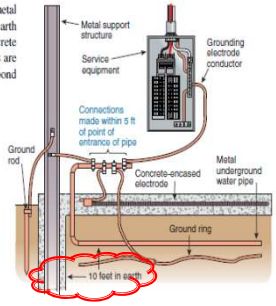
If (1) through (7) exist, you must use, otherwise install one or more of (4) through (8).

- **250.52 Grounding Electrodes.**
- **(A) Electrodes Permitted for Grounding:**
- (1) Metal Underground Water Pipe.
- (2) Metal Frame of the Building or Structure. (in 10' of earth)
- (3) Concrete-Encased Electrode. (in 20' of earth with ½" min rebar)
- (4) Ground Ring. (2 AWG Min, 20' min)
- (5) Rod and Pipe Electrodes. (8' min x ¾" min)
- (6) Other Listed Electrodes
- (7) Plate Electrodes. (2 ft² min, ¼" thick)
- (8) Other Local Metal Underground Systems or Structures.

250.52 Grounding Electrodes

250.52(A)(2) Metal In-ground Support Structures(s)

(2) Metal In-ground Support Structure(s). One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.



250.52(A)(2) continued

Informational Note: Metal in-ground support structures include, but are not limited to, pilings, casings, and other structural metal.

Metal in-ground support structure electrodes extend the metal building frame into the ground. Connection to more than one in-ground structural member is not necessary. Metal frames of buildings that are secured to hold down bolts connected to a concrete-encased electrode are permitted by 250.68(C)(2) to serve as the grounding electrode conductor.

250.52(A)(3) Concrete Encased Electrode

(3) Concrete-Encased Electrode. A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either (1) or (2):

(1) One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than 13 mm (½ in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length; or

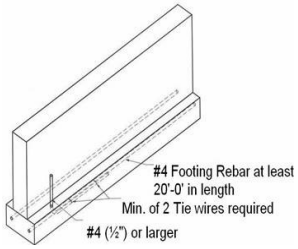
(2) Bare copper conductor not smaller than 4 AWG

Metallic components shall be encased by at east 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

250.52(A)(3) Concrete Encased Electrode

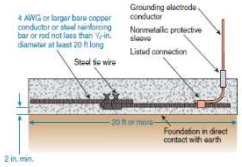
Requirements:

20' minimum rebar
#4 rebar = ½" Diameter
or 20' #4 CU wire,
with steel tie wire(s),
encased by 2" of
concrete.



250.52(A)(3) Concrete Encased Electrode

To qualify as a grounding electrode, the horizontal or vertical installation of the steel reinforcing rod or the 4 AWG bare copper conductor within the concrete encasement is required to be in contact with the earth for one continuous 20-foot length. Shorter lengths of reinforcing rod can be connected together to form an electrode of at least 20 feet using the connection methods identified in this requirement.

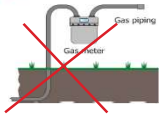


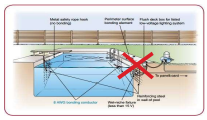
250.52(B) Not Permitted for Use as Grounding Electrodes

(B) Not Permitted for Use as Grounding Electrodes. The following systems and materials shall not be used as grounding electrodes:

(1) Metal underground gas piping systems
(2) Aluminum
(3) The structures and structural reinforcing steel described in 680.26(B)(1) and (B)(2)

Informational Note: See 250.104(B) for bonding requirements of gas piping.





Number (3) is New!

The structures and structural reinforcing steel described in 680.26(B)(1) and (B)(2).

Swimming pool perimeter surfaces, bonding purposes only; not permitted for grounding

250.53(A)(2) Supplemental Electrode Required

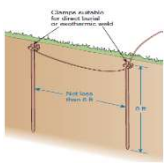
A single rod, pipe, or plate electrode shall be ***supplemented*** by an additional electrode of a type specified in 250.52(A)(2) – (A)(8). The supplemental electrode shall be permitted to be bonded to ***one*** of the following:

(1) Rod, pipe or plate electrode
(2) Grounding electrode conductor
(3) Grounded service-entrance conductor
(4) Non-flexible grounded service raceway
(5) Any grounded service enclosure

250.53(A)(2) Continued

Exception:
If a single rod, pipe or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode ***shall not*** be required.

250.53(A)(3) **6' minimum spacing required between electrodes.**



250.53(D)(2) Supplemental Electrode Required

Metal UG Water Pipe shall be Supplemented

A metal underground water pipe shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) – (8). If the supplemental electrode is of the rod, pipe, or plate type, it ***shall*** comply with 250.53(A). ***25 ohms or less; or (2) Rods Required***

1. Service upgrades with UG water pipe only.
2. New Construction
3. Temporary poles
4. Oil wells, traffic signals, etc.

Grounding Electrode Conductor Installation
250.64(B)(4) Securing and Protection Against Physical Damage

(4) In Contact with the Earth. Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth shall not be required to comply with 300.5, but shall be buried or otherwise protected if subject to physical damage.

Previous editions did not address buried GEC's.

250.64(E) Raceways and Enclosures for Grounding Electrode Conductors

Clarification of Intent

Ferrous metal raceways and enclosures shall be bonded at each end of the raceway or enclosure to the grounding electrode or grounding electrode conductor ***(in order)*** **to create an electrically parallel** ***(or continuous)*** **path.**

250.66 Size of AC Grounding Electrode Conductor

Clarification; Applies to (A), (B) & (C)

The size of the GEC shall not be less than Table 250.66 except as permitted by 250.66 (A), (B) & (C): "does not extend on or to other types of electrodes" that require a larger size conductor.

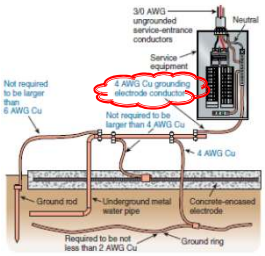
(A) Rod, pipe or plate (#6 CU);

(B) Concrete-encased electrodes (#4 CU); or

(C) Ground rings (#2 CU minimum)

FOR EXAMPLE

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems



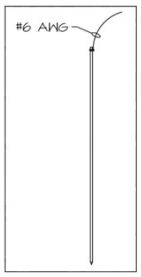
Grounding Electrode System

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

250.66(A) Connections to a Rod, Pipe, or Plate Electrode(s)

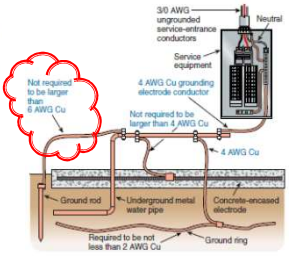
(A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.



FOR EXAMPLE

250.66(A) Connections to a Rod, Pipe, or Plate Electrode(s)

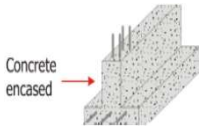
(A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.



Grounding Electrode System

250.66(B) Connections to Concrete-Encased Electrodes

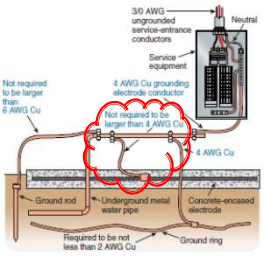
(B) Connections to Concrete-Encased Electrodes. If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 250.52(A)(3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.



FOR EXAMPLE

250.66(B) Connections to Concrete-Encased Electrodes

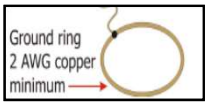
(B) Connections to Concrete-Encased Electrodes. If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 250.52(A)(3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.



Grounding Electrode System

250.66(C) Connections to Ground Rings

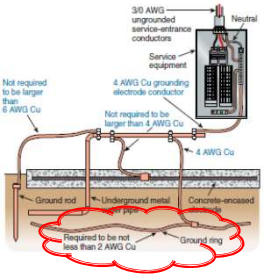
(C) Connections to Ground Rings. If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A)(4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.



FOR EXAMPLE

250.66(C) Connections to Ground Rings

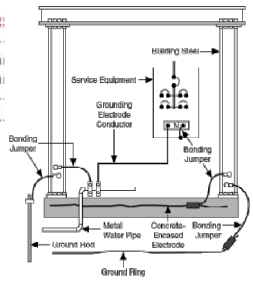
(C) Connections to Ground Rings. If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A)(4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.



Grounding Electrode System

250.68 Grounding Electrode Conductor and Bonding Connection to Grounding Electrodes

250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes. The connection of a grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system and associated bonding jumper(s) shall be made as specified 250.68(A) through (C).

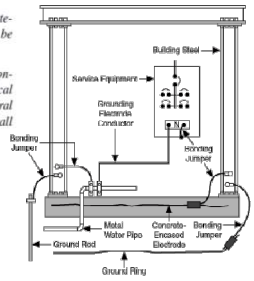


250.68(A) Accessibility

(A) Accessibility. All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode shall be accessible.

Exception No. 1: An encased or buried connection to a concrete-encased, driven, or buried grounding electrode shall not be required to be accessible.

Exception No. 2: Exothermic or irreversible compression connections used at terminations, together with the mechanical means used to attach such terminations to fireproofed structural metal whether or not the mechanical means is reversible, shall not be required to be accessible.



250.68(A) Accessibility

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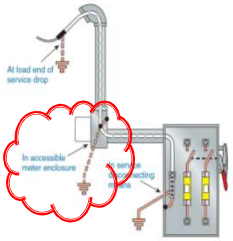
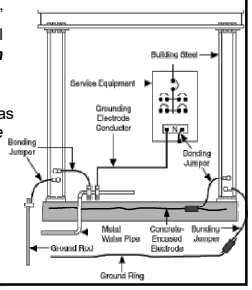


Would the mechanical termination be accessible if the meter was "sealed" by the utility company?

250.68(C) Grounding Electrode Conductor Connections

Clarification

Interior metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 5' from the point of entrance to the building shall be permitted to ***extend the connection to an electrode(s). Interior metal water piping located more than 5' from the point of entrance to the building shall not*** be used as a conductor to interconnect ***electrodes of*** *the GES*.



250.92(A) Bonding at Service

(A) Bonding of Equipment for Services. The normally non–current-carrying metal parts of equipment indicated in 25(1) All raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors, except as permitted in 250.80 ogether.

(2) All enclosures containing service conductors, including meter fittings, boxes, or the like, interposed in the service raceway or armor

250.92(B) Method of Bonding at Service

(B) Method of Bonding at the Service. Bonding jumpers meeting the requirements of this article shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts. Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make a mechanical connection of the raceway(s).

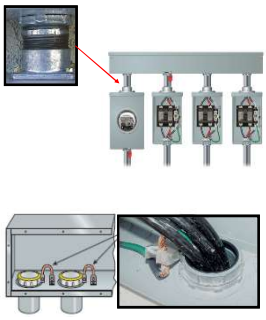
Electrical continuity at service equipment, service raceways, and service conductor enclosures shall be ensured by one of the following methods:

(1) Bonding equipment to the grounded service conductor in a manner provided in 250.8

(2) Connections utilizing threaded couplings or threaded hubs on enclosures if made up wrenchtight

(3) Threadless couplings and connectors if made up tight for metal raceways and metal-clad cables

(4) Other listed devices, such as bonding-type locknuts, bushings, or bushings with bonding jumpers



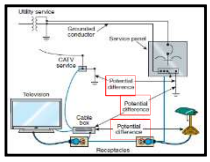
250.94(A) Bonding for "Communication" Systems

Intersystem Bonding Termination Device

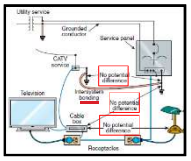
1. Be accessible for connection / inspection
2. Capacity for not less than (3) IB conductors
3. Not to interfere with opening SE equipment
4. Securely mounted & electrically connected to SE
5. Securely mounted to disconnecting means
6. Terminals listed for grounding & bonding

Designed for minimum #6 CU conductors

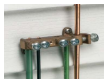
250.94(A) Bonding for "Communication" Systems



Incorrect!

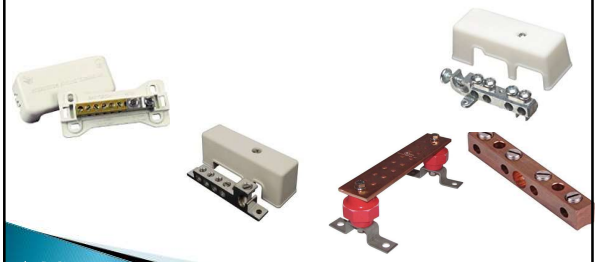


Correct
No potential differences



250.94(B) Other Means

N *Recognizes Aluminum and Copper Bus bars provided with (3) terminations for communication systems in addition to other connections.*



250.97 Bonding for Over 250 Volts

250.97 Bonding for Over 250 Volts. For circuits of over 250 volts to ground, the electrical continuity of metal raceways and cables with metal sheaths that contain any conductor other than service conductors shall be ensured by one or more of the methods specified for services in 250.92(B), except for (B)(1).

Exception: Where oversized, concentric, or eccentric knockouts are not encountered, or where a box or enclosure with concentric or eccentric knockouts is listed to provide a reliable bonding connection, the following methods shall be permitted:

(1) Threadless couplings and connectors for cables with metal sheaths
(2) Two locknuts, on rigid metal conduit or intermediate metal conduit, one inside and one outside of boxes and cabinets
(3) Fittings with shoulders that seat firmly against the box or cabinet, such as electrical metallic tubing connectors, flexible metal conduit connectors, and cable connectors, with one locknut on the inside of boxes and cabinets
(4) Listed fittings

480V Primary conductors supplying transformer

Bonding Examples

250.97 Bonding for Over 250 Volts. For circuits of over 250 volts to ground, the electrical continuity of metal raceways and cables with metal sheaths that contain any conductor other than service conductors shall be ensured by one or more of the methods specified for services in 250.92(B), except for (B)(1).

Exception: Where oversized, concentric, or eccentric knockouts are not encountered, or where a box or enclosure with concentric or eccentric knockouts is listed to provide a reliable bonding connection, the following methods shall be permitted:

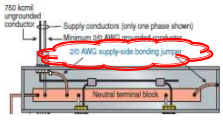
(1) Threadless couplings and connectors for cables with metal sheaths
(2) Two locknuts, on rigid metal conduit or intermediate metal conduit, one inside and one outside of boxes and cabinets
(3) Fittings with shoulders that seat firmly against the box or cabinet, such as electrical metallic tubing connectors, flexible metal conduit connectors, and cable connectors, with one locknut on the inside of boxes and cabinets
(4) Listed fittings

250.100 Bonding in Hazardous (Classified) Locations

Regardless of the voltage of the electrical system, the electrical continuity of non–current-carrying metal parts of equipment, raceways, and other enclosures in any hazardous (classified) location, as defined in 500.5, 505.5, and 506.5, shall be ensured by any of the bonding methods specified in 250.92(B)(2) through (B)(4). One or more of these bonding methods shall be used whether or not equipment grounding conductors of the wire type are installed.

250.102 Grounded Conductor, Bonding Conductors, and Jumpers

- For proper sizing of a **grounded conductor**, **main bonding jumper**, **system bonding jumper**, or a **supply-side bonding jumper** for an alternating-current (ac) systems, provisions of 250.102 and Table 205.102(C)(1) must be utilized
- The term "**Grounded Conductor**" was added to the title of 250.102 to more accurately reflect what the section addresses



250.102 Grounded Conductor, Bonding Conductors, and Jumpers*(cont.)*

- The term "**Aluminum and copper-clad aluminum**" added to the choices of material acceptable for bonding jumpers
- Title of 250.102(C)(2) has been revised from "Size for Parallel Conductor Installations in Two or More Raceways" to "**Size for Parallel Conductor Installations in Two or More Raceways or Cables**"
- This will help avoid any misperception as a cable is not the same as a raceway

250.102 Grounded Conductor, Bonding Conductors, and Jumpers

- Shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material such as ….wire, bus, screw.
- Attached per 250.8 for circuits and equipment and 250.70 for grounding electrodes.

(C) Size — Supply-Side Bonding Jumper.

(1) Size for Supply-Conductors in a Single Raceway or Cable. The supply-side bonding jumper shall not be smaller than specified in Table 250.102(C)(1).

(2) Size for Parallel Conductor Installations in Two or More Raceways or Cables. Where the ungrounded supply conductors are paralleled in two or more raceways or cables, and an individual supply-side bonding jumper is used for bonding these raceways or cables, the size of the supply-side bonding jumper for each raceway or cable shall be selected from Table 250.102(C)(1) based on the size of the ungrounded supply conductors in each raceway or cable. A single supply-side bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with 250.102(C)(1).

TABLE 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:
1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper and will have an ampacity equivalent to that of the installed ungrounded supply conductors.
3. If multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, or if multiple sets of ungrounded supply conductors are installed for a separately derived system, the equivalent size of the largest ungrounded supply conductor(s) shall be determined by the largest sum of the areas of the corresponding conductors of each set.
4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

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250.102 Grounded Conductor, Bonding Conductors, and Jumpers

- Shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material such as ….wire, bus, screw.
- Attached per 250.8 for circuits and equipment and 250.70 for grounding electrodes.

(D) Size — Equipment Bonding Jumper on Load Side of an Overcurrent Device. The equipment bonding jumper on the load side of an overcurrent device(s) shall be sized in accordance with 250.122.

A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 250.122 for the largest overcurrent device supplying circuits therein.

TABLE 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:
1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper and will have an ampacity equivalent to that of the installed ungrounded supply conductors.
3. If multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, or if multiple sets of ungrounded supply conductors are installed for a separately derived system, the equivalent size of the largest ungrounded supply conductor(s) shall be determined by the largest sum of the areas of the corresponding conductors of each set.
4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

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250.104(B) Other Metal Piping

(B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

(1) Equipment grounding conductor for the circuit that is likely to energize the piping system
(2) Service equipment enclosure
(3) Grounded conductor at the service
(4) Grounding electrode conductor, if of sufficient size
(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

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FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Photo courtesy of OmegaFlex

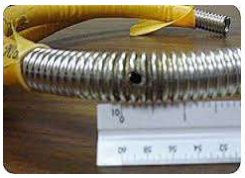
Non-arc-resistant CSST

CSST

ACS ASSOCIATED CONSULTING SOLUTIONS

CSST Bonding

- First - Understand Grounding and Bonding



FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

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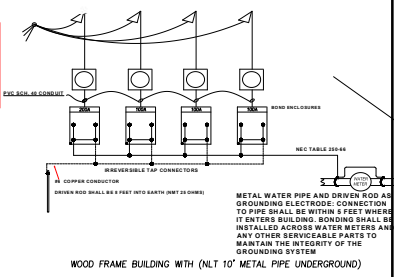
Electrical Grounding (IFGC 309.1)

309.1 Grounding. Gas *piping* shall not be used as a grounding electrode.

The intent of 309.1 is to not intentionally connect buried metallic piping in earth via a wire (GEC) to the grounded service conductor.



FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Gas Pipe & Tubing other than CSST (IFGC 310.1)

SECTION 310 (IFGS)
ELECTRICAL BONDING

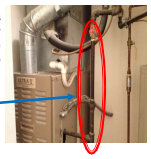
310.1 Pipe and tubing other than CSST. Each aboveground portion of a gas *piping* system other than corrugated stainless steel tubing (CSST) that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas *piping* other than CSST shall be considered to be bonded where it is connected to an appliance that is connected to the *equipment* grounding conductor of the circuit that supplies that *appliance*.

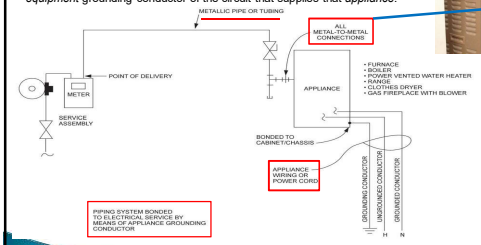
Schedule 40 Steel Gas Piping System

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Gas Pipe & Tubing other than CSST (IFGC 310.1)

310.1 Pipe and tubing other than CSST. Each aboveground portion of a gas *piping* system other than corrugated stainless steel tubing (CSST) that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas *piping* other than CSST shall be considered to be bonded where it is connected to an appliance that is connected to the *equipment* grounding conductor of the circuit that supplies that *appliance*.





Gas Pipe Bonding by Appliance Equipment Grounding Conductor Permitted: 2018 IFGC 310.1 & NEC 250.104(B) Informational Note #2

IFGC 310.2 CSST (New Requirements)

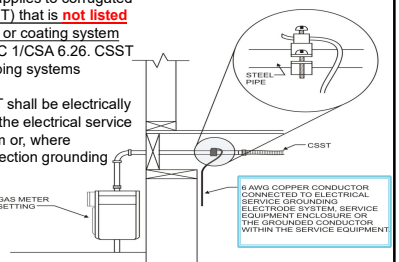
- This section previously applied to ALL CSST products but is now restricted to only the traditional yellow jacketed CSST product. A new Section 310.3 was added to address the arc-resistant CSST products.

Non-arc-resistant CSST

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Gas Piping CSST Bonding (IFGC 310.2)

310.2 CSST. This section applies to corrugated stainless steel tubing (CSST) that is **not listed** with an arc-resistant jacket or coating system in accordance with ANSI LC 1/CSA 6.26. CSST gas *piping* systems and piping systems containing one or more segments of CSST shall be electrically continuous and bonded to the electrical service grounding electrode system or, where provided, the lightning protection grounding electrode system.



FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Gas Piping CSST Bonding (IFGC 310.2)

310.2 CSST. This section applies to corrugated stainless steel tubing (CSST) that is **not** listed with an arc-resistant jacket or coating system in accordance with ANSI LC 1/CSA 6.26. CSST gas *piping* systems and piping systems containing one or more segments of CSST shall be electrically continuous and bonded to the electrical service grounding electrode system, or where provided, the lightning protection grounding electrode system.

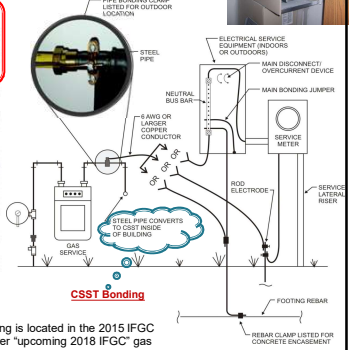
310.2.1 Point of connection. The bonding jumper shall connect to a metallic pipe, pipe fitting or CSST fitting.

310.2.2 Size and material of jumper. The bonding jumper shall be not smaller than 6 AWG copper wire or equivalent.

310.2.3 Bonding jumper length. The length of the bonding jumper between the connection to a gas piping system and the connection to a grounding electrode system shall not exceed 75 feet (22 860 mm). Any additional grounding electrodes installed to meet this requirement shall be bonded to the electrical service grounding electrode system or, where provided, the lightning protection grounding electrode system.

310.2.4 Bonding connections. Bonding connections shall be in accordance with NFPA 70.

310.2.5 Connection devices. Devices used for making the bonding connections shall be listed for the application in accordance with UL 467.



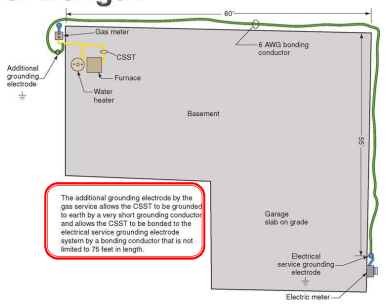
FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Bonding jumper point of connection. IFGC 310.2.1

310.2.1 Point of connection. The bonding jumper shall connect to a metallic pipe, pipe fitting or CSST fitting.

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

IFGC 310.2.3 Bonding Jumper Length



FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

IFGC 310.3 ARC-RESISTANT CSST (New Section)

IFGC Section 310.3 was added to address the arc-resistant CSST products.

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

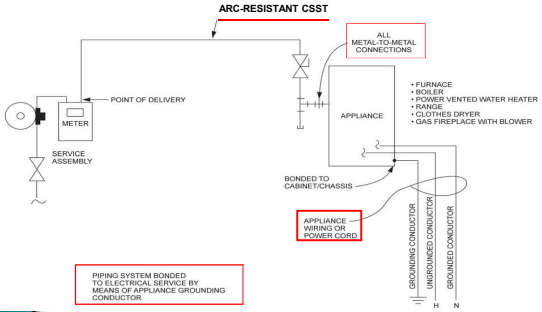
IFGC 310.3 ARC-RESISTANT CSST (New Section)

- Arc-resistant-jacketed CSST shall be considered to be bonded where it is connected to an appliance that is connected to the appliance grounding conductor of the circuit that supplies that appliance.

310.3 Arc-resistant CSST. This section applies to corrugated stainless steel tubing (CSST) that is listed with an arc-resistant jacket or coating system in accordance with ANSI LC 1/CSA 6.26. The CSST shall be electrically continuous and bonded to an effective ground fault current path. Where any CSST component of a piping system does not have an arc-resistant jacket or coating system, the bonding requirements of Section 310.2 shall apply. Arc-resistant-jacketed CSST shall be considered to be bonded where it is connected to an appliance that is connected to the appliance grounding conductor of the circuit that supplies that appliance.

FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

Arc-resistant CSST Considered to be Bonded

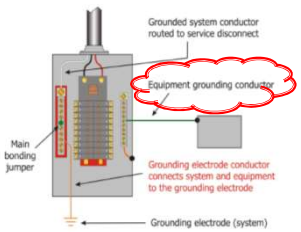


FYI: Specific bonding requirements for gas piping is located in the 2015 IFGC (Referenced by OMC 301.6). Note: We will cover "upcoming 2018 IFGC" gas piping modifications and new arc-resistant CSST requirements.

250.122 Size of Equipment Grounding Conductors

(A) General. Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table 250.122, but in no case shall they be required to be larger than the circuit conductors supplying the equipment. Where a cable tray, a raceway, or a cable armor or sheath is used as the equipment grounding conductor, as provided in 250.118 and 250.134(A), it shall comply with 250.4(A)(5) or (B)(4).

Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable, provided the combined circular mil area complies with Table 250.122.



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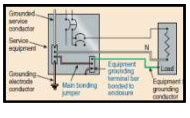


TABLE 250.122 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil) Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120.

250.122 Size of Equipment Grounding Conductors

(B) Increased in Size. Where ungrounded conductors are increased in size from the minimum size that has sufficient ampacity for the intended installation, wire-type equipment grounding conductors, where installed, shall be increased in size proportionately, according to the circular mil are of the ungrounded conductors.

A 240-V, single-phase, 250-A load is supplied from a 300-A breaker located in a panelboard 500 ft away. The conductors are 250 kcmil copper, installed in rigid nonmetallic conduit, with a 4 AWG copper EGC.
If the conductors are increased to 350 kcmil, what is the minimum size for the EGC based on the proportional-increase requirement?

Solution
Step 1. Calculate the size ratio of the new conductors to the existing conductors:
Size ratio = 350,000 circular mils /250,000 circular mils = 1.4
Step 2. Calculate the cross-sectional area of the new EGC:
41,740 circular mils × 1.4 = 58,436 circular mils
According to Table 8 of Chapter 9, the size of the existing grounding conductor, 4 AWG, has a cross-sectional area of 41,740 circular mils.
Step 3. Determine the size of the new EGC. Again, referring to Chapter 9, Table 8, we find that 58,436 circular mils is larger than 3 AWG. The next larger size is 66,360 circular mils, which converts to a 2 AWG copper

250.122(F) EGCs Installed in Parallel

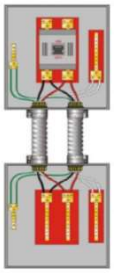
- Revision and new text added to clarify how to size and install equipment grounding conductors when installed in parallel in single or multiple raceways, multiconductor cable, auxiliary gutter, or cable tray
- Expanded to cover equipment grounding conductors installed as part of a **multiconductor cable** as well as when installed in **auxiliary gutters**
- Previous single, long paragraph has been expanded into two separate second level subdivisions
  - 250.122(F)(1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays
  - 250.122(F)(2) Multiconductor Cables

250.122(F) EGCs Installed in Parallel

***N* (1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.**

(a) *Single Raceway or Cable Tray.* If conductors are installed in parallel in the same raceway or cable tray, a single wire-type conductor shall be permitted as the equipment grounding conductor. The wire-type equipment grounding conductor shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit. Wire-type equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

(b) *Multiple Raceways.* If conductors are installed in parallel in multiple raceways, wire type equipment grounding conductors, where used, shall be installed in parallel in each raceway. The equipment grounding conductor installed in each raceway shall be sized in compliance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.
Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.



250.122(F) EGCs Installed in Parallel

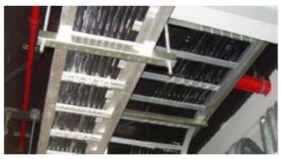
***N* (2) Multiconductor Cables**

(a) If multiconductor cables are installed in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel.

(b) If multiconductor cables are installed in parallel in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.

(c) Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Cable trays complying with 392.60(B), metal raceways in accordance with 250.118, or auxiliary gutters, shall be permitted as the equipment grounding conductor.

(d) Except as provided in 250.122(F)(2)(b) for raceway or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.



250.146 Connecting Receptacle Grounding Terminal to Box

An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box unless grounded as in 250.146(A) through (D). The equipment bonding jumper shall be sized in accordance with Table 250.122 based on the rating of the overcurrent device protecting the circuit conductors.

250.146 Connecting Receptacle Grounding Terminal to Box

An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box unless grounded as in 250.146(A) through (D). The equipment bonding jumper shall be sized in accordance with Table 250.122 based on the rating of the overcurrent device protecting the circuit conductors.

(A) Surface-Mounted Box. Where the box is mounted on the surface, direct metal-to-metal contact between the device yoke and the box or a contact yoke or device that complies with 250.146(B) shall be permitted to ground the receptacle to the box. At least one of the insulating washers shall be removed from receptacles that do not have a contact yoke or device that complies with 250.146(B) to ensure direct metal-to-metal contact. This provision shall not apply to cover-mounted receptacles unless the box and cover combination are listed as providing satisfactory ground continuity between the box and the receptacle. A listed exposed work cover shall be permitted to be the grounding and bonding means when (1) the device is attached to the cover with at least two fasteners that are permanent (such as a rivet) or have a thread locking or screw or nut locking means and (2) when the cover mounting holes are located on a flat non-raised portion of the cover.

250.146 Connecting Receptacle Grounding Terminal to Box

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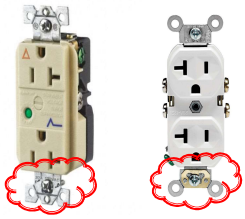
(B) Contact Devices or Yokes. Contact devices or yoke designed and listed as self-grounding shall be permitted in con junction with the supporting screws to establish equipment bon ing between the device yoke and flush-type boxes.

Receptacles designed with a spring-type grounding strap for hold mounting screw and establishing the grounding connection so equipment bonding jumper is not required. Such devices are listed a grounding" and are permitted to be used for bonding the flush-t receptacle to a grounded metal box.



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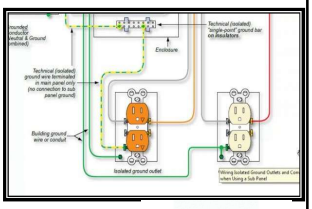
250.146 Connecting Receptacle Grounding Terminal to Box

(D) Isolated Ground Receptacles. Where installed for the reduction of electrical noise (electromagnetic interference) on the grounding circuit, a receptacle in which the grounding terminal is purposely insulated from the receptacle mounting means shall be permitted. The receptacle grounding terminal shall be connected to an insulated equipment grounding conductor run with the circuit conductors. This equipment grounding conductor shall be permitted to pass through one or more panelboards without a connection to the panelboard grounding terminal bar as permitted in 408.40, Exception, so as to terminate within the same building or structure directly at an equipment grounding conductor terminal of the applicable derived system or service. Where installed in accordance with the provisions of this section, this equipment grounding conductor shall also be permitted to pass through boxes, wireways, or other enclosures without being connected to such enclosures.



Informational Note: Use of an isolated equipment grounding conductor does not relieve the requirement for grounding the raceway system and outlet box.

406.3(D) Isolated Ground Receptacles. Receptacles incorporating an isolated grounding conductor connection intended for the reduction of electrical noise (electromagnetic interference) as permitted in 250.146(D) shall be identified by an orange triangle located on the face of the receptacle.

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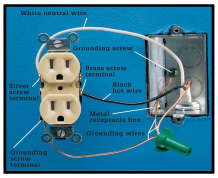
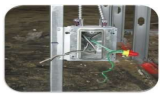
250.148 Continuity and Attachment of EGC to Boxes

250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes. If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, all equipment grounding conductor(s) associated with any of those circuit conductors shall be connected within the box or to the box with devices suitable for the use in accordance with 250.8 and 250.148(A) through (E).



- Revision clarified that **all equipment grounding conductors** associated with any and all circuits in the box must be connected together and to the box *(not just EGCs of each associated circuit)*
- Existing exception gives relief to EGCs of an **isolated ground circuit** *(isolated ground receptacle not required to be connected to the other EGCs or to the box)*
- Reference to **250.8** *(Connection of Grounding and Bonding Equipment)* was also added to this section to provide guidance on terminating an EGC or bonding jumper to a metal box or enclosure



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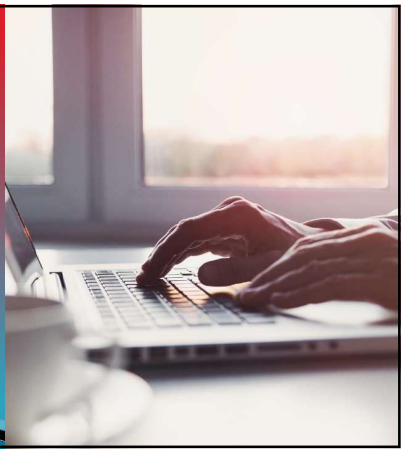
Do you have questions?

Now is the time to ask!



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Thank you for participating!

To schedule a seminar, webinar, or online course:

www.associatedconsultingsolutions.com

Or call

Associated Consulting Solutions, LLC
216-256-3556

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File Attachments for Item:

ER-2 2017 NEC Requirements for General and Special Equipment and Special Conditions (Flanik)

All Certifications (6 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend 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: Jerry Flanik
(Contact Name)

Organization: Associated Consulting Solutions, LLC
(Organization/Company)

Address: 9671 Oxford Glen Drive
(Include Room Number, Suite, etc.)

City: Mentor State: Ohio Zip: 44060

E-Mail: jerry@associatedconsultingsolutions.com

Telephone: 216-256-3556 Fax: _____

Course Sponsor: Associated Consulting Solutions, LLC

COURSE INFORMATION:

Course Title: 2017 NEC Requirements for General and Special Equipment and Special Conditions

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

Purpose and Objective: This 6-hour seminar is designed for online or in-person training that highlights 2017 OBC Requirements, electric signs, swimming pools, storage batteries, fire pumps, and emergency systems.

Number of Instructional Contact Hours that can be obtained upon completion: 6 hours

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

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:		x

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

2017 NEC Requirements for General & Special Equipment and Special Conditions

6-Hours of Continuing Education Credit

Course Description: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar highlights key provisions of the *2017 NEC Requirements for General & Special Equipment and Special Conditions. It*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- Electric Signs
- Swimming Pools
- Storage Batteries
- Fire Pumps
- Emergency Systems

Course Outline:

1. **2017 OBC – CHAPTER 1**
    - **OBC Section 105.1 Approvals Required**
    - **OBC Section 102.10 Work Exempt From Approval**
    - **OBC Section 102.10.1 Emergency Repairs**
    - **OBC Section 102.10.2 Minor Repairs**
    - **OBC Section 106.1.1 Information on Construction Documents**

2. **2017 OBC – CHAPTER 27**
    - **OBC Section 2701.1 Scope**
    - **OBC Section 2701.2 Appliance and Fixture Listing**
    - **OBC Section 2702 Emergency and Standby Power Systems**
    - **OBC Section 2702.1 Installation**
    - **OBC Section 2702.2 Where Required**
    - **OBC Section 2702.3 Critical Circuits**
    - **OBC Section 2702.4 Maintenance**
    - **OBC Section 2703.1 Penetrations**
    - **OBC Section 2703.2 Cutting, Notching, and Boring**
    - **OBC Section 2704 Smoke Detection**
    - **OBC Section 2704.1 Smoke Alarm Circuits**

3. **2017 NEC 5 New Articles**
    - **Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment**
    - **Article 691 – Large Scale PV Production Facility**
    - **Article 706 – Energy Storage Systems**
    - **Article 710 – Stand Alone Systems**
    - **Article 712 – DC Micro Grids**

4. **Article 600 Electric Signs and Outline Lighting250 Grounding and Bonding**
    - **600.2 Definitions**
    - **600.4 Markings**
    - **600.5 Branch Circuits**
    - **600.6 Disconnects**
    - **600.33 Class 2 Sign Illumination Systems, Secondary Wiring**
    - **600.34 Photovoltaic (PV) Powered Sign**

5. **Article 680 Swimming Pools, Fountains, and Similar Installations 230 Services**

- **680.1 Scope**
- **680.2 Definitions**
- **680.5 Ground-Fault Circuit Interrupters**
- **680.7 Grounding and Bonding Terminals**
- **680.9 Overhead Conductor Clearances**
- **Table 680.9(A) Overhead Conductor Clearances**
- **680.13 Maintenance Disconnecting Means**
- **680.14 Corrosive Environment**
- **680.21 Motors**
- **680.21(A)(1) General**
- **680.21(A)(2) Flexible Connections**
- **680.21(A)(3) Cord-and-Plug Connections**
- **680.22 Lighting, Receptacles, and Equipment**
- **680.22(B) Luminaires, Lighting Outlets, and Ceiling-Suspended (Paddle) Fans**
- **680.22(B)(6) Low-Voltage Luminaires**
- **680.23(A)(2) Transformers and Power Supplies**
- **680.22(7) Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment**
- **680.23 Underwater Luminaires**
- **680.23(B) Wet-Niche Luminaires**
- **680.25 Feeders**
- **680.26 Equipotential Bonding**
- **680.26(B)(1) Conductive Pool Shells**
- **680.26(B)(2) Perimeter Surfaces**
- **680.26(B)(4) Underwater Lighting**
- **680.26(B)(5) Metal Fittings**
- **680.26(B)(6) Bonding of Electrical Equipment**
- **680.26(B)(7) Fixed Metal Parts**
- **680.28 Gas-Fired Water Heater**

6. **Article 480 Storage Batteries**

- **480.1 Scope**
- **480.3 Equipment**
- **480.4 Battery and Cell Terminations**
- **480.6 Overcurrent Protection for Prime Movers**
- **480.7 DC Disconnect Methods**
- **480.10 Battery Locations**
- **480.10(E) Egress**

7. **Article 695 Fire Pumps**

- **695.1 Scope**
- **695.3 Power Source(s) for Electric Motor-Driven Fire Pumps**
- **695.3(B) Connection Through Disconnecting Means and Overcurrent Device**
- **695.5 Transformers**
- **695.6 Power Wiring**
- **695.7 Voltage Drop**
- **695.10 Listed Equipment**
- **695.14 Control Wiring**
- **695.14(E) Electric Fire Pump Control Wiring Methods**
- **695.15 Surge Protection**

8. **Article 700 Emergency Systems**

- **700.3 Tests and Maintenance**
- **700.4 Emergency Systems Capacity**
- **700.5 Transfer Equipment**
- **700.7 Signs**
- **700.10 Wiring, Emergency System**
- **700.12(B)(6) Outdoor Generator Sets**

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2017 NEC Requirements for General & Special Equipment and Special Conditions

Based on the 2017 National Electrical Code (NEC)

Welcome

- Meet the instructor
- Participant introductions

Meet the Instructor

ICC PREFERRED EDUCATION PROVIDER

- Gerald C. Flanik is an ICC-Certified Master Code Professional (MCP), and holds over 40 various licenses and certifications. He is also a LEED BD+C Accredited Professional, Certified Floodplain Manager (CFM).
- Mr. Flanik is President of Associated Consulting Solutions, LLC (ACS) in Cleveland, Ohio. ACS provides plan review services, pre and post design analysis services for architectural and engineering firms, and code consulting services throughout the United States. ACS is also an ICC Preferred Education Provider, providing education throughout the United States. Previously, Gerald served as the Chief Building Official for Lake County, Ohio for 16 years. Prior to working as a code official, he owned and operated a design build contracting company.
- Gerald holds a Bachelor of Science Degree in Mechanical Engineering and a Bachelor of Science Degree in Electrical Engineering from Cleveland State University; as well as, a degree in Civil Engineering Technology. He is also an adjunct faculty instructor at Lakeland College in the Civil and Electrical Engineering Departments.
- Jerry is a professional consultant for corporations and government agencies throughout the United States, and for the International Code Council throughout the world.

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2017 NEC Requirements for General & Special Equipment and Special Conditions

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- Electric Signs
- Swimming Pools
- Storage Batteries
- Fire Pumps
- Emergency Systems

Description

This seminar highlights key provisions of the *2017 NEC Requirements for General & Special Equipment and Special Conditions.*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

OBC Chapter 1

- This chapter is largely concerned with maintaining "due process of law" in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.

OBC Section 105.1

105.1 Approvals Required

Any owner or owner's representative who intends to construct, enlarge, alter, repair, move, or change the occupancy of a building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required approval.

However, OBC 102.10 contains additional information.

OBC Section 102.10

102.10 Work Exempt From Approval

Approval shall not be required for the following work; however, this work shall comply with all applicable provisions of the rules of the board:

Electrical:

1. Minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
2. Electrical equipment used for radio and television transmissions except equipment and wiring for power supply, and the installations of towers and antennas.
3. The installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.
4. Electrical wiring, devices, appliances, apparatus or equipment operating at less than twenty-five volts and not capable of supplying more than fifty watts of energy, unless specifically addressed in this code.
5. Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
6. Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70 as referenced in Chapter 35.

OBC Section 102.10.1

102.10.1 Emergency Repairs

Where equipment replacements and repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Provide some examples of electrical emergency situations???

OBC Section 102.10.2

102.10.2 Minor Repairs

Minor repairs to structures may be made without application or notice to the building official. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall minor repairs include addition to, alteration of, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Provide some examples of minor repairs???

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

OBC Section 106.1.1

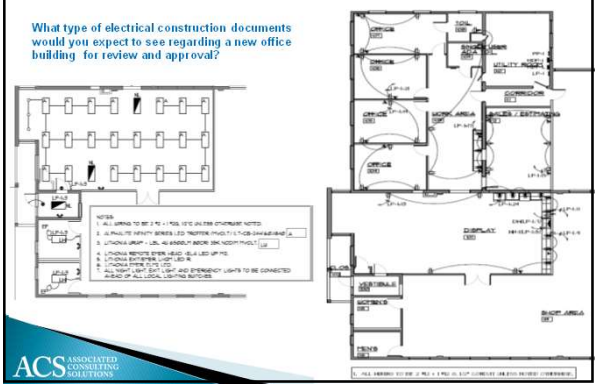
106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

OBC Section 106.1.1

What type of electrical construction documents would you expect to see regarding a new office building for review and approval?



OBC Chapter 27

2701.1 Scope

This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment, and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

2701.2 Appliance and Fixture Listing

Electrical appliances and fixtures within the scope of this code shall be tested and listed in published reports of inspected electrical equipment by an approved agency and installed in accordance with all instructions included as part of such listing.

UL LISTED

OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

OBC Chapter 27

Section 2703 Penetrations

2703.1 Penetrations
Penetrations of walls, floors, ceilings and assemblies required to have a fire-resistance rating, shall be protected in accordance with Chapter 7. Where cables, conductors and raceways penetrate fireblocking or draftstopping, such penetrations shall be protected by filling the annular space with an approved fireblocking material.

2703.2 Cutting, Notching, and Boring
The cutting, notching and boring of wood and steel framing members, structural members and engineered wood products shall be in accordance with this code and as prescribed by the registered design professional.

Section 2704 Smoke Detection

2704.1 Smoke Alarm Circuits
Smoke detectors required by this code and installed within dwelling units shall not be connected as the only load on a branch circuit. Such detectors shall be supplied by branch circuits having lighting loads consisting of lighting outlets in habitable spaces.

Why do we need codes and standards?

IKEA Rooftop PV Install (Illinois)

1.124 MW System

Bolingbrook (05.12.2018)

4,784 Panels

No Injuries Reported

Lake County; Fair Painesville, Ohio

Bumper Car Ride - Electrocution

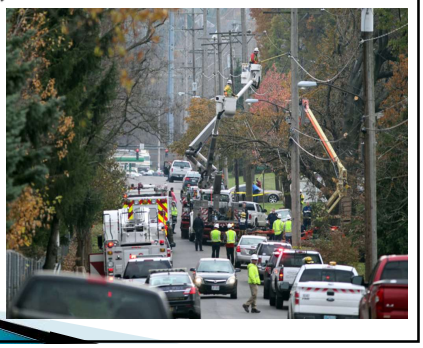
08.12.2003

- Boy 8 Years old
- 22 Safety Violations
- Grounding & Bonding
- 2 Mil. Settlement

11.15.2017 Tree trimmer fatality in Akron, Ohio

Electrocution:
23kv Line bucket lift accident; 1 died, 1 in serious condition

Update:
2 deaths



2017 NEC "Features"

The 2017 NEC edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new.

"5" New 2017 NEC Articles

Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment

Article 691 – Large Scale PV Production Facility

Article 706 – Energy Storage Systems

Article 710 – Stand Alone Systems

Article 712 – DC Micro Grids

Article 600 Electric Signs and Outline Lighting

600.2 Definitions

LED Sign Illumination System. A complete lighting system for use in signs and outline lighting consisting of light-emitting diode (LED) light sources, power supplies, wire, and connectors to complete the installation.

Neon Tubing. Electric-discharge luminous tubing, including cold cathode luminous tubing, that is manufactured into shapes to illuminate signs, form letters, parts of letters, skeleton tubing, outline lighting, other decorative elements, or art forms and filled with various inert gases.

N **Photovoltaic (PV) Powered Sign.** A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.

Section Sign. A sign or outline lighting system, shipped as subassemblies, that requires field-installed wiring between the subassemblies to complete the overall sign. The subassemblies are either physically joined to form a single sign unit or are installed as separate remote parts of an overall sign.

FOR EXAMPLE

New Definition: Photovoltaic (PV) Powered Sign

N **Photovoltaic (PV) Powered Sign.** A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.

Markings & Branch Circuits

600.4 Markings.

(A) Signs and Outline Lighting Systems. Signs and outline lighting systems shall be listed; marked with the manufacturer's name, trademark, or other means of identification; and input voltage and current rating.

600.5 Branch Circuits.

(A) Required Branch Circuit. Each commercial building and each commercial occupancy accessible to pedestrians shall be provided with at least one outlet in an accessible location at each entrance to each tenant space for sign or outline lighting system use. The outlet(s) shall be supplied by a branch circuit rated at least 20 amperes that supplies no other load. Service hallways or corridors shall not be considered accessible to pedestrians.

(B) Rating. Branch circuits that supply signs shall be rated in accordance with 600.5(B)(1) or (B)(2) and shall be considered to be continuous loads for the purposes of calculations.

(1) Neon Signs. Branch circuits that supply neon tubing installations shall not be rated in excess of 30 amperes.

(2) All Other Signs. Branch circuits that supply all other signs and outline lighting systems shall be rated not to exceed 20 amperes.

Marking???... Branch Circuit???...
Wiring Method???...Cord & Plug???

600.6 Disconnects

600.6 Disconnects. Each sign and outline lighting system, feeder conductor(s), or branch circuit(s) supplying a sign, outline lighting system, or skeleton tubing shall be controlled by an externally operable switch or circuit breaker that opens all ungrounded conductors and controls no other load. The switch or circuit breaker shall open all ungrounded conductors simultaneously on multi-wire branch circuits in accordance with 210.4(B). Signs and outline lighting systems located within fountains shall have the disconnect located in accordance with 680.13.

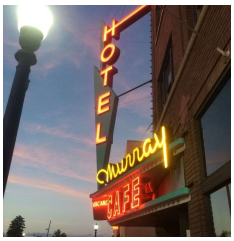
Exception No. 1: A disconnecting means shall not be required for an exit directional sign located within a building.

Exception No. 2: A disconnecting means shall not be required for cord-connected signs with an attachment plug.

(A) Location. The disconnecting means shall be permitted to be located in accordance with 600.6(A)(1), (A)(2), and (A)(3):

(1) At Point of Entry to a Sign. The disconnect shall be located at the point the feeder circuit or branch circuit(s) supplying a sign or outline lighting system enters a sign enclosure, a sign body, or a pole in accordance with 600.5(C)(3). The disconnect shall open all ungrounded conductors where it enters the enclosure of the sign or pole.

See Exceptions



The location of the disconnect is intended to allow service or maintenance personnel complete and local control of the disconnecting means.

600.6 Disconnects

(2) Within Sight of the Sign. The disconnecting means shall be within sight of the sign or outline lighting system that it controls. Where the disconnecting means is out of the line of sight from any section that is able to be energized, the disconnecting means shall be lockable in accordance with 110.25. A permanent field-applied marking identifying the location of the disconnecting means shall be applied to the sign in a location visible during servicing. The warning label shall comply with 110.21(B).

(3) Within Sight of the Controller. The following shall apply for signs or outline lighting systems operated by electronic or electromechanical controllers located external to the sign or outline lighting system:

(1) The disconnecting means shall be located within sight of the controller or in the same enclosure with the controller.
(2) The disconnecting means shall disconnect the sign or outline lighting system and the controller from all ungrounded supply conductors.
(3) The disconnecting means shall be designed such that no pole can be operated independently and shall be lockable in accordance with 110.25.

Exception: Where the disconnecting means is not located within sight of the controller, a permanent field-applied marking identifying the location of the disconnecting means shall be applied to the controller in a location visible during servicing. The warning label shall comply with 110.21(B).

600.33 Class 2 Sign Illumination Systems, Secondary Wiring

600.33 Class 2 Sign Illumination Systems, Secondary Wiring. The wiring methods and materials used shall be in accordance with the sign manufacturer's installation instructions using any applicable wiring methods from Chapter 3, Wiring Methods, and the requirements contained in 600.12(C), 600.24, and 600.33(A), (B), (C), and (D).

(A) Insulation and Sizing of Class 2 Conductors. Class 2 cable listed for the application that complies with Table 600.33(A)(1) or Table 600.33(A)(2) for substitutions shall be installed on the load side of the Class 2 power source. The conductors shall have an ampacity not less than the load to be supplied and shall not be sized smaller than 18 AWG.

N TABLE 600.33(A)(1) Applications of Power Limited Cable in Signs and Outline Lighting

Location	CL2	CL3	CL2R	CL3R	CL2P	CL3P	PLTC
Non-concealed spaces inside buildings	Y	Y	Y	Y	Y	Y	Y
Concealed spaces inside buildings that are not used as plenums or risers	Y	Y	Y	Y	Y	Y	Y
Environmental air spaces plenums or risers	N	N	N	N	Y	Y	N
Wet locations	N	N	N	N	N	N	Y

Y = Permitted. N = Not Permitted.

N TABLE 600.33(A)(2) Class 2 Cable Substitutions

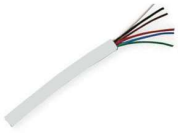
Cable Type	Permitted Substitutions
CL3P	CMP
CL2P	CMP, CL3P
CL3R	CMP, CL3P, CMR
CL2R	CMP, CL3P, CL2P, CMR, CL3R
CL3	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC
CL2	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3
CL3X	CMP, CL3P, CMR, CL3R, CMG, CM, PLTC, CL3, CMX
CL2X	CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3, CL2, CMX, CL3X

600.33 Class 2 Sign Illumination Systems, Secondary Wiring

Reference to Part III of Article 725 *(Class 2 and Class 3 Circuits)* has been removed and replaced with proper Article 600 references *[600.12(C), 600.24, and 600.33(A), (B), (C), and (D)]*

For sizing of Class 2 conductors for secondary wiring of sign illumination systems, the minimum size conductor is not to be sized smaller than **18 AWG** *(rather than 22 AWG)*

Typically, Class 2 conductors referred to in UL product standards relating to secondary wiring for signs and outline lighting all refer to 18 AWG as the minimum size



600.34 Photovoltaic (PV) Powered Sign

N **600.34 Photovoltaic (PV) Powered Sign.** All field wiring of components and subassemblies for an off-grid stand-alone, on-grid interactive, or non-grid interactive PV installation shall be installed in accordance with Article 690, as applicable, 600.34, and the PV powered sign installation instructions.

(A) Equipment. Inverters, motor generators, PV modules, PV panels, ac PV modules, dc combiners, dc-ac converters, and charge controllers intended for use in PV powered sign systems shall be listed for PV application.

600.34 Photovoltaic (PV) Powered Sign

(B) Wiring. Wiring from a photovoltaic panel or wiring external to the PV sign body shall be:

(1) Listed, labeled, and suitable for photovoltaic applications
(2) Routed to closely follow the sign body or enclosure
(3) As short as possible and secured at intervals not exceeding 0.91 m (3 ft)
(4) Protected where subject to physical damage

(C) Flexible Cords and Cables. Flexible cords and cables shall comply with Article 400 and be identified as extra hard usage, rated for outdoor use, and water and sunlight resistant.

(D) Grounding. Grounding a PV powered sign shall comply with Article 690, Part V and 600.7.

(E) Disconnecting Means. The disconnecting means for a PV powered sign shall comply with Article 690, Part III and 600.6.

(F) Battery Compartments. Battery compartments shall require a tool to open.

Recall "New Definition"

N **Photovoltaic (PV) Powered Sign.** A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system.

ACS ASSOCIATED CONSULTING SOLUTIONS

Article 680 Swimming Pools, Fountains, and Similar Installations

ACS ASSOCIATED CONSULTING SOLUTIONS

680.1 Scope

The provisions of this article apply to the construction and installation of electrical wiring for, and equipment in or adjacent to, all swimming, wading, therapeutic, and decorative pools; fountains; hot tubs; spas; and hydromassage bathtubs, whether permanently installed or storable, and to metallic auxiliary equipment, such as pumps, filters, and similar equipment. The term body of water used throughout Part I applies to all bodies of water covered in this scope unless otherwise amended.

The installations covered by this article can be indoors or outdoors, permanent or storable, and may or may not be directly supplied by electrical circuits of any nature. This article also applies to pools used in religious services where participants are immersed in water.

ACS ASSOCIATED CONSULTING SOLUTIONS

680.2 Definitions

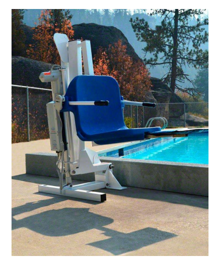
Cord-and-Plug-Connected Lighting Assembly. A lighting assembly consisting of a luminaire intended for installation in the wall of a spa, hot tub, or storable pool, and a cord-and-plug-connected transformer.

Dry-Niche Luminaire. A luminaire intended for installation in the floor or wall of a pool, spa, or fountain in a niche that is sealed against the entry of water.

N **Electrically Powered Pool Lift.** An electrically powered lift that provides accessibility to and from a pool or spa for people with disabilities.

Fixed (as applied to equipment). Equipment that is fastened or otherwise secured at a specific location.

Forming Shell. A structure designed to support a wet-niche luminaire assembly and intended for mounting in a pool or fountain structure.



ACS ASSOCIATED CONSULTING SOLUTIONS

680.2 Definitions

Low Voltage Contact Limit. A voltage not exceeding the following values:

(1) 15 volts (RMS) for sinusoidal ac
(2) 21.2 volts peak for nonsinusoidal ac
(3) 30 volts for continuous dc
(4) 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz

The low voltage contact limits are based on the wet contact limits specified in Tables 11(A) and 11(B) in Chapter 9. Before 2008, the use of isolated winding–type transformers that provided a sinusoidal ac voltage not exceeding 15 volts was used as the "low-voltage" operational threshold for underwater luminaires. The 15-volt limit in Article 680 was based on a transformer-type power supply. Any luminaire operating at more than 15 volts was required to be protected by a GFCI.

Underwater lighting has been developed that integrates power supplies other than the traditional isolated winding–type transformer, and this definition and associated requirements in Article 680 ensure that those power supplies can be safely integrated into the swimming pool environment.

ACS ASSOCIATED CONSULTING SOLUTIONS

680.2 Definitions

Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools. Those that are constructed in the ground or partially in the ground, and all others capable of holding water in a depth greater than 1.0 m (42 in.), and all pools installed inside of a building, regardless of water depth, whether or not served by electrical circuits of any nature.

Storable Swimming, Wading, or Immersion Pools; or Storable/Portable Spas and Hot Tubs. Swimming, wading, or immersion pools that are intended to be stored when not in use, constructed on or above the ground and are capable of holding water to a maximum depth of 1.0 m (42 in.), or a pool, spa, or hot tub constructed on or above the ground, with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension.

Equipment and products shall be listed.

680.4 Approval of Equipment. All electrical equipment installed in the water, walls, or decks of pools, fountains, and similar installations shall comply with the provisions of this article. Equipment and products shall be listed.

ACS ASSOCIATED CONSULTING SOLUTIONS

680.5 Ground-Fault Circuit Interrupters

Ground-fault circuit interrupters (GFCIs) shall be self-contained units, circuit breaker or receptacle types, or other listed types.

680.7 Grounding and Bonding Terminals

N 680.7 Grounding and Bonding Terminals. Grounding and bonding terminals shall be identified for use in wet and corrosive environments. Field-installed grounding and bonding connections in a damp, wet, or corrosive environment shall be composed of copper, copper alloy, or stainless steel. They shall be listed for direct burial use.

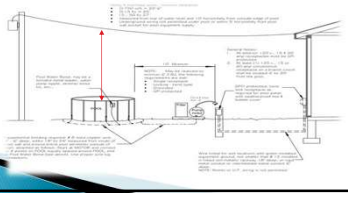
680.9 Overhead Conductor Clearances

680.9 Overhead Conductor Clearances. Overhead conductors shall meet the clearance requirements in this section. Where a minimum clearance from the water level is given, the measurement shall be taken from the maximum water level of the specified body of water.

(A) Power. With respect to service-drop conductors, overhead service conductors, and open overhead wiring, swimming pool and similar installations shall comply with the minimum clearances given in Table 680.9(A) and illustrated in Figure 680.9(A).

(B) Communications Systems. Communications, radio, and television coaxial cables within the scope of Articles 800 through 820 shall be permitted at a height of not less than 3.0 m (10 ft) above swimming and wading pools, diving structures, and observation stands, towers, or platforms.

(C) Network-Powered Broadband Communications Systems. The minimum clearances for overhead network-powered broadband communications systems conductors from pools or fountains shall comply with the provisions in Table 680.9(A) for conductors operating at 0 to 750 volts to ground.

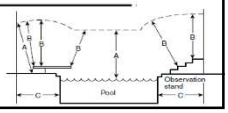


FOR EXAMPLE

Table 680.9(A) Overhead Conductor Clearances

TABLE 680.9(A) Overhead Conductor Clearances

	Clearance Parameters	Insulated Cables, 0–750 Volts to Ground, Supported on and Cabled Together with a Solidly Grounded Bare Messenger or Solidly Grounded Neutral Conductor		All Other Conductors Voltage to Ground			
				0 through 15 kV		Over 15 through 50 kV	
		m	ft	m	ft	m	ft
A.	Clearance in any direction to the water level, edge of water surface, base of diving platform, or permanently anchored raft	6.9	22.5	7.5	25	8.0	27
B.	Clearance in any direction to the observation stand, tower, or diving platform	4.4	14.5	5.2	17	5.5	18
C.	Horizontal limit of clearance measured from inside wall of the pool	This limit shall extend to the outer edge of the structures listed in A and B of this table but not less than 3 m (10 ft).					



680.13 Maintenance Disconnecting Means

680.13 Maintenance Disconnecting Means. One or more means to simultaneously disconnect all ungrounded conductors shall be provided for all utilization equipment other than lighting. Each means shall be readily accessible and within sight from its equipment and shall be located at least 1.5 m (5 ft) horizontally from the inside walls of a pool, spa, fountain, or hot tub unless separated from the open water by a permanently installed barrier that provides a 1.5 m (5 ft) reach path or greater. This horizontal distance shall be measured from the water's edge along the shortest path required to reach the disconnect.

FOR EXAMPLE

Readily accessible and within sight from equipment

Readily accessible and within sight from equipment

680.14 Corrosive Environment

N 680.14 Corrosive Environment.

(A) General. Areas where pool sanitation chemicals are stored, as well as areas with circulation pumps, automatic chlorinators, filters, open areas under decks adjacent to or abutting the pool structure, and similar locations shall be considered to be a corrosive environment. The air in such areas shall be considered to be laden with acid, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors, and any liquids or condensation in those areas shall be considered to be laden with acids, chlorine, and bromine vapors, or any combination of acid, chlorine, or bromine vapors.

(B) Wiring Methods. Wiring methods in the areas described in 680.14(A) shall be listed and identified for use in such areas. Rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride conduit, and reinforced thermosetting resin conduit shall be considered to be resistant to the corrosive environment specified in 680.14(A).

680.21 Motors

(A) Wiring Methods. The wiring to a pool motor shall comply with (A)(1) unless modified for specific circumstances by (A)(2), (A)(3), (A)(4), or (A)(5).

680.21(A)(1) General. Wiring methods installed in the corrosive environment described in 680.14 shall comply with 680.14(B) or shall be type MC cable listed for that location. Wiring methods installed in these locations shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122 but not smaller than 12 AWG.

Where installed in noncorrosive environments, branch circuits shall comply with the general requirements in Chapter 3.

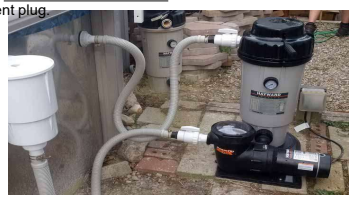
680.21(A)(2) Flexible Connections. Where necessary to employ flexible connections at or adjacent to the motor, liquid tight flexible metal or liquid tight flexible nonmetallic conduit with listed fittings shall be permitted.

680.21 Motors

(A) Wiring Methods. The wiring to a pool motor shall comply with (A)(1) unless modified for specific circumstances by (A)(2), (A)(3), (A)(4), or (A)(5).

680.21(A)(3) Cord-and-Plug Connections. Pool-associated motors shall be permitted to employ cord-and-plug connections. The flexible cord shall not exceed 900 mm (3 ft) in length. The flexible cord shall include a copper equipment grounding conductor sized in accordance with 250.122 but not smaller than 12 AWG. The cord shall terminate in a grounding-type attachment plug.

Note: Referencing 680.21(B) Double Insulated Pool Pumps. The internal metal parts of a swimming pool pump incorporating a system of double insulation are grounded; however, they are not required to be incorporated into the bonding system required by 680.26(B), because bonding compromises the double insulation system.



680.21 Motors

680.21(C) GFCI Protection. Outlets supplying pool pump motors connected to single-phase, 120-volt through 240-volt branch circuits, whether by receptacle or by direct connection, shall be provided with ground-fault circuit-interrupter protection for personnel.

680.22 Lighting, Receptacles, and Equipment

(A) Receptacles.

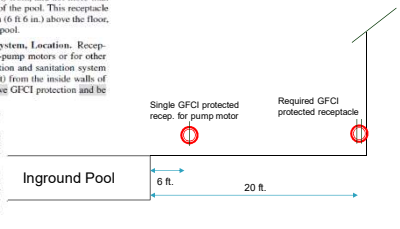
(1) **Required Receptacle, Location.** Where a permanently installed pool is installed, no fewer than one 125-volt, 15- or 20-ampere receptacle on a general-purpose branch circuit shall be located not less than 1.83 m (6 ft) from, and not more than 6.0 m (20 ft) from, the inside wall of the pool. This receptacle shall be located not more than 2.0 m (6 ft 6 in.) above the floor, platform, or grade level serving the pool.

(2) **Circulation and Sanitation System, Location.** Receptacles that provide power for water-pump motors or for other loads directly related to the circulation and sanitation system shall be located at least 1.83 m (6 ft) from the inside walls of the pool. These receptacles shall have GFCI protection and be of the grounding type.

(3) Other Receptacles, Location. Other receptacles shall be not less than 1.83 m (6 ft) from the inside walls of a pool.

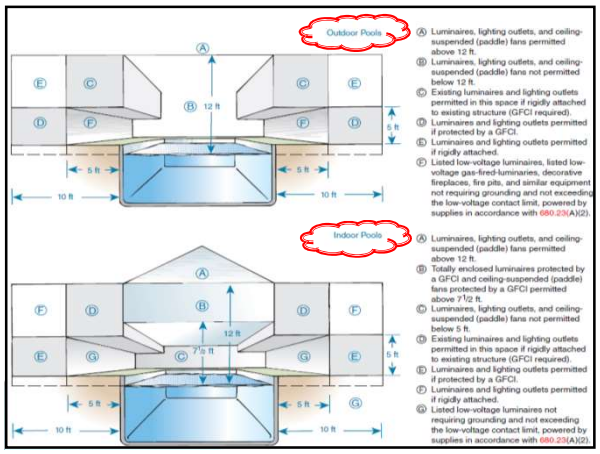
(4) GFCI Protection. All 15- and 20-ampere, single-phase, 125-volt receptacles located within 6.0 m (20 ft) of the inside walls of a pool shall be protected by a ground-fault circuit interrupter.

(5) Measurements. In determining the dimensions in this section addressing receptacle spacings, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.



680.22(B) Luminaires, Lighting Outlets, and Ceiling-Suspended (Paddle) Fans

(1) New Outdoor Installation Clearances. In outdoor pool areas, luminaires, lighting outlets, and ceiling-suspended (paddle)
fans installed above the pool or the area extending 1.5 m (5 ft) horizontally from the inside walls of the pool shall be installed at a height not less than 3.7 m (12 ft) above the maximum
(2) Indoor Clearances. For installations in indoor pool areas, the clearances shall be the same as for outdoor areas unless modified as provided in this paragraph. If the branch circuit supplying the equipment is protected by a ground-fault circuit interrupter, the following equipment shall be permitted at a height not less than 2.3 m (7 ft 6 in.) above the maximum pool water level:
(1) Totally enclosed luminaires
(2) Ceiling-suspended (paddle) fans identified for use beneath ceiling structures such as provided on porches or patios



(A) Luminaires, lighting outlets, and ceiling-suspended (paddle) fans permitted above 12 ft.
(B) Luminaires, lighting outlets, and ceiling-suspended (paddle) fans not permitted below 12 ft.
(C) Existing luminaires and lighting outlets permitted in this space if rigidly attached to existing structure (GFCI required).
(D) Luminaires and lighting outlets permitted if protected by a GFCI.
(E) Luminaires and lighting outlets permitted if rigidly attached.
(F) Listed low-voltage luminaires, listed low-voltage gas-fired-luminaires, decorative fireplaces, fire pits, and similar equipment not requiring grounding and not exceeding the low-voltage contact limit, powered by supplies in accordance with 680.23(A)(2).

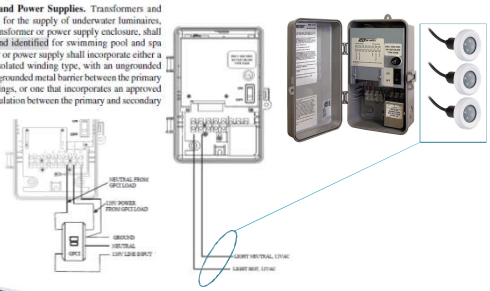
(A) Luminaires, lighting outlets, and ceiling-suspended (paddle) fans permitted above 12 ft.
(B) Totally enclosed luminaires protected by a GFCI and ceiling-suspended (paddle) fans protected by a GFCI permitted above 7½ ft.
(C) Luminaires, lighting outlets, and ceiling-suspended (paddle) fans not permitted below 5 ft.
(D) Existing luminaires and lighting outlets permitted in this space if rigidly attached to existing structure (GFCI required).
(E) Luminaires and lighting outlets permitted if protected by a GFCI.
(F) Luminaires and lighting outlets permitted if rigidly attached.
(G) Listed low-voltage luminaires not requiring grounding and not exceeding the low-voltage contact limit, powered by supplies in accordance with 680.23(A)(2).

680.22(B)(6) Low-Voltage Luminaires

Listed low-voltage luminaires not requiring grounding, not exceeding the low-voltage contact limit, and supplied by listed transformers or power supplies that comply with 680.23(A)(2) shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool.

680.23(A)(2) Transformers and Power Supplies

(2) Transformers and Power Supplies. Transformers and power supplies used for the supply of underwater luminaires, together with the transformer or power supply enclosure, shall be listed, labeled, and identified for swimming pool and spa use. The transformer or power supply shall incorporate either a transformer of the isolated winding type, with an ungrounded secondary that has a grounded metal barrier between the primary and secondary windings, or one that incorporates an approved system of double insulation between the primary and secondary windings.



680.22(7) Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment

N (7) **Low-Voltage Gas-Fired Luminaires, Decorative Fireplaces, Fire Pits, and Similar Equipment.** Listed low-voltage gas-fired-luminaires, decorative fireplaces, fire pits, and similar equipment using low-voltage igniters that do not require grounding, and are supplied by listed transformers or power supplies that comply with 680.23(A)(2) with outputs that do not exceed the low-voltage contact limit shall be permitted to be located less than 1.5 m (5 ft) from the inside walls of the pool. Metallic equipment shall be bonded in accordance with the requirements in 680.26(B). Transformers or power supplies supplying this type of equipment shall be installed in accordance with the requirements in 680.24. Metallic gas piping shall be bonded in accordance with the requirements in 250.104(B) and 680.26(B)(7).

Low voltage systems can ignite a gas powered decorative fireplace just as easily as a 120-volt branch circuit can. It's becoming quite common to see gas-fired luminaires, decorative fireplaces, fire pits, and similar equipment that only requires a low voltage supply to ignite the burners.

The new code language permits the low voltage equipment mentioned above to be located closer than 5 feet from the inside walls of the pool as long as the following conditions are met:

The equipment is listed.
The equipment does not require grounding as part of the listing.
The equipment is supplied from a listed power supply that complies with 680.23(A)(2) with an output that does not exceed the low-voltage contact limit (specified in 680.2).

680.23 Underwater Luminaires

This section covers all luminaires installed below the maximum water level of the pool.

(3) GFCI Protection, Lamping, Relamping, and Servicing. Ground-fault circuit-interrupter protection for personnel shall be installed in the branch circuit supplying luminaires operating at voltages greater than the low-voltage contact limit.

Dry-niche, no-niche, or wet-niche underwater luminaires operating at more than 15 volts require GFCI protection.

(4) Voltage Limitation. No luminaires shall be installed for operation on supply circuits over 150 volts between conductors.

(5) Location, Wall-Mounted Luminaires. Luminaires mounted in walls shall be installed with the top of the luminaire lens not less than 450 mm (18 in.) below the normal water level of the pool, unless the luminaire is listed and identified for use at lesser depths. No luminaire shall be installed less than 100 mm (4 in.) below the normal water level of the pool.

680.23(B) Wet-Niche Luminaires

(1) Forming Shells. Forming shells shall be installed for the mounting of all wet-niche underwater luminaires and shall be equipped with provisions for conduit entries. Metal parts of the luminaire and forming shell in contact with the pool water shall be of brass or other approved corrosion-resistant metal. All forming shells used with nonmetallic conduit systems, other than those that are part of a listed low-voltage lighting system not requiring grounding, shall include provisions for terminating an 8 AWG copper conductor.

(2) Wiring Extending Directly to the Forming Shell. Conduit shall be installed from the forming shell to a junction box or other enclosure conforming to the requirements in 680.24. Conduit shall be rigid metal, intermediate metal, liquidtight flexible nonmetallic, or rigid nonmetallic.

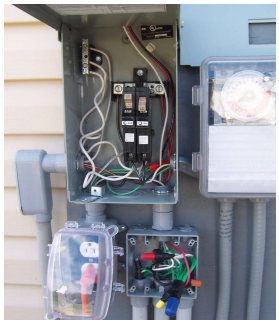
(a) *Metal Conduit.* Metal conduit shall be approved and shall be of brass or other approved corrosion-resistant metal.

(b) *Nonmetallic Conduit.* Where a nonmetallic conduit is used, an 8 AWG insulated solid or stranded copper bonding jumper shall be installed in this conduit unless a listed low-voltage lighting system not requiring grounding is used. The bonding jumper shall be terminated in the forming shell, junction box or transformer enclosure, or ground-fault circuit-interrupter enclosure. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a listed potting compound to protect the connection from the possible deteriorating effect of pool water.

Wet Niche Fixture

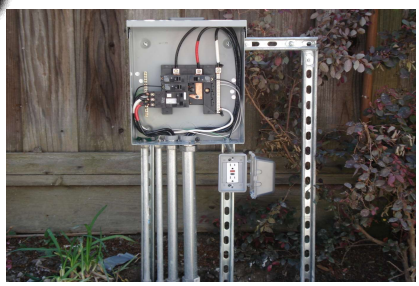
680.25 Feeders

(A) Feeders. Where feeders are installed in corrosive environments as described in 680.14, the wiring method of that portion of the feeder shall be as required in 680.14(B) or shall be liquidtight flexible nonmetallic conduit. Wiring methods installed in corrosive environments as described in 680.14 shall contain an insulated copper equipment grounding conductor sized in accordance with Table 250.122, but not smaller than 12 AWG.



Sub panel for pool…..EGC with feeder wire nutted with other EGCs
No bonding jumper to panel enclosure!!!

680.25 Feeders



Sub panel for pool…..insulated EGC with feeder??? Bonding jumper??

680.26 Equipotential Bonding

(A) Performance. The equipotential bonding required by this section shall be installed to reduce voltage gradients in the pool area.

(B) Bonded Parts. The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

The only function of the 8 AWG conductor required by 680.26(B) is equipotential bonding to eliminate the voltage gradient in the pool area. The bonding conductor is not required to extend or connect to any parts or equipment other than those covered in 680.26(B)(1) through (B)(7) and to a pool water bonding element covered in 680.26(C).

680.26 Equipotential Bonding

680.26(B)(1) Conductive Pool Shells

(B) Bonded Parts. The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells. Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Poured concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

Conductive (Metal) Pool Shell

680.26 Equipotential Bonding

680.26(B)(2) Perimeter Surfaces

(2) **Perimeter Surfaces.** The perimeter surface to be bonded shall be considered to extend for 1 m (3 ft) horizontally beyond the inside walls of the pool and shall include unpaved surfaces and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a) or (2)(b) and shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four (4) points uniformly spaced around the perimeter of the pool. For nonconductive pool shells, bonding at four points shall not be required.

(a) *Structural Reinforcing Steel.* Structural reinforcing steel shall be bonded in accordance with 680.26(B)(1)(a).

(b) *Alternate Means.* Where structural reinforcing steel is not available or is encapsulated in a nonconductive compound, a copper conductor(s) shall be utilized where the following requirements are met:

(1) At least one minimum 8 AWG bare solid copper conductor shall be provided.
(2) The conductors shall follow the contour of the perimeter surface.
(3) Only listed splices shall be permitted.
(4) The required conductor shall be 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.
(5) The required conductor shall be secured within or under the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below the subgrade.

680.26(B)(5) Metal Fittings. All metal fittings within or attached to the pool structure shall be bonded. Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.) shall not require bonding.

680.26 Equipotential Bonding

680.26(B) (4) Underwater Lighting

(4) Underwater Lighting. All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

680.26 Equipotential Bonding

680.26(B) (6) Electrical Equipment

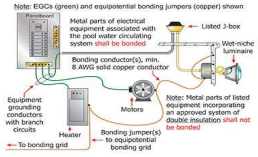
(6) **Electrical Equipment.** Metal parts of electrical equipment associated with the pool water circulating system, including pump motors and metal parts of equipment associated with pool covers, including electric motors, shall be bonded.

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the bonding grid to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool bonding grid and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

680.26(B)(6) Bonding of Electrical Equipment



Bonding Terminal on Pump Motor

Good or Bad??

680.26 Equipotential Bonding

680.26(B)(5) Metal Fittings. All metal fittings within or attached to the pool structure shall be bonded. Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.) shall not require bonding.

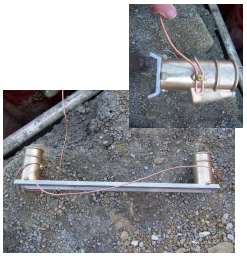
680.26(B)(7) Fixed Metal Parts

(7) **Fixed Metal Parts.** All fixed metal parts shall be bonded including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames.

Exception No. 1: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

Exception No. 2: Those greater than 1.5 m (5 ft) horizontally from the inside walls of the pool shall not be required to be bonded.

Exception No. 3: Those greater than 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures, shall not be required to be bonded.



FYI: Ladder, diving board, slide, and handrail bases require bonding

Equipotential Bonding

FOR EXAMPLE

680.28 Gas-Fired Water Heater

Circuits serving gas-fired swimming pool and spa water heaters operating at voltages above the low-voltage contact limit shall be provided with ground-fault circuit-interrupter protection for personnel.

Article 480 Storage Batteries

480 Storage Batteries

480.1 Scope. This article applies to all stationary installations of storage batteries.

Informational Note: The following standards are frequently referenced for the installation of stationary batteries:

(1) IEEE 484, *Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*
(2) IEEE 485, *Recommended Practice for Sizing Vented Lead-Acid Storage Batteries for Stationary Applications*
(3) IEEE 1145, *Recommended Practice for Installation and Maintenance of Nickel-Cadmium Batteries for Photovoltaic (PV) Systems*
(4) IEEE 1187, *Recommended Practice for Installation Design, and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications*
(5) IEEE 1375, *IEEE Guide for the Protection of Stationary Battery Systems*
(6) IEEE 1578, *Recommended Practice for Stationary Battery Electrolyte Spill Containment and Management*
(7) IEEE 1635/ASHRAE 21, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*
(8) UL 1973, *Standard for Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications*
(9) UL Subject 2436, *Outline of Investigation for Spill Containment for Stationary Lead Acid Battery Systems*
(10) UL 1989, *Standard for Standby Batteries*

480.3 Equipment

- New requirement were added at 480.3 that will require **storage batteries** and **battery management equipment** to be **listed** *(other than **lead-acid batteries**)*
- Recognizes the need for a National Recognized Testing Laboratory *(NRTL)* evaluation of storage batteries and battery management equipment by a third-party testing laboratory
- Through the use of new technologies, energy density for storage batteries has significantly increased and continues to increase
- Lithium-ion battery energy density has been increasing at approximately 10 percent annually

480.4 Battery and Cell Terminations

(A) Corrosion Prevention. Where mating dissimilar metals, antioxidant material suitable for the battery connection shall be used where recommended by the battery manufacturer.

Informational Note: The battery manufacturer's installation and instruction manual can be used for guidance for acceptable materials.

(B) Intercell and Intertier Conductors and Connections. The ampacity of field-assembled intercell and intertier connectors and conductors shall be of such cross-sectional area that the temperature rise under maximum load conditions and at maximum ambient temperature shall not exceed the safe operating temperature of the conductor insulation or of the material of the conductor supports.

Informational Note: Conductors sized to prevent a voltage drop exceeding 3 percent of maximum anticipated load, and where the maximum total voltage drop to the furthest point of connection does not exceed 5 percent, may not be appropriate for all battery applications. IEEE 1375-2003, *Guide for the Protection of Stationary Battery Systems*, provides guidance for overcurrent protection and associated cable sizing.

(C) Battery Terminals. Electrical connections to the battery, and the cable(s) between cells on separate levels or racks, shall not put mechanical strain on the battery terminals. Terminal plates shall be used where practicable.

OCP & DC Disconnect

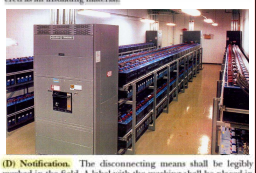
480.6 Overcurrent Protection for Prime Movers. Overcurrent protection shall not be required for conductors from a battery with a voltage of 60 volts dc or less if the battery provides power for starting, ignition, or control of prime movers. Section 300.3 shall not apply to these conductors.

480.7 DC Disconnect Methods.

(A) Disconnecting Means. A disconnecting means shall be provided for all ungrounded conductors derived from a stationary battery system with a voltage over 60 volts dc. A disconnecting means shall be readily accessible and located within sight of the battery system.

(B) Remote Actuation. Where a disconnecting means, located in accordance with 480.7(A), is provided with remote controls to activate the disconnecting means and the controls for the disconnecting means are not located within sight of the stationary battery system, the disconnecting means shall be capable of being locked in the open position, in accordance with 110.25, and the location of the controls shall be field marked on the disconnecting means.

480.9 Battery Support Systems. For battery chemistries with corrosive electrolyte, the structure that supports the battery shall be resistant to deteriorating action by the electrolyte. Metallic structures shall be provided with nonconducting support members for the cells, or shall be constructed with a continuous insulating material. Paint alone shall not be considered as an insulating material.



(D) Notification. The disconnecting means shall be legibly marked in the field. A label with the marking shall be placed in a conspicuous location near the battery if a disconnecting means is not provided. The marking shall be of sufficient durability to withstand the environment involved and shall include the following:

(1) Nominal battery voltage
(2) Maximum available short-circuit current derived from the stationary battery system
(3) Date the short-circuit current calculation was performed
(4) The battery disconnecting means shall be marked in accordance with 110.16.

480.10 Battery Locations

480.10 Battery Locations. Battery locations shall conform to 480.10(A), (B), and (C).

(A) Ventilation. Provisions appropriate to the battery technology shall be made for sufficient diffusion and ventilation of gases from the battery, if present, to prevent the accumulation of an explosive mixture.

Informational Note No. 1: See NFPA 1-2015, *Fire Code*, Chapter 52, for ventilation considerations for specific battery chemistries.

Informational Note No. 2: Some battery technologies do not require ventilation.

Informational Note No. 3: For additional information on the ventilation of stationary battery systems, see *IEEE Std 1635-2012/ ASHRAE Guideline 21-2012 Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications.*

(B) Live Parts. Guarding of live parts shall comply with 110.27.

(C) Spaces About Battery Systems. Spaces about battery systems shall comply with 110.26. Working space shall be measured from the edge of the battery cabinet, racks, or trays.

For battery racks, there shall be a minimum clearance of 25 mm (1 in.) between a cell container and any wall or structure on the side not requiring access for maintenance. Battery stands shall be permitted to contact adjacent walls or structures, provided that the battery shelf has a free air space for not less than 90 percent of its length.

(D) Top Terminal Batteries. Where top terminal batteries are installed on tiered racks or on shelves of battery cabinets, working space in accordance with the battery manufacturer's instructions shall be provided between the highest point on a cell and the row, shelf, or ceiling above that point.

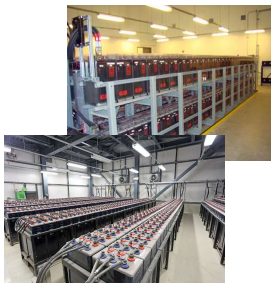
480.10 Battery Locations

480.10(E) Egress. A personnel door(s) intended for entrance to, and egress from, rooms designated as battery rooms shall open in the direction of egress and shall be equipped with listed panic hardware.

(F) Piping in Battery Rooms. Gas piping shall not be permitted in dedicated battery rooms.

(G) Illumination. Illumination shall be provided for working spaces containing battery systems. The lighting outlets shall not be controlled by automatic means only. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source. The location of luminaires shall not:

(1) Expose personnel to energized battery components while performing maintenance on the luminaires in the battery space; or
(2) Create a hazard to the battery upon failure of the luminaire.



Article 695
Fire Pumps

695.1 Scope

(A) Covered. This article covers the installation of the following:

(1) Electric power sources and interconnecting circuits
(2) Switching and control equipment dedicated to fire pump drivers

(B) Not Covered. This article does not cover the following:

(1) The performance, maintenance, and acceptance testing of the fire pump system, and the internal wiring of the components of the system
(2) The installation of pressure maintenance (jockey or makeup) pumps

Informational Note: For the installation of pressure maintenance (jockey or makeup) pumps supplied by the fire pump circuit or another source, see Article 430.

(3) Transfer equipment upstream of the fire pump transfer switch(es)

Informational Note: See NFPA 20-2013, *Standard for the Installation of Stationary Pumps for Fire Protection*, for further information.

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695.3 Power Source(s) for Electric Motor-Driven Fire Pumps

Electric motor-driven fire pumps shall have a reliable source of power.

(A) Individual Sources. Where reliable, and where capable of carrying indefinitely the sum of the locked-rotor current of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current of the associated fire pump accessory equipment when connected to this power supply, the power source for an electric motor driven fire pump shall be one or more of the following:

(1) Electric Utility Service Connection. A fire pump shall be permitted to be supplied by a separate service, or from a connection located ahead of and not within the same cabinet, enclosure, vertical switchgear section, or vertical switchboard section as the service disconnecting means. The connection shall be located and arranged so as to minimize the possibility of damage by fire from within the premises and from exposing hazards. A tap ahead of the service disconnecting means shall comply with 230.82(5). The service equipment shall comply with the labeling requirements in 250.2 and the location requirements in 230.72(B). [**20**:9.2.2(1)]

(2) On-Site Power Production Facility. A fire pump shall be permitted to be supplied by an on-site power production facility. The source facility shall be located and protected to minimize the possibility of damage by fire. [**20**:9.2.2(3)]

(3) Dedicated Feeder. A dedicated feeder shall be permitted where it is derived from a service connection as described in 695.3(A)(1). [**20**:9.2.2(3)]

Informational Note: See Sections 9.3.2 and A.9.3.2 from NFPA 20-2013, *Standard for the Installation of Stationary Pumps for Fire Protection*, for guidance on the determination of power source reliability.

Also see 695.3 (B) – 695.3(H)

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695.3(B) Connection Through Disconnecting Means and Overcurrent Device

(1) Number of Disconnecting Means.

(a) *General.* A single disconnecting means and associated overcurrent protective device(s) shall be permitted to be installed between the fire pump power source(s) and one of the following: [**20**:9.1.2]

(1) A listed fire pump controller
(2) A listed fire pump power transfer switch
(3) A listed combination fire pump controller and power transfer switch

(b) *Feeder Sources.* For systems installed under the provisions of 695.3(C) only, additional disconnecting means and the associated overcurrent protective device(s) shall be permitted.

(c) *On-Site Standby Generator.* Where an on-site standby generator is used to supply a fire pump, an additional disconnecting means and an associated overcurrent protective device(s) shall be permitted.

(2) Overcurrent Device Selection. Overcurrent devices shall comply with 695.4(B)(2)(a) or (b).

(a) *Individual Sources.* Overcurrent protection for individual sources shall comply with 695.4(B)(2)(a)(1) or (2).

(1) Overcurrent protective device(s) shall be rated to carry indefinitely the sum of the locked-rotor current of the largest fire pump motor and the pressure maintenance pump motor(s) and the full-load current of all of the other pump motors and associated fire pump accessory equipment when connected to this power supply. Where the locked-rotor current value does not correspond to a standard overcurrent device size, the next standard overcurrent device size shall be used in accordance with 240.6. The requirement to carry the locked-rotor currents indefinitely shall not apply to conductors or devices other than overcurrent devices in the fire pump motor circuit(s). The requirement to carry the locked rotor currents indefinitely shall not apply to feeder overcurrent protective devices installed in accordance with 695.3(C). [**20**:9.2.5.4]

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695.3(B) Connection Through Disconnecting Means and Overcurrent Device

(2) Overcurrent protection shall be provided by an assembly listed for fire pump service and complying with the following:

a. The overcurrent protective device shall not open within 2 minutes at 600 percent of the full-load current of the fire pump motor(s).
b. The overcurrent protective device shall not open with a re-start transient of 24 times the full-load current of the fire pump motor(s).
c. The overcurrent protective device shall not open within 10 minutes at 300 percent of the full-load current of the fire pump motor(s).
d. The trip point for circuit breakers shall not be field adjustable. [**20**:9.2.3.4.1]

(b) *On-Site Standby Generators.* Overcurrent protective devices between an on-site standby generator and a fire pump controller shall be selected and sized to allow for instantaneous pickup of the full pump room load, but shall not be larger than the value selected to comply with 430.62 to provide short-circuit protection only. [**20**:9.6.1.1]

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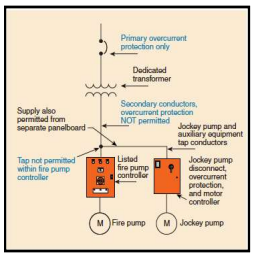
695.5 Transformers

695.5 Transformers. Where the service or system voltage is different from the utilization voltage of the fire pump motor, transformer(s) protected by disconnecting means and overcurrent protective devices shall be permitted to be installed between the system supply and the fire pump controller in accordance with 695.5(A) and (B), or with (C). Only transformers covered in 695.5(C) shall be permitted to supply loads not directly associated with the fire pump system.

(A) Size. Where a transformer supplies an electric motor driven fire pump, it shall be rated at a minimum of 125 percent of the sum of the fire pump motor(s) and pressure maintenance pump(s) motor loads, and 100 percent of the associated fire pump accessory equipment supplied by the transformer.

(B) Overcurrent Protection. The primary overcurrent protective device(s) shall be selected or set to carry indefinitely the sum of the locked-rotor current of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current of the associated fire pump accessory equipment when connected to this power supply. Secondary overcurrent protection shall not be permitted. The requirement to carry the locked-rotor currents indefinitely shall not apply to conductors or devices other than overcurrent devices in the fire pump motor circuit(s).



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695.6 Power Wiring

(A) Supply Conductors.

(1) Services and On-Site Power Production Facilities. Service conductors and conductors supplied by on-site power production facilities shall be physically routed outside a building(s) and shall be installed as service-entrance conductors in accordance with 230.6, 230.9, and Parts III and IV of Article 230. Where supply conductors cannot be physically routed outside of buildings, the conductors shall be permitted to be routed through the building(s) where installed in accordance with 230.6(1) or (2).

230.6 Conductors Considered Outside the Building. Conductors shall be considered outside of a building or other structure under any of the following conditions:

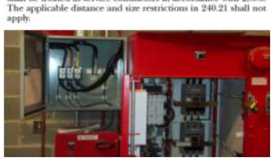
(1) Where installed under not less than 50 mm (2 in.) of concrete beneath a building or other structure
(2) Where installed within a building or other structure in a raceway that is encased in concrete or brick not less than 50 mm (2 in.) thick

(B) Conductor Size.

(1) Fire Pump Motors and Other Equipment. Conductors supplying a fire pump motor(s), pressure maintenance pumps, and associated fire pump accessory equipment shall have a rating not less than 125 percent of the sum of the fire pump motor(s) and pressure maintenance motor(s) full-load current(s), and 100 percent of the associated fire pump accessory equipment.

(2) Fire Pump Motors Only. Conductors supplying only a fire pump motor shall have a minimum ampacity in accordance with 430.22 and shall comply with the voltage drop requirements in 695.7.

(C) Overload Protection. Power circuits shall not have automatic protection against overloads. Except for protection of transformer primaries provided in 695.5(C)(2), branch-circuit and feeder conductors shall be protected against short circuit only. Where a tap is made to supply a fire pump, the wiring shall be treated as service conductors in accordance with 230.6. The applicable distance and size restrictions in 240.21 shall not apply.



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695.6 Power Wiring (Feeders)

(A) Supply Conductors.

(2) Feeders. Fire pump supply conductors on the load side of the final disconnecting means and overcurrent device(s) permitted by 695.4(B), or conductors that connect directly to an on-site standby generator, shall comply with all of the following:

(a) *Independent Routing.* The conductors shall be kept entirely independent of all other wiring.

(b) *Associated Fire Pump Loads.* The conductors shall supply only loads that are directly associated with the fire pump system.

(c) *Protection from Potential Damage.* The conductors shall be protected from potential damage by fire, structural failure, or operational accident.

(d) *Inside of a Building.* Where routed through a building, the conductors shall be protected from fire for 2 hours using one of the following methods:

(1) The cable or raceway is encased in a minimum 50 mm (2 in.) of concrete.

(2) The cable or raceway is a listed fire-resistive cable system.

Informational Note 1: Fire-resistive cables are tested to ANSI/UL 2196, *Tests for Fire Resistive Cables.*

Informational Note 2: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

(3) The cable or raceway is a listed electrical circuit protective system.

(D) Pump Wiring. All wiring from the controllers to the pump motors shall be in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, liquidtight flexible metal conduit, or liquidtight flexible nonmetallic conduit, listed Type MC cable with an impervious covering, or Type MI cable. Electrical connections at motor terminal boxes shall be made with a listed means of connection. Twist-on, insulation-piercing-type, and soldered wire connectors shall not be permitted to be used for this purpose.

695.7 Voltage Drop & 695.10 Listed Equipment

695.7 Voltage Drop.

(A) Starting. The voltage at the fire pump controller line terminals shall not drop more than 15 percent below normal (controller-rated voltage) under motor starting conditions.

Exception: This limitation shall not apply for emergency run mechanical starting. [20: 9.4.2]

(B) Running. The voltage at the load terminals of the fire pump controller shall not drop more than 5 percent below the voltage rating of the motor connected to those terminals when the motor is operating at 115 percent of the full-load current rating of the motor.

695.10 Listed Equipment. Diesel engine fire pump controllers, electric fire pump controllers, electric motors, fire pump power transfer switches, foam pump controllers, and limited service controllers shall be listed for fire pump service. [20:9.5.1.1, 10.1.2.1, 12.1.3.1]

695.14 Control Wiring

695.14(E) Electric Fire Pump Control Wiring Methods. All electric motor–driven fire pump control wiring shall be in rigid metal conduit, intermediate metal conduit, liquid tight flexible metal conduit, electrical metallic tubing, liquidtight flexible nonmetallic conduit, listed Type MC cable with an impervious covering, or Type MI cable.

(F) Generator Control Wiring Methods. Control conductors installed between the fire pump power transfer switch and the standby generator supplying the fire pump during normal power loss shall be kept entirely independent of all other wiring. The integrity of the generator control wiring shall be continuously monitored. Loss of integrity of the remote start circuit(s) shall initiate visual and audible annunciation of generator malfunction at the generator local and remote annunciator(s) and start the generator(s).

The control conductors shall be protected to resist potential damage by fire or structural failure. They shall be permitted to be routed through a building(s) using one of the following methods:

(1) Be encased in a minimum 50 mm (2 in.) of concrete.

(2) Be protected by a fire-rated assembly listed to achieve a minimum fire rating of 2 hours and dedicated to the fire pump circuits.

(3) Be a listed electrical circuit protective system with a minimum 2-hour fire rating. The installation shall comply with any restrictions provided in the listing of the electrical circuit protective system used.

695.15 Surge Protection

N **695.15 Surge Protection.** A listed surge protection device shall be installed in or on the fire pump controller.

A study was conducted, commissioned by the NFPA Fire Protection Research Foundation, and it concluded that 12% of the fire pumps tested had damage due to surges. Surges can damage motor windings, which shortens the life of motors. Controls are at even greater risk for damage from surges. It's not prudent if a fire pump has to operate during a fire at full capacity and can't because of unnoticed damage.

Article 700
Emergency Systems

OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

Emergency Systems
700.3 Tests and Maintenance

(A) Conduct or Witness Test. The authority having jurisdiction shall conduct or witness a test of the complete system upon installation and periodically afterward.

(B) Tested Periodically. Systems shall be tested periodically on a schedule acceptable to the authority having jurisdiction to ensure the systems are maintained in proper operating condition.

(C) Maintenance. Emergency system equipment shall be maintained in accordance with manufacturer instructions and industry standards.

(D) Written Record. A written record shall be kept of such tests and maintenance.

(E) Testing Under Load. Means for testing all emergency lighting and power systems during maximum anticipated load conditions shall be provided.

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Emergency Systems
700.3 Tests and Maintenance

N **(F) Temporary Source of Power for Maintenance or Repair of the Alternate Source of Power.** If the emergency system relies on a single alternate source of power, which will be disabled for maintenance or repair, the emergency system shall include permanent switching means to connect a portable or temporary alternate source of power, which shall be available for the duration of the maintenance or repair. The permanent switching means to connect a portable or temporary alternate source of power shall comply with the following:

(1) Connection to the portable or temporary alternate source of power shall not require modification of the permanent system wiring.
(2) Transfer of power between the normal power source and the emergency power source shall be in accordance with 700.12.
(3) The connection point for the portable or temporary alternate source shall be marked with the phase rotation and system bonding requirements.
(4) Mechanical or electrical interlocking shall prevent inadvertent interconnection of power sources.
(5) The switching means shall include a contact point that shall annunciate at a location remote from the generator or at another facility monitoring system to indicate that the permanent emergency source is disconnected from the emergency system.

It shall be permissible to utilize manual switching to switch from the permanent source of power to the portable or temporary alternate source of power and to utilize the switching means for connection of a load bank.

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Emergency Systems
700.4 Capacity

(A) Capacity and Rating. An emergency system shall have adequate capacity and rating for all loads to be operated simultaneously. The emergency system equipment shall be suitable for the maximum available fault current at its terminals.

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Emergency Systems
700.5 Transfer Equipment

700.5 Transfer Equipment.

(A) General. Transfer equipment, including automatic transfer switches, shall be automatic, identified for emergency use, and approved by the authority having jurisdiction. Transfer equipment shall be designed and installed to prevent the inadvertent interconnection of normal and emergency sources of supply in any operation of the transfer equipment. Transfer equipment and electric power production systems installed to permit operation in parallel with the normal source shall meet the requirements of Article 705.

(B) Bypass Isolation Switches. Means shall be permitted to bypass and isolate the transfer equipment. Where bypass isolation switches are used, inadvertent parallel operation shall be avoided.

(C) Automatic Transfer Switches. Automatic transfer switches shall be electrically operated and mechanically held. Automatic transfer switches shall be listed for emergency system use.

(D) Use. Transfer equipment shall supply only emergency loads.

N **(E) Documentation.** The short-circuit current rating of the transfer equipment, based on the specific overcurrent protective device type and settings protecting the transfer equipment, shall be field marked on the exterior of the transfer equipment.

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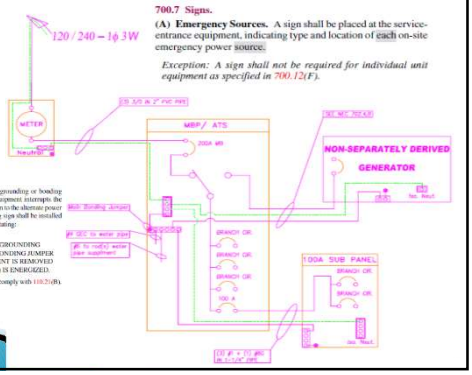
Emergency Systems
700.7 Signs

700.7 Signs.

(A) Emergency Sources. A sign shall be placed at the service-entrance equipment, indicating type and location of each on-site emergency power source.

Exception: A sign shall not be required for individual unit equipment as specified in 700.12(F).



(B) Grounding. Where removal of a grounding or bonding connection in normal power source equipment interrupts the grounding electrode conductor connection to the alternate power source(s) grounded conductor, a warning sign shall be installed at the normal power source equipment stating:

WARNING
SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED.

The warning sign(s) or label(s) shall comply with 110.21(B).

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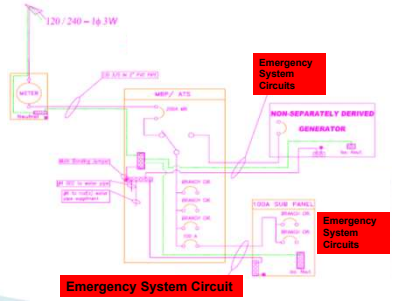
Emergency Systems
700.10 Wiring, Emergency System

(A) Identification. Emergency circuits shall be permanently marked so they will be readily identified as a component of an emergency circuit or system by the following methods:

(1) All boxes and enclosures (including transfer switches, generators, and power panels) for emergency circuits shall be permanently marked as a component of an emergency circuit or system.
(2) Where boxes or enclosures are not encountered, exposed cable or raceway systems shall be permanently marked to be identified as a component of an emergency circuit or system, at intervals not to exceed 7.6 m (25 ft).

Receptacles supplied from the emergency system shall have a distinctive color or marking on the receptacle cover plates or the receptacles.



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Emergency Systems
700.10 Wiring, Emergency System

(D) Fire Protection. Emergency systems shall meet the additional requirements in (D)(1) through (D)(3) in the following occupancies:

(1) Assembly occupancies for not less than 1000 persons
(2) Buildings above 23 m (75 ft) in height
(3) Health care occupancies where persons are not capable of self preservation
(4) Educational occupancies with more than 300 occupants

(1) Feeder-Circuit Wiring. Feeder-circuit wiring shall meet one of the following conditions:

(1) The cable or raceway is installed in spaces or areas that are fully protected by an approved automatic fire suppression system.
(2) The cable or raceway is protected by a listed electrical circuit protective system with a minimum 2-hour fire rating.
(3) The cable or raceway is a listed fire-resistive cable system.

Informational Note No. 1: Fire-resistive cables are tested to ANSI/UL 2196, *Tests for Fire Resistive Cables.*

Informational Note No. 2: The listing organization provides information for fire-resistive cable systems on proper installation requirements to maintain the fire rating.

(4) The cable or raceway is protected by a listed fire-rated assembly that has a minimum fire rating of 2 hours and contains only emergency circuits.
(5) The cable or raceway is encased in a minimum of 50 mm (2 in.) of concrete.

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Emergency Systems
700.12(B)(6) Outdoor Generator Sets

700.12(B)(6) Outdoor Generator Sets. Where an outdoor housed generator set is equipped with a readily accessible disconnecting means in accordance with 445.18, and the disconnecting means is located within sight of the building or structure supplied, an additional disconnecting means shall not be required where ungrounded conductors serve or pass through the building or structure. Where the generator supply conductors terminate at a disconnecting means in or on a building or structure, the disconnecting means shall meet the requirements of 225.36.

225.36 Type of Disconnecting Means. The disconnecting means specified in 225.31 shall be comprised of a circuit breaker, molded case switch, general-use switch, snap switch, or other approved means. Where applied in accordance with 250.32(B), Exception No. 1, the disconnecting means shall be suitable for use as service equipment.

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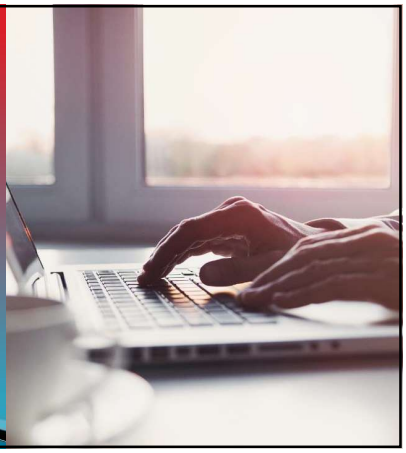
Do you have questions?

Now is the time to ask!



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Thank you for participating!

To schedule a seminar, webinar, or online course:

www.associatedconsultingsolutions.com

Or call

Associated Consulting Solutions, LLC
216-256-3556

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File Attachments for Item:

ER-3 2017 NEC Wiring, Equipment, and Overcurrent Protection (Flanik)

All Certifications (6 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend 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: Jerry Flanik
(Contact Name)

Organization: Associated Consulting Solutions, LLC
(Organization/Company)

Address: 9671 Oxford Glen Drive
(Include Room Number, Suite, etc.)

City: Mentor State: Ohio Zip: 44060

E-Mail: jerry@associatedconsultingsolutions.com

Telephone: 216-256-3556 Fax: _____

Course Sponsor: Associated Consulting Solutions, LLC

COURSE INFORMATION:

Course Title: 2017 NEC Wiring, Equipment, and Overcurrent Protection

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

Purpose and Objective: This 6-hour seminar is designed for online or in-person training that highlights main provisions regarding the 2017 NEC wiring, equipment, and overcurrent protection. Participants will be provided with requirements for branch circuits, feeders, services, overcurrent protection devices and ratings, generators, transformers, motors, and HVAC equipment and panels.

Number of Instructional Contact Hours that can be obtained upon completion: 6 hours

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

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■
Building Plans Exam. ■
Plumbing Plans Exam. ■
Electrical Plans Exam. ■
Mechanical Plans Exam. ■
Fire Protect. Plans Exam. ■

Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■
Plumbing Inspector ■
Non-Res IU Inspector ■

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

Electrical Safety Inspectors ■
Location of ESI Course: TBD Date(s) of ESI Course(s): TBD

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:		x

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

2017 NEC Wiring, Equipment, and Overcurrent Protection

6-Hours of Continuing Education Credit

Course Description: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar highlights key provisions of the *2017 NEC regarding wiring, equipment, and overcurrent protection.*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- Branch Circuits & Feeders
- Services
- Overcurrent Protection Devices and Ratings
- Generators & Transformers
- Motors & HVAC Equipment
- Panels

Course Outline:

1. **2017 OBC – CHAPTER 1**
   - **OBC Section 105.1 Approvals Required**
   - **OBC Section 102.10 Work Exempt From Approval**
   - **OBC Section 102.10.1 Emergency Repairs**
   - **OBC Section 102.10.2 Minor Repairs**
   - **OBC Section 106.1.1 Information on Construction Documents**

2. **2017 OBC – CHAPTER 27**

- **OBC Section 2701.1 Scope**
- **OBC Section 2701.2 Appliance and Fixture Listing**
- **OBC Section 2702 Emergency and Standby Power Systems**
- **OBC Section 2702.1 Installation**
- **OBC Section 2702.2 Where Required**
- **OBC Section 2702.3 Critical Circuits**
- **OBC Section 2702.4 Maintenance**
- **OBC Section 2703.1 Penetrations**
- **OBC Section 2703.2 Cutting, Notching, and Boring**
- **OBC Section 2704 Smoke Detection**
- **OBC Section 2704.1 Smoke Alarm Circuits**

3. **2017 NEC 5 New Articles**

- **Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment**
- **Article 691 – Large Scale PV Production Facility**
- **Article 706 – Energy Storage Systems**
- **Article 710 – Stand Alone Systems**
- **Article 712 – DC Micro Grids**

4. **Article 210 Branch Circuits**

- **210.4 Multiwire Branch Circuits**
- **210.7 Multiple Branch Circuits**
- **210.11(C)(4) Garage Branch Circuits**
- **210.12 AFCI Protection**
- **210.12(C) Guest Rooms and Guest Suites**
- **210.17 Guest Rooms and Guest Suites**
- **210.18 Rating**
- **210.20 Overcurrent Protection**
- **210.21(B)(1) Single Receptacle on an Individual Branch Circuit**
- **210.52(B)(1) Exception #2**
- **210.52(C)(3) Peninsula Countertops**
- **210.52(G)(1) Garages**
- **210.63 HACR Receptacle**
- **210.64 Electrical Service Areas**
- **210.70(C) Lighting Outlets Required**
- **210.71(A) + (B) Meeting Rooms**

5. **Article 215 Feeders**

- **215.5 Diagrams of Feeders**
- **215.10 Ground-Fault Protection of Equipment**
- **225.1 Scope**
- **225.18 Clearance for Overhead Conductors and Cables**
- **225.31 Disconnecting Means**
- **225.33 Maximum Number of Disconnects**
- **225.37 Identification**

6. **Article 225 Feeders**

- **225.1 Scope**
- **225.18 Clearance for Overhead Conductors and Cables**
- **225.31 Disconnecting Means**
- **225.33 Maximum Number of Disconnects**
- **225.37 Identification**

7. **Article 230 Services**

- **230.2 Number of Services**
- **230.9 Clearances on Buildings**
- **230.24 Overhead Service Conductors Clearances**
- **230.28 Service Masts as Supports**
- **230.30 Underground Service Conductors Installation**
- **230.40 Number of Service-Entrance Conductor Sets**
- **230.42 Service-Entrance Conductor Minimum Size and Rating.**
- **230.43 Wiring Methods for 1000 Volts, Nominal, or Less.**
- **230.66 Marking Service Equipment General**
- **230.70 Service Equipment-Disconnecting Means**
- **230.82 Equipment Connected to the Supply Side of SE Equipment**
- **230.91 Location Service Equipment-Overcurrent Protection**
- **230.95 Ground-Fault Protection of Equipment**
- **230.95(C) Performance Testing**

8. **Article 240 Overcurrent Protection**

- **240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers**
- **240.13 Ground-Fault Protection of Equipment**
- **240.15 Ungrounded Conductors (Slash / rated breaker)**
- **240.24 Location in or on Premises – new exception**
- **240.67 Arc Energy Reduction – new section**

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9. **Article 445 Generators**

- **445.11 Marking**
- **445.13 Ampacity of Conductors**
- **445.18 Disconnecting Means and Shutdown of Prime Mover**
- **700.12(B)(6) Outdoor Generator Sets**

10. **Article 450 Transformers**

- **450.3 Overcurrent Protection**
- **Application of Table 450.3(B)**
- **450.21 Dry-Type Transformers Installed Indoors**
- **450.21(C) Over 35,000 Volts**
- **450.26 Oil-Insulated Transformers Installed Indoors**

11. **ARTICLE 440 Air-Conditioning and Refrigerating Equipment**

- **440.1 Scope**
- **210.63 HACR Receptacle**
- **440.4(B) Multimotor and Combination-Load Equipment**
- **440.6 Ampacity and Rating**
- **440.9 Grounding and Bonding**
- **440.10 Short-Circuit Current Rating**
- **440.12 Rating and Interrupting Capacity**
- **440.14 Location**
- **440.63 Disconnect Locations**
- **440.64 Supply Cords**
- **440.65 Protection Devices**

12. **ARTICLE 430 Motors, Motor Circuits, and Controllers**

- **430.10 Wiring Space in Enclosures**
- **430.10(B) Wire-Bending Space in Enclosures**
- **430.28 Feeder Taps**
- **430.52(C)(1), Exception No. 1**
- **430.99 Available Fault Current**
- **430.102 Disconnecting Means Location**
- **430.109 Type**

13. <u>Article 408 Switchboards, Switchgear, and Panelboards</u>

- **408.3(A)(2) Service Panelboards**
- **408.3(C) Used as Service Equipment**
- **408.4 Field Identification Required**
- **408.7 Unused Openings**
- **408.36 Overcurrent Protection**
- **408.36(D) Back-Fed Devices**
- **408.58 Panelboard Marking**

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2017 NEC Wiring, Equipment, and Overcurrent Protection

Based on the 2017 National Electrical Code (NEC)

Welcome

- Meet the instructor
- Participant introductions

Meet the Instructor

- Gerald C. Flanik is an ICC-Certified Master Code Professional (MCP), and holds over 40 various licenses and certifications. He is also a LEED BD+C Accredited Professional, Certified Floodplain Manager (CFM).
- Mr. Flanik is President of Associated Consulting Solutions, LLC (ACS) in Cleveland, Ohio. ACS provides plan review services, pre and post design analysis services for architectural and engineering firms, and code consulting services throughout the United States. ACS is also an ICC Preferred Education Provider, providing education throughout the United States. Previously, Gerald served as the Chief Building Official for Lake County, Ohio for 16 years. Prior to working as a code official, he owned and operated a design build contracting company.
- Gerald holds a Bachelor of Science Degree in Mechanical Engineering and a Bachelor of Science Degree in Electrical Engineering from Cleveland State University; as well as, a degree in Civil Engineering Technology. He is also an adjunct faculty instructor at Lakeland College in the Civil and Electrical Engineering Departments.
- Jerry is a professional consultant for corporations and government agencies throughout the United States, and for the International Code Council throughout the world.

Associated Consulting Solutions, LLC
www.associatedconsultingsolutions.com

2017 NEC Wiring, Equipment, and Overcurrent Protection

Key topics covered with in-depth discussion :

- 2017 OBC Requirements
- Branch Circuits & Feeders
- Services
- Overcurrent Protection Devices and Ratings
- Generators & Transformers
- Motors & HVAC Equipment
- Panels

Description

This seminar highlights key provisions of the *2017 NEC regarding wiring, equipment, and overcurrent protection.*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

OBC Chapter 1

- This chapter is largely concerned with maintaining "due process of law" in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.

OBC Section 105.1

105.1 Approvals Required

Any owner or owner's representative who intends to construct, enlarge, alter, repair, move, or change the occupancy of a building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required approval.

However, OBC 102.10 contains additional information.

OBC Section 102.10

102.10 Work Exempt From Approval

Approval shall not be required for the following work; however, this work shall comply with all applicable provisions of the rules of the board:

Electrical:

1. Minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
2. Electrical equipment used for radio and television transmissions except equipment and wiring for power supply, and the installations of towers and antennas.
3. The installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.
4. Electrical wiring, devices, appliances, apparatus or equipment operating at less than twenty-five volts and not capable of supplying more than fifty watts of energy, unless specifically addressed in this code.
5. Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
6. Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70 as referenced in Chapter 35.

OBC Section 102.10.1

102.10.1 Emergency Repairs

Where equipment replacements and repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Provide some examples of electrical emergency situations???

OBC Section 102.10.2

102.10.2 Minor Repairs

Minor repairs to structures may be made without application or notice to the building official. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall minor repairs include addition to, alteration of, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Provide some examples of minor repairs???

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

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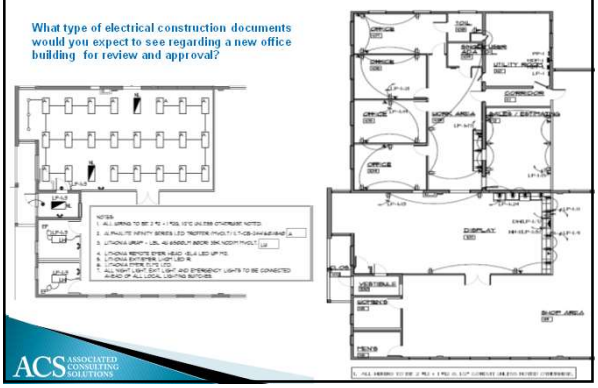
OBC Section 106.1.1

What type of electrical construction documents would you expect to see regarding a new office building for review and approval?



OBC Chapter 27

2701.1 Scope

This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment, and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

2701.2 Appliance and Fixture Listing

Electrical appliances and fixtures within the scope of this code shall be tested and listed in published reports of inspected electrical equipment by an approved agency and installed in accordance with all instructions included as part of such listing.

UL LISTED

OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

OBC Chapter 27

Section 2703 Penetrations

2703.1 Penetrations
Penetrations of walls, floors, ceilings and assemblies required to have a fire-resistance rating, shall be protected in accordance with Chapter 7. Where cables, conductors and raceways penetrate fireblocking or draftstopping, such penetrations shall be protected by filling the annular space with an approved fireblocking material.

2703.2 Cutting, Notching, and Boring
The cutting, notching and boring of wood and steel framing members, structural members and engineered wood products shall be in accordance with this code and as prescribed by the registered design professional.

Section 2704 Smoke Detection

2704.1 Smoke Alarm Circuits
Smoke detectors required by this code and installed within dwelling units shall not be connected as the only load on a branch circuit. Such detectors shall be supplied by branch circuits having lighting loads consisting of lighting outlets in habitable spaces.

Why do we need codes and standards?

IKEA Rooftop PV Install (Illinois)

1.124 MW System

Bolingbrook (05.12.2018)

4,784 Panels

No Injuries Reported

Lake County; Fair Painesville, Ohio

Bumper Car Ride - Electrocution

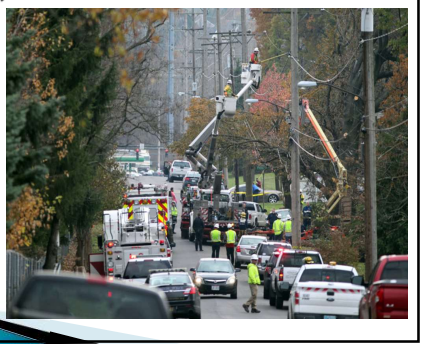
08.12.2003

- Boy 8 Years old
- 22 Safety Violations
- Grounding & Bonding
- 2 Mil. Settlement

11.15.2017 Tree trimmer fatality in Akron, Ohio

Electrocution: 23kv Line bucket lift accident; 1 died, 1 in serious condition

Update: **2 deaths**



2017 NEC "Features"

The 2017 NEC edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new.

"5" New 2017 NEC Articles

Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment

Article 691 – Large Scale PV Production Facility

Article 706 – Energy Storage Systems

Article 710 – Stand Alone Systems

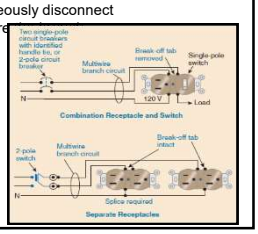
Article 712 – DC Micro Grids

Article 210 Branch Circuits

210.4 Multiwire Branch Circuits

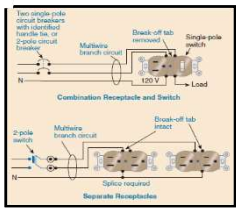
(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. All conductors of a multiwire branch circuit shall originate from the same panelboard or similar distribution equipment.

(B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the circuit originates.



210.7 Multiple Branch Circuits

210.7 Multiple Branch Circuits. Where two or more branch circuits supply devices or equipment on the same yoke or mounting strap, a means to simultaneously disconnect the ungrounded supply conductors shall be provided at the point at which the branch circuits originate.



210.11(C)(4) Garage Branch Circuits

N In addition to the number of branch circuits required by other parts of this section, ***at least one 120-volt 20-ampere branch circuit shall be installed*** to supply receptacle outlets in attached garages and in detached garages with electric power. ***This circuit shall have no other outlets.***

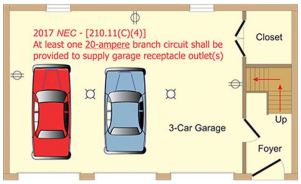
Exception*: This circuit* ***shall be*** *permitted to supply readily accessible outdoor receptacle outlets.*

210.11(C)(4) Garage Branch Circuits

N **(4) Garage Branch Circuits.** In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets in attached garages and in detached garages with electric power. This circuit shall have no other outlets.

Exception: This circuit shall be permitted to supply readily accessible outdoor receptacle outlets.

210.11(C)(4) Dwelling Unit Garages



The branch circuit supplying this receptacle(s) shall not supply outlets outside of the garage [210.52(G)(1)]

At least one receptacle outlet shall be installed in each vehicle bay and not more than 1.7 m (5½ ft) above the floor [210.52(G)(1)]

210.12 AFCI Protection

Arc-Fault Circuit Interrupter Protection

All 120-v 15- and 20-ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas shall be protected by any of means described in 210.12(A)(1) through (6).

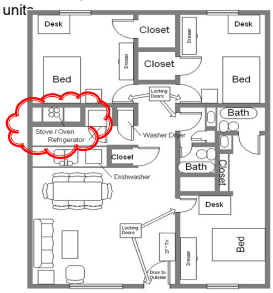
210.12(C) Guest Rooms and Guest Suites

New "AFCI" Requirement

N ***All*** 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed ***in*** guest rooms and guest suites of hotels and motels shall be protected by any of the means described in 210.12 (A) (1) through (6).

210.17 Guest Rooms and Guest Suites

- **210.17 Guest Rooms and Guest Suites.** Guest rooms and guest suites that are provided with permanent provisions for cooking shall have branch circuits installed to meet the rules for dwelling units.



210.18 Rating

New Requirement

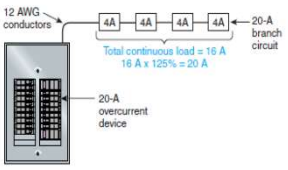
N **210.18 Rating.** Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for other than individual branch circuits shall be 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

The rating of a branch circuit is determined by the rating of the overcurrent protective device, not by the ampacity of the circuit conductors. An increase in conductor ampacity from 20 amperes (12 AWG) to 30 amperes (10 AWG) for any reason does not change the rating of the circuit. If the rating of the branch-circuit overcurrent device is 20 amperes, then the rating of the circuit is 20 amperes.

210.20 Overcurrent Protection

210.20 Overcurrent Protection. Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 210.20(A) through (D).

(A) Continuous and Noncontinuous Loads. Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.



210.21(B)(1) Single Receptacle on an Individual Branch Circuit

(B) Receptacles.

(1) Single Receptacle on an Individual Branch Circuit. A single receptacle installed on an individual branch circuit shall have an ampere rating not less than that of the branch circuit.

210.21(B)(3) Receptacle Ratings. Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings shall conform to the values listed in Table 210.21(B)(3), or, where rated higher than 50 amperes, the receptacle rating shall not be less than the branch-circuit rating.

TABLE 210.21(B)(3) Receptacle Ratings for Various Size Circuits

Circuit Rating (Amperes)	Receptacle Rating (Amperes)
15	Not over 15
20	15 or 20
30	30
40	40 or 50
50	50

20A Receptacle 15A Receptacle

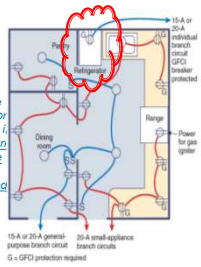
210.52(B)(1) Ex. #2

Small Appliances

Exception #2 has been expanded to include any specific appliance, not just refrigeration equipment.

In addition to the required receptacles specified by 210.52, a receptacle outlet to serve a specific appliance shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater.

This exception allows a choice for refrigeration equipment receptacle outlets located in a kitchen or similar area. An individual 15-ampere or larger branch circuit may serve this equipment, or it may be included in the 20-ampere small-appliance branch circuit. Refrigeration equipment is exempt from the GFCI requirements of 210.8 where the receptacle outlet is greater than 6 feet from the edge of any sink and where it is located so that it cannot be used to serve countertop surfaces.

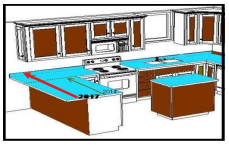


210.52(C)(3) Peninsula Countertops

Relaxing the Rule!

At least one receptacle outlet shall be installed at each peninsular countertop **long** dimension space of 24" or greater and a short dimension of 12" or greater. A peninsular countertop is measured from the ***connected perpendicular wall***.

The wall outlet serving the base cabinet *may* now serve as the peninsula outlet.



210.52(G)(1) Garages

Clarified Intent: (Location)

In each attached garage and in each detached garage with electric power, ***at*** least one receptacle outlet shall be installed ***in each vehicle bay*** and not more than ***5'6"*** (66") ***above the floor***.

(G) Basements, Garages, and Accessory Buildings. For one- and two- family dwellings, at least one receptacle outlet shall be installed in the areas specified in 210.52(G)(1) through (3). These receptacles shall be in addition to receptacles required for specific equipment.

(1) Garages. In each attached garage and in each detached garage with electric power, at least one receptacle outlet shall be installed in each vehicle bay and not more than 1.7 m (5½ ft) above the floor.

(2) Accessory Buildings. In each accessory building with electric power.

(3) Basements. In each separate unfinished portion of a basement.

210.63 HACR Recep.

210.63 Heating, Air-Conditioning, and Refrigeration Equipment Outlet. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment. The receptacle shall be located on the same level and within 7.5 m (25 ft) of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

Informational Note: See 210.8 for ground-fault circuit interrupter requirements.

210.64 Electrical Service Areas

210.64 Electrical Service Areas. At least one 125-volt, single phase, 15- or 20-ampere-rated receptacle outlet shall be installed in an accessible location within 7.5 m (25 ft) of the indoor electrical service equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

Exception No. 1: The receptacle outlet shall not be required to be installed in one- and two-family dwellings.

210.70(C) Lighting Outlets Required

(C) All Occupancies. For attics and underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch shall be installed where these spaces are used for storage or contain equipment requiring servicing. At least one point of control shall be at the usual point of entry to these spaces. The lighting outlet shall be provided at or near the equipment requiring servicing.

210.71(A) + (B) Meeting Rooms

New Requirement

N Section

- ***Each meeting room of not more than 1000 sq. ft. in other than dwelling units shall have outlets for nonlocking-type, 125-volt, 15- or 20-ampere receptacles.***
- ***The minimum number of outlets that are required, shall be as determined by the 2' / 6' / 12' rule in (210.52) + floor outlets for each 215 sq. ft. of floor space when the room is at least 12' wide (>6' from wall).***

Meeting Room(s)

Articles 215 & 225 Feeders

215.5 Diagrams of Feeders

215.5 Diagrams of Feeders. If required by the authority having
jurisdiction, a diagram showing feeder details shall be provided
prior to the installation of the feeders. Such a diagram shall show the area in square feet of the building or other structure
supplied by each feeder, the total calculated load before applying
demand factors, the demand factors used, the calculated load after applying demand factors, and the size and type of conductors to be used.

215.10 Ground-Fault Protection of Equipment

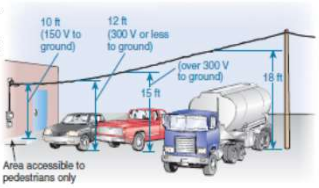
215.10 Ground-Fault Protection of Equipment. Each feeder disconnect rated 1000 amperes or more and installed on solidly
grounded wye electrical systems of more than 150 volts to ground, but not exceeding 600 volts phase-to-phase, shall be provided with ground-fault protection of equipment in accordance
with the provisions of 230.95.

Exception No. 1: The provisions of this section shall not apply
to a disconnecting means for a continuous industrial process
where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: The provisions of this section shall not apply
if ground-fault protection of equipment is provided on the supply side of the feeder and on the load side of any transformer supplying the feeder.

225.1 Scope

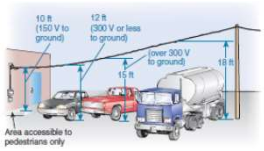
225.1 Scope. This article covers requirements for outside branch
circuits and feeders run on or between buildings, structures, or
poles on the premises; and electrical equipment and wiring for
the supply of utilization equipme
attached
to the outside of buildings, struc



225.18 Clearance for Overhead Conductors and Cables

225.18 Clearance for Overhead Conductors and Cables.
Overhead spans of open conductors and open multiconductor
cables of not over 1000 volts, nominal, shall have a clearance of
not

(1) 3.0 m (10 ft) — above finished grade, sidewalks, or from any platform or projection that will permit personal contact where the voltage does not exceed 150 volts to ground and accessible to pedestrians only
(2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground
(3) 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground
(4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles, such as cultivated, grazing, forest, and orchard
(5) 7.5 m (24½ ft) — over track rails of railroads



225.31 Disconnecting Means

225.31 Disconnecting Means. Means shall be provided for disconnecting all ungrounded conductors that supply or pass through the building or structure.

225.32 Location. The disconnecting means shall be installed either inside or outside of the building or structure served or where the conductors pass through the building or structure. The disconnecting means shall be at a readily accessible location nearest the point of entrance of the conductors. For the purposes of this section, the requirements in 230.6 shall be utilized.

225.33 Maximum Number of Disconnects

225.33 Maximum Number of Disconnects.

(A) General. The disconnecting means for each supply permitted by 225.30 shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six disconnects per supply grouped in any one location.

Exception: For the purposes of this section, disconnecting means used solely for the control circuit of the ground-fault protection system, or the control circuit of the power-operated supply disconnecting means, installed as part of the listed equipment, shall not be considered a supply disconnecting means.

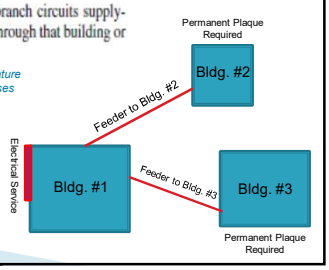
225.35 Access to Occupants. In a multiple-occupancy building, each occupant shall have access to the occupant's supply disconnecting means.

Exception: In a multiple-occupancy building where electric supply and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the supply disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

225.37 Identification

225.37 Identification. Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

This identification is an important safety feature during an emergency, because in many cases first responders are not familiar with the electrical distribution system of a facility.



Use your 2017 NEC

1. An outdoor feeder will supply a new building that is not under single management and must have the disconnecting means installed _____.

A. within a vault
B. at a location provided by the owner
C. nearest the point of entrance of the conductors
D. in conduit and within 10 feet near the building exit

Use your 2017 NEC

1. An outdoor feeder will supply a new building that is not under single management and must have the disconnecting means installed _____.

A. within a vault
B. at a location provided by the owner
C. nearest the point of entrance of the conductors
D. in conduit and within 10 feet near the building exit

Reference: 2017 NEC: 225.32

Article 230 Services

230.2 Number of Services

230.2 Number of Services. A building or other structure served shall be supplied by only one service unless permitted in 230.2(A) through (D). For the purpose of 230.40, Exception No. 2 only, underground sets of conductors, 1/0 AWG and larger, running to the same location and connected together at their supply end but not connected together at their load end shall be considered to be supplying one service.

(A) Special Conditions. Additional services shall be permitted to supply the following:

(1) Fire pumps
(2) Emergency systems
(3) Legally required standby systems
(4) Optional standby systems
(5) Parallel power production systems
(6) Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability

230.2 Number of Services

230.2 Number of Services. A building or other structure served shall be supplied by only one service unless permitted in 230.2(A) through (D). For the purpose of 230.40, Exception No. 2 only, underground sets of conductors, 1/0 AWG and larger, running to the same location and connected together at their supply end but not connected together at their load end shall be considered to be supplying one service.

(B) Special Occupancies. By special permission, additional services shall be permitted for either of the following:

(1) Multiple-occupancy buildings where there is no available space for service equipment accessible to all occupants

(2) A single building or other structure sufficiently large to make two or more services necessary

(C) Capacity Requirements. Additional services shall be permitted under any of the following:
(1) Where the capacity requirements are in excess of 2000 amperes at a supply voltage of 1000 volts or less

(2) Where the load requirements of a single-phase installation are greater than the serving agency normally supplies through one service

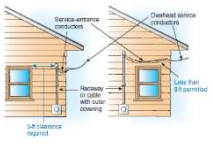
(3) By special permission

230.9 Clearances on Buildings

230.9 Clearances on Buildings. Service conductors and final spans shall comply with 230.9(A), (B), and (C).

(A) Clearances. Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of not less than 900 mm (3 ft) from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

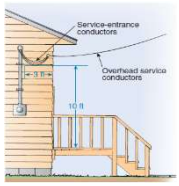
Exception: Conductors run above the top level of a window shall be permitted to be less than the 900 mm (3 ft) requirement.



230.9 Clearances on Buildings

230.9 Clearances on Buildings. Service conductors and final spans shall comply with 230.9(A), (B), and (C).

(B) Vertical Clearance. The vertical clearance of final spans above, or within 900 mm (3 ft) measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 230.24(B).



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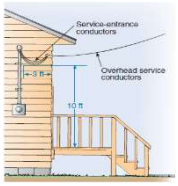


(C) Building Openings. Overhead service conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and shall not be installed where they obstruct entrance to these building openings.

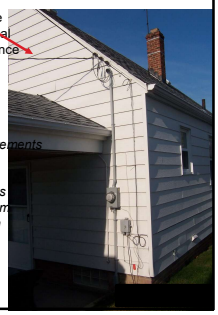
Overhead Service Conductors 230.24 Clearances

230.24 Clearances. Overhead service conductors shall not be readily accessible and shall comply with 230.24(A) through (E) for services not over 1000 volts, nominal.

(A) Above Roofs. Conductors shall have a vertical clearance of not less than 2.5 m (8 ft) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance of not less than 900 mm (3 ft) in all directions from the edge of the roof.

Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 230.24(B).

Exception No. 2: Where the voltage between conductors does not exceed 300 and the roof has a slope of 100 mm in 300 mm (4 in. in 12 in.) or greater, a reduction in clearance to 900 mm (3 ft) shall be permitted.



Overhead Service Conductors 230.24 Clearances

(B) Vertical Clearance for Overhead Service Conductors.

Overhead service conductors, where not in excess of 600 volts, non
fina
gra

(1) 3.0 m (10 ft) — at the electrical service entrance to buildings, also at the lowest point of the drip loop of the building electrical entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for overhead service conductors supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground

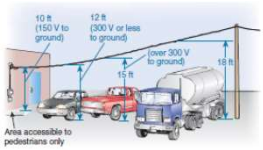
(2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground

(3) 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground

(4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard

(5) 7.5 m (24½) over tracks of railroads

m clearance from



230.28 Service Masts as Supports

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230.28 Service Masts as Supports. Only power service-drop overhead service conductors shall be permitted to be attached a service mast. Service masts used for the support of service- or overhead service conductors shall be installed in accordanc with 230.28(A) and (B).

(A) Strength. The service mast shall be of adequate strength or be supported by braces or guys to withstand safely the stra imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipme

(B) Attachment. Service-drop or overhead service conductors shall not be attached to a service mast between a weatherhead or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structu

Underground Service Conductors 230.30 Installation

(B) Wiring Methods

Underground service conductors shall be installed in accordance with the applicable requirements of this *Code* covering the type of wiring method used and shall be limited to the following methods:

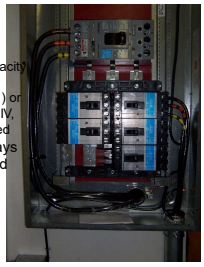
(1) Type RMC conduit
(2) Type IMC conduit
(3) Type NUCC conduit
(4) Type HDPE conduit
(5) Type PVC conduit
(6) Type RTRC conduit
(7) Type IGS cable
(8) Type USE conductors or cables
(9) Type MV or Type MC cable identified for direct burial applications
(10) Type MI cable, where suitably protected against physical damage and corrosive conditions

Service-Entrance Conductors

230.40 Number of Service-Entrance Conductor Sets. Each service drop, set of overhead service conductors, set of underground service conductors, or service lateral shall supply only one set of service-entrance conductors.

230.42 Minimum Size and Rating.

(A) General. Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 230.42(A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.15. The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.



Service-Entrance Conductors

230.43 Wiring Methods for 1000 Volts, Nominal, or Less. Service-entrance conductors shall be installed in accordance with the applicable requirements of this Code covering the type of wiring method used and shall be limited to the following methods:

(1) Open wiring on insulators
(2) Type IGS cable
(3) Rigid metal conduit (RMC)
(4) Intermediate metal conduit (IMC)
(5) Electrical metallic tubing (EMT)
(6) Electrical nonmetallic tubing
(7) Service-entrance cables
(8) Wireways
(9) Busways
(10) Auxiliary gutters
(11) Rigid polyvinyl chloride conduit (PVC)
(12) Cablebus
(13) Type MC cable
(14) Mineral-insulated, metal-sheathed cable, Type MI
(15) Flexible metal conduit (FMC) not over 1.8 m (6 ft) long or liquidtight flexible metal conduit (LFMC) not over 1.8 m (6 ft) long between a raceway, or between a raceway and service equipment, with a supply-side bonding jumper routed with the flexible metal conduit (FMC) or the liquidtight flexible metal conduit (LFMC) according to the provisions of 250.102(A), (B), (C), and (E)
(16) Liquidtight flexible nonmetallic conduit (LFNC)
(17) High density polyethylene conduit (HDPE)
(18) Nonmetallic underground conduit with conductors (NUCC)
(19) Reinforced thermosetting resin conduit (RTRC)

Service Equipment General 230.66 Marking

230.66 Marking. Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed or field labeled. Individual meter socket enclosures shall not be considered service equipment but shall be listed and rated for the voltage and ampacity of the service.

Exception: Meter sockets supplied by and under the exclusive control of an electric utility shall not be required to be listed.

Service Equipment-Disconnecting Means

230.70 General. Means shall be provided to disconnect all conductors in a building or other structure from the service entrance conductors.

(A) Location. The service disconnecting means shall be installed in accordance with 230.70(A)(1), (A)(2), and (A)(3).

(1) Readily Accessible Location. The service disconnecting means shall be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the service conductors.

(2) Bathrooms. Service disconnecting means shall not be installed in bathrooms.

(3) Remote Control. Where a remote control device(s) is used to actuate the service disconnecting means, the service disconnecting means shall be located in accordance with 230.70(A)(1).

(B) Marking. Each service disconnect shall be permanently marked to identify it as a service disconnect.

(C) Suitable for Use. Each service disconnecting means shall be suitable for the prevailing conditions. Service equipment installed in hazardous (classified) locations shall comply with the requirements of Articles 500 through 517.

230.82 Equipment Connected to the Supply Side of SE Equipment

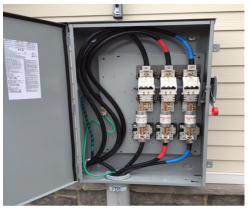
The meter disconnect is not the service disconnecting means. It is a load break disconnect switch designed to interrupt the service load. The purpose of the meter disconnect switch is to facilitate meter change, maintenance, or disconnecting of the service.

Section 230.82(3) requires meter disconnect switches to have a short-circuit current rating that is not less than the available short-circuit current at the line terminals of the meter disconnect switch.

Service Equipment-Overcurrent Protection

Re: Fused SE Disconnects

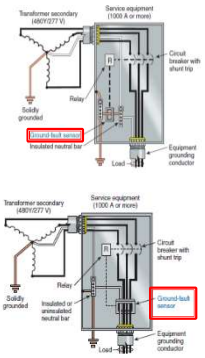
230.91 Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto. ***Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the fuses.***



Service Equipment-Overcurrent Protection

230.95 Ground-Fault Protection of Equipment. Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amperes or more. The grounded conductor for the solidly grounded wye system shall be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.

The rating of the service disconnect shall be considered to be the rating of the largest fuse that can be installed or the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted.



(A) **Setting.** The ground-fault protection system shall operate to cause the service disconnect to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amperes, and the maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 amperes.

(B) **Fuses.** If a switch and fuse combination is used, the fuses employed shall be capable of interrupting any current higher than the interrupting capacity of the switch during a time that the ground-fault protective system will not cause the switch to open.

(C) **Performance Testing.** The ground-fault protection system shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

230.95(C) Performance Testing

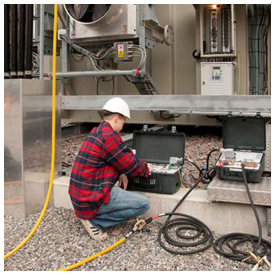
The ground-fault protection system shall be performance tested when first installed on site. **This testing** shall be conducted **by a qualified person(s) using a test process of primary current injection,** in accordance with instructions that shall be provided with the equipment. A written record of this **testing** shall be made and shall be available to the authority having jurisdiction.

Typically utilized in substations
Comprehensive Test

Primary Current Injection Testing

Secondary Testing:
Electronic Breakers Only
Tests Trip Unit Only

Primary Testing:
Tests Thermal Magnetic & Electronic Breakers.
Tests breaker from CT, CT Wiring to the Trip Unit, and Trip Unit



Use your 2017 NEC

1. An additional service is permitted for a building when the electrical service capacity of _____ amperes is exceeded with a supply voltage of 1000 volts or less.

A. 3000
B. 2000
C. 1000
D. 800

Use your 2017 NEC

1. An additional service is permitted for a building when the electrical service capacity of _____ amperes is exceeded with a supply voltage of 1000 volts or less.

A. 3000
B. 2000
C. 1000
D. 800

Reference 2017 NEC: 230.2(C)(1)

Use your 2017 NEC

2.What is the maximum number of switches or sets of breakers grouped in one location that are permitted to be used as service disconnects per service?

A. 1
B. 2
C. 5
D. 6

Use your 2017 NEC

2. What is the maximum number of switches or sets of breakers grouped in one location that are permitted to be used as service disconnects per service?

A. 1
B. 2
C. 5
D. 6

Reference 2017 NEC: 230.71(A)

Article 240 Overcurrent Protection

240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

240.6 Standard Ampere Ratings.

(A) Fuses and Fixed-Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6(A). Additional standard ampere ratings for fuses shall be 1, 3, 6, 10, and 601. The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

N *TABLE 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers*

Standard Ampere Ratings				
15	20	25	30	35
40	45	50	60	70
80	90	100	110	125
150	175	200	225	250
300	350	400	450	500
600	700	800	1000	1200
1600	2000	2500	3000	4000
5000	6000	—	—	—

240.13 Ground-Fault Protection of Equipment.

240.13 Ground-Fault Protection of Equipment. Ground-fault protection of equipment shall be provided in accordance with the provisions of 230.95 for solidly grounded wye electrical systems of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each individual device used as a building or structure main disconnecting means rated 1000 amperes or more

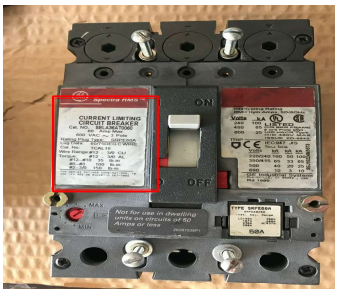
The provisions of this section shall not apply to the disconnecting means for the following:

(1) Continuous industrial processes where a nonorderly shutdown will introduce additional or increased hazards
(2) Installations where ground-fault protection is provided by other requirements for services or feeders
(3) Fire pumps

240.15 Ungrounded Conductors (Slash / rated breaker)

Maximum voltage to ground the breaker can clear in the event of a fault. **120/240v** (lowest number; 120-v)

Straight rated breaker, made for delta or wye system (480V).



240.24 Location in or on Premises

240.24 Location in or on Premises.

(A) Accessibility. Switches containing fuses and circuit breakers shall be readily accessible and installed so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 2.0 m (6 ft 7 in.) above the floor or working platform, unless one of the following applies:

(1) For busways, as provided in 368.17(C).
(2) For supplementary overcurrent protection, as described in 240.10.
(3) For overcurrent devices, as described in 225.40 and 230.92.
(4) For overcurrent devices adjacent to utilization equipment that they supply, access shall be permitted to be by portable means.

240.24 Location in or on Premises

New Exception

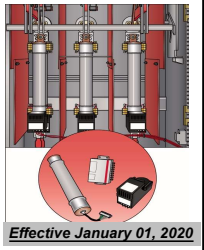
Exception: The use of a tool shall be permitted to access overcurrent devices located within listed industrial control panels or similar enclosures.

240.67 Arc Energy Reduction

New Section

N **Where fuses 1200a or higher are installed, 240.67(A) and (B) shall apply. This requirement shall become effective: *January 01, 2020*.**

(A) Documentation to AHJ
(B) Method to Reduce Clearing Time



Effective January 01, 2020

Circuit Breakers

240.81 Indicating. Circuit breakers shall clearly indicate whether they are in the open "off" or closed "on" position. Where circuit breaker handles are operated vertically rather than rotationally or horizontally, the "up" position of the handle shall be the "on" position.

240.85 Applications:

1. A circuit breaker marked 480Y/277 volts is not intended for use on a 480-volt system with up to 480 volts to ground, such as a 480-volt circuit derived from a corner-grounded, delta-connected system.
2. A circuit breaker marked either 480 volts or 600 volts should be used on such a system. Similarly, a circuit breaker marked 120/240 volts is not intended for use on a delta-connected 240-volt circuit.
3. A 240-volt, 480-volt, or 600-volt circuit breaker should be used on such a circuit. The slash (/) between the lower and higher voltage ratings in the marking indicates that the circuit breaker has been tested for use on a circuit with the higher voltage between phases and with the lower voltage to ground.

Article 445 Generators

445.11 Marking

445.11 Marking. Each generator shall be provided with a nameplate giving the manufacturer's name, the rated frequency, the number of phases if ac, the rating in kilowatts or kilovolt amperes, the power factor, the normal volts and amperes corresponding to the rating, the rated ambient temperature, and the rated temperature rise.
Nameplates or manufacturer's instructions shall provide the following information for all stationary generators and portable generators rated more than 15 kW:

(1) Subtransient, transient, synchronous, and zero sequence reactances
(2) Power rating category
(3) Insulation system class
(4) Indication if the generator is protected against overload by inherent design, an overcurrent protective relay, circuit breaker, or fuse
(5) Maximum short-circuit current for inverter-based generators, in lieu of the synchronous, subtransient, and transient reactances

Marking shall be provided by the manufacturer to indicate whether or not the generator neutral is bonded to its frame. Where the bonding is modified in the field, additional marking shall be required to indicate whether the neutral is bonded to the frame.

445.13 Ampacity of Conductors

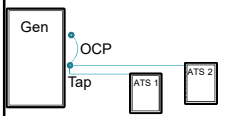
445.13 Ampacity of Conductors.
(A) General. The ampacity of the conductors from the generator output terminals to the first distribution device(s) containing overcurrent protection shall not be less than 115 percent of the nameplate current rating of the generator. It shall be permitted to size the neutral conductors in accordance with 220.61. Conductors that must carry ground-fault currents shall not be smaller than required by 250.30(A). Neutral conductors of dc generators that must carry ground-fault currents shall not be smaller than the minimum required size of the largest conductor.

Exception: Where the design and operation of the generator prevent overloading, the ampacity of the conductors shall not be less than 100 percent of the nameplate current rating of the generator.

445.13 Ampacity of Conductors

N (B) Overcurrent Protection Provided. Where the generator set is equipped with a listed overcurrent protective device or a combination of a current transformer and overcurrent relay, conductors shall be permitted to be tapped from the load side of the protected terminals in accordance with 240.21(B).

Tapped conductors shall not be permitted for portable generators rated 15 kW or less where field wiring connection terminals are not accessible.



445.18 Disconnecting Means and Shutdown of Prime Mover

445.18 Disconnecting Means and Shutdown of Prime Mover.

N (A) Disconnecting Means. Generators other than cord- and plug-connected portable shall have one or more disconnecting means. Each disconnecting means shall simultaneously open all associated ungrounded conductors. Each disconnecting means shall be lockable in the open position in accordance with 110.25.

N (B) Shutdown of Prime Mover. Generators shall have provisions to shut down the prime mover. The means of shutdown shall comply with all of the following:

(1) Be equipped with provisions to disable all prime mover start control circuits to render the prime mover incapable of starting
(2) Initiate a shutdown mechanism that requires a mechanical reset

The provisions to shut down the prime mover shall be permitted to satisfy the requirements of 445.18(A) where it is capable of being locked in the open position in accordance with 110.25.

The emergency shutdown/lockout means allows for a disconnecting means that is not a breaker or other device that requires overload protection to simultaneously open all ungrounded conductors. An emergency shutdown means makes the system inherently more reliable and safer than if more traditional designs are used.

Generators with greater than 15 kW rating shall be provided with an additional requirement to shut down the prime mover. This additional shutdown means shall be located outside the equipment room or generator enclosure and shall also meet the requirements of 445.18(B)(1) and (B)(2).

Emergency Systems

700.12(B)(6) Outdoor Generator Sets. Where an outdoor housed generator set is equipped with a readily accessible disconnecting means in accordance with 445.18, and the disconnecting means is located within sight of the building or structure supplied, an additional disconnecting means shall not be required where ungrounded conductors serve or pass through the building or structure. Where the generator supply conductors terminate at a disconnecting means in or on a building or structure, the disconnecting means shall meet the requirements of 225.36.

225.36 Type of Disconnecting Means. The disconnecting means specified in 225.31 shall be comprised of a circuit breaker, molded case switch, general-use switch, snap switch, or other approved means. Where applied in accordance with 250.32(B), Exception No. 1, the disconnecting means shall be suitable for use as service equipment.

Emergency Systems

700.7 Signs.

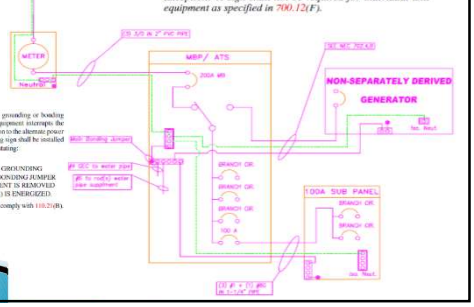
(A) Emergency Sources. A sign shall be placed at the service-entrance equipment, indicating type and location of each on-site emergency power source.

Exception: A sign shall not be required for individual unit equipment as specified in 700.12(F).

(B) Grounding. Where removal of a grounding or bonding connection in normal power source equipment interrupts the grounding-electrode conductor connection to the alternate power source(s) grounded conductor, a warning sign shall be installed at the normal power source equipment stating:

WARNING
SHOCK HAZARD EXISTS IF GROUNDING ELECTRODE CONDUCTOR OR BONDING JUMPER CONNECTION IN THIS EQUIPMENT IS REMOVED WHILE ALTERNATE SOURCE(S) IS ENERGIZED.

The warning sign(s) or label(s) shall comply with 110.21(B).



Article 450 Transformers

450.3 Overcurrent Protection

450.3 Overcurrent Protection. Overcurrent protection of transformers shall comply with 450.3(A), (B), or (C). As used in this section, the word transformer shall mean a transformer or polyphase bank of two or more single-phase transformers operating as a unit.

Informational Note No. 1: See 240.4, 240.21, 240.100, and 240.101 for overcurrent protection of conductors.

TABLE 450.3(B) Maximum Rating or Setting of Overcurrent Protection for Transformers 1000 Volts and Less (as a Percentage of Transformer-Rated Current)

	Primary Protection			Secondary Protection (See Note 2.)	
Protection Method	Currents of 9 Amperes or More	Currents Less Than 9 Amperes	Currents Less Than 2 Amperes	Currents of 9 Amperes or More	Currents Less Than 9 Amperes
Primary only protection	125% (See Note 1.)	167%	300%	Not required	Not required
Primary and secondary protection	250% (See Note 3.)	250% (See Note 3.)	250% (See Note 3.)	125% (See Note 1.)	167%

Notes:
1. Where 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, a higher rating that does not exceed the next higher standard rating shall be permitted.
2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device.
3. A transformer equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current shall be permitted to have primary overcurrent protection rated or set at a current value that is not more than six times the rated current of the transformer for transformers having not more than 6 percent impedance and not more than four times the rated current of the transformer for transformers having more than 6 percent but not more than 10 percent impedance.

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Application of Table 450.3(B)

TABLE 450.3(B) Maximum Rating or Setting of Overcurrent Protection for Transformers 1000 Volts and Less (as a Percentage of Transformer-Rated Current)

	Primary Protection			Secondary Protection (See Note 2.)	
Protection Method	Currents of 9 Amperes or More	Currents Less Than 9 Amperes	Currents Less Than 2 Amperes	Currents of 9 Amperes or More	Currents Less Than 9 Amperes
Primary only protection	125% (See Note 1.)	167%	300%	Not required	Not required
Primary and secondary protection	250% (See Note 3.)	250% (See Note 3.)	250% (See Note 3.)	125% (See Note 1.)	167%

Apply the 10-ft secondary conductor protection criteria of 240.21(C)(2) to a transformer rated 75 kVA, 3-phase, 480 V primary to 208Y/120 V secondary. The transformer primary OCPD is rated 125 A. Determine the minimum secondary conductor size for the installation of one of the sets of secondary conductors.

Solution

Step 1. Determine 1/10 of the primary OCPD rating using the following calculation:

$$125\text{ A} \div 10 = 12.5\text{ A}$$

Step 2. Determine the line-to-line primary-to-secondary voltage ratio:

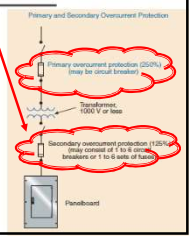
$$\left(\frac{480}{208}\right) = 2.31$$

Step 3. Determine the minimum ampacity for ungrounded transformer secondary conductor:

$$12.5\text{ A} \times 2.31 = 29\text{ A} \rightarrow 10\text{ AWG copper THWN}$$

[Table 310.15(B)(16)]: 30 A from 60°C column

A 10 AWG copper conductor is permitted to be supplied from the secondary of this transformer with primary overcurrent protection rated 125 A. The load supplied by this secondary conductor cannot exceed the conductor's allowable ampacity from Table 310.15(B)(16) coordinated with the temperature rating of the conductor terminations in accordance with 110.14(C)(1)(a).



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450.21 Dry-Type Transformers Installed Indoors

450.21 Dry-Type Transformers Installed Indoors.

(A) Not Over 112½ kVA. Dry-type transformers installed indoors and rated 112½ kVA or less shall have a separation of at least 300 mm (12 in.) from combustible material unless separated from the combustible material by a fire-resistant, heat-insulated barrier.

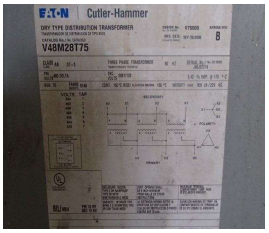
Exception: This rule shall not apply to transformers rated for 1000 volts, nominal, or less that are completely enclosed, except for ventilating openings.

(B) Over 112½ kVA. Individual dry-type transformers of more than 112½ kVA rating shall be installed in a transformer room of fire-resistant construction. Unless specified otherwise in this article, the term *fire resistant* means a construction having a minimum fire rating of 1 hour.

Exception No. 1: Transformers with Class 155 or higher insulation systems and separated from combustible material by a fire-resistant, heat-insulating barrier or by not less than 1.83 m (6 ft) horizontally and 3.7 m (12 ft) vertically.

Exception No. 2: Transformers with Class 155 or higher insulation systems and completely enclosed except for ventilating openings.

Dry-type transformers with a Class 155 or higher insulation system rating
are not required to be installed in transformer rooms or vaults if space separation or a fire-resistant heat-insulating barrier is provided.
Although these units are designed for higher operating temperatures,
[illegible] for a transformer vault is mitigated by the fire-resistant characteristics of high-temperature insulations.



ACS ASSOCIATED CONSULTING SOLUTIONS

450.21(C) Over 35,000 Volts. Dry-type transformers rated over 35,000 volts shall be installed in a vault complying with Part III of this article.

450.26 Oil-Insulated Transformers Installed Indoors. Oil insulated transformers installed indoors shall be installed in a vault constructed as specified in Part III of this article. (see exceptions)

Transformer Vaults: Key Criteria

- Located where they can be ventilated to the outside air without using flues or ducts.
- Minimum fire resistance of 3 hours.
- Floors of vaults in contact with the earth shall be of concrete that is not less than 4 inches thick.
- Concrete construction, studs and wallboard construction shall not be permitted.
- Tight-fitting door that has a minimum fire rating of 3 hours.
- Doors shall be equipped with locks, and doors shall be kept locked, access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed panic hardware.
- Ventilation Openings. Where required by 450.9, openings for ventilation shall be provided in accordance with 450.45(A) through (F).

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Use your 2017 NEC

1. A 480 volt ventilated 75 kVA dry-type transformer installed indoors shall have a separation of at least _____ from combustible materials.

A. 12 inches
B. 18 inches
C. 24 inches
D. 36 inches

ACS ASSOCIATED CONSULTING SOLUTIONS

Use your 2017 NEC

1. A 480 volt ventilated 75 kVA dry-type transformer installed indoors shall have a separation of at least _____ from combustible materials.

A. 12 inches
B. 18 inches
C. 24 inches
D. 36 inches

Reference: 2017 NEC: 450.21(A)

ACS ASSOCIATED CONSULTING SOLUTIONS

Use your 2017 NEC

2. What is the minimum fire resistance rating required for walls, roofs, and floors of transformer vaults when not protected with an automatic fire suppression system?

A. 1-hour
B. 2-hours
C. 3-hours
D. 4-hours

Use your 2017 NEC

2. What is the minimum fire resistance rating required for walls, roofs, and floors of transformer vaults when not protected with an automatic fire suppression system?

A. 1-hour
B. 2-hours
C. 3-hours
D. 4-hours

Reference: 2017 NEC: 450.42

ARTICLE 440
Air-Conditioning and Refrigerating Equipment

440.1 Scope

440.1 Scope. The provisions of this article apply to electric motor-driven air-conditioning and refrigerating equipment and to the branch circuits and controllers for such equipment. It provides for the special considerations necessary for circuits supplying hermetic refrigerant motor-compressors and for any air-conditioning or refrigerating equipment that is supplied from a branch circuit that supplies a hermetic refrigerant motor-compressor.

FYI…….210.63 HACR Recep.

210.63 Heating, Air-Conditioning, and Refrigeration Equipment Outlet. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment. The receptacle shall be located on the same level and within 7.5 m (25 ft) of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

Informational Note: See 210.8 for ground-fault circuit interrupter requirements.

440.4(B) Multimotor and Combination-Load Equipment

Multimotor and combination-load equipment shall be provided with a visible nameplate marked with the maker's name, the rating in volts, frequency and number of phases, minimum supply circuit conductor ampacity, the maximum rating of the branch-circuit
short-circuit and ground-fault protective device, and the short-circuit current rating of the motor controllers or industrial control panel.

440.6 Ampacity and Rating

The size of conductors for equipment covered by this article shall be selected from Table 310.15(B)(16) through Table 310.15(B)(19) or calculated in accordance with 310.15 as applicable. The required ampacity of conductors and rating of equipment shall be determined according to 440.6(A) and 440.6(B).

440.9 Grounding and Bonding + 440.10 Short-Circuit Current Rating

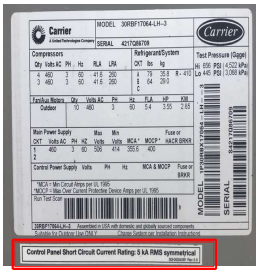
N 440.9 Grounding and Bonding. Where multimotor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

Non-threaded metal raceway systems on rooftops supplying electric motor-driven air-conditioning and refrigerating equipment could be subject to movement and damage. This is a result of rooftop activities such as snow removal or roof repair/replacement. These activities could result in separation of the raceway system compromising the ground-fault return path. The installation of a wire-type equipment ground will ensure the integrity of the ground-fault return path.

N 440.10 Short-Circuit Current Rating.

(A) Installation. Motor controllers of multimotor and combination-load equipment shall not be installed where the available short-circuit current exceeds its short-circuit current rating as marked in accordance with 440.4(B).

(B) Documentation. When motor controllers or industrial control panels of multimotor and combination load equipment are required to be marked with a short circuit current rating, the available short circuit current and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.



440.10 Short-Circuit Current Rating

Verifying Calculations.
Date: 1/1/2017
- 3 phase 208 Volts
- 3 single conductors per circuit
- 6 AWG Copper conductors
- 1" IMT conduit
- AFC where branch circuit originates = 56,000 Amps
- Length of branch circuit conductor = 55 feet

2425 (Constant or "C" value)

$F = \frac{1.732 \times L \times I_{sc}}{C \times E_{LL}}$ Or $\frac{1.732 \times 55 \times 56{,}000}{2425 \times 208}$ F = 10.576

Multiplier (M) = $\frac{1}{1+F}$ Or $\frac{1}{1+10.576}$ M = .0864

Isc = I X M Or 56,000 X .0864 = 4,838 (Short-circuit current at control panel)

440.12 Rating and Interrupting Capacity

440.12 Rating and Interrupting Capacity.

(A) Hermetic Refrigerant Motor-Compressor. A disconnecting means serving a hermetic refrigerant motor-compressor shall be selected on the basis of the nameplate rated-load current or branch-circuit selection current, whichever is greater, and locked rotor current, respectively, of the motor-compressor as follows.

(1) Ampere Rating. The ampere rating shall be at least 115 percent of the nameplate rated-load current or branch-circuit selection current, whichever is greater.

Exception: A listed unfused motor circuit switch, without fuse holders, having a horsepower rating not less than the equivalent horsepower determined in accordance with 440.12(A)(2) shall be permitted to have an ampere rating less than 115 percent of the specified current.

440.14 & 440.63 Disconnect Locations

440.14 Location. Disconnecting means shall be located within sight from, and readily accessible from the air-conditioning or refrigerating equipment. The disconnecting means shall be permitted to be installed on or within the air-conditioning or refrigerating equipment. The disconnecting means shall not be located on panels that
are designed to allow access to the air-conditioning or refrigeration equipment or to obscure the equipment nameplate(s).

Room Air Conditioners

440.63 Disconnecting Means. An attachment plug and receptacle
or cord connector shall be permitted to serve as the disconnecting
means for a single-phase room air conditioner rated
250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of
the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

440.22 Application and Selection

440.22(C) Protective Device Rating Not to Exceed the Manufacturer's Values. Where maximum protective device ratings shown on a manufacturer's overload relay table for use with a motor controller are less than the rating or setting selected in accordance with 440.22(A) and (B), the protective device rating shall not exceed the manufacturer's values marked on the equipment.

Part VII. Provisions for Room Air Conditioners

440.63 Disconnecting Means. An attachment plug and receptacle or cord connector shall be permitted to serve as the disconnecting means for a single-phase room air conditioner rated 250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

440.64 Supply Cords. Where a flexible cord is used to supply a room air conditioner, the length of such cord shall not exceed 3.0 m (10 ft) for a nominal, 120-volt rating or 1.8 m (6 ft) for a nominal, 208- or 240-volt rating.

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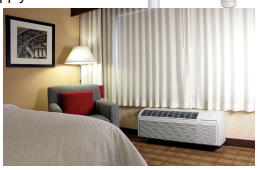
Part VII. Provisions for Room Air Conditioners

Leakage-Current Detector-Interrupter (LCDI). A device provided in a power supply cord or cord set that senses leakage current flowing between or from the cord conductors and interrupts the circuit at a predetermined level of leakage current.

440.65 Protection Devices. Single-phase cord- and plug-connected room air conditioners shall be provided with one of the following factory-installed devices:
(1) Leakage-current detector-interrupter (LCDI)
(2) Arc-fault circuit interrupter (AFCI)
(3) Heat detecting circuit interrupter (HDCI)

The protection device shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

A heat detecting circuit interrupter (HDCI) incorporates all of the protection functions of a leakage-current detector-interrupter (LCDI) and also includes a thermal detecting function to provide protection against overheating of an air conditioner compressor.



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ARTICLE 430
Motors, Motor Circuits, and Controllers

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430.10 Wiring Space in Enclosures.

430.10(B) Wire-Bending Space in Enclosures. Minimum wire bending space within the enclosures for motor controllers shall be in accordance with Table 430.10(B) where measured in a straight line from the end of the lug or wire connector (in the direction the wire leaves the terminal) to the wall or barrier.

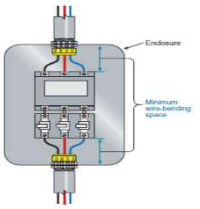

***TABLE 430.10(B)** Minimum Wire-Bending Space at the Terminals of Enclosed Motor Controllers*

Size of Wire (AWG or kcmil)	Wires per Terminal*			
	1		2	
	mm	in.	mm	in.
10 and smaller	Not specified		—	—
8–6	38	1½	—	—
4–3	50	2	—	—
2	65	2½	—	—
1	75	3	—	—
1/0	125	5	125	5
2/0	150	6	150	6
3/0–4/0	175	7	175	7
250	200	8	200	8
300	250	10	250	10
350–500	300	12	300	12
600–700	350	14	400	16
750–900	450	18	475	19

*Where provision for three or more wires per terminal exists, the minimum wire-bending space shall be in accordance with the requirements of Article 312.

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430.28 Feeder Taps

430.28 Feeder Taps. Feeder tap conductors shall have an ampacity not less than that required by Part II, shall terminate in a branch-circuit protective device, and, in addition, shall meet one of the following requirements:

(1) Be enclosed either by an enclosed controller or by a raceway, be not more than 3.0 m (10 ft) in length, and, for field installation, be protected by an overcurrent device on the line side of the tap conductor, the rating or setting of which shall not exceed 1000 percent of the tap conductor ampacity.
(2) Have an ampacity of at least one-third that of the feeder conductors, be suitably protected from physical damage or enclosed in a raceway, and be not more than 7.5 m (25 ft) in length.
(3) Have an ampacity not less than the feeder conductors

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FOR EXAMPLE

430.28 Feeder Taps

A 15-hp, 230-V, 3-phase, NEMA Design B, squirrel-cage induction motor with a service factor of 1.15 and a nameplate FLC of 40 A is to be supplied by a tap from a 250-kcmil feeder. Assuming three Type THWN copper conductors in a raceway and no ambient correction factor, the feeder has an ampacity of 255 A (from Table 310.15(B)(16), 75°C column). The tap conductors are not over 25 ft long (see Exhibit 430.5). Determine the required branch-circuit short-circuit and ground-fault protection required by 430.28 and the overload protection required by 430.32.

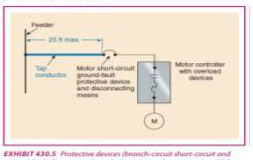

***EXHIBIT 430.5** Protective devices (branch-circuit short-circuit and ground-fault) for a motor branch circuit located not more than 25 feet from the point where the conductors are tapped to a feeder.*

Solution

Step 1. The tap conductors are required to have a minimum ampacity of 85 A (4 AWG) (1/3 × 255 A = 85 A).

Step 2. The FLC of the motor is 42 A based on 430.6(A) and Table 430.250. Therefore, the motor can be supplied by the 85-A (4 AWG) tap conductor.

Step 3. Because the tap conductors have to terminate in a single branch-circuit protective device, the short-circuit protective device rating must be determined. According to 430.52(C)(1), the protective device for the motor cannot exceed the values given in Table 430.52.

The maximum time-delay fuse value is 42 × 1.75 = 73.5 A. The maximum inverse time circuit breaker value is 42 × 2.50 = 105 A.

Section 430.52(C)(1), Exception No. 1, allows the next higher standard size — 80 and 110 A, respectively. A higher size, based on Exception No. 2, is allowed if the 80- or 110-A size is not adequate to start the motor.

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430.28 Feeder Taps (cont.)

A 15-hp, 230-V, 3-phase, NEMA Design B, squirrel-cage induction motor with a service factor of 1.15 and a nameplate FLC of 40 A is to be supplied by a tap from a 250-kcmil feeder. Assuming three Type THWN copper conductors in a raceway and no ambient correction factor, the feeder has an ampacity of 255 A (from Table 310.15(B)(16), 75°C column). The tap conductors are not over 25 ft long (see Exhibit 430.5). Determine the required branch-circuit short-circuit and ground-fault protection required by 430.28 and the overload protection required by 430.32.

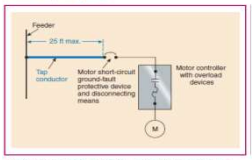


EXHIBIT 430.5 Protective devices (branch-circuit short-circuit and ground-fault) for a motor branch circuit located not more than 25 feet from the point where the conductors are tapped to a feeder.

Solution

Step 4. Because overload protection is also required for the motor, determine the rating of the overload protection.

Based on 430.32, for a motor with a service factor of 1.15, the motor overload protective devices (heaters) are required to be set at a value not greater than 125 percent of the FLC marked on the motor nameplate and not at the FLC value from the table.

A setting of up to 140 percent may be used according to the permissive rules in 430.32(C). With the motor overload protection set at 50 A, the circuit conductors and motor are protected from overload.

430.99 Available Fault Current

430.99 Available Fault Current. The available short circuit current at the motor control center and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.

A motor control center is required to be marked with its short-circuit current rating per 430.98. The requirement in 430.99 requires the motor control center be marked with the available short-circuit current. This provides a means to easily compare the equipment rating with the available short-circuit current and to confirm compliance with 110.10.

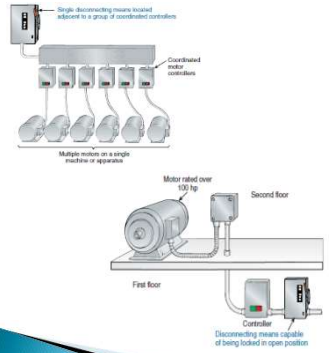
⚠WARNING

Maximum Available Fault Current: 52,600 Amps.

August 12, 2014

Jolt Electric Service 1-866-555-JOLT

Disconnecting Means



430.102 Location.

(A) Controller. An individual disconnecting means shall be provided for each controller and shall disconnect the controller. The disconnecting means shall be located in sight from the controller location.

Exception No. 1: For motor circuits over 1000 volts, nominal, a controller disconnecting means lockable in accordance with 110.25 shall be permitted to be out of sight of the controller, provided that the controller is marked with a warning label giving the location of the disconnecting means.

Exception No. 2: A single disconnecting means shall be permitted for a group of coordinated controllers that drive several parts of a single machine or piece of apparatus. The disconnecting means shall be located in sight from the controllers, and both the disconnecting means and the controllers shall be located in sight from the machine or apparatus.

(B) Motor. A disconnecting means shall be provided for a motor in accordance with (B)(1) or (B)(2).

(1) Separate Motor Disconnect. A disconnecting means for the motor shall be located in sight from the motor location and the driven machinery location.

(2) Controller Disconnect. The controller disconnecting means required in accordance with 430.102(A) shall be permitted to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

Exception to (1) and (2): The disconnecting means for the motor shall not be required under either condition (a) or condition (b), which follow, provided that the controller disconnecting means required in 430.102(A) is lockable in accordance with 110.25.

(a) Where such a location of the disconnecting means for the motor is impracticable or introduces additional or increased hazards to persons or property.

(b) In industrial installations, with written safety procedures, where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

Disconnecting Means

430.109 Type. The disconnecting means shall be a type specified in 430.109(A), unless otherwise permitted in 430.109(B) through (G), under the conditions specified.

(A) General.

(1) Motor Circuit Switch. A listed motor-circuit switch rated in horsepower.

(2) Molded Case Circuit Breaker. A listed molded case circuit breaker.

(3) Molded Case Switch. A listed molded case switch.

(4) Instantaneous Trip Circuit Breaker. An instantaneous trip circuit breaker that is part of a listed combination motor controller.

(5) Self-Protected Combination Controller. Listed self-protected combination controller.

(6) Manual Motor Controller. Listed manual motor controllers additionally marked "Suitable as Motor Disconnect" shall be permitted as a disconnecting means where installed between the final motor branch-circuit short-circuit protective device and the motor. Listed manual motor controllers additionally marked "Suitable as Motor Disconnect" shall be permitted as disconnecting means on the line side of the fuses permitted in 430.52(C)(5). In this case, the fuses permitted in 430.52(C)(5) shall be considered supplementary fuses, and suitable branch-circuit short-circuit and ground-fault protective devices shall be installed on the line side of the manual motor controller additionally marked "Suitable as Motor Disconnect."

430.103 Operation. The disconnecting means shall open all ungrounded supply conductors and shall be designed so that no pole can be operated independently. The disconnecting means shall be permitted in the same enclosure with the controller. The disconnecting means shall be designed so that it cannot be closed automatically.

430.110 Ampere Rating and Interrupting Capacity.

(A) General. The disconnecting means for motor circuits rated 1000 volts, nominal, or less shall have an ampere rating not less than 115 percent of the full-load current rating of the motor.

Use your 2017 NEC

1. The maximum rating of a dual element (time delay) fuse for branch circuit protection of an AC three phase motor is _____ of the full load current.

A. 150%
B. 175%
C. 250%
D. 325%

Use your 2017 NEC

1. The maximum rating of a dual element (time delay) fuse for branch circuit protection of an AC three phase motor is _____ of the full load current.

A. 150%
B. 175%
C. 250%
D. 325%

Reference: 2017 NEC: Table 430.52

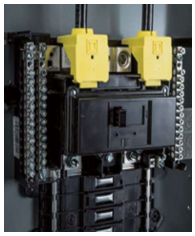
ARTICLE 408
Switchboards, Switchgear, and Panelboards

408.3(A)(2) Service Panelboards

Barriers shall be placed in all service panelboards, switchboards, & switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while serving load terminations.

N **Does not apply to service panels w/ provisions for more that 1 service disc**

Re: 408.36 / Split-bus panels



408.3(C) Used as Service Equipment

(C) **Used as Service Equipment.** Each switchboard, switchgear, or panelboard, if used as service equipment, shall be provided with a main bonding jumper sized in accordance with 250.28(D) or the equivalent placed within the panelboard or one of the sections of the switchboard or switchgear for connecting the grounded service conductor on its supply side to the switchboard, switchgear, or panelboard frame. All sections of a switchboard or switchgear shall be bonded together using an equipment-bonding jumper or a supply-side bonding jumper sized in accordance with 250.122 or 250.102(C)(1) as applicable.

TABLE 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2	

Notes:

1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper and will have an ampacity equivalent to that of the installed ungrounded supply conductors.
3. If multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, or if multiple sets of ungrounded supply conductors are installed for a separately derived system, the equivalent size of the largest ungrounded supply conductor(s) shall be determined by the largest sum of the areas of the corresponding conductors of each set.
4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

408.4 Field Identification Required

408.4 Field Identification Required.

(A) Circuit Directory or Circuit Identification. Every circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face or inside of the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

(B) Source of Supply. All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be permanently marked to indicate each device or equipment where the power originates. The label shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

???

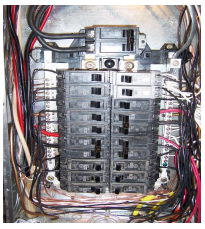
408.7 Unused Openings

408.7 Unused Openings. Unused openings for circuit breakers and switches shall be closed using identified closures, or other approved means that provide protection substantially equivalent to the wall of the enclosure.

An unused opening may exist as a result of a renovation or an alteration of existing equipment. The requirement of this section is for closing unused openings for a circuit breaker where none is installed.

408.36 Overcurrent Protection

408.36 Overcurrent Protection. In addition to the requirement of 408.30, a panelboard shall be protected by an overcurrent protective device having a rating not greater than that of the panelboard. This overcurrent protective device shall be located within or at any point on the supply side of the panelboard.



408.36(D) Back-Fed Device

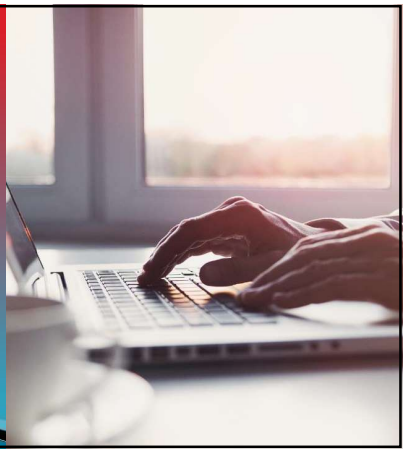
408.36 (D) Back-Fed Devices. Plug-in-type overcurrent protection devices or plug-in type main lug assemblies that are backfed and used to terminate field-installed ungrounded supply conductors shall be secured in place by an additional fastener that requires other than a pull to release the device from the mounting means on the panel.

408.58 Panelboard Marking.

408.58 Panelboard Marking. Panelboards shall be durably marked by the manufacturer with the voltage and the current rating and the number of ac phases or dc buses for which they are designed and with the manufacturer's name or trademark in such a manner so as to be visible after installation, without disturbing the interior parts or wiring.

Do you have questions?

Now is the time to ask!



Thank you for participating!

To schedule a seminar, webinar, or online course:

www.associatedconsultingsolutions.com

Or call

Associated Consulting Solutions, LLC
216-256-3556

File Attachments for Item:

ER-4 2017 NEC Wiring, Equipment, and Special Occupancies (Flanik)

All Certifications (6 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend approval

Committee Recommendation:

2017 NEC Wiring, Equipment, and Special Occupancies

6-Hours of Continuing Education Credit

Course Description: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar highlights key provisions of the *2017 NEC Wiring, Equipment, and Special Occupancies.* Provides practice in applying key requirements, reinforces learning by supplying immediate feedback and clarification and walks participants through content and intent.

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- Wiring Methods
- Equipment for General Use
- Hazardous (Classified) Locations
- Commercial Garages
- Health Care Facilities

Course Outline:

1. **2017 OBC – CHAPTER 1**
   - **OBC Section 105.1 Approvals Required**
   - **OBC Section 102.10 Work Exempt From Approval**
   - **OBC Section 102.10.1 Emergency Repairs**
   - **OBC Section 102.10.2 Minor Repairs**
   - **OBC Section 106.1.1 Information on Construction Documents**

2. **2017 OBC – CHAPTER 27**

- **OBC Section 2701.1 Scope**
- **OBC Section 2701.2 Appliance and Fixture Listing**
- **OBC Section 2702 Emergency and Standby Power Systems**
- **OBC Section 2702.1 Installation**
- **OBC Section 2702.2 Where Required**
- **OBC Section 2702.3 Critical Circuits**
- **OBC Section 2702.4 Maintenance**
- **OBC Section 2703.1 Penetrations**
- **OBC Section 2703.2 Cutting, Notching, and Boring**
- **OBC Section 2704 Smoke Detection**
- **OBC Section 2704.1 Smoke Alarm Circuits**

3. **2017 NEC 5 New Articles**

- **Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment**
- **Article 691 – Large Scale PV Production Facility**
- **Article 706 – Energy Storage Systems**
- **Article 710 – Stand Alone Systems**
- **Article 712 – DC Micro Grids**

Chapter 3 Wiring Methods and Materials

4. **Article 300**

- **300.3(B)(4) Column-Width Panelboard Enclosures**
- **300.4 Protection Against Physical Damage**
- **300.5 Minimum Cover Requirements**

5. **Article 310 Conductors for General Wiring**

- **310.15(B)(3)(c)**
- **Table 310.15(B(2)(A)**
- **Table 310.15(B(16)**
- **310.15(B)(7) Dwelling Services and Feeders**

6. **Article 314**

- **314.16 Outlet Device Boxes**
- **314.16(A) & (C)**
- **314.27(E) Separable Attachment Fittings**
- **314.28(E) Power Distribution Blocks**

7. **Article 320**
    - **320.30 Securing and Supporting**
8. **Article 330**
    - **330.15 MC Cable**
9. **Article 334**
    - **334.6 NM Cable**
10. **Article 338**
    - **338.6 SE**
    - **338.10(B)(4) SE Cable Installation Method for Branch Circuits & Feeders**
11. **Article 340**
    - **340 UF**
12. **Article 366**
    - **366.20 Conductors Connected in Parallel Auxiliary Gutters**

Chapter 4 Equipment for General Use

13. **Article 440 Air-Conditioning and Refrigerating Equipment**

    - **440.1 Scope**
    - **440.4(B) Multimotor and Combination-Load Equipment**
    - **440.6 Ampacity and Rating**
    - **440.9 Grounding and Bonding**
    - **440.10 Short-Circuit Current Rating**
    - **440.12 Rating and Interrupting Capacity**
    - **440.14**
    - **440.63 Disconnect Locations**
    - **440.22 Application and Selection**
    - **440.22(C) Protective Device Rating Not to Exceed the Manufacturer's Values**
    - **440.63 Disconnecting Means**
    - **440.64 Supply Cords**
    - **440.65 Protection Devices**

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14. Article 430 Motors, Motor Circuits, and Controllers

- **430.10 Wiring Space in Enclosures**
- **430.10(B) Wire-Bending Space in Enclosures**
- **430.28 Feeder Taps**
- **430.99 Available Fault Current**
- **430.102 Disconnecting Means Location**
- **430.103 Operation**
- **430.109 Disconnecting Means Type**

15. Article 408 Switchboards, Switchgear, and Panelboards

- **408.3(A)(2) Service Panelboards**
- **408.3(C) Used as Service Equipment**
- **408.4 Field Identification Required**
- **408.7 Unused Openings**
- **408.36 Overcurrent Protection**
- **408.36(D) Back-Fed Device**
- **408.58 Panelboard Marking**

Chapter 5 Special Occupancies

16. Article 500 Special Occupancies

- **500.5 Classification of Locations**
- **501.10(B)(1) Class I Div. II General**
- **501.15 Cable Seals, Class I, Division I (Terminations)**
- **511.3(C) (New) Classification Table**
- **511.8 Underground Wiring**
- **514.3(C) Fuel Storage Requirements**
- **514.8 Underground Wiring**
- **514.11 Circuit Disconnects**
- **514.11(B) & (C) Circuit Disconnects**
- **517 Health Care Facilities**
- **Seven Parts to 517**
- **517.2 Health Care Facilities Definitions**
- **517.16 Use of Isolated Ground Receptacles**
- **517.16(B) Isolated Ground Receptacles**

16. Cont'd <u>Article 500 Special Occupancies</u>

- **517.29 "EES" for Hospitals**
- **517.30 Essential Electrical Systems**
- **Fuel Cell Technology**
- **517.30(A) Two Independent Power Sources**
- **517.32 "EES" Three Components**
- **517.34(B) Critical Branch "EES"**
- **517.160 Isolated Power Systems**
- **517.160 Isolated Power Systems System Requirements**

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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: Jerry Flanik (Contact Name)

Organization: Associated Consulting Solutions, LLC (Organization/Company)

Address: 9671 Oxford Glen Drive (Include Room Number, Suite, etc.)

City: Mentor State: Ohio Zip: 44060

E-Mail: jerry@associatedconsultingsolutions.com

Telephone: 216-256-3556 Fax: _____

Course Sponsor: Associated Consulting Solutions, LLC

COURSE INFORMATION:

Course Title: 2017 NEC Wiring, Equipment, and Special Occupancies

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

Purpose and Objective: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the 2017 NEC wiring, equipment, and special occupancies. Participants will be provided with in-depth discussions of the 2017 OBC, wiring methods, equipment for general use, hazardous (classified) locations, commercial garages, and healthcare facilities.

Number of Instructional Contact Hours that can be obtained upon completion: 6 hours

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

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:		x

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

ACS ASSOCIATED CONSULTING SOLUTIONS

2017 NEC Wiring, Equipment, and Special Occupancies

Based on the 2017 National Electrical Code (NEC)

Welcome

- Meet the instructor
- Participant introductions

ACS ASSOCIATED CONSULTING SOLUTIONS

Meet the Instructor

ICC PREFERRED EDUCATION PROVIDER

- Gerald C. Flanik is an ICC-Certified Master Code Professional (MCP), and holds over 40 various licenses and certifications. He is also a LEED BD+C Accredited Professional, Certified Floodplain Manager (CFM).
- Mr. Flanik is President of Associated Consulting Solutions, LLC (ACS) in Cleveland, Ohio. ACS provides plan review services, pre and post design analysis services for architectural and engineering firms, and code consulting services throughout the United States. ACS is also an ICC Preferred Education Provider, providing education throughout the United States. Previously, Gerald served as the Chief Building Official for Lake County, Ohio for 16 years. Prior to working as a code official, he owned and operated a design build contracting company.
- Gerald holds a Bachelor of Science Degree in Mechanical Engineering and a Bachelor of Science Degree in Electrical Engineering from Cleveland State University; as well as, a degree in Civil Engineering Technology. He is also an adjunct faculty instructor at Lakeland College in the Civil and Electrical Engineering Departments.
- Jerry is a professional consultant for corporations and government agencies throughout the United States, and for the International Code Council throughout the world.

Associated Consulting Solutions, LLC
www.associatedconsultingsolutions.com

ACS ASSOCIATED CONSULTING SOLUTIONS

2017 NEC Wiring, Equipment, and Special Occupancies

Key topics covered with in-depth discussion:

- 2017 OBC Requirements
- Wiring Methods
- Equipment for General Use
- Hazardous (Classified) Locations
- Commercial Garages
- Health Care Facilities

ACS ASSOCIATED CONSULTING SOLUTIONS

Description

This seminar highlights key provisions of the *2017 NEC Wiring, Equipment, and Special Occupancies*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

ACS ASSOCIATED CONSULTING SOLUTIONS

OBC Chapter 1

- This chapter is largely concerned with maintaining "due process of law" in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.

ACS ASSOCIATED CONSULTING SOLUTIONS

OBC Section 105.1

105.1 Approvals Required

Any owner or owner's representative who intends to construct, enlarge, alter, repair, move, or change the occupancy of a building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required approval.

However, OBC 102.10 contains additional information.

OBC Section 102.10

102.10 Work Exempt From Approval

Approval shall not be required for the following work; however, this work shall comply with all applicable provisions of the rules of the board:

Electrical:

1. Minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
2. Electrical equipment used for radio and television transmissions except equipment and wiring for power supply, and the installations of towers and antennas.
3. The installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.
4. Electrical wiring, devices, appliances, apparatus or equipment operating at less than twenty-five volts and not capable of supplying more than fifty watts of energy, unless specifically addressed in this code.
5. Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
6. Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70 as referenced in Chapter 35.

OBC Section 102.10.1

102.10.1 Emergency Repairs

Where equipment replacements and repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Provide some examples of electrical emergency situations???

OBC Section 102.10.2

102.10.2 Minor Repairs

Minor repairs to structures may be made without application or notice to the building official. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall minor repairs include addition to, alteration of, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Provide some examples of minor repairs???

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

OBC Section 106.1.1

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Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

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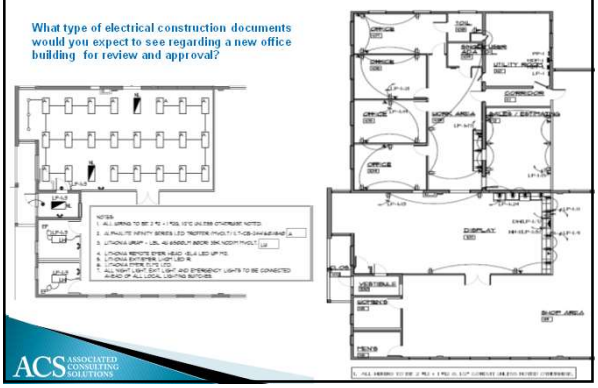
OBC Section 106.1.1

What type of electrical construction documents would you expect to see regarding a new office building for review and approval?



OBC Chapter 27

2701.1 Scope

This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment, and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

2701.2 Appliance and Fixture Listing

Electrical appliances and fixtures within the scope of this code shall be tested and listed in published reports of inspected electrical equipment by an approved agency and installed in accordance with all instructions included as part of such listing.

UL LISTED

OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

OBC Chapter 27

Section 2703 Penetrations

2703.1 Penetrations
Penetrations of walls, floors, ceilings and assemblies required to have a fire-resistance rating, shall be protected in accordance with Chapter 7. Where cables, conductors and raceways penetrate fireblocking or draftstopping, such penetrations shall be protected by filling the annular space with an approved fireblocking material.

2703.2 Cutting, Notching, and Boring
The cutting, notching and boring of wood and steel framing members, structural members and engineered wood products shall be in accordance with this code and as prescribed by the registered design professional.

Section 2704 Smoke Detection

2704.1 Smoke Alarm Circuits
Smoke detectors required by this code and installed within dwelling units shall not be connected as the only load on a branch circuit. Such detectors shall be supplied by branch circuits having lighting loads consisting of lighting outlets in habitable spaces.

Why do we need codes and standards?

IKEA Rooftop PV Install (Illinois)

1.124 MW System

Bolingbrook (05.12.2018)

4,784 Panels

No Injuries Reported

Lake County; Fair Painesville, Ohio

Bumper Car Ride - Electrocution

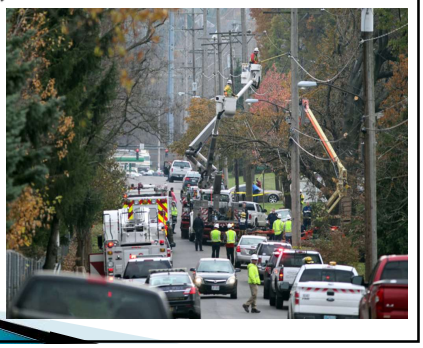
08.12.2003

- Boy 8 Years old
- 22 Safety Violations
- Grounding & Bonding
- 2 Mil. Settlement

11.15.2017 Tree trimmer fatality in Akron, Ohio

Electrocution:
23kv Line bucket lift accident; 1 died, 1 in serious condition

Update:
2 deaths



2017 NEC "Features"

The 2017 NEC edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new.

"5" New 2017 NEC Articles

Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment

Article 691 – Large Scale PV Production Facility

Article 706 – Energy Storage Systems

Article 710 – Stand Alone Systems

Article 712 – DC Micro Grids

Chapter 3 Wiring Methods and Materials

300.3(B)(4) Column-Width Panelboard Enclosures

Designed / Intended to fit in 10" I-Beams
For use on AC systems only
Available for 480/277-v 3ø – 240-3ø Systems

300.4 Protection Against Physical Damage

Where subject to physical damage, conductors, raceways, and cables shall be protected.

New Informational Note:

Informational Note: Minor damage to a raceway, cable armor, or cable insulation does not necessarily violate the integrity of either the contained conductors or the conductors' insulation.

300.5 Minimum Cover Requirements

Expanded Information

[a] *A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.*

[b] *A depth of 6" shall be permitted for pool, spa, and fountain lighting, installed in a nonmetallic raceway, limited to not more than 30v where part of a listed low-voltage lighting system.*

Table 310.15(B(2)(a)

Ambient Temp. Correction Factors Based on 86°F

75° Conductor	Ambient Temperature °F
1.00	78 - 86°F
.94	87 - 95°F
.88	96 - 104°F
.82	105 - 113°F
.75	114 - 122°F
.67	123 - 131°F
.58	132 - 140°F

310.15(B)(3)(c)

Raceways and Cables Exposed to Sunlight on Rooftops.

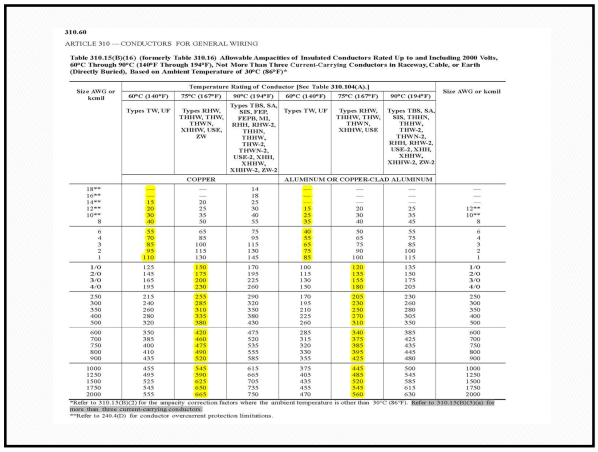
"raceways or cables shall be installed a minimum distance above the roof to the bottom of the raceway or cable of 7/8". Where the distance above the roof to the bottom of the raceway or cable is less than 7/8", a temperature adder of 60°F shall be added to the outdoor temperature".

Exception: XHHW-2 = No Adjustment Required

TABLE 310.15(B)(2)(A) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor 60°C	75°C	90°C	Ambient Temperature (°F)
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140
61–65	—	0.47	0.65	141–149
66–70	—	0.33	0.58	150–158
71–75	—	—	0.50	159–167
76–80	—	—	0.41	168–176
81–85	—	—	0.29	177–185



310.60

ARTICLE 310 — CONDUCTORS FOR GENERAL WIRING

Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).] 60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	Size AWG or kcmil
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18**	—	—	14	—	—	—	—
16**	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F). Refer to 310.15(C)(1)(a) for more than three current-carrying conductors.

**Refer to 240.4(D) for conductor overcurrent protection limitations.

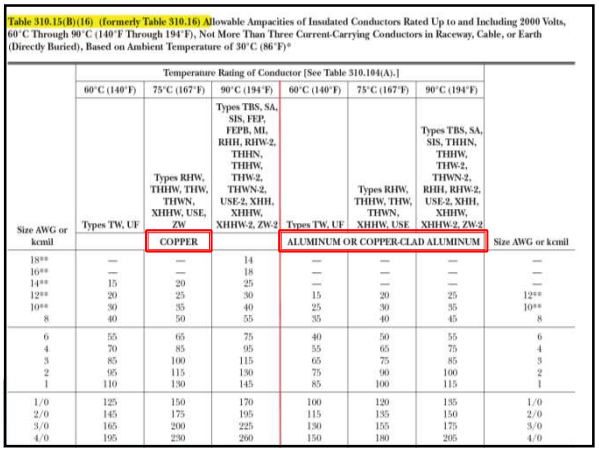


Table 310.15(B)(16) (formerly Table 310.16) Allowable Ampacities of Insulated Conductors Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F), Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)*

Size AWG or kcmil	Temperature Rating of Conductor [See Table 310.104(A).] 60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	Size AWG or kcmil
	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, ZW-2	
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18**	—	—	14	—	—	—	—
16**	—	—	18	—	—	—	—
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0

310.15(B)(7) 1ø Dwelling Services and Feeders

For one-family dwellings and the individual dwelling units of two-family and multifamily dwellings, single-phase feeder conductors and the neutral conductor from a 208Y/120-v system shall permitted to be sized in accordance with 310.15(B)(7)(1) through (3).

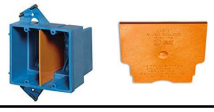
2017 NEC Now recognizes 208Y/120-v 1ø Systems

314.16 Outlet Device Boxes

Box Volume / Box Fill Calculations

314.16(A) & (C) Where a box is provided with one or more securely installed barriers, the volume shall be apportioned to ***each*** of the resulting spaces. Each barrier if not marked with its volume, shall be considered to take up:

Metal: = ½ cubic inch **Non-metallic: 1 cubic inch**



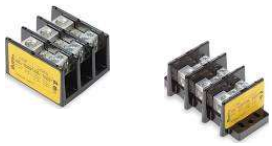
314.27(E) Separable Attachment Fittings

N *Outlet boxes required in 314.27 shall be permitted to support listed locking support and mounting receptacles used in combination with compatible attachment fittings. The combination shall be identified for the support of equipment within the weight and mounting orientation limits of the listing. Where the supporting receptacle is installed within a box, it shall be included in the conductor fill calculation.*

314.28(E) Power Distribution Blocks

Line Side of Service Equipment

Power distribution blocks installed in boxes shall be listed. Power distribution blocks installed on the line side of the service equipment shall be listed and marked "suitable for use on the line side of service equipment" or equivalent.



320.30 Securing and Supporting

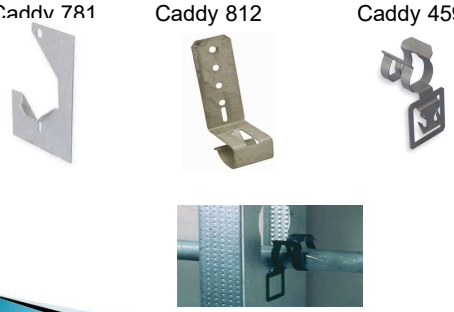
Cable Ties

*Type AC cable shall be supported and secured by staples; **cable ties listed and identified for securement and support……or other approved means**.*

Article 320 AC Cable	***Article 348 FMC***
Article 328 MV Cable	***Article 350 LFM***
Article 330 MC Cable	***Article 356 LFNC***
Article 334 NM Cable	***Article 362 ENT***

Metal Stud Anti-Rattle Straps

Caddy 781 Caddy 812 Caddy 459



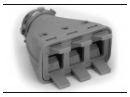
330.15 MC Cable

N **Exposed Work**

Exposed runs of cable, except as provided in 300.11(A), shall closely follow the surface of the building finish or on running boards.

Exposed runs of cable shall also be permitted to be installed on the underside of joists where supported at each joist and located so as not to be subject to physical damage.

334.6 NM Cable / 338.6 SE / 340 UF



Applies to NM / SE / UF Cables

Type NM, AC, FC, FCC, MV, MC, MI, NM, TC UF; **(SE & USE)** cables and ***associated fittings*** *shall be listed.*

338.10(B)(4) SE Cable

Installation Method for Branch Circuits & Feeders.

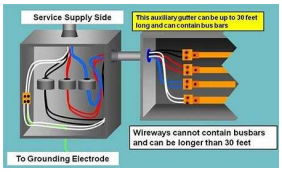
For Type SE cable with ungrounded conductor sizes #10 AWG and smaller, where installed in thermal installation, the ampacity shall be in accordance with 60°C conductor temperature rating.

Previously, any size SE cable installed in thermal insulation needed to utilize the 60°C ampacity.

366.20 Conductors Connected in Parallel

Auxiliary Gutters

N Where single conductor cables comprising each phase, neutral, or grounded conductor of an alternating-current circuit are connected in parallel as permitted in 310.10(H), the conductors **shall be** installed in groups consisting of not more than one conductor per phase, neutral, or grounded conductor to prevent inductive heating.



Chapter 4 Equipment for General Use

ARTICLE 440 Air-Conditioning and Refrigerating Equipment

440.1 Scope

440.1 Scope. The provisions of this article apply to electric motor-driven air-conditioning and refrigerating equipment and to the branch circuits and controllers for such equipment. It provides for the special considerations necessary for circuits supplying hermetic refrigerant motor-compressors and for any air-conditioning or refrigerating equipment that is supplied from a branch circuit that supplies a hermetic refrigerant motor-compressor.

FYI…….210.63 HACR Recep.

210.63 Heating, Air-Conditioning, and Refrigeration Equipment Outlet. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment. The receptacle shall be located on the same level and within 7.5 m (25 ft) of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

Informational Note: See 210.8 for ground-fault circuit interrupter requirements.

440.4(B) Multimotor and Combination-Load Equipment

Multimotor and combination-load equipment shall be provided with a visible nameplate marked with the maker's name, the rating in volts, frequency and number of phases, minimum supply circuit conductor ampacity, the maximum rating of the branch-circuit
short-circuit and ground-fault protective device, and the short-circuit current rating of the motor controllers or industrial control panel.

440.6 Ampacity and Rating

The size of conductors for equipment covered by this article shall be selected from Table 310.15(B)(16) through Table 310.15(B)(19) or calculated in accordance with 310.15 as applicable. The required ampacity of conductors and rating of equipment shall be determined according to 440.6(A) and 440.6(B).

440.9 Grounding and Bonding + 440.10 Short-Circuit Current Rating

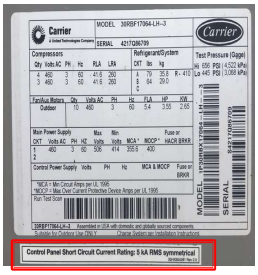
440.9 Grounding and Bonding. Where multimotor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

Non-threaded metal raceway systems on rooftops supplying electric motor-driven air-conditioning and refrigerating equipment could be subject to movement and damage. This is a result of rooftop activities such as snow removal or roof repair/replacement. These activities could result in separation of the raceway system compromising the ground-fault return path. The installation of a wire-type equipment ground will ensure the integrity of the ground-fault return path.

440.10 Short-Circuit Current Rating.

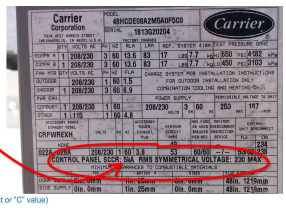
(A) Installation. Motor controllers of multimotor and combination-load equipment shall not be installed where the available short-circuit current exceeds its short-circuit current rating as marked in accordance with 440.4(B).

(B) Documentation. When motor controllers or industrial control panels of multimotor and combination load equipment are required to be marked with a short circuit current rating, the available short circuit current and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.



440.10 Short-Circuit Current Rating

FOR EXAMPLE



VERIFYING CALCULATIONS.
Date: 1/1/2017
- 3 phase 208 Volts
- 3 single conductors per circuit
- 6 AWG Copper conductors } 2425 (Constant or "C" value)
- 1" MT conduit
- AIC where branch circuit delegates = 56,000 amps
- Length of branch circuit conductor = 55 feet

$F = \frac{1.732 \times L \times I_{sc}}{C \times E_{L-L}}$ Or $\frac{1.732 \times 55 \times 56{,}000}{2425 \times 208}$ F = 10.576

Multiplier (M) = $\frac{1}{1+F}$ Or $\frac{1}{1+10.576}$ M = .0864

Isc = I X M Or 56,000 X .0864 = 4,838 (Short-circuit current at control panel)

440.12 Rating and Interrupting Capacity

440.12 Rating and Interrupting Capacity.
(A) Hermetic Refrigerant Motor-Compressor. A disconnecting means serving a hermetic refrigerant motor-compressor shall be selected on the basis of the nameplate rated-load current or branch-circuit selection current, whichever is greater, and locked rotor current, respectively, of the motor-compressor as follows.

(1) Ampere Rating. The ampere rating shall be at least 115 percent of the nameplate rated-load current or branch-circuit selection current, whichever is greater.

Exception: A listed unfused motor circuit switch, without fuse holders, having a horsepower rating not less than the equivalent horsepower determined in accordance with 440.12(A)(2) shall be permitted to have an ampere rating less than 115 percent of the specified current.

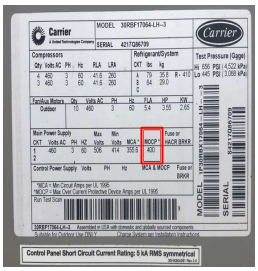
440.14 & 440.63 Disconnect Locations

440.14 Location. Disconnecting means shall be located within sight from, and readily accessible from the air-conditioning or refrigerating equipment. The disconnecting means shall be permitted to be installed on or within the air-conditioning or refrigerating equipment. The disconnecting means shall not be located on panels that
are designed to allow access to the air-conditioning or refrigeration equipment or to obscure the equipment nameplate(s).

Room Air Conditioners
440.63 Disconnecting Means. An attachment plug and receptacle
or cord connector shall be permitted to serve as the disconnecting
means for a single-phase room air conditioner rated
250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of
the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

440.22 Application and Selection

440.22(C) Protective Device Rating Not to Exceed the Manufacturer's Values. Where maximum protective device ratings shown on a manufacturer's overload relay table for use with a motor controller are less than the rating or setting selected in accordance with 440.22(A) and (B), the protective device rating shall not exceed the manufacturer's values marked on the equipment.



Part VII. Provisions for Room Air Conditioners

440.63 Disconnecting Means. An attachment plug and receptacle or cord connector shall be permitted to serve as the disconnecting means for a single-phase room air conditioner rated 250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

440.64 Supply Cords. Where a flexible cord is used to supply a room air conditioner, the length of such cord shall not exceed 3.0 m (10 ft) for a nominal, 120-volt rating or 1.8 m (6 ft) for a nominal, 208- or 240-volt rating.

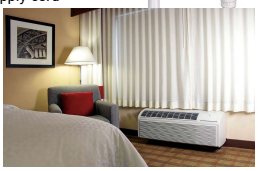
Part VII. Provisions for Room Air Conditioners

440.65 Protection Devices. Single-phase cord- and plug-connected room air conditioners shall be provided with one of the following factory-installed devices:
(1) Leakage-current detector-interrupter (LCDI)
(2) Arc-fault circuit interrupter (AFCI)
(3) Heat detecting circuit interrupter (HDCI)

The protection device shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

A heat detecting circuit interrupter (HDCI) incorporates all of the protection functions of a leakage-current detector-interrupter (LCDI) and also includes a thermal detecting function to provide protection against overheating of an air conditioner compressor.

Leakage-Current Detector-Interrupter (LCDI). A device provided in a power supply cord or cord set that senses leakage current flowing between or from the cord conductors and interrupts the circuit at a predetermined level of leakage current.



ARTICLE 430
Motors, Motor Circuits, and Controllers

430.10 Wiring Space in Enclosures.

430.10(B) Wire-Bending Space in Enclosures. Minimum wire bending space within the enclosures for motor controllers shall be in accordance with Table 430.10(B) where measured in a straight line from the end of the lug or wire connector (in the direction the wire leaves the terminal) to the wall or barrier.

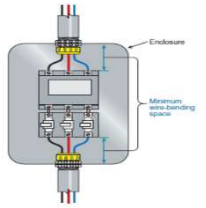


TABLE 430.10(B) Minimum Wire-Bending Space at the Terminals of Enclosed Motor Controllers

Size of Wire (AWG or kcmil)	Wires per Terminal* 1 mm	1 in.	2 mm	2 in.
10 and smaller	Not specified		—	—
8–6	38	1½	—	—
4–3	50	2	—	—
2	65	2½	—	—
1	75	3	—	—
1/0	125	5	125	5
2/0	150	6	150	6
3/0–4/0	175	7	175	7
250	200	8	200	8
300	250	10	250	10
350–500	300	12	300	12
600–700	350	14	400	16
750–900	450	18	475	19

*Where provision for three or more wires per terminal exists, the minimum wire-bending space shall be in accordance with the requirements of Article 312.

430.28 Feeder Taps

430.28 Feeder Taps. Feeder tap conductors shall have an ampacity not less than that required by Part II, shall terminate in a branch-circuit protective device, and, in addition, shall meet one of the following requirements:

(1) Be enclosed either by an enclosed controller or by a raceway, be not more than 3.0 m (10 ft) in length, and, for field installation, be protected by an overcurrent device on the line side of the tap conductor, the rating or setting of which shall not exceed 1000 percent of the tap conductor ampacity

(2) Have an ampacity of at least one-third that of the feeder conductors, be suitably protected from physical damage or enclosed in a raceway, and be not more than 7.5 m (25 ft) in length

(3) Have an ampacity not less than the feeder conductors

FOR EXAMPLE

430.28 Feeder Taps

A 15-hp, 230-V, 3-phase, NEMA Design B, squirrel-cage induction motor with a service factor of 1.15 and a nameplate FLC of 40 A is to be supplied by a tap from a 250-kcmil feeder. Assuming three Type THWN copper conductors in a raceway and no ambient correction factor, the feeder has an ampacity of 255 A (from Table 310.15(B)(16), 75°C column). The tap conductors are not over 25 ft long (see Exhibit 430.5). Determine the required branch-circuit short-circuit and ground-fault protection required by 430.28 and the overload protection required by 430.32.

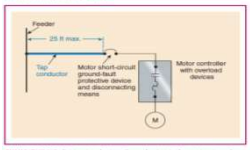


EXHIBIT 430.5 Protective devices (branch-circuit short-circuit and ground-fault) for a motor branch circuit located not more than 25 feet from the point where the conductors are tapped to a feeder.

Solution

Step 1. The tap conductors are required to have a minimum ampacity of 85 A (4 AWG) (1/3 × 255 A = 85 A).

Step 2. The FLC of the motor is 42 A based on 430.6(A) and Table 430.250. Therefore, the motor can be supplied by the 85-A (4 AWG) tap conductor.

Step 3. Because the tap conductors have to terminate in a single branch-circuit protective device, the short-circuit protective device rating must be determined. According to 430.52(C)(1), the protective device for the motor cannot exceed the values given in Table 430.52.
The maximum time-delay fuse value is 42 × 1.75 = 73.5 A. The maximum inverse time circuit breaker value is 42 × 2.50 = 105 A.

Section 430.52(C)(1), Exception No. 1, allows the next higher standard size — 80 and 110 A, respectively. A higher size, based on Exception No. 2, is allowed if the 80- or 110-A size is not adequate to start the motor.

FOR EXAMPLE

430.28 Feeder Taps (cont.)

A 15-hp, 230-V, 3-phase, NEMA Design B, squirrel-cage induction motor with a service factor of 1.15 and a nameplate FLC of 40 A is to be supplied by a tap from a 250-kcmil feeder. Assuming three Type THWN copper conductors in a raceway and no ambient correction factor, the feeder has an ampacity of 255 A (from Table 310.15(B)(16), 75°C column). The tap conductors are not over 25 ft long (see Exhibit 430.5). Determine the required branch-circuit short-circuit and ground-fault protection required by 430.28 and the overload protection required by 430.32.

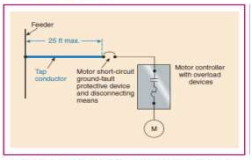


EXHIBIT 430.5 Protective devices (branch-circuit short-circuit and ground-fault) for a motor branch circuit located not more than 25 feet from the point where the conductors are tapped to a feeder.

Solution

Step 4. Because overload protection is also required for the motor, determine the rating of the overload protection.

Based on 430.32, for a motor with a service factor of 1.15, the motor overload protective devices (heaters) are required to be set at a value not greater than 125 percent of the FLC marked on the motor nameplate and not at the FLC value from the table.

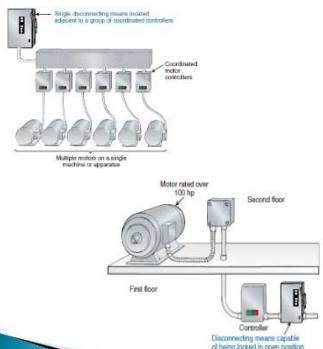
A setting of up to 140 percent may be used according to the permissive rules in 430.32(C). With the motor overload protection set at 50 A, the circuit conductors and motor are protected from overload.

430.99 Available Fault Current

N 430.99 Available Fault Current. The available short circuit current at the motor control center and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.

A motor control center is required to be marked with its short-circuit current rating per 430.98. The requirement in 430.99 requires the motor control center be marked with the available short-circuit current. This provides a means to easily compare the equipment rating with the available short-circuit current and to confirm compliance with 110.10.

Disconnecting Means



430.102 Location.

(A) Controller. An individual disconnecting means shall be provided for each controller and shall disconnect the controller. The disconnecting means shall be located in sight from the controller location.

Exception No. 1: For motor circuits over 1000 volts, nominal, a controller disconnecting means lockable in accordance with 110.25 shall be permitted to be out of sight of the controller, provided that the controller is marked with a warning label giving the location of the disconnecting means.

Exception No. 2: A single disconnecting means shall be permitted for a group of coordinated controllers that drive several parts of a single machine or piece of apparatus. The disconnecting means shall be located in sight from the controllers, and both the disconnecting means and the controllers shall be located in sight from the machine or apparatus.

(B) Motor. A disconnecting means shall be provided for a motor in accordance with (B)(1) or (B)(2).

(1) Separate Motor Disconnect. A disconnecting means for the motor shall be located in sight from the motor location and the driven machinery location.

(2) Controller Disconnect. The controller disconnecting means required in accordance with 430.102(A) shall be permitted to serve as the disconnecting means for the motor if it is in sight from the motor location and the driven machinery location.

Exception to (1) and (2): The disconnecting means for the motor shall not be required under either condition (a) or condition (b), which follow, provided that the controller disconnecting means required in 430.102(A) is lockable in accordance with 110.25.

(a) Where such a location of the disconnecting means for the motor is impracticable or introduces additional or increased hazards to persons or property

(b) In industrial installations, with written safety procedures, where conditions of maintenance and supervision ensure that only qualified persons service the equipment

Disconnecting Means

430.109 Type. The disconnecting means shall be a type specified in 430.109(A), unless otherwise permitted in 430.109(B) through (G), under the conditions specified.

(A) General.

(1) Motor Circuit Switch. A listed motor-circuit switch rated in horsepower.

(2) Molded Case Circuit Breaker. A listed molded case circuit breaker.

(3) Molded Case Switch. A listed molded case switch.

(4) Instantaneous Trip Circuit Breaker. An instantaneous trip circuit breaker that is part of a listed combination motor controller.

(5) Self-Protected Combination Controller. Listed self-protected combination controller.

(6) Manual Motor Controller. Listed manual motor controllers additionally marked "Suitable as Motor Disconnect" shall be permitted as a disconnecting means where installed between the final motor branch-circuit short-circuit protective device and the motor. Listed manual motor controllers additionally marked "Suitable as Motor Disconnect" shall be permitted as disconnecting means on the line side of the fuses permitted in 430.52(C)(5). In this case, the fuses permitted in 430.52(C)(5) shall be considered supplementary fuses, and suitable branch-circuit short-circuit and ground-fault protective devices shall be installed on the line side of the manual motor controller additionally marked "Suitable as Motor Disconnect."

430.103 Operation. The disconnecting means shall open all ungrounded supply conductors and shall be designed so that no pole can be operated independently. The disconnecting means shall be permitted in the same enclosure with the controller. The disconnecting means shall be designed so that it cannot be closed automatically.

430.110 Ampere Rating and Interrupting Capacity.

(A) General. The disconnecting means for motor circuits rated 1000 volts, nominal, or less shall have an ampere rating not less than 115 percent of the full-load current rating of the motor.

Use your 2017 NEC

1. The maximum rating of a dual element (time delay) fuse for branch circuit protection of an AC three phase motor is _____ of the full load current.

A. 150%
B. 175%
C. 250%
D. 325%

Use your 2017 NEC

1. The maximum rating of a dual element (time delay) fuse for branch circuit protection of an AC three phase motor is _____ of the full load current.

A. 150%
B. 175%
C. 250%
D. 325%

Reference: 2017 NEC: Table 430.52

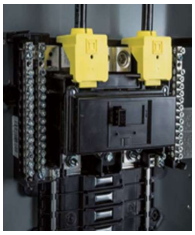
ARTICLE 408
Switchboards, Switchgear, and Panelboards

408.3(A)(2) Service Panelboards

Barriers shall be placed in all service panelboards, switchboards, & switchgear such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while serving load terminations.

***N* Does not apply to service panels w/ provisions for more that 1 service disc**

Re: 408.36 / Split-bus panels



408.3(C) Used as Service Equipment

(C) Used as Service Equipment. Each switchboard, switchgear, or panelboard, if used as service equipment, shall be provided with a main bonding jumper sized in accordance with 250.28(D) or the equivalent placed within the panelboard or one of the sections of the switchboard or switchgear for connecting the grounded service conductor on its supply side to the switchboard, switchgear, or panelboard frame. All sections of a switchboard or switchgear shall be bonded together using an equipment-bonding jumper or a supply-side bonding jumper sized in accordance with 250.122 or 250.102(C)(1) as applicable.

***TABLE 250.102(C)(1)** Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems*

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:
1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper and will have an ampacity equivalent to that of the installed ungrounded supply conductors.
3. If multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, or if multiple sets of ungrounded supply conductors are installed for a separately derived system, the equivalent size of the largest ungrounded supply conductor(s) shall be determined by the largest sum of the areas of the corresponding conductors of each set.
4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

408.4 Field Identification Required

408.4 Field Identification Required.

(A) Circuit Directory or Circuit Identification. Every circuit and circuit modification shall be legibly identified as to its clear, evident, and specific purpose or use. The identification shall include an approved degree of detail that allows each circuit to be distinguished from all others. Spare positions that contain unused overcurrent devices or switches shall be described accordingly. The identification shall be included in a circuit directory that is located on the face or inside of the panel door in the case of a panelboard and at each switch or circuit breaker in a switchboard or switchgear. No circuit shall be described in a manner that depends on transient conditions of occupancy.

(B) Source of Supply. All switchboards, switchgear, and panelboards supplied by a feeder(s) in other than one- or two-family dwellings shall be permanently marked to indicate each device or equipment where the power originates. The label shall be permanently affixed, of sufficient durability to withstand the environment involved, and not handwritten.

???

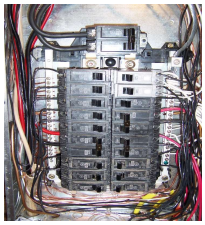
408.7 Unused Openings

408.7 Unused Openings. Unused openings for circuit breakers and switches shall be closed using identified closures, or other approved means that provide protection substantially equivalent to the wall of the enclosure.

An unused opening may exist as a result of a renovation or an alteration of existing equipment. The requirement of this section is for closing unused openings for a circuit breaker where none is installed.

408.36 Overcurrent Protection

408.36 Overcurrent Protection. In addition to the requirement of 408.30, a panelboard shall be protected by an overcurrent protective device having a rating not greater than that of the panelboard. This overcurrent protective device shall be located within or at any point on the supply side of the panelboard.



408.36(D) Back-Fed Device

408.36 (D) Back-Fed Devices. Plug-in-type overcurrent protection devices or plug-in type main lug assemblies that are backfed and used to terminate field-installed ungrounded supply conductors shall be secured in place by an additional fastener that requires other than a pull to release the device from the mounting means on the panel.

408.58 Panelboard Marking.

408.58 Panelboard Marking. Panelboards shall be durably marked by the manufacturer with the voltage and the current rating and the number of ac phases or dc buses for which they are designed and with the manufacturer's name or trademark in such a manner so as to be visible after installation, without disturbing the interior parts or wiring.

Chapter 5 Special Occupancies

500.5 Classification of Locations

Informational Note #1

Refrigerant machinery rooms that contain ammonia refrigeration systems and are equipped with adequate mechanical ventilation that operates continuously or is initiated by a detection system at concentrations ***not exceeding 150ppm*** shall be permitted to be classified as "***unclassified***" locations.

Widely used in food cold storage facilities

iar International Institute of Ammonia Refrigeration

501.10(B)(1) Class I Div. II General

Allowable Wiring Methods

Both rigid metal conduit (RMC) and intermediate metal conduit (IMC) that utilize *listed* threadless fittings were added as an acceptable wiring method in Class I, Division II locations.

2014 NEC required threaded conduit only!

501.15 Cable Seals, Class I, Division I (Terminations)

Additional Requirement

Seals for cables entering enclosures shall be installed within 18" of the enclosure or as required by the enclosure marking. Only explosionproof unions, couplings, reducers, elbows, and capped elbows that are *not* larger than the trade size of the enclosure entry shall be permitted between the sealing fitting and the enclosure.

No splices or taps

511.3(C) (New) Classification Table

Commercial Garages, Repair and Storage

N **Extent of Classified Locations**

for major and minor Repair Garages with heavier-than-air fuel (Gasoline & LPG)

Lighter-than-air fuels (Hydrogen & Natural Gas)

511.8 Underground Wiring

N **UG Wiring shall be installed in threaded rigid metal conduit or intermediate metal conduit**

Exception: Type PVC, RTRC, and type HDPE conduit shall be permitted where buried under not less than **2'** of cover. Where type PVC, RTRC or Type HDPE conduit is used, threaded RMC or IMC shall be used for the last 2' of the UG run to emergence or to the point of connection to the UG raceway, and an equipment grounding conductor ***shall be included*** to ensure electrical continuity of the raceway system and grounding metal parts.

Similar to Articles 514 & 515

514.3(C) Fuel Storage Requirements

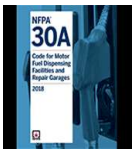
Motor Fuel Dispensing Facilities

N New Requirements regarding location of aboveground CNG, LNG and LP-Gas fuel storage tanks

Location on Property

Reference to NFPA 30A (2012 Edition)

Dispenser Installation Beneath Canopies Class I Div. II



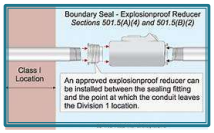
20' Separation from other tanks or dispensers

514.8 Underground Wiring

Additional Acceptable Wiring Method

Exception #2 Added HDPE conduit as an acceptable wiring method where buried under not less than of 2' cover.

514.9 A *listed explosionproof reducer* at the seal is now acceptable (Class I Div. II location)



514.11 Circuit Disconnects

Revision - Compliance with NFPA 30A

Emergency Electrical Disconnects. Fuel dispensing systems shall be provided with one or more clearly identified emergency shutoff devices or electrical disconnects. Not less than 20' and not more than 100' from the fuel dispensing devices that they serve.

514.11(B) & (C) Circuit Disconnects

(B) Attended Self-Service Motor Fuel Dispensing Facilities. The devices or disconnects *shall* be readily accessible to the attendant.

(C) Unattended Self-Service Motor Fuel Dispensing Facilities. The devices or disconnects shall be readily accessible to patrons and at least one additional device on an individual island.

517 Health Care Facilities

HCF Compliance Codes

Ohio Building Code
National Electrical Code
NFPA 99- Health Care Facilities Code
NFPA 101- Life-Safety Code
Joint Commission on Accreditation of Healthcare Organizations (JCAHO)
Facilities Guidelines Institute (FGI)

517 Health Care Facilities

There are "7" Parts to Article 517

I. **General**
II. **Wiring and Protection**
III. **Essential Electrical System**
IV. **Inhalation Anesthetizing Locations**
V. **X-Ray Installations**
VI. **Comm., Signaling, Data, F/A Systems, <120-v**
VII. **Isolated Power Systems**

517.2 Health Care Facilities

NEW- Definition

Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility. [**99:**3.3.62]

517.2 Health Care Facilities

Definitions

Health Care Facilities. Buildings, portions of buildings **or mobile enclosures** in which ***human*** medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. [**NFPA 99:**3.3.67]

517.2 Health Care Facilities

NEW- Definition

N ***Invasive Procedure*. Any procedure that penetrates the protective surfaces of a patient's body (i.e., skin, mucous membrane, cornea) and that is performed with an aseptic field (procedural site). Not included in this category are placement of peripheral intravenous needles or catheters used to administer fluids and/or medications…….**

[**99:**3.3.87]

517.2 Health Care Facilities

NEW- Definition

N **Medical Office *(Dental Office)*. A building or part thereof in which the following occur:**

1. Exams & minor treatments or procedures are performed under continuous supervision of a medical / dental professional.
2. Only sedation or local anesthesia is involved in treatment or procedures and does not render the patient incapable of self-preservation under emergency conditions.
3. Overnight stays for patients or 24 hour care is not provided.

[**99:**3.3.98]

517.2 Health Care Facilities

Definition-Modifications

Added **staff** and **visitor** concerns [**99:**3.3.127]

Basic Care (Category 3) *Space* – No injury likely
General Care (Category 2) Space – Minor injury
Critical Care (Category 1) Space – Major injury or death
N *Support (Category 4) Space* – No physical impact on patient care.

517.16 Use of Isolated Ground Receptacles

Isolated Ground Receptacles are *not* permitted in patient care vicinity.

Isolated ground receptacles *are* permitted to be installed outside the patient care vicinity.

i.e. Corridor receptacle outlets for nurse station computers on wheels *(COWS)*.

517.16(B) Isolated Ground Receptacles

(A) 2014 NEC, Article 517 only stated that isolated ground receptacles shall ***not*** to be installed inside a patient care vicinity (Any space where patients are intended to be treated or examined).

(B) N ***Outside of a patient care vicinity*. Isolated ground receptacles are permitted outside of patient care spaces.**

***Requires an insulated green wire with 1 or more yellow stripes along it's entire length*.**

517.29 "EES" for Hospitals

(A) **Applicability.** ***N*** (Formerly 517.30) The requirements of Part III, 517.29 through 517.30, shall apply to critical care (Category 1) and general care (Category 2) hospitals and other health care facilities using Type 1 essential electrical systems where patients are sustained by electrical life-support equipment.

(B) Critical care (Category 1) spaces shall be served only by a Type 1 ees. [**99:**6.3.2.2.10.1]

Re: 517.40 Nursing Homes

517.30 Essential Electrical Systems

Sources of Power. (Recognizes Fuel Cells)

517.30(A) Two Independent Power Sources. ***Normal and alternate source*** (same).

(B)(1). Types of Power Sources. Where the normal source consists of gen-sets on the premises, the alternate shall be another gen-set or external utility service.

N **(B)(2) Fuel Cell Systems. Fuel cell systems shall be permitted as the alternate source for all or part of the EES, provided conditions 1-6 apply…..**

Fuel Cell Technology

517.32 "EES"

"3" Components of the Essential Electrical System

Essential Electrical System

Critical Branch	**Life-Safety**	**Equipment**
Branch Circuits	Maintains	Typically
Feeders	Egress	3-Phase Equip.
Related to	Exit Lighting	**Automatic**
Patient Care	Alarms	**Delayed or**
Automatic	**Automatic**	**Manual**

Connection to Alternate Power Sources

517.34(B) Critical Branch "EES"

Essential Electrical System

Clarification of Intent

517.34(B) ***Switching*****. It** ***shall*** **be permitted to control task illumination on the critical branch.**

Was open to interpretation, now the intent is clear.

517.160 Isolated Power Systems

Alternative to GFCI protection in ***Critical Care (Category 1)*** **areas of Health Care Facilities**

Operating Rooms
Intensive Care Units (ICU's)
Coronary Care Units (CCU)
Emergency Departments
Other Wet Procedure Locations

Provides protection without interrupting power supply, due to a single phase-to-ground fault

517.160 Isolated Power Systems

System Requirements

(1) Each isolated power circuit shall be provided with a disconnecting pole in each isolated conductor (**2-pole breaker / phase & neutral; 120-v ph. to neutral)**

(2) Type **XHHW** or **XHHW-2** CU conductors only (must pass 3.5 die-electric test; **no wire lube**).

(3) Shall ***not*** be placed in hazardous locations
Circuit #1 – ***Orange*** in color w/ stripe (1ø systems)
Circuit #2 – ***Brown*** in color w/ stripe (1ø systems)
Circuit #3 – ***Yellow*** in color w/ stripe (3ø systems)

(4) Line isolation monitor, total hazard current >**5mA**
Visual + Audible Alarm Requirement

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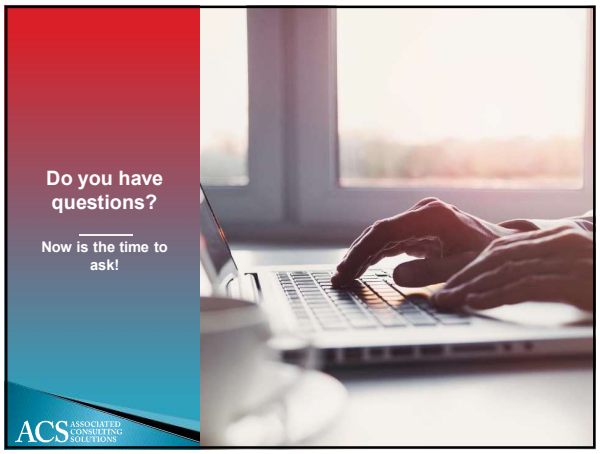

Thank you for participating!

To schedule a seminar, webinar, or online course:

www.associatedconsultingsolutions.com

Or call

Associated Consulting Solutions, LLC
216-256-3556

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File Attachments for Item:

ER-5 2017 OBC Electrical Requirements and 2017 NEC General Equipment Installation (Flanik)

All Certifications (6 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend approval

Committee Recommendation:

2017 OBC Electrical Requirements & 2017 NEC General Equipment Installation

6-hours of Continuing Education Credit

Course Description: This 6-hour seminar is designed for online or in-person training that highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

Key topics covered with in-depth discussion:

- 2017 OBC Electrical Requirements
- Key NEC Definitions
- Requirements for Electrical Installations
- Lighting, Switches, and Receptacles
- HVAC Equipment

Course Outline:

1. **2017 OBC – CHAPTER 1**
   - **OBC Section 105.1 Approvals Required**
   - **OBC Section 102.10 Work Exempt From Approval**
   - **OBC Section 102.10.1 Emergency Repairs**
   - **OBC Section 102.10.2 Minor Repairs**
   - **OBC Section 106.1.1 Information on Construction Documents**

2. **2017 OBC – CHAPTER 27**

- **OBC Section 2701.1 Scope**
- **OBC Section 2701.2 Appliance and Fixture Listing**
- **OBC Section 2702 Emergency and Standby Power Systems**
- **OBC Section 2702.1 Installation**
- **OBC Section 2702.2 Where Required**
- **OBC Section 2702.3 Critical Circuits**
- **OBC Section 2702.4 Maintenance**
- **OBC Section 2703.1 Penetrations**
- **OBC Section 2703.2 Cutting, Notching, and Boring**
- **OBC Section 2704 Smoke Detection**
- **OBC Section 2704.1 Smoke Alarm Circuits**

3. **2017 NEC 5 New Articles**

- **Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment**
- **Article 691 – Large Scale PV Production Facility**
- **Article 706 – Energy Storage Systems**
- **Article 710 – Stand Alone Systems**
- **Article 712 – DC Micro Grids**

4. **Article 90 Introduction**

- **90.2 (A)**

5. **Article 100 Definitions**

6. **Article 110.3(C)**

- **Examination, Identification, *Installation, Use & Listing (Product Certification)* of Equipment**
- **Loose Connection / Terminal Damage**

7. **Article 110.14(D) Installation**
    - **Torque Devices**
    - **Informative Annex I: Recommended Tightening Torque Tables from UL Standard 486A-B**

8. **Article 110.16(B) Arc-Flash Hazard Warning**
    - **Service Equipment**
    - **Exception if an arc flash label is installed per NFPA 70E**
    - **Signage**
    - **PPE Protection**
    - **PPE Category Level Chart**

9. **Article 110.21(A)(2) Marking**
    - **Equipment Markings**
    - **Reconditioned Equipment**

10. **Article 110.24 Available Fault Current**
    - **Field Marking**
    - **Potential AFC Conditions**
    - **Short-Circuit Current Calculations Required by the NEC**
        - **110.9 Interrupting Rating**
        - **110.10 Component Protection**
        - **110.16 Arc-Flash Hazard Warning**
        - **110.24 Available Fault Current**
        - **240.1 Overcurrent Protection**
        - **517.17 Health Care Facilities**
    - **Short Circuit Analysis**
    - **Fully Rated vs. Series Rated systems**

11. Arc-Fault Factors

- **Variables per project to consider:**
  - **KVA Rating & % Impedance of Transformer**
  - **Secondary Voltage Info; (1ø / 3ø); (208v or 480v)**
  - **Conductor & Raceway Material (CU / AL)**
  - **Length of Secondary Conductors & Parallel**
  - **Typical 3ø Transformer Ω Values 3 - 5.75%**

12. Article 110.25 Locking Disconnecting Means Revised

13. Article 110.26(A)(4) Spaces About Electrical Equipment

- **Limited Access Locations**
- **Above Ceiling & Crawl Space Installed Equipment, Both – Existing and New Conditions**

14. Article 110.41 Inspection and Tests

- **Limited Access Locations**
- **Above Ceiling & Crawl Space Installed Equipment, Both – Existing and New Conditions**

15. Article 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel

- **Dwelling Units.**
- **Other Than Dwelling Units.**
- **Boat Hoists.**
- **Kitchen Dishwasher Branch Circuit.**
- **Crawl Space Lighting Outlets.**

16. Article 210.8(A)(5) + (B)(10)

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17. **Article 210.8(A)(7) + (B)(5)**
    - **Applies to both Dwelling Units & other than Dwelling Units**

18. **Article 210.8(B) Other Than Dwelling Units**
    - **Bathrooms**
    - **Kitchens**
    - **Rooftops**
    - **Outdoors**
    - **Within 6' from the top inside edge of the bowl**
    - **Indoor wet locations**
    - **Locker rooms with associated shower facilities**
    - **Garages, service bays, and similar areas other than vehicle exhibition halls and showrooms**
    - **<u>Crawl spaces – at or below grade level</u>**
    - **Unfinished portions or areas of the basement not intended as habitable rooms**

19. **Article 210.8(E) Crawl Space Lighting Outlets**

20. **Article 404 Switches**

21. **Article 404.2(C) Switches Controlling Lighting Loads**

22. **Article 404.9 Provisions for General-Use Snap Switches**

23. **Article 404.22 Electronic Lighting Control Switches; NEW (Exception)**

24. **Article 406.2 NEW Definition – Outlet Box Hood**

25. **Article 406.3(E) Controlled Receptacle Marking**

26. **Article 406.3(F) Receptacle w/ USB Charger**

27. **Article 406.4(D)(2) Non-Grounding Type Receptacle Outlets**

28. **Article 406.4(D)(4) Replacements**

29. **Article 406.12 Tamper Resistant Receptacles – <u>NEW</u> Required Additional Locations**

30. **Article 410 Luminaires, Lampholders, and Lamps**

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31. **Article 410.10(A) Wet and Damp Locations**

32. **Article 410.10(C) In Ducts or Hoods**

33. **Article 410.36 Means of Support**

34. **Article 410.62 Cord-Connected Lampholders and Luminaires**

35. **Article 410.116 Clearance**

36. **Article 411 Low-Voltage Lighting**

37. **Article 440 Air-Conditioning and Refrigerating Equipment**

38. **Article 440.1 Scope**

39. **Article 440.4(B) Multimotor and Combination-Load Equipment**

40. **Article 440.6 Ampacity and Rating**

41. **Article 440.10 Short-Circuit Current Rating**

42. **Article 440.12 Rating and Interrupting Capacity**

43. **Article 440.14 & 440.63 Disconnect Locations**

44. **Article 440.22 Application and Selection**

45. **Part VII. Provisions for Room Air Conditioners**

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: Jerry Flanik (Contact Name)

Organization: Associated Consulting Solutions, LLC (Organization/Company)

Address: 9671 Oxford Glen Drive (Include Room Number, Suite, etc.)

City: Mentor State: Ohio Zip: 44060

E-Mail: jerry@associatedconsultingsolutions.com

Telephone: 216-256-3556 Fax: _____

Course Sponsor: Associated Consulting Solutions, LLC

COURSE INFORMATION:

Course Title: 2017 OBC Electrical Requirements & 2017 NEC General Equipment Installation

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

Purpose and Objective: This 6-hour seminar is designed for online or in-person training that highlights main provisions regarding the 2017 OBC Electrical Requirements and the 2017 NEC general equipment installation. Participants will be provided with key requirements regarding NEC definitions, requirements for electrical installations, lighting, switches, receptacles, and HVAC equipment.

Number of Instructional Contact Hours that can be obtained upon completion: 6 hours

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

Program Applicable for the Following Participants:

Building Official ■ Master Plans Examiner ■
Building Plans Exam. ■
Plumbing Plans Exam. ■
Electrical Plans Exam. ■
Mechanical Plans Exam. ■
Fire Protect. Plans Exam. ■

Building Inspector ■ Fire Protection Inspector ■ Mechanical Inspector ■
Plumbing Inspector ■
Non-Res IU Inspector ■

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

Electrical Safety Inspectors ■
Location of ESI Course: TBD Date(s) of ESI Course(s): TBD

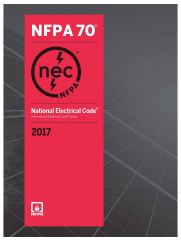
SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	x
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related 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:		x

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

2017 OBC Electrical Requirements & 2017 NEC General Equipment Installation

Based on 2017 Ohio Building Code (OBC) and the 2017 National Electrical Code (NEC)

2017 OBC Electrical Requirements & 2017 NEC General Equipment Installation



Welcome

- Meet the instructor
- Participant introductions

Meet the Instructor

PREFERRED EDUCATION PROVIDER

- Gerald C. Flanik is an ICC-Certified Master Code Professional (MCP), and holds over 40 various licenses and certifications. He is also a LEED BD+C Accredited Professional, Certified Floodplain Manager (CFM).
- Mr. Flanik is President of Associated Consulting Solutions, LLC (ACS) in Cleveland, Ohio. ACS provides plan review services, pre and post design analysis services for architectural and engineering firms, and code consulting services throughout the United States. ACS is also an ICC Preferred Education Provider, providing education throughout the United States. Previously, Gerald served as the Chief Building Official for Lake County, Ohio for 16 years. Prior to working as a code official, he owned and operated a design build contracting company.
- Gerald holds a Bachelor of Science Degree in Mechanical Engineering and a Bachelor of Science Degree in Electrical Engineering from Cleveland State University; as well as, a degree in Civil Engineering Technology. He is also an adjunct faculty instructor at Lakeland College in the Civil and Electrical Engineering Departments.
- Jerry is a professional consultant for corporations and government agencies throughout the United States, and for the International Code Council throughout the world.

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2017 OBC Electrical Requirements & 2017 NEC General Equipment Installation

Key topics covered with in-depth discussion :

- 2017 OBC Electrical Requirements
- Key NEC Definitions
- Requirements for Electrical Installations
- Lighting, Switches, and Receptacles
- HVAC Equipment

Description

This seminar highlights key provisions of the *2017 OBC Electrical Requirements & 2017 NEC*

This seminar:

- Provides practice in applying key requirements.
- Reinforces learning by supplying immediate feedback and clarification.
- Walks participants through content and intent.

OBC Chapter 1

- This chapter is largely concerned with maintaining “due process of law” in enforcing the performance criteria contained in the body of the code.
- Chapter 1 is geared toward code officials, design professionals, contractors and building owners.

OBC Section 105.1

105.1 Approvals Required

Any owner or owner's representative who intends to construct, enlarge, alter, repair, move, or change the occupancy of a building or structure, or portion thereof, or to erect, install, enlarge, alter, repair, remove, convert or replace any electrical, gas, mechanical, plumbing system, other building service equipment, or piping system the installation of which is regulated by this code, or to cause any such work to be done, shall first make application to the building official and obtain the required approval.

However, OBC 102.10 contains additional information.

OBC Section 102.10

102.10 Work Exempt From Approval

Approval shall not be required for the following work; however, this work shall comply with all applicable provisions of the rules of the board:

Electrical:

1. Minor repair work, including the replacement of lamps or the connection of approved portable electrical equipment to approved permanently installed receptacles.
2. Electrical equipment used for radio and television transmissions except equipment and wiring for power supply, and the installations of towers and antennas.
3. The installation of any temporary system required for the testing or servicing of electrical equipment or apparatus.
4. Electrical wiring, devices, appliances, apparatus or equipment operating at less than twenty-five volts and not capable of supplying more than fifty watts of energy, unless specifically addressed in this code.
5. Process equipment and the associated wiring on the load side of the power disconnect to the equipment.
6. Electrical wiring equipment not connected to building services equipment in and adjacent to natural or artificially made bodies of water as defined in Article 682 of NFPA 70 as referenced in Chapter 35.

OBC Section 102.10.1

102.10.1 Emergency Repairs

Where equipment replacements and repairs must be performed in an emergency situation, an application for approval shall be submitted within the next working business day to the building official.

Provide some examples of electrical emergency situations???

OBC Section 102.10.2

102.10.2 Minor Repairs

Minor repairs to structures may be made without application or notice to the building official. Such repairs shall not include the cutting away of any wall, partition or portion thereof, the removal or cutting of any structural beam or load bearing support, or the removal or change of any required means of egress, or rearrangement of parts of a structure affecting the egress requirements; nor shall minor repairs include addition to, alteration of, replacement or relocation of any standpipe, water supply, sewer, drainage, drain leader, gas, soil, waste, vent or similar piping, electric wiring or mechanical or other work affecting public health or general safety.

Provide some examples of minor repairs???

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

OBC Section 106.1.1

106.1.1 Information on Construction Documents

Construction documents shall be dimensioned and drawn upon suitable material. Electronic media documents are permitted to be submitted when approved by the building official. Construction documents shall be coordinated and of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that it will conform to the provisions of this code. Construction documents, adequate for the scope of the project, shall include information necessary to determine compliance with the building, mechanical, plumbing, fire, electrical, energy, and fuel gas codes such as:

Item #15: System descriptions. Complete description of the plumbing, mechanical and electrical systems, including: materials, insulation "R"-values, general routing and sizes of all piping; location and type of plumbing fixtures and equipment; plumbing schematics and isometrics; materials, insulation "R"-values, general routing and sizes of all ductwork, vents, and louvers; location and type of heating, ventilation, air conditioning, and other mechanical equipment; location and type of all fire alarm, lighting and power equipment; type and size of all electrical conductors.

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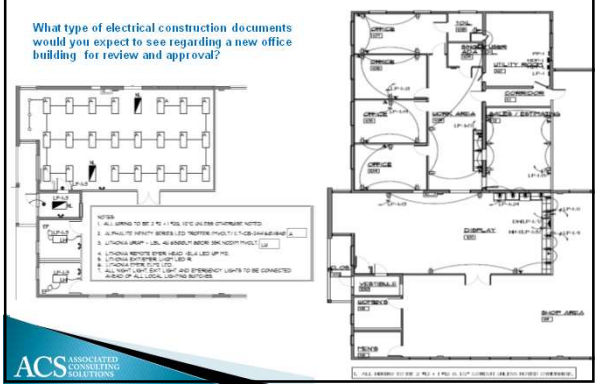
OBC Section 106.1.1

What type of electrical construction documents would you expect to see regarding a new office building for review and approval?



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OBC Chapter 27

2701.1 Scope

This chapter governs the electrical components, equipment and systems used in buildings and structures covered by this code. Electrical components, equipment, and systems shall be designed and constructed in accordance with the provisions of NFPA 70.

2701.2 Appliance and Fixture Listing

Electrical appliances and fixtures within the scope of this code shall be tested and listed in published reports of inspected electrical equipment by an approved agency and installed in accordance with all instructions included as part of such listing.

UL LISTED

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OBC Chapter 27

Section 2702 Emergency and Standby Power Systems

2702.1 Installation
Emergency power systems and standby power systems shall comply with Sections 2702.1.1 through 2702.1.7.

2702.2 Where Required
Emergency and standby power systems shall be provided where required by Sections 2702.2.1 through 2702.2.16.

2702.3 Critical Circuits
Cables used for survivability of required critical circuits shall be listed in accordance with UL 2196. Electrical circuit protective systems shall be installed in accordance with their listing requirements.

2702.4 Maintenance
Emergency and standby power systems shall be maintained and tested in accordance with Sections 604.4 to 604.5 of the fire code.

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OBC Chapter 27

Section 2703 Penetrations

2703.1 Penetrations
Penetrations of walls, floors, ceilings and assemblies required to have a fire-resistance rating, shall be protected in accordance with Chapter 7. Where cables, conductors and raceways penetrate fireblocking or draftstopping, such penetrations shall be protected by filling the annular space with an approved fireblocking material.

2703.2 Cutting, Notching, and Boring
The cutting, notching and boring of wood and steel framing members, structural members and engineered wood products shall be in accordance with this code and as prescribed by the registered design professional.

Section 2704 Smoke Detection

2704.1 Smoke Alarm Circuits
Smoke detectors required by this code and installed within dwelling units shall not be connected as the only load on a branch circuit. Such detectors shall be supplied by branch circuits having lighting loads consisting of lighting outlets in habitable spaces.

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Why do we need codes and standards?

IKEA Rooftop PV Install (Illinois)

1.124 MW System

Bolingbrook (05.12.2018)

4,784 Panels

No Injuries Reported

Lake County; Fair Painesville, Ohio

Bumper Car Ride - Electrocution

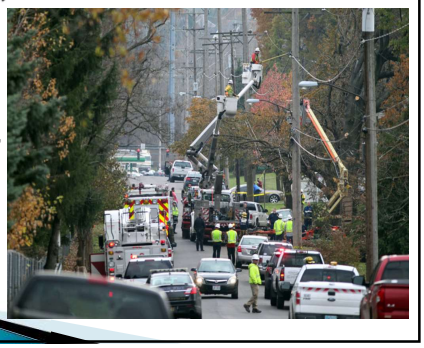
08.12.2003

- Boy 8 Years old
- 22 Safety Violations
- Grounding & Bonding
- 2 Mil. Settlement

11.15.2017 Tree trimmer fatality in Akron, Ohio

Electrocution: 23kv Line bucket lift accident; 1 died, 1 in serious condition

Update: **2 deaths**



2017 NEC "Features"

The 2017 NEC edition includes the following usability features as aids to the user. Changes other than editorial are indicated with gray shading within sections. An entire figure caption with gray shading indicates a change to an existing figure. New sections, tables, and figures are indicated by a bold, italic ***N*** in a gray box to the left of the new material. An ***N*** next to an Article title indicates that the entire Article is new.

"5" New 2017 NEC Articles

Article 425 – Fixed Resistance & Electrode Industrial Process Htg. Equipment

Article 691 – Large Scale PV Production Facility

Article 706 – Energy Storage Systems

Article 710 – Stand Alone Systems

Article 712 – DC Micro Grids

Article 90 Introduction

Article 90 Introduction

90.2 (A) Covered

This *Code* covers the installation ***and removal*** of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables and raceways for the following: ……

was temporary power wiring and abandoned communication cables only.

Article 100 Definitions

Accessible, Readily (Readily Accessible).

Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools ***(other than keys)***, to climb over or ***under***, ***to*** remove obstacles, or to resort to portable ladders, and so forth.

Use your 2017 NEC

1. Which one of the following describes when the authority having jurisdiction for enforcing this Code may grant exceptions for the installation of conductors and equipment that are not under the exclusive control of the electric utilities?

A. Special Permission
B. Variance
C. Over Rule
D. earthing / expansion

Use your 2017 NEC

1. Which one of the following describes when the authority having jurisdiction for enforcing this Code may grant exceptions for the installation of conductors and equipment that are not under the exclusive control of the electric utilities?

A. Special Permission
B. Variance
C. Over Rule
D. earthing / expansion

Reference 2017 NEC: 90.2(C)

Article 100 Definitions

N Cord Connector [as applied to Hazardous (classified) Locations].

A fitting intended to terminate a cord to a box or similar device and reduce the strain at points of termination and may include an explosionproof, a dust-ignitionproof, or a flameproof seal.
(CMP-14)

Was 500.2

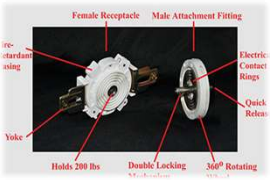
Article 100 Receptacle

Now include the CMP responsible for the definition

Receptacle. A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke. (CMP-18)

Article 100 Receptacle

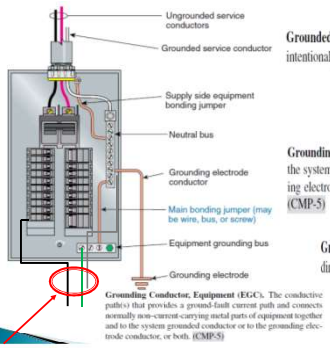
Quick connect



Safety Quick Lighting & Fans

Definitions

120/240V 3-Wire



Grounded Conductor. A system or circuit conductor that is intentionally grounded. (CMP-5)

Grounding Electrode Conductor. A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. (CMP-5)

Grounding Electrode. A conducting object through which a direct connection to earth is established. (CMP-5)

Ground. The earth. (CMP-5)

Branch Circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). (CMP-2)

Article 100 Definitions

- **Modified**--Accessible,Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth.

Article 100 Definitions

- **Modified--Building.** A structure that stands alone or that is separated from adjoining structures by fire walls.

Modified--Structure. That which is built or constructed, other than equipment.

Well……what is equipment?

No Changes-Equipment. A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation.

110.3(C) Examination, Identification, *Installation, Use & Listing (Product Certification)* of Equipment

2017 NEC Recognizing other than new Equipment

Informational Note #1: Equipment may be new, reconditioned, refurbished, or remanufactured.

A few Nationally Recognized Testing Labs

1. CSA Group Testing & Certification (Canada)
2. FM Approvals
3. IAMPO
4. Intertek
5. MET Laboratories
6. NEMKO North America
7. NSF International
8. Underwriters Laboratories, Inc.

Loose Connection / Terminal Damage

Improper terminations create thermal / heat damage that can lead to equipment failure and potential fire hazard.

N 110.14(D) Installation.

Where a tightening torque is indicated as a numeric value on equipment or in installation instructions provided by the manufacturer, a calibrated torque tool ***shall*** be used to achieve the indicated torque value, unless the equipment manufacturer has provided installation instructions for an alternative method of achieving the required torque.

Torque Devices

Torque Screwdrivers

Torque Wrench

Informative Annex I: Recommended Tightening Torque Tables from UL Standard 486A-B

Typical Tightening Torque Values

Table I.1 Tightening Torque for Screws

Test Conductor Installed in Connector		Tightening Torque, N-m (lbf-in.)							
		Slotted head No. 10 and larger[a]				Hexagonal head — external drive socket wrench			
		Slot width 1.2 mm (0.047 in.) or less and slot length 6.4 mm (¼ in.) or less		Slot width over 1.2 mm (0.047 in.) or slot length over 8.4 mm (1.4 in.)		Split-bolt connectors		Other connectors	
AWG or kcmil	mm²	A	B	A	B	A	B	A	B
30–10	0.05–5.3	1.7 (15)	2.3 (20)	2.8 (25)	4.0 (35)	7.3 (65)	9.0 (80)	6.8 (60)	8.5 (75)
8	8.4	2.3 (20)	2.8 (25)	3.4 (30)	4.5 (40)	7.3 (65)	9.0 (80)	6.8 (60)	8.5 (75)
6–4	13.2–21.2	2.8 (25)	4.0 (35)	4.0 (35)	5.1 (45)	15.3 (135)	18.5 (165)	10.2 (90)	12.4 (110)
3	26.7	2.8 (25)	4.0 (35)	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125	16.9 (150)
2	33.6	3.4 (30)	4.5 (40)	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125	16.9 (150)
1	42.4	—	—	4.5 (40)	5.6 (50)	25.4 (225)	31.1 (275)	14.1 (125	16.9 (150)
1/0–2/0	53.5–67.4	—	—	4.5 (40)	5.6 (50)	35.6 (315)	43.5 (385)	16.9 (150)	20.3 (180)
3/0–4/0	85.0–107.2	—	—	4.5 (40)	5.6 (50)	45.2 (400)	56.5 (500)	22.6 (200)	28.2 (250)
250–350	127–177	—	—	4.5 (40)	5.6 (50)	62.1 (550)	73.4 (650)	28.2 (250)	36.7 (325)
400	203	—	—	4.5 (40)	5.6 (50)	76.3 (675)	93.2 (825)	28.2 (250)	36.7 (325)
500	253	—	—	4.5 (40)	5.6 (50)	76.3 (675)	93.2 (825)	33.9 (300)	42.4 (375)
600–750	304–380	—	—	4.5 (40)	5.6 (50)	90.4 (800)	113.0 (1000)	33.9 (300)	42.4 (375)
800–1000	405–508	—	—	4.5 (40)	5.6 (50)	111.7 (900)	124.3 (1100)	45.2 (400)	56.5 (500)
1250–2000	635–1010	—	—	—	—	111.7 (900)	124.3 (1100)	56.5 (500)	67.8 (600)

[a]For values of slot width or length not corresponding to those specified, select the largest torque value associated with the conductor size. Slot width is the nominal design value. Slot length shall be measured at the bottom of the slot.

110.16 (B) Arc-Flash Hazard Warning

Service Equipment

In other than dwelling units, in addition to the requirements in (A), a permanent label shall be field or factory applied to ***service equipment rated 1200 amps or more. The label shall meet the requirements of 110.21 (B) and contain the following information:***

(1) Nominal system voltage
(2) Available fault current at the service OCD
(3) The clearing time of the service OCD, based on the avail. Fault current at the SE equipment
(4) The date the label was applied

Exception if an arc flash label is installed per NFPA 70E

Arc-flash hazard

Signage

PPE Protection

- Required Information
- Proper Hazard Protection

110.21(A)(2) Marking.

Equipment Markings.

N ***(2) Reconditioned Equipment.***
Reconditioned equipment ***shall*** be marked with the name, trademark, or other descriptive marking by which the organization responsible for reconditioning the electrical equipment can be identified, along with the date of the reconditioning.

110.24 Available Fault Current

(A) Field Marking.

Service equipment ***at*** other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault current calculation was performed and be of sufficient durability to withstand the environment involved. **The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.**

110.24 Available Fault Current.

Updated- Informational Note:

Arc flash hazard analysis information is available in NFPA 70E-**2015**. *Standard for Electrical Safety in the Workplace,* provides assistance in determining the severity of potential exposure, planning safe work practices, and selecting personal protective equipment.

Potential AFC Conditions

The arc flash or blast melts, even vaporizes the metallic components / and destroys the insulation.

Typical Interrupting Ratings of Breakers: 10k, 22k, 35k & 65k
Fuses can go as high as 200k

Electrical blasts can be 30-40,000°F

Melting Points:
Aluminum; 1221°F
Copper; 1984°F
(Sun Surface Temp. 9900°F)

Short-Circuit Current Calculations

Required by the National Electrical Code

110.9 Interrupting Rating
110.10 Component Protection
110.16 Arc-Flash Hazard Warning
110.24 Available Fault Current
240.1 Overcurrent Protection
517.17 Health Care Facilities

Short Circuit Analysis

Technical Specifications

Short Circuit Analysis and Coordination Study

Many projects require this study as part of the bid approval process (and plan review as well).

An engineering analysis and coordination study shall be performed on the electrical distribution system.

Fully Rated vs. Series Rated systems

A fully-rated system is when ***all*** overcurrent devices are rated for the available fault current present on the line side of the overcurrent device(s).

A series-rated (coordinated) system is one in which short-circuit ratings of overcurrent devices ***may*** be lower than the actual fault current present. Typically, the manufacturer has adequate documentation (engineering) where two or more devices is properly protected and the OCD's in the circuit operate, test and reset as designed.

Arc-Fault Factors

Variables per project to consider:

1. **KVA Rating & % Impedance of Transformer**
2. **Secondary Voltage Info; (1ø / 3ø); (208v or 480v)**
3. **Conductor & Raceway Material (CU / AL)**
4. **Length of Secondary Conductors & Parallel**

Typical 3ø Transformer Ω Values 3 - 5.75%

Arc-Fault Factors

110.25 Locking Disconnecting Means

Revised

If a disconnecting means is required to be lockable open elsewhere in this Code, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.

Exception: ***Locking provisions for a cord-***and plug ***connection shall*** not be required to remain in place without the lock installed.

Refer to 422.31

110.25 Lockable Disconnecting Means

Permanently Installed

External Padlock Device

Factory Manufactured

MC, H & J Frame Breakers

110.26(A)(4) Spaces About Electrical Equipment

***N* Limited Access Locations**

Where equipment operating at 1000-v, nominal or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized is required by installation instructions or function to be located in a space with limited access, all of the following shall apply:

Refer to NFPA 70E-2015

Limited Access Locations Cont'd

(a) Where equipment is installed above a lay-in ceiling, there ***shall*** be an opening not smaller than (22" x 22"), or in a crawl space, there shall be an accessible opening not smaller than (22" x 30").

(b) The width of the working space ***shall*** be the width of the equipment or minimum of 30", whichever is greater.

(c) All enclosure doors ***shall*** be capable of opening a minimum of 90°.

(d) The space in front of the enclosure **shall** comply with the depth requirements of Table 110.26(A)(1). The maximum height of the working space ***shall*** be the height necessary to install the equipment. A horizontal ceiling structural member is permitted in this space.

Above Ceiling & Crawl Space Installed Equipment

Both; Existing and New Conditions

Typically above Ceiling Locations

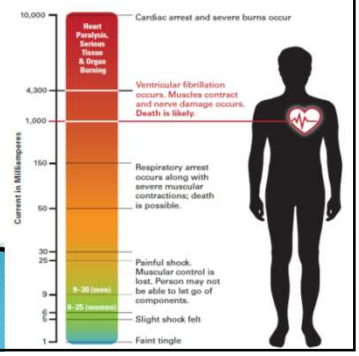
110.41 Inspection and Tests.

Over 1000 Volts.

N* (A) Pre-energization and Operating Tests.** Where required elsewhere in this Code, the complete electrical system design, including settings for protective, switching, and control circuits, ***shall be prepared in advance and made available on request to the AHJ and ***shall*** be tested when first installed on-site.

(B) Test Report. Results to be available to AHJ.

210.8 Ground-Fault Circuit-Interrupter Protection for Personnel



210.8 GFCI Protection for Personnel.

Reference 210.8 in NEC and discuss…

- (A) Dwelling Units.
- (B) Other Than Dwelling Units.
- (C) Boat Hoists.
- (D) Kitchen Dishwasher Branch Circuit.
- (E) Crawl Space Lighting Outlets.

210.8 GFCI Protection for Personnel.

For the purpose of this section, when determining distance from the receptacles the distance ***shall*** be measured as the shortest path the cord of an appliance connected would follow ***without*** piercing a floor, wall, ceiling, or fixed barrier, or passing through a **door**, doorway or window.

Specific measurement requirement.

210.8(A)(5) + (B)(10)

Applies to all Locations

210.8(A)(5) Unfinished portions or areas of the basement ***not*** intended as habitable rooms.

Exception Remains: A receptacle supplying only a permanently installed fire alarm or burglar alarm shall **not** be required to have GFCI protection.

Exception applies to Residential Only

N **210.8(B)(10) Other than Dwellings**

210.8(A)(7) + (B)(5)

Applies to both Dwelling Units & other than Dwelling Units

Clarification of the 6' sink measurement rule?

Sinks – where receptacles are installed within 6' *from* the "*top inside*" edge of the *bowl of the* sink.

This GFCI requirement is not limited to receptacles serving countertop surfaces; rather, it covers all 125-volt, 15- and 20-ampere receptacles within 6 feet of any point along the inside edge of the top of the sink bowl. Many appliances used in these locations are ungrounded, and the presence of water and grounded surfaces contributes to a hazardous environment. Any 125-volt, 15- or 20-ampere receptacle installed within 6 feet of a sink located in other than a kitchen is also required to be GFCI protected.

Undersink Receptacle Outlets

Bathroom Sink

Kitchen Sink

Above Counter Sinks

The 6' rule is measured from 6' from top edge of sink

210.8(B) Other Than Dwelling Units

GFCI Protection for Personnel Required

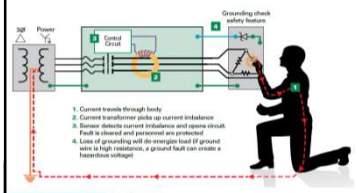
Other Than Dwelling Units. All 1ø receptacles rated 150-v to ground or less, 50 amperes or less and 3ø rated 150-v to ground or less, 100 amperes or less installed in the following locations, shall have GFCI protection for personnel.

1. **Bathrooms**
2. **Kitchens**
3. **Rooftops**
4. **Outdoors**
5. **Within 6' from the top inside edge of the bowl**
6. **Indoor wet locations**
7. **Locker rooms with associated shower facilities**
8. **Garages, service bays, and similar areas other than vehicle exhibition halls and showrooms**
9. **Crawl spaces – at or below grade level**
10. ***Unfinished portions or areas of the basement not intended as habitable rooms***

GFCI Protection for Personnel

Other than Dwelling Units (150-v to ground or less)

Applies to all 1ø receptacles rated 50 amps or less
Applies to all 3ø receptacles 100 amps or less



3ø Rec.
20ma trip
Levels
Shock block

210.8(E) Crawl Space Lighting Outlets

Applies to Both Residential & Commercial Locations

N **GFCI protection shall be provided for *lighting outlets* not exceeding 120 volts installed in crawl spaces.**

Other than dwelling units receptacle outlets as well!

FYI….NEC 422.5 GFCI

422.5 Ground-Fault Circuit-Interrupter (GFCI) Protection for Personnel.

N **(A) General.** Appliances identified in 422.5(A)(1) through (5) rated 250 volts or less and 60 amperes or less, single- or 3-phase, shall be provided with GFCI protection for personnel. Multiple GFCI protective devices shall be permitted but shall not be required.

(1) Automotive vacuum machines provided for public use
(2) Drinking water coolers
(3) High-pressure spray washing machines — cord-and-plug-connected
(4) Tire inflation machines provided for public use
(5) Vending machines

N **(B) Type.** The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

(1) Within the branch circuit overcurrent device
(2) A device or outlet within the supply circuit
(3) An integral part of the attachment plug
(4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug
(5) Factory installed within the appliance

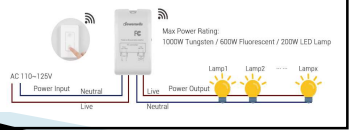
Several options are available for providing GFCI protection for appliances. The readily accessible requirement facilitates required periodic testing as well as resetting a tripped device.

ARTICLE 404 Switches

404.2(C) Switches Controlling Lighting Loads

Grounded Circuit Conductor

The grounded circuit conductor for the controlled lighting circuit shall be ***installed*** at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit ***serving bathrooms, hallways, stairways, or rooms suitable for human habitation or occupancy as defined in the applicable building code. Where multiple switch locations controlling the same lighting load such that the entire floor area of the room is visible from all locations, the grounded conductor shall be required only at one location.***



404.2(C) Switches Controlling Lighting Loads

Grounded Circuit Conductor

Exception: The connection requirement shall become effective on January 1, 2020. It shall not apply to replacement or retrofit switches installed in locations prior to local adoption of 404.2(C) and where the grounded conductor cannot be extended without removing finish materials. The number of electronic lighting control switches on a branch circuit shall not exceed five, and the number connected to any feeder on the load side of a system or main bonding jumper shall not exceed twenty five. For the purpose of this exception, a neutral busbar, in compliance with 200.2(B) and to which a main or system bonding jumper is connected shall not be limited as to the number of electronic lighting control switches connected.

Informational Note: The provision for a (future) grounded conductor is to complete a circuit path for electronic lighting control devices.

404.2(C) Switches Controlling Lighting Loads

Grounded Circuit Conductor

Many electronic lighting control devices require a standby current to maintain the ready state and detection capability of the device. This allows immediate switching of the load to the "on" condition. These devices require standby current when they are in the "off" state, that is, when there is no load current. In existing installations, many of these devices utilize the equipment grounding conductor (EGC) for the standby current flow because a grounded conductor was not usually provided in the switch box.

Section 404.2(C) does not require a grounded circuit conductor in every installation. For example, a grounded conductor is not required at initial installation if a conductor can be readily added in the future, such as in raceway installations or where the construction of the framing cavity in which the switch box is located permits access. The grounded conductor is also not required where the area served is not a habitable room or bathroom, or the load is a switched receptacle.

404.2(C) Items (1) – (5)

A grounded conductor shall not be required to be installed at lighting switch locations under any of the following conditions:

1. ***Raceway installations that can accept adding a grounded conductor***
2. ***Where the box is accessible for adding a grounded conductor***
3. ***Integral snap switch enclosures*** 300.15 (E)
4. ***Lighting controlled by automatic means***
5. ***Where a switch controls a receptacle load***

404.2(C) Continued (NEW)

The grounded conductor shall be extended to any switch location as necessary and shall be connected to switching devices that require line-to-neutral voltage to operate the electronics of the switch in the standby mode (404.22)

Exception: The connection requirement shall become effective on January 1, 2020. It shall not apply to replacement or retrofit switches installed in locations prior to local adoption of 404.2(C) and where the wall finish would require removal.

404.2(C) Exception Continued (NEW)

It shall not apply to replacement or retrofit switches installed in locations prior to local adoption of 404.2(C) and where the wall finish would require removal.

The number of electronic lighting control switches on a branch circuit shall not exceed (5), and the number connected to any feeder on the load-side of a system bonding jumper or main bonding jumper; (feeder panel enclosure) shall not exceed (25). For the purpose of this exception, a neutral busbar, in compliance with 200.2(B) and to which a main or system bonding jumper is connected shall not be limited as to the number of electronic lighting control switches connected.

404.9 Provisions for General-Use Snap Switches

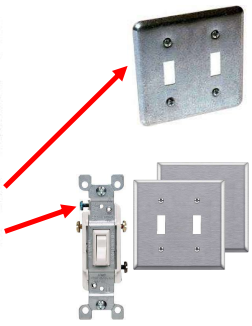
404.9 Provisions for General-Use Snap Switches.

(A) Faceplates. Faceplates provided for snap switches mounted in boxes and other enclosures shall be installed so as to completely cover the opening and, where the switch is flush mounted, seat against the finished surface.

(B) Grounding. Snap switches, including dimmer and similar control switches, shall be connected to an equipment grounding conductor and shall provide a means to connect metal faceplates to the equipment grounding conductor, whether or not a metal faceplate is installed. Metal faceplates shall be grounded. Snap switches shall be considered to be part of an effective ground-fault current path if either of the following conditions is met:

(1) The switch is mounted with ˊmetal screws to a metal box or metal cover that is connected to an equipment grounding conductor or to a nonmetallic box with integral means for connecting to an equipment grounding conductor.

(2) An equipment grounding conductor or equipment bonding jumper is connected to an equipment grounding termination of the snap switch.



Also, see exceptions

404.22 Electronic Lighting Control Switches; NEW (Exception)

404.22 Electronic Lighting Control Switches. Electronic lighting control switches shall be listed. Electronic lighting control switches shall not introduce current on the equipment grounding conductor during normal operation. The requirement to not introduce current on the equipment grounding conductor shall take effect on January 1, 2020.

Exception: Electronic lighting control switches that introduce current on the equipment grounding conductor shall be permitted applications covered by 404.2(C), Exception. Electronic lighting control switches that introduce current on the equipment grounding conductor shall be listed and marked for use in replacement or retrofit applications only.

406.2 NEW Definition

Outlet Box Hood

A housing shield intended to fit over a faceplate for flush-mounted wiring devices, or an integral component of an outlet box or of a faceplate for flush-mounted wiring devices. The hood does not serve to complete the electrical enclosure; it reduces the risk of water coming in contact with electrical components within the hood, such as attachment plugs, current taps, surge protective devices, direct plug-in transformer units, or wiring devices.

406.3(E) Controlled Receptacle Marking.

(E) Controlled Receptacle Marking. All nonlocking-type, 125-volt, 15- and 20-ampere receptacles that are controlled by an automatic control device, or that incorporate control features that remove power from the receptacle for the purpose of energy management or building automation, shall be permanently marked with the symbol shown in Figure 406.3(E) and the word "controlled."

For receptacles controlled by an automatic control device, the marking shall be located on the receptacle face and visible after installation.

In both cases where a multiple receptacle device is used, the required marking of the word "controlled" and symbol shall denote which contact device(s) are controlled.

Exception: The marking shall not be required for receptacles controlled by a wall switch that provide the required room lighting outlets as permitted by 210.70.

Many energy efficiency codes require that a percentage of installed 125-volt, 15- and 20-ampere receptacles be automatically controlled. Controlled receptacles are required to be marked to indicate which

FIGURE 406.3(E) Controlled Receptacle Marking Symbol.

ASHRAE Standard 90.1-2010 requires that 50 percent of all 125V, 15A and 20A receptacles in private offices, open offices, and computer classrooms be controlled by an automatic control device. Controlled receptacles need to be marked to differentiate them from non-controlled receptacles.

406.3(F) Receptacle w/ USB Charger

A 125-volt 15-or 20-ampere receptacle that additionally provides Class 2 power shall be listed and constructed such as the Class 2 circuitry is integral with the receptacle.

The average power of a USB port is about **5 volts**. A USB device will be able to draw out a maximum of **500 milliamperes (mA)**, but most default to **100 mA** until prompted to provide more power by the device software.

406.4(D)(2) Non-Grounding Type Receptacle Outlets

(2) Non–Grounding-Type Receptacles. Where attachment to an equipment grounding conductor does not exist in the receptacle enclosure, the installation shall comply with (D)(2)(a), (D)(2)(b), or (D)(2)(c).

(a) A non–grounding-type receptacle(s) shall be permitted to be replaced with another non–grounding-type receptacle(s).

(b) A non–grounding-type receptacle(s) shall be permitted to be replaced with a ground-fault circuit interrupter-type of receptacle(s). These receptacles or their cover plates shall be marked "No Equipment Ground." An equipment grounding conductor shall not be connected from the ground-fault circuit-interrupter-type receptacle to any outlet supplied from the ground-fault circuit-interrupter receptacle.

(c) A non–grounding-type receptacle(s) shall be permitted to be replaced with a grounding-type receptacle(s) where supplied through a ground-fault circuit interrupter. Where grounding-type receptacles are supplied through the ground-fault circuit interrupter, grounding-type receptacles or their cover plates shall be marked "GFCI Protected" and "No Equipment Ground," visible after installation. An equipment grounding conductor shall not be connected between the grounding-type receptacles.

Informational Note No. 1: Some equipment or appliance manufacturers require that the branch circuit to the equipment or appliance includes an equipment grounding conductor.

Informational Note No. 2: See 250.114 for a list of a cord-and-plug-connected equipment or appliances that require an equipment grounding conductor.

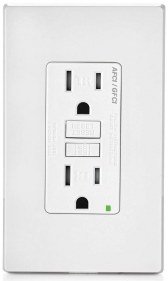
406.4(D)(4) Replacements

(4) Arc-Fault Circuit-Interrupter Protection. Where a receptacle outlet is located in any areas specified in 210.12(A) or (B), a replacement receptacle at this outlet shall be one of the following:

(1) A listed outlet branch-circuit-type arc-fault circuit-interrupter receptacle

(2) A receptacle protected by a listed outlet branch-circuit-type arc-fault circuit-interrupter-type receptacle

(3) A receptacle protected by a listed combination-type arc-fault circuit-interrupter-type circuit breaker



Dual Function AFCI / GFCI Device

406.12 Tamper Resistant Receptacles

NEW; Required Additional Locations

1. Dwelling Units.
2. Guest Rooms & Guest Suites of Hotels / Motels.
3. Child Care Facilities.
4. **Preschools and elementary education facilities.**
5. **Business offices, corridors, waiting rooms, and the like in clinics, medical and dental offices and outpatient facilities.**
6. **Subset of assembly occupancies; waiting transportation, gymnasiums, skating rinks and auditoriums.**
7. **Dormitories.**

Use your 2017 NEC

1. What marking must receptacles rated 20 amperes or less have when designed for the direct connection of aluminum conductors?

A. CU
B. AL/AL
C. CO/ALR
D. CLD/AL

Use your 2017 NEC

1. What marking must receptacles rated 20 amperes or less have when designed for the direct connection of aluminum conductors?

A. CU
B. AL/AL
C. CO/ALR
D. CLD/AL

Reference: 2017 NEC: 406.3(C)

Use your 2017 NEC

2. How must isolated ground receptacles be identified?

A. Red colored receptacle.
B. No identification is required
C. Green dot located on the back of the receptacle.
D. Orange triangle located on the face of the receptacle.

Use your 2017 NEC

2. How must isolated ground receptacles be identified?

A. Red colored receptacle.
B. No identification is required
C. Green dot located on the back of the receptacle.
D. Orange triangle located on the face of the receptacle.

Reference: 2017 NEC: 406.3(D)

Article 410 Luminaires, Lampholders, and Lamps

410.10(A) Wet and Damp Locations.

Article 100 Definitions

Location, Damp. Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture.

Location, Dry. A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

Location, Wet. Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

410.6 Listing Required. All luminaires, lampholders, and retrofit kits shall be listed.

410.10 Luminaires in Specific Locations.

An Underwriters Laboratories Inc. pamphlet entitled *Luminaires Marking and Application Guide, 2015* (available for download at http://ul.com/wp-content/uploads/2014/09/Luminaires_MG.pdf), provides information on markings to help the AHJ quickly determine whether common types of listed fluorescent, high-intensity discharge, and incandescent fixtures are suitable for the application and are installed correctly.

(A) Wet and Damp Locations. Luminaires installed in wet or damp locations shall be installed such that water cannot enter or accumulate in wiring compartments, lampholders, or other electrical parts. All luminaires installed in wet locations shall be marked, "Suitable for Wet Locations." All luminaires installed in damp locations shall be marked "Suitable for Wet Locations" or "Suitable for Damp Locations."

Correct design, construction, and installation of these luminaires will prevent the entrance of rain, snow, ice, and dust. Outdoor parks and parking lots, outdoor recreational areas, car wash areas, and building exteriors are examples of wet locations.

Luminaires in locations protected from the weather and not subject to water saturation but still exposed to moisture must be marked "Suitable for Damp Locations" or "Suitable for Wet Locations." The following are examples of damp locations:

1. The underside of store or gasoline station canopies
2. Some cold-storage warehouses
3. Some agricultural buildings
4. Some basements
5. Roofed open porches and carports

Definitions of the terms *location, damp; location, dry;* and *location, wet* can be found in Article 100.

ACS ASSOCIATED CONSULTING SOLUTIONS

UL Marking for Damp Locations

FOR EXAMPLE

Note: Follow listing, labeling, and all markings on products.

DAMP LOCATIONS — Only luminaires marked "SUITABLE FOR DAMP LOCATIONS" or "SUITABLE FOR WET LOCATIONS" are intended to be installed in damp locations. A damp location is an exterior or interior location that is normally or periodically subject to condensation of moisture in, on, or adjacent to, electrical equipment, and includes partially protected locations.

ACS ASSOCIATED CONSULTING SOLUTIONS

UL Marking for Wet Locations

FOR EXAMPLE

Note: Follow listing, labeling, and all markings on products.

WET LOCATIONS — Only luminaires marked "SUITABLE FOR WET LOCATIONS" are intended to be installed in wet locations. A wet location is a location in which water or other liquids may drip, splash or flow on or against electrical equipment. A luminaire marked "SUITABLE FOR WET LOCATIONS" may be additionally marked as specified below:

a. **Covered Ceiling Mount Only** — A wet locations luminaire marked "COVERED CEILING MOUNT ONLY" is intended for locations such as a vehicle washing area where the luminaire will not be subjected to water and precipitation from the back side. A ceiling mounted luminaire not identified for covered ceiling mount only is suitable for mounting in locations where it may be subjected to precipitation from the back side, such as under a metal grate-type catwalk.

b. **Less Than 1.2 M (4 Feet) Above Ground Level** — A wet locations wall or post mounted luminaire may be installed within 1.2 m (4 feet) of ground level if it is marked "SUITABLE FOR MOUNTING WITHIN 1.2 M (4 FEET) OF GROUND." luminaires with this marking are intended to be subjected to water from lawn and garden sprinkler systems, but are not intended to be installed at or below ground level where they may be subjected to immersion in water.

Exception: A luminaire with an integral post (bollard type luminaire) needs to be so marked.

c. **Below Ground Level** — A wet locations recessed luminaire may be installed at or below ground level if it's marked "SUITABLE FOR GROUND-MOUNTED RECESSED." A luminaire with this marking is intended to be subjected to infrequent immersion under water which may occur because of heavy precipitation. The luminaire is provided with instructions for its proper installation.

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410.10(C) In Ducts or Hoods.

(C) In Ducts or Hoods. Luminaires shall be permitted to be installed in commercial cooking hoods where all of the following conditions are met:

(1) The luminaire shall be identified for use within commercial cooking hoods and installed such that the temperature limits of the materials used are not exceeded.
(2) The luminaire shall be constructed so that all exhaust vapors, grease, oil, or cooking vapors are excluded from the lamp and wiring compartment. Diffusers shall be resistant to thermal shock.
(3) Parts of the luminaire exposed within the hood shall be corrosion resistant or protected against corrosion, and the surface shall be smooth so as not to collect deposits and to facilitate cleaning.
(4) Wiring methods and materials supplying the luminaire(s) shall not be exposed within the cooking hood.

FYI.....110.11 Deteriorating Agents. Unless identified for use in the operating environment, no conductors or equipment shall be located in damp or wet locations; where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment; or where exposed to excessive temperatures.

ACS ASSOCIATED CONSULTING SOLUTIONS

UL Marking for Commercial Cooking Hood Use

FOR EXAMPLE

Note: Follow listing, labeling, and all markings on products.

COMMERCIAL COOKING HOOD USE— A luminaire intended for installation in non-residential occupancies in exhaust or hood ducts or hoods above cooking equipment, in accordance with the National Electrical Code and the Standard for Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment, NFPA 96, is marked with the minimum temperature rating of the supply wiring, and with the wording "SUITABLE FOR USE WITHIN COMMERCIAL COOKING HOODS," or the equivalent, and "MOUNT A MINIMUM OF 1.2 M (4 FEET) ABOVE COOKING SURFACE." A recessed luminaire is additionally marked with the minimum acceptable spacing between the centers of adjacent units, the minimum spacing from the center of the luminaire to side building member, and the minimum spacing above the luminaire

ACS ASSOCIATED CONSULTING SOLUTIONS

410.36 Means of Support

410.36 Means of Support.

(A) Outlet Boxes. Outlet boxes or fittings installed as required by 314.23 and complying with the provisions of 314.27(A)(1) and 314.27(A)(2) shall be permitted to support luminaires.

The outlet box or support should be securely fastened to the independent rod or hanger to ensure that the luminaire is securely mounted in place, regardless of whether a luminaire is attached to an outlet box or is supported independently of the outlet box. The luminaire may be securely mounted to the box; however, if the box is not secured, it becomes the weak link in the luminaire support.

(B) Suspended Ceilings. Framing members of suspended ceiling systems used to support luminaires shall be securely fastened to each other and shall be securely attached to the building structure at appropriate intervals. Luminaires shall be securely fastened to the ceiling framing member by mechanical means such as bolts, screws, or rivets. Listed clips identified for use with the type of ceiling framing member(s) and luminaire(s) shall also be permitted.

ACS ASSOCIATED CONSULTING SOLUTIONS

410.62 Cord-Connected Lampholders and Luminaires

410.62(B) Adjustable Luminaires. Luminaires that require adjusting or aiming after installation shall not be required to be equipped with an attachment plug or cord connector, provided the exposed cord is suitable for hard-usage or extra-hard-usage and is not longer than that required for maximum adjustment. The cord shall not be subject to strain or physical damage.

Informational Note: For application provisions, see Table 400.4, "Use" column.

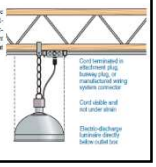
410.62 (C) Electric-Discharge and LED Luminaires. Electric discharge and LED luminaires shall comply with (1), (2), and (3) as applicable.

(1) Cord-Connected Installation. A luminaire or a listed assembly in compliance with any of the conditions in (a) through (c) shall be permitted to be cord connected provided the luminaire is located directly below the outlet or busway, the cord is not subject to strain or physical damage, and the cord is visible over its entire length except at terminations.

(a) A luminaire shall be permitted to be connected with a cord terminating in a grounding-type attachment plug or busway plug.
(b) A luminaire assembly equipped with a strain relief and canopy shall be permitted to use a cord connection between the luminaire assembly and the canopy. The canopy shall be permitted to include a section of raceway not over 150 mm (6 in.) in length and intended to facilitate the connection to an outlet box mounted above a suspended ceiling.
(c) Listed luminaires connected using listed assemblies that incorporate manufactured wiring system connectors in accordance with 604.100(C) shall be permitted to be cord connected.

(2) Provided with Mogul-Base, Screw Shell Lampholders. Electric-discharge luminaires provided with mogul-base, screw shell lampholders shall be permitted to be connected to branch circuits of 50 amperes or less by cords complying with 240.5. Receptacles and attachment plugs shall be permitted to be of a lower ampere rating than the branch circuit but not less than 125 percent of the luminaire full-load current.

(3) Equipped with Flanged Surface Inlet. Electric-discharge luminaires equipped with a flanged surface inlet shall be permitted to be supplied by cord pendants equipped with cord connectors. Inlets and connectors shall be permitted to be of a lower ampere rating than the branch circuit but not less than 125 percent of the luminaire load current.



410.116 Clearance

410.116(B) Installation. Thermal insulation shall not be installed above a recessed luminaire or within 75 mm (3 in.) of the recessed luminaire's enclosure, wiring compartment, ballast, transformer, LED driver, or power supply unless the luminaire is identified as Type IC for insulation contact.

Use your 2017 NEC

1. Given: Luminaires are planned to be installed in exposed locations under metal corrugated sheet roof decking. What is the minimum distance required from the lowest surface of the roof decking to the top of the luminaires?

A. 1-1/2 inches
B. 2 inches
C. 3-1/2 inches
D. 4 inches

Use your 2017 NEC

1. Given: Luminaires are planned to be installed in exposed locations under metal corrugated sheet roof decking. What is the minimum distance required from the lowest surface of the roof decking to the top of the luminaires?

A. 1-1/2 inches
B. 2 inches
C. 3-1/2 inches
D. 4 inches

Reference: 2017 NEC: 410.10(F)

Use your 2017 NEC

2. Which one of the following conditions is not permitted when luminaires are installed in commercial cooking hoods?

A. Wiring methods and materials supplying luminaire(s) shall be exposed within the cooking hood.
B. The luminaire shall be identified for use within commercial cooking hoods and installed such that the temperature limits of the materials used are not exceeded.
C. The luminaire shall be constructed so that all exhaust vapors, grease, oil, or cooking vapors are excluded from the lamp and wiring compartment. Diffusers shall be resistant to thermal shock.
D. Parts of the luminaire exposed within the hood shall be corrosion resistant or protected against corrosion, and the surface shall be smooth so as not to collect deposits and to facilitate cleaning.

Reference: 2017 NEC: 410.10(C)(4)

Use your 2017 NEC

2. Which one of the following conditions is not permitted when luminaires are installed in commercial cooking hoods?

A. Wiring methods and materials supplying luminaire(s) shall be exposed within the cooking hood.
B. The luminaire shall be identified for use within commercial cooking hoods and installed such that the temperature limits of the materials used are not exceeded.
C. The luminaire shall be constructed so that all exhaust vapors, grease, oil, or cooking vapors are excluded from the lamp and wiring compartment. Diffusers shall be resistant to thermal shock.
D. Parts of the luminaire exposed within the hood shall be corrosion resistant or protected against corrosion, and the surface shall be smooth so as not to collect deposits and to facilitate cleaning.

Reference: 2017 NEC: 410.10(C)(4)

Low-Voltage Lighting Article 411

411.1 Scope. This article covers lighting systems and their associated components operating at no more than 30 volts ac or 60 volts dc. Where wet contact is likely to occur, the limits are 15 volts ac or 30 volts dc.

Informational Note: Refer to Article 680 for applications involving immersion.

Article 411 covers low-voltage interior and exterior (landscape) lighting systems consisting of a maximum 30-volt isolating ac or 60-volt dc power supply. In wet locations, if contact with the lighting system might occur, the maximum voltage limits are 15 volts ac or 30 volts dc.

411.3 Low-Voltage Lighting Systems. Low voltage lighting systems shall consist of an isolating power supply, low-voltage luminaires, and associated equipment that are all identified for the use. The output circuits of the power supply shall be rated for 25 amperes maximum under all load conditions.

411.4 Listing Required. Low-voltage lighting systems shall comply with 411.4(A) or 411.4(B).

(A) Listed System. The luminaires, power supply, and luminaire fittings (including the exposed bare conductors) of an exposed bare conductor lighting system shall be listed for the use as part of the same identified lighting system.

(B) Assembly of Listed Parts. A lighting system assembled from the following listed parts shall be permitted:

(1) Low-voltage luminaires
(2) Power supply
(3) Low-voltage luminaire fittings
(4) Suitably rated cord, cable, conductors in conduit, or other fixed Chapter 3 wiring method for the secondary circuit

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Low-Voltage Lighting Article 411

411.6 Secondary Circuits.

(A) Grounding. Secondary circuits shall not be grounded.

(B) Isolation. The secondary circuit shall be insulated from the branch circuit by an isolating transformer.

(C) Bare Conductors. Exposed bare conductors and current-carrying parts shall be permitted for indoor installations only. Bare conductors shall not be installed less than 2.1 m (7 ft) above the finished floor, unless specifically listed for a lower installation height.

(D) Insulated Conductors. Insulated secondary circuit conductors shall be of the type, and installed as, described in (1), (2), or (3):

(1) Class 2 cable supplied by a Class 2 power source and installed in accordance with Parts I and III of Article 725.
(2) Conductors, cord, or cable of the listed system and installed not less than 2.1 m (7 ft) above the finished floor unless the system is specifically listed for a lower installation height.
(3) Wiring methods described in Chapter 3.

Sections 411.6(D)(1) and (3) refer to wiring methods that are not necessarily restricted to exposed locations. The term *exposed* is appropriate for the bare conductors covered under 411.6(C), but the wiring options permitted under 411.6(D) apply to both exposed and concealed secondary circuit wiring.

411.7 Branch Circuit. Lighting systems covered by this article shall be supplied from a maximum 20-ampere branch circuit.

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ARTICLE 440
Air-Conditioning and Refrigerating Equipment

ACS ASSOCIATED CONSULTING SOLUTIONS

440.1 Scope

440.1 Scope. The provisions of this article apply to electric motor-driven air-conditioning and refrigerating equipment and to the branch circuits and controllers for such equipment. It provides for the special considerations necessary for circuits supplying hermetic refrigerant motor-compressors and for any air-conditioning or refrigerating equipment that is supplied from a branch circuit that supplies a hermetic refrigerant motor-compressor.

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FYI…….210.63 HACR Recep.

210.63 Heating, Air-Conditioning, and Refrigeration Equipment Outlet. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment. The receptacle shall be located on the same level and within 7.5 m (25 ft) of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

Informational Note: See 210.8 for ground-fault circuit interrupter requirements.

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440.4(B) Multimotor and Combination-Load Equipment

Multimotor and combination-load equipment shall be provided with a visible nameplate marked with the maker's name, the rating in volts, frequency and number of phases, minimum supply circuit conductor ampacity, the maximum rating of the branch-circuit
short-circuit and ground-fault protective device, and the short-circuit current rating of the motor controllers or industrial control panel.

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440.6 Ampacity and Rating

The size of conductors for equipment covered by this article shall be selected from Table 310.15(B)(16) through Table 310.15(B)(19) or calculated in accordance with 310.15 as applicable. The required ampacity of conductors and rating of equipment shall be determined according to 440.6(A) and 440.6(B).

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440.9 Grounding and Bonding + 440.10 Short-Circuit Current Rating

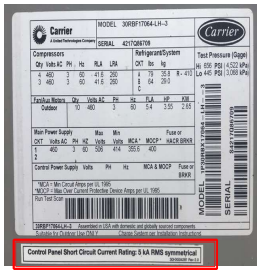
N 440.9 Grounding and Bonding. Where multimotor and combination-load equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use non-threaded fittings.

Non-threaded metal raceway systems on rooftops supplying electric motor-driven air-conditioning and refrigerating equipment could be subject to movement and damage. This is a result of rooftop activities such as snow removal or roof repair/replacement. These activities could result in separation of the raceway system compromising the ground-fault return path. The installation of a wire-type equipment ground will ensure the integrity of the ground-fault return path.

N 440.10 Short-Circuit Current Rating.

(A) Installation. Motor controllers of multimotor and combination-load equipment shall not be installed where the available short-circuit current exceeds its short-circuit current rating as marked in accordance with 440.4(B).

(B) Documentation. When motor controllers or industrial control panels of multimotor and combination load equipment are required to be marked with a short circuit current rating, the available short circuit current and the date the short circuit current calculation was performed shall be documented and made available to those authorized to inspect the installation.



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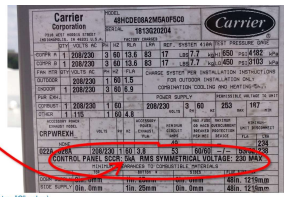
440.10 Short-Circuit Current Rating

FOR EXAMPLE



Verifying Calculations.
Date: 1/1/2017
- 3 phase 208 Volts
- 3 single conductors per circuit
- 6 AWG Copper conductors
- EMT conduit
- AFC where branch circuit initiates = 56,000 Amps
- Length of branch circuit conductor = 55 feet

2425 (Constant or "C" value)

$F = \frac{1.732 \times L \times I_{sc}}{C \times E_{LL}}$ Or $\frac{1.732 \times 55 \times 56{,}000}{2425 \times 208}$ F = 10.576

Multiplier (M) = $\frac{1}{1+F}$ Or $\frac{1}{1+10.576}$ M = .0864

Isc = I X M Or 56,000 X .0864 = 4,838 (Short-circuit current at control panel)

ACS ASSOCIATED CONSULTING SOLUTIONS

440.12 Rating and Interrupting Capacity

440.12 Rating and Interrupting Capacity.

(A) Hermetic Refrigerant Motor-Compressor. A disconnecting means serving a hermetic refrigerant motor-compressor shall be selected on the basis of the nameplate rated-load current or branch-circuit selection current, whichever is greater, and locked rotor current, respectively, of the motor-compressor as follows.

(1) Ampere Rating. The ampere rating shall be at least 115 percent of the nameplate rated-load current or branch-circuit selection current, whichever is greater.

Exception: A listed unfused motor circuit switch, without fuse holders, having a horsepower rating not less than the equivalent horsepower determined in accordance with 440.12(A)(2) shall be permitted to have an ampere rating less than 115 percent of the specified current.

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440.14 & 440.63 Disconnect Locations

440.14 Location. Disconnecting means shall be located within sight from, and readily accessible from the air-conditioning or refrigerating equipment. The disconnecting means shall be permitted to be installed on or within the air-conditioning or refrigerating equipment. The disconnecting means shall not be located on panels that
are designed to allow access to the air-conditioning or refrigeration equipment or to obscure the equipment nameplate(s).

Room Air Conditioners

440.63 Disconnecting Means. An attachment plug and receptacle
or cord connector shall be permitted to serve as the disconnecting
means for a single-phase room air conditioner rated 250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of
the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

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440.22 Application and Selection

440.22(C) Protective Device Rating Not to Exceed the Manufacturer's Values. Where maximum protective device ratings shown on a manufacturer's overload relay table for use with a motor controller are less than the rating or setting selected in accordance with 440.22(A) and (B), the protective device rating shall not exceed the manufacturer's values marked on the equipment.

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Part VII. Provisions for Room Air Conditioners

440.63 Disconnecting Means. An attachment plug and receptacle or cord connector shall be permitted to serve as the disconnecting means for a single-phase room air conditioner rated 250 volts or less if (1) the manual controls on the room air conditioner are readily accessible and located within 1.8 m (6 ft) of the floor, or (2) an approved manually operable disconnecting means is installed in a readily accessible location within sight from the room air conditioner.

440.64 Supply Cords. Where a flexible cord is used to supply a room air conditioner, the length of such cord shall not exceed 3.0 m (10 ft) for a nominal, 120-volt rating or 1.8 m (6 ft) for a nominal, 208- or 240-volt rating.

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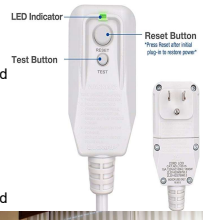
Part VII. Provisions for Room Air Conditioners

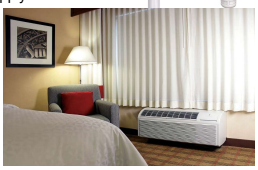
440.65 Protection Devices. Single-phase cord- and plug-connected room air conditioners shall be provided with one of the following factory-installed devices:
(1) Leakage-current detector-interrupter (LCDI)
(2) Arc-fault circuit interrupter (AFCI)
(3) Heat detecting circuit interrupter (HDCI)

The protection device shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

A heat detecting circuit interrupter (HDCI) incorporates all of the protection functions of a leakage-current detector-interrupter (LCDI) and also includes a thermal detecting function to provide protection against overheating of an air conditioner compressor.

Leakage-Current Detector-Interrupter (LCDI). A device provided in a power supply cord or cord set that senses leakage current flowing between or from the cord conductors and interrupts the circuit at a predetermined level of leakage current.





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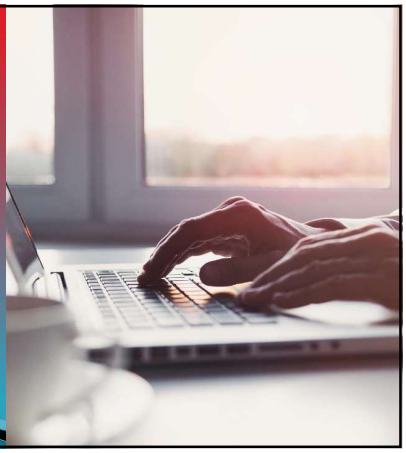
Do you have questions?

Now is the time to ask!



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Thank you for participating!

To schedule a seminar, webinar, or online course:

www.associatedconsultingsolutions.com

Or call

Associated Consulting Solutions, LLC
216-256-3556

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File Attachments for Item:

ER-6 Buildings and Homes in Flood Hazard Areas (Simpson Strong-Tie)

BO, MPE, BI, RBO, RPE, RBI (1 hour)

Staff Notes: Same instructor as other course

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 course, BBS approval #, date and location 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; capable of being climatically controlled so that approximately 68° F can be maintained; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

ADDITIONAL ELECTRICAL SAFETY INSPECTOR COURSE CRITERIA:

Trainees: During the first year, shall attend an approved thirty-hour course on the "Fundamentals of Electricity" and pass a test upon completion of the course. A second approved thirty-hour course and test covering the "National Electrical Code" shall be successfully completed prior to the examination for a certificate of competency. ESI trainee courses shall be designated as either of the following:

ESI TRAINEE COURSE - PART I - FUNDAMENTALS OF ELECTRICITY (THEORY)
ESI TRAINEE COURSE - PART II - ESI REFRESHER COURSE

ESI course instructors: Shall hold a current certificate of competency as an electrical safety inspector.
ESI course: ESI course applicants must give location(s) and date(s) of course(s).

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: Ian McCallion (Contact Name)
Organization: Simpson Strong-Tie (Organization/Company)
Address: 5956 W. Las Positas (Include Room Number, Suite, etc.)
City: Pleasanton State: CA Zip: 94588
E-Mail: imccallion@strongtie.com
Telephone: 925-560-9112 Fax: _____
Course Sponsor: _____

COURSE INFORMATION:

Course Title: Buildings & Homes in Flood Hazard Areas: Connections at or below Design Flood Elevations

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

Purpose and Objective: Please see attachment for purpose and objective.

Number of Instructional Contact Hours that can be obtained upon completion: 1

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

Program Applicable for the Following Participants:

Building Official	X	Master Plans Examiner	X	Building Inspector	X	Fire Protection Inspector	☐
		Plumbing Plans Exam.	☐				
		Electrical Plans Exam.	☐				
		Mechanical Plans Exam.	☐				

Mechanical Inspector	☐	Plumbing Inspector	☐	Non-Res IU Inspector	☐				

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

Electrical Safety Inspectors ☐
Electrical Safety Inspector Trainee Part I - Fundamentals of Electricity (Theory) ☐
Electrical Safety Inspector Trainee Part II – ESI Refresher Course ☐
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
Course Sponsor:	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:	Copy of quizzes or tests to be given	X
Completed Application:		X

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

Buildings and Homes in Flood Hazard Areas: Connections at or below Design Flood Elevations - Submittal

1. Course Objectives:

After this training, you should be able to:

- Specify and detail the appropriate approach to flood-resistant construction in any context
- Choose and locate the correct anchors, fasteners, and connectors when designing flood-resistant structures
- Design safe structures that are connected and anchored to resist flotation, collapse, or permanent lateral movement during flood events, and
- Communicate effectively and accurately with flood construction experts and authorities by using the correct terminology

2. Instructor Qualifications/Subject Matter Expert Bio: http://training.strongtie.com/custom/bios/jmailey.html

3. Course Syllabus:

Simpson Strong-Tie is an accredited provider of IACET CEUs. This course qualifies for IACET CEUs, AIA HSW LUs, ICC CEUs and AIBD CEUs.

Flooding is an increasingly frequent and costly danger, and flood-prone areas are expanding in the US as storms worsen, floodplains expand, and sea levels rise. As a result, many homes and buildings that were poorly built, were built without flood-resistant construction, or were inappropriately detailed have been swept away, demolished, or significantly damaged. This course begins with an overview of flood requirements and then explores the concepts and details of flood-resistant construction, provides detailed advice on how anchors, fasteners, and connectors can be used to create flood-resistant buildings, and records the relevant terminology, codes, and standards that should be used when consulting experts and authorities and designing flood-resistant buildings.

Participants must pass a 10 question quiz (80% to pass) at the conclusion of the course to earn CEUs, see attached quiz. Here is the link to the course.

Link to the course. (Course length 1 hr)

Buildings and Homes in Flood Hazard Areas: Connections at or below Design Flood Elevations - Submittal

4. Sample Course Evaluation link

5. Course outline:

- Lesson 0: Introduction (2 min)

- Lesson 1: General Flood Requirements (15 min)
- Lesson 2: Flood Elevation Considerations (12 min)
- Lesson 3: Raised Foundations and Connections (12 min)
- Lesson 4: Solid Foundations and Connections (12 min)
- Lesson 5: Conclusions (4 min)
- Test: (5 min)

Total time 62 min - 1 hr. Credit

NY20 INTRO

In-Service Credit in the State of New York

This course has been approved by the State of NY Codes Division for In-Service credits. In order to receive credit, learners must complete this course and pass the required assessment with 80% or higher. Simpson will forward your credit information to the NY State Codes Division before the 10th of the next month. Once received, this information will be applied to your transcript. Please do not forward your Completion Certificate to the NY State Codes Division but retain only for your records. Be sure that your NYID number is inserted into your Simpson profile and is correct.

NYS BUILDING STANDARDS AND CODES

For credit in the state of NY, use the appropriate reference version of the code for this program.

NEXT

This course may reference different building codes throughout. Designers are responsible for referring to the governing code in their jurisdiction.

For professionals operating in the state of New York, the appropriate code from the 2020 Residential Code of New York State (RCNYS) or 2020 Building Code of New York State (BCNYS) should be referred to in place of any reference to a specific ICC code. Please note that some sections of the 2020 RCNYS and BCNYS have been amended.

NEXT

Buildings and Homes in Flood Hazard Areas

1.1 Buildings and Homes in Flood Hazard Areas: Connections at or Below Design Flood Elevations

Notes:

Welcome to this continuing education course. “Buildings and Homes in Flood Hazard Areas: Connections at or Below Design Flood Elevations”.

2. Welcome

2.1 Presenter Information

Notes:

This course was authored by Jim Mailey, who was the training specialist and outreach coordinator for the Midwest, Northeast, and Mid-Atlantic US at Simpson Strong-Tie.

2.2 Course Description

Notes:

Flooding is an increasingly frequent and costly danger, and flood-prone areas are expanding in the US as storms worsen, floodplains expand, and sea levels rise. As a result, many homes and buildings that were poorly built, were built without flood-resistant construction, or were inappropriately detailed have been swept away, demolished, or significantly damaged. This course begins with an overview of flood requirements and then explores the concepts and details of flood-resistant construction, provides detailed advice on how anchors, fasteners, and connectors can be used to create flood-resistant buildings, and records the relevant terminology, codes, and standards that should be used when consulting experts and authorities and designing flood-resistant buildings.

2.3 Learning Objectives

Notes:

At the end of this program, participants will be able to:

- specify and detail the appropriate approach to flood-resistant construction in any context
- choose and locate the correct anchors, fasteners, and connectors when designing flood-resistant structures
- design safe structures that are connected and anchored to resist flotation, collapse, or permanent lateral movement during flood events, and
- communicate effectively and accurately with flood construction experts and authorities by using the correct terminology.

3. Introduction

3.1 Introduction and Terminology

Notes:

Let’s start with an introduction and some commonly used terminology.

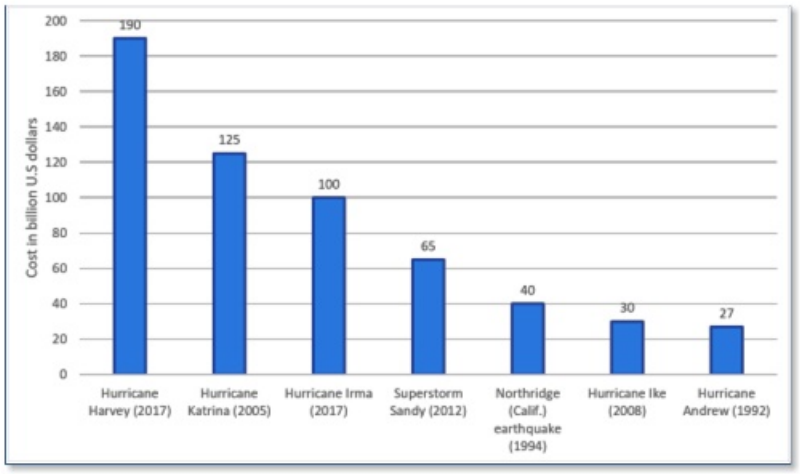
3.2 Understanding Floods

Notes:

Floods are the most common and most deadly natural disaster in the US and the world, and the situation is worsening. In the past five years, all states have had at least one significant flood, and 21 states have had frequent flooding.

Nearly 50% of the US population is within fifty miles of a coastline, and there are more than 3.5 million miles of streams and rivers in the US. Floodplains are dynamic, and flood maps such as those created by the Federal Emergency Management Agency (known as FEMA) must constantly be updated. Unfortunately for us, homeowners insurance does not typically cover flood damage or loss.

3.3 The Costs of Flooding



6 billion dollars in property damage

140 lives

More presidential disaster declarations

Notes:

Take a moment to look at this chart. It shows the cost of damages, for different storms occurring between 1992 and 2017.
The US Geological Survey notes that floods cause an average of 6 billion dollars in property damage, claim 140 lives, and prompt more presidential disaster declarations per year than any other hazard.
Hurricane Harvey damaged or destroyed more than 200,000 homes and businesses due to massive flooding from 30-50 inches of rainfall. Superstorm Sandy, which was considered a large flood event, significantly damaged or destroyed more than 305,000 homes.

3.4 Minor Mitigation Considerations

Notes:

Flood mitigation considerations can be minor or major, and they include:

- the acquisition of flood-prone properties through voluntary buyouts or sellouts and/or the relocation of buildings or even communities in an attempt to mitigate the problem completely. In the past 30 years, however, FEMA has funded fewer than 45,000 voluntary buyouts of flood-prone properties.
- floodproofing of basements
- elevating heating and air conditioning units
- elevating entire buildings or structures
- constructing new buildings well above current or predicted design elevation requirements in anticipation of future events, and
- forbidding new or reconstruction in floodplain or flood-prone areas.

3.5 Major Mitigation Considerations

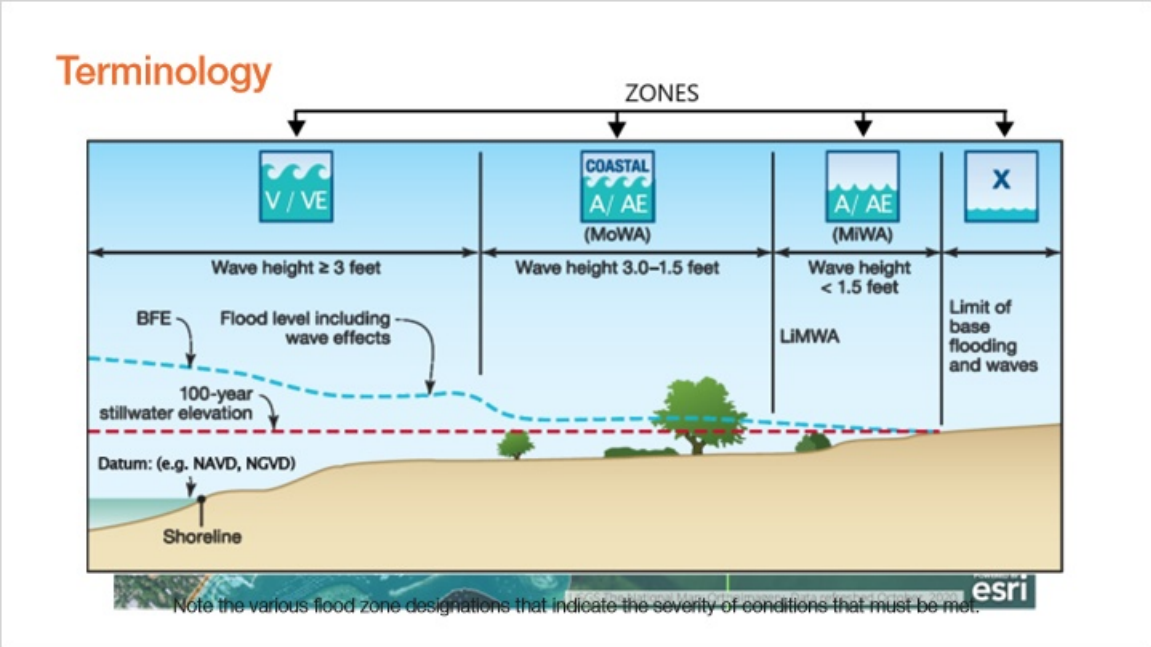
Notes:

The city of Norfolk, Virginia, has rewritten its entire zoning ordinance because of issues with frequent severe flooding. The new ordinance contains a universal requirement that any new or expanding development must situate its ground floor 1.5’ to 3’ above flood level as well as dictating where new development may be located.

The city of Miami is considering abandoning an entire neighborhood because of the increasing frequency of flooding, which is due primarily to sea level rise in this case. Real estate values on the coast have dropped significantly, and interior land prices have risen as people move inland to avoid danger.

Cities such as Houston, San Francisco, and New Orleans are creating new huge floodwater catchment areas, reconstructing wetlands, and creating major coastal defenses.

3.6 Terminology

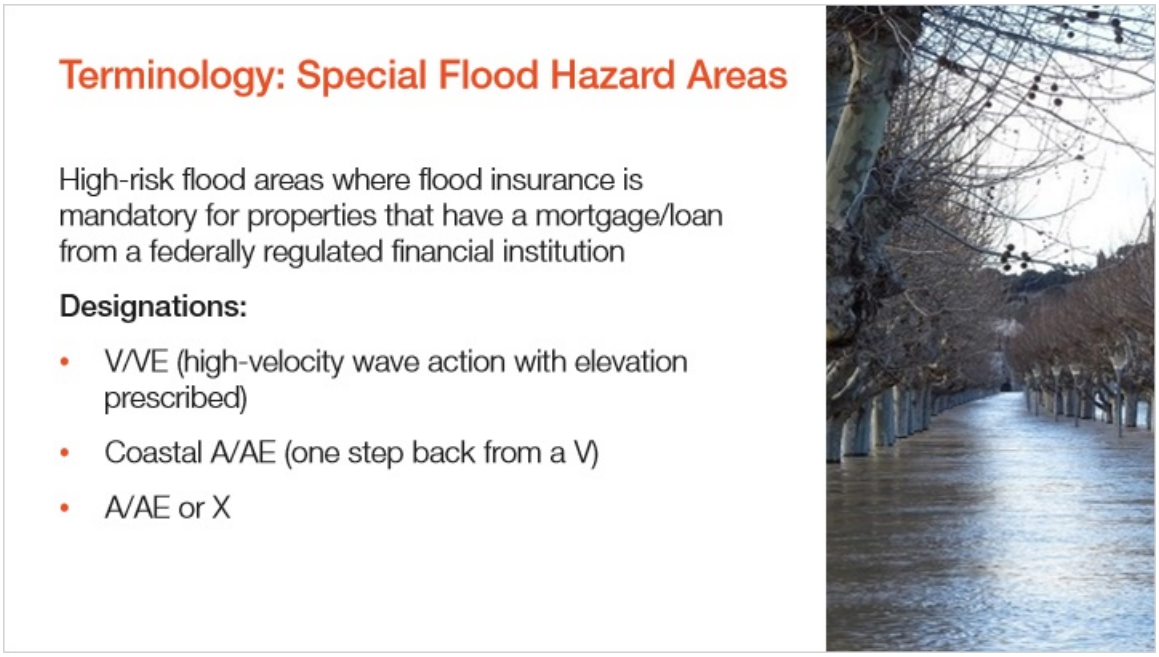


Notes:

In order to communicate effectively with flood design experts and to understand flood construction ordinances and maps accurately, it is critical that designers understand flood-related terminology that describes the nature and severity of flood events, flood zones, and flood-resistant construction.

This graphic illustrates important terminology. Familiarize yourself with the zones, wave heights, and water and wave elevations. When you are ready to continue, click Next, and we will dive in to the terminology a little deeper.

3.7 Terminology: Special Flood Hazard Areas



Notes:

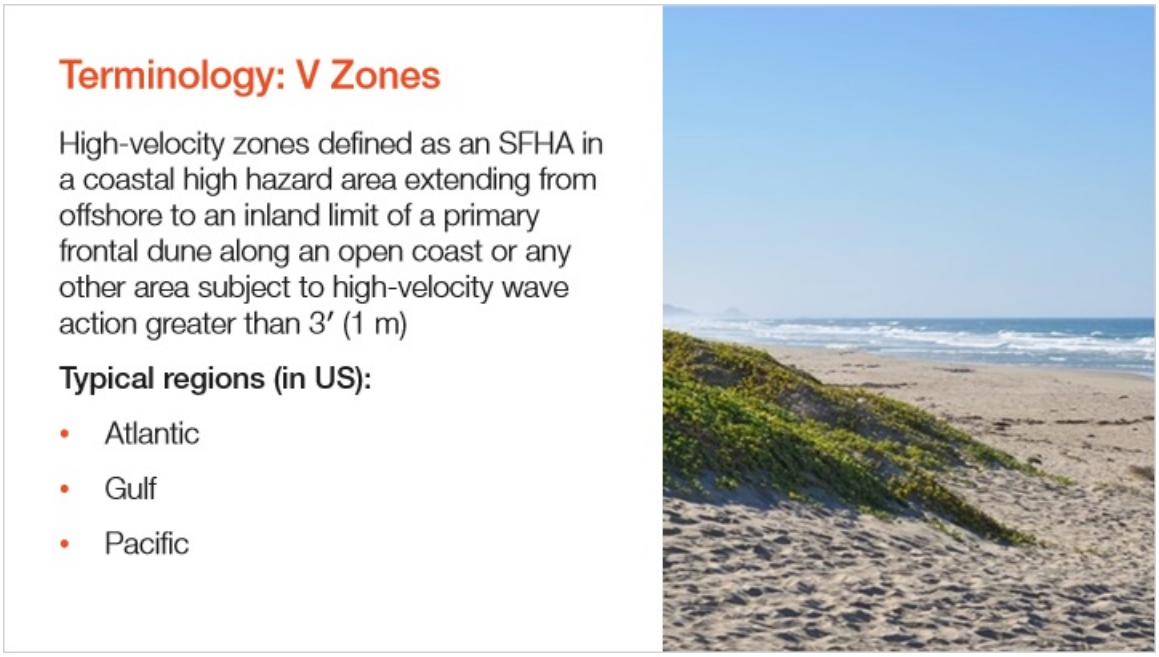
Special flood hazard areas (or SFHAs) are high-risk flood areas where flood insurance is mandatory for properties that have a mortgage or loan from a federally regulated financial institution.

They have various designations, such as:

- V/VE (high-velocity wave action with elevation prescribed),
- coastal A/AE (one step back from a V), and
- A/AE or X.

A number after the letter refers to the base flood elevation (or BFE), which is the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.

3.8 Terminology: V Zones



Notes:

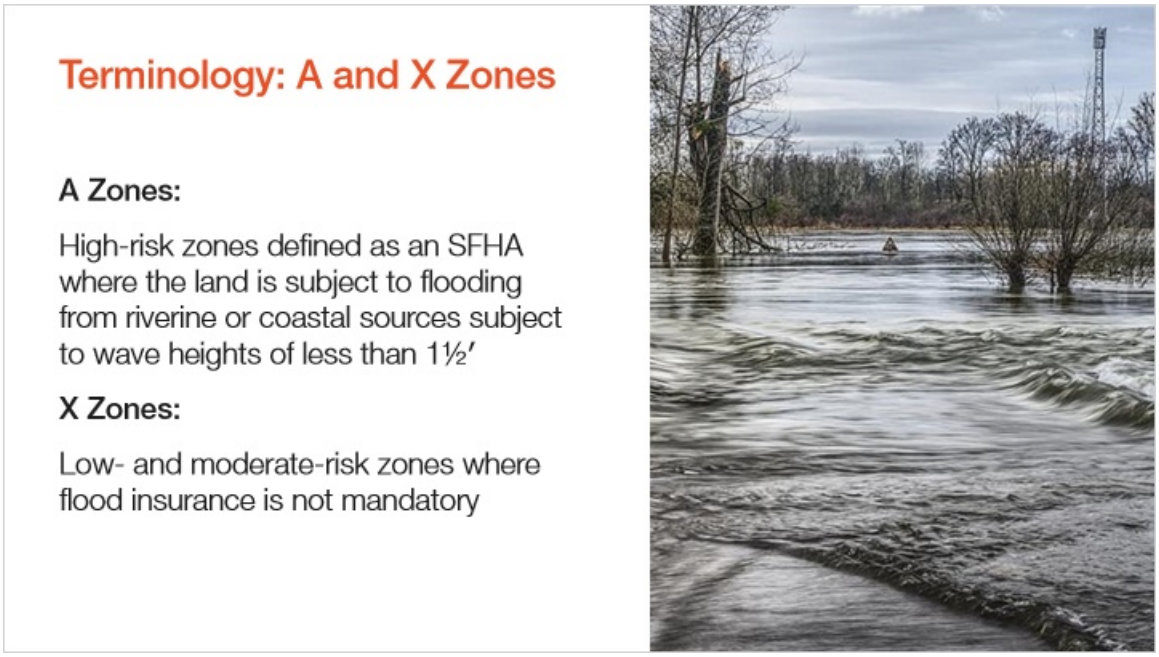
Let's talk about V zones. These are high-velocity zones defined as an SFHA in a coastal high hazard area extending from offshore to an inland limit of a primary frontal dune along an open coast or any other area subject to high-velocity wave action greater than 3'.

In many cases, the landward limit is defined by an unclear definition of the primary frontal dune rather than by analysis of water level or wave conditions.

V zones are well known along the Atlantic, Gulf, and Pacific coasts of the US. However, waves on southern Lake Michigan reached >20' during Superstorm Sandy, the second highest official reading for that lake on record.

Costal A zones have higher wave heights of 1.5 feet to 3 feet. And many of the requirements for a V zone, apply to costal A zones if the design is governed by ASCE 24.

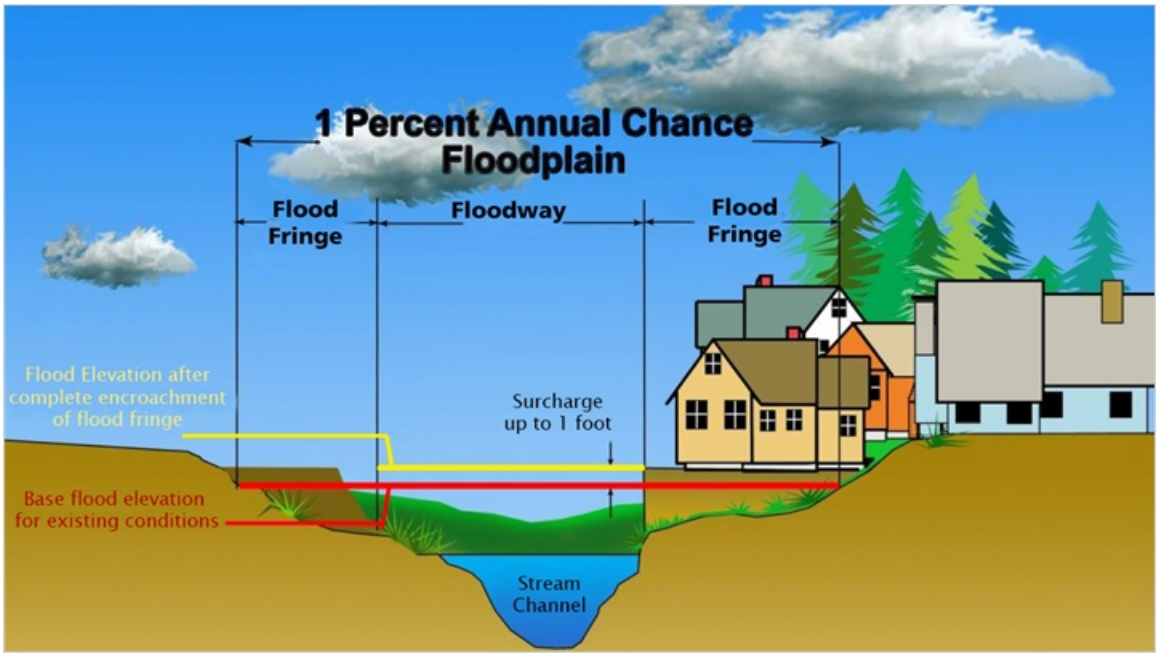
3.9 Terminology: A and X Zones



Notes:

A and X zones.
A zones are high-risk zones defined as an SFHA, where the land is subject to flooding from riverine or coastal sources subject to wave heights of less than 1½'.
X zones are low- and moderate-risk zones. Flood insurance is not mandatory in these zones, but it is highly advisable as 25% of all flood insurance claims occur outside of A or V zones.

3.10 Terminology: Floodways



Notes:

A floodway is that portion of the stream and the floodplain reserved to convey the base flood without cumulatively raising the water surface elevation to a point higher than a designated elevation.

Take a look at all the areas of this illustration, and click Next when you are ready to move on.

3.11 Terminology: Floodways

Notes:

Floodways vary in scale and definition. Some are well defined and relatively local, while others are very large, not as well defined, and cover vast areas.

Designers should determine whether they are designing buildings in a current floodway, a future one, or one that may grow over time.

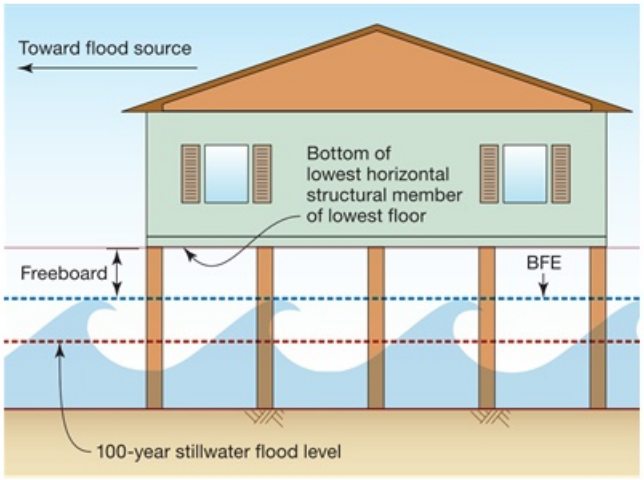
Because of continuously shifting weather patterns and behaviors and the shifting of flood conditions, sizes, and locations, FEMA is constantly redrawing its flood maps.

You can find more information at this link: here.

3.12 Terminology: Freeboard

Terminology: Freeboard

Additional height that the structure is protected from flood waters above the BFE (1′ to 2′ common)



Notes:

Freeboard is an additional amount of height above the BFE used as a factor of safety in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations.

In essence, it is the additional height that the structure is protected from flood waters above the BFE. In normal flood protection design, a freeboard of 1′ to 2′ is common, although there may be instances when this should be increased if future flood levels are not certain.

There could be instances where the original design freeboard has been eliminated by increases in flood levels; this could mean the structure must be raised even further.

The higher the freeboard used for the design, the less the flood insurance will cost the owner of the structure.

3.13 Terminology: Freeboard

Notes:

This gingerbread home illustrates the important issue of freeboard quite clearly. You can see the freeboard dimension between the white coconut layer (that represents the wave tops of a flood) and the red base of the house, that represents the underside of a structure.

4. General Flood Requirements

4.1 General Flood Requirements

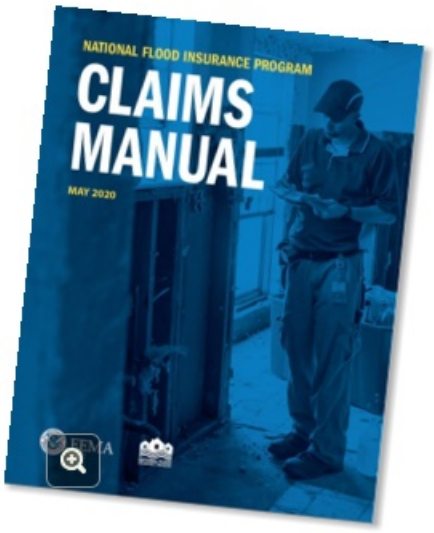
Notes:

Let’s move on to some general flood requirements.

4.2 General Flood Requirements

All new construction and substantial improvements shall be:

1. Designed (modified) and adequately anchored to prevent flotation, collapse, lateral movement of structure resulting from hydrodynamic and hydrostatic loads, including effects of buoyancy
2. Constructed with materials resistant to flood damage
3. Constructed by methods/practices that minimize flood damages



Notes:

The National Flood Insurance Program (NFIP) Section 60.3(a)(3) states that if a proposed building site is in a flood-prone area, all new construction and substantial improvements shall be:

1. designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy
2. constructed with materials resistant to flood damage, and
3. constructed by methods and practices that minimize flood damages.

Flooding is the only natural disaster for which the federal government provides insurance through FEMA's NFIP. According to the NFIP, to be eligible for flood insurance, there is a requirement that the community be constructed according to the criteria of floodplain construction.

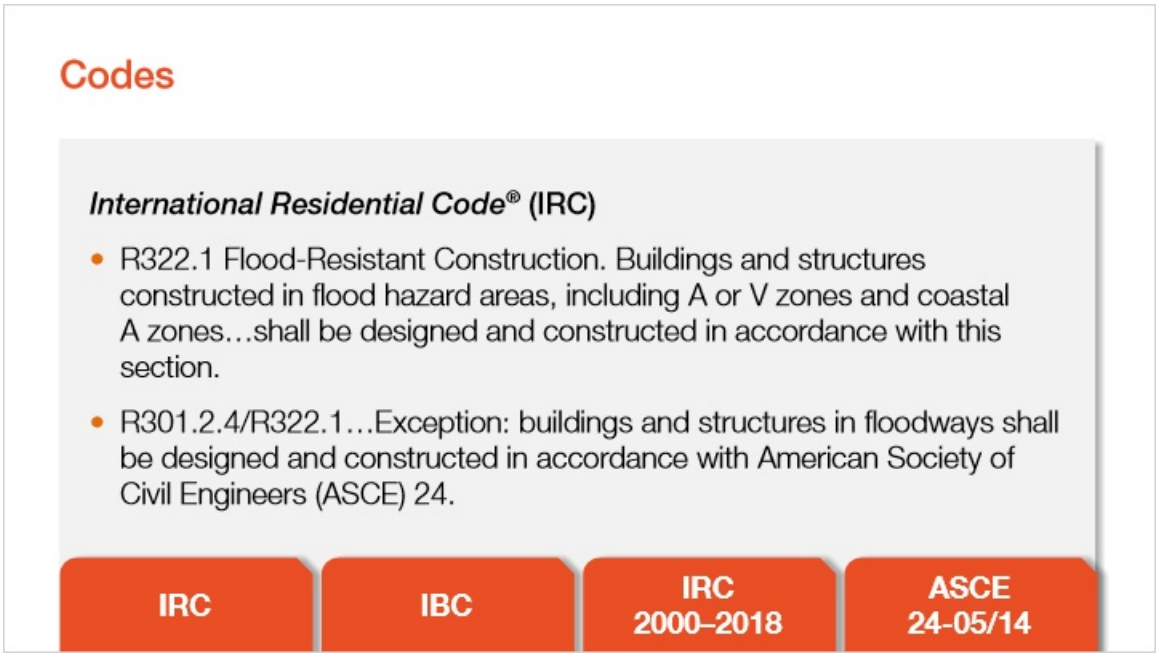
4.3 Codes

Notes:

The following codes outline requirements to comply with the concept of flood construction. Designers should become familiar with the full text of these sections. Because the IBC refers to ASCE 24, this course will reference the IRC and ASCE 24. The NFIP, IRC, and ASCE 24 all require structural systems to be designed, connected, and anchored to resist flotation, collapse, or permanent lateral movement from flooding**.**

Flip through the tabs on the screen to read about each code. When you're done, click Next to continue.

IRC (Slide Layer)



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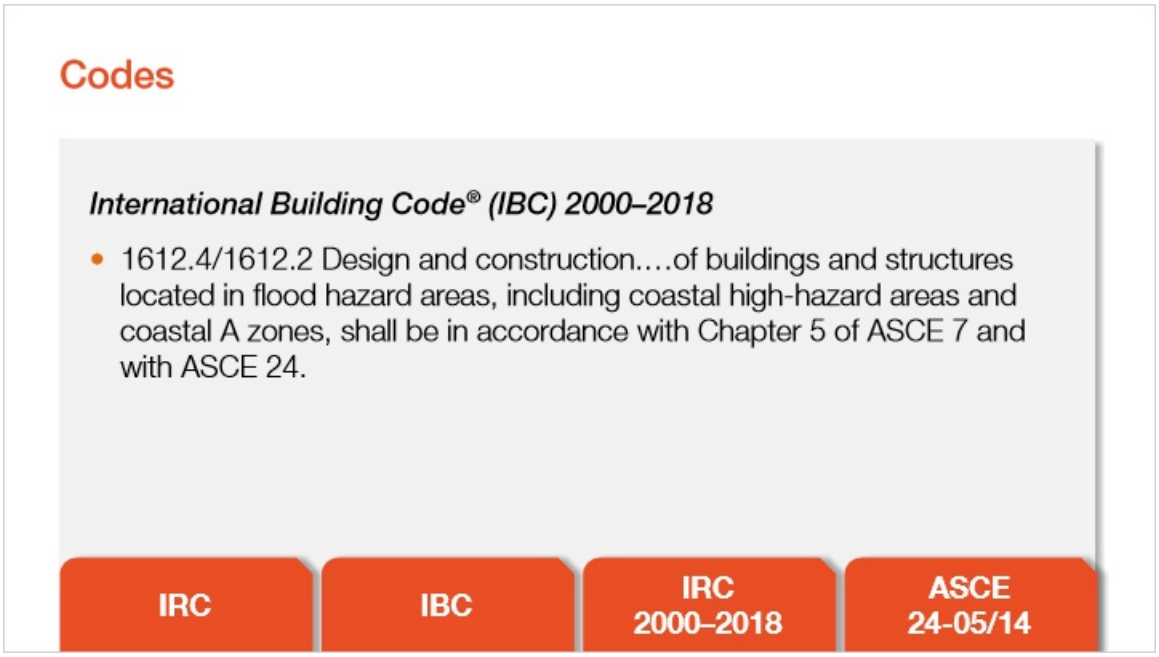
IBC (Slide Layer)



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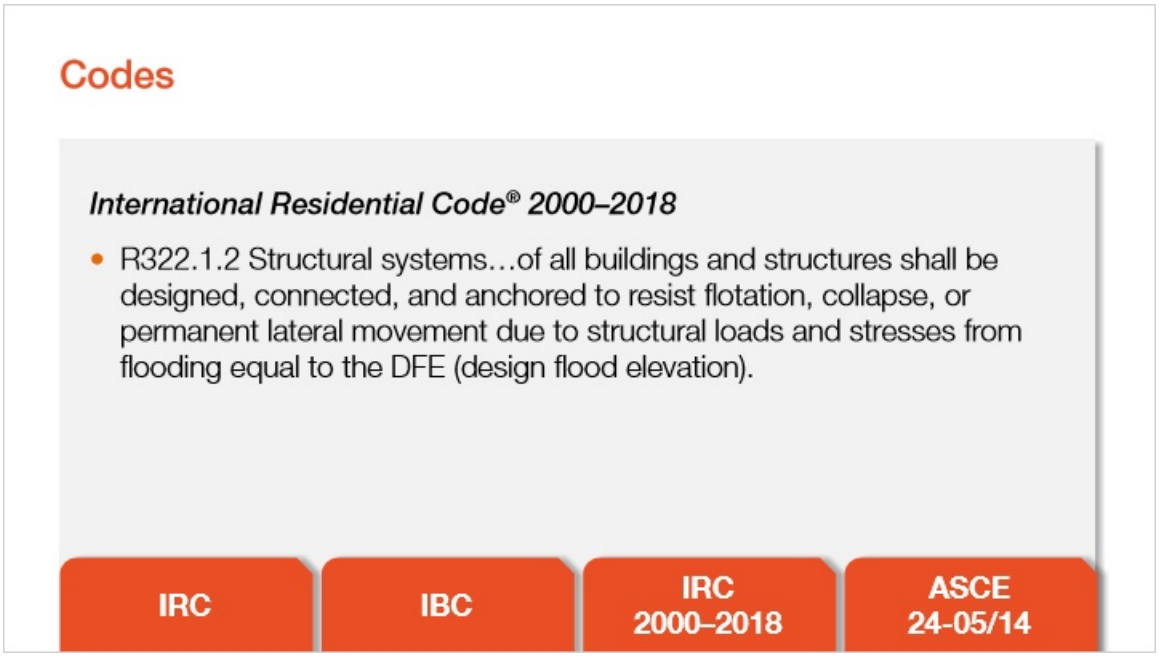
IRC 2000-2018 (Slide Layer)



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ASCE (Slide Layer)

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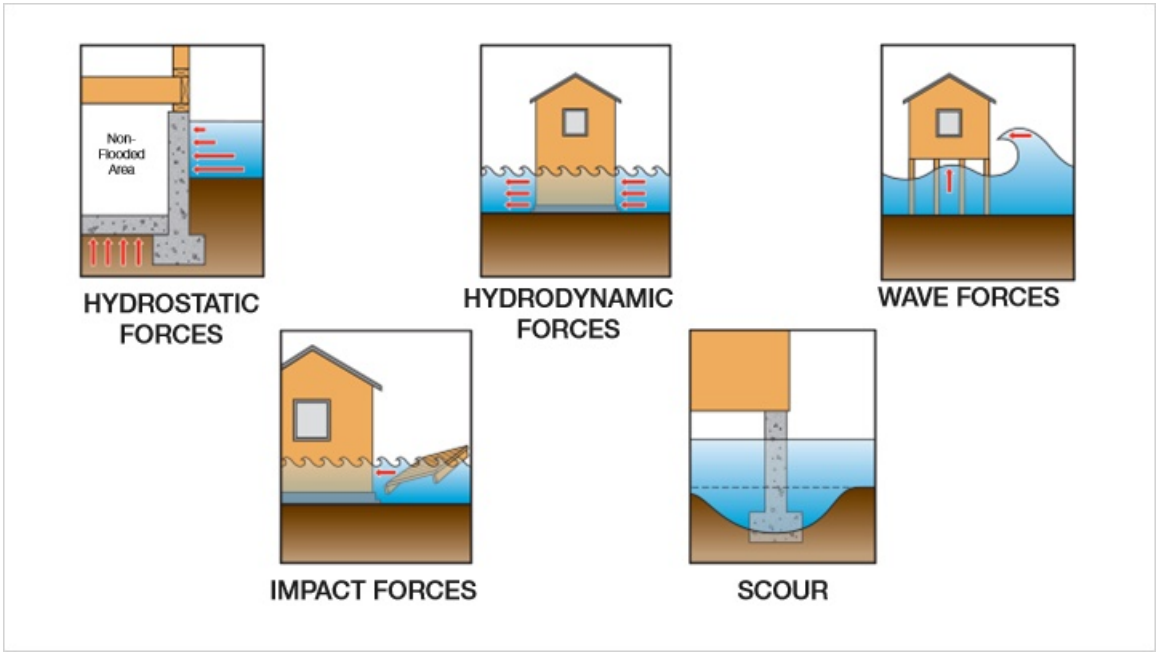
4.4 Flood Forces



Notes:

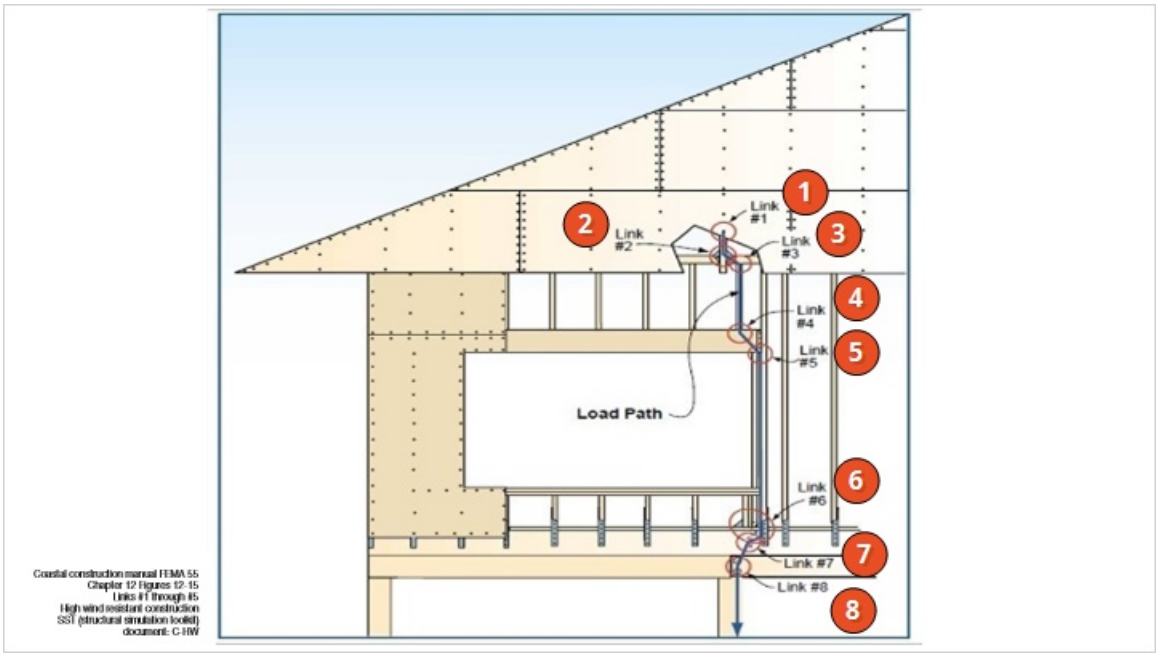
Flood-resistant construction must resist flood forces. Some of them are horizontal while others are vertical (referred to as uplift). There are hydrostatic forces, hydrodynamic forces, wave forces, impact forces, and scour.

4.5 Flood Forces

Notes:

Keep in mind that, especially during storms, buildings are subject to significant wind-related forces as well; all attachments and connections must be able to deal with both sets of forces simultaneously.

4.6 Providing a Continuous Load Path



Notes:

All loads and forces must be continuously transferred through the structure to the base of the foundation, and into the surrounding soils, and thus all the links in the path must be strong enough to transfer the loads without breaking or failing in any way. Click through the icons on this image to read about each of the 8 links.

4.7 Examples

Notes:

These photos show the potential consequences for non-flood-resistant construction or insufficient connection to the foundations. This home floated off its foundation, knocked into and damaged the adjacent house, and then floated 600 yards down the street.

4.8 Examples

Notes:

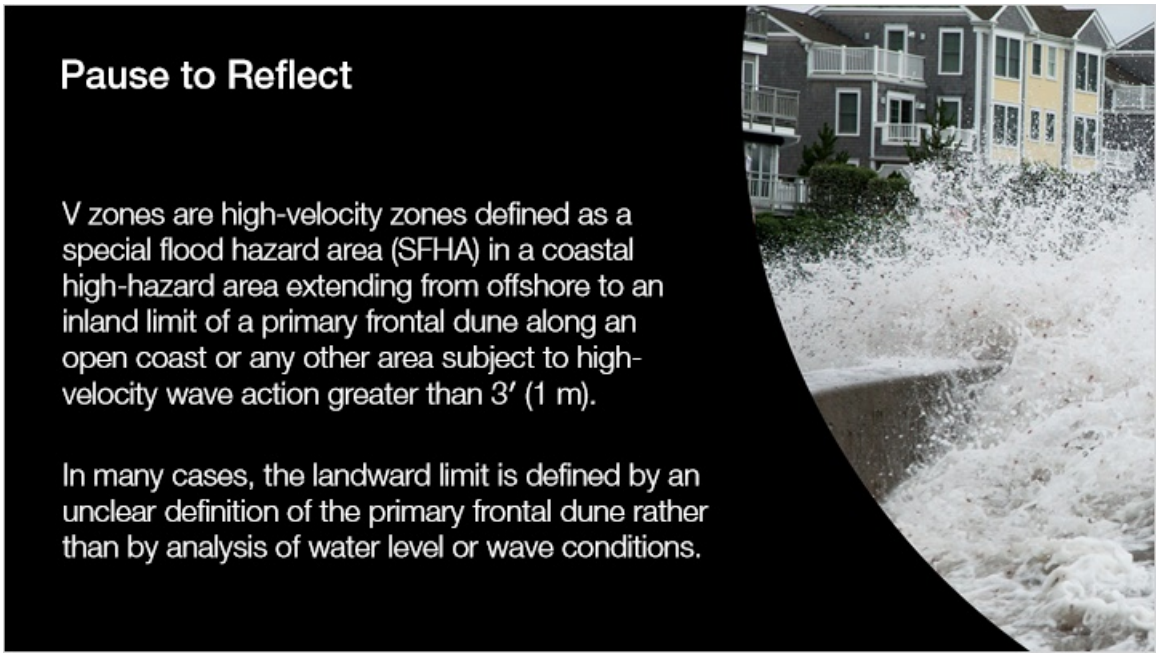
Here, we can see that this home totally collapsed from powerful flooding forces.

4.9 Review: Question 1

Notes:

Time for a quick review of what we've learned so far.

4.10 Review: Answer 1



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5. Flood Elevation Considerations

5.1 Flood Elevation Considerations

Notes:

Time to dive into flood elevation considerations.

5.2 Determining the Design Flood Elevation (DFE)

Determining the Design Flood Elevation (DFE)

The DFE is the elevation of flooding, including wave height, that is generally used for design.

The DFE = base flood elevation (BFE) + freeboard. Thus: *The DFE will always be the BFE or higher.*

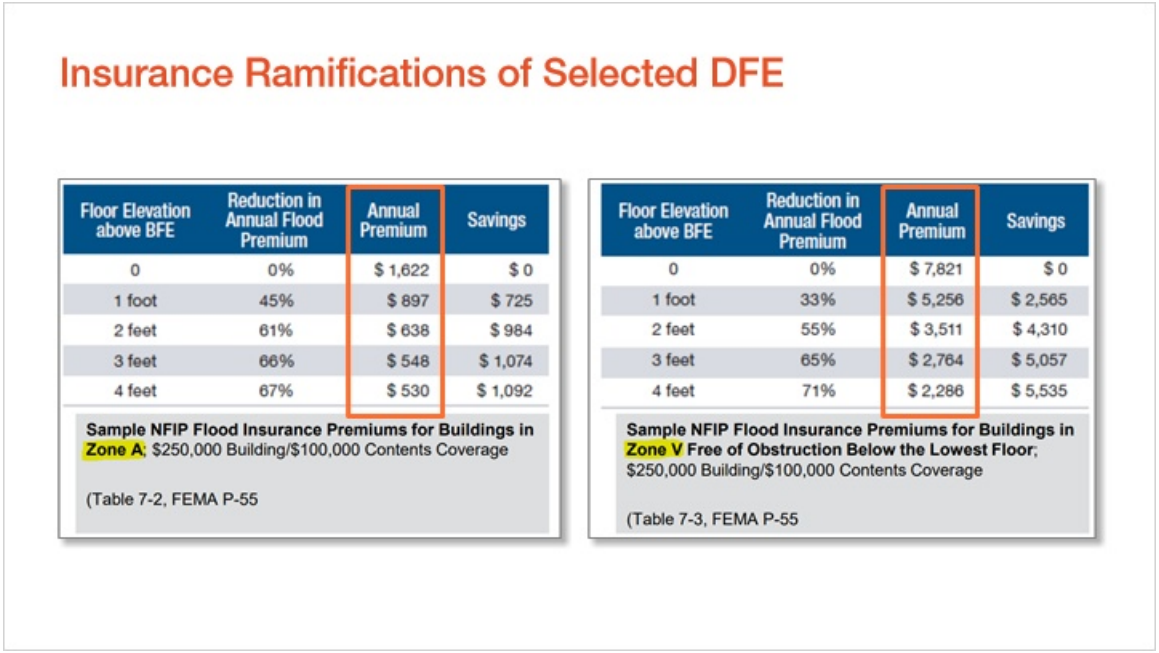
		Flood Design Class 1	Flood Design Class 2	Flood Design Class 3	Flood Design Class 4
Minimum Elevation* of Lowest Floor (Zone A: ASCE 24-14 Table 2-1)	Zone A not identified as Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher
Minimum Elevation of Bottom of Lowest Horizontal Structural Member (Zone V: ASCE 24-14 Table 4-1)	Coastal High Hazard Areas (Zone V) and Coastal A Zone	DFE	BFE +1 ft or DFE, whichever is higher	BFE +2 ft or DFE, whichever is higher	BFE +2 ft or DFE, or 500-year flood elevation, whichever is higher

Notes:

This chart outlines how to determine the design flood elevation (DFE) for ASCE 24. The DFE is the elevation of flooding, including wave height, that is generally used for design. The DFE is equal to base floor elevation (BFE) plus freeboard. Thus the DFE will always be the BFE or higher.

Review the chart, then click next when you're ready to continue.

5.3 Insurance Ramifications of Selected DFE



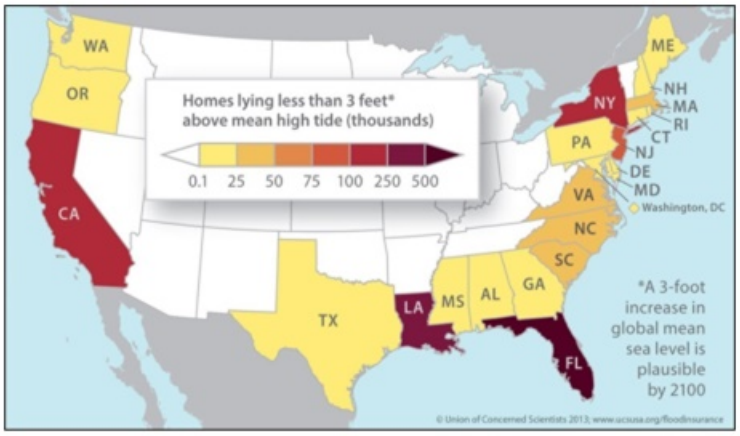
Notes:

These 2 graphics show the insurance ramifications of selected DFE for Zones A and V. Note that insurance premiums drop when a higher floor level above BFE or DFE is selected. As noted previously, a higher DFE means that a higher freeboard dimension has been used for the design of a structure.

5.4 Determining the Flood Event to Design for

Consider:

- there have been at least 25 500-year floods since 2010!
- sea level rise*
- climate change



Notes:

How do you determine the flood event you should design for? Should you design to the 500-year flood? This is now a minimum for Flood Design Class 4 in ASCE 24-14.

According to the National Climate Assessment study, more than 1 trillion dollars of property and structures in the US are at risk of inundation from a sea level rise of 2' above current sea level, which could be reached by 2050. That's not so far away!

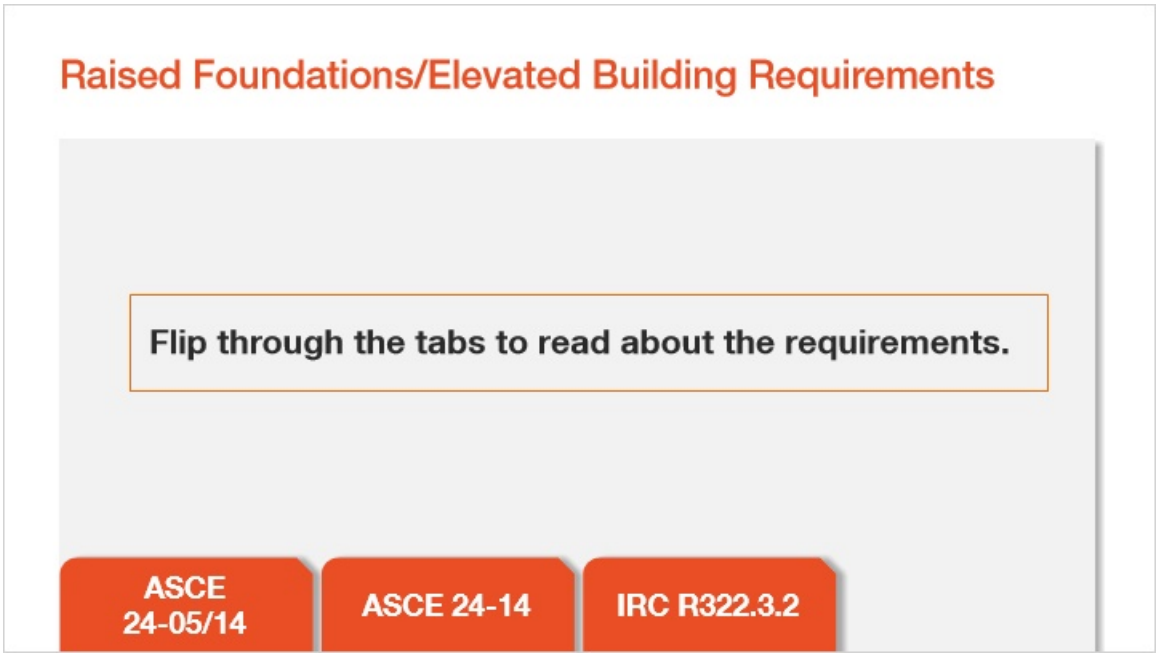
6. Raised Foundations and Connections

6.1 Raised Foundations and Connections

Notes:

Moving on to raised foundations and connections.

6.2 Raised Foundations/Elevated Building Requirements



Notes:

Let's take a look at raised foundations and elevated building requirements. Designers should always verify which codes are applicable in their area, and in the case of conflict or doubt, they should design to the strictest standard.

There are some more tabs with code information on this slide and the following slides. When you see the tabs, flip through them to read about each one, then click Next when you're ready to proceed.

ASCE 1 (Slide Layer)

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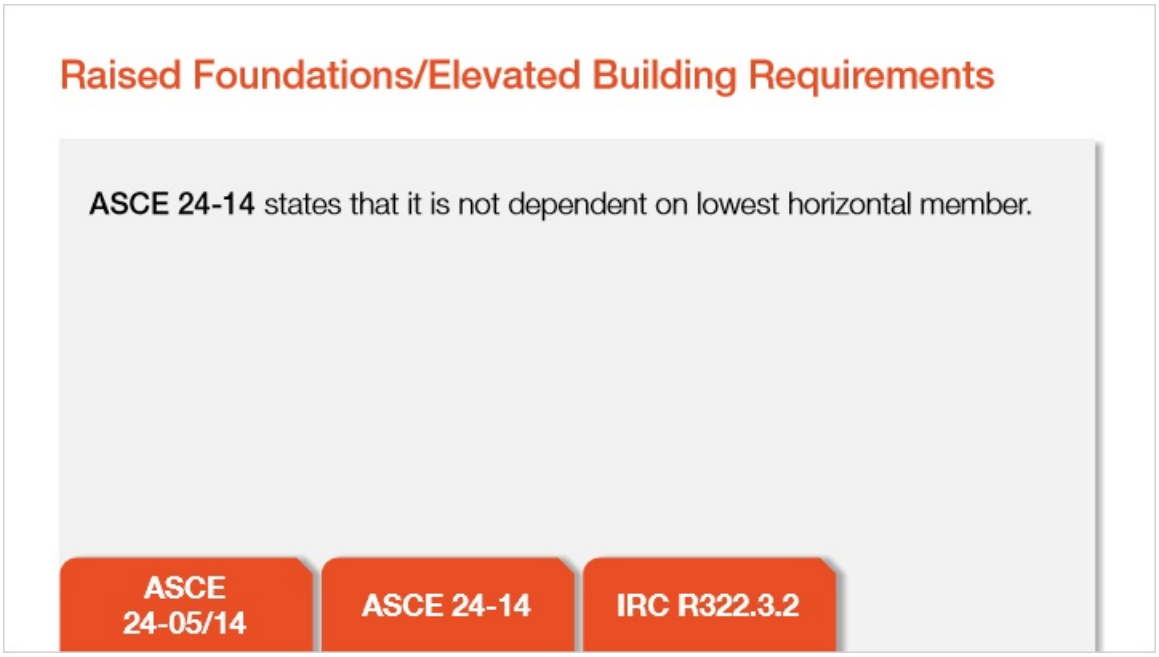
ASCE 2 (Slide Layer)



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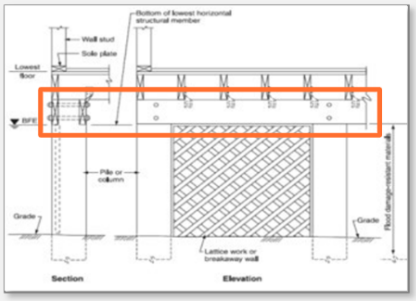
IRC (Slide Layer)

Raised Foundations/Elevated Building Requirements

IRC R322.3.2 elevation requirement for V zones and coastal A zones is:

- 1.2. BFE plus 1′: The reference is the bottom of the lowest portion of all horizontal structural members supporting the lowest floor.*



*NY requires 2′ of freeboard to BFE

ASCE 24-05/14 | ASCE 24-14 | IRC R322.3.2

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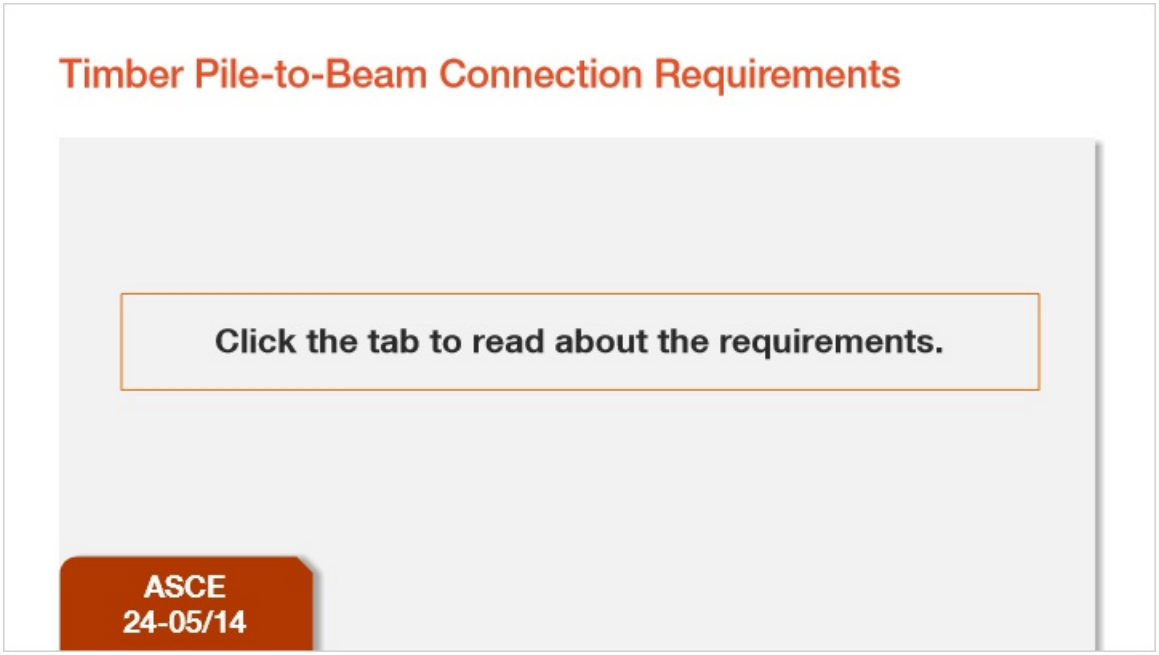
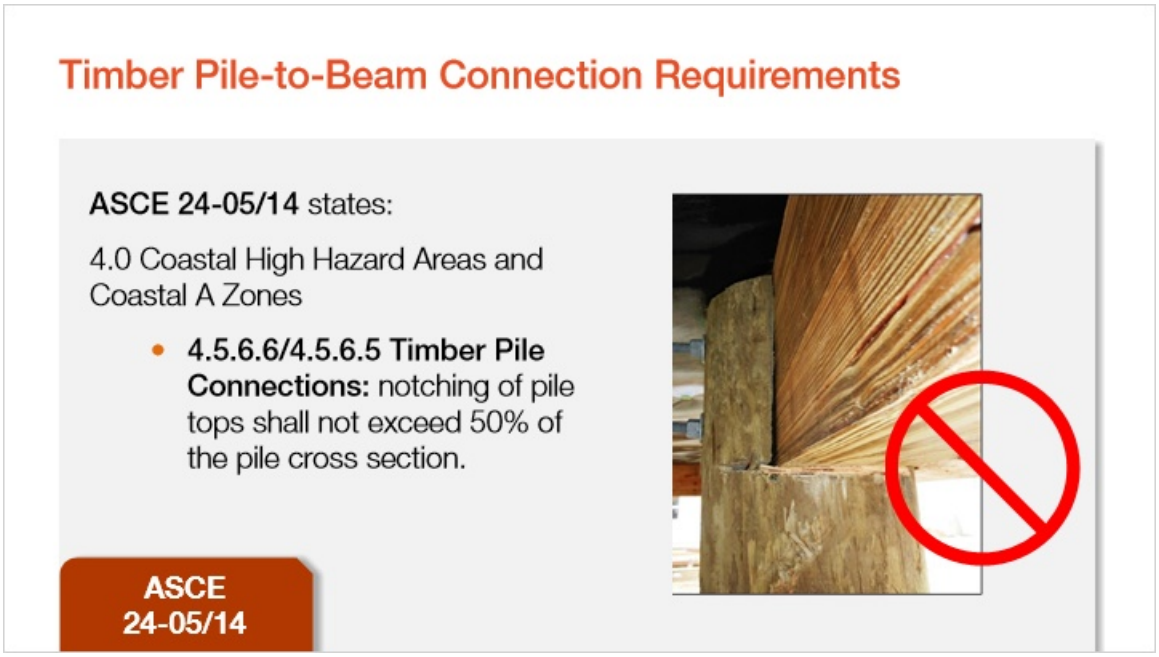
6.3 Timber Pile-to-Beam Connection Requirements



Notes:

Timber pile-to-beam connection requirements. Here's another tab for you to take a look at.

ASCE 1 (Slide Layer)



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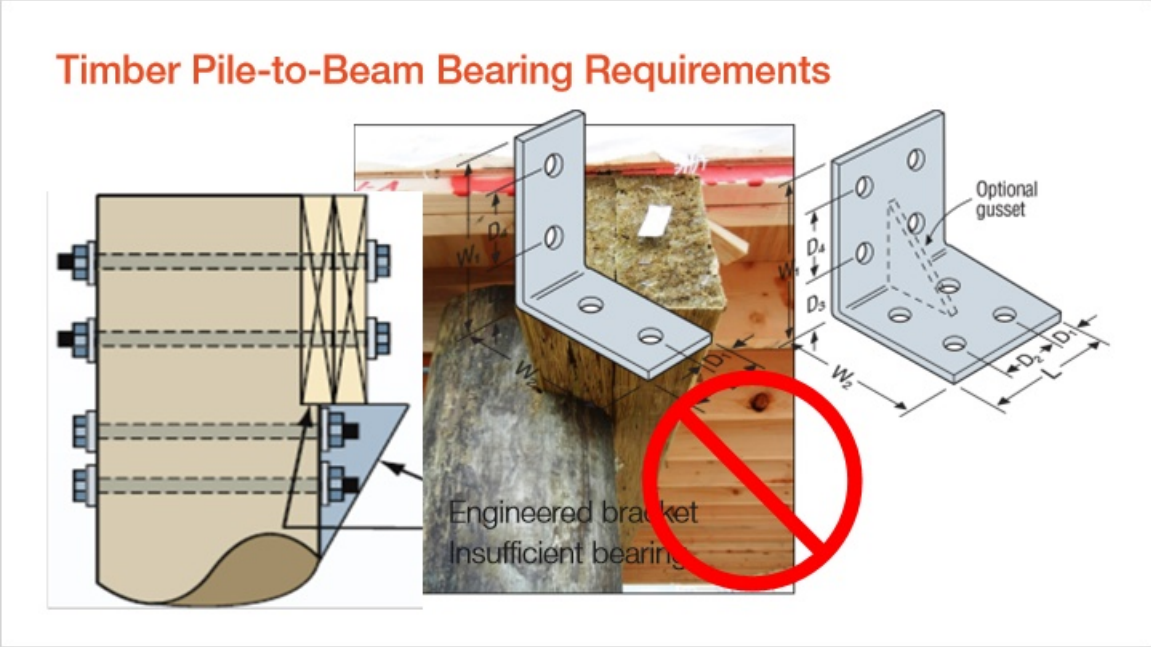
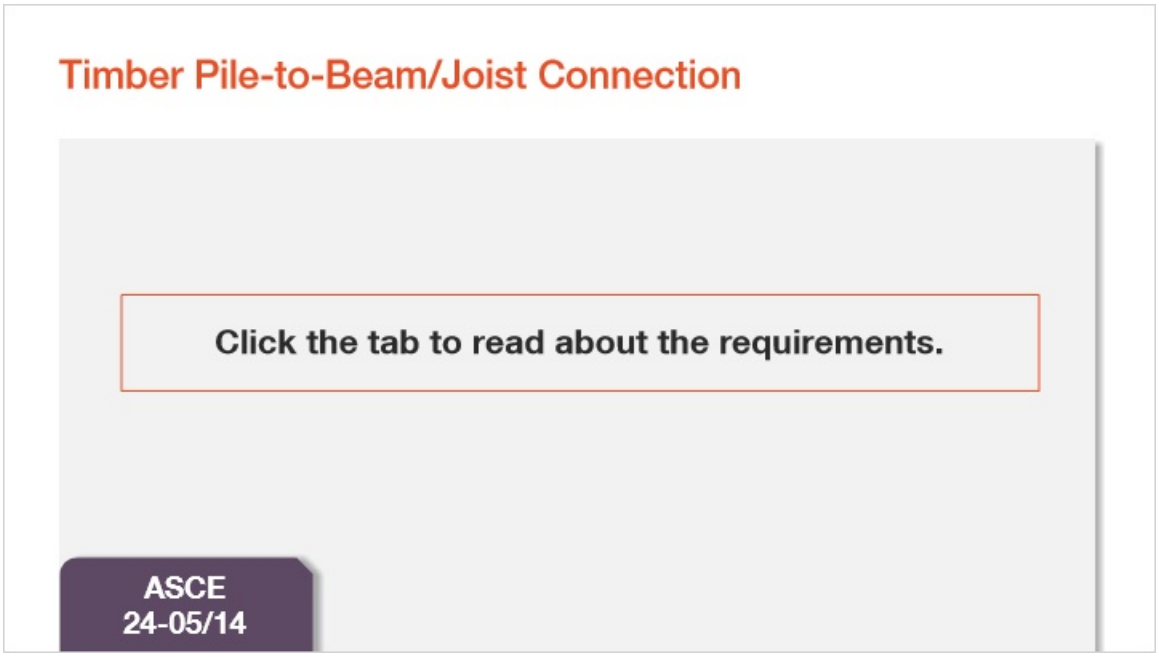
6.4 Timber Pile-to-Beam Bearing Requirements



Notes:

Timber pile-to-beam bearing requirements. If the bearing under the beam is insufficient, it is necessary to install an engineered bracket and to have the connection designed by an engineer.

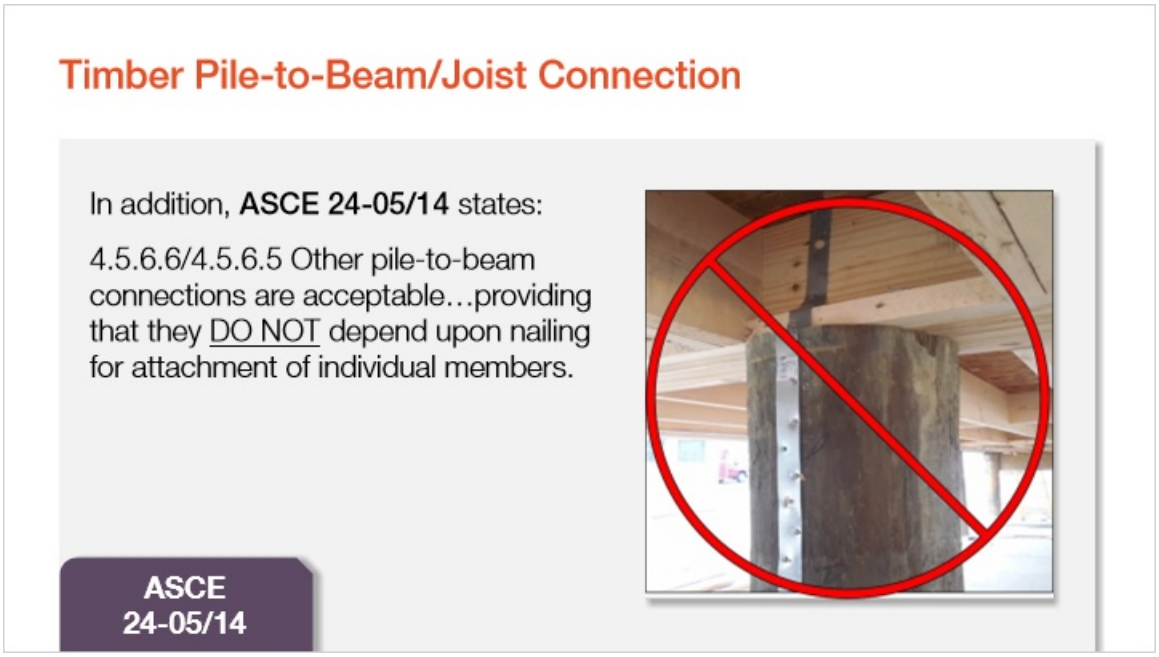
6.5 Timber Pile-to-Beam/Joist Connection



Notes:

Timber pile-to beam or joist connection. Unless otherwise noted, bending steel in the field may cause fractures at the bend line. Fractured steel will not carry the load and must be replaced.

ASCE 1 (Slide Layer)



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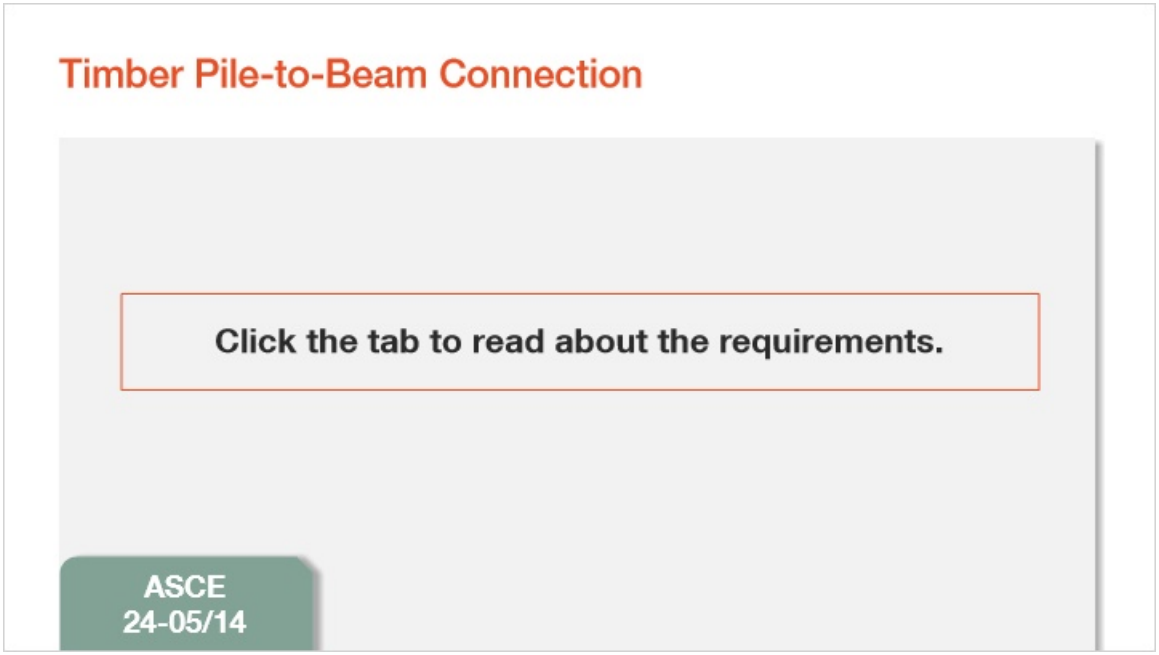
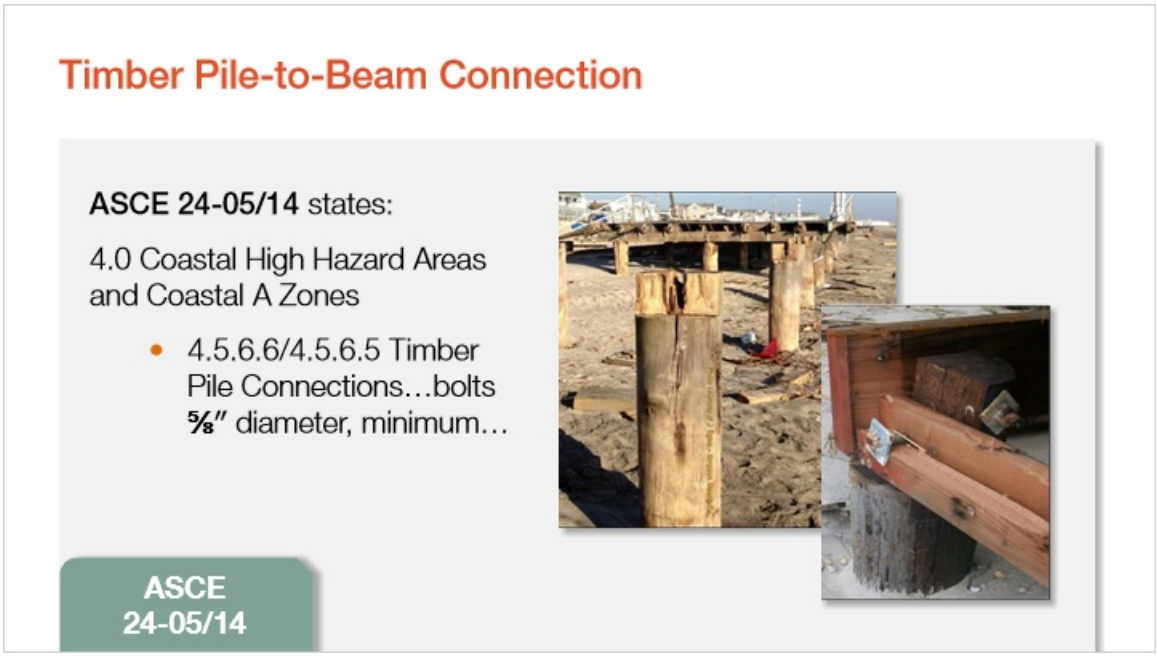
6.6 Timber Pile-to-Beam Connection



Notes:

Timber pile-to-beam connection. One common wood failure is the tearing of the wood perpendicular to the grain at bolt holes.

ASCE 1 (Slide Layer)



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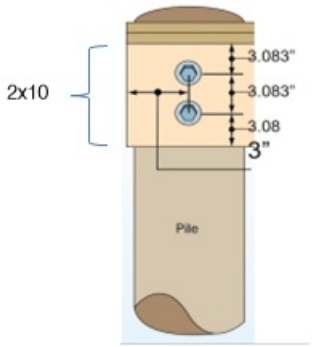
6.7 Timber Pile-to-Beam Connection: ⅝" Bolts

Timber Pile-to-Beam Connection: ⅝" Bolts



BOLT DIAM				
0.62				
END DISTANCE DIAMETERS (D)	INCHES	ACTUAL INCHES (best case scenario)	INCHES NEEDED FOR FULL CAPACITY	C_Δ = Geometry factor
2	1.24			
2.5	1.55			
3	1.86			
3.5	2.17			
4	2.48	3.08	4.34	0.71
5	3.1			
6	3.72			
7	4.34			
8	4.96	(9.25/3)	(7 diam)	

Parallel to grain end distance requirements in uplift = 7 diameters (see NDS 2015 table 12.5.1A).

Notes:

Now, timber pile-to-beam connection for the use of 5/8" bolts. Review this chart. Parallel to grain end distance requirements in uplift = **7 diameters** (see NDS 2015 table 12.5.1A).

NDS is the American Wood Council (AWC) *National Design Specification® for Wood Construction*.

6.8 Timber Pile-to-Beam Connection: ⅝" Bolts

Timber Pile-to-Beam Connection: ⅝" Bolts

BOLT: SHEAR CALCULATION (UPLIFT)

BOLT DIAMETER	$Z' = Z * C_D * C_M * C_g * C_\Delta$	
5/8	Z = shear per bolt (see AWC calc output)	780
	C_D = wind uplift	1.6
	C_M = wet service	0.7
	C_g = Group action factor (1.0 to be conservative)	1.0
	C_Δ = Geometry factor (end and edge distance requirements; spacing of fasteners in a row.)	0.71
	Quantity of bolt	2
	Z' = total shear capacity of connection (lbs)	**1,240**

Notes:

This chart outlines the shear calculation (or uplift). Take a look before moving on.

6.9 Timber Pile-to-Beam Connection: Proprietary Screw

Notes:

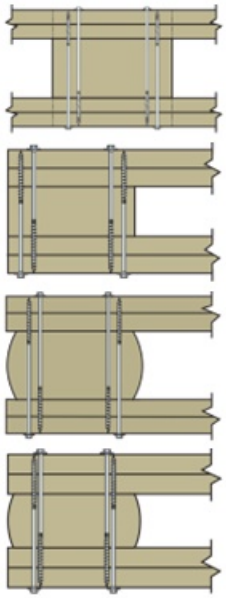
A proprietary, hot-dip galvanized screw is a 0.276” diameter screw suitable for heavy-duty marine and coastal applications.

This screw:

- Installs from one side
- Does not require predrilling or auger bits
- Does not require you to purchase separate washers, nuts, and bolts, and
- Eliminates the need for separate washers due to the oversized 0.903” diameter integral washer.

6.10 Timber Pile-to-Beam Connection: Proprietary Screw

- Good for single and double stringers
- Good for square / round piles
- Have an ASTM A153 Class-C HDG coating suitable for coastal and marine environments (minimum ASCE 24 requirement)
- Available in lengths of 4″, 6″, 8″, 10″, and 12″

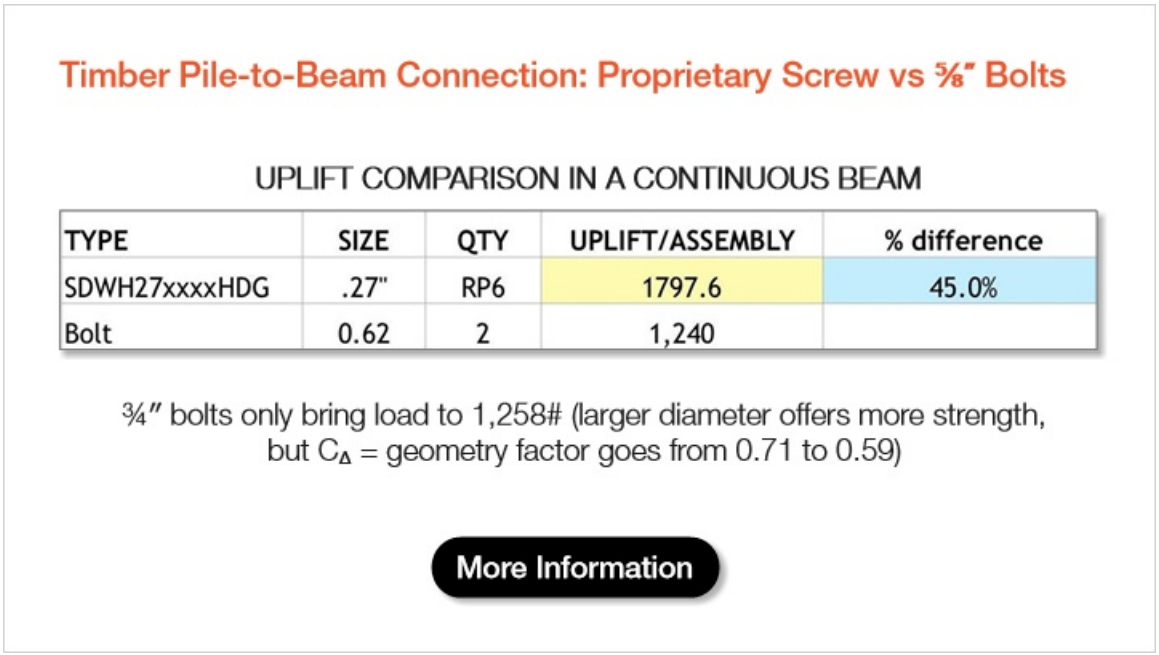


Notes:

Proprietary screws:

- are good for single and double stringers
- are good for square or round piles
- have an ASTM A153 Class-C HDG coating suitable for coastal and marine environments (the minimum ASCE 24 requirement), and
- are available in lengths of 4”, 6”, 8”, 10”, and 12”.

6.11 Timber Pile-to-Beam Connection: Proprietary Screw vs ⅝" Bolts



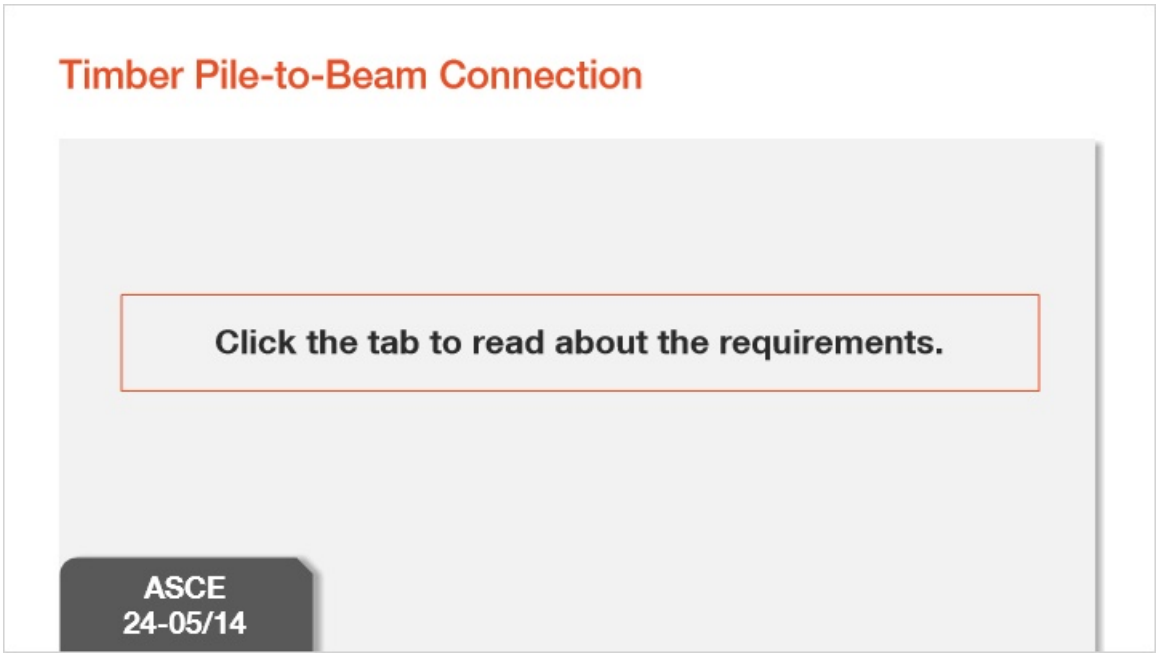
Notes:

Let's compare proprietary screws and 5/8" bolts.

Larger bolts must be a greater distance from the edge (7x the diameter) for full capacity because the bolt is more likely to fail (or tear through the wood) without this additional edge distance. Because the size of the wood member doesn't change, the bolt holes become closer to the edge and the load permitted would need to be reduced by the geometry factor.

Wood connections are stronger when the load is spread out over a number of fasteners. To accomplish this, designers should consider using more, smaller fasteners and fewer, larger ⅝" bolts when possible. You can find more information at the link on this page.

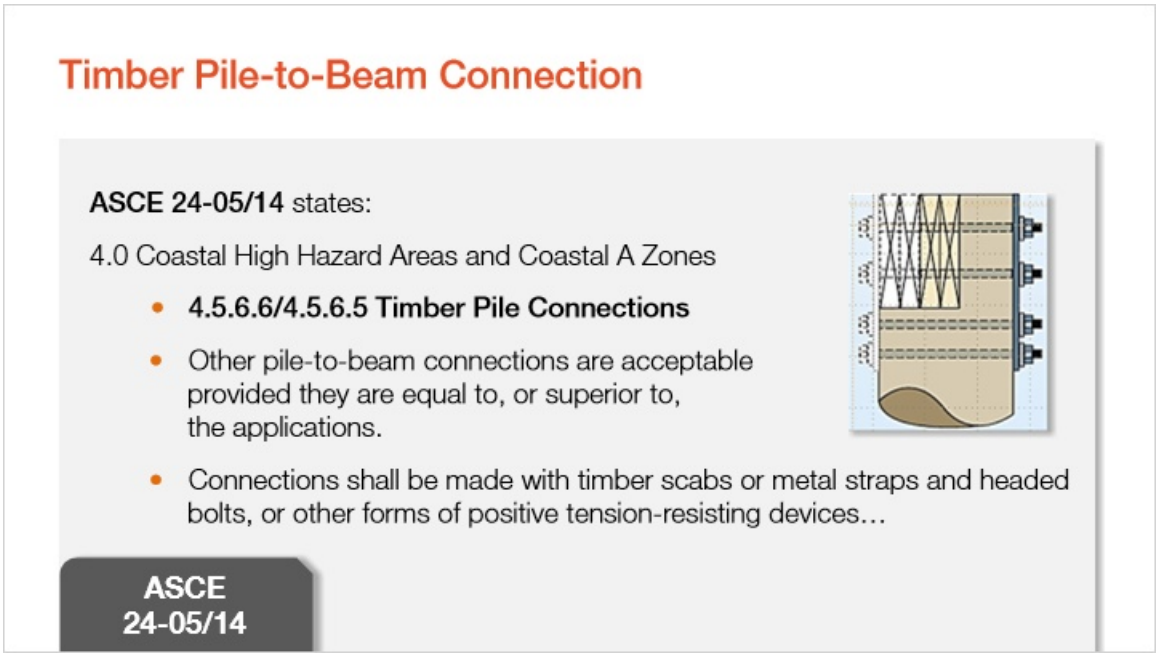
6.12 Timber Pile-to-Beam Connection



Notes:

Here's another tab. Click to take a look.

ASCE 1 (Slide Layer)



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6.13 Timber Pile-to-Beam Connection:

Piling Straps

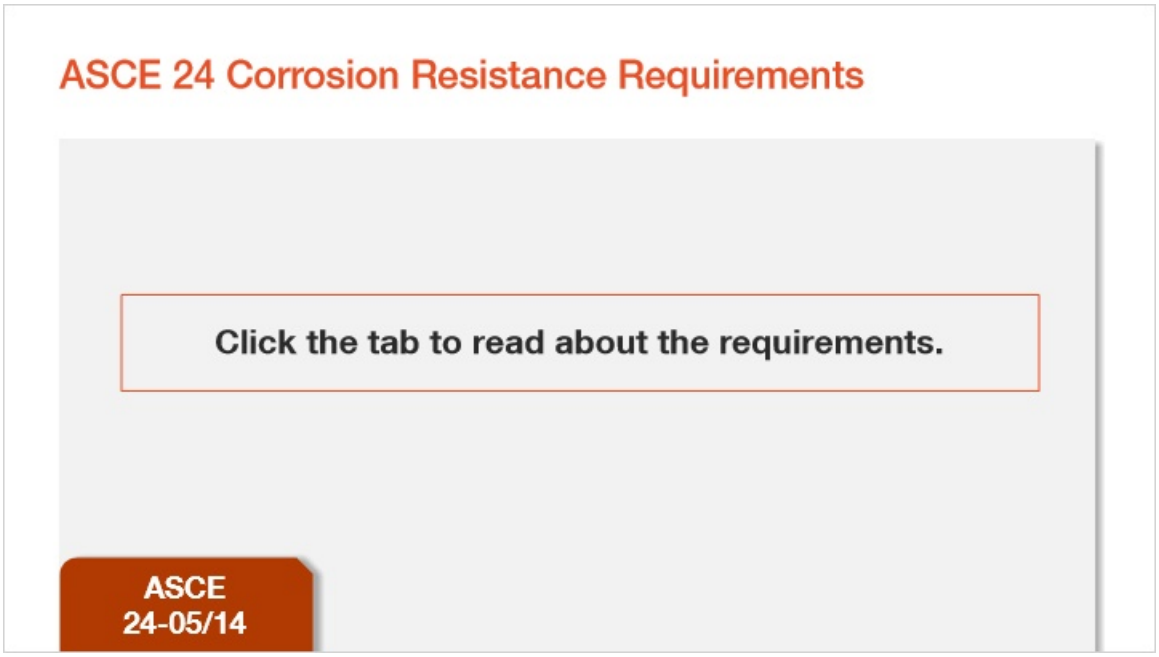
Notes:

Piling straps can also be used.

You can use them:

- where there is insufficient uplift resistance from the pile-to-beam connection, or
- as another pile-to-beam option.

6.14 ASCE 24 Corrosion Resistance Requirements



Notes:

Review these ASCE 24 corrosion-resistance requirements, and click next when you're ready to move on.

ASCE 1 (Slide Layer)

No audio on this slide layer.

6.15 ASCE 24 Corrosion Resistance Requirements

Note:

- ASTM A653, G185, and G90 connectors are hot-dip galvanized *prior* to fabrication.
- Batch/Post-HDG connectors per ASTM A123, grade 95 are hot-dip galvanized *after* fabrication. (Amount of zinc varies with the thickness of the steel and must be ≥14 ga.)

Therefore:

All exposed connectors and fasteners based on the IBC or in floodways shall meet the following guidelines:

- Connectors: Batch/Post-HDG (ASTM A123, grade 95) or 316 stainless steel
- Fasteners: HDG per ASTM A153, class C (2.1 mils/53 microns min.) or stainless steel

Notes:

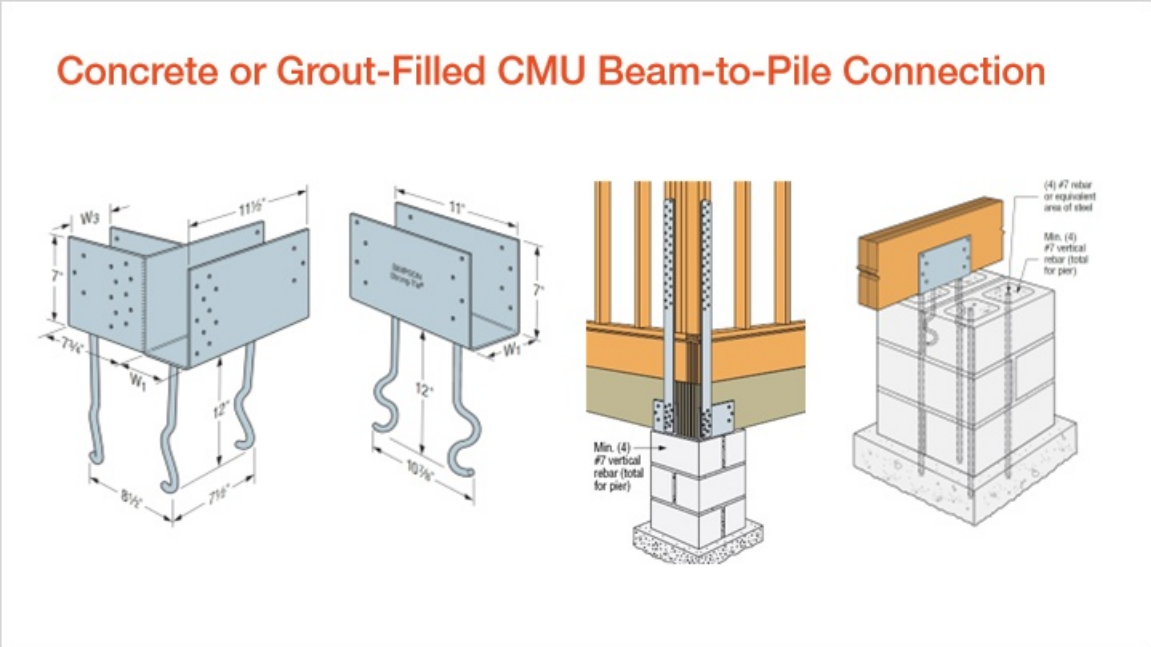
Click next when you're ready to proceed.

6.16 Building in a Flood Hazard Zone

Notes:

Here you can see a lack of hardware at all the connections. This construction is relying solely on friction to resist all horizontal and vertical forces. This would be insufficient during a flood, and this building would be likely swept off its piers.

6.17 Concrete or Grout-Filled CMU Beam-to-Pile Connection



Notes:

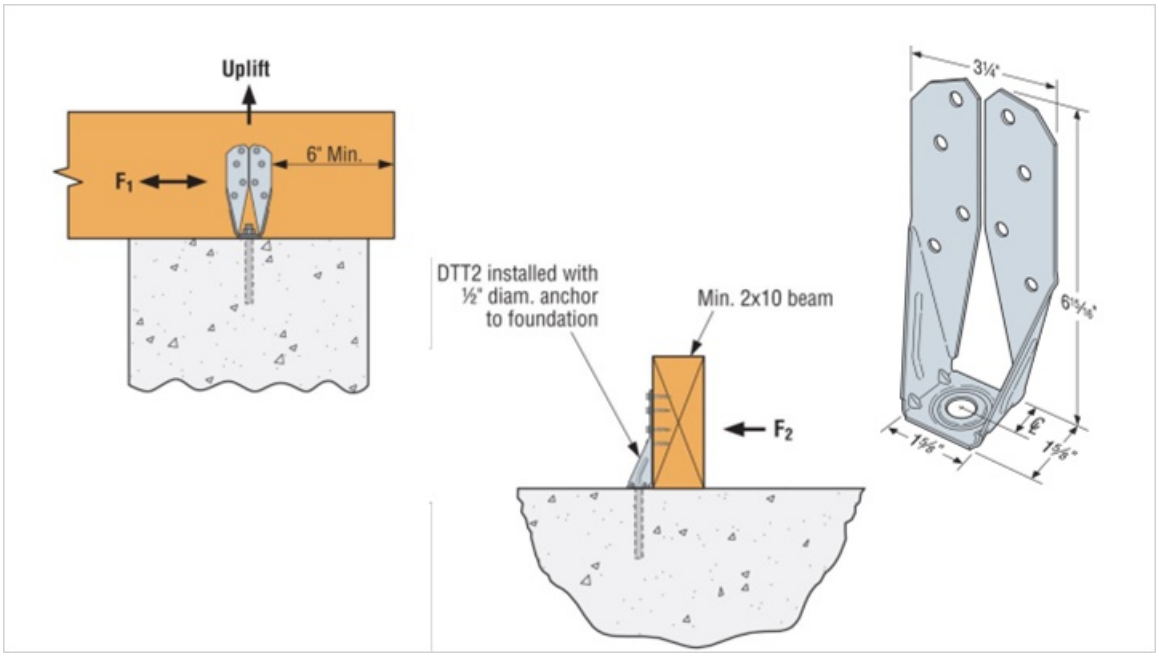
Let's take a look at concrete or grout-filled CMU beam-to-pile connection.

Many structures use concrete or masonry piers to support elevated framing. These piers function much like the wood piles that were reviewed previously.

They take both uplift and lateral forces from the framing above and transfer them to the foundation.

Options like the column caps are cast-in-place at the time of construction.

6.18 Concrete or Grout-Filled CMU Beam-to-Pile Connection



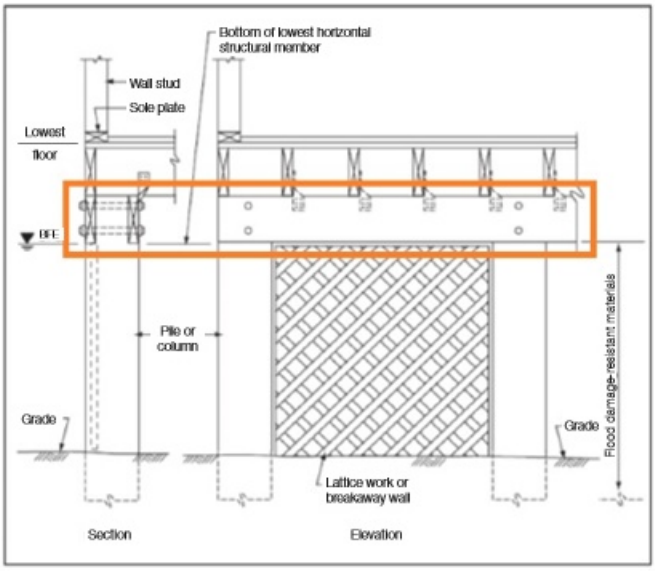
Notes:

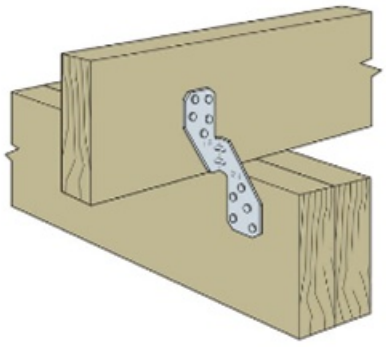
Other options may allow for a post-installed or retrofit solution such as the hold-down shown here on the right.

It is important to note that the concrete and masonry piers must be constructed to resist the forces transferred into them.

They should have the proper amounts of reinforcing bar and appropriate compressive strength for the grout or concrete.

6.19 Beam-to-Joist Connections Pre-Superstorm Sandy

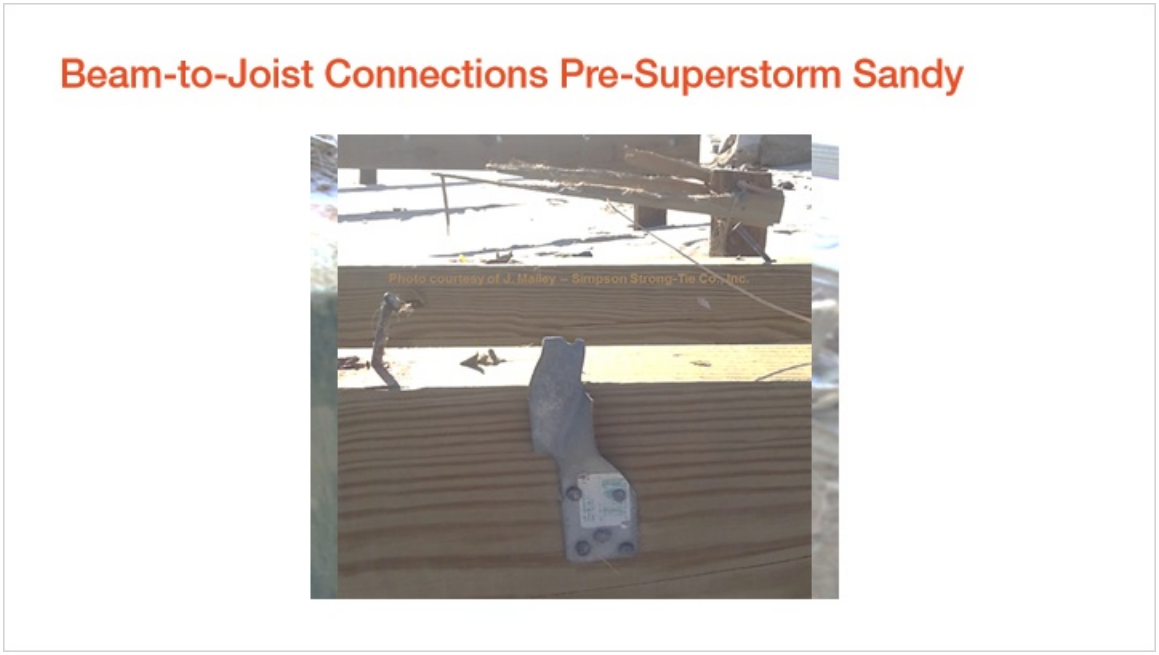




Notes:

These images show FEMA detail prior to Superstorm Sandy, showing the H2.5-type connector.

6.20 Beam-to-Joist Connections Pre-Superstorm Sandy



Notes:

We can see here, how (unfortunately) the connectors failed during the storm because they lacked the capacity to transfer the loads and forces.

6.21 Beam-to-Joist Connections Pre-Superstorm Sandy

Notes:

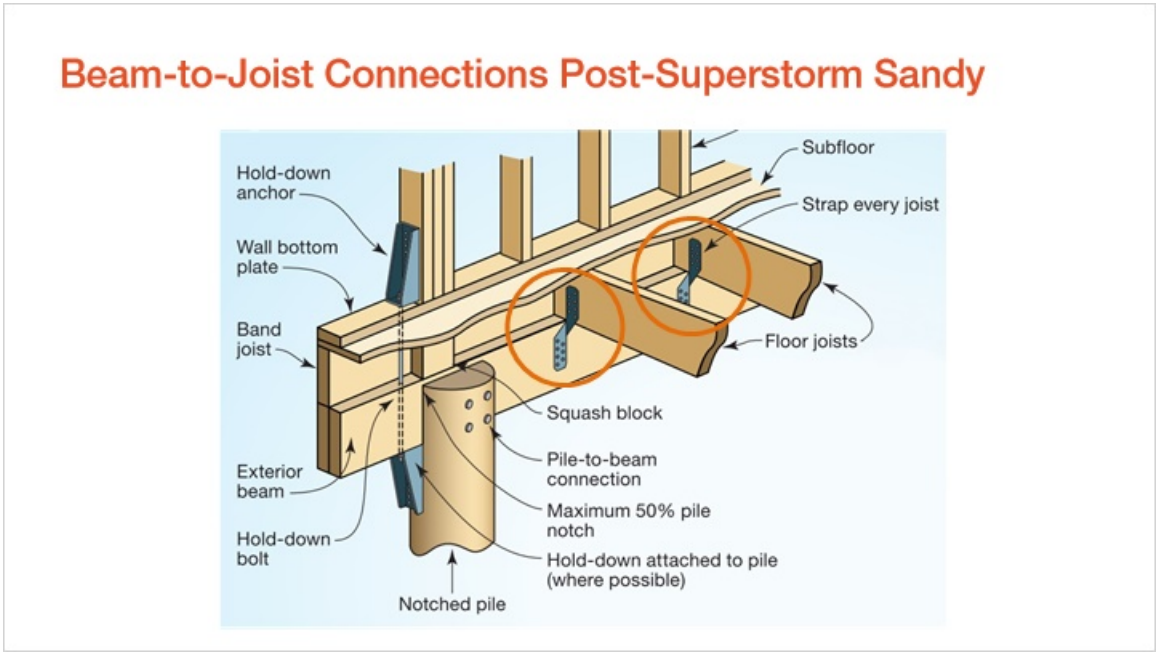
This shows how the wood failed because connectors were too close to the edges.

6.22 Beam-to-Joist Connections Pre-Superstorm Sandy

Notes:

Thinner-gauge straps also failed since they didn't have adequate corrosion protection.

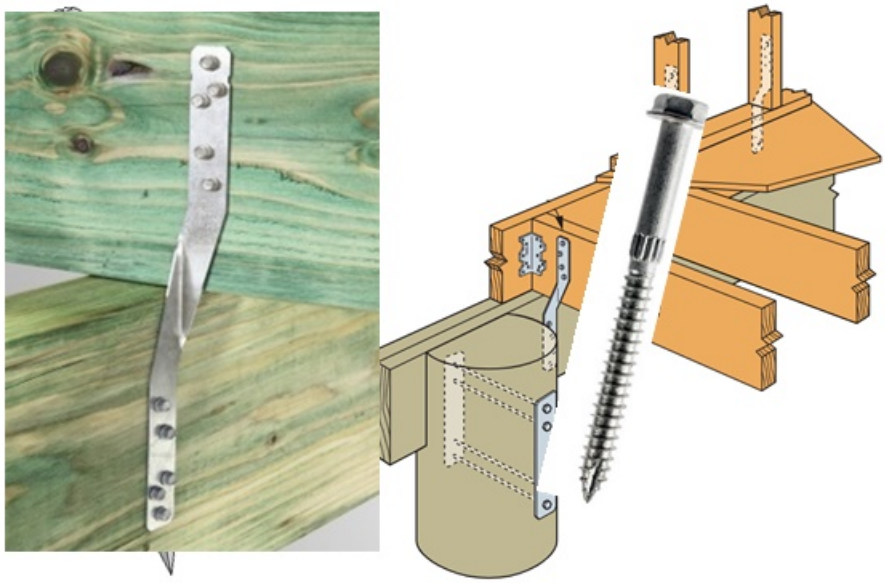
6.23 Beam-to-Joist Connections Post-Superstorm Sandy



Notes:

After Superstorm Sandy, things changed. FEMA improved connections for elevated coastal residential buildings in February 2013. The new detail shows longer twist straps that must be applied to every joist along with other necessary hold-down connections.

6.24 Beam-to-Joist Connections Post-Superstorm Sandy

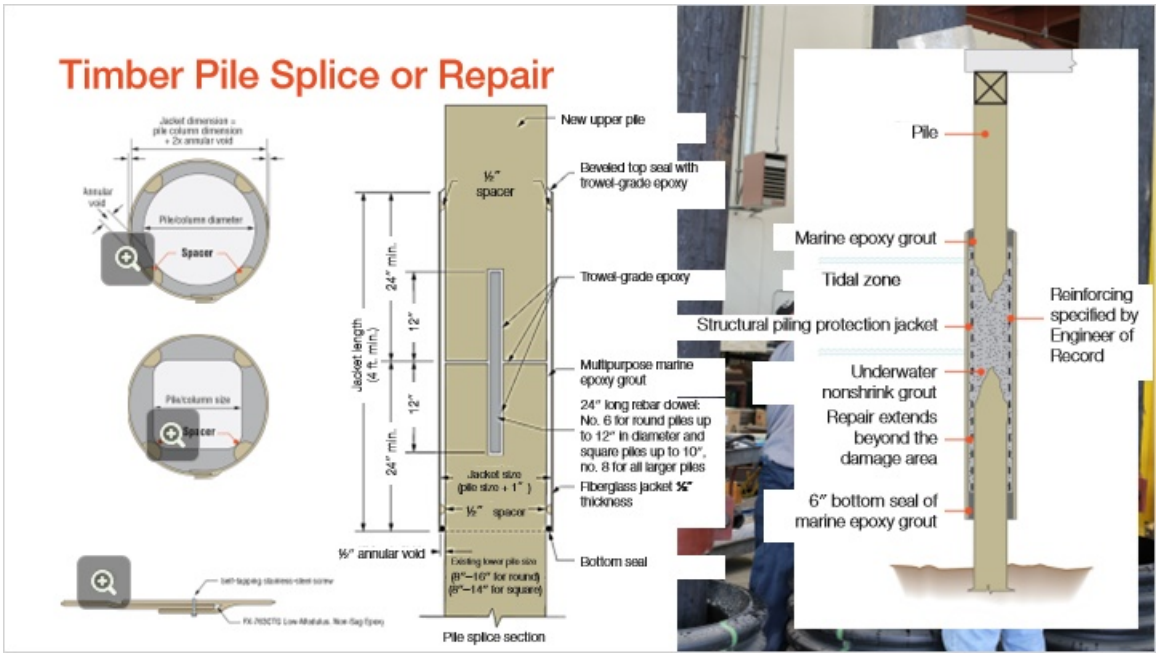


Notes:

Here's the longer twist strap with proprietary structural screws or longer stainless steel twist straps with stainless steel ring shank nails.

We can see the longer hot-dipped galvanized or stainless steel twist straps with heavy duty, proprietary, structural screws.

6.25 Timber Pile Splice or Repair

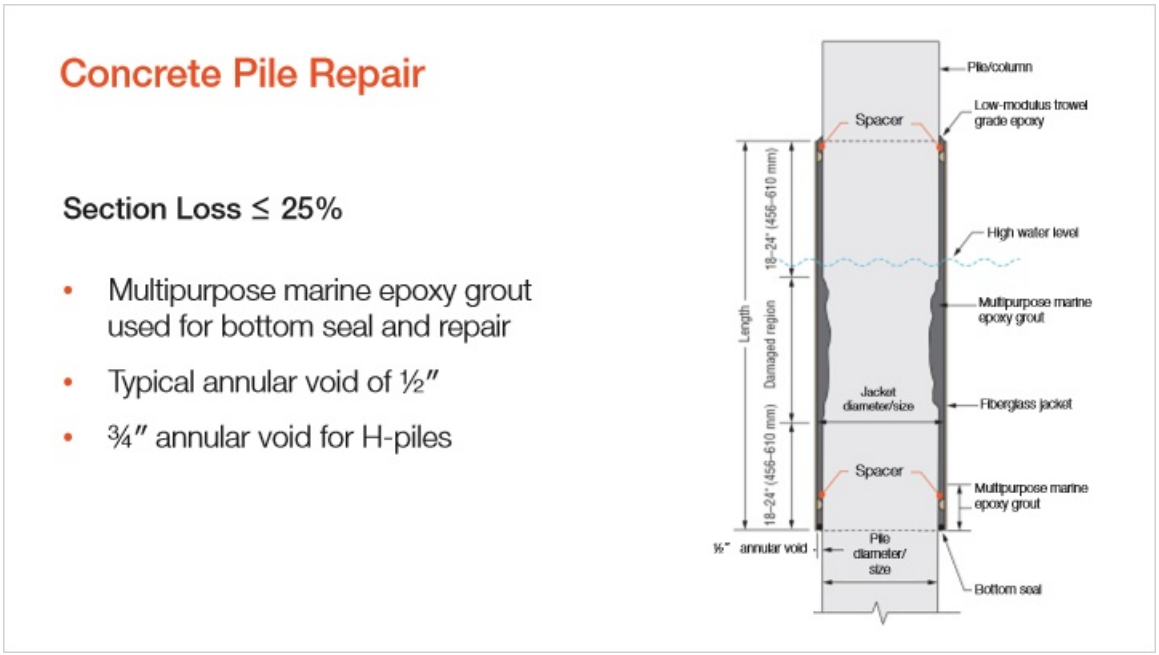


Notes:

Sometimes, a home may require repairs after being damaged. When that occurs, structures must be brought to compliance to the current building code. If a structure was built many years back, it's highly possible that the BFE has become higher, and the structure will need to be raised.

That could mean removing current piles and installing new ones, which is often very costly, and susceptible to material shortages. Or, using a proprietary jacket system to splice a new pile section on top of the existing one. This would bring the structure back to compliance with the current code and higher BFE. Take a moment to examine these diagrams before moving on.

6.26 Concrete Pile Repair



Notes:

In other cases, floodwaters can erode piles, both wood and concrete.

Repairs can be costly and may involve shoring the structure to remove or replace sections of the pile.

This is time consuming and difficult and could even require the erection of water barriers to establish dry working conditions for new concrete.

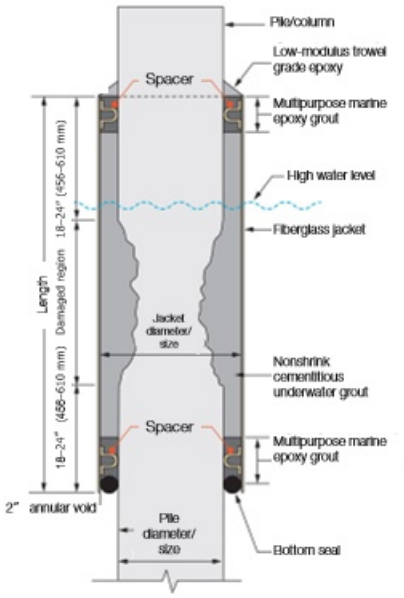
Again, take a moment to review these diagrams and click Next when you're ready to continue.

6.27 Concrete Pile Repair

Concrete Pile Repair

Section Loss > 25%

- Multipurpose marine epoxy grout used for top and bottom seal
- Nonshrink nonmetallic underwater grout used for repair
- Typical annular void of 2″



Notes:

Again, take a moment to review these diagrams and click Next when you're ready to continue.

6.28 Concrete Pile Repair

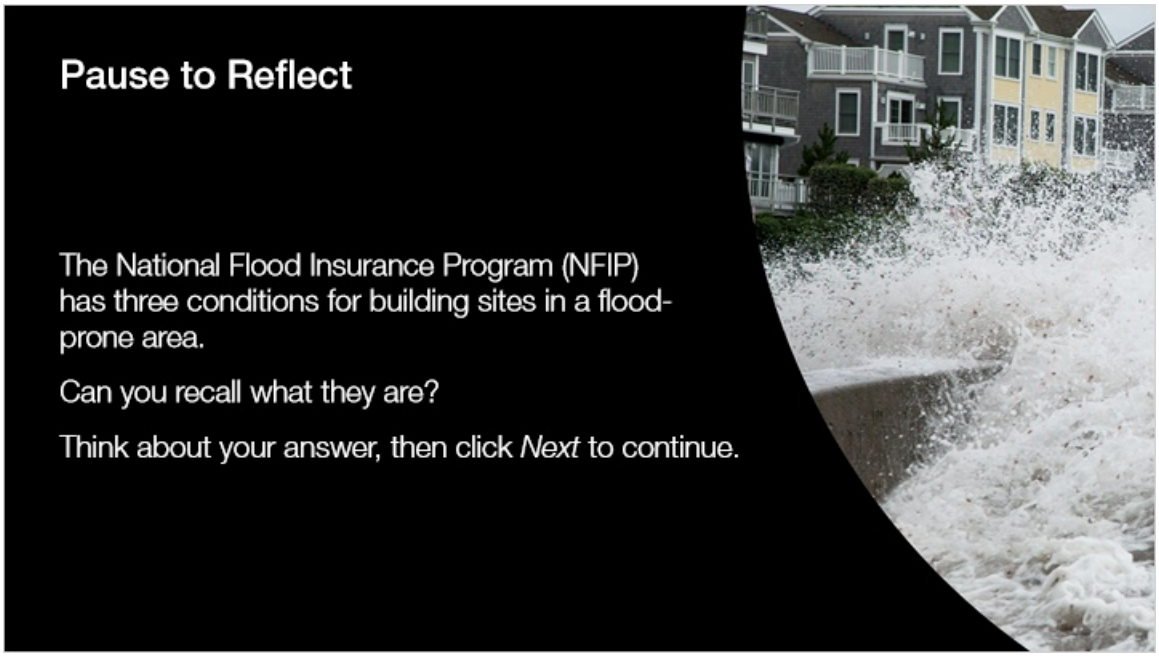
Notes:

Another option is to repair in place, using a fiberglass jacket section, which encapsulates the damaged section of the pile.

First, loose debris is removed, then the jacket is filled with either a cementitious or epoxy grout, restoring its strength and load capacity.

These repairs are long lasting and usually more durable than the original pile installation.

6.29 Review: Question 2



Notes:

Time for another quick review.

6.30 Review: Answer 2

Notes:

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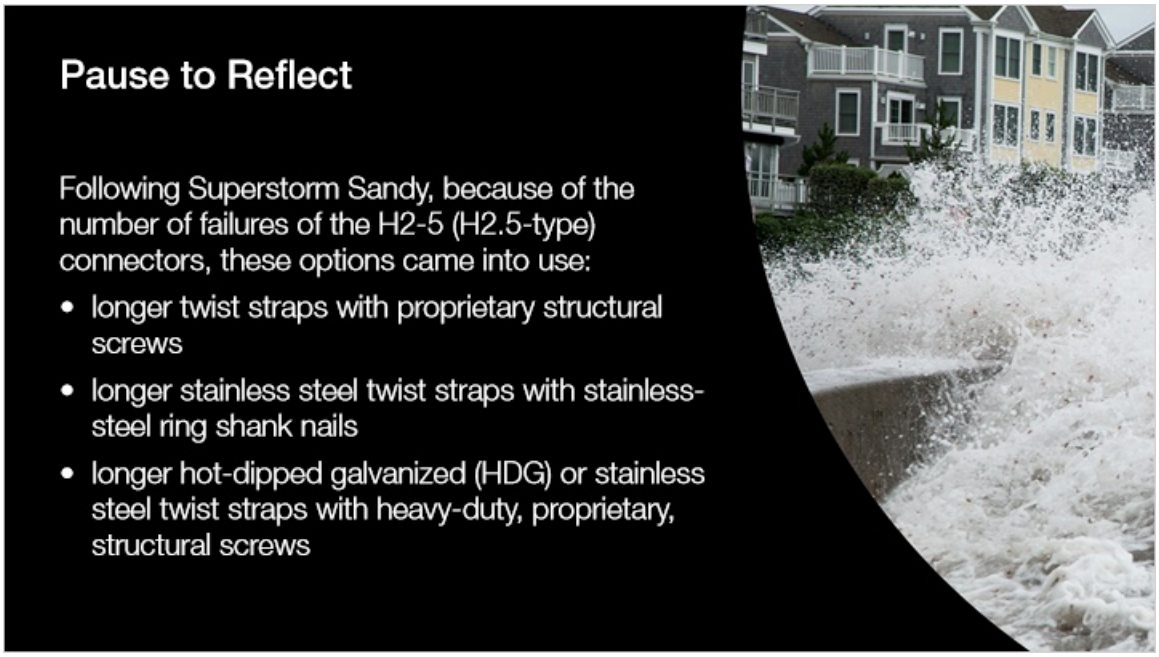
6.31 Review: Question 3

Notes:

No audio on this slide.

6.32 Review: Answer 3



Notes:

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7. Solid Foundations and Connections

7.1 Solid Foundations and Connections

Notes:

Alright, let's continue with a discussion on solid foundations and connections.

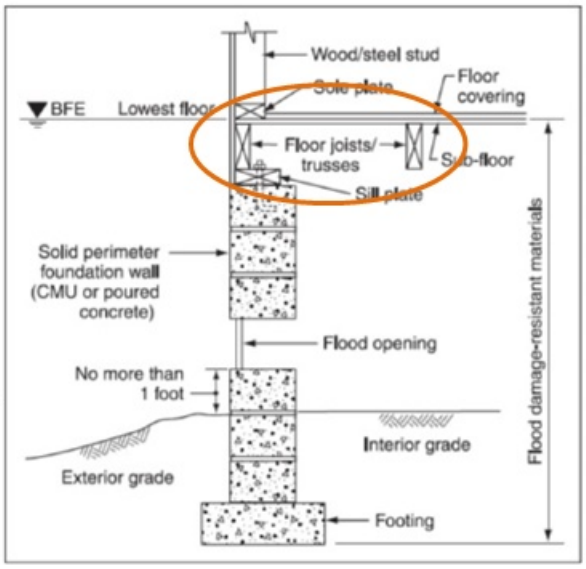
7.2 Requirements

Used in:

- A zones
- coastal A zones

Not permitted:

- in V zones
- if design governed by ASCE 24



Notes:

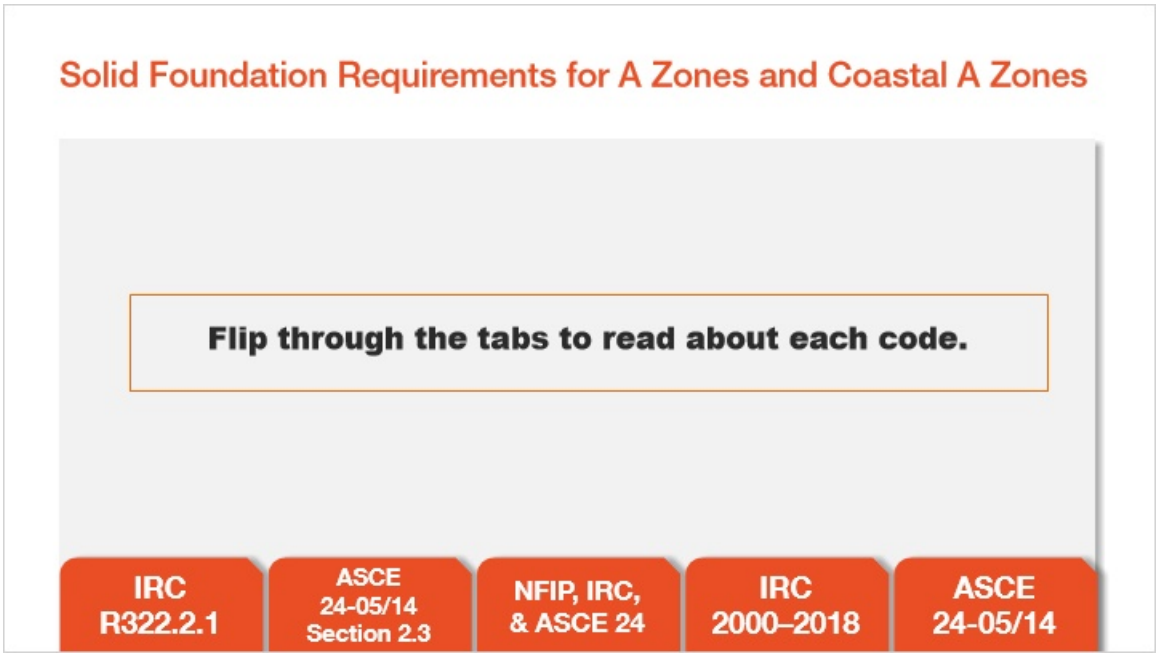
Solid foundations are usually used in A zones or coastal A zones.

Solid foundations are not permitted in V zones or if the design is governed by ASCE 24 in coastal A zones.

The NFIP recommends that everything below the BFE, including the lowest floor, address flood-related loads even if the lowest floor is elevated above the BFE.

Concrete/masonry reinforcing is not shown in this diagram for clarity purposes but is required per designer.

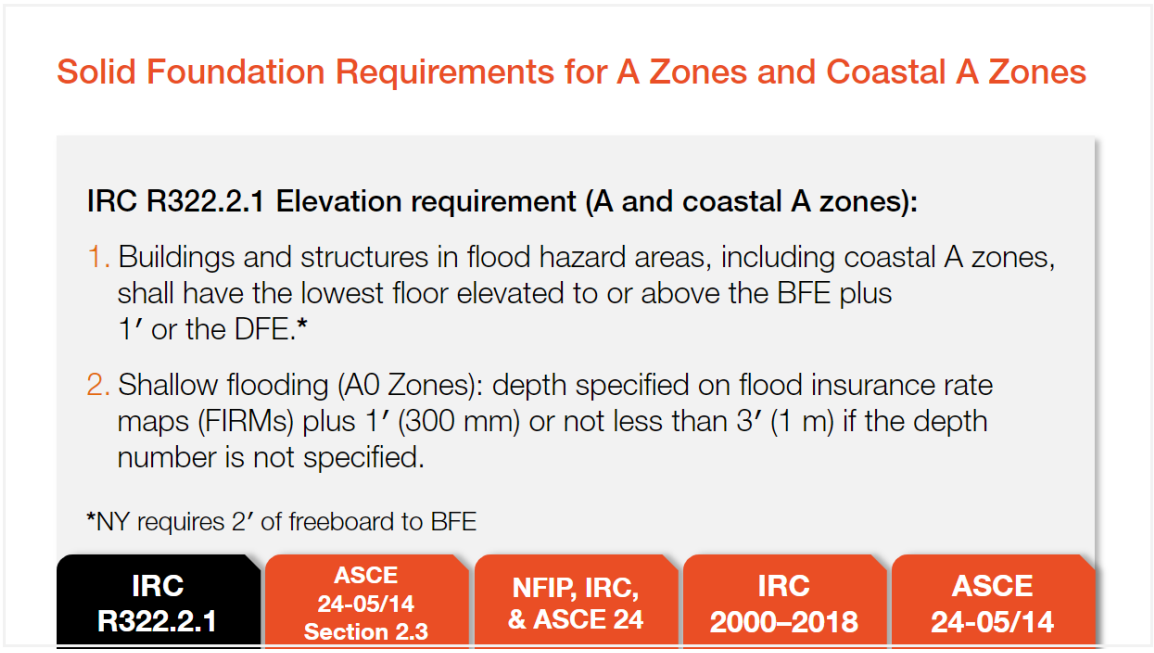
7.3 Solid Foundation Requirements for A Zones and Coastal A Zones



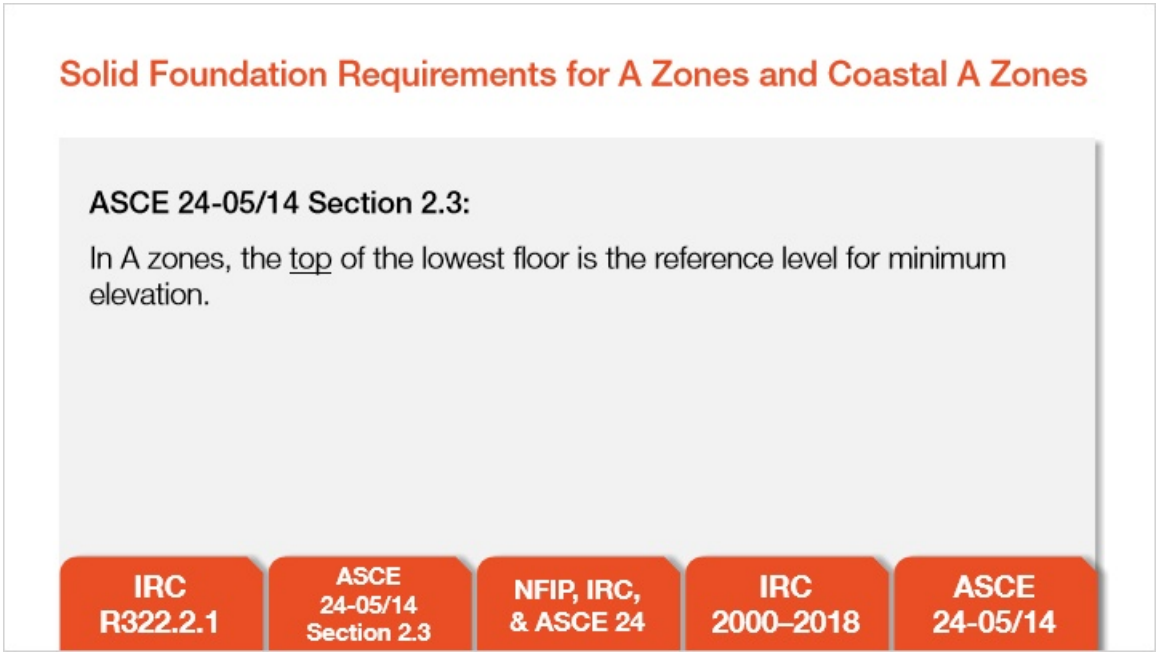
Notes:

Here are some more tabs that cover solid foundation requirements for A zones and coastal A zones - you know what to do!

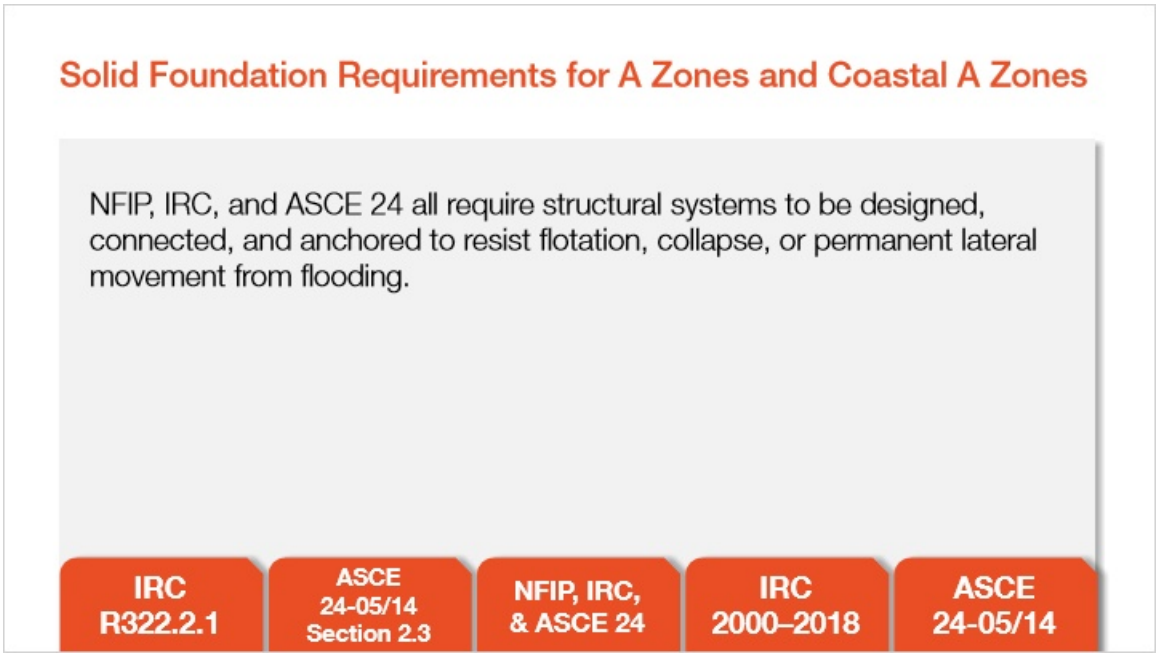
IRC R322.2.1 (Slide Layer)



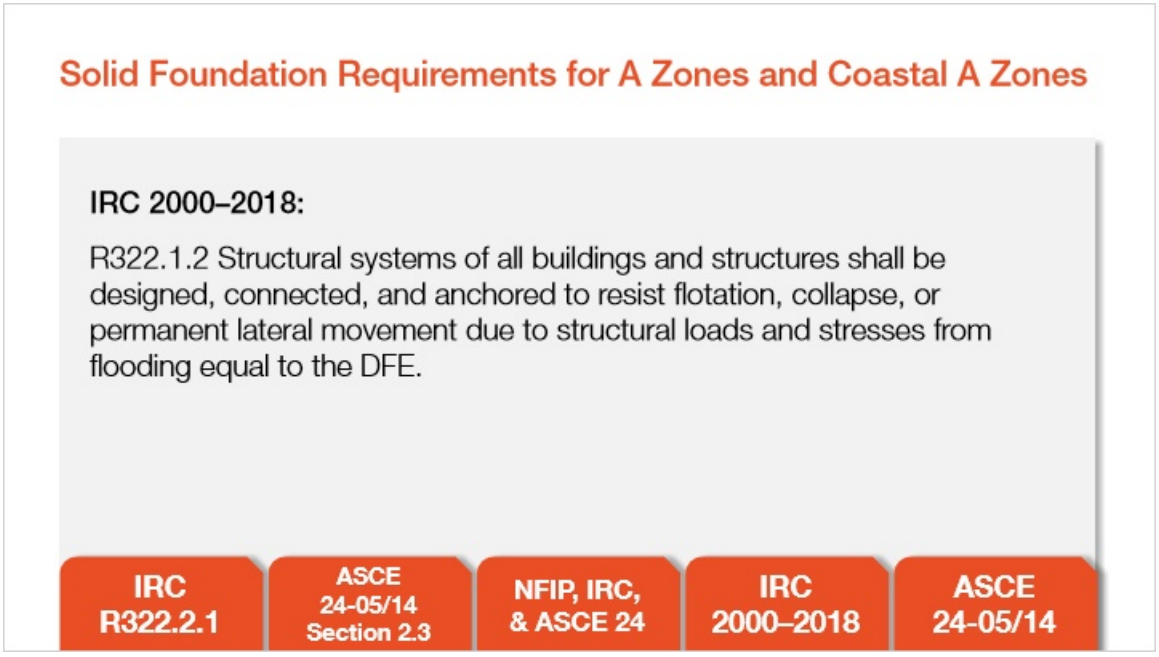
ASCE (second tab) (Slide Layer)



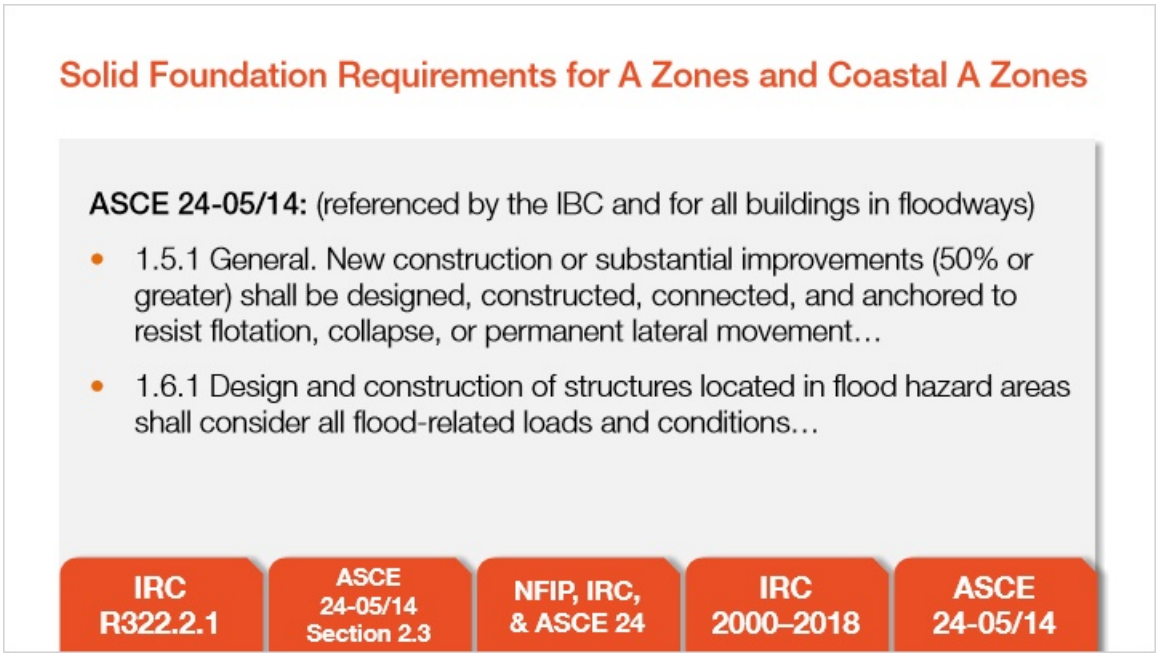
NFIP, IRC, ETC (Slide Layer)



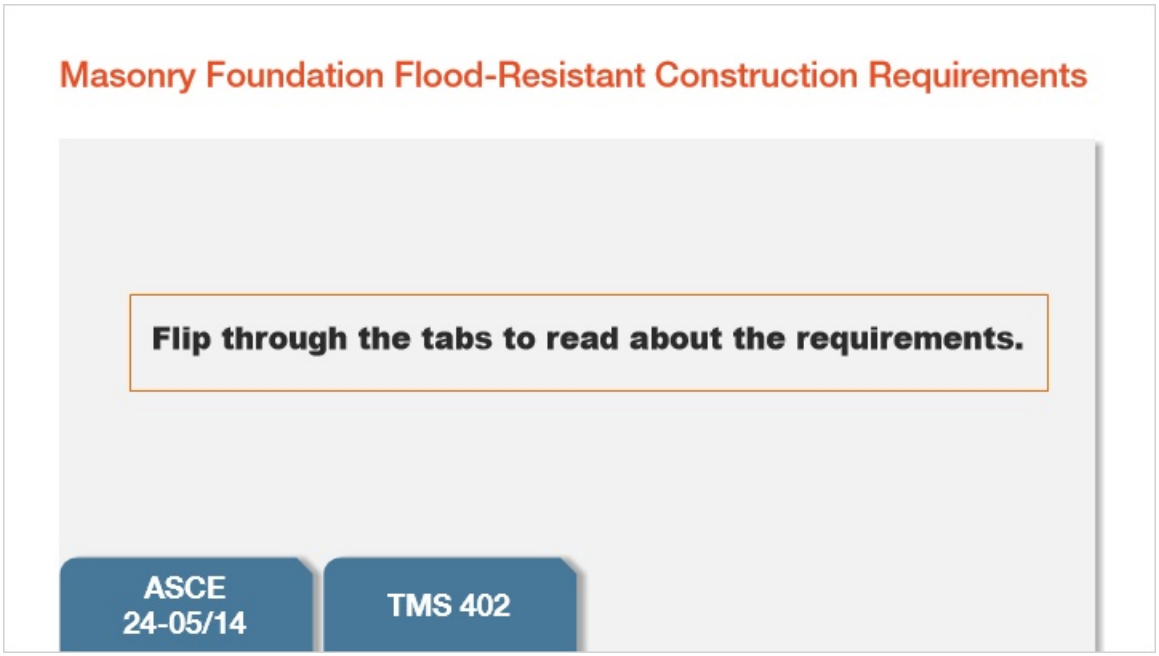
IRC 2000-2018 (Slide Layer)



ASCE (fifth tab) (Slide Layer)



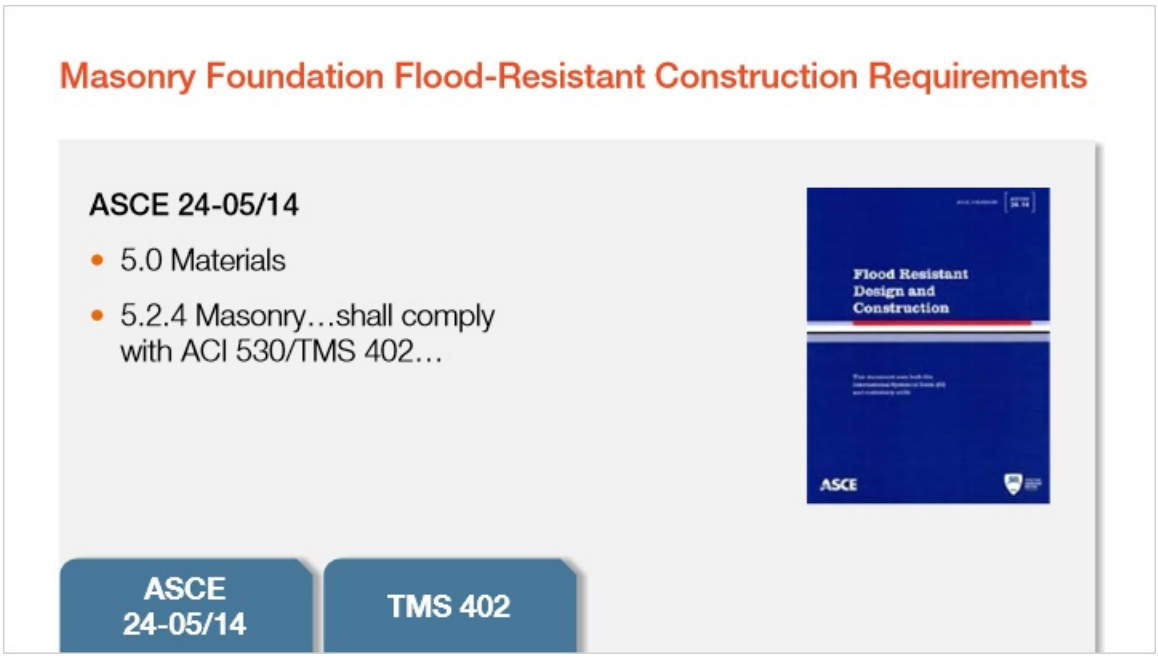
7.4 Masonry Foundation Flood-Resistant Construction Requirements



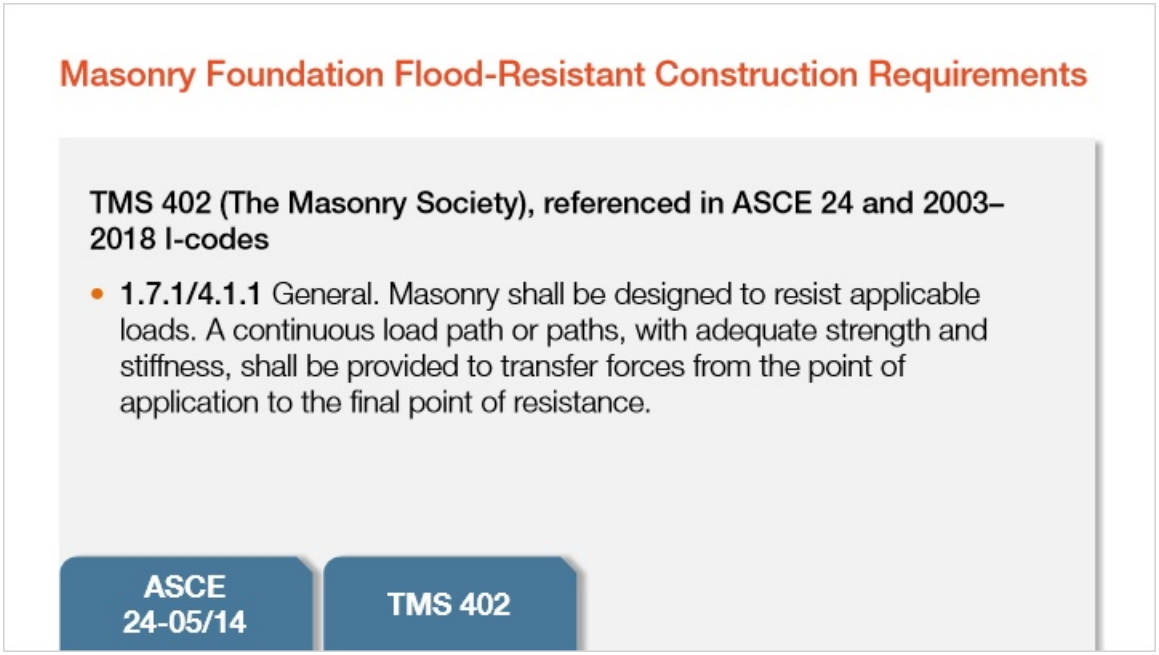
Notes:

Here we have the requirements for masonry foundation flood-resistant construction.

ASCE 1 (Slide Layer)



TMS (Slide Layer)



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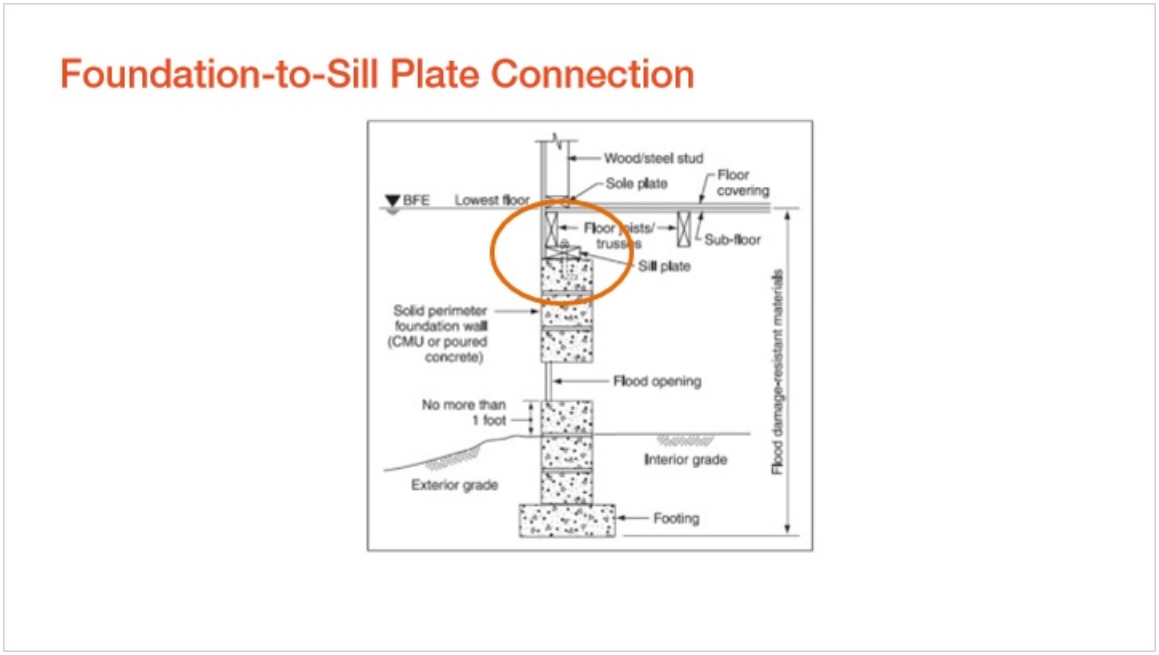
7.5 Foundation-to-Sill Plate Connection



Notes:

The connection below the top of the lowest horizontal member is the sill plate.

The sill plate has to be adequately anchored to the foundation (the concrete or grout-filled concrete masonry unit, or CMU).

This can be done with anchor bolts, sill plate straps, structural adhesives with threaded rod, or a concrete/masonry screw approved for use with sill plates.

Concrete/masonry reinforcement is not shown here for clarity but is required per designer.

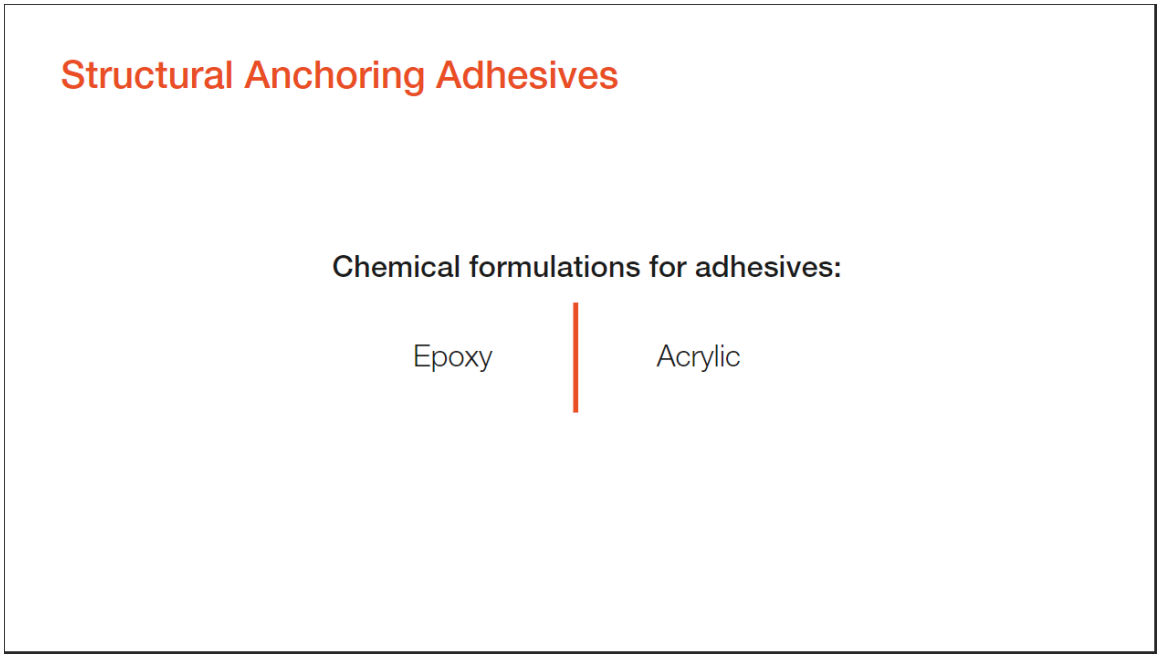
7.6 CMU Foundation to Wall Failure Due to Flooding

Notes:

Whether the foundation is concrete or masonry, it must be adequately anchored to the foundation.

This building was not anchored at all and consequently was able to significantly slide off the foundation.

7.7 Structural Anchoring Adhesives



Notes:

Many structures have a need to be retrofitted, and some installers simply prefer to post-install anchorage to concrete or masonry. Both involve drilling holes into concrete or grout-filled concrete masonry.

There are different chemical formulations for these adhesives including epoxy and acrylic. They both exhibit similar performance when cured but different behaviors at installation. There are several anchor types that can be used with these materials.

The next few slides describe these adhesive anchors as well as mechanical anchors that can be used to attach framing members such as sill plates, beams, or connectors to concrete or masonry piers and the conditions that dictate which adhesive is appropriate in each case.

7.8 Structural Anchoring Adhesives: Epoxy and Acrylic

Notes:

Epoxies are a slower cure, usually a bit less expensive, and very high strength in all applications. They are limited to warmer weather and typically perform best at installation temperatures above 50°F (10°C). Acrylic formulations are rapid set (like 1 hour at higher temperatures) and perform very well in colder installation conditions. Both types can accomplish the anchor needs, but the installation conditions can affect which should be used. In either case, the components of the system include using a carbide bit to drill the hole and remove the dust, the adhesive to be injected into the hole, and the threaded rod inserted. It is best to use adhesives that have a code report and are rated for use in cracked concrete per the IBC. Both types of adhesives cure fast, even in water-saturated concrete.

Click each adhesive to reveal its unique specifications.

7.9 High-Strength Structural Adhesives for Post-Installed Anchoring

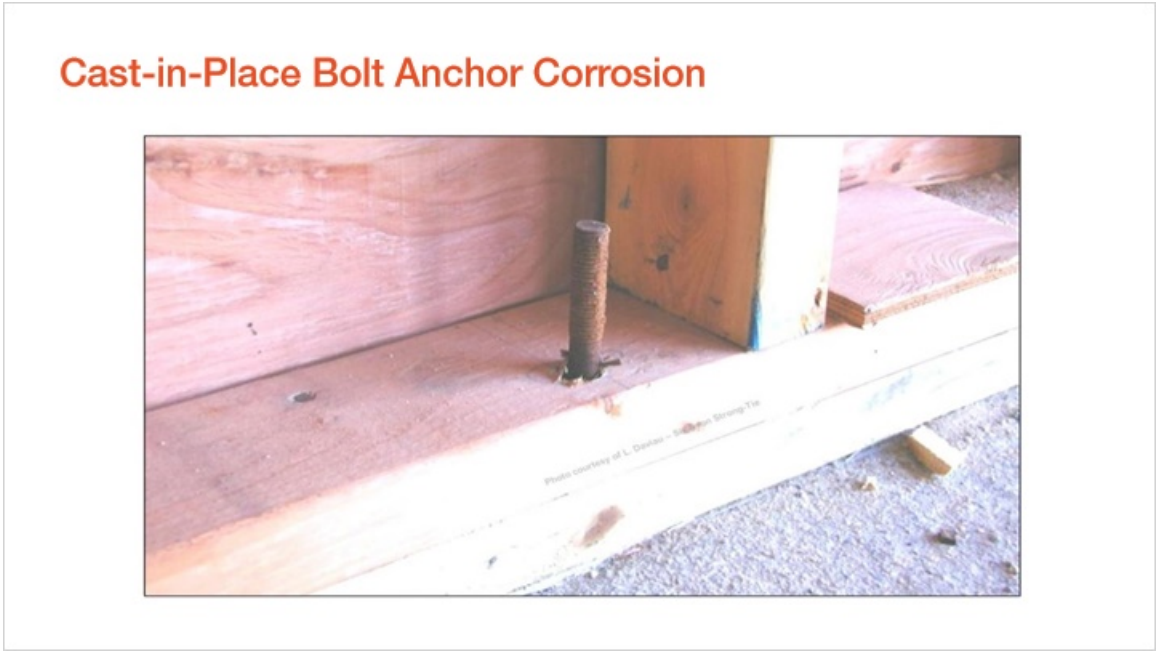
High-Strength Structural Adhesives for Post-Installed Anchoring

Anchor Bolt to Replace	Sill Plate Nominal Thickness	Adhesive Anchor Model	Threaded Rod Nominal Diameter (in.)	Drill Bit Diameter (in.)	Min. Nominal Embed Depth (in.)	Min. Edge Distance (in.)	Min. End Distance (in.)
½" diameter with 7" embedment	2x, 3x	High-strength acrylic or epoxy adhesive	½	9/16 5/8 9/16	7	1¾	7½
⅝" diameter with 7" embedment	2x, 3x		⅝	11/16 ¾ 11/16	7	1¾	9⅜

Notes:

This table shows the adhesive anchors that can replace standard ½" (12.7 mm) and ⅝" (15 mm) diameter cast-in-place L bolts used to anchor sill plates. It is a 1:1 replacement for both diameter and depth. Sill plates can also be anchored mechanically.

7.10 Cast-in-Place Bolt Anchor Corrosion



Notes:

Corrosion can significantly affect anchor bolts. This is all that was left of a corroded bolt where the top showed above the surface but everything below had disappeared. The portion of the bolt here is too rusty and corroded to accept a nut or washer and cannot be used. It is important to use the right degree of corrosion resistance for the anchor in every case, especially in coastal zones.

7.11 Concrete and Masonry Screw Anchors

Notes:

Use zinc-plated or mechanically galvanized concrete and masonry screw anchors in dry, interior applications where corrosion is not a risk.

Use 304 and 316 stainless steel concrete and masonry screw anchors where the anchor is exposed or in applications that may be considered corrosive.

These anchors are a 1:1 replacement for equivalent diameter sill bolts in concrete or grout-filled CMUs with only 4½" of embedment.

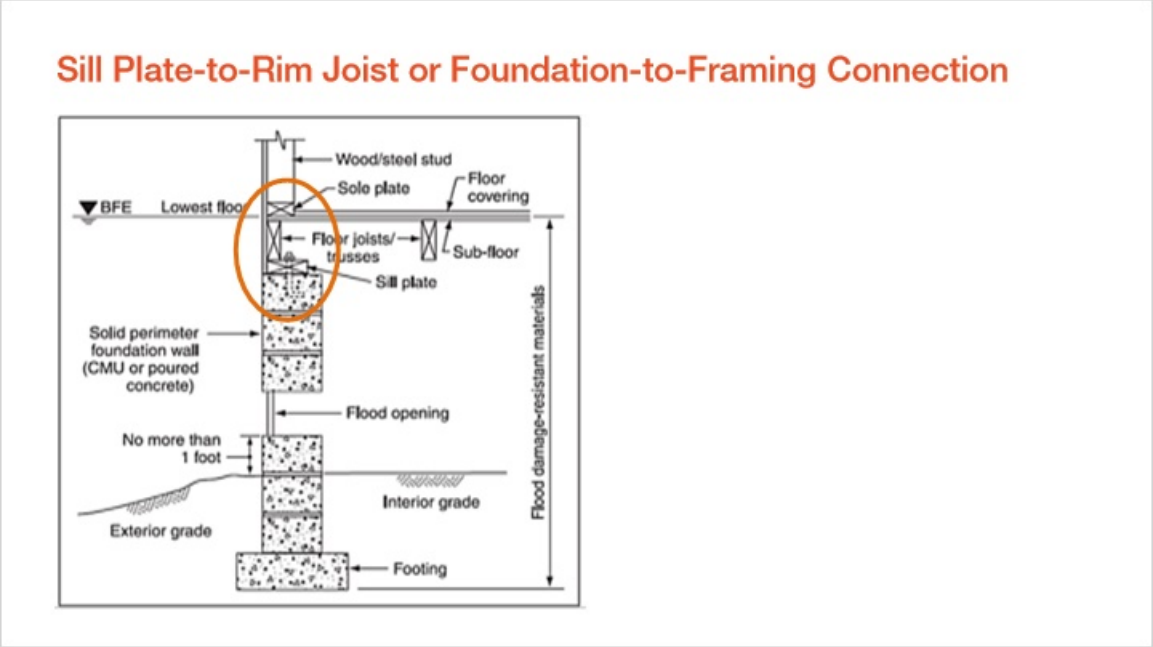
7.12 Concrete and Masonry Screw Anchors

Detail	Anchor Bolt to Replace	Sill Plate Nominal Thickness	Titen HD Model	Drill Bit Diameter (in.)	Min. Nominal Embed Depth (in.)	Min. Edge Distance (in.)	Min. End Distance (in.)
1	½" diameter with 7" embedment	2x	½" x 6"	½	4¼	1¾	6
		Double 2x, 3x	½" x 8"	½	4¾	1¾	6
1	⅝" diameter with 7" embedment	2x, Double 2x, 3x	⅝" x 8"	⅝	4¾	1¾	6

Notes:

Take a look at these details for replacing different anchor bolts. You can see the differences between the ½" diameter and the 5/8" diameter.

7.13 Sill Plate-to-Rim Joist or Foundation-to-Framing Connection



Notes:

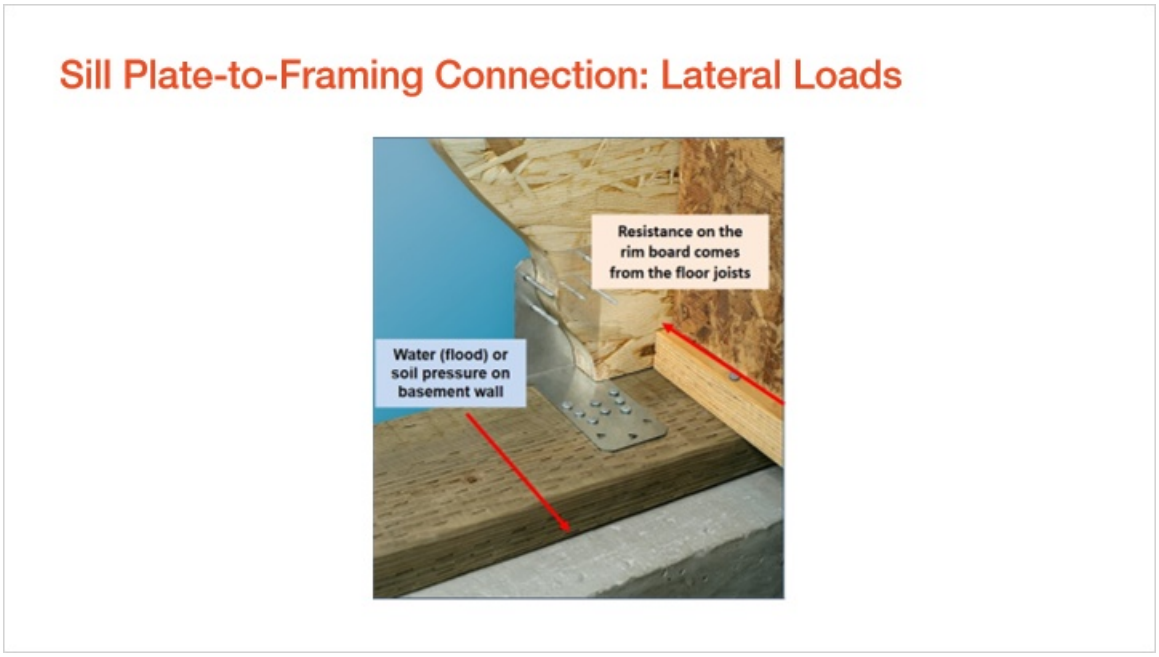
The rim joist connection must transfer lateral and uplift loads from the framing above to the sill plate or directly to the foundation.

There are many straps designed to connect to concrete or masonry on one end and wood on the other.

There are also many reinforcing angles along with the use of blocking to transfer loads from the rim joist to the sill plate.

You can find many standard details in various high wind publications. Coming up, we'll examine some examples of how to transfer the load to the next wood member or foundation.

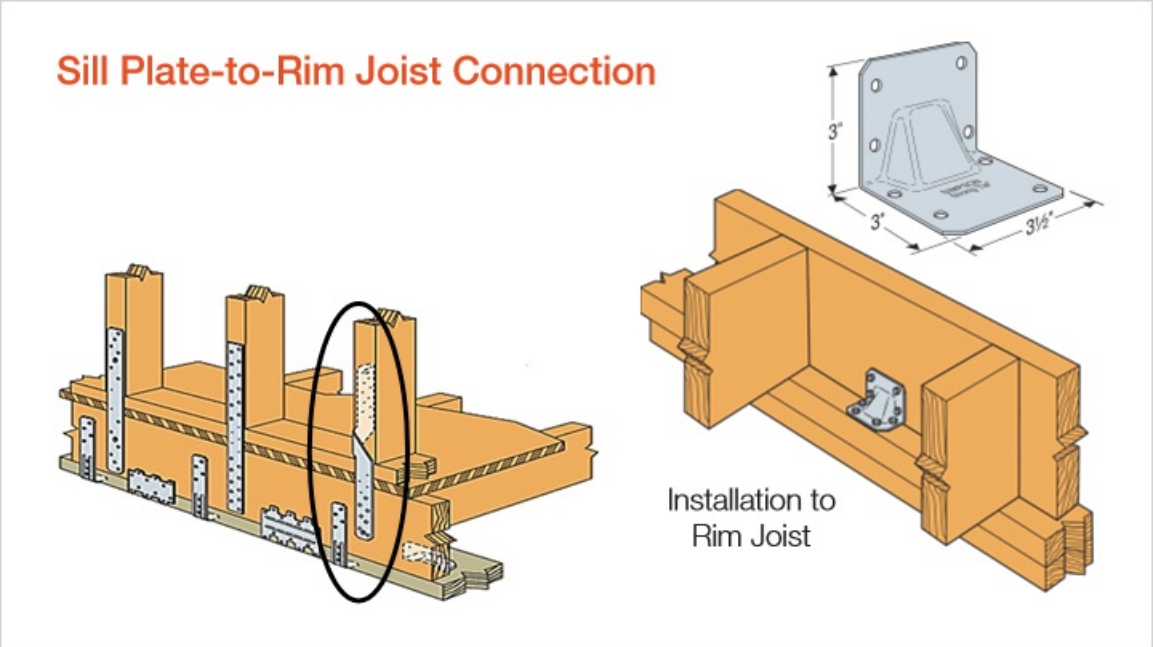
7.14 Sill Plate-to-Framing Connection: Lateral Loads



Notes:

Here's a lateral load. This connection is not floor system dependent and the connector spacing is independent of the joist spacing. Note that forces are coming from two directions at the same time.

7.15 Sill Plate-to-Rim Joist Connection



Notes:

For rim-joist, or band-joint connections, uplift connectors must bypass each other to prevent cross-grain tension of the rim joist, or band joist.

7.16 Foundation Connections for Raised Homes

Notes:

Here's a house that was raised in order to meet new height requirements resulting from steadily increasing flood heights or storm activity.

Note that in this case, the screw anchors described earlier could not be installed, so alternate connection solutions were used instead.

7.17 Foundation Connections for Raised Homes

Notes:

First, the existing floor system was separated from the old block foundation, and the house was raised to permit the creation of a new foundation underneath it.

7.18 Foundation Connections for Raised Homes

Notes:

Then the house was lowered back down, and connectors resisting uplift loads, and connectors resisting parallel to plate forces, were used to connect the house to the new foundation. This connector solution applies to new construction as well as retrofits.

7.19 Flood Protection for Critical Infrastructure

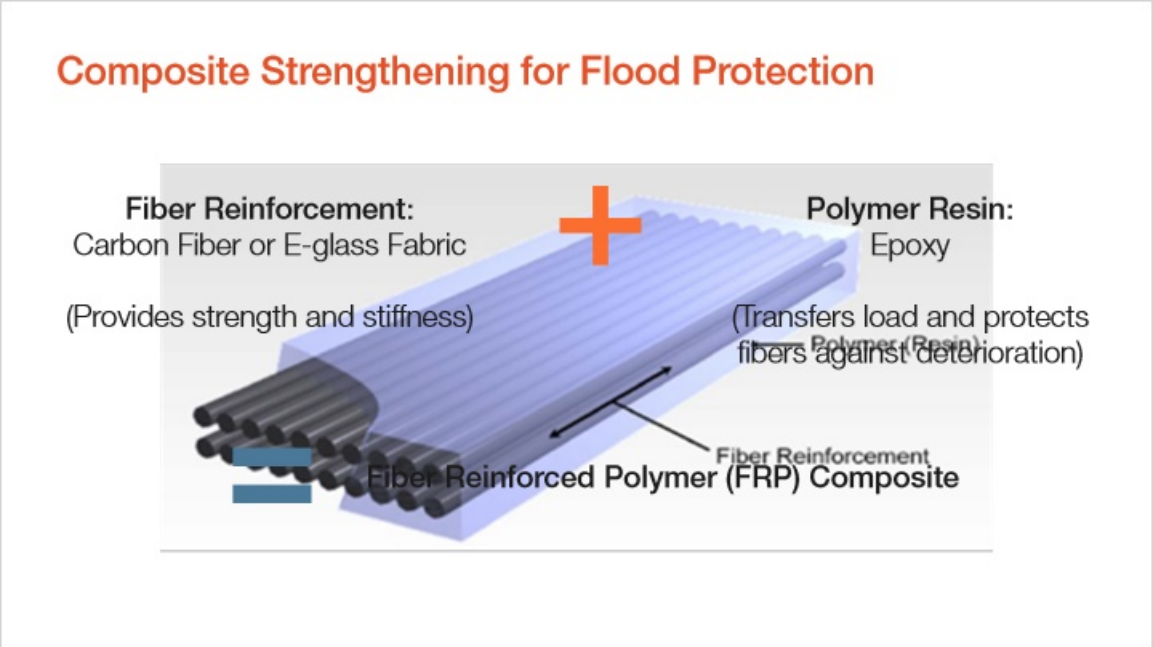
Notes:

It's also important to think about protecting critical infrastructure from flooding.

There are certain buildings and facilities such as wastewater plants, electrical generation plants, bridges, and tunnels that cannot simply be moved or raised to provide flood protection.

These facilities often require floodproofing and strengthening in order to meet new conditions and standards and therefore to remain operational during a flood and long afterwards.

7.20 Composite Strengthening for Flood Protection



Notes:

Now let's touch on composite strengthening.

Composite strengthening is:

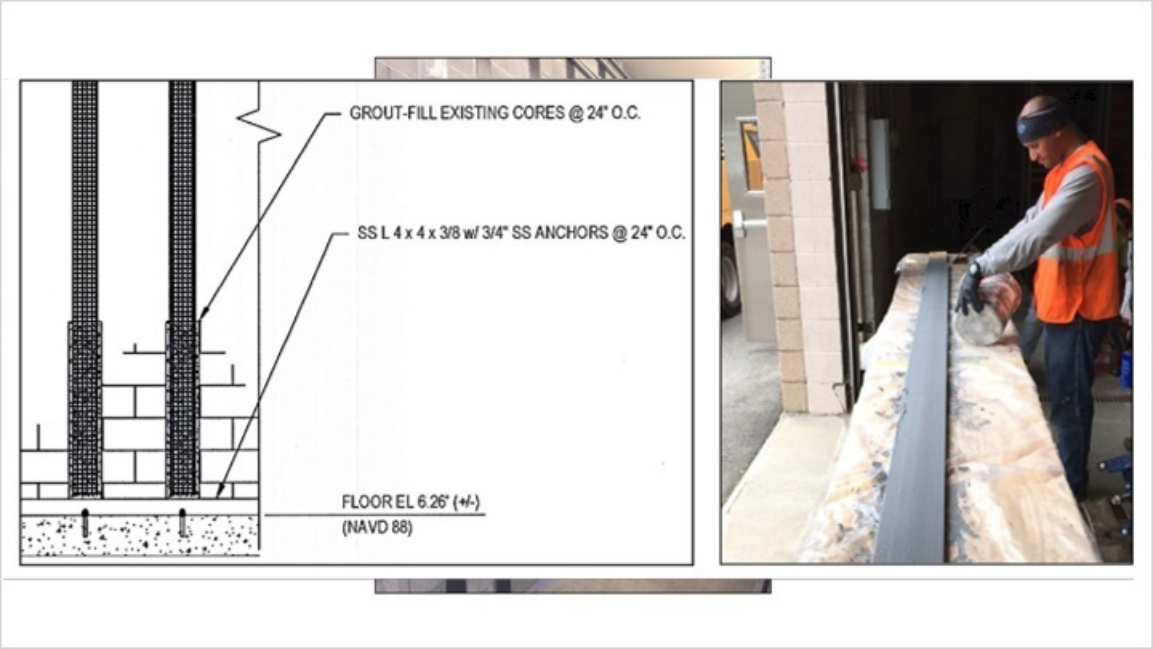
- Fiber reinforcement, such as carbon fiber or e-glass fabric, that provides strength and stiffness
- Plus, polymer resin such as epoxy that transfers load and protects fibers against deterioration

This combination results in fiber-reinforced polymer (or FRP) composite.

These materials offer great tension strength in a lightweight material to reinforce structural members and can be shaped around existing beams, columns and walls.

The materials are applied using a polymer resin that bonds the fabric to the structural member.

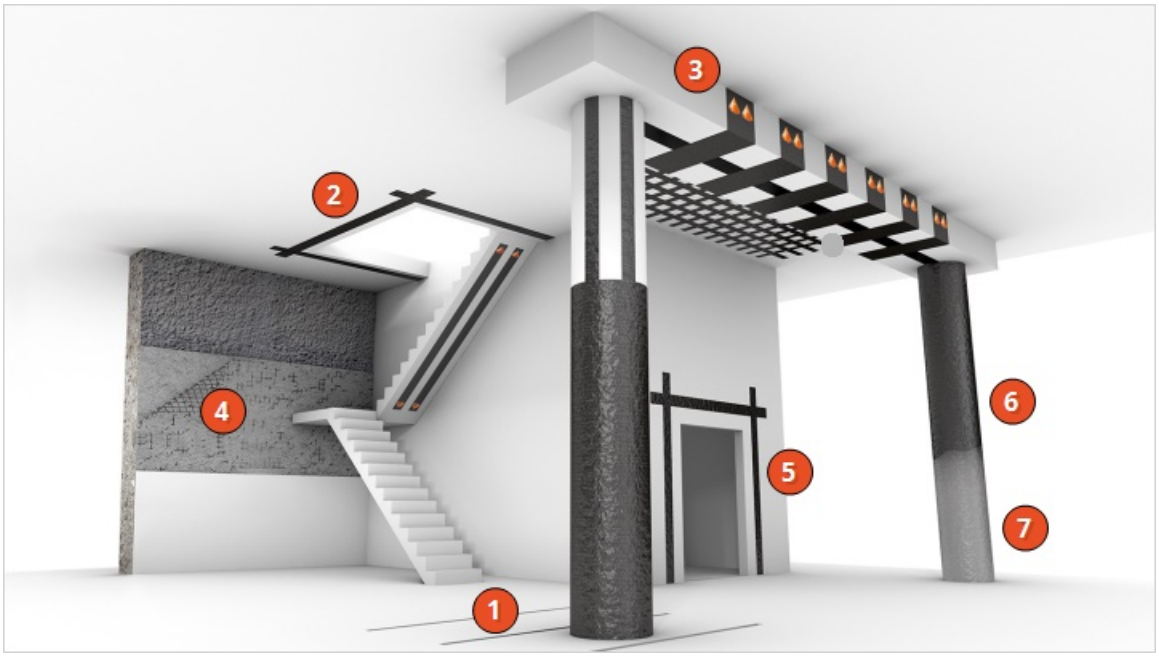
7.21 Composite Strengthening for Flood Protection



Notes:

FRPs are an economical means of reinforcing at-risk facilities. Composite strengthening systems can also be used with the installation of pre-cured laminates. In this case, the carbon fiber is pre-cured with resin into stiffer strips. An epoxy paste is applied to the laminate, and then it is applied to the surface of the structural member. It's important to note that the installation of these products can require extensive surface preparation and should be done by a certified installation contractor.

7.22 Composite Strengthening for Flood Protection

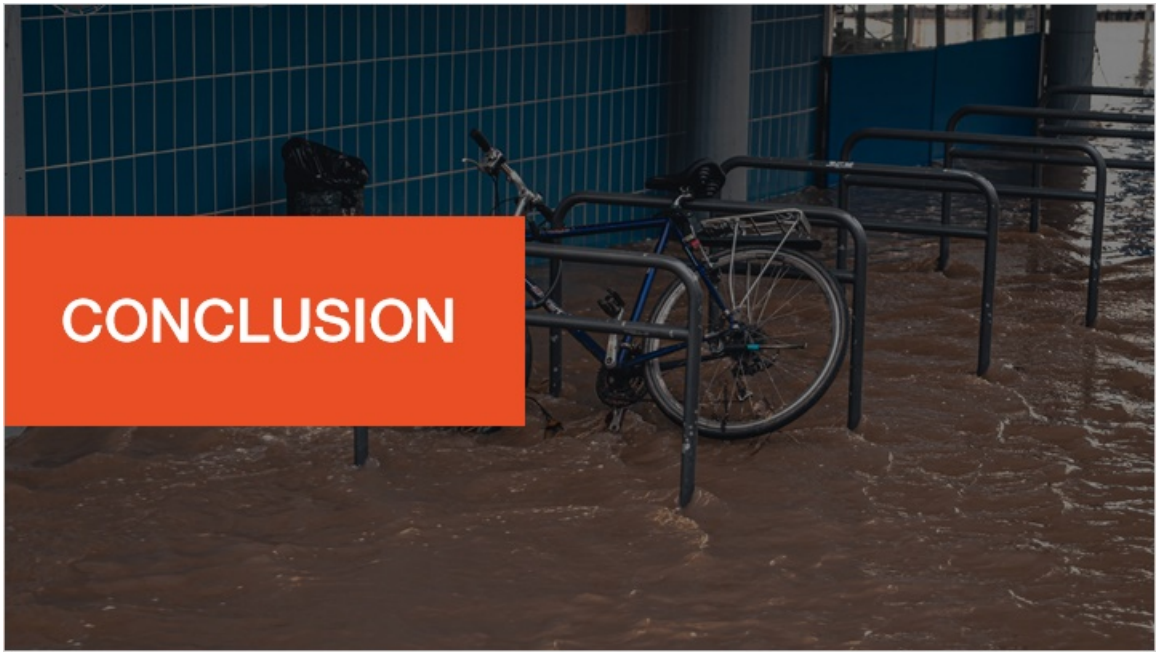


Notes:

Click the icons around this room to learn how composite strengthening can be used in different areas.

8. Conclusion

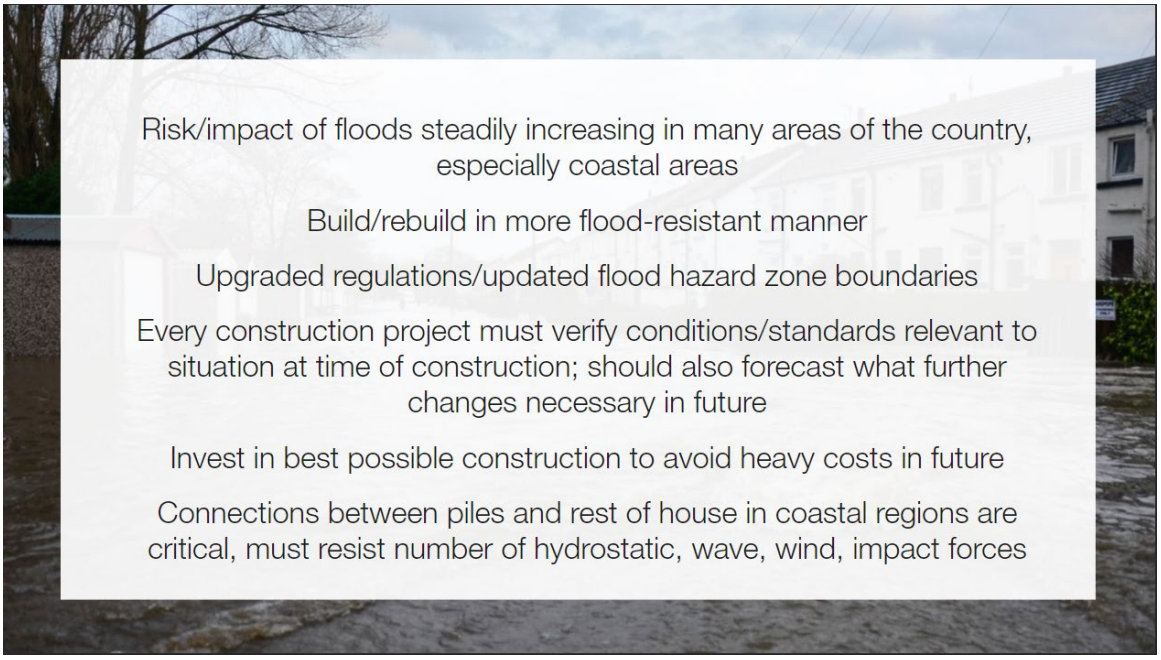
8.1 Conclusion



Notes:

We've reached the end of our course. Let's quickly go over what we've learned together.

8.2 Summary



Notes:

As many aspects of our climate constantly change, storms become more frequent and ferocious and seas rise, the risk/impact of floods is steadily increasing in many areas of the country, especially coastal areas. This has, in turn, raised the overall number of structures that have been seriously damaged or destroyed, and thus the cost to repair or replace them, as well as the need to build or rebuild them in a more flood resistant manner. Much has been learned from these failures, and as a result, there are now many upgraded regulations and updated flood hazard zone boundaries that designers should become fluent with.
Because conditions constantly change, and flood zone boundaries are flexible, every construction project must also verify which conditions and standards are relevant to their situation at the time of construction. They should also forecast what further changes may be necessary in the future.

There are a number of situations where buildings were designed to meet the conditions at the time of construction, but which now must be substantially upgraded at great expense to meet current conditions and regulations, and to qualify for insurance. It is wise to invest in the best possible construction in order to avoid these heavy costs in the future.

The lessons acquired the hard way from inadequate construction and connection methods, have resulted in the development of a number of improved connection products and methodologies that designers can use to ensure they make these new update requirements and to deal with any future requirements or weather conditions.

Many homes in coastal areas are built on raised foundations, fabricated with a series of wooden piles. Connections between these piles, and the rest of the house, are critical, and must resist a

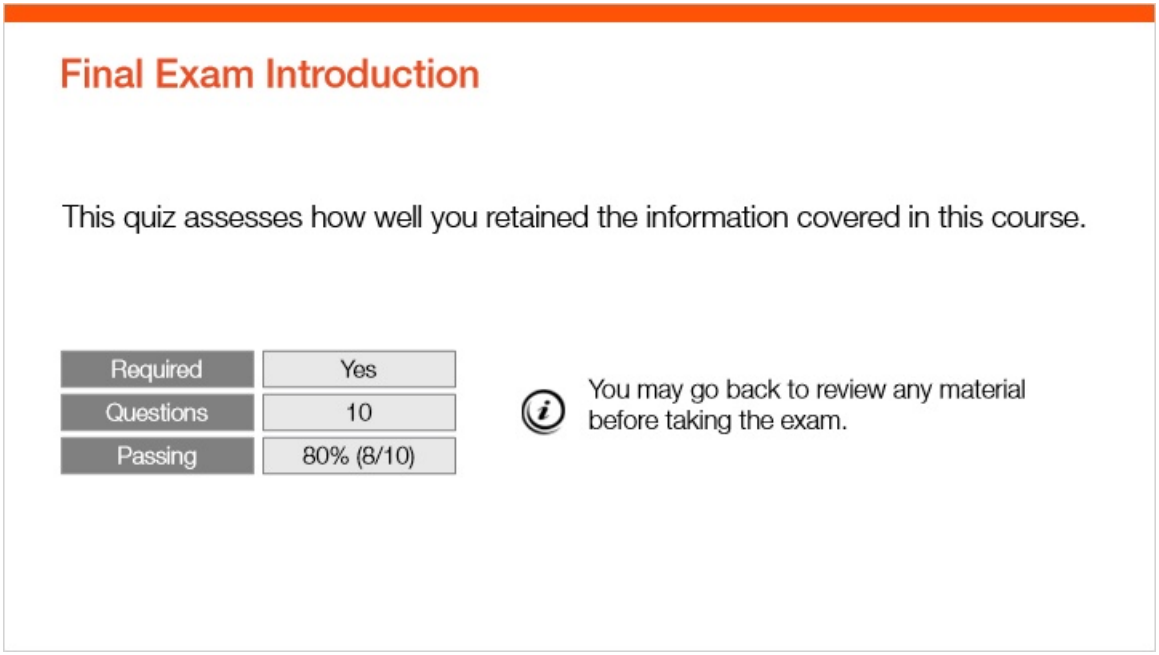
number of hydrostatic, wave, wind and impact forces.

These connectors must also be integrated into a full connection system, that provides a continuous path for all loads and storm forces, starting from the roof and extending down to the bearing point of the foundation.

Designers can integrate purpose-designed proprietary screws, connectors, brackets, and specialty straps created for every unique connection situation, as well as anchoring adhesives and timber, and concrete pile repair or splicing products to create a fully linked connection system that can resist every conceivable flood situation.

There are specialty screws and anchors that have been developed for masonry and concrete foundations, as well as timber pile foundations.

8.3 Final Exam Introduction



Notes:

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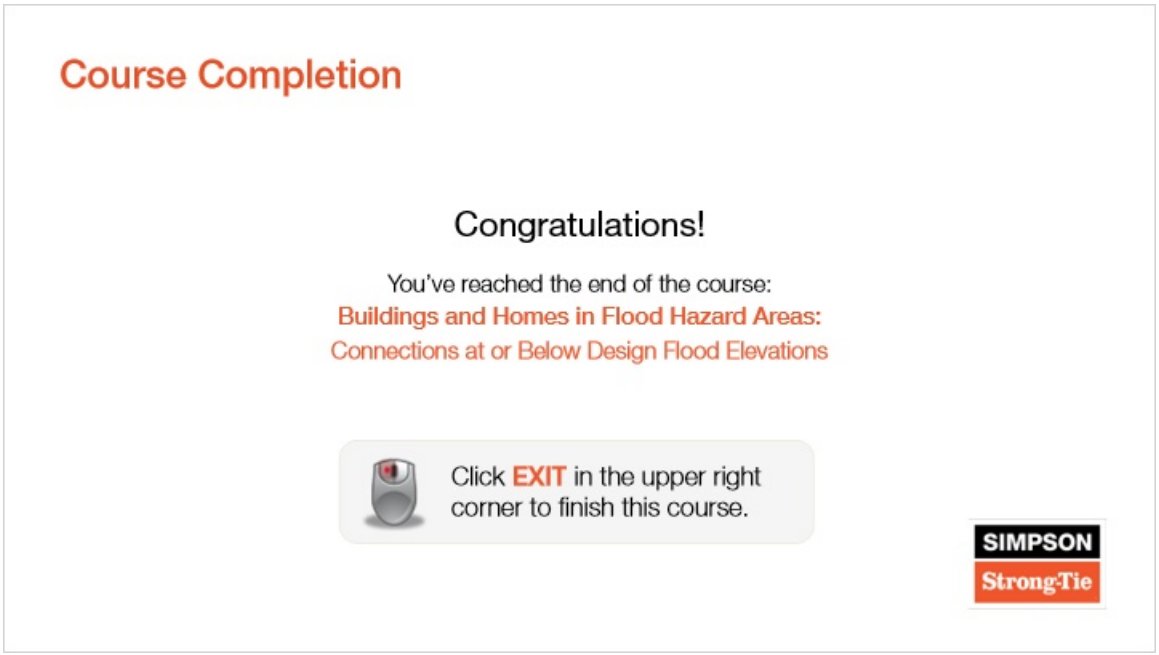
8.7 Thank You



Notes:

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File Attachments for Item:

ER-7 Cincinnati Cross Training, Part 5 (Building and Fire Code Academy)

RBI, RMI (two 3-hour sessions)

Staff Notes:

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: City of Cincinnati Cross Training Program - Framing & Geotech

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

Purpose and Objective: Students will to explain to list the parts of a framing inspection. Students will utilize a framing checklist to insure all areas of the structure are checked for compliance with the approved plan and the Residential Code of Ohio. The student will be able to apply the Residential Code of Ohio to a framing inspection. Students will to explain to the purpose of a geo-technical report. Students will be able to indicate the code sections used to show when and why a soil test is required. The student will be able to use the soil report to assist in the review and construction inspection for footing and foundation systems

The student will be able to apply the Residential Code of Ohio to a footing and foundation system based on the submitted geotechnical report.

Number of Instructional Contact Hours that can be obtained upon completion: 6

If Multi-Session, Number of Instructional Contact Hours Per Session: 3

Program Applicable for the Following Participants:

Building Official ☐ Master Plans Examiner ☐
Building Plans Exam. ☐
Plumbing Plans Exam. ☐
Electrical Plans Exam. ☐
Mechanical Plans Exam. ☐
Fire Protect. Plans Exam. ☐

Building Inspector ☐ Fire Protection Inspector ☐ Mechanical Inspector ☐
Plumbing Inspector ☐
Non-Res IU Inspector ☐

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.

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City of Cincinnati Inspection Cross Training ©

Part 5 - Geotechnical Reports

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2021

Learning Objectives / Learning Outcomes

Students will to explain to the purpose of a geotechnical report.

Students will be able to indicate the code sections used to show when and why a soil test is required.

The student will be able to use the soil report to assist in the review and construction inspection for footing and foundation systems.

The student will be able to apply the Residential Code of Ohio to a footing and foundation system based on the submitted geotechnical report.

GEOTECHNCIAL REPORTS

- General
  - Commonly called soil reports
- Foundation systems including footings 401.2
  - Capable of passing the building loads to the supporting soil
  - Fill soil shall be designed by a licensed engineer
- Waterproofing verse damp proofing 406
  - System used bases on the ground water elevation

- When required
  - Questionable soil characteristics
  - Expansive, compressible, shifting or other questionable conditions
  - Adjacent lot soil reports can be used when approved by the BCO

- Why do soil reports
  - Provides information on the underground conditions
  - Identify soil types
  - Provides data on the different bearing values at different elevation
  - Provides the depth of underground water table
  - Used by the structural engineer or architect in the foundation design
  - Used by the contractor to determine amount of soil to be removed or filled
  - Used by the inspector to check for compliance
  - Determine damp proofing verse water proofing 406
  - Used in the design of the footing and foundation walls
  - Engineer will provide footing and foundation design recommendation

- Basis for soil classification
  - Unified Soil Classification System

TABLE 401.4.1
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS [a]

CLASS OF MATERIAL	LOAD-BEARINGPRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy, silty clay, clayey silt, silt and sandy siltclay (CL, ML, MH and CH)	1,500[b]

For SI: 1 pound per square foot = 0.0479 kPa.

a. Where soil tests are required by Section 401.4, the allowable bearing capacities of the soil shall be part of the recommendations.

b. Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

- Types of soil reports
  - Complete test with multiple borings
  - Single boring
  - Site inspection after excavation
- Typical methods
  - Soil borings
  - Trenches
  - On site excavation samples

- Borings
  - By machine
  - By hand
- Result
  - After analysis by soils engineer
  - Geotechnical report

- Report contains
  - Scope of investigation
  - Site showing location of borings
  - Soil classification at each boring
    - Abbreviations
  - Depth of water Table
  - Depth of fill if applicable
  - Soil engineer’s recommendations

- Boring locations

- Boring or coring
- https://www.youtube.com/watch?v=i9eQcc7ilVw

EQUIPMENT VertekS4 CPTw/Discrete Sampler ELEVATION 552.6± DATE DRILLED 12/17/19

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					SILT (ML): Dark brown and brown		1							552
	1	BS					2	26		1.5		32	6	
3					FAT CLAY (CH): Gray, with brown									
	2	BS						25		6.5				549
					LEAN CLAY (CL): Gray, with brown									
6	3	BS						26		4.5				546
	4	BS						27		1.5				
9														543
					Boring terminated at 10 feet.									
12														540
15														537
18														534

WATER LEVEL:

X	NONE OBSERVED WHILE DRILLING
___ ft	WHILE DRILLING
___ ft	___ HRS AFTER DRILLING
___ ft	___ DAYS AFTER DRILLING

REMARKS:

1) Plow zone.
2) Organic Content = 1.8%

BORING LOG LEGEND AND NOMENCLATURE

Depth is in feet below ground surface. **Elevation** is in feet mean sea level, site datum, or as otherwise noted.

Sample Type

- **SS** Split-spoon sample, disturbed, obtained by driving a 2-inch-O.D. split-spoon sampler (ASTM D 1586).
- **NX** Diamond core bit, nominal 2-inch-diameter rock sample (ASTM D 2113).
- **ST** Thin-walled (Shelby) tube sample, relatively undisturbed, obtained by pushing a 3-inch-diameter, tube (ASTM D 1587).
- **CS** Continuous sample tube system, relatively undisturbed, obtained by split-barrel sampler in conjunction with auger advancement.
- **SV** Shear vane, field test to determine strength of cohesive soil by pushing or driving a 2-inch-diameter vane, and then shearing by torquing soil in existing and remolded states (ASTM D 2573).
- **BS** Bag sample, disturbed, obtained from cuttings.

Recovery is expressed as a ratio of the length recovered to the total length pushed, driven, cored.

Blows Numbers indicate blows per 6 inches of split-spoon sampler penetration when driven with a 140-pound hammer falling freely 30 inches. The number of total blows obtained for the second and third 6-inch increments is the N value (Standard Penetration Test or SPT) in blows per foot (ASTM D 1586). Practical refusal is considered to be 50 or more blows without achieving 6 inches of penetration, and is expressed as a ratio of 50 to actual penetration, e.g., 50/2 (50 blows for 2 inches).

For analysis, the N value is used when obtained by a cathead and rope system. When obtained by an automatic hammer, the N value may be increased by a factor of 1.3.

Vane Shear Strength is expressed as the peak strength (existing state) / the residual strength (remolded state).

Description indicates soil constituents and other classification characteristics (ASTM D 2488) and the Unified Soil Classification (ASTM D 2487). Secondary soil constituents (expressed as a percentage) are described as follows:

Trace	<5
Few	5-15
With	>15-30

Stratigraphic Breaks may be observed or interpreted, and are indicated by a dashed line. Transition between described materials may be gradual.

Laboratory Test Results

- Natural moisture content (ASTM D 2216) in percent.
- Dry density in pounds per cubic foot (pcf).
- Hand penetrometer value of apparently intact cohesive sample in kips per square foot (ksf).
- Unconfined compressive strength (ASTM D 2166) in kips per square foot (ksf).
- Liquid and Plastic Limits (ASTM D 4318) in percent.

RQD (Rock Quality Designation) is the ratio between the total length of core segments 4 inches or more in length and the total length of core drilled. RQD (expressed as a percentage) indicates insitu rock quality as follows:

Excellent	90 to 100
Good	75 to 90
Fair	50 to 75
Poor	25 to 50
Very Poor	0 to 25

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- Other testing methods
  - Trench excavation

- Other testing methods
  - Trench excavation
  - Test pits
- https://www.youtube.com/watch?v=DxneZgQTvqU

- Other testing methods
  - Trench excavation
  - Test pits
  - In situ testing
    - Pocket penetrometer
    - https://www.youtube.com/watch?v=kWaCaKE7jXc
    - https://www.youtube.com/watch?v=wg0cy-UgSEo
    - https://www.youtube.com/watch?v=PBo0UDVWhSo

- Test result
  - Residential reports the same type of information

FOOTING INSPECTION REPORT

PROJECT: 418 Cumnock
LOCATION: Inverness, IL
CLIENT: Tom Brannon

REPORT NO. 1
DATE: 11/20/19
OUR JOB NO. 19719

LOCATION: 418 Cumnock

CC: field

BASEMENT DEPTH FOOTING

DESIGN ELEVATION? Yes

IF NO, DESCRIPTION OF MATERIAL REMOVED: –

APPROX. DEPTH OF UNDERCUT – FT / IN

DESCRIPTION OF BEARING MATERIAL: Grey silty clay

FILL ____ NATURAL X UNKNOWN ____

STRENGTH/CONSISTENCY: 1.5 tsf

FILL REQUIRED TO DESIGN ELEVATION? No

~~DESCRIPTION OF FILL MATERIALS:~~ Footings in place at time of inspection

REMARKS: Wall footings backfilled w/ CA-11. Measured strength of soil beneath stone, sidewalls and spread footings

FROST DEPTH FOOTING

DESIGN ELEVATION? ____

IF NO, DESCRIPTION OF MATERIAL REMOVED:

APPROX. DEPTH OF UNDERCUT ____ FT / IN

DESCRIPTION OF BEARING MATERIAL:

FILL ____ NATURAL ____ UNKNOWN ____

STRENGTH/CONSISTENCY: ____ ____

FILL REQUIRED TO DESIGN ELEVATION? ____

DESCRIPTION OF FILL MATERIALS:

REMARKS:

COMMENTS: with static cone penetrometer. Interior drain installation in progress.

MATERIALS INSPECTED ARE APPROVED FOR CONCRETE PLACEMENT THIS DATE.

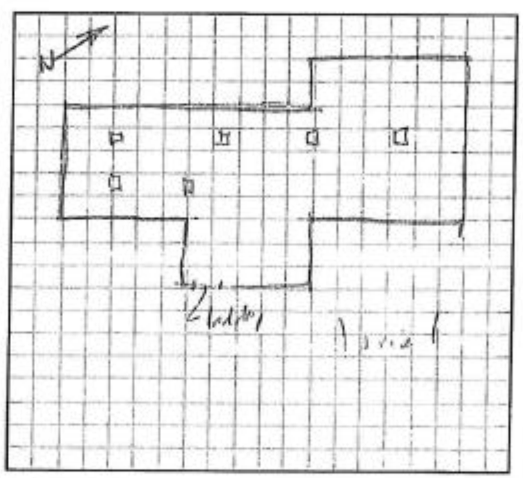
DESIGN BEARING CAPACITY: 3,000 PSF

ALLOWABLE BEARING CAPACITY: 3000 PSF

THIS BEARING INSPECTION IS VALID AT THE TIME OF INSPECTION AND DOES NOT EXTEND TO FOUNDATION CONCRETE OR WARRANT THE PERFORMANCE OF SAME.

SIGNED [signature]

APPROVED ____



File No.: ______

Arrival Time: ______

Client: American Deck Builders, Inc. Project Name: Inverness Country Club

Tested soils below ~~(trenched or spread) footings for~~ (deck support posts).
Choose one — lot # & unit #, or as described

The exposed soils encountered include (Brown Gray Silty Clay) (type of soil(s))

______) with pocket penetrometer readings ranging from (1.5) to (2.5) tons/sq.ft.

Test results were reported to (Mike) with (ADBI).
name of person — name of company

Summary:

Location	Soil Description	Penetrometer Readings

Design Soil Bearing Capacity 3000 lbs/sq.ft. as reported by ADBI.

Recommendations (check when applicable):

______ Key-in footings to remove any loose or saturated surface soils.

______ Undercut the lower strength or unsuitable soils to depths of ______.

______ Fill undercut to the proposed footing elevation with compacted crushed granular fill.

______ Place adequate reinforcing steel in all foundation walls, typically 2 No. 5 rebars near the top and 2 No. 5 rebars near the bottom.

Additional Recommendations & Comments: Compact loose soils in bottom of holes prior to concrete placement.

Weather:		Site Conditions:		Time:	
Clear	X	Clear	X	Travel Time	______ Hrs.
Overcast		Muddy		Time on Site	______ Hrs.
Rain		Standing Water		Time in Lab	______ Hrs.
Mist		Dusty			
Snow		Other		Total Job Time	______ Hrs.

Temperature range: -20 -10 0 10 20 30 40 (50) 60 70 80 90 100

Joe Kl... Signature: [signature]

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Case Study

You are inspecting an excavation for a house and they provided the following soil information. It is a sinlge boring report.

It is a two story house with a basement, with a 20 psf snow load.

The height of the foundation wall is 8 feet with 6 feet of unbalance fill

Answer the following questions.

1. If the elevation of the basement floor is 8 feet below grade. Will the foundation walls require damp proofing or water proofing.
2. Is any fill located on site, which could affect the new footings and foundation.
3. What is the minimum width and thickness of the footing
4. What is the minimum thickness of a plain masonry foundation wall?

EQUIPMENT VertekS4 CPTw/Discrete Sampler ELEVATION 552.6± DATE DRILLED 12/17/19

DEPTH (ft)	SAMPLE NUMBER	SAMPLE TYPE	SAMPLE RECOVERY (in/in)	SAMPLE BLOWS (per 6 in)	DESCRIPTION (UNIFIED SOIL CLASSIFICATION)	GRAPHIC	SEE REMARK NO.	LABORATORY TEST RESULTS: MOISTURE CONTENT (%)	DRY DENSITY (pcf)	HAND PENETROMETER (ksf)	UNCONFINED COMPRESSIVE STRENGTH (ksf)	LIQUID LIMIT	PLASTICITY INDEX	ELEVATION (ft)
					SILT (ML): Dark brown and brown		1							552
	1	BS					2	26		1.5		32	6	
3					FAT CLAY (CH): Gray, with brown									
	2	BS						25		6.5				549
					LEAN CLAY (CL): Gray, with brown									
6	3	BS						26		4.5				546
	4	BS						27		1.5				
9														543
					Boring terminated at 10 feet.									
12														540
15														537
18														534

WATER LEVEL:

X NONE OBSERVED WHILE DRILLING
___ ft WHILE DRILLING
___ ft ___ HRS AFTER DRILLING
___ ft ___ DAYS AFTER DRILLING

REMARKS:

1) Plow zone.
2) Organic Content = 1.8%

Case Study

You are inspecting an excavation for a house and they provided the following soil information. It is a sinlge boring report.

It is a two story house with a basement, with a 20 psf snow load.

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1. If the elevation of the basement floor is 8 feet below grade. Will the foundation walls require damp proofing or water proofing.
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4. What is the minimum thickness of a plain masonry foundation wall?

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Questions?

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Thank You For Your Time

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Building & Fire Code Academy

Website: bfcacademy.com

Email: info@bfcacademy.com

Voice: (800) 488-7057 (847) 428-2951

Fax: (847) 428-2911

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

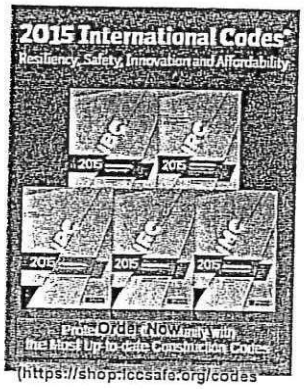
William Rainey Harper College – Palatine, IL (1984 – 1999)
- Course Title: BOCA ® National Building Code
- Course Title: Basic Code Enforcement
- Course Title: Fire Inspection Principles

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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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

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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)
Residential Energy Inspector/Plans Examiner (expires 08/26/2017)

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Contact Information

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Contact Us (mailto:certexam@iccsafe.org

Gregory D. Sengstock

(630) 770-5348

1037 Ash Street, St. Charles, IL 60174

Greg@SengstockArchitects.com

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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Part 5 - Framing

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April 2021

Learning Objectives / Learning Outcomes

Students will to explain to list the parts of a framing inspection.

Students will utilize a framing checklist to insure all areas of the structure are checked for compliance with the approved plan and the Residential Code of Ohio.

The student will be able to apply the Residential Code of Ohio to a framing inspection.

FRAMING INSPECTION

- Conventional light frame construction
- Utilize the framing checklist
- Purpose of the inspection
  - Check for compliance with the approved plan
  - Apply the applicable sections of the Residential Code of Ohio
  - Look for items not easily shown or not shown on plan

- Equipment required
  - Approved plans
  - Wall bracing plan
  - Checklist
  - Tape measure
  - Flashlight
  - Appropriate clothing

Purpose of the checklist

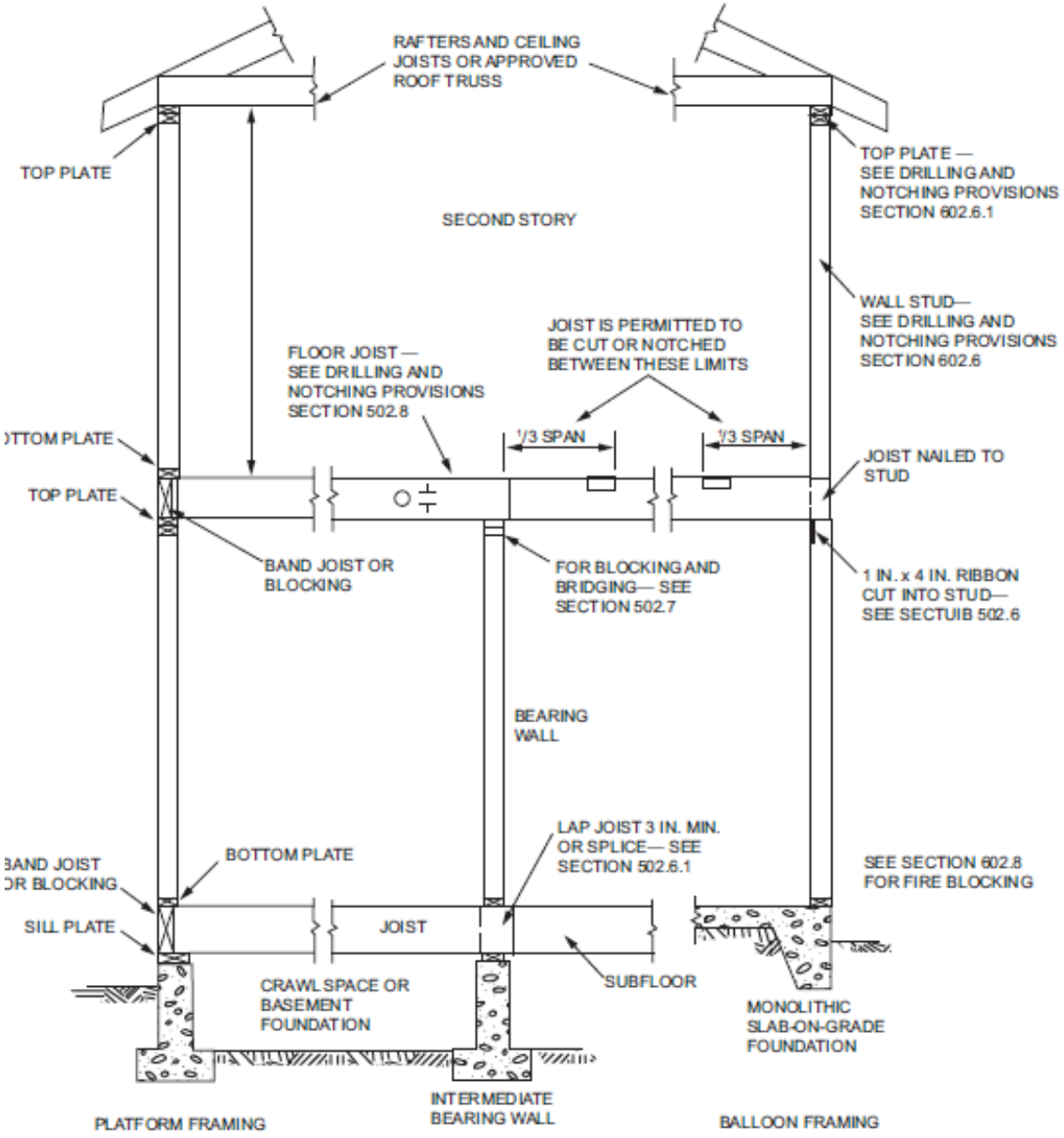
- Guide the inspector through the process
- Separate framing inspection report should be prepared
- Checklist starts at the bottom and goes up
- Reverse could be performed
- Some items on the checklist may not apply

- Before you start
  - Walk around the building
    - Number of stories
    - Garage location
    - Walk out basement
    - Cantilevers
    - Building layout
    - Building openings
    - Special features

* Assume concrete inspections were performed and approved
  - Look for inspection reports
  - Includes footing, foundation, backfill
  - Storm water system
  - Underground plumbing, electric

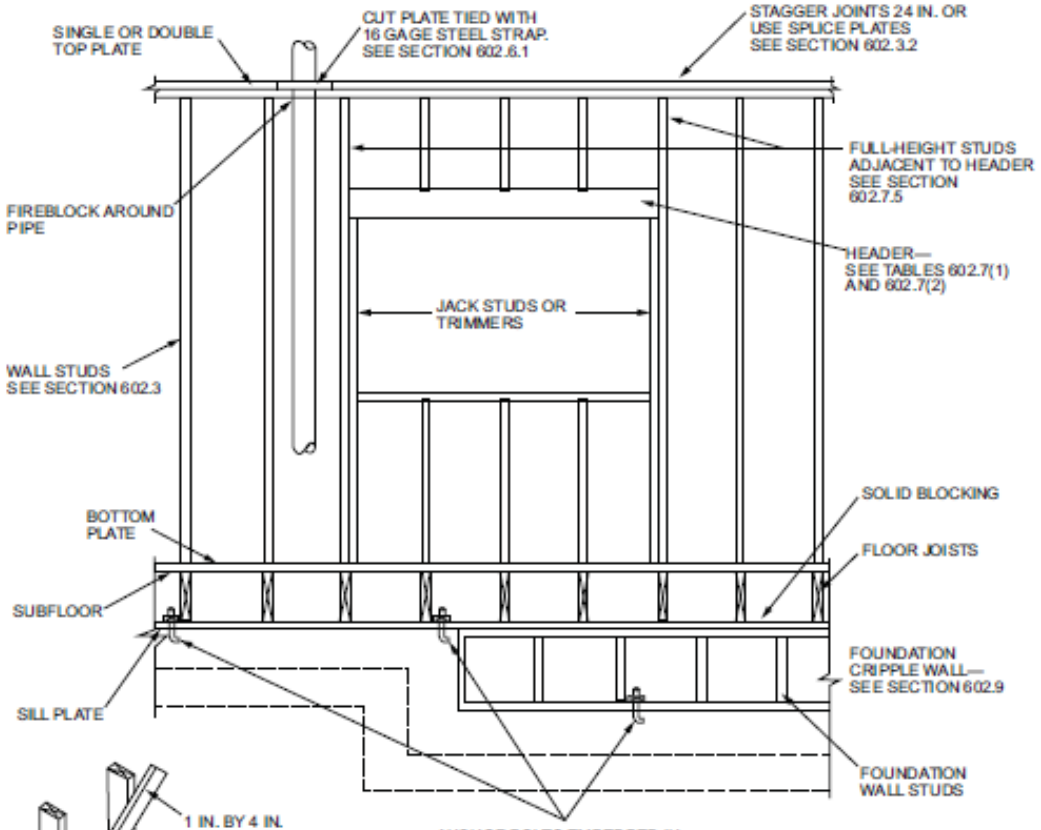
- Lets get started
- Top of the form

	Framing Checklist – Conventional light frame construction		
Framing plan and wall bracing plan on site		Documentation for engineered wood beams and headers	
Nails, fasteners per the Table in the code		All prefabricated metal fasteners installed and fastened per the manufacturer	
	Bearing on wood or steel beams is a minimum of 1 ½ inches Bearing on concrete or masonry is a minimum of 3 inches		



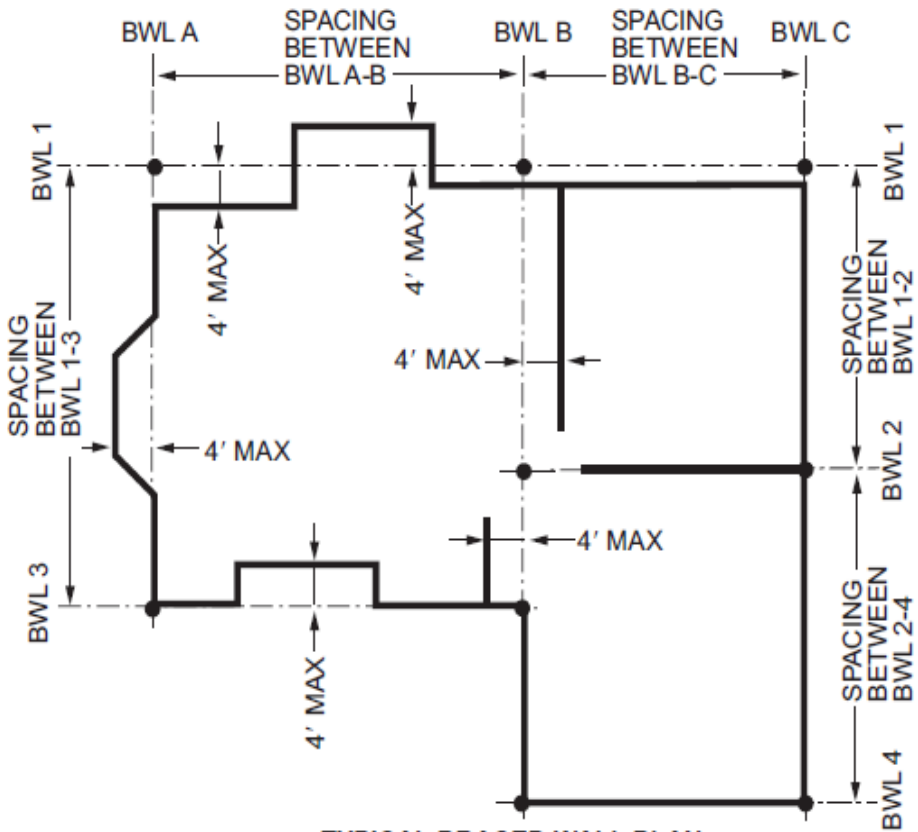
SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING

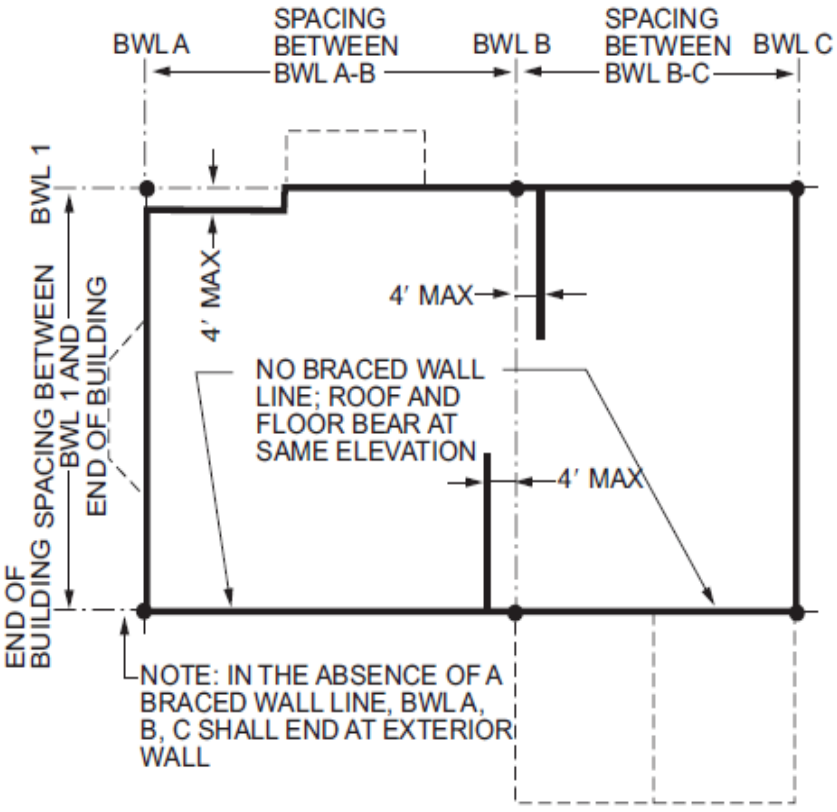


:h = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 602.3(2)
FRAMING DETAILS



TYPICAL BRACED WALL PLAN



TYPICAL UPPER FLOOR BRACED WALL PLAN

For SI: 1 foot = 304.8 mm.

FIGURE 602.10.1.1
BRACED WALL LINES

TABLE 602.3(1)
FASTENING SCHEDULE

ITEM	DESCRIPTION OF BUILDING ELEMENTS	NUMBER AND TYPE OF FASTENER[a, b, c]	SPACING AND LOCATION
		Roof	
1	Blocking between ceiling joists or rafters to top plate	4-8d box ($2^1/_2$″ × 0.113″) or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Toe nail
2	Ceiling joists to top plate	4-8d box ($2^1/_2$″ × 0.113″); or 3-8d common ($2^1/_2$″ × 0.131″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	Per joist, toe nail
3	Ceiling joist not attached to parallel rafter, laps over partitions (see Section 802.5.2 and Table 802.5.2)	4-10d box (3″ × 0.128″); or 3-16d common ($3^1/_2$″ × 0.162″); or 4-3″ × 0.131″ nails	Face nail
4	Ceiling joist attached to parallel rafter (heel joint) (see Section 802.5.2 and Table 802.5.2)	Table 802.5.2	Face nail
5	Collar tie to rafter, face nail or $1^1/_4$″ × 20 ga. ridge strap to rafter	4-10d box (3″ × 0.128″); or 3-10d common (3″ × 0.148″); or 4-3″ × 0.131″ nails	Face nail each rafter
6	Rafter or roof truss to plate	3-16d box nails ($3^1/_2$″ × 0.135″); or 3-10d common nails (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	2 toe nails on one side and 1 toe nail on opposite side of each rafter or truss[i]
7	Roof rafters to ridge, valley or hip rafters or roof rafter to minimum 2″ ridge beam	4-16d ($3^1/_2$″ × 0.135″); or 3-10d common (3″ × 0.148″); or 4-10d box (3″ × 0.128″); or 4-3″ × 0.131″ nails	Toe nail
		3-16d box $3^1/_2$″ × 0.135″); or 2-16d common ($3^1/_2$″ × 0.162″); or 3-10d box (3″ × 0.128″); or 3-3″ × 0.131″ nails	End nail

Interior

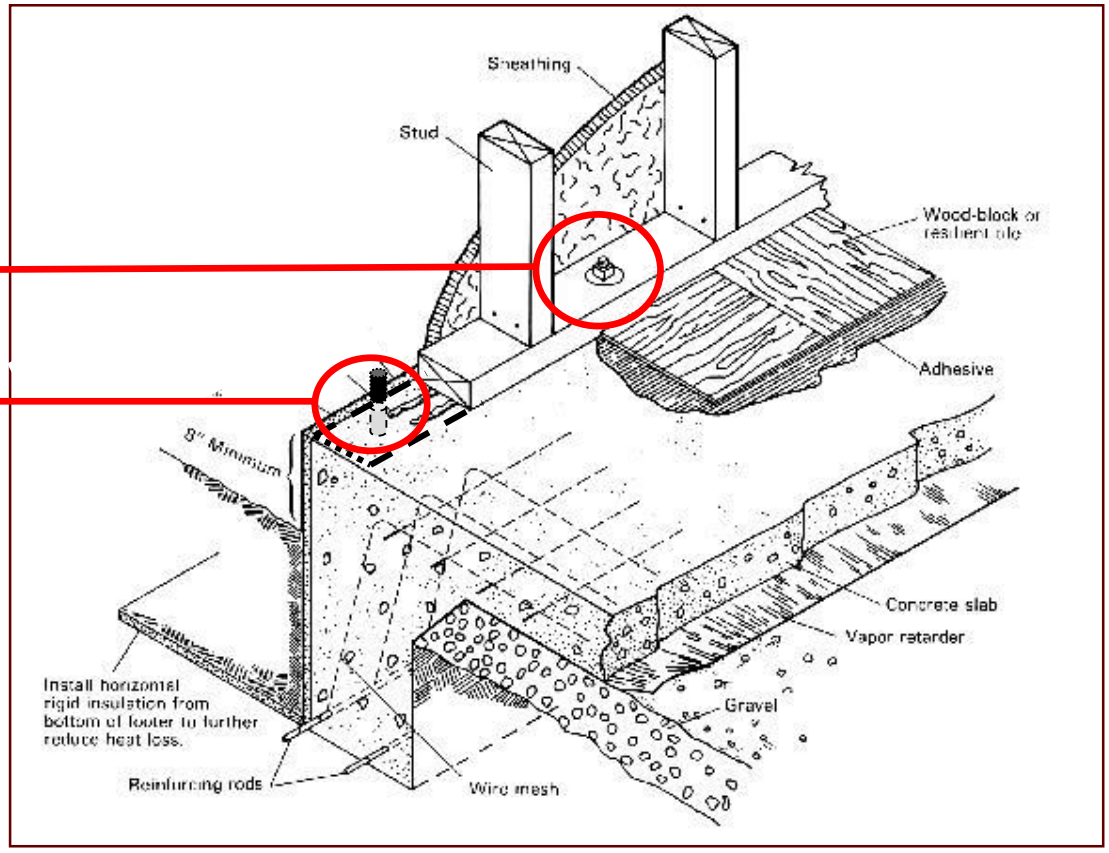
- Underfloor space

Interior space										
				G	B	1	2	3		
Underfloor space										
	Sill plate	Size								
			Material							
		Sill sealer								
		Anchor bolt	Size							
			Spacing							
			Location							
			Nut and washer							
		Alternate								

G – Garage B – Basement 1- 1st floor 2 - 2nd floor 3- 3rd floor

- Underfloor space
  - Crawl space, or basement
  - Sill plate – size match the plate above
    - Material – Pressure treated
  - Sill sealer – Part of the energy requirements

* Foundation anchorage 403.1.6
* Check size / spacing / location with the plan
* Check condition and installation on site



Note: ½" minimum anchor bolts 6' O.C., 2 bolts per section of plate minimum, one bolt w/in 12" of end of plate but not less than 7 bolt diameters from end

* Spacing
  - Every six feet
    – Over 2 stories 4 feet on center
  - 12 inches from the end of plate
  - Minimum two per plate
* Location
  - Center 1/3 of plate
* Washer and nut
  - Nut tightened down
  - Some exposed thread above nut
* Alternate product


08/11/2016 15:22


08/11/2016 15:22

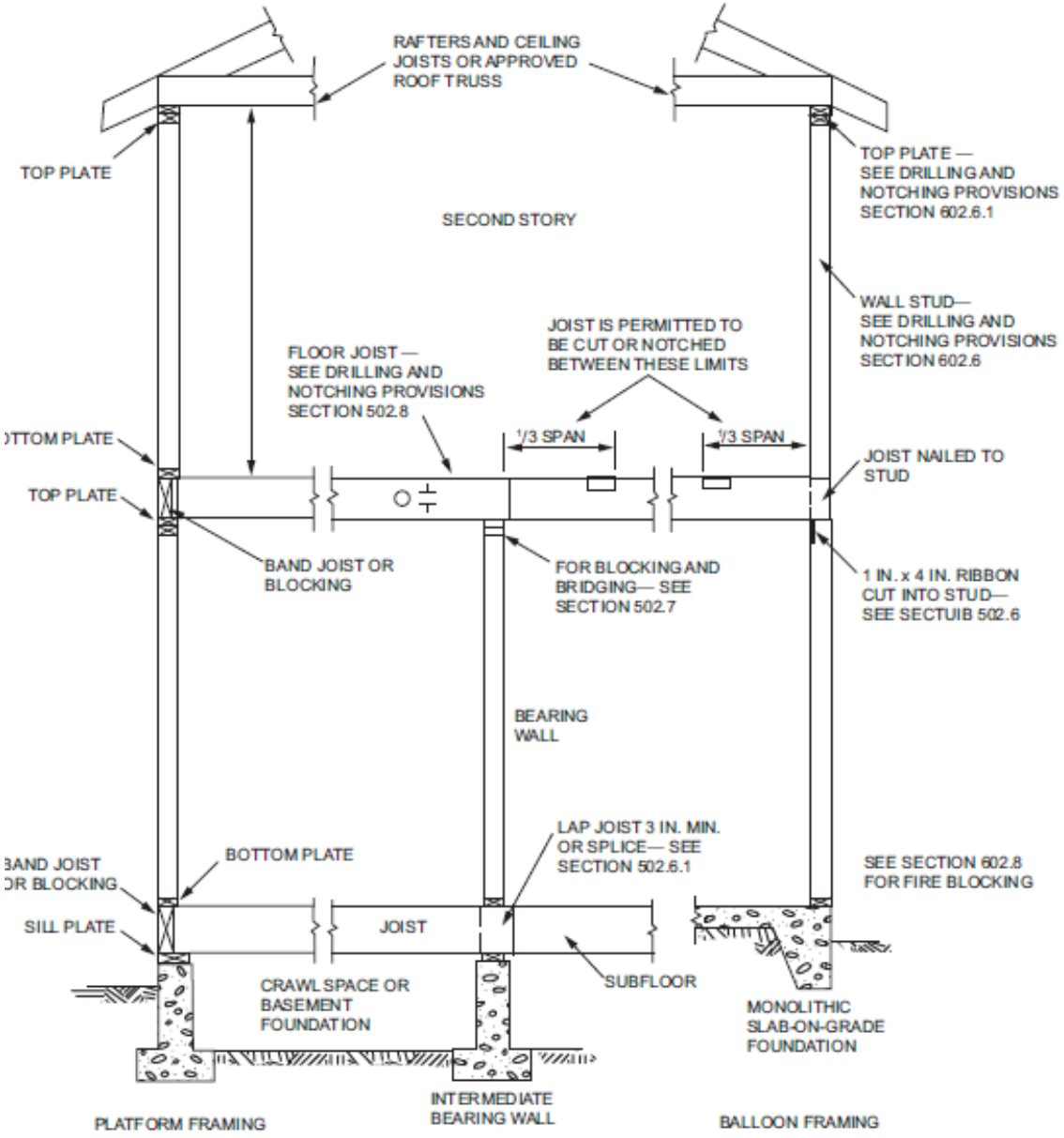

08/11/2016 15:22

♦ Columns

					G	B	1	2	3	
	Columns	Spacing	Size							
		Secured	Bolts							
		Beams	Connection	Species						
			Bearing on	Column						
				Beam						

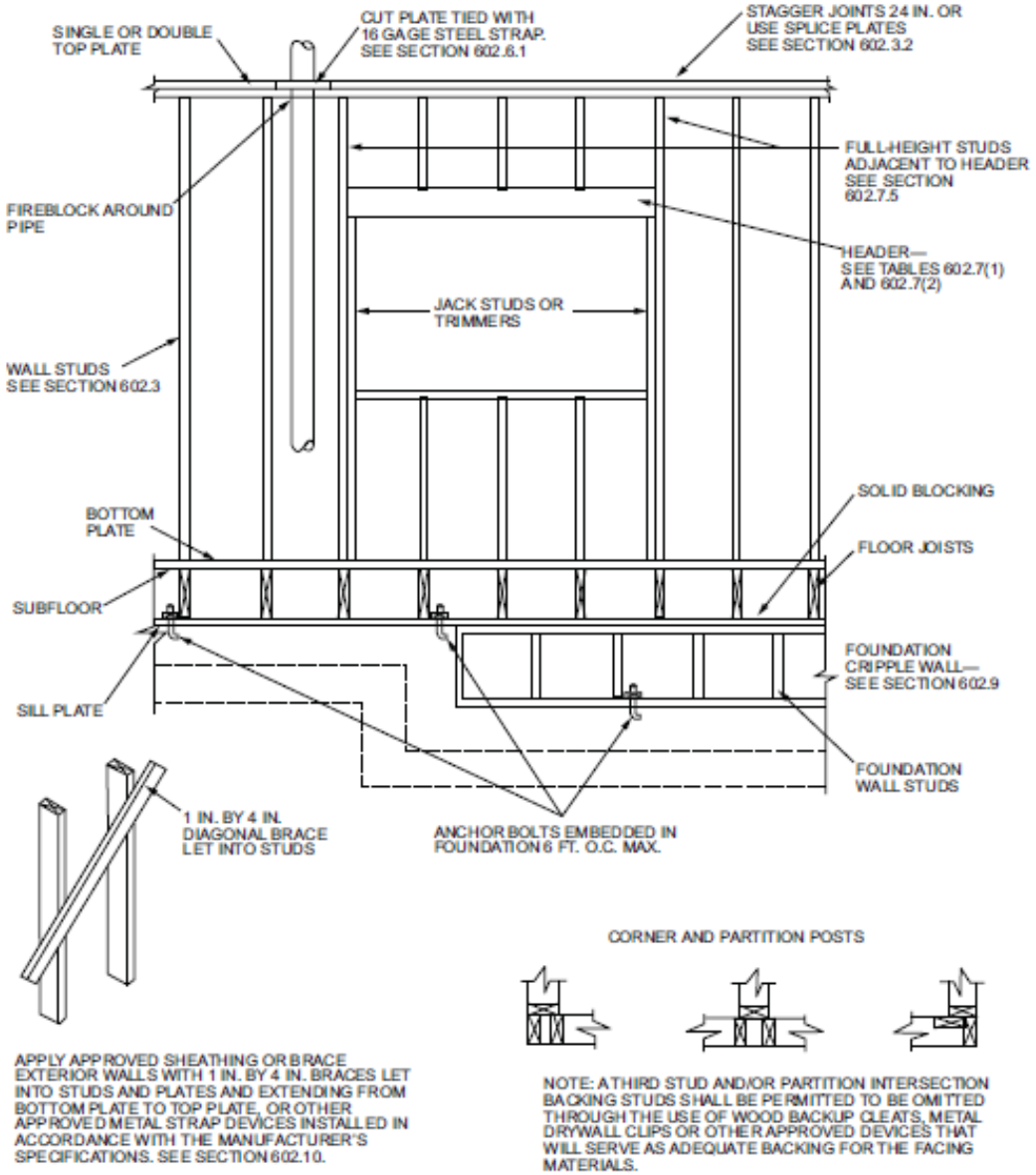
* Check size / spacing with the plan
* Check condition and installation on site
* Spacing and size
* Secured – top and bottom
* Bearing on columns
  - Beams – species of building or engineered product
  - Secure beam to column


PO#



SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 602.3(1)
TYPICAL WALL, FLOOR AND ROOF FRAMING



:h = 25.4 mm, 1 foot = 304.8 mm.

FIGURE 602.3(2)
FRAMING DETAILS

Floors

- Apply checklist as you inspect each floor
- Some information on plan - balance site conditions

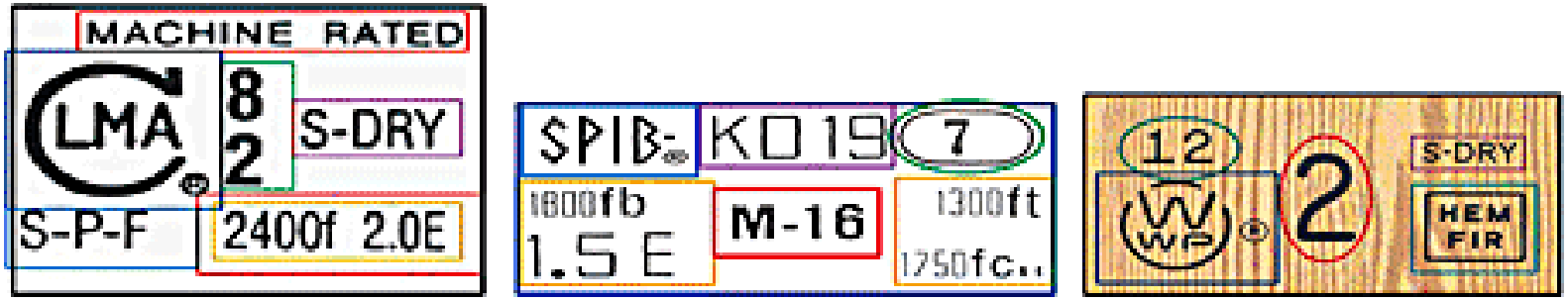
					G	B	1	2	3	
	Floors	Joists	Size							
			Spacing							
			Condition	Grade						
			Sheathing	Grade						
				Direction						
			Openings	Framing						
			Cutting, notching	Boring						
			Overlap							
		Engineered/ TJI								
		trusses	Layout plans							
			Size, spacing							
			Squash block							
			Web stiffeners							
			Bracing							
		Wall bracing conn.								

Floors

- Check size, spacing, grade openings with the plan
- Check condition and installation on site
- Check framing of openings with plan
- Check installation on site

- Grade stamps

How to Read a Grade Stamp:



MSR Grade | MEL Grade | Visual Grade

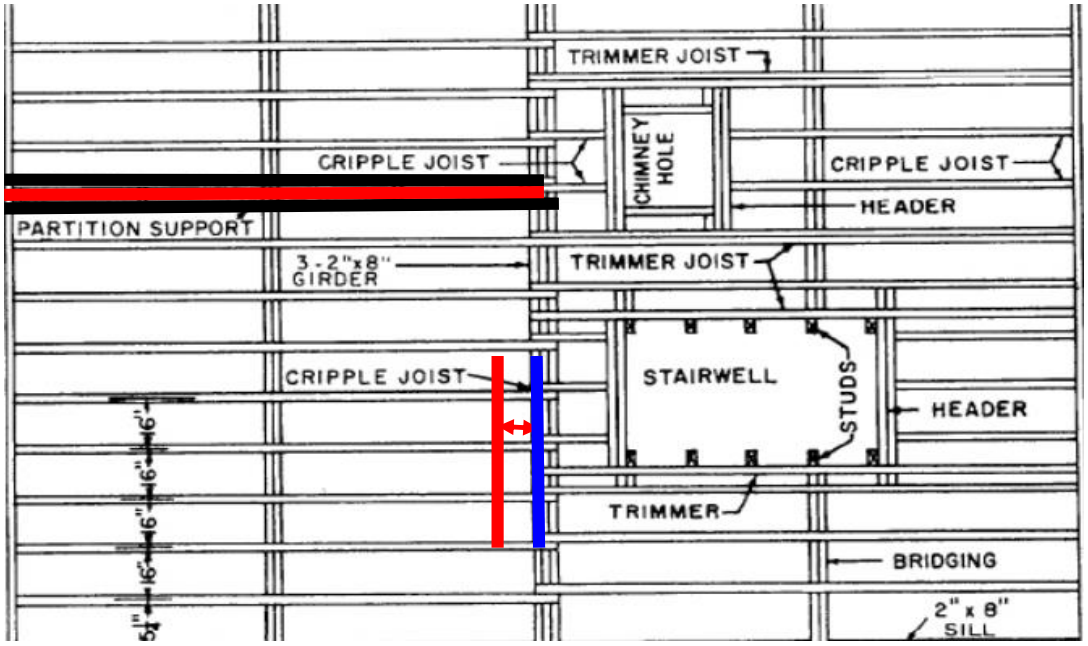
- Lumber Grade
- Species Group
- Lumber Strength Properties
- Moisture Content at the time of surfacing
  - MC15 or KD15 for a moisture content of 15 percent or less;
  - S-DRY, KD, or KD19 for a moisture content of 19 percent or less;
  - S-GRN for unseasoned with a moisture content of more than 19 percent
- Mill Producer
- Grading Agency

- https://www.youtube.com/watch?v=02nj8qDFIfs

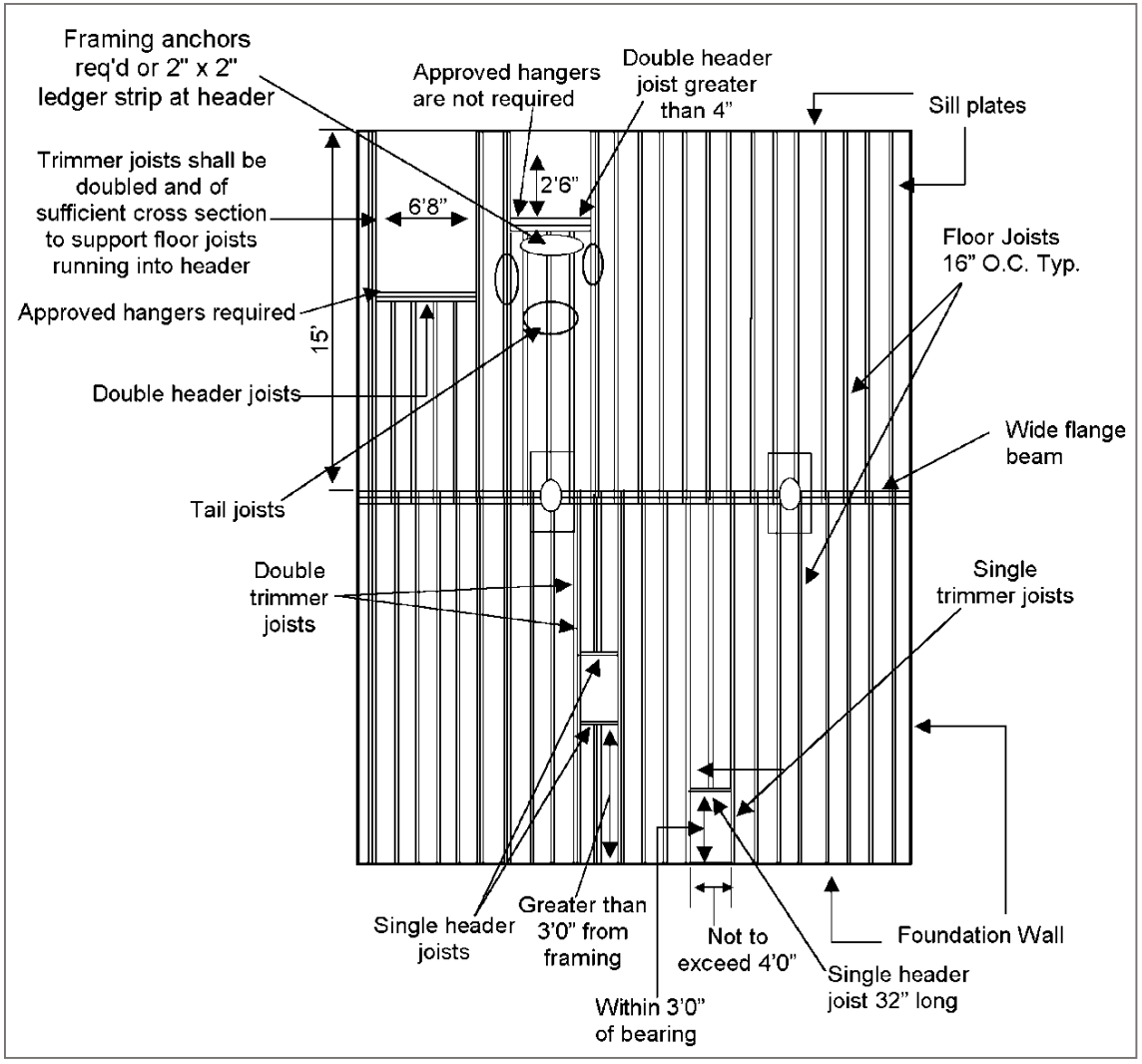
https://www.youtube.com/watch?v=Qxq7dD6gCqw

- https://www.youtube.com/watch?v=ClKMT627tck

* Joists under bearing partitions 502.4
  - Parallel – sized to carry load
  - Special provisions under plumbing wall – full depth blocking – minimum 2”
  - Perpendicular – offset from girder no more than 1 joist depth



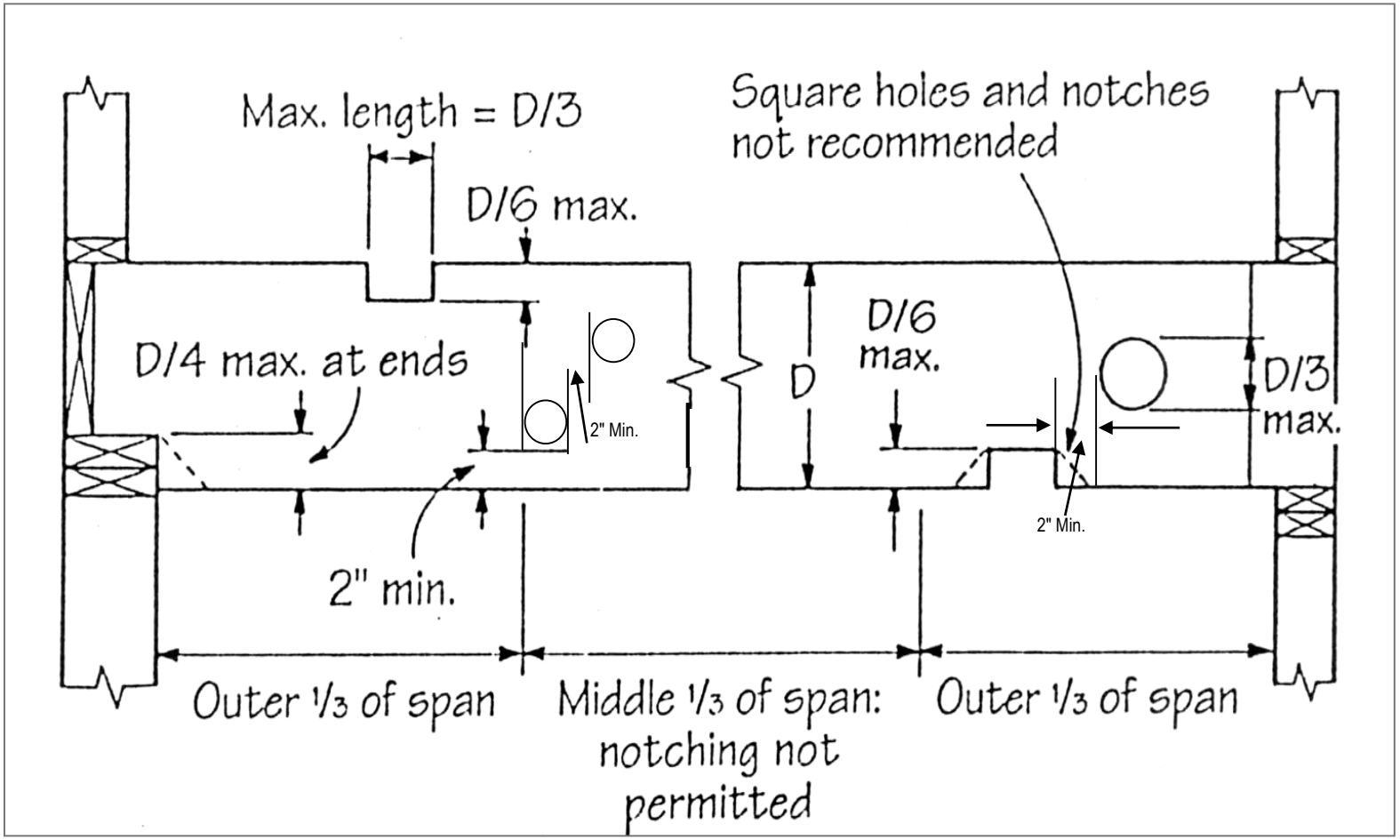
* Framing of floor openings 502.10, Figure 5022



* Cutting, notching and borings 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 R502.8



* Cutting, drilling and notching R502.8

* Cutting, drilling and notching R502.8


AF 100
181B-FX


ESR-1


2.0

* 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
* Fastening per Table 602.3(1)
  - Fastener schedule for structural members Table 602.3.1

* Wood truss 502.11
  - Wood truss bracing 502.11.2
  - Section references the current Guide for Truss Bracing (BCSI 1-03)

* Engineered / TJI or trusses
  - Layout from supplier
  - Size and spacing
  - Squash blocks
  - Web stiffeners
* Wall bracing connections
* Always check all bearing points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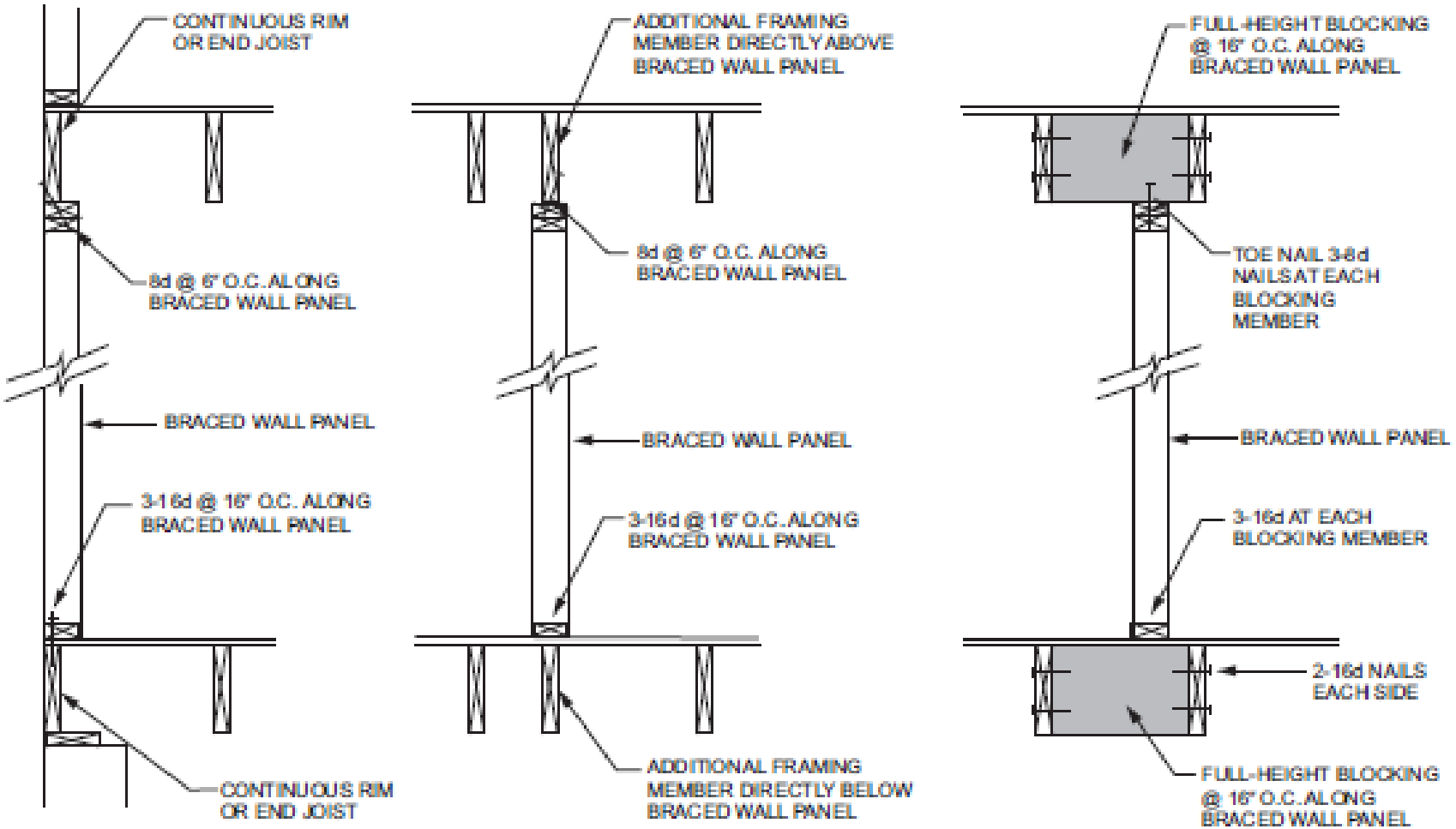


For SI: 1 inch = 25.4 mm.

FIGURE 602.10.8(2)
BRACED WALL PANEL CONNECTION WHEN PARALLEL TO FLOOR/CEILING FRAMING

- Always check all bearing points

Walls - Exterior

* Apply checklist as you inspect each floor

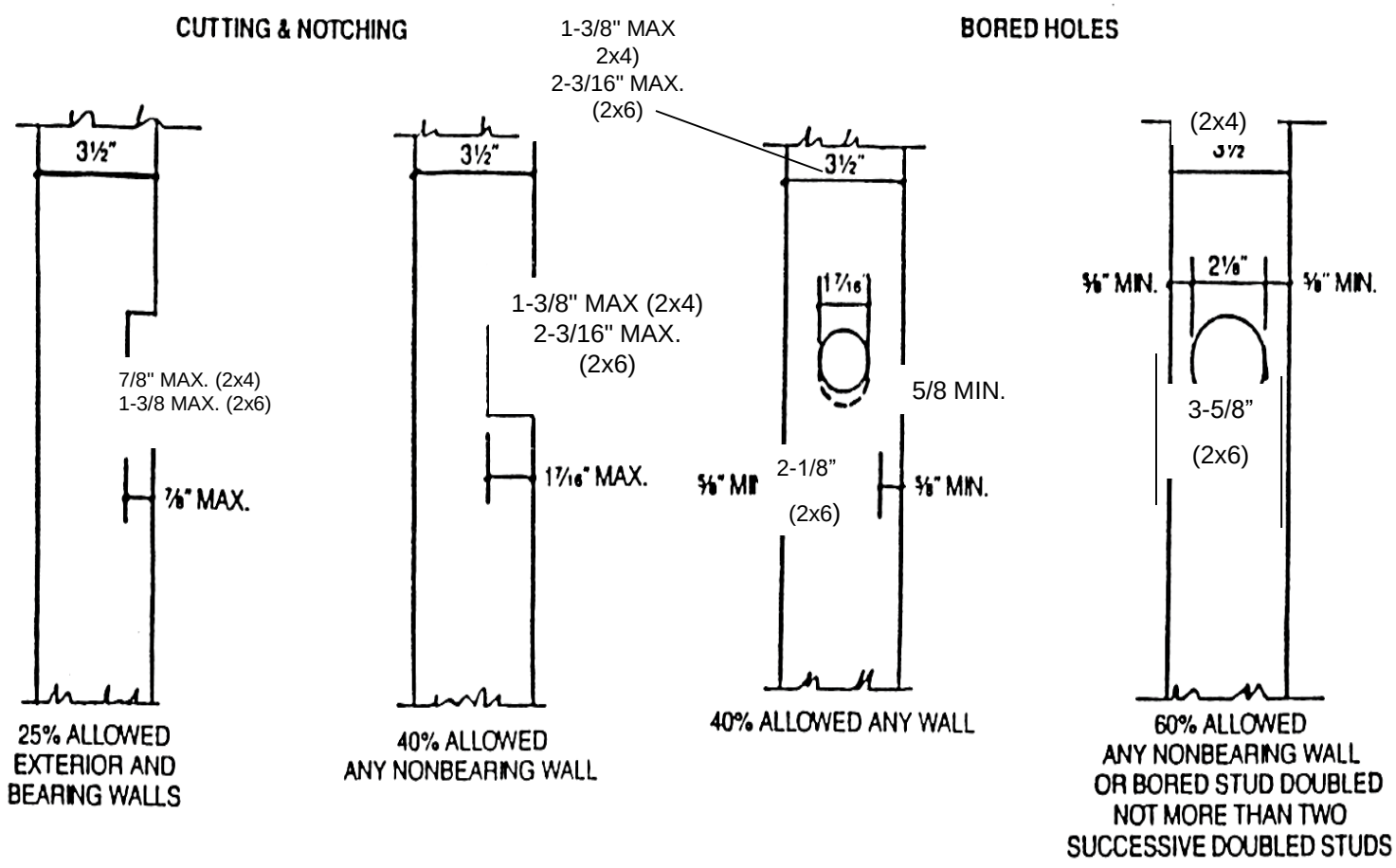
					G	B	1	2	3
Walls									
	Exterior	Studs	Size	Spacing					
			Grade / cond.	Nail plates					
			Corners	Outside					
		Plates	Top/ bottom						
			Cutting/ notching	boring					
		Wall bracing	Type of panel						
			# of panels						
			Location						
			Proper nailing						
			Connection at each floor line						
		Headers	Size and length						
				Support					

Walls

- Check size / spacing, grade, headers with the plan
- Double top plates – single bottom plates
- Check condition and installation on site
  - Cutting, notching
- Wall bracing
  - Type of panel
  - # of panels
  - Location
  - Proper nailing
  - Connection at each floor line
- Apply checklist as you inspect each floor

* 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 bearing wall stud width cutting / Notching (25% or less)
  - Non-bearing partitions
    - 40% or less of its width
    - 2” x 4” nominal stud size = 1-3/8”
    - 2” x 6” nominal stud size = 2-3/16”

- Non-bearing partitions
  - IF: Exterior wall or bearing studs are doubled
  - AND IF: Are 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

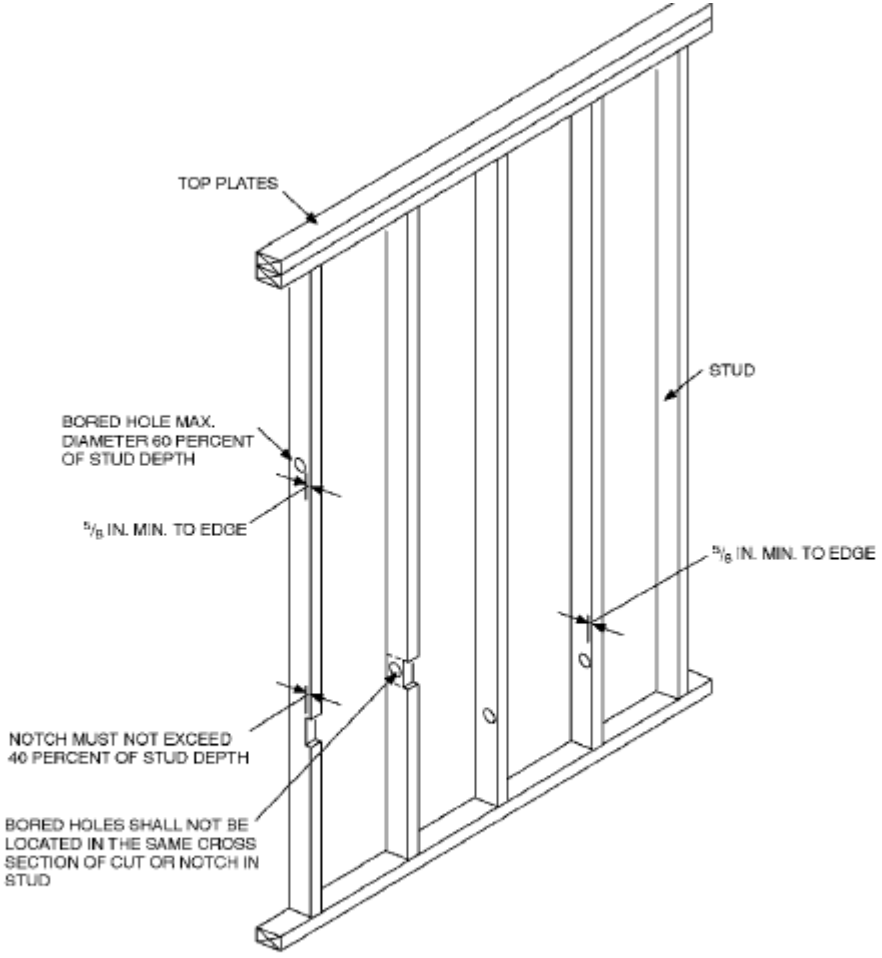
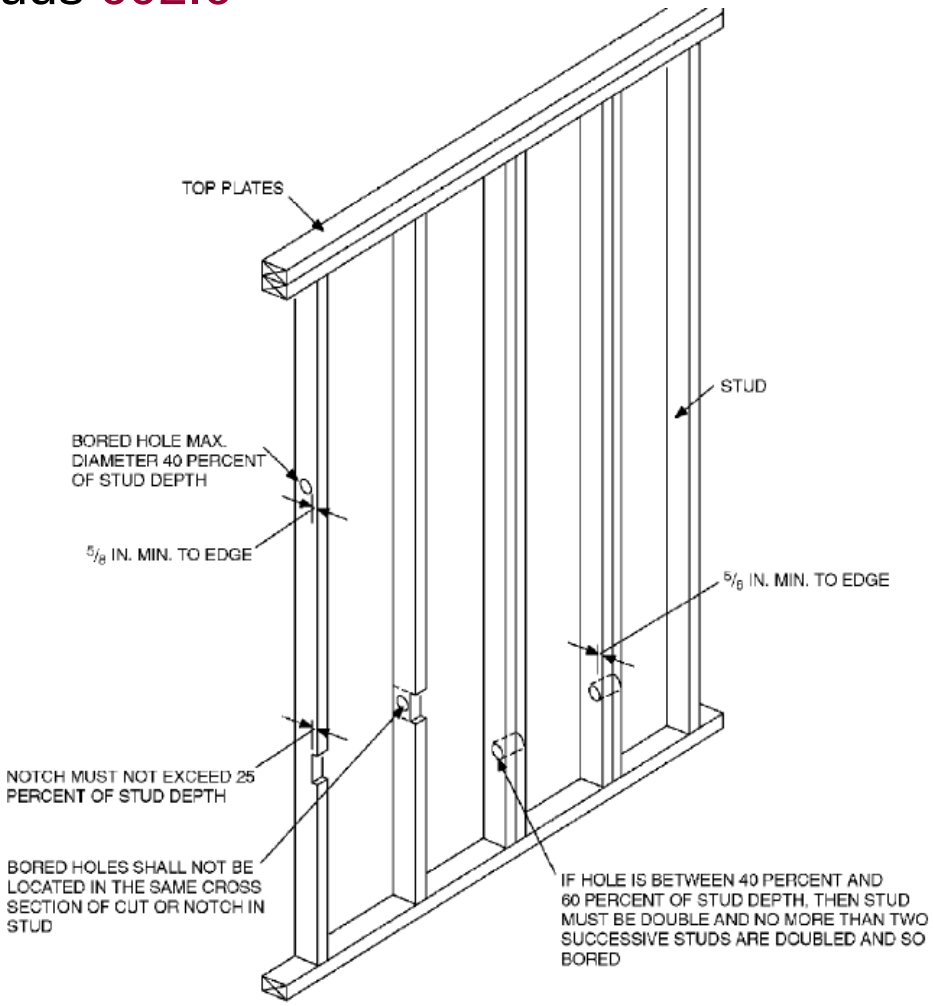


FIGURE 602.6(2)
NOTCHING AND BORED HOLE LIMITATIONS FOR INTERIOR NONBEARING WALLS

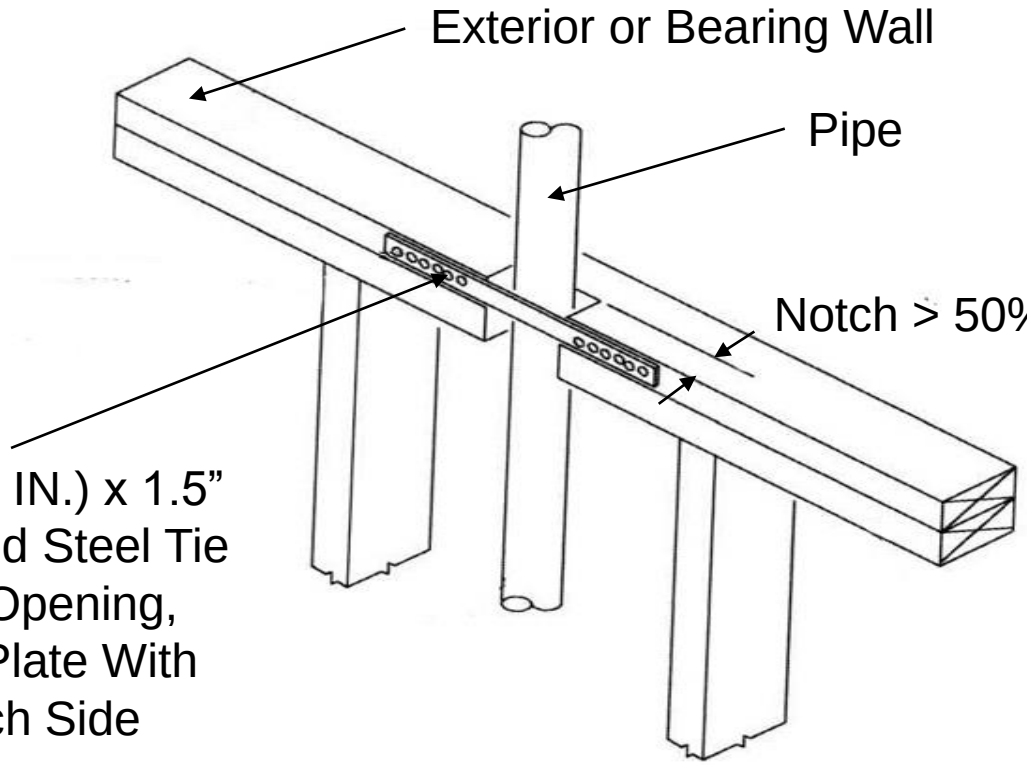


nch = 25.4 mm.
dition for exterior and bearing walls.

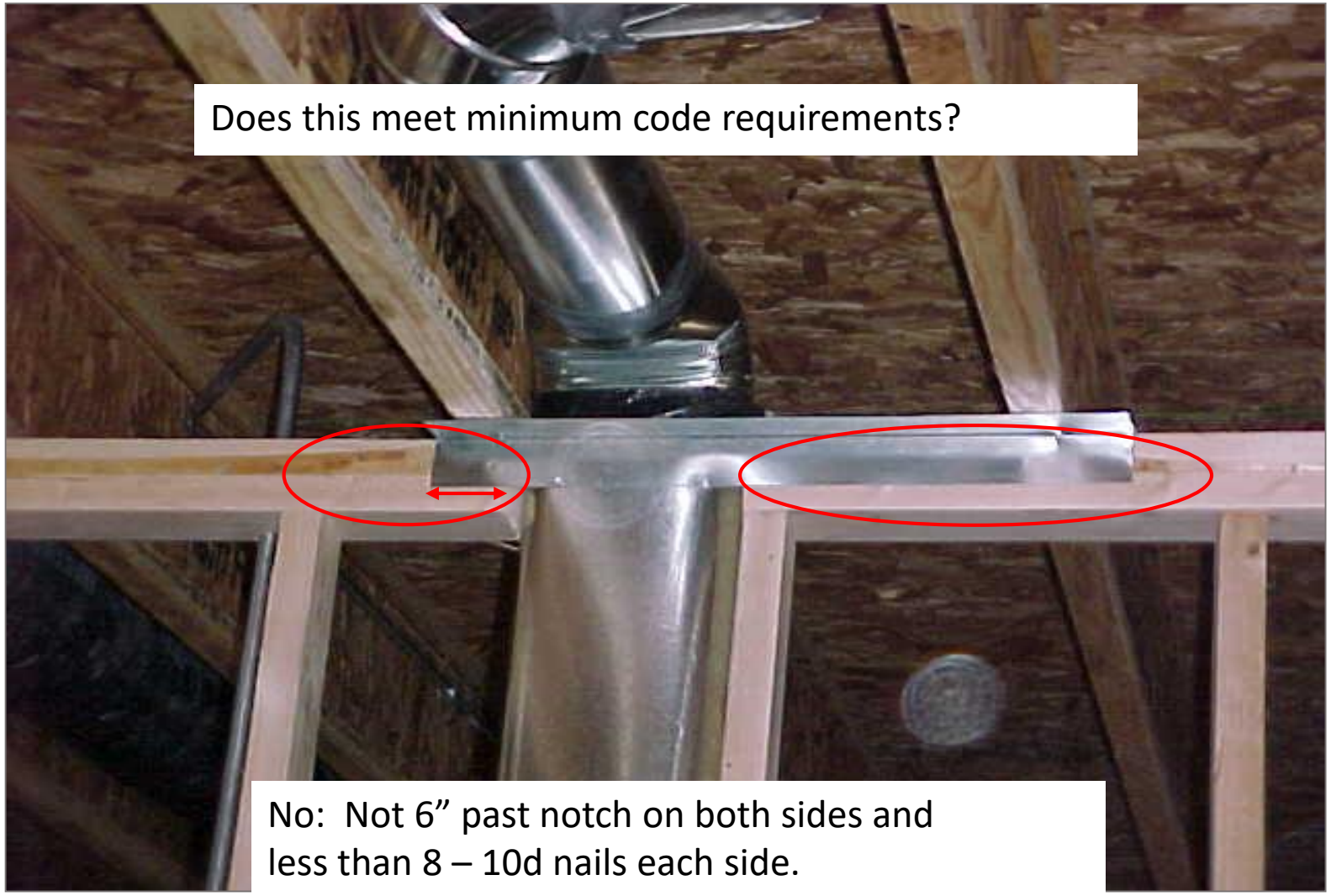
FIGURE 602.6(1)
NOTCHING AND BORED HOLE LIMITATIONS FOR EXTERIOR WALLS AND BEARING WALLS

* 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 eight 10d nails (min 1-½” long) and 0.148” diameter each side
  - 2” x 4” top plate = 1-7/8”
  - 2” x 6” top plate = 2-1/4”

* Drilling and notching top plate 602.6.1



* Drilling and notching top plate 602.6.1



* Drilling and notching top plate 602.6.1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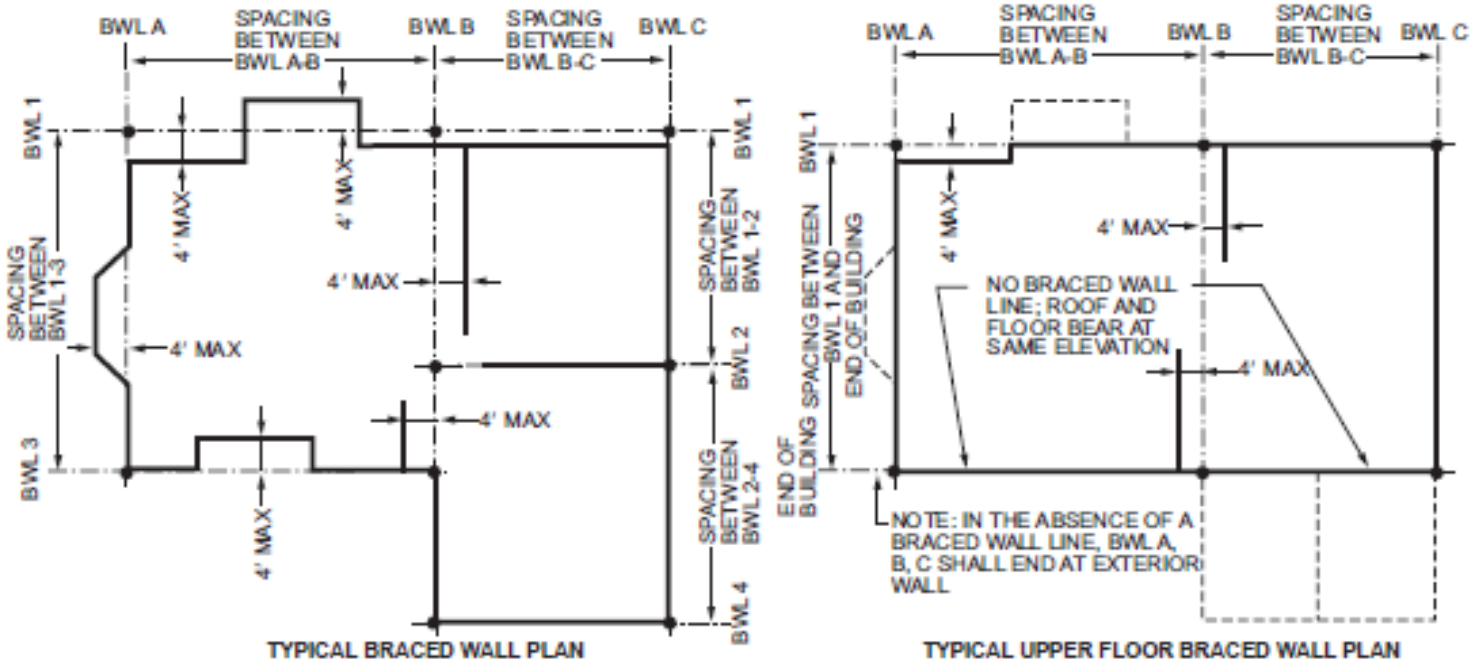
R-19
R-19
R-19
R-19


Glass
liner

- Wall bracing
- Check approved wall bracing panel



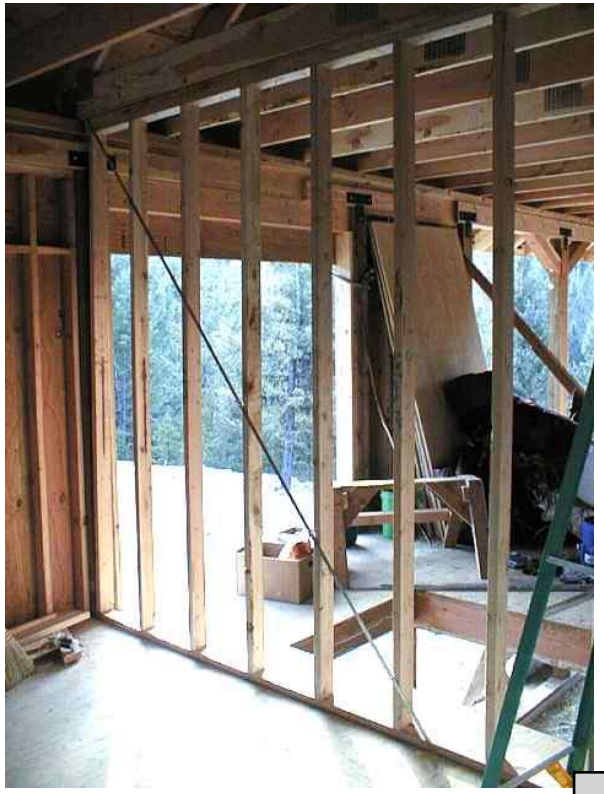
For SI: 1 foot = 304.8 mm.

FIGURE 602.10.1.1
BRACED WALL LINES


Rboard
Rboard
Rboard
Rboard
Rboard
Rboard

Method LIB (Let-in Bracing)

* Intermittent Bracing Methods Table 602.10.4
  - 1x4 or metal strap at 45 to 60° angle for studs 16 inches on center



- Method WSP (Wood Structural Panel) Intermittent Bracing Methods Table 602.10.4
  - Minimum thickness 3/8 inch
  - Per DOC or CSA standard
  - Span rating per Table 602.3(3)

Photo courtesy of Georgia Pacific

Walls – Interior

* Apply checklist as you inspect each floor

					G	B	1	2	3	
Walls										
	Exterior	Studs	Size	Spacing						
			Grade / cond.	Nail plates						
			Corners	Outside						
		Plates	Top/ bottom							
			Cutting/ notching	boring						
		Wall bracing	Type of panel							
			# of panels							
			Location							
			Proper nailing							
			Connection at each floor line							
		Headers	Size and length							
				Support						

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Walls

- Load bearing and nn loading bearing
- Studs
- Check size / spacing, grade, headers with the plan
- Double top plates – single bottom plates
- Check condition and installation on siteHeaders
  - Size / length
  - Support
- Point loads
  - Proper load path
  - Support
  - Check location on floor below
- Apply checklist as you inspect each floor


R-21
OWENS CORNING
ECOTOUCH
PINK
EcoTouch
R-21


ONLY

Roof / ceiling

* Apply checklist to each roof level

					G	B	1	2	3	
Roof/ceiling	Joists	Size and spacing								
			Condition	Bearing						
			Uplift protect.							
			Openings							
			Overlap							
			Cutting, notching	boring						
		Rafters	Size	Spacing						
			Point loads	Load path						
		Hips & valleys	Size							
		Sheathing	Size							
			Direction							
			clips							
		Collar ties	Size							
			Location							
		Ridgeboard								
			Size							
		Attic access	Size	Location						
		Trusses	Layout	Spacing						
			Bracing	Gable end						

* Rafters
  - Size / Spacing
  - Point loads / load path
* Hips & Valleys
  - Size
* Sheathing
  - Size / Direction
  - H clips

* Collar ties
  - Size
  - Location
* Ridge board
  - Size – Not less than the depth of the cut – minimum 1 inchbpard
* Attic access
  - Size
* Trusses
  - Layout / spacing
  - Bracing / Gable end


2x10


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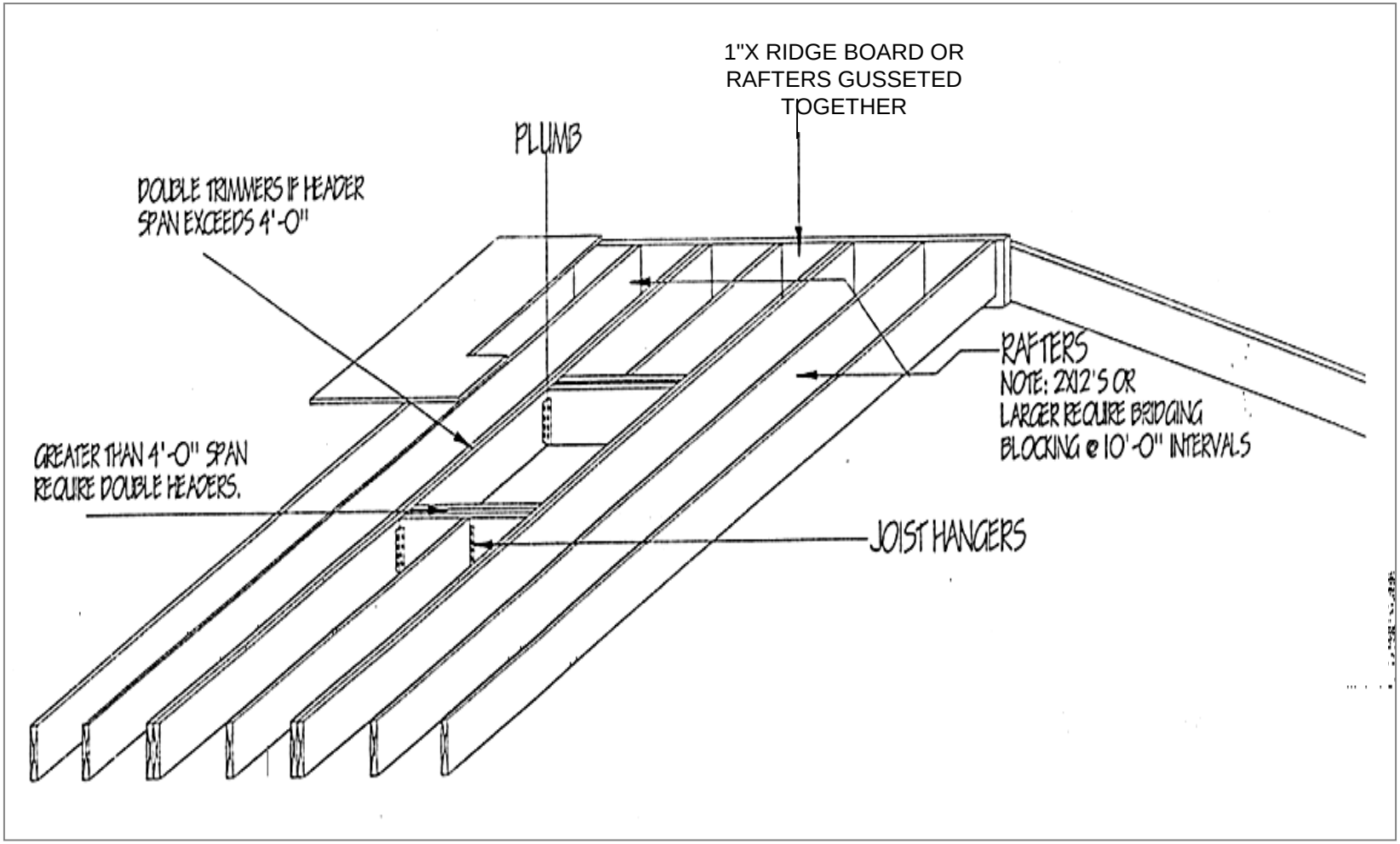
* Framing of openings 802.9
  - Roofs and ceiling
  - Headers spanning up to 4’ may be single member, same size as the ceiling joist or rafter
  - Header spans greater than 4’ require the header and trimmer joist and rafters to be doubled
  - Hangers required
    – Header to trimmer with header over 6’
  - Tail joist over 12’ with framing anchors or on a 2” ledger

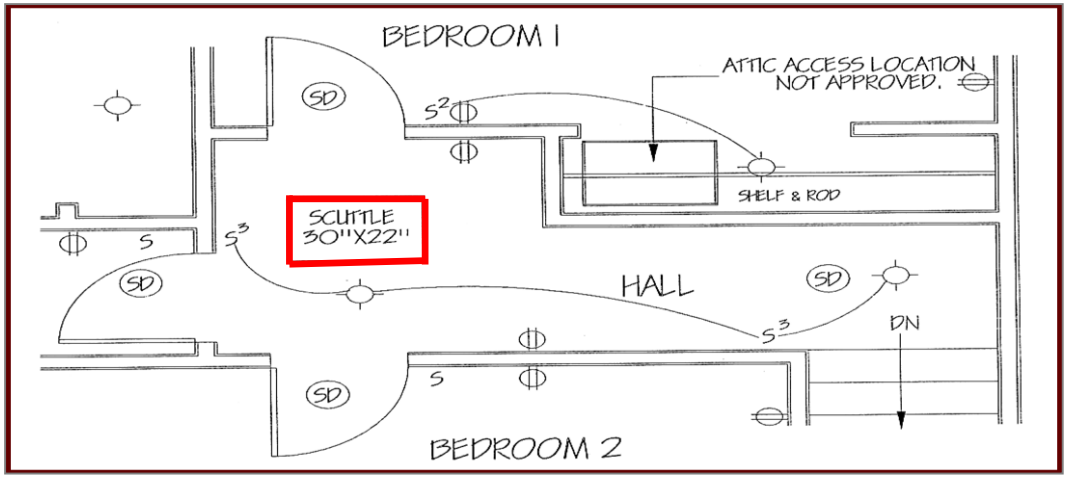
* Framing of openings (roof) 802.9




APA
24/16
7-3-10

Attic Access 807

- Ready access – hallway or other location with ready access
- 22" x 30" minimum
- Height: >30" in height at opening and exceeding 30 square feet
- See M1305.1.3 when mechanicals are located in the attic



- Stairs
  - Apply the checklist as each floor level is inspected

					G	B	1	2	3	
Stairs	Int and ext	If permanent	Width							
			Treads							
			Risers							
			Headroom							
			Total rise							
			Landings							
			Material							
		Winders	Dimensions							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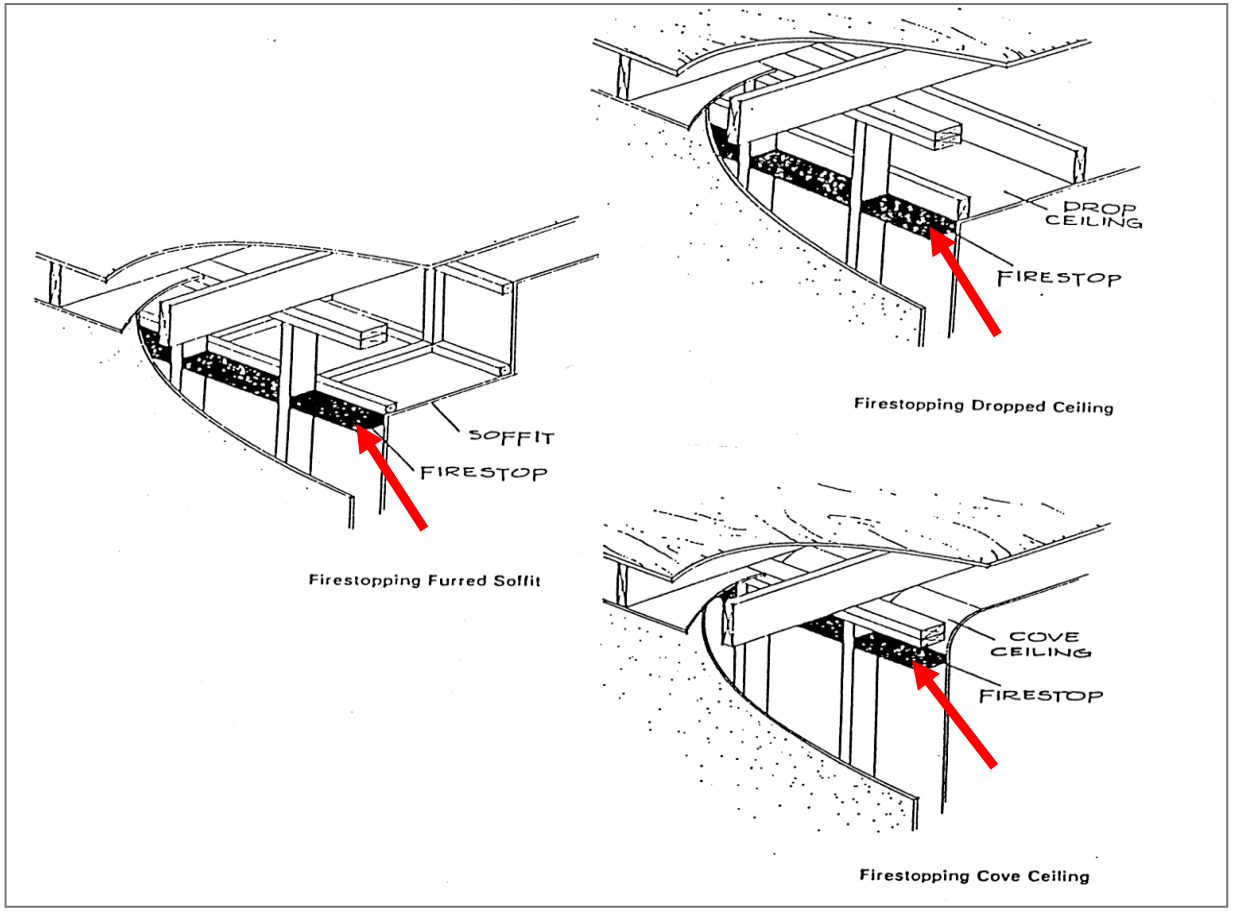
Fire blocking

* Apply checklist as each floor level is inspected

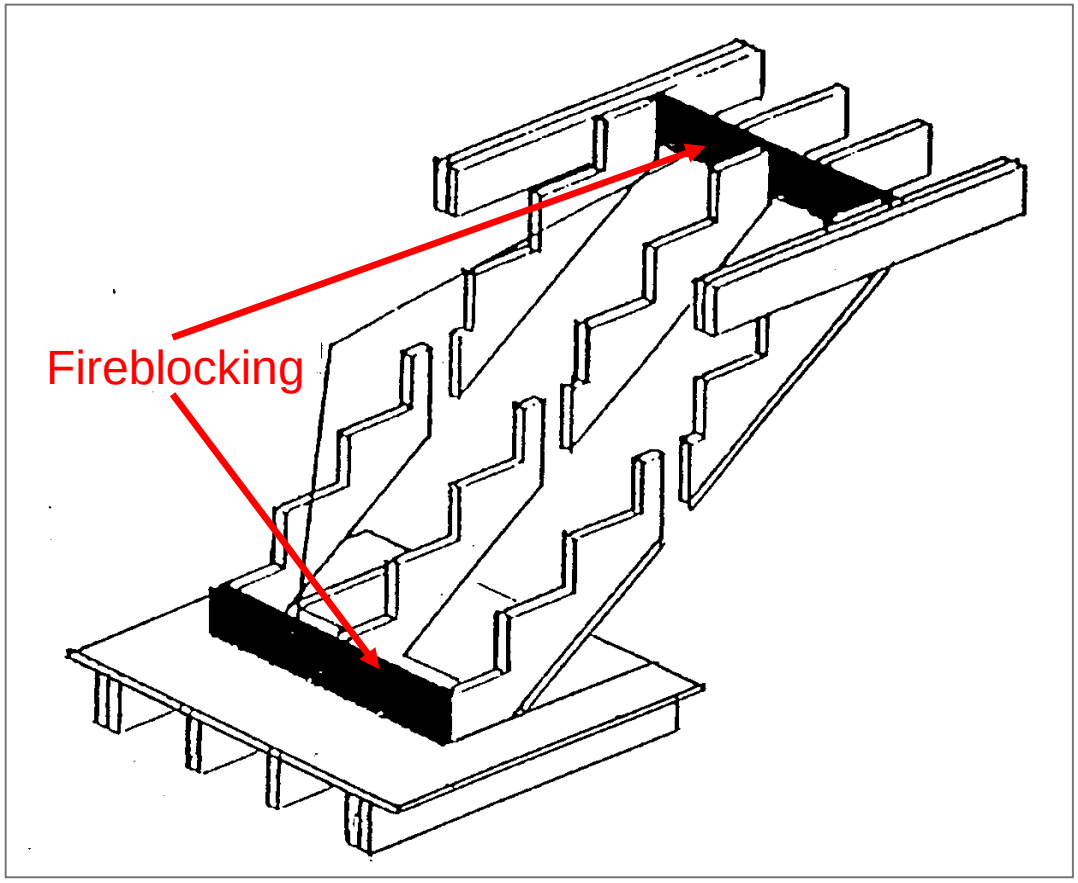
				G	B	1	2	3	
Fire blocking	Vertical	At floor lines							
		Top & bottom	plates						
	Horizontal	Every 10 ft							
		Pipes, conduit							
		Ductwork							
		Material	In tght						

- Location
  - Vertical
    - At floor lines
    - Top and bottom plates
  - Horizontal
    - Each 10 feet / Pipes, conduit
    - Ductwork / Material – tight

* Fireblocking 302.11
  - At vertical and horizontal intersections

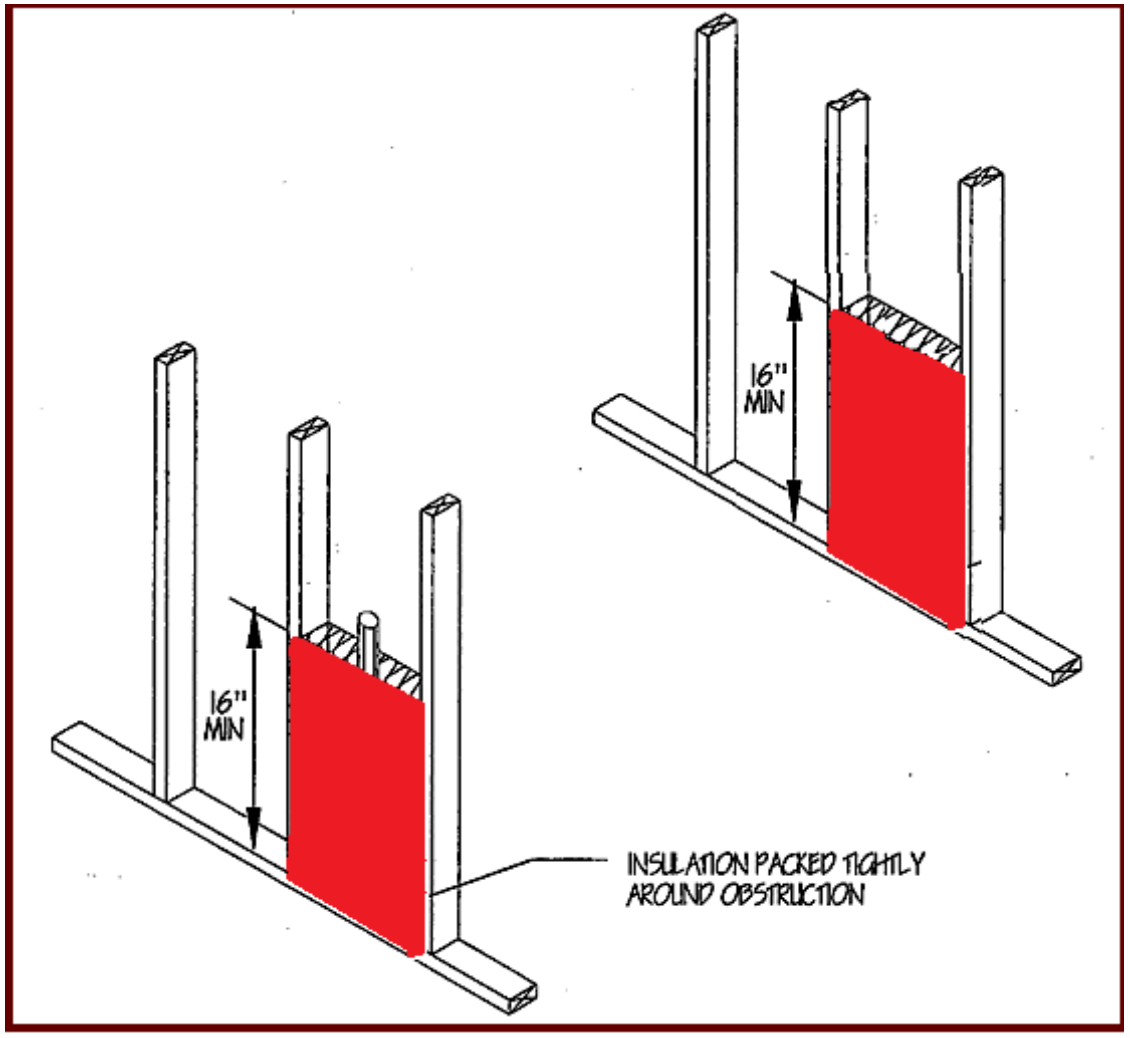


* Fireblocking R302.11
  - Top and bottom of stair runs if concealed

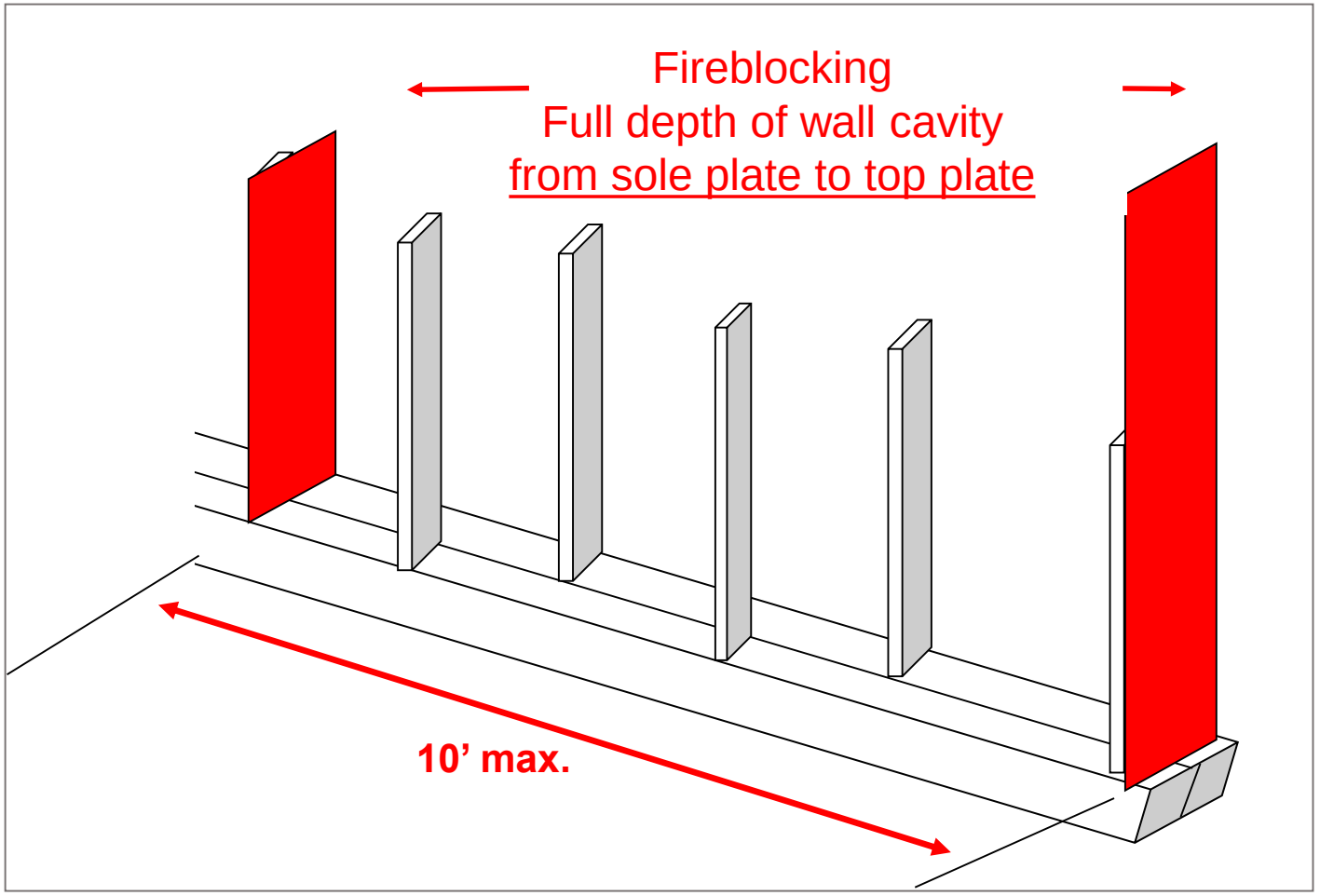


* Fireblocking material 302.11.1
  - 2 x lumber, 2 layers of 1 x lumber, 23/32” Wood structural panel
  - ½” gypsum board, 1/4” cement-based millboard
  - Un-faced insulation (mineral wool or fiberglass)
  - Approved materials around cables & pipes, vents and ducts
  - Concealed wall spaces at floors and ceilings

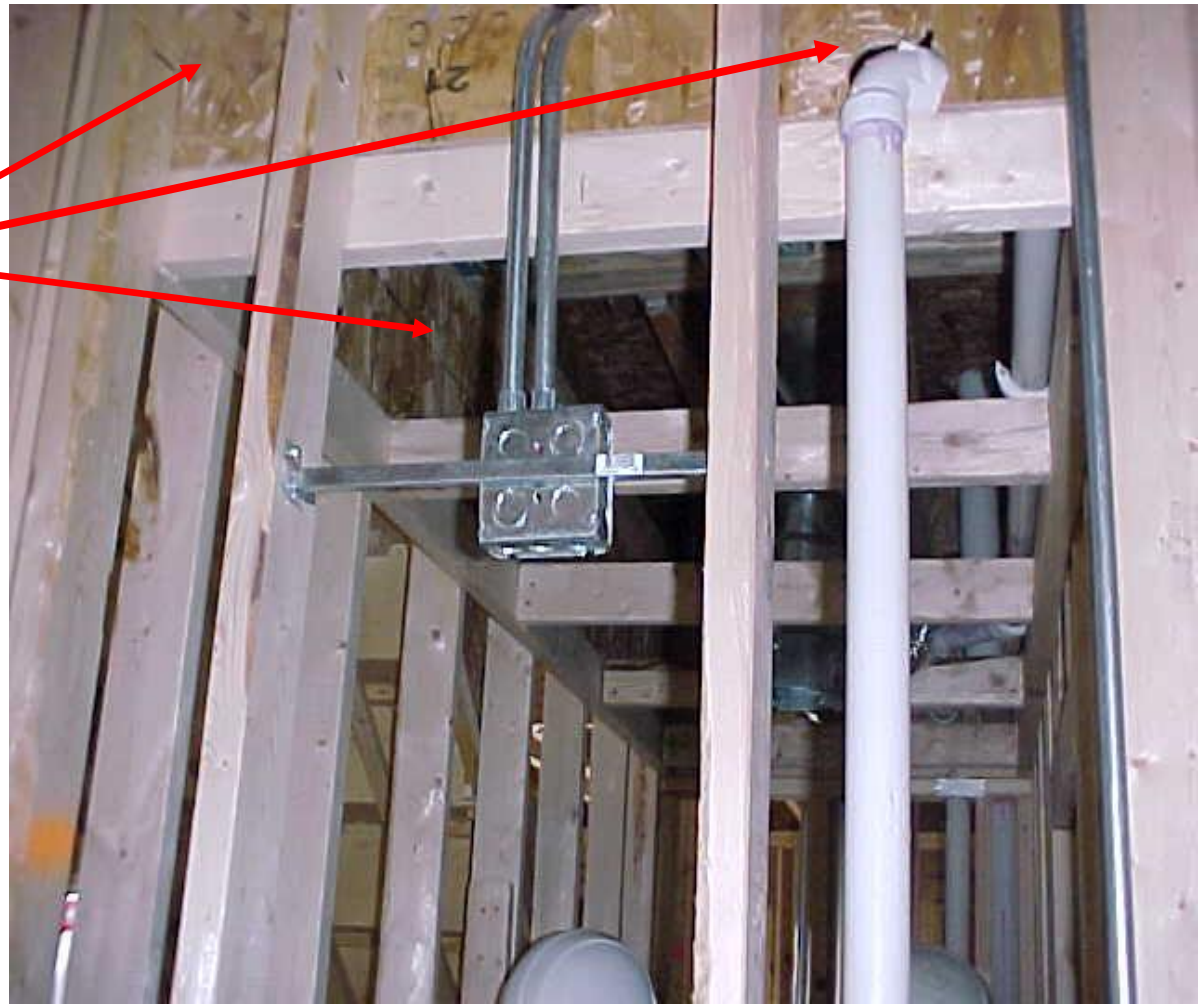
* Fireblocking 302.11.1.2



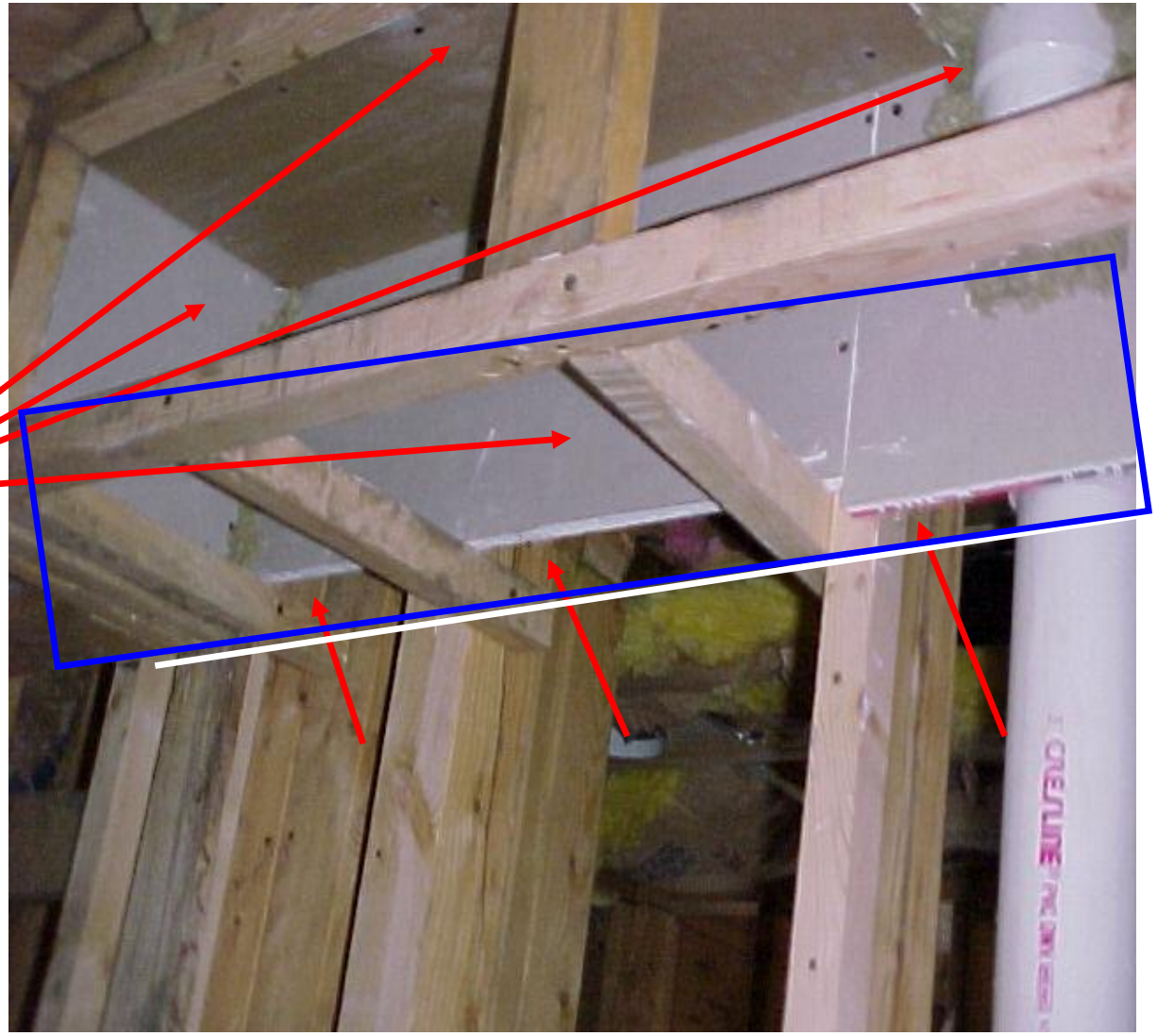
* Fireblocking 302.11
  - Horizontal spacing – maximum 10’
  - Parallel rows of studs or staggered studs



* Fireblocking 302.11 *(continued)*



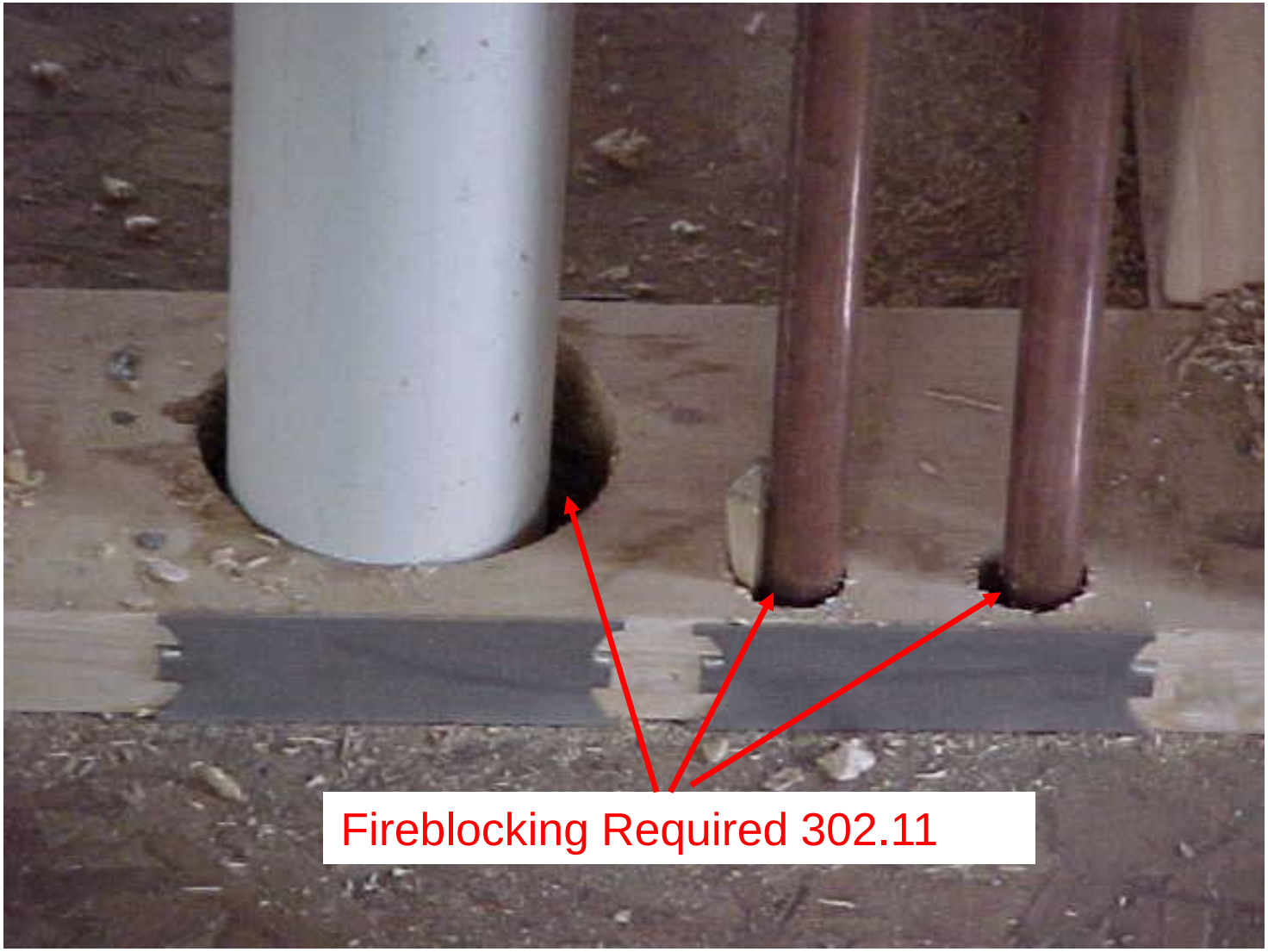
* Fireblocking 302.11



Is this dropped ceiling soffit fireblocked properly?

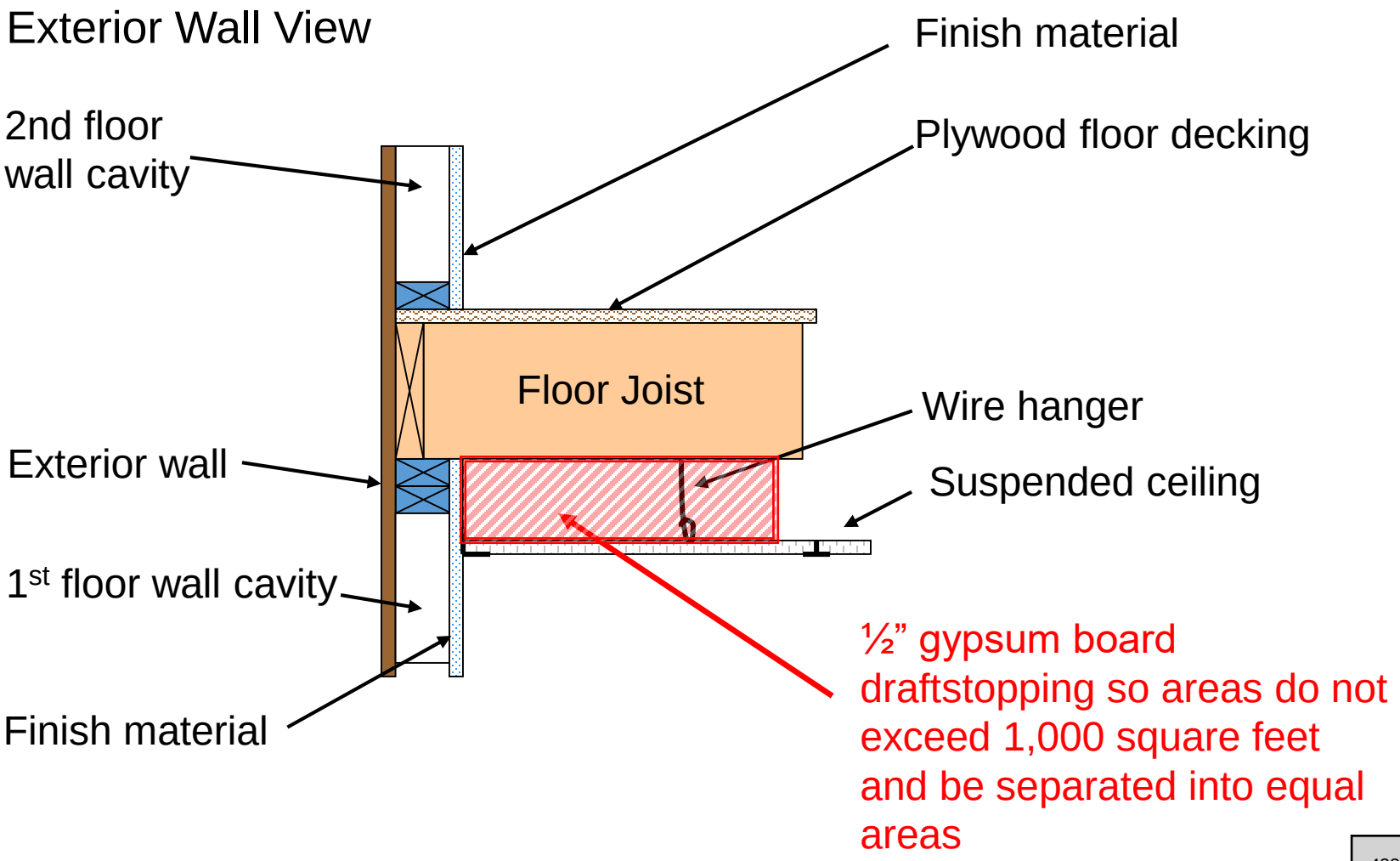
* Fireblocking 302.11

* Fireblocking 30



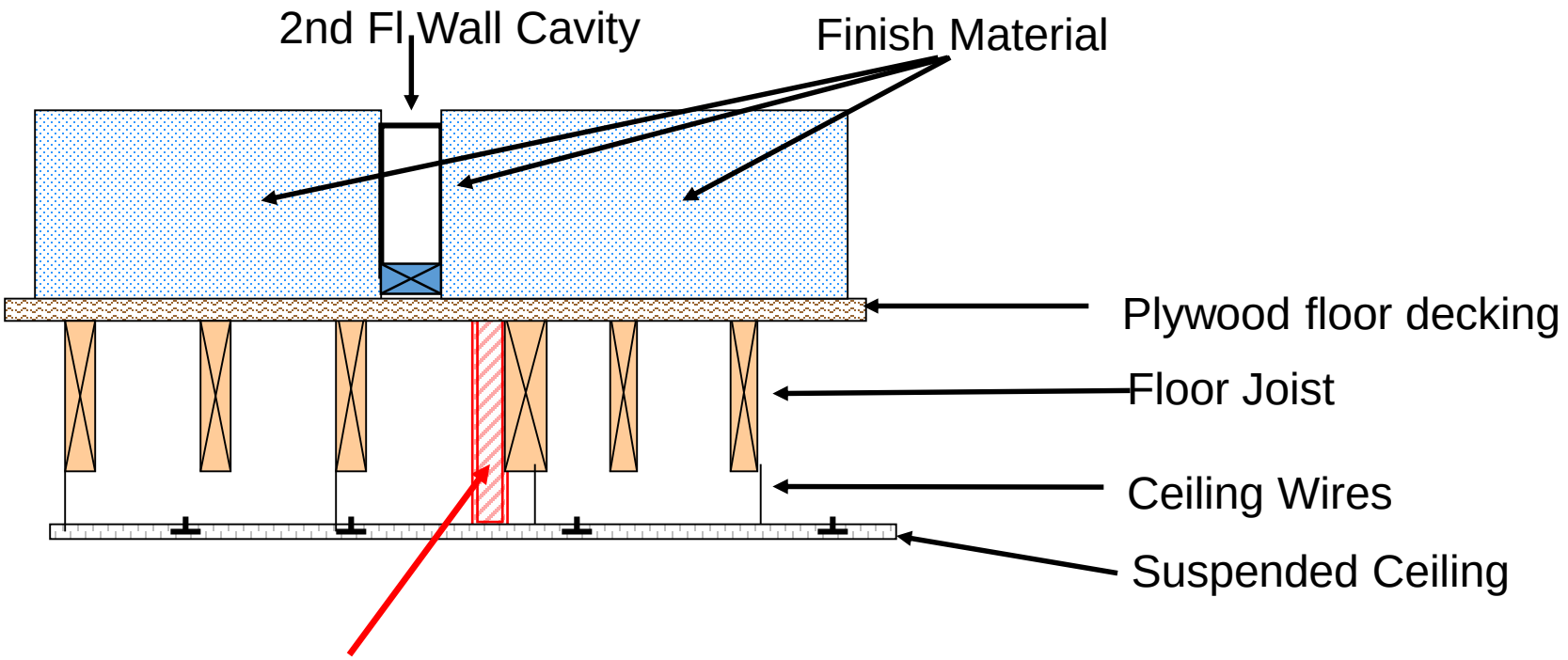
* Fireblocking 302.11

* Draftstopping 302.12

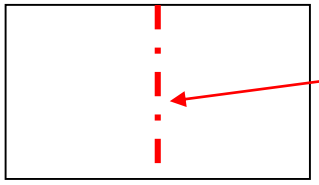


* Draftstopping R02.12

Interior floor view



½" gypsum board draftstopping so areas do not exceed 1,000 square feet and are separated into equal areas



Plan View

Location of draftstopping so areas appear equal

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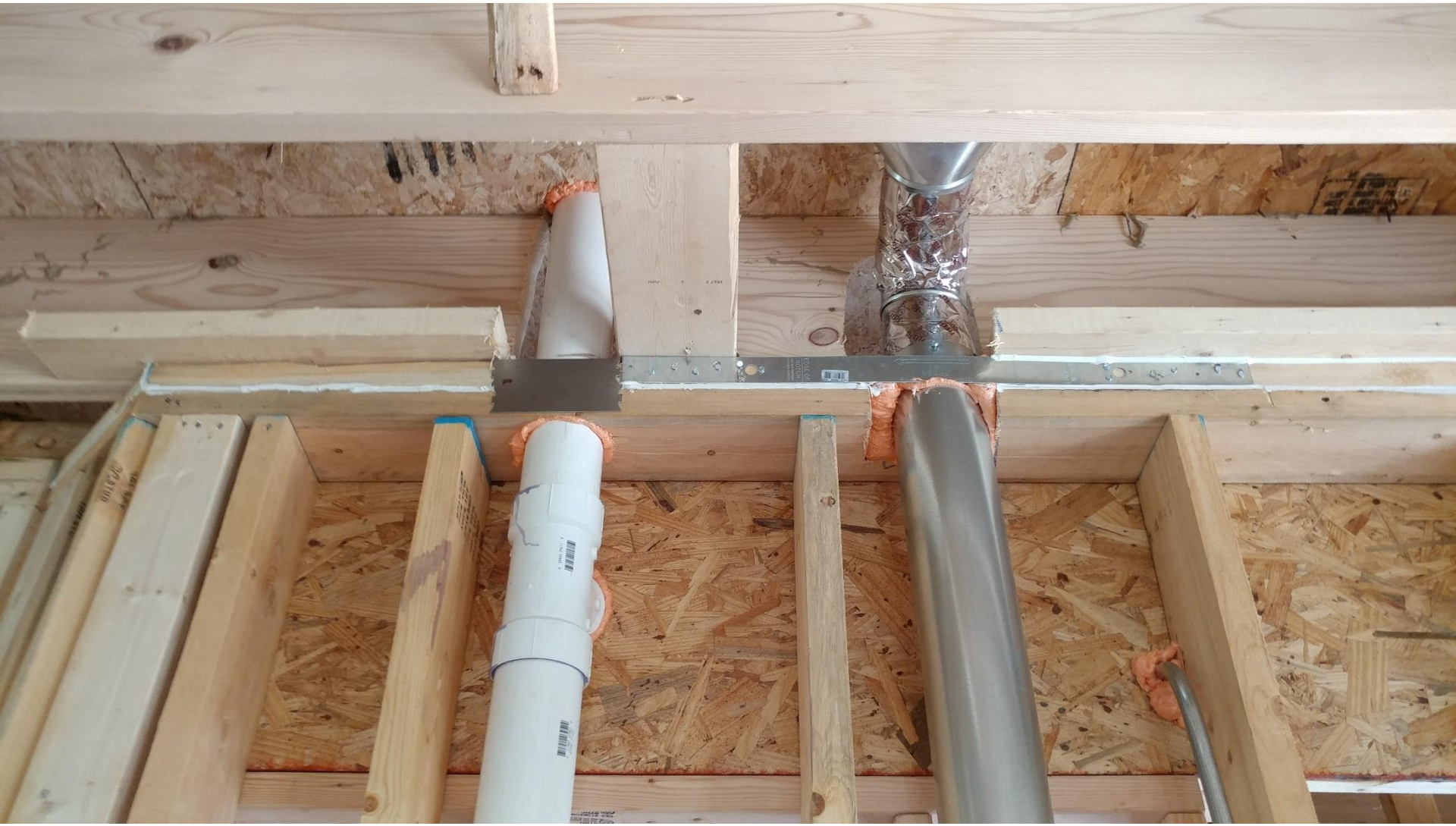
OWENS CORNING
ECOTOUCH™
PINK® INSULATION
EcoTouch
PureFiber® Technology
R-11
6 x 12



Exterior

Exterior of building									
				G	B	1	2	3	
	Sheathing	Proper nailing							
		Wall bracing							
		# of panels	Fastening						
	House wrap	If installed							
		Fastening							
		Taped seams							
	Windows if install	U-factors							
		Installation	Per Man.						

- Exterior
  - Sheathing / Proper nailing
  - Wall bracing
    - # of panels – Fastening
  - House wrap – if installed
    - Fastening
    - Taped seams
  - Windows – If installed
  - U factors
    - Installation
    - Per manufacturer

- Prepare written report
- Site specific locations such as:
- The floor joist on the second floor master bedroom do not match the plans *and may be overspanned*.
  - This may create a joist which is over the allowable span.
- The bathroom wall on the second floor for bedrooms 2 and 3 exceed the allowable for cutting notching and boring.

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Questions?

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Thank You For Your Time

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Voice:	**(800) 488-7057 (847) 428-2951**
Fax:	**(847) 428-2911**

File Attachments for Item:

ER-8 Decks, Porches, and Boardwalks in Flood Hazard Areas (Simpson Strong-Tie)

BO, MPE, BI, RBO, RPE, RBI (1 hour)

Staff Notes:

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 course, BBS approval #, date and location 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; capable of being climatically controlled so that approximately 68° F can be maintained; non-smoking in the training room; sound controlled so that outside noise will not interfere with the training.

ADDITIONAL ELECTRICAL SAFETY INSPECTOR COURSE CRITERIA:

Trainees: During the first year, shall attend an approved thirty-hour course on the "Fundamentals of Electricity" and pass a test upon completion of the course. A second approved thirty-hour course and test covering the "National Electrical Code" shall be successfully completed prior to the examination for a certificate of competency. ESI trainee courses shall be designated as either of the following:

ESI TRAINEE COURSE - PART I - FUNDAMENTALS OF ELECTRICITY (THEORY)
ESI TRAINEE COURSE - PART II - ESI REFRESHER COURSE

ESI course instructors: Shall hold a current certificate of competency as an electrical safety inspector.
ESI course: ESI course applicants must give location(s) and date(s) of course(s).

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: Ian McCallion (Contact Name)
Organization: Simpson Strong-Tie (Organization/Company)
Address: 5956 W. Las Positas (Include Room Number, Suite, etc.)
City: Pleasanton State: CA Zip: 94588
E-Mail: imccallion@strongtie.com
Telephone: 925-560-9112 Fax: _____
Course Sponsor: _____

COURSE INFORMATION:

Course Title: Decks, Porches, and Boardwalks in Flood Hazard Areas

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

Purpose and Objective: Please see attachment for purpose and objective.

Number of Instructional Contact Hours that can be obtained upon completion: 1

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

Program Applicable for the Following Participants:

Building Official	X	Master Plans Examiner	X	Building Inspector	X	Fire Protection Inspector	☐
		Plumbing Plans Exam.	☐				
		Electrical Plans Exam.	☐				
		Mechanical Plans Exam.	☐				

Mechanical Inspector	☐	Plumbing Inspector	☐	Non-Res IU Inspector	☐				

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

Electrical Safety Inspectors ☐
Electrical Safety Inspector Trainee Part I - Fundamentals of Electricity (Theory) ☐
Electrical Safety Inspector Trainee Part II – ESI Refresher Course ☐
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
Course Sponsor:	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:	Copy of quizzes or tests to be given	X
Completed Application:		X

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

Decks, Porches, and Boardwalks in Flood Hazard Areas - Submittal

1. Course Objectives:

After this training, you should be able to:

- Design and specify safe, code-compliant, flood-resistant decks, porches, and boardwalks
- Identify and select systems components that will properly resist corrosion in flood hazard areas
- Create systems of key connections for decks, porches, or boardwalks that will resist flotation, collapse, or permanent lateral movement for flooding, and
- Utilize the appropriate code requirements as design resources in order to design safe decks and porches.

2. Instructor Qualifications/Subject Matter Expert Bio: http://training.strongtie.com/custom/bios/jmailey.html

3. Course Syllabus:

Simpson Strong-Tie is an accredited provider of IACET CEUs. This course qualifies for IACET CEUs, AIA HSW LUs, ICC CEUs and AIBD CEUs.

Flood-prone areas are expanding in the US as storms worsen, floodplains expand, and sea levels rise. As a result, many decks and porches that were poorly built or were built without flood-resistant construction have been demolished, significantly damaged, or swept away. This course examines flood considerations and the concepts and details of flood-resistant deck and porch construction; provides detailed advice on using anchors, fasteners, and connectors for flood-resistant decks, porches, and boardwalks; and identifies the relevant terminology, codes, and standards that should be used when consulting experts and authorities and designing flood-resistant facilities.

Participants must pass a 10 question quiz (80% to pass) at the conclusion of the course to earn CEUs, see attached quiz. Here is the link to the course.

Link to the course. (Course length 1 hr)

Decks, Porches, and Boardwalks in Flood Hazard Areas

4. Sample Course Evaluation link

5. Course outline:

- Lesson 0: Introduction (2min)
- Lesson 1: General Flood Requirements (15min)
- Lesson 2: Flood Elevation Considerations (14min)
- Lesson 3: Raised Foundation and Connections (11min)
- Lesson 4: Solid Foundations and Connections (15min)
- Lesson 5: Conclusion (4min)
- Test: (5 min)
-
- Total time 66 min - 1 hr. Credit

About the Instructor
Instructor Jim Mailey

Jim is the Midwest, Northeast and Mid-Atlantic market Technical Training Manager for Simpson Strong-Tie. Since joining Simpson Strong-Tie in 1992, Jim has given hundreds of presentations to more than 25,000 design professionals, building officials, home inspectors, builders, contractors and dealers. He has developed numerous programs designed to educate industry professionals about how to install Simpson Strong-Tie products as well as how structural products meet various building code requirements and safety standards. In addition to training he has written articles about deck safety for the ASHI Reporter and NAHI Forum home inspector publications, has written for ThisIsCarpentry about deck construction and has been quoted in contractor magazines, including Professional Deck Builder, Fine Home Building and Coastal Contractor and numerous internet articles.

NY20 INTRO

In-Service Credit in the State of New York

This course has been approved by the State of NY Codes Division for In-Service credits. In order to receive credit, learners must complete this course and pass the required assessment with 80% or higher. Simpson will forward your credit information to the NY State Codes Division before the 10th of the next month. Once received, this information will be applied to your transcript. Please do not forward your Completion Certificate to the NY State Codes Division but retain only for your records. Be sure that your NYID number is inserted into your Simpson profile and is correct.

NYS BUILDING STANDARDS AND CODES

For credit in the state of NY, use the appropriate reference version of the code for this program.

NEXT

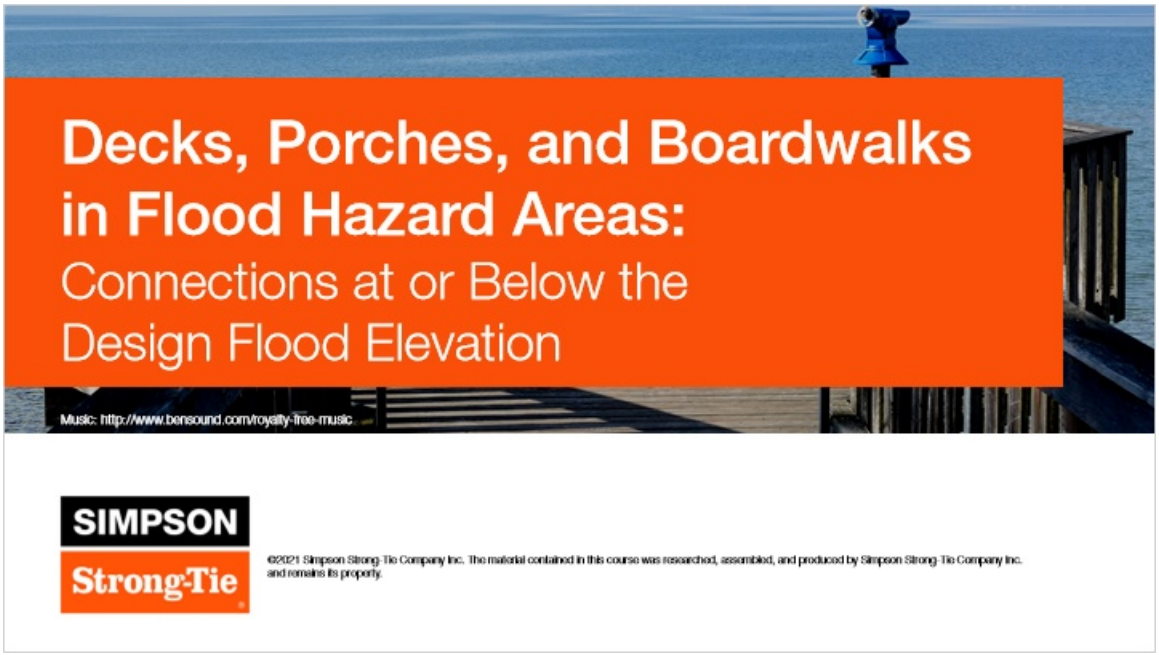
This course may reference different building codes throughout. Designers are responsible for referring to the governing code in their jurisdiction.

For professionals operating in the state of New York, the appropriate code from the 2020 Residential Code of New York State (RCNYS) or 2020 Building Code of New York State (BCNYS) should be referred to in place of any reference to a specific ICC code. Please note that some sections of the 2020 RCNYS and BCNYS have been amended.

NEXT

Decks, Porches, and Boardwalks in Flood Hazard Areas

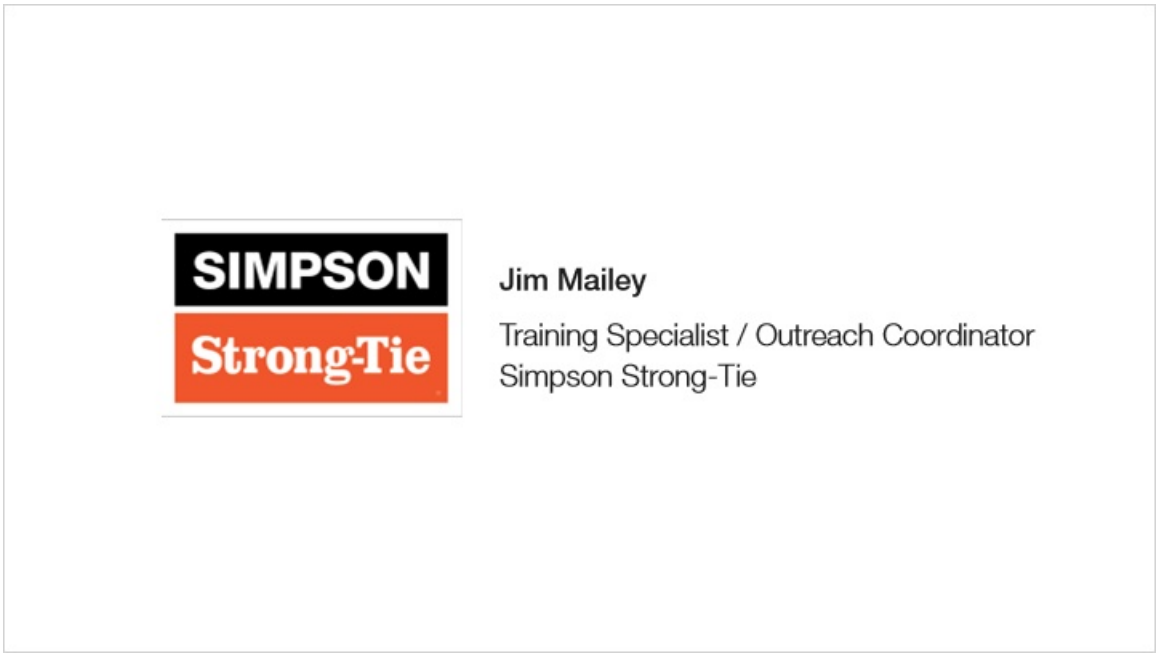
1.1 Decks, Porches, and Boardwalks in Flood Hazard Areas: Connections at or Below the Design Flood Elevation



Notes:

Welcome to this continuing education program “Decks, Porches, and Boardwalks in Floor Hazard Areas: Connections at or Below the Design Flood Elevation”. AEC Daily is pleased to partner with Simpson Strong-Tie, a North American company that since 1956 has developed structural products to help people build safer and stronger homes, buildings, and decks, and make this online learning seminar available to the AEC community.

2.1 Presenter Information



Notes:

This course was authored by Jim Mailey, who is the Training Specialist and Outreach Coordinator for the Midwest, Northeast, and Mid-Atlantic US at Simpson Strong-Tie. Let's get started.

2.2 Course Description

Notes:

Flood-prone areas are expanding in the US as storms worsen, floodplains expand, and sea levels rise. As a result, many decks and porches that were poorly built or were built without flood-resistant construction techniques have been demolished, significantly damaged, or swept away. This course examines flood considerations and the concepts and details of flood-resistant deck and porch construction; provides detailed advice on using anchors, fasteners, and connectors for flood-resistant decks, porches, and boardwalks; and identifies the relevant terminology, codes, and standards that should be used when consulting experts and authorities and designing flood-resistant facilities.

2.3 Learning Objectives

Design and specify safe, code-compliant, flood-resistant decks, porches, and boardwalks

Notes:

At the end of this program, participants will be able to:

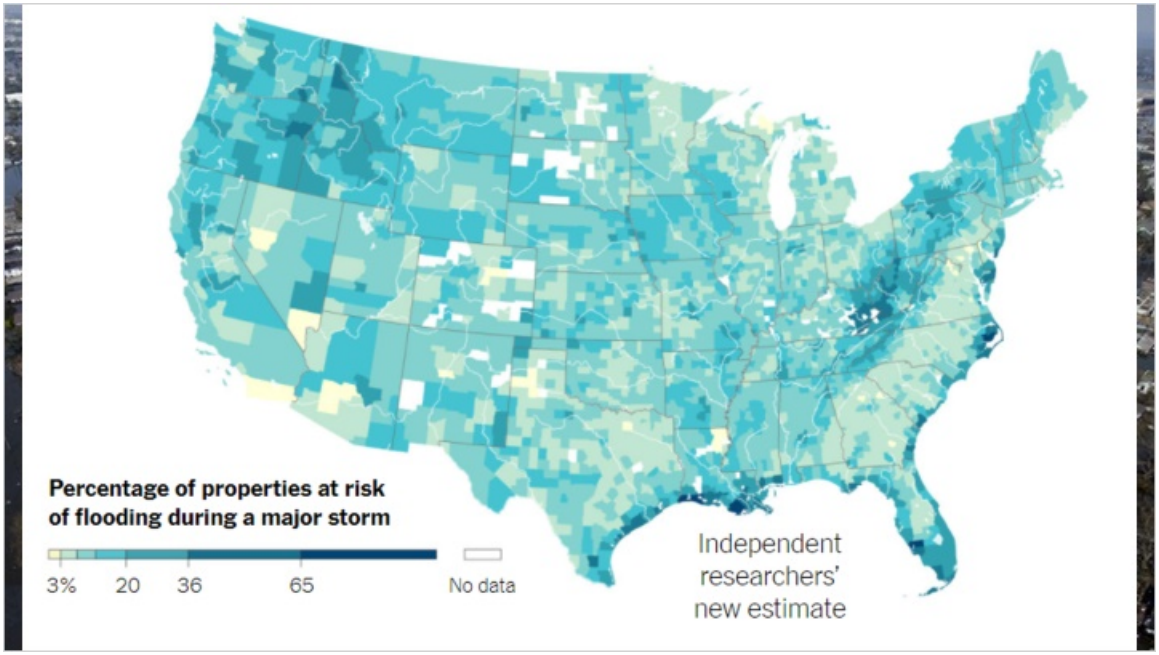
- design and specify safe, code-compliant, flood-resistant decks, porches, and boardwalks
- identify and select system components that will properly resist corrosion in flood hazard areas
- create systems of key connections for decks, porches, or boardwalks that will resist flotation, collapse, or permanent lateral movement from flooding, and
- utilize the appropriate code requirements as design resources in order to design safe decks and porches.

3.1 Introduction and Resources

Notes:

We'll begin with an overview of flood-related terminology and the types of resources available to designers.

3.2 Introduction

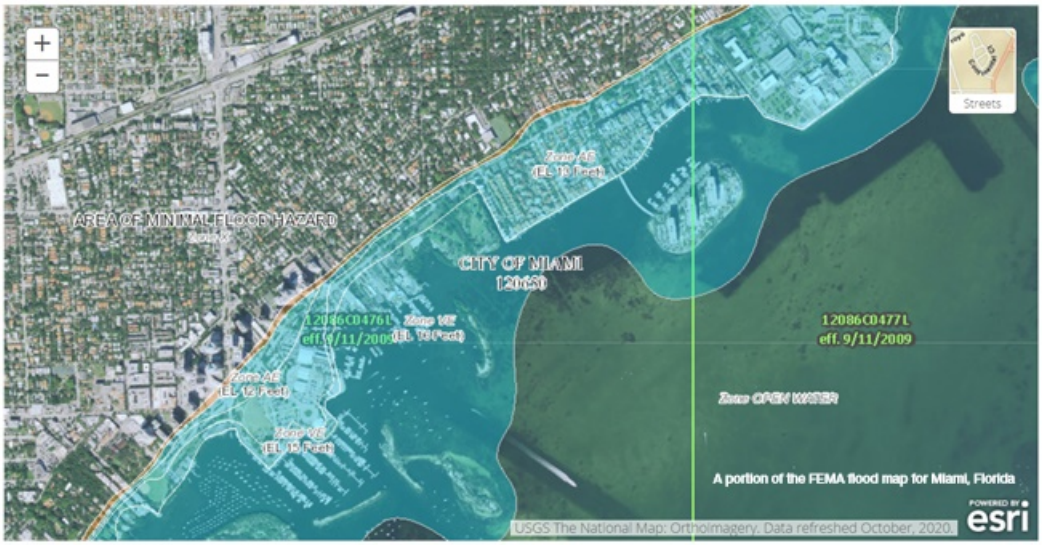


Notes:

Floods are the most common and most deadly natural disaster in the US and the world, and the situation is worsening. According to a 2020 study, by First Street Foundation, there are more than 21 million properties at risk of flooding, and more than 14 million of those properties are at substantial risk.

People have settled near water for the whole of history. Nearly 50% of the US population is within fifty miles of a coastline, and there are more than 3.5 million miles of streams and rivers in the US. Floodplains are dynamic, and flood maps such as those created by the Federal Emergency Management Agency (FEMA) must constantly be updated. Homeowners' insurance does not typically cover flood damage or loss.

3.3 Terminology

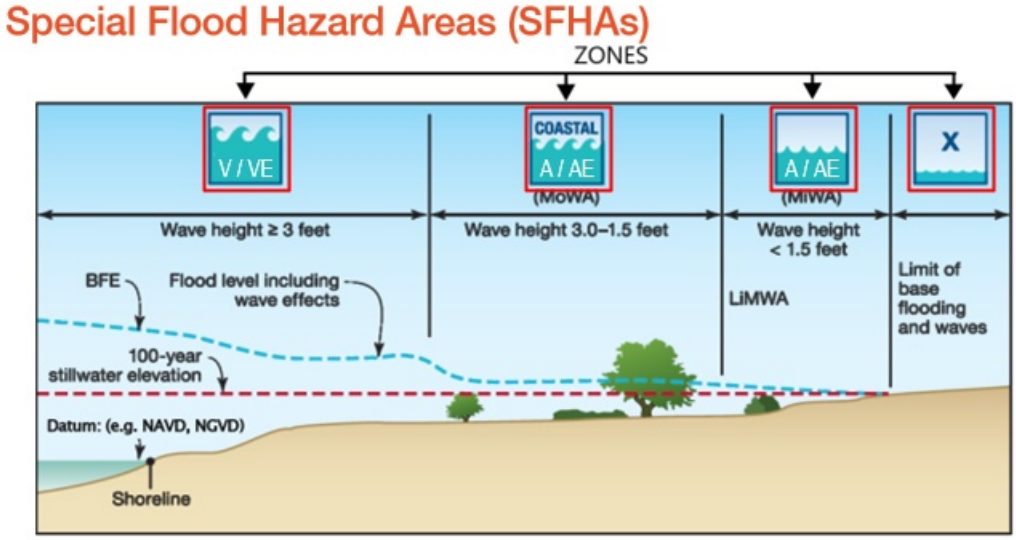


Notes:

In order to communicate effectively with flood design experts and to understand flood construction ordinances and maps accurately, it is critical that designers understand flood-related terminology that describes the nature and severity of flood events, flood zones, and flood-resistant construction.

The next few slides cover some of the basic terminology that building designers should become fluent with.

3.4 Special Flood Hazard Areas (SFHAs)



Note the various flood zone designations that indicate the severity of conditions that must be met.

Notes:

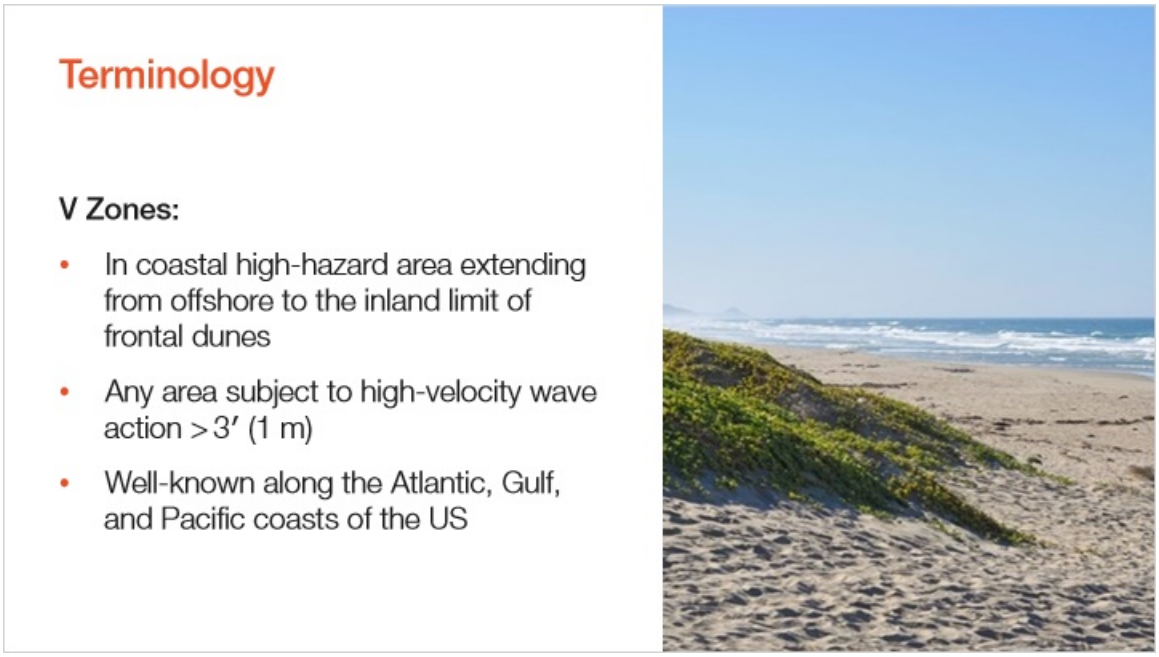
Special flood hazard areas (SFHAs) are high-risk flood areas where flood insurance is mandatory for properties that have a mortgage or loan from a federally regulated financial institution.

As seen here, they generally have various designations such as:

- V/VE (high-velocity wave action with elevation prescribed),
- coastal A/AE (one step back from a V), or
- A/AE or X.

A number after the letter refers to the base flood elevation (BFE), which is the elevation of surface water resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.

3.5 Terminology



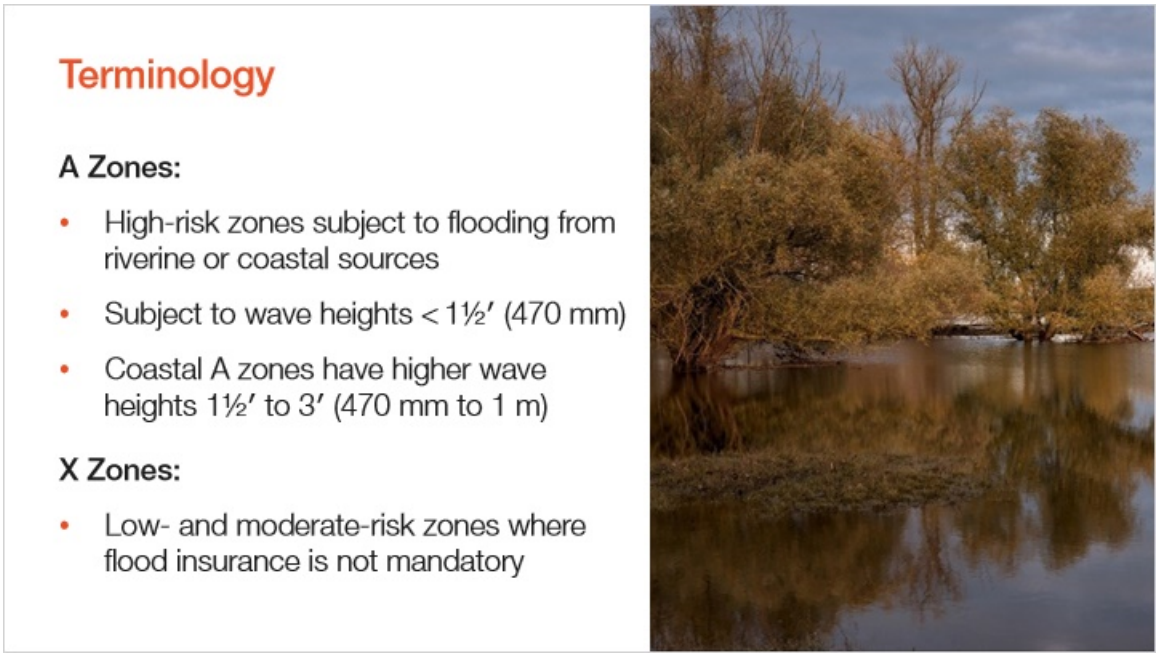
Notes:

Let's talk about V zones. These are high-velocity zones defined as an SFHA in a coastal high hazard area extending from offshore to an inland limit of a primary frontal dune along an open coast or any other area subject to high-velocity wave action greater than 3'.

In many cases, the landward limit is defined by an unclear definition of the primary frontal dune rather than by analysis of water level or wave conditions.

V zones are well known along the Atlantic, Gulf, and Pacific coasts of the US. However, waves on southern Lake Michigan reached >20' during Superstorm Sandy, the second highest official reading for that lake on record.

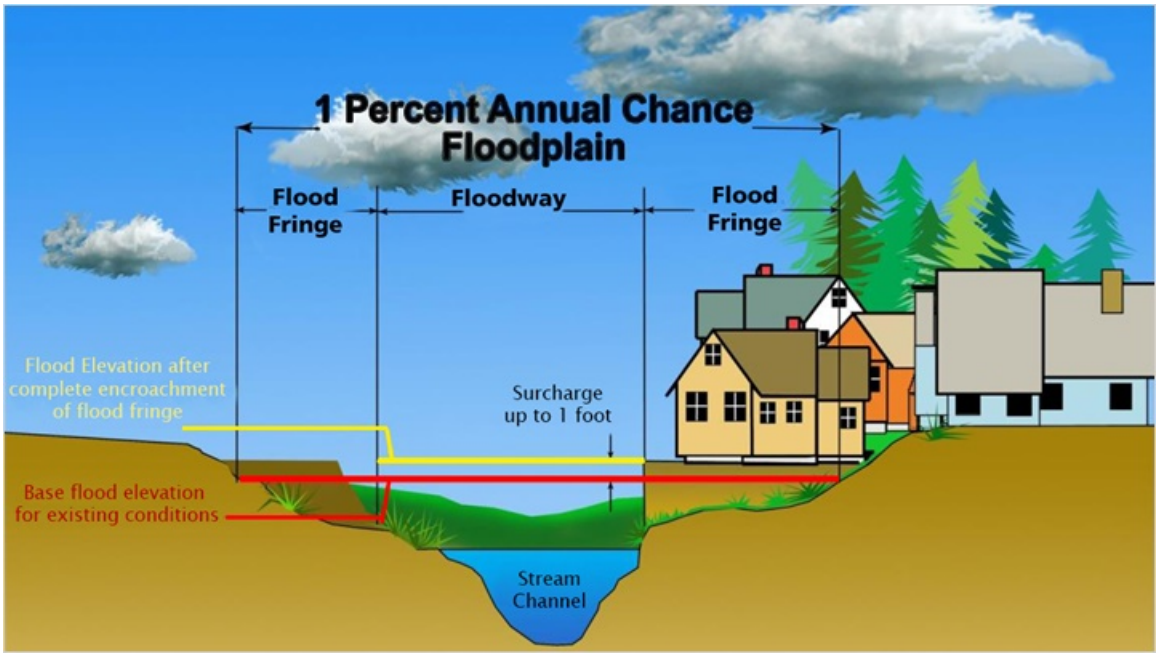
3.6 Terminology



Notes:

A zones are high-risk zones defined as an SFHA where the land is subject to flooding from riverine or coastal sources subject to wave heights of less than 1½'. Coastal A zones have higher wave heights of 1½' to 3'.
X zones are low- and moderate-risk zones. Flood insurance is not mandatory in these zones, but it is highly advisable as 25% of all flood insurance claims occur outside of A or V zones.

3.7 Terminology: Floodways



Notes:

A floodway is that portion of the stream and the floodplain reserved to convey the base flood without cumulatively raising the water surface elevation to a point higher than a designated elevation.

Take a look at all the areas of this illustration, and click Next when you are ready to move on.

3.8 Terminology: Floodways

More Information

Notes:

Designers should determine whether they are designing buildings in a current floodway, a future one, or one that may grow from looking like the one in the left image to the one in the image on the right over time.

As noted previously, because of continuously shifting weather patterns and behaviors and the shifting of flood conditions, sizes, and locations, FEMA is constantly redrawing its flood maps. These can be a good source of information as to the flood status in a specific location at a particular time.

Click the link on the slide to access the FEMA website for more information.

3.9 Terminology

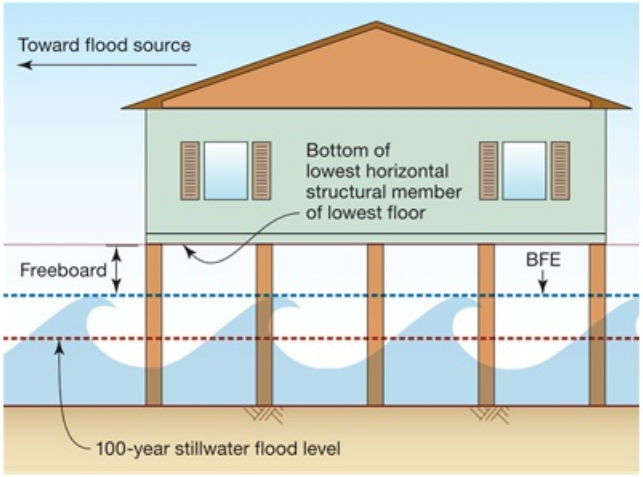
Terminology

BFE: base flood elevation

Freeboard: additional height above BFE

DFE: design flood elevation

DFE = BFE + freeboard



Notes:

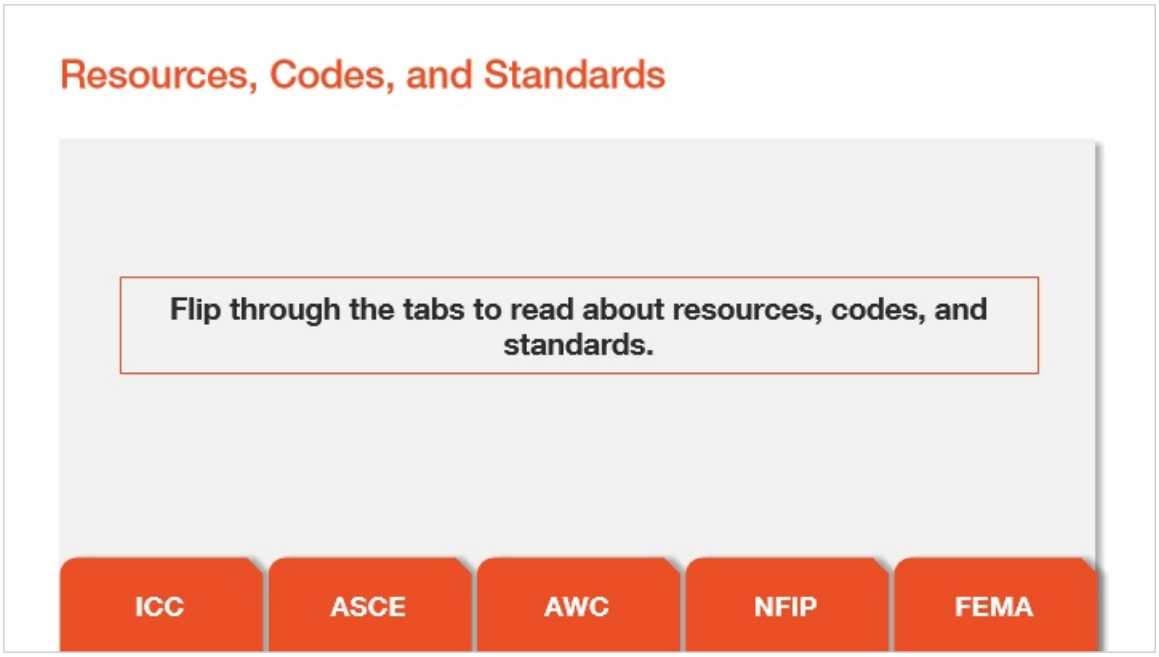
BFE or base flood elevation, is the computed elevation to which the flood is anticipated to rise during the base flood, including wave effects. The base flood is also referred to as the 1% annual chance flood or a 100-year flood.

Freeboard is the additional height above the BFE used as a factor of safety in determining the level at which a structure's lowest floor must be elevated or floodproofed. In normal flood protection design, a freeboard of 1' to 2' (300 to 600 mm) is common, although there may be instances when this should be increased.

The DFE is the elevation of flooding, including wave height, that is generally used for design.

The DFE = BFE + freeboard. Thus: The DFE will always be the BFE or higher.

3.10 Resources, Codes, and Standards

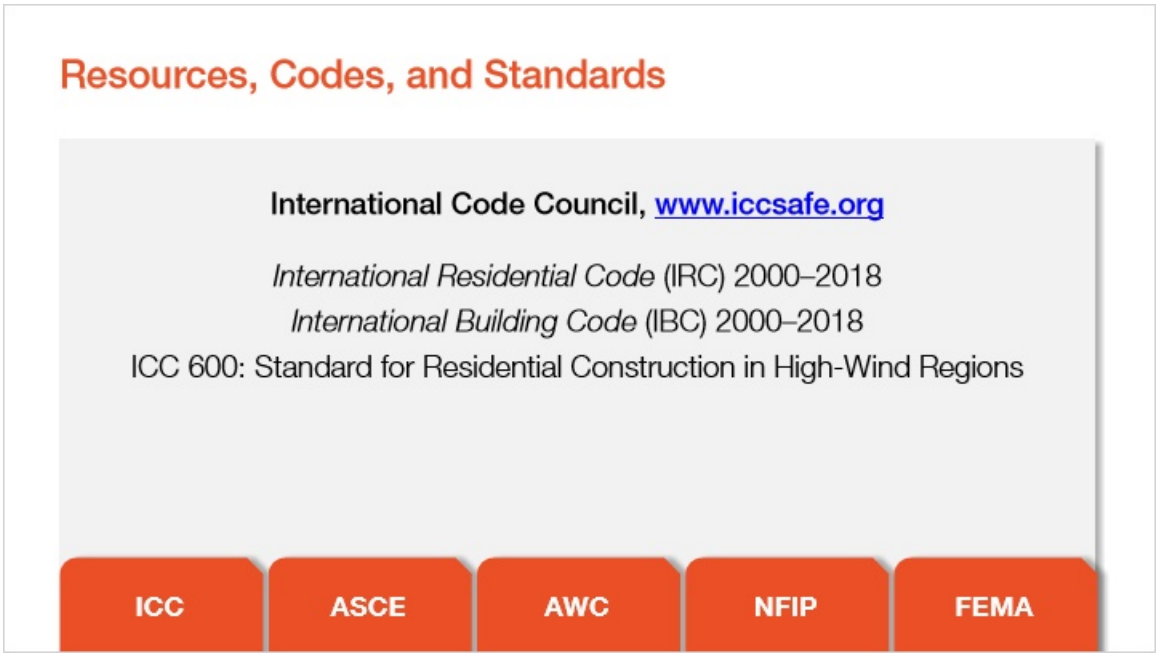


Notes:

Designers should also be fluent with the various codes, standards, and regulations that flood construction must comply with. These standards should be regarded as minimum standards as well as design resources.

Click on each tab to learn more. When you are done, click *Next* to continue.

ICC (first) (Slide Layer)



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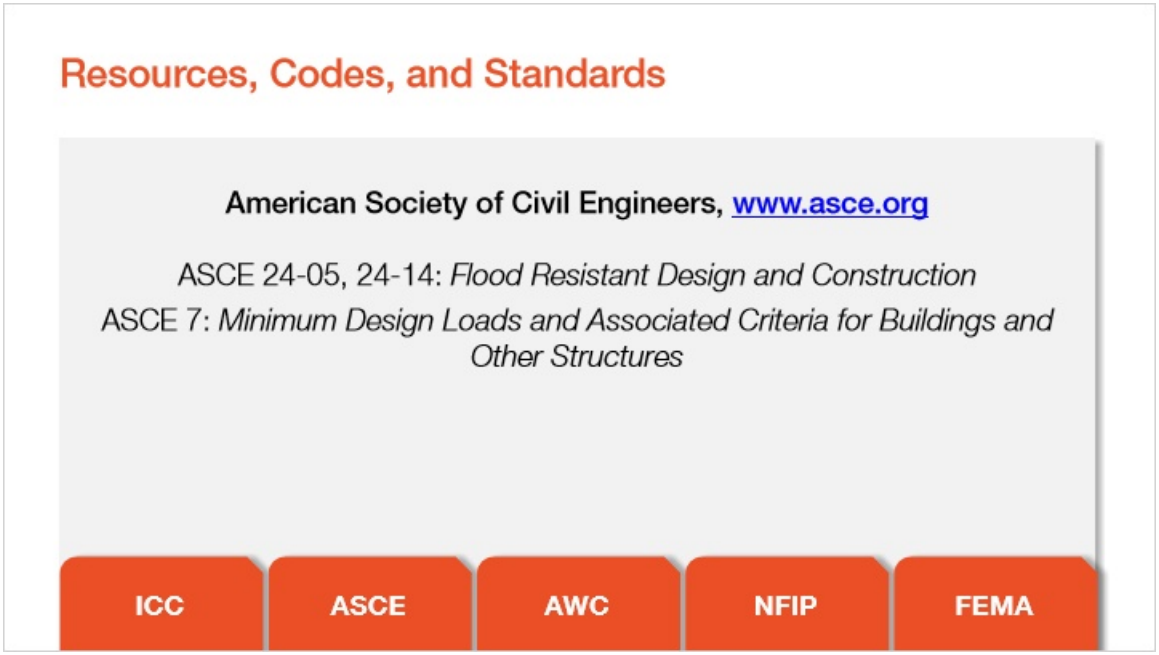
ASCE (second) (Slide Layer)



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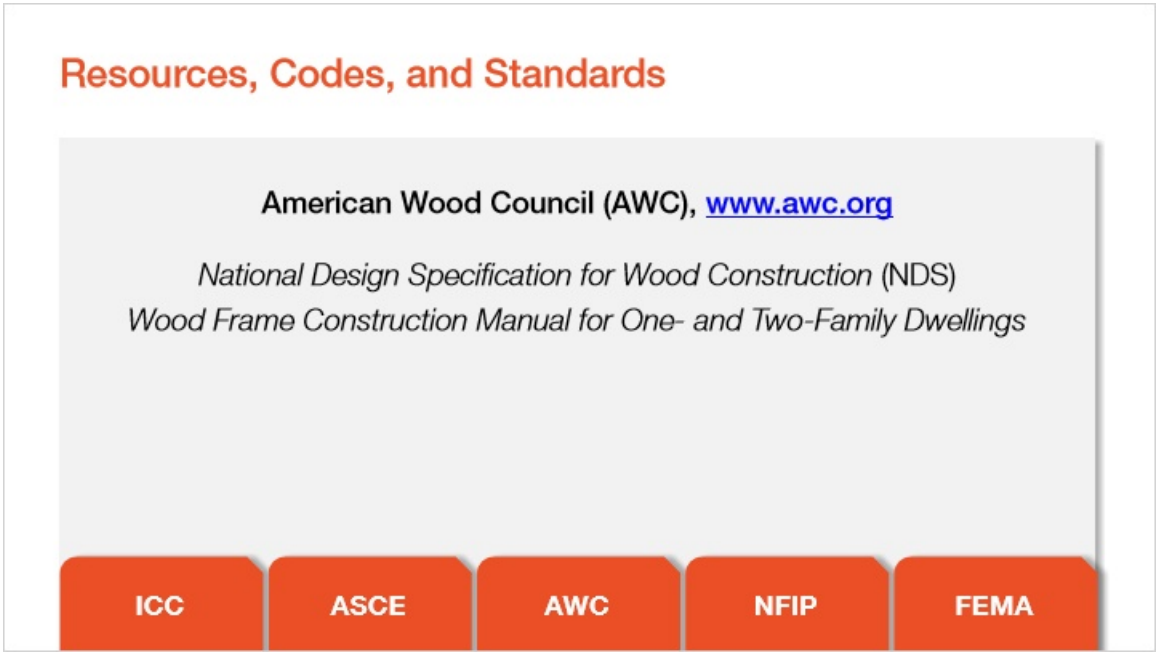
AWC (third) (Slide Layer)



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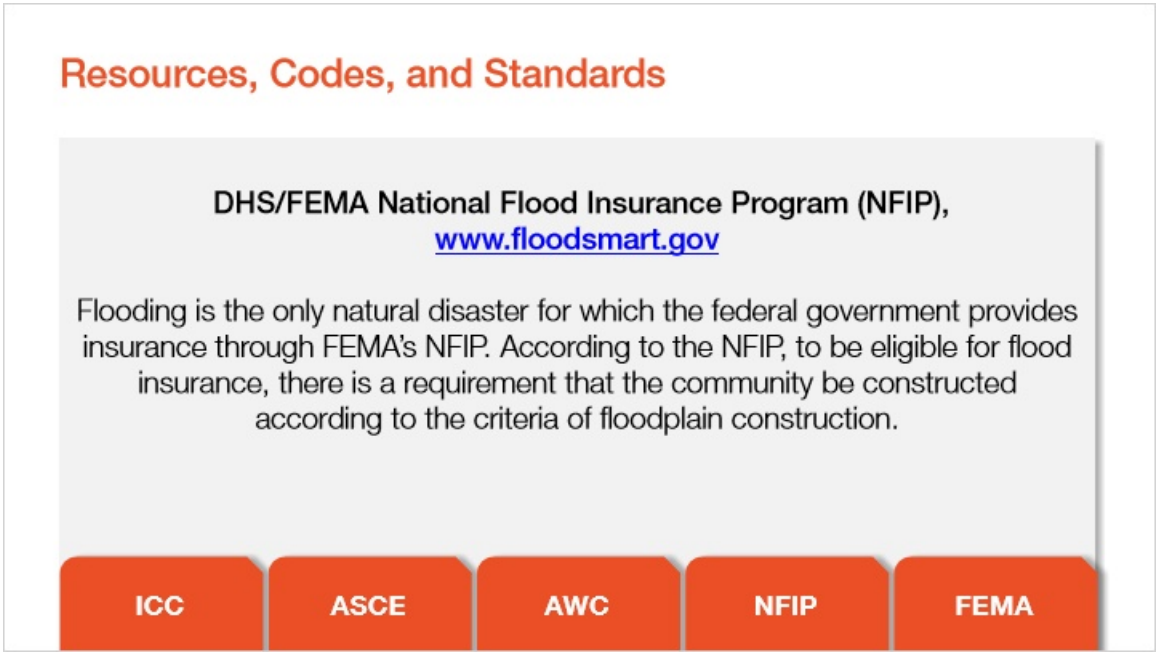
NFIP (fourth) (Slide Layer)



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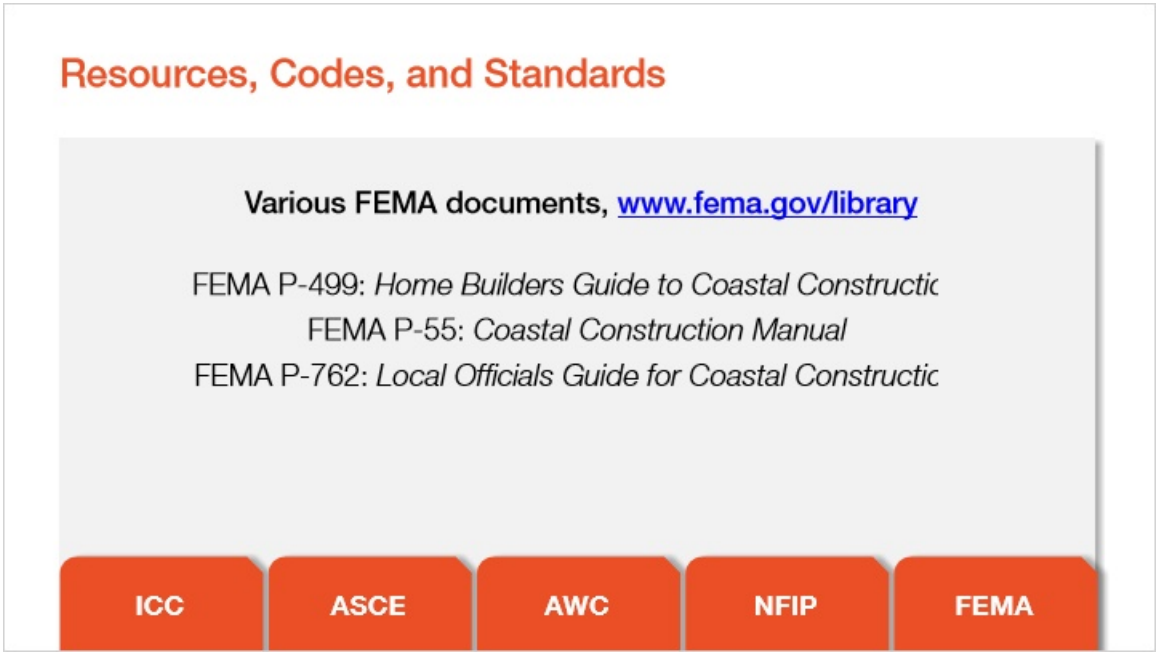
FEMA (fifth) (Slide Layer)



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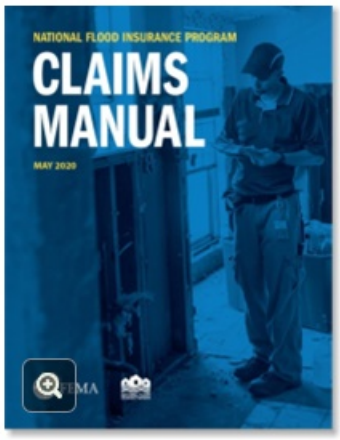
3.11 NFIP Requirements

All new construction and substantial improvements shall be:

1. Designed (modified) and adequately anchored to prevent flotation, collapse, lateral movement of structure resulting from hydrodynamic and hydrostatic loads, including effects of buoyancy
2. Constructed with materials resistant to flood damage
3. Constructed by methods/practices that minimize flood damages

NATIONAL FLOOD INSURANCE PROGRAM



Notes:

The National Flood Insurance Program (NFIP) Section 60.3(a)(3) states that if a proposed building site is in a flood-prone area, all new construction and substantial improvements shall be:

1. Designed (or modified) and adequately anchored to prevent flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads, including the effects of buoyancy
2. Constructed with materials resistant to flood damage, and
3. Constructed by methods and practices that minimize flood damages.

3.12 NFIP Exclusions

Property and belongings outside of the building envelope are generally NOT covered.

Notes:

Buildings (defined as two or more outside rigid walls and a roof) and contents may be covered under a NFIP. However, property and belongings outside of the building envelope are generally NOT covered (for example, decks and porches).

The NFIP Dwelling Form Standard Flood Insurance Policy, section IV, Property Not Covered, # 9 states that “Those portions of walks, walkways, decks, driveways, patios, and other surfaces, all whether protected by a roof or not, located outside the perimeter exterior walls of the insured building or the building in which the insured unit is located.”

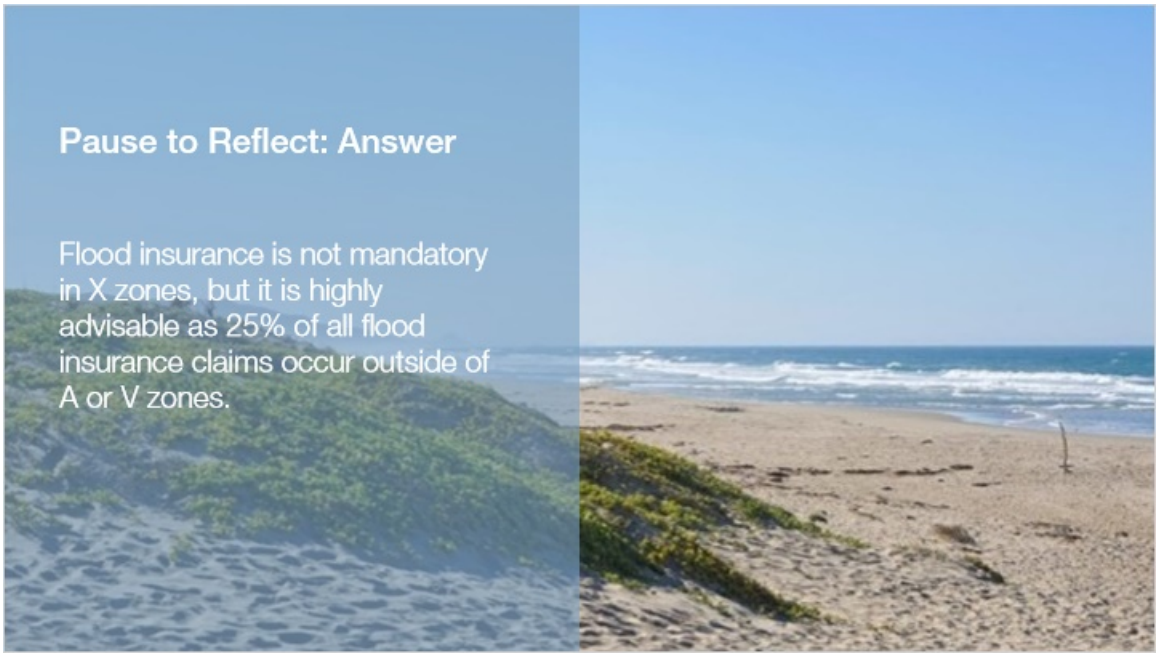
3.13 Review: Question 1

Notes:

Time for a review of what we have covered so far.

Think about your answer, then click *Next* to continue.

3.14 Review: Answer 1



Notes:

Review the answer, then click *Next* to continue.

4.1 Flood Resistance Codes and Standards

Notes:

We'll now take a closer look at the relevant codes and standards.

4.2 Codes and Standards

Notes:

Codes and standards are constantly evolving as lessons are learned from flood-related construction failures. Designers should ensure they are using the most recent versions of these codes. The following few slides provide some key excerpts from the codes and resources identified in the previous section, but designers should familiarize themselves with the full text of the relevant documents.

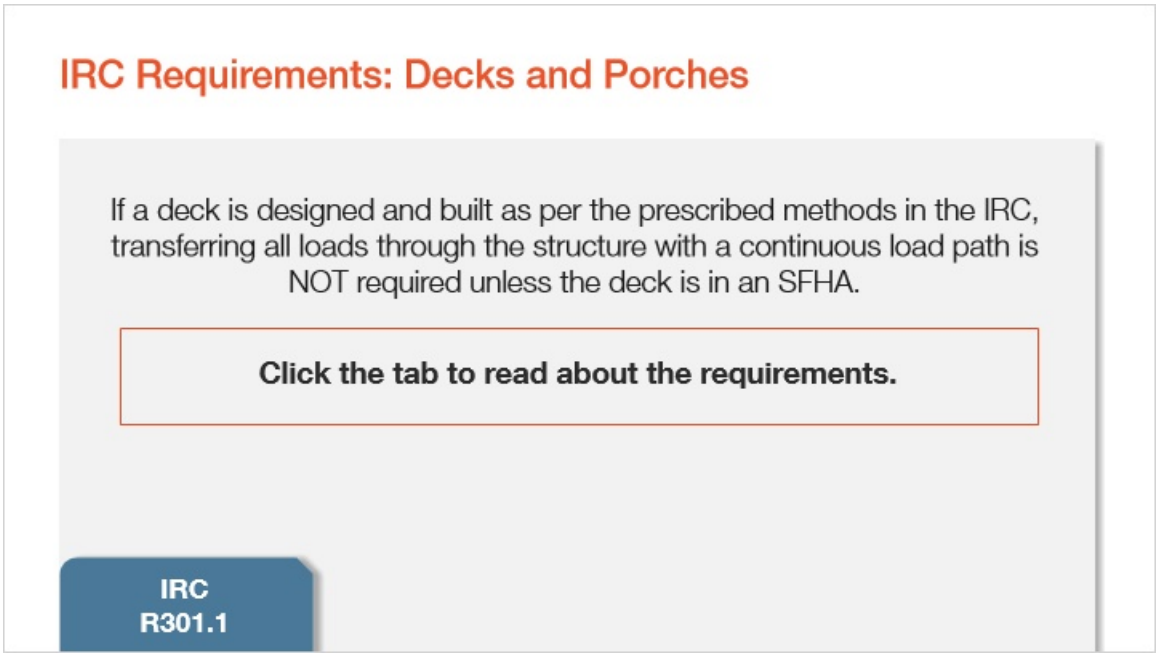
To help identify where and when significant changes have occurred, this course uses the following codes:

- "R" before the numbers indicates International Residential Code

Font color code:

- For entire sections in black: it started as a code requirement in 2000 and remains the same in the current version (2018)
- Red is for significant changes in 2009
- Green is for changes in 2012
- Purple is for changes in 2015
- And Brown is for changes in 2018

4.3 IRC Requirements: Decks and Porches



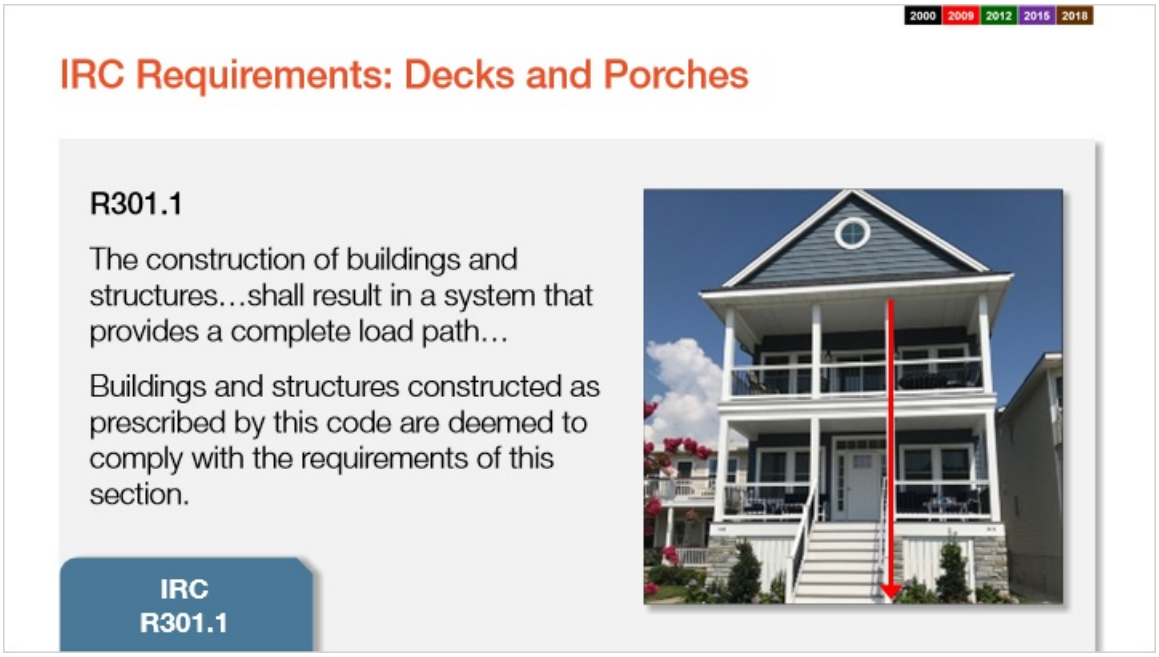
Notes:

Let's look at the IRC requirements for decks and porches.

If a deck is designed and built as per the prescribed methods in the IRC, transferring all loads through the structure with a continuous load path is NOT required unless the deck is in an SFHA.

This slide, and many that follow, have tabs with code information. When you see the tabs, flip through them to read about each code, then click *Next* when you're ready to proceed.

IRC R301.1 (Slide Layer)



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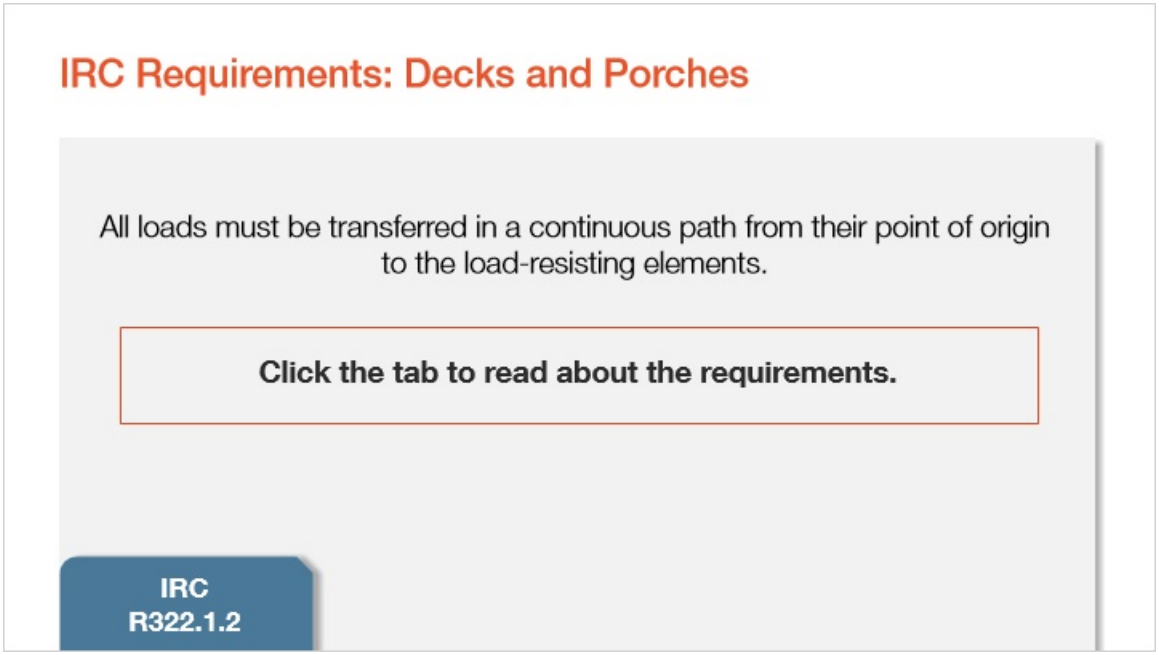
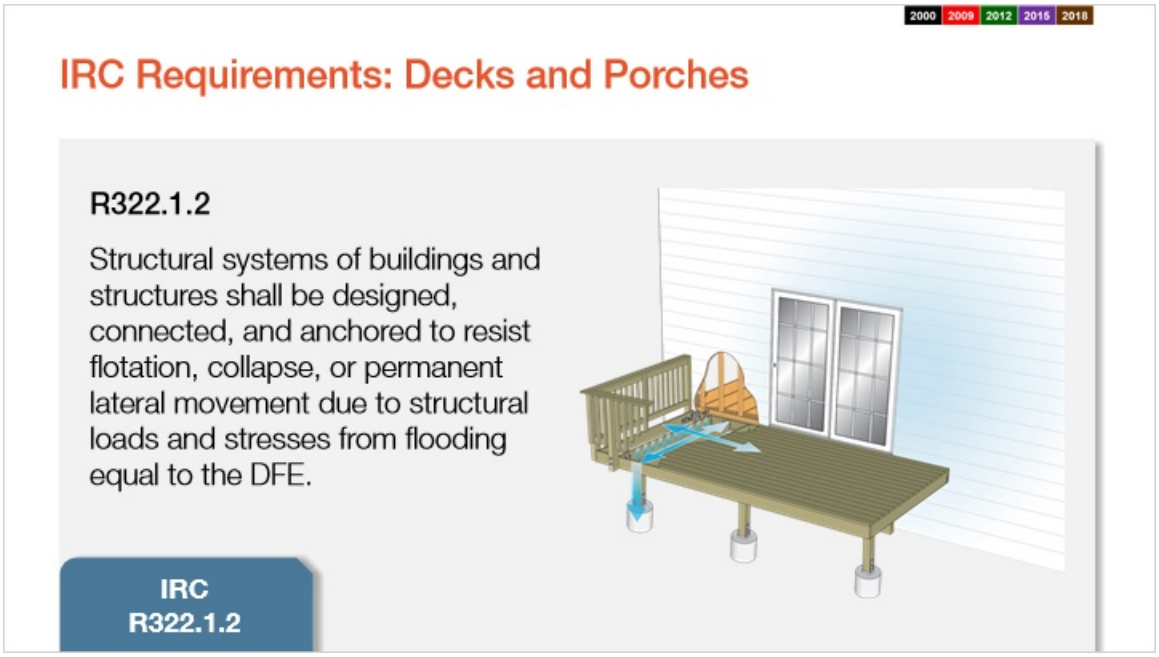
4.4 IRC Requirements: Decks and Porches



Notes:

All loads must be transferred in a continuous path from their point of origin to the load-resisting elements.

IRC R301.1 (Slide Layer)



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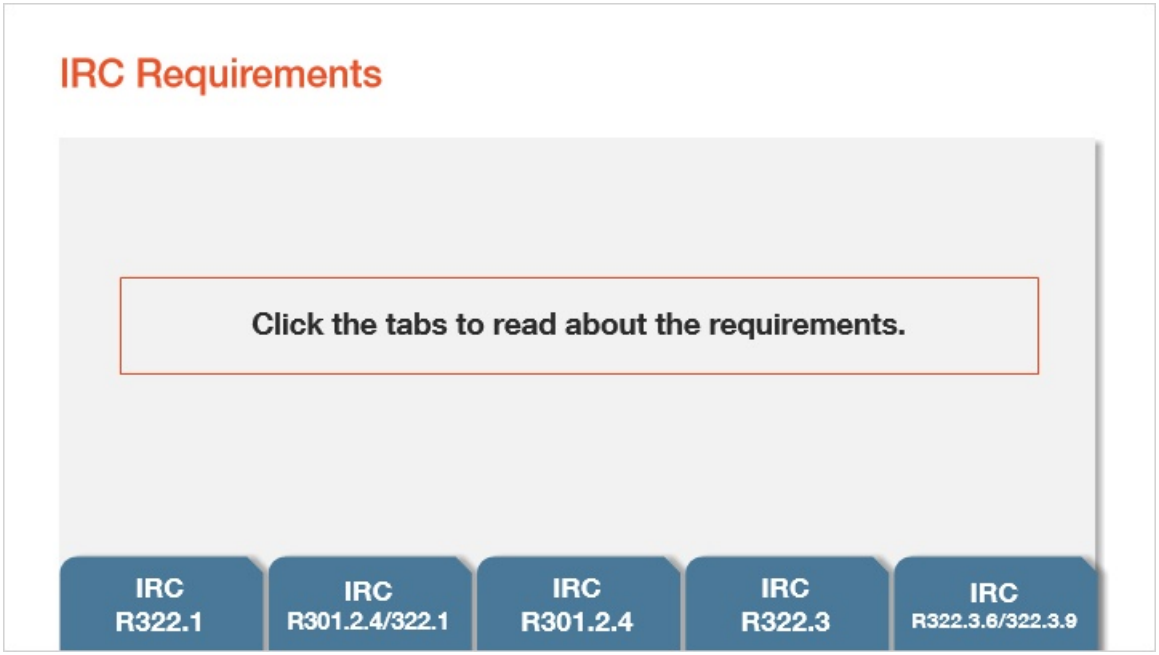
4.5 IRC Requirements



Notes:

Section R322 of the IRC addresses flood-resistant construction. Review the requirements and click *Next* when you're ready to move on.

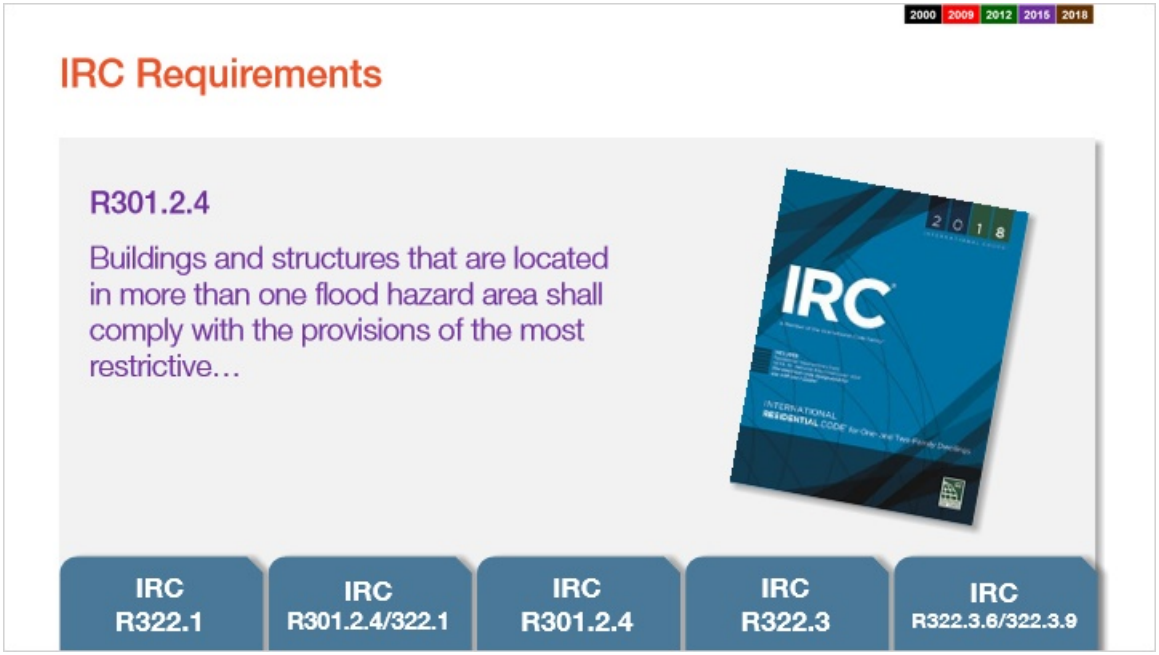
IRC (first) (Slide Layer)

No audio on this slide.

IRC (second) (Slide Layer)

No audio on this slide.

IRC (third) (Slide Layer)



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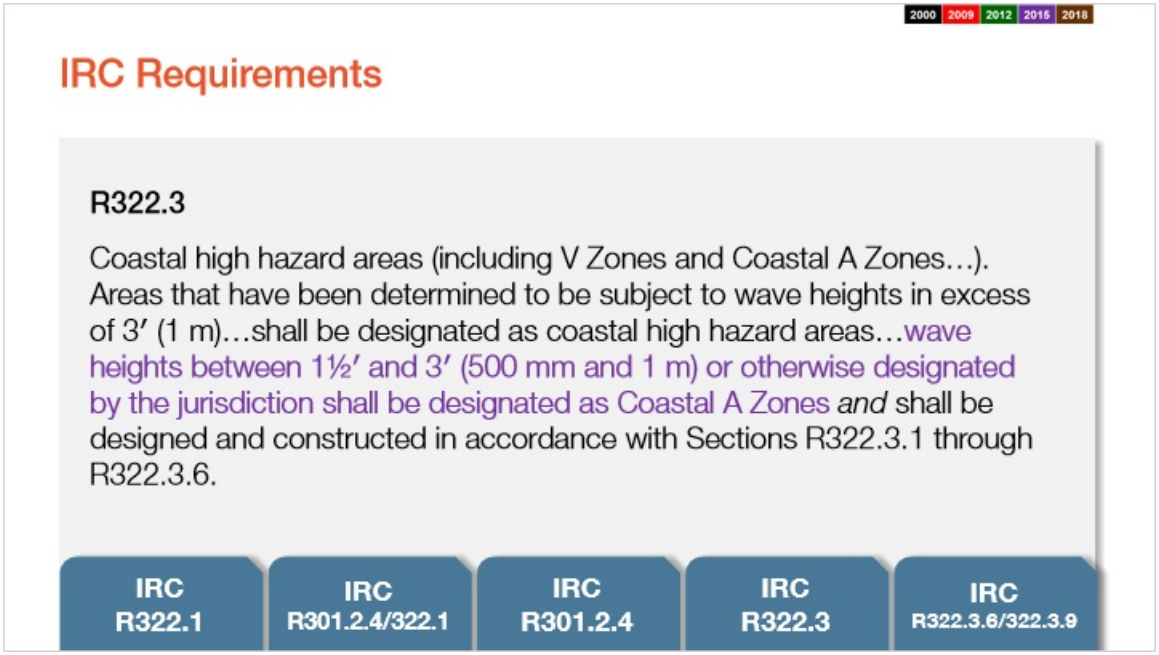

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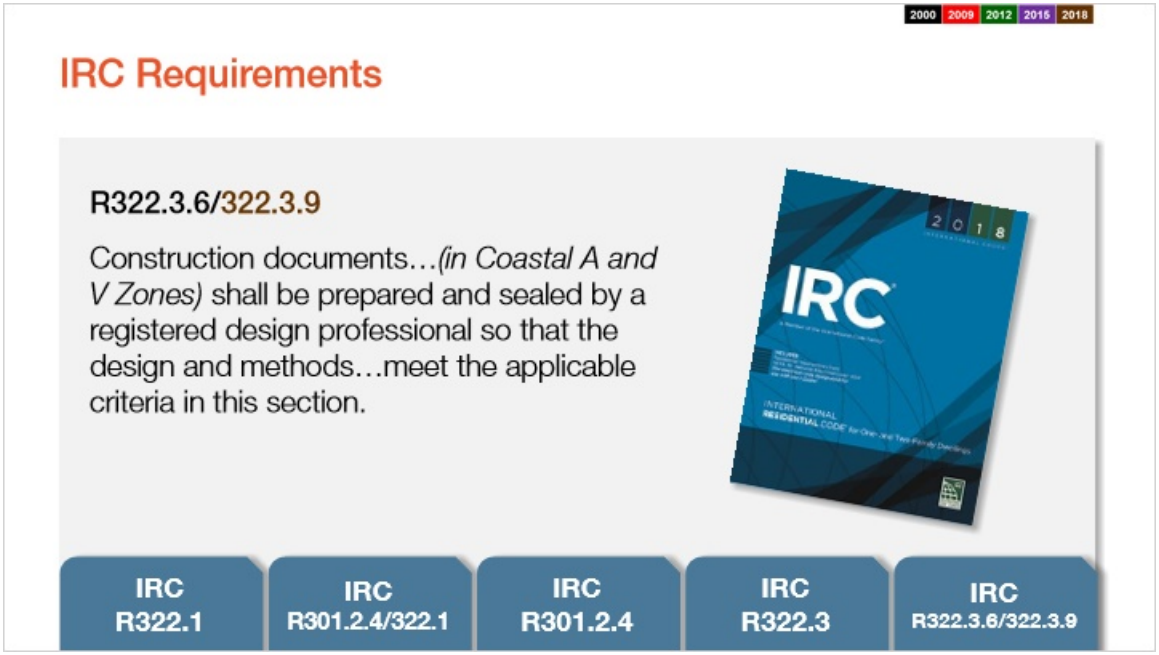
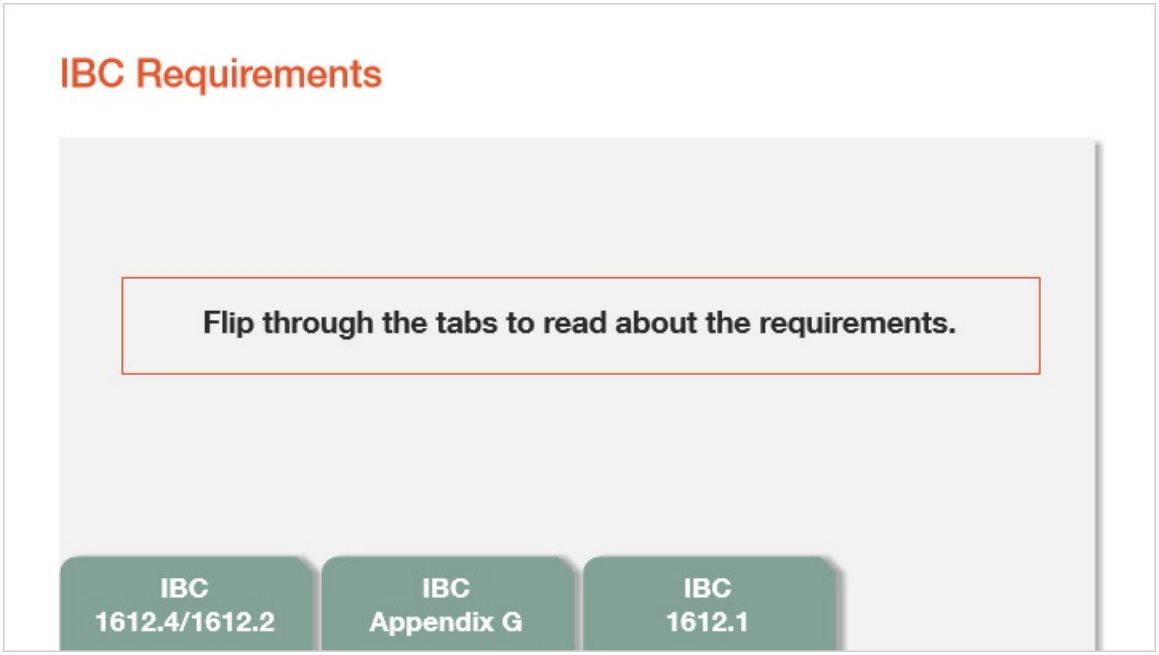


No audio on this slide.

4.6 IBC Requirements

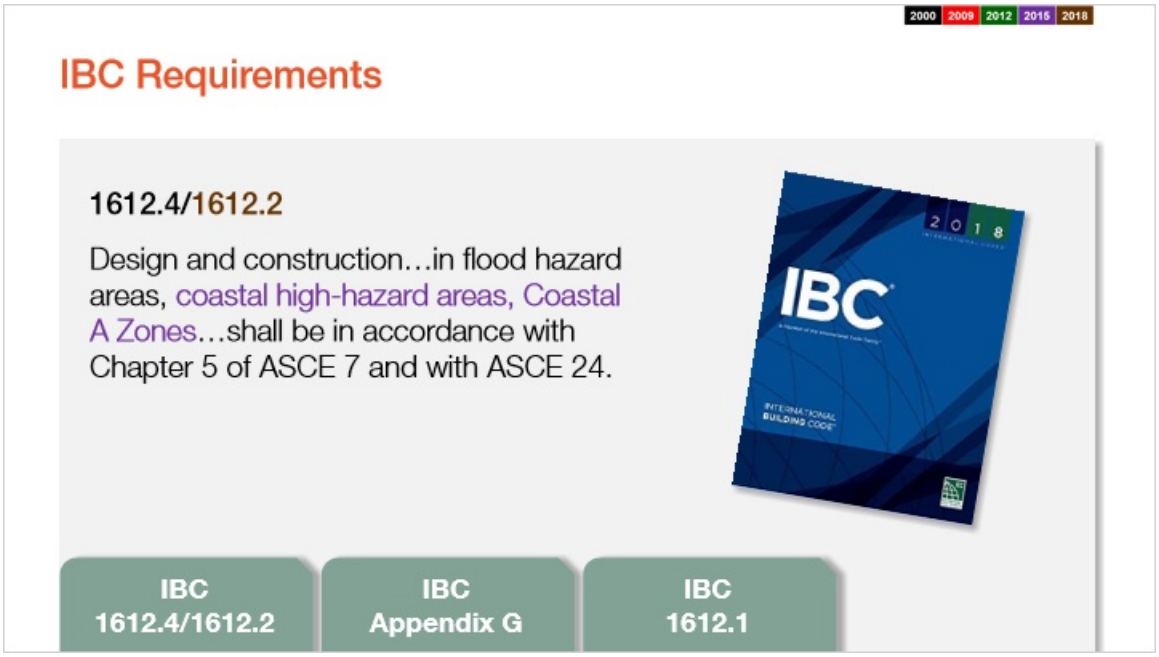


Notes:

Section 1612 of the IBC addresses flood loads. Have a look at the tabs.

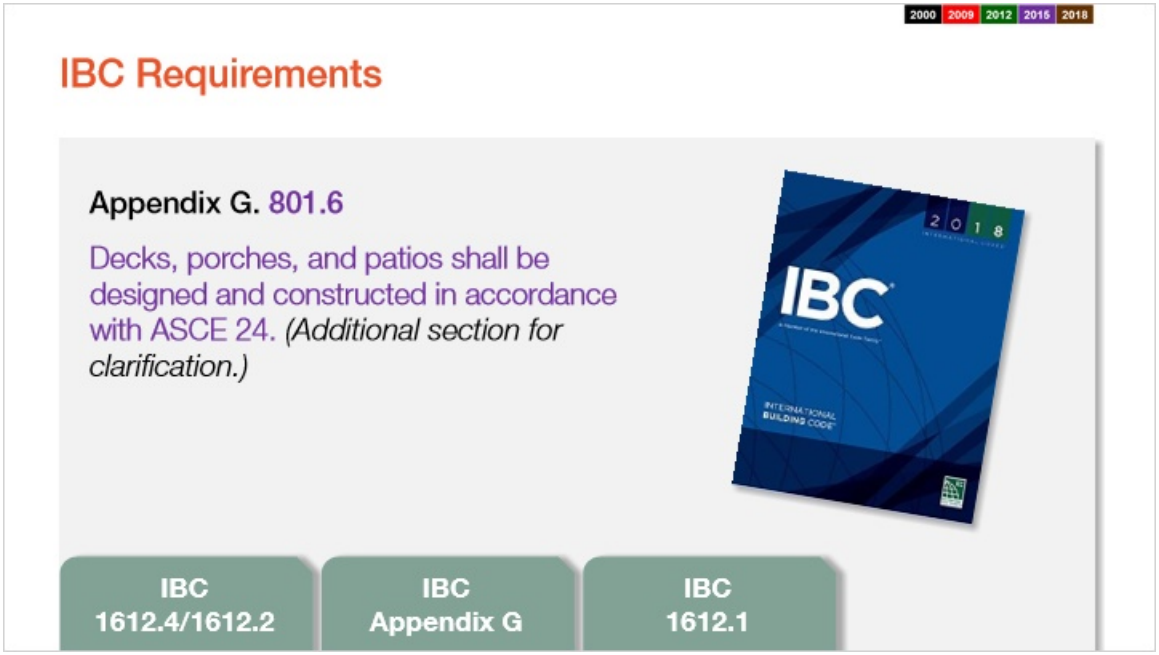
Because the IBC refers to ASCE 24, the course will reference the IRC and ASCE 24 throughout.

IBC (first) (Slide Layer)



No audio on this slide.

IBC (second) (Slide Layer)

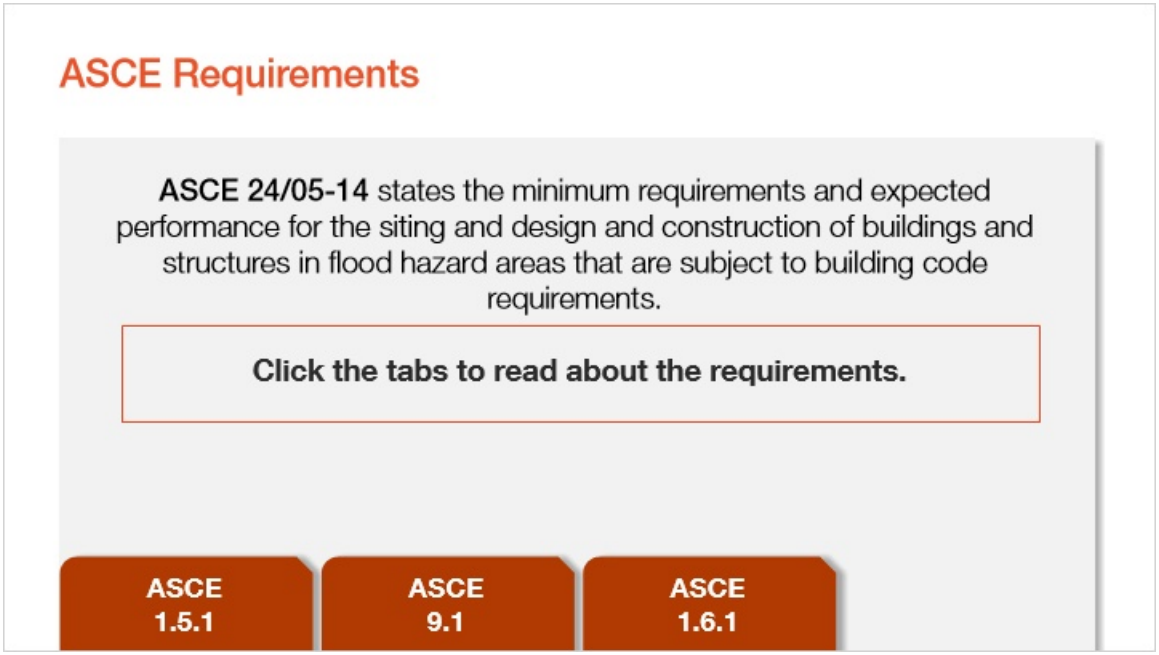


No audio on this slide.

IBC (third) (Slide Layer)

No audio on this slide.

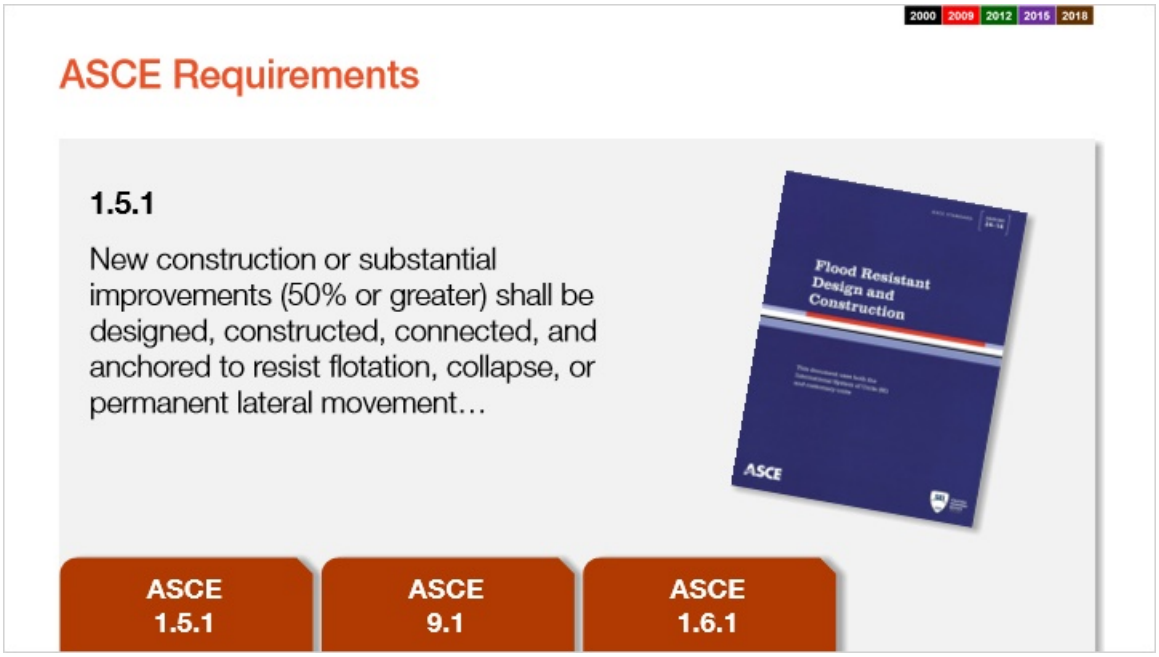
4.7 ASCE Requirements



Notes:

ASCE 24 is a referenced standard in the International Codes® (I-Codes®). ASCE 24 states the minimum requirements and expected performance for the siting and design and construction of buildings and structures in flood hazard areas that are subject to building code requirements. Take a look at the requirements and click Next to move on.

ASCE (first) (Slide Layer)



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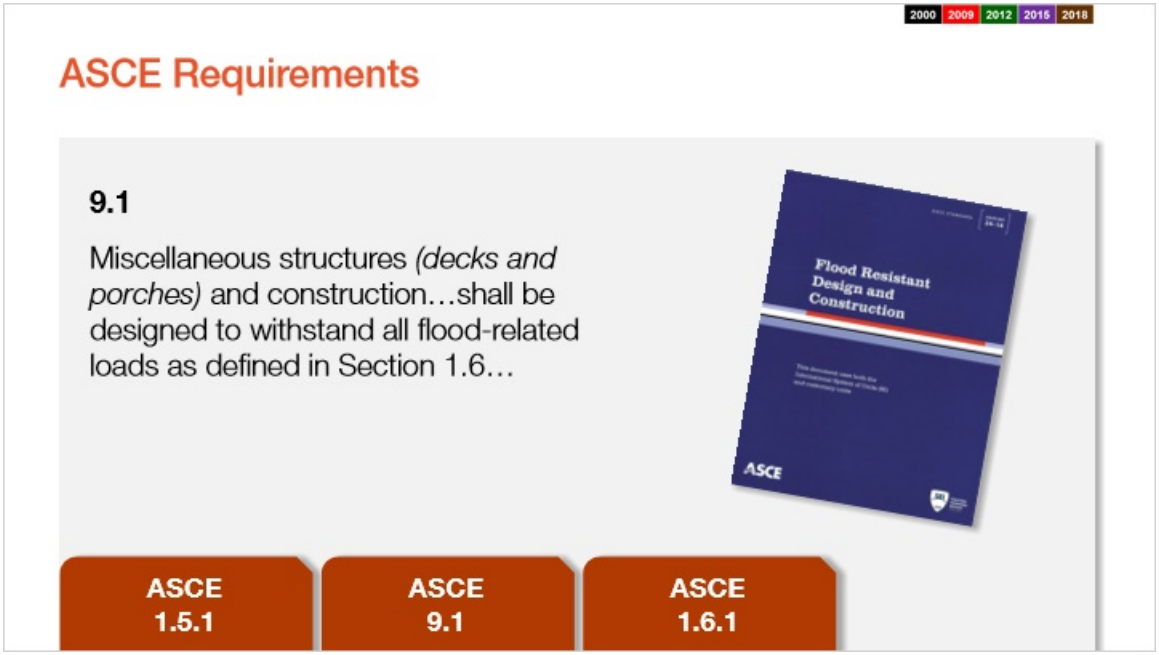

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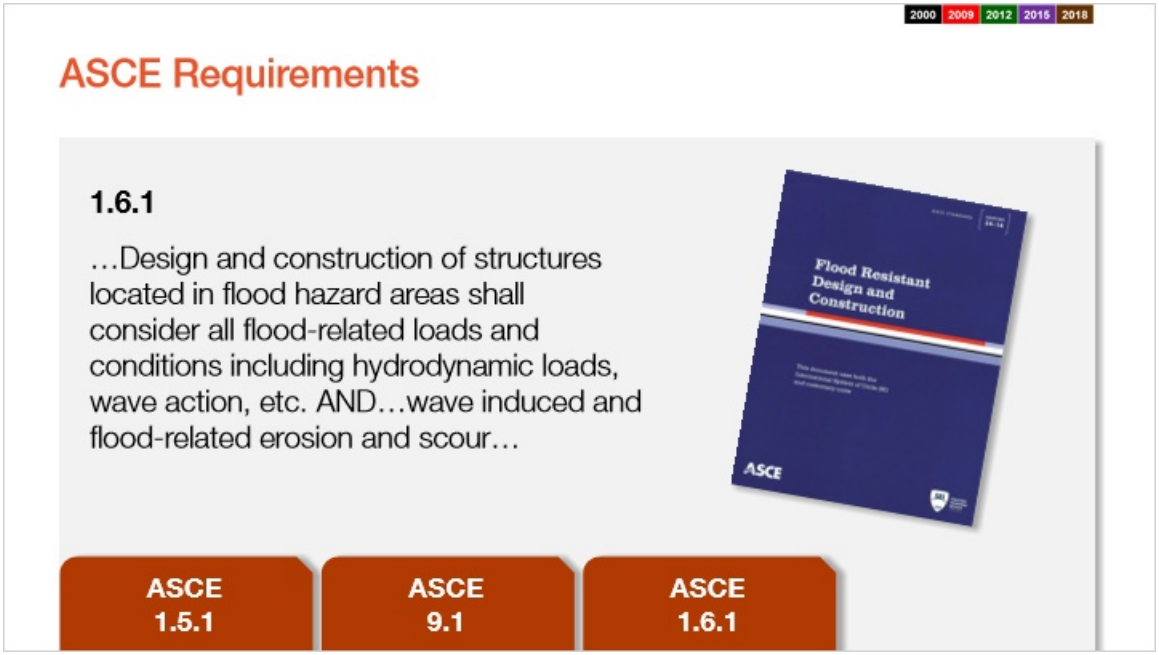

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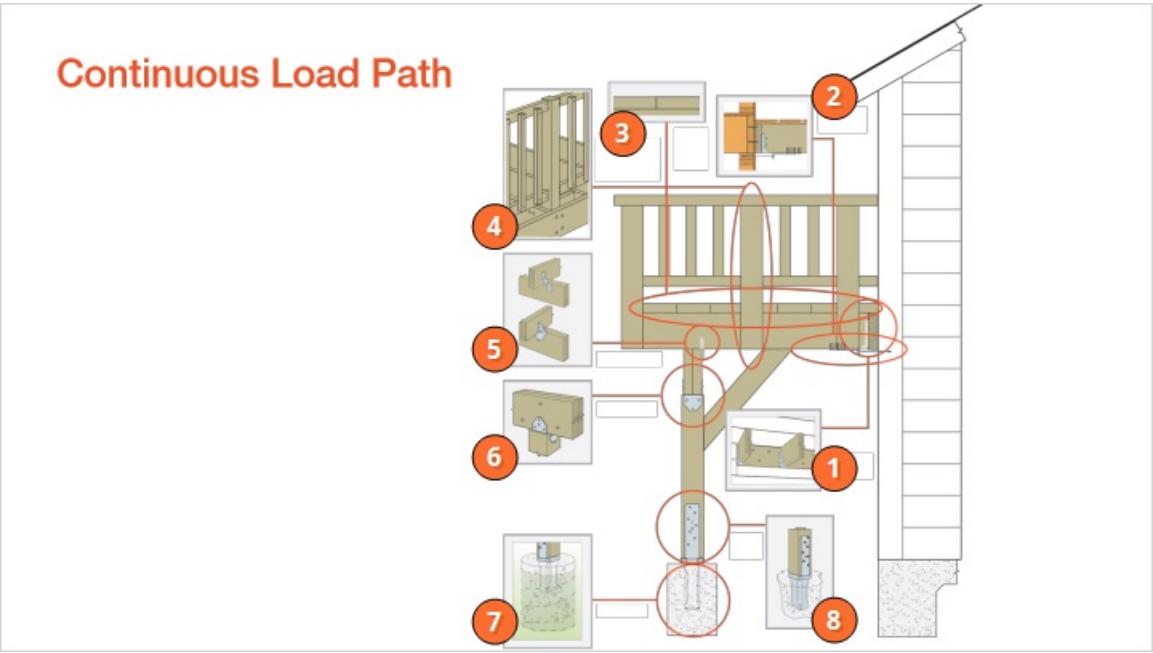
5.1 Deck and Porch Construction in Flood Hazard Areas

Notes:

In this section of this course, we will address continuous load path connections, post-to-footing connections, post or column to beam or joist connections, beam-to-joist connections, attached decks, lateral load connections, and exterior stairways in flood hazard areas.

5.2 Continuous Load Path



Notes:

All the links in the load path must be strong enough to transfer the loads without breaking or failing in any way.

Click through the numbered icons to reveal each of the 8 links. When you are ready, click Next to continue.

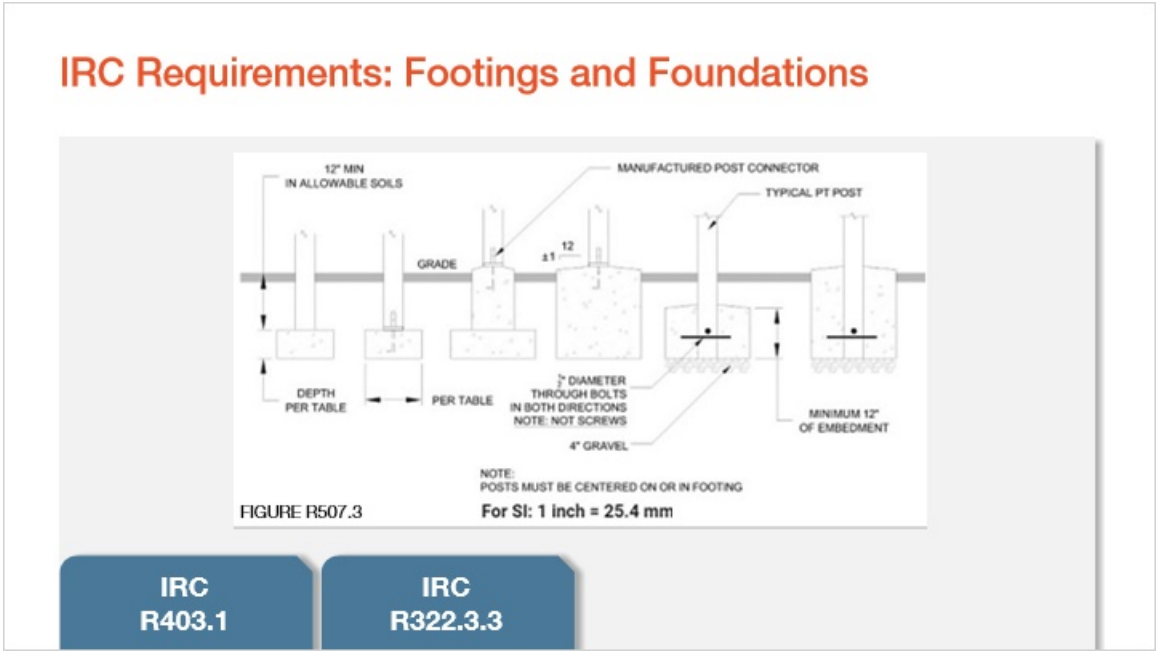
5.3 Continuous Load Path

Notes:

The porch pictured here has no continuous load path. As you can see, the upper columns are not directly supported.

In contrast, the continuous load paths are quite evident in this double porch construction where columns are directly supported from foundation to roof.

5.4 IRC Requirements: Footings and Foundations

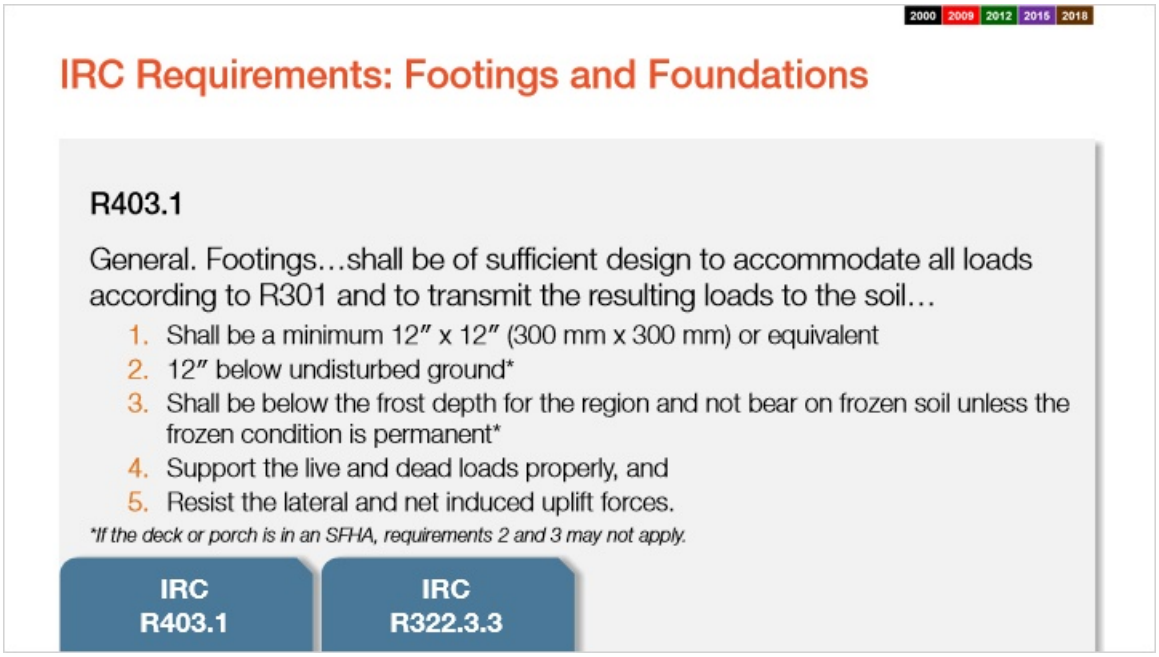


Notes:

The tabs reveal the IRC requirements for footings and foundations.

Pictured here is IRC figure R507.3, deck posts to deck footing connection.

IRC (first) (Slide Layer)



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IRC (second) (Slide Layer)

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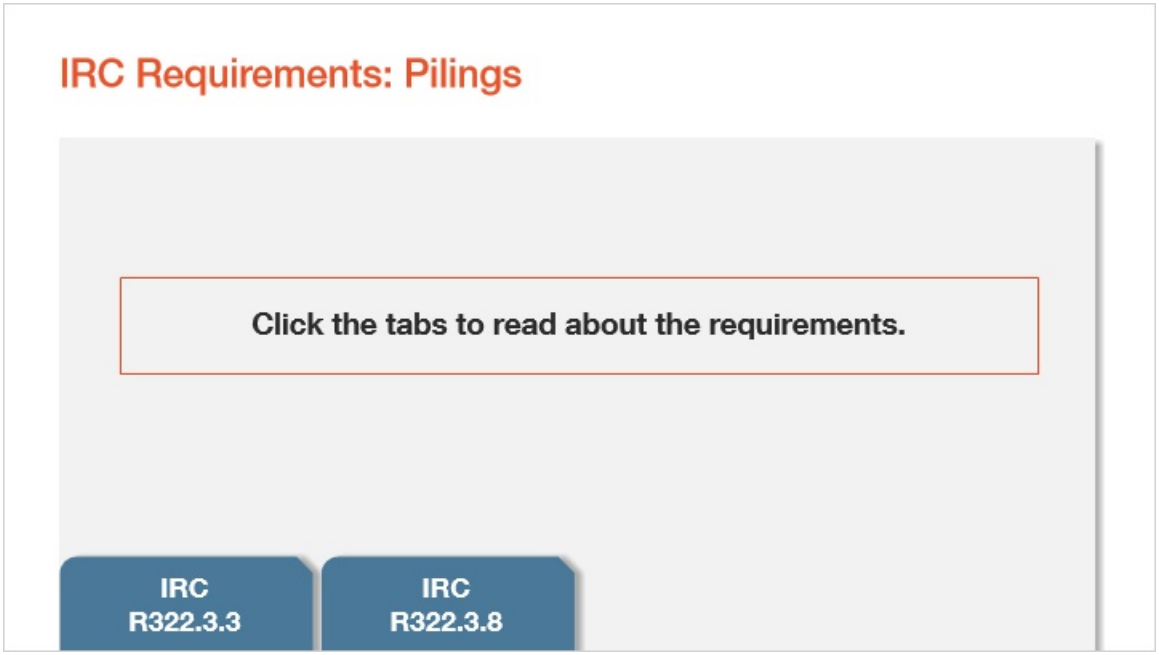
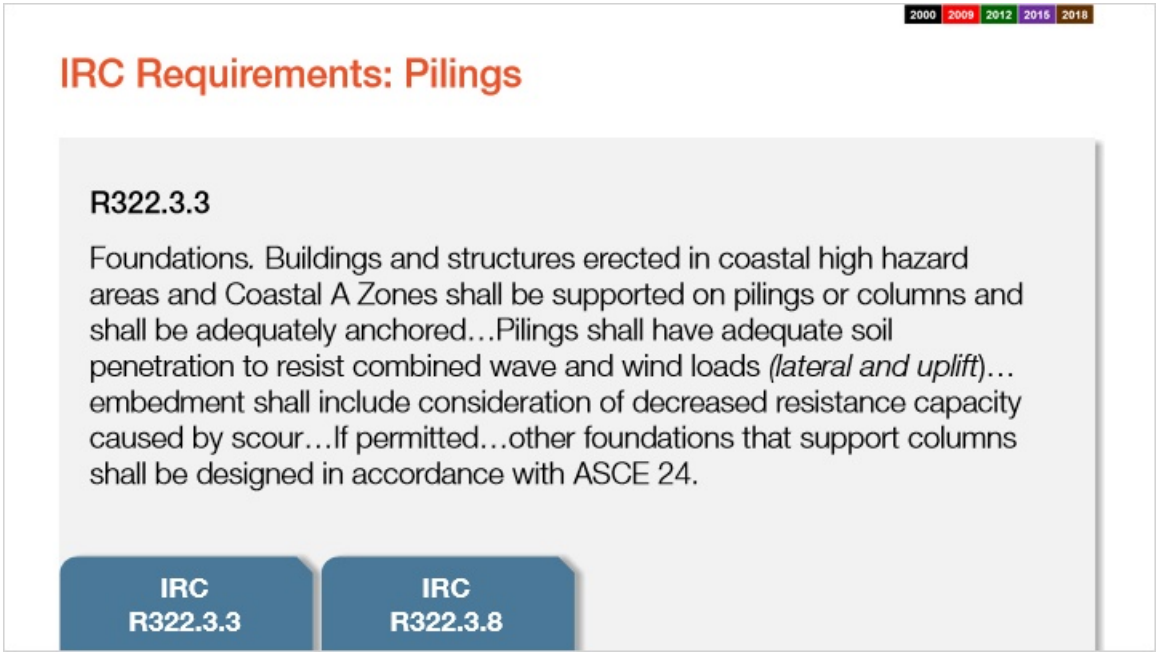
5.5 IRC Requirements: Pilings



Notes:

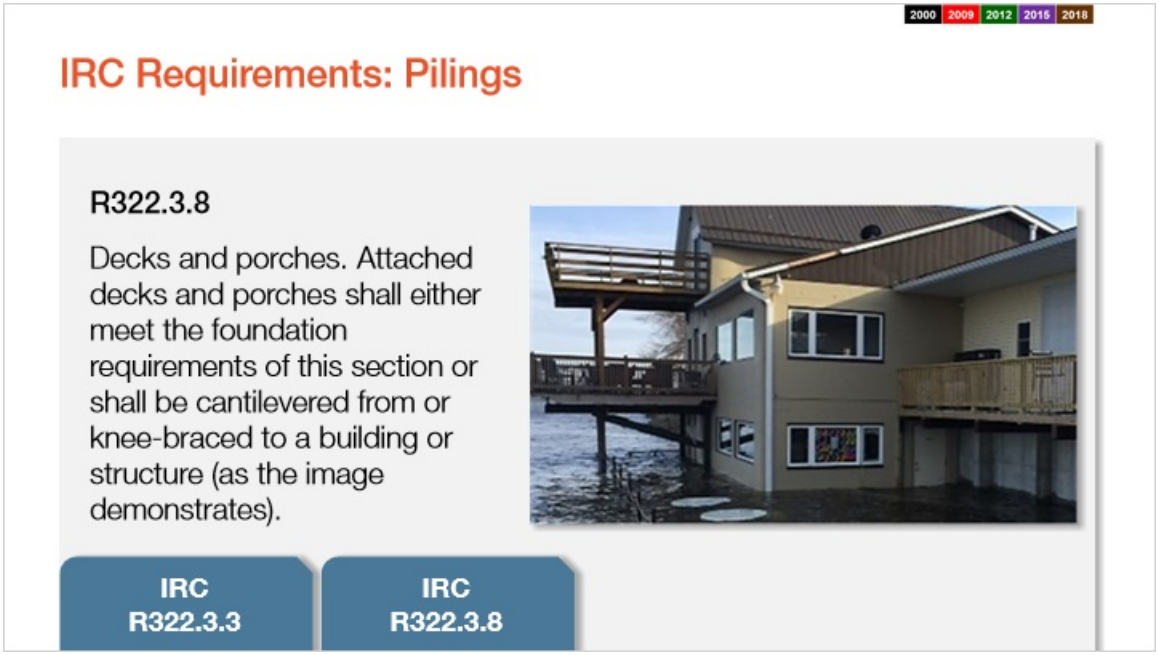
Click the tabs to read the IRC requirements for pilings.

IRC (first) (Slide Layer)



No audio on the slide.

IRC (second) (Slide Layer)



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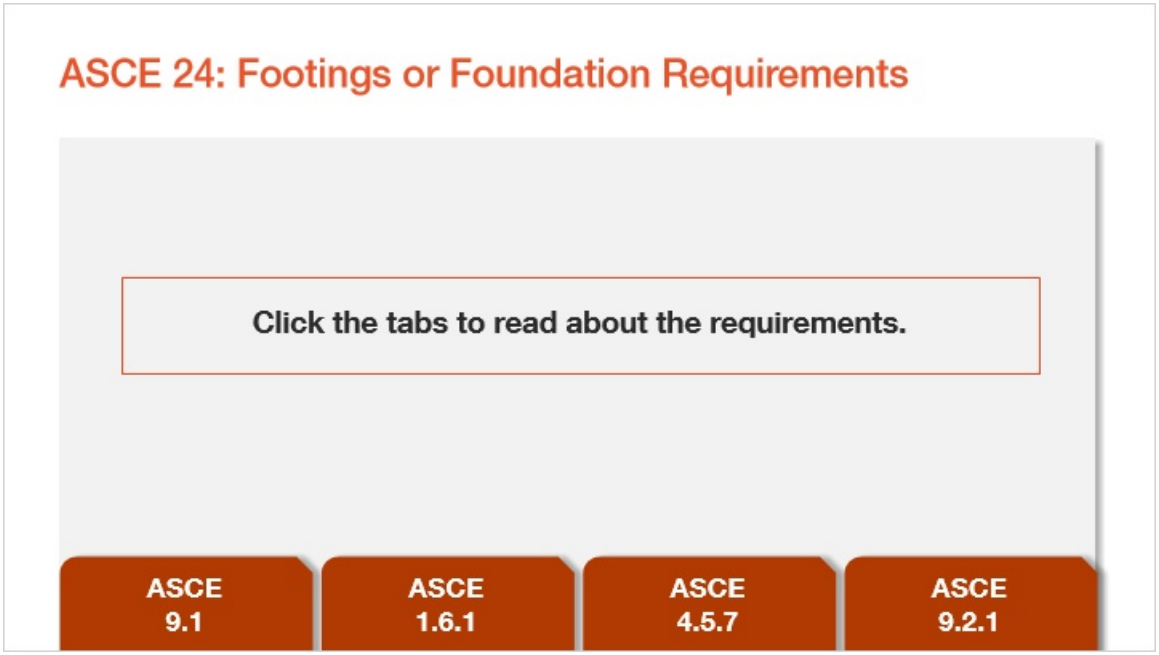
5.6 ASCE 24: Footings or Foundation Requirements



Notes:

Here are the ASCE 24 footings and foundation requirements for you to review.

ASCE (first) (Slide Layer)

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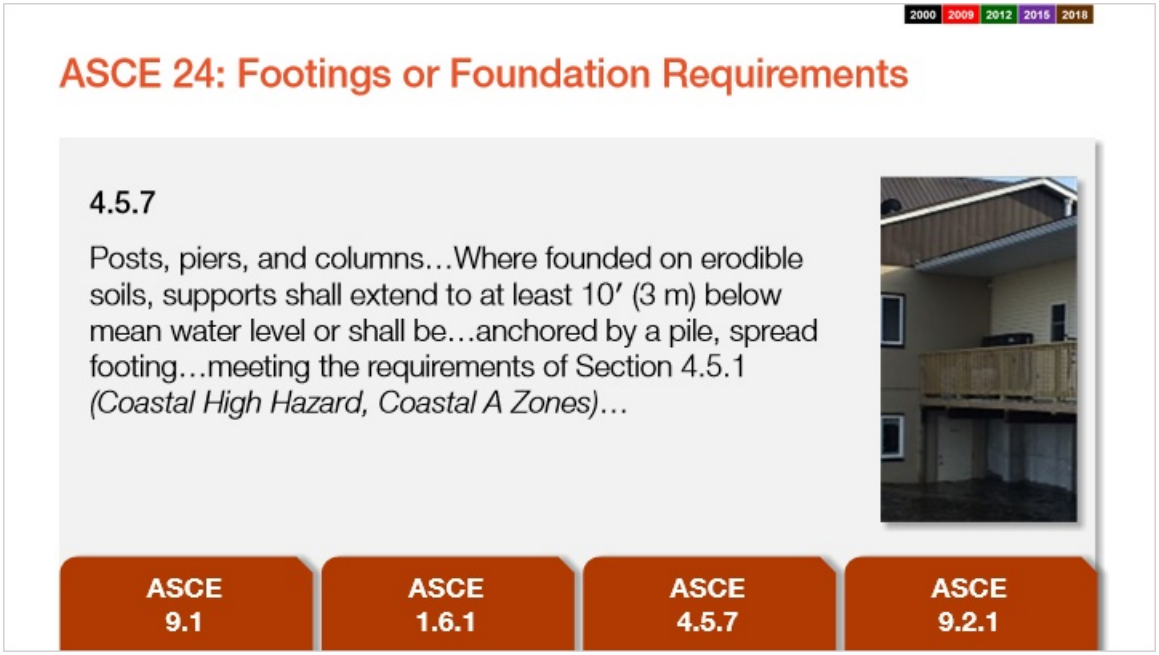
ASCE (second) (Slide Layer)

No audio on the slide.

ASCE (third) (Slide Layer)



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ASCE (fourth) (Slide Layer)

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5.7 Footing/Foundation Failure

Notes:

This deck failed from inadequate footing depth and questionable soil.

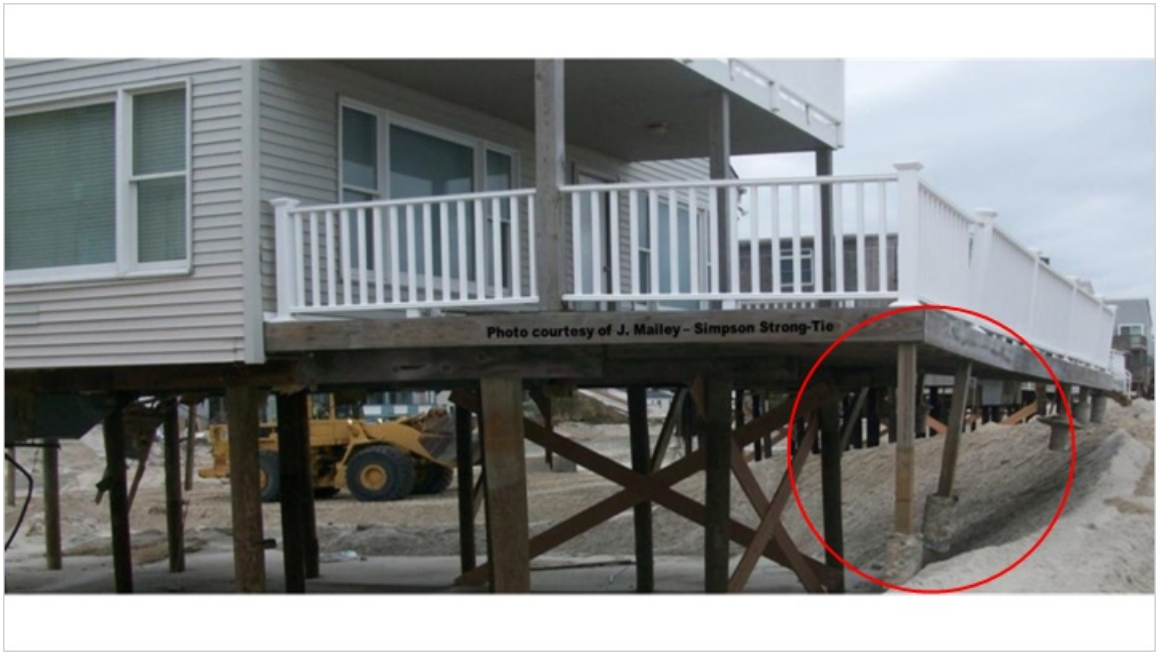
The post base held onto the footing and lifted up the concrete.

5.8 Footing/Foundation Failure

Notes:

This deck also failed from flood-related erosion and scour.

5.9 Footing/Foundation Failure



Notes:

Flood-related erosion and scouring is also what caused this porch to fail.

5.10 IRC Requirements: Post-to-Footing Connections

Notes:

The connectors shown are rated for both uplift and lateral resistance. They also provide a 1” (25 mm) standoff to reduce the potential for decay.

Review the IRC requirements for post-to-footing connections and click *Next* to continue.

IRC (first) (Slide Layer)

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IRC (second) (Slide Layer)

No audio on this slide.

IRC (third) (Slide Layer)

No audio on this slide.

IRC (fourth) (Slide Layer)

No audio on this slide.

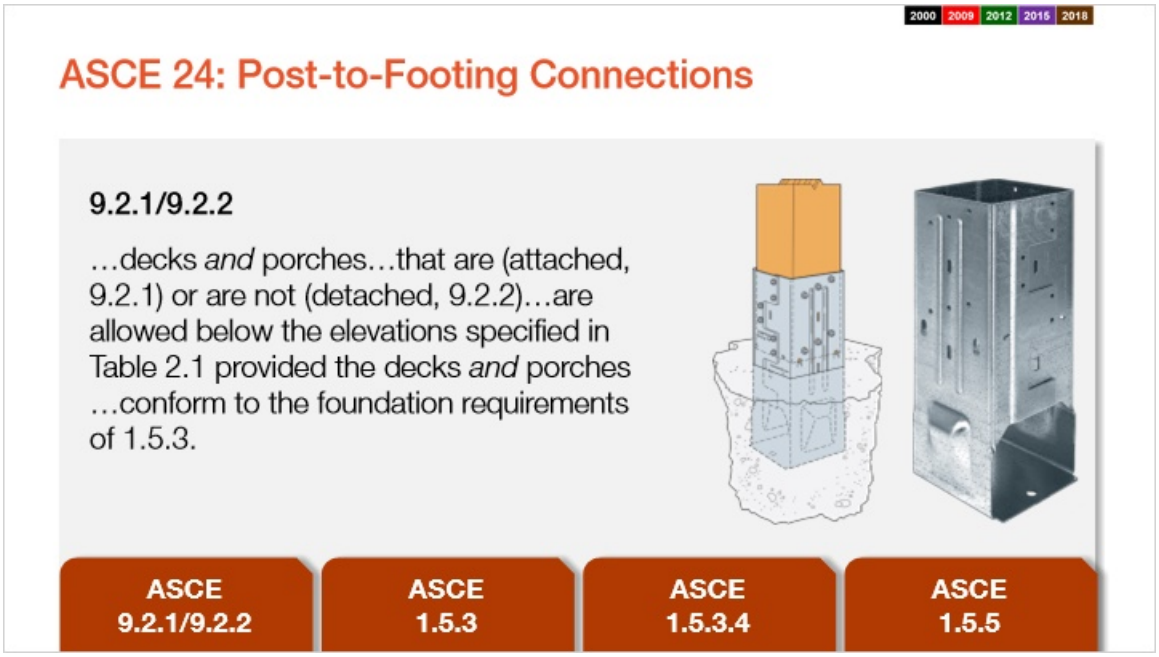
5.11 ASCE 24: Post-to-Footing Connections

Notes:

These post-to-footing connections can be hot-dip galvanized as per the requirements of ASCE 24..

Review the ASCE 24 requirements.

ASCE (first) (Slide Layer)



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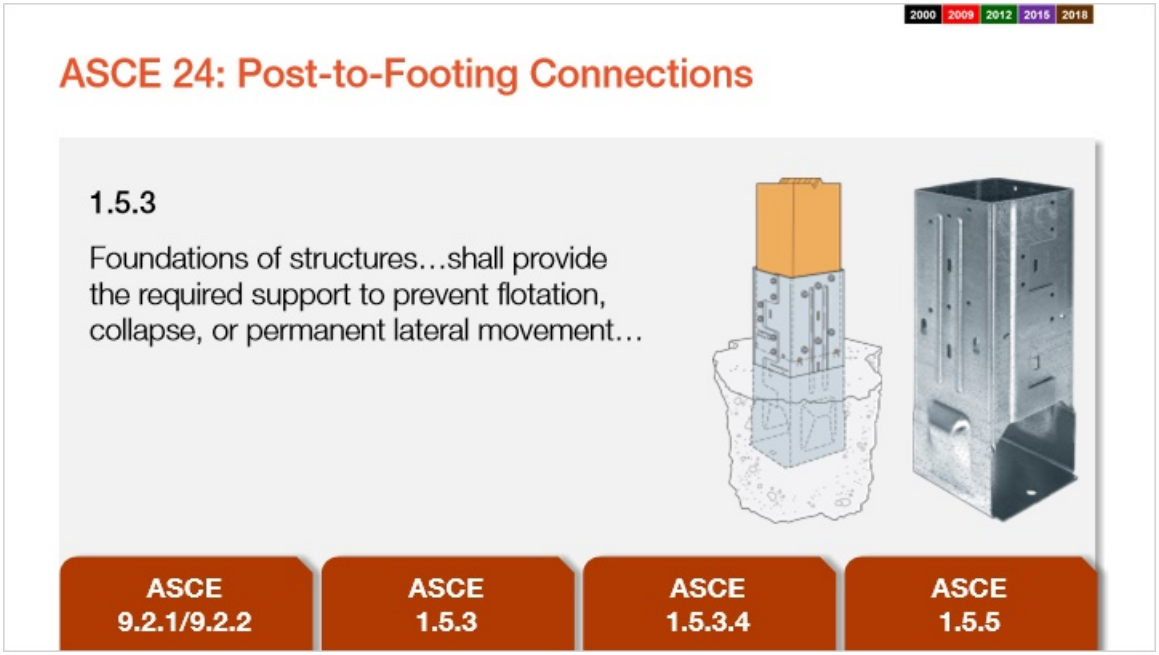
ASCE (second) (Slide Layer)



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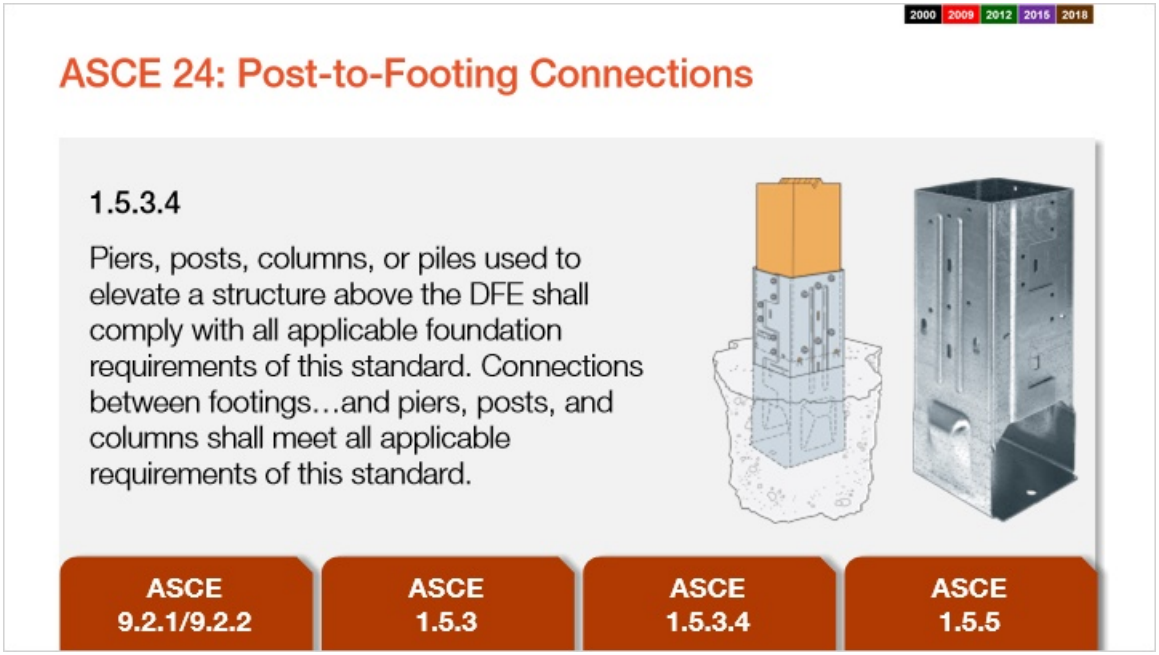
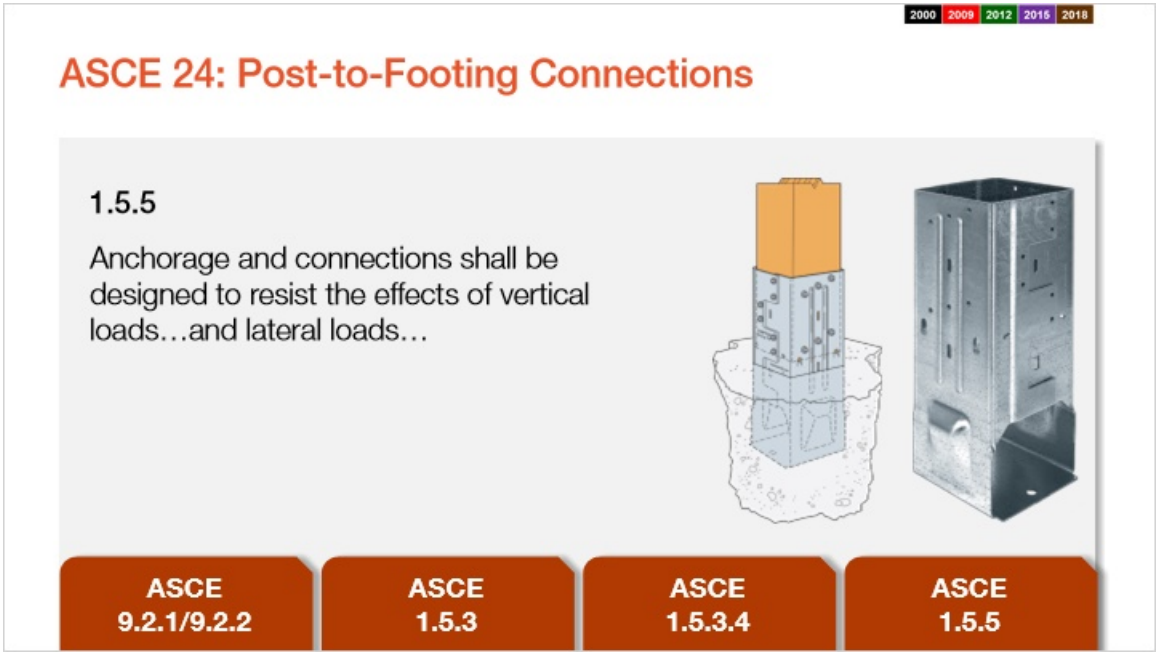
ASCE (third) (Slide Layer)



No audio on this slide.

ASCE (fourth) (Slide Layer)



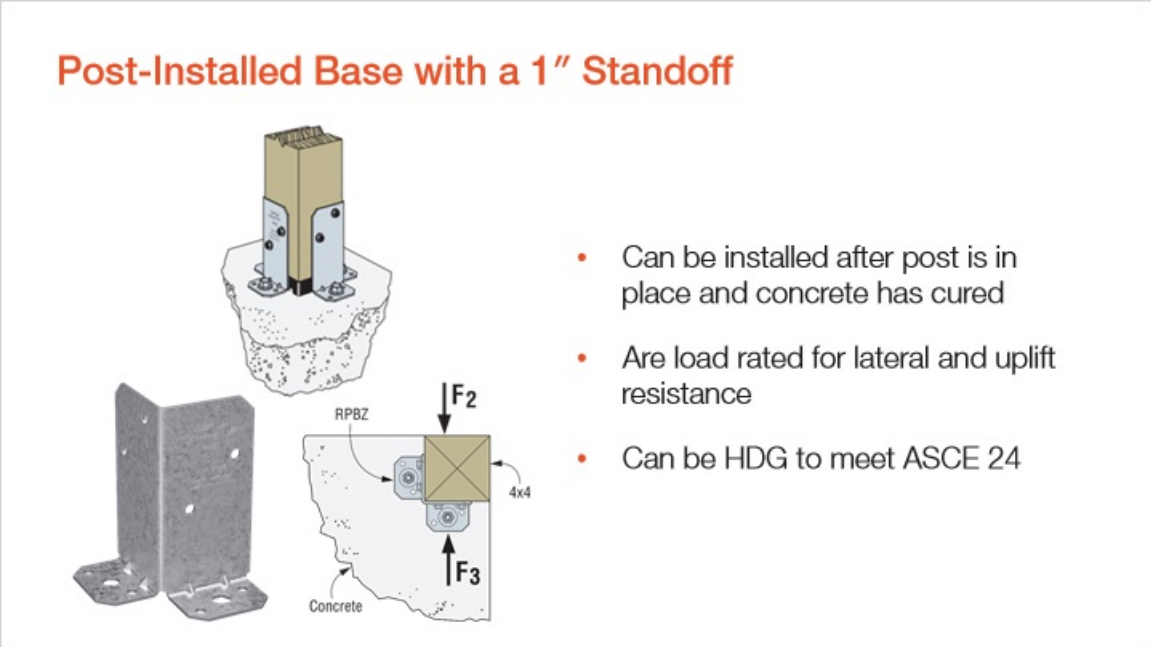
No audio on this slide.

5.12 Post-to-Foundation Failure

Notes:

This image shows an attached porch that failed because of inadequate lateral load connections at the post-to-foundation connection.

5.13 Post-Installed Base with a 1” Standoff

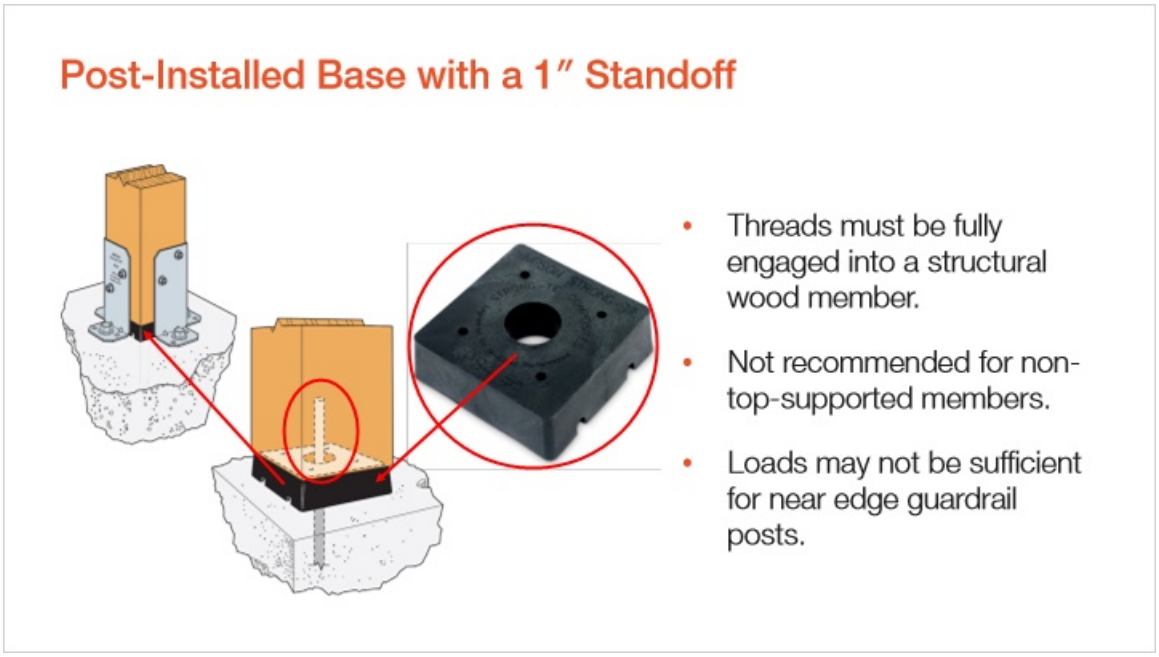


Notes:

Post-installed bases with a 1” standoff:

- Can be installed after the post is in place and the concrete has cured with ⅜” (9.5 mm) anchors (ideal for existing wood posts on porches).
- Are load rated for lateral and uplift resistance.
- Can be HDG (hot dip galvanized) to meet the requirements of ASCE 24.

5.14 Post-Installed Base with a 1" Standoff



Notes:

Note that threads must be fully engaged into a structural wood member.

This is not recommended for non-top-supported members.

Additionally, loads may not be sufficient for near edge guardrail posts.

Use CPS (composite plastic standoff) to meet 1" (25 mm) post standoff requirements.

5.15 Post-Installed Base with a 1" Standoff

Notes:

The illustrated standoff:

- is rated for both uplift and lateral resistance
- provides 1" (25 mm) standoff to reduce the potential for decay
- can be HDG per ASCE 24 requirements, and
- uses dowel pins and a ½" (12.5 mm) anchor for all sizes.

5.16 Post-Installed Anchor Options

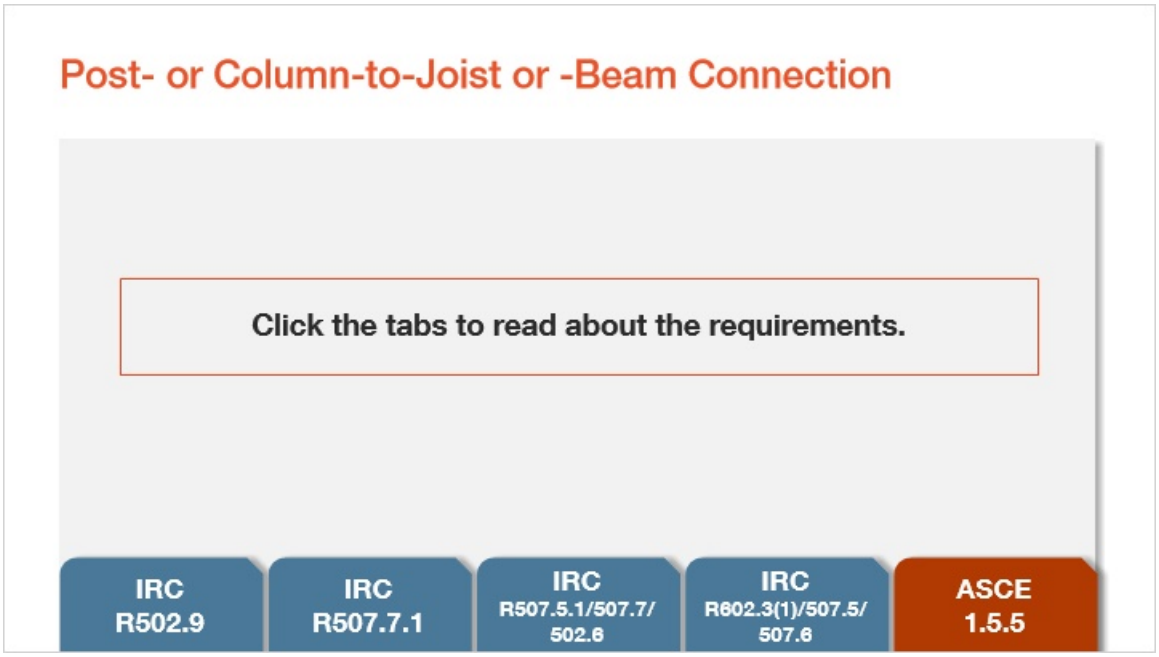
Notes:

There are a few anchor options for after the concrete has cured.

- An acrylic-based structural adhesive,
- Or an epoxy-based structural adhesive
- Plus a precut HDG or stainless-steel all-thread rod,
- Or, a stainless-steel concrete screw anchor.

If edge distance permits, use a mechanically galvanized or stainless-steel wedge anchor.

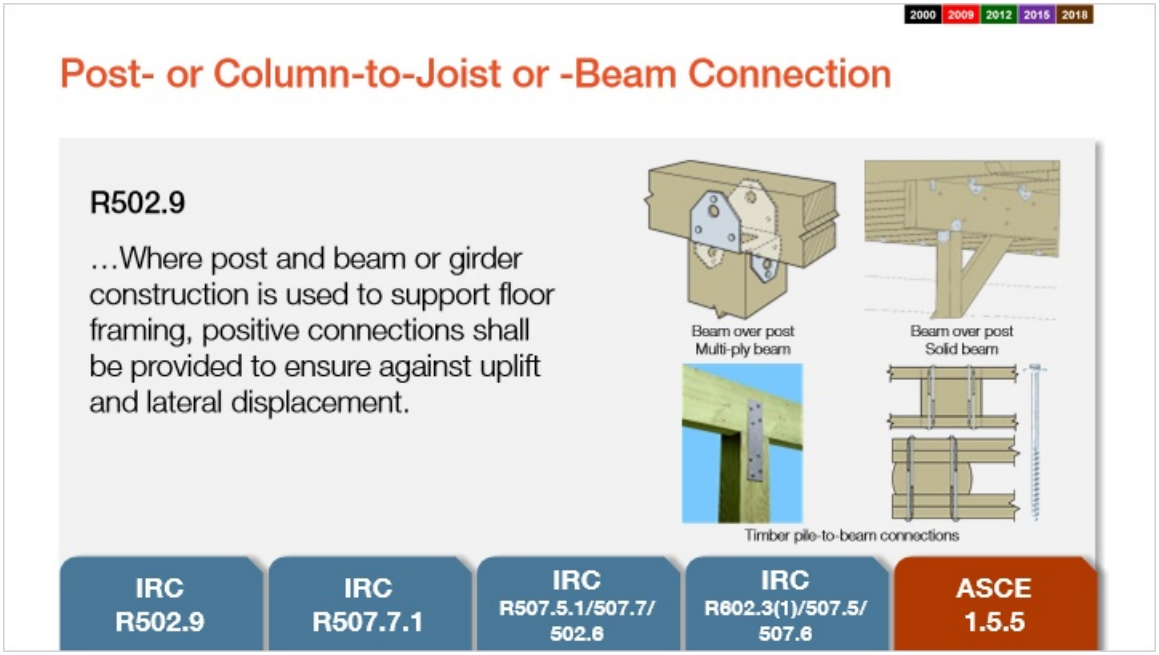
5.17 Post- or Column-to-Joist or -Beam Connection



Notes:

More tabs! You know what to do!

IRC (first) (Slide Layer)



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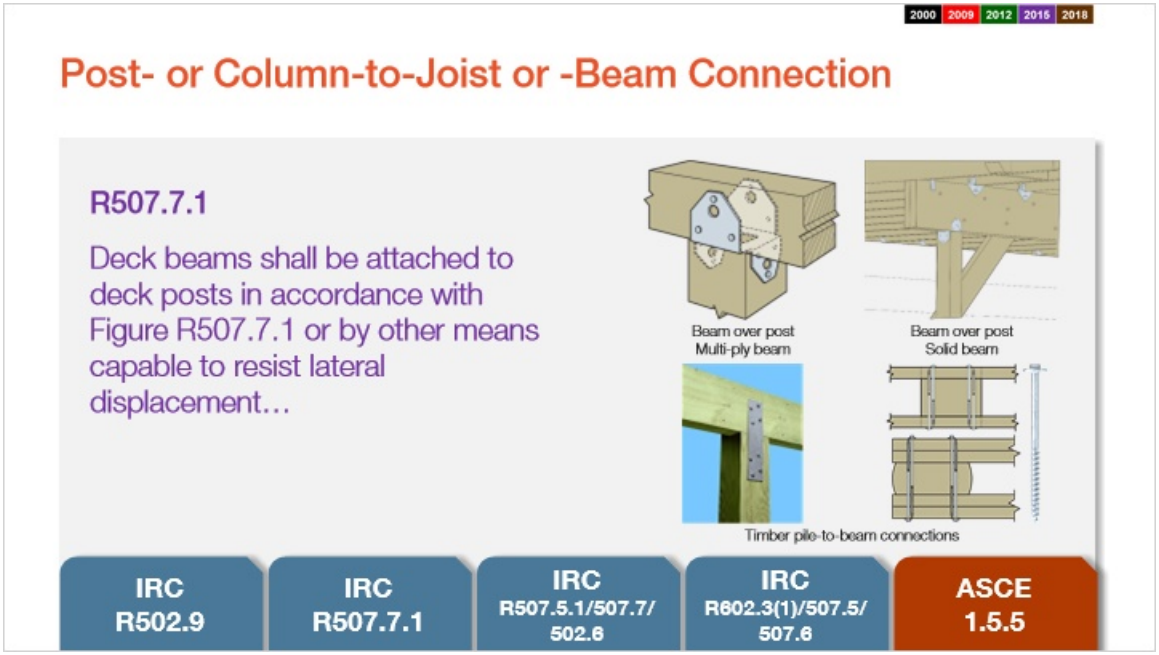
IRC (second) (Slide Layer)



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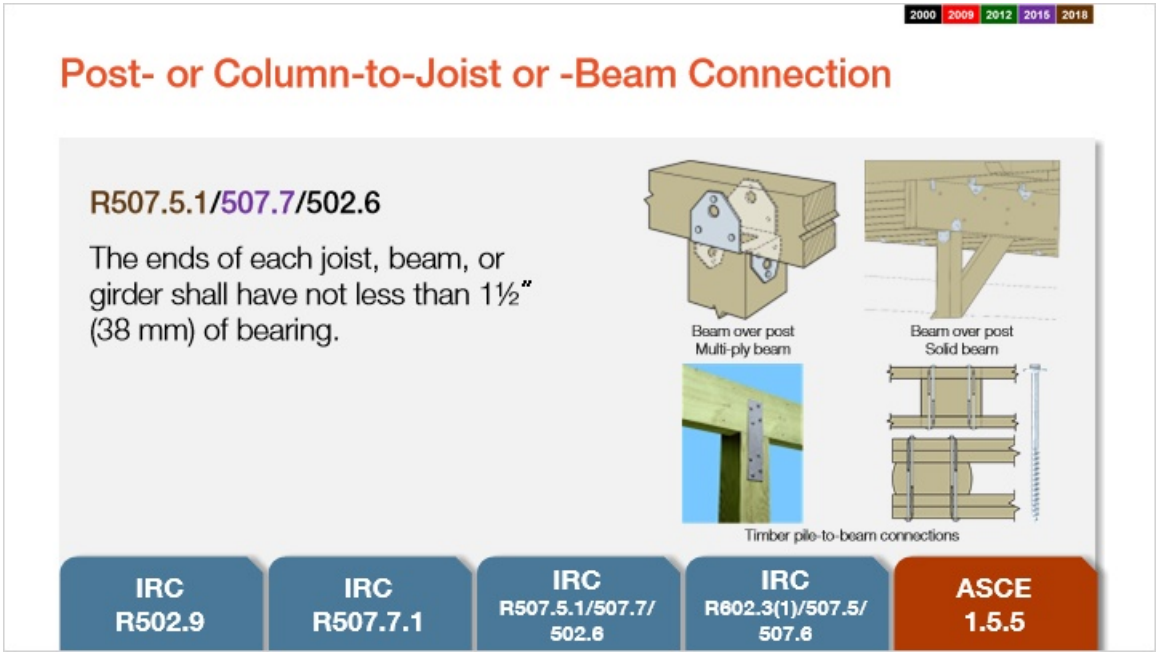
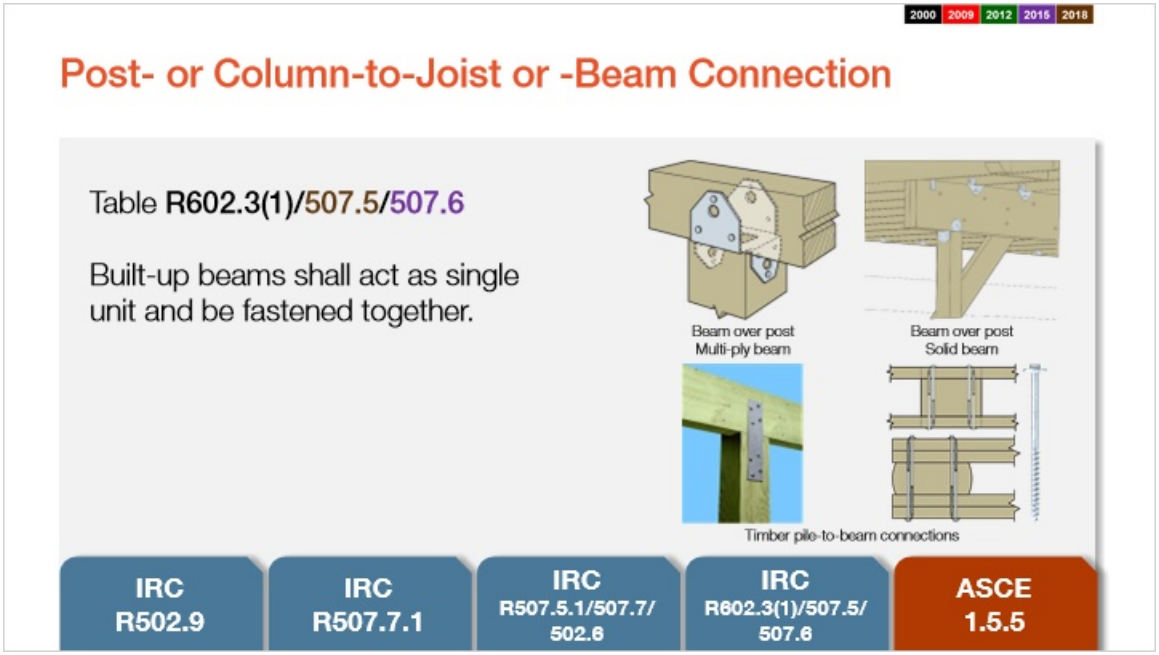
IRC (third) (Slide Layer)



No audio on the slide.

IRC (fourth) (Slide Layer)



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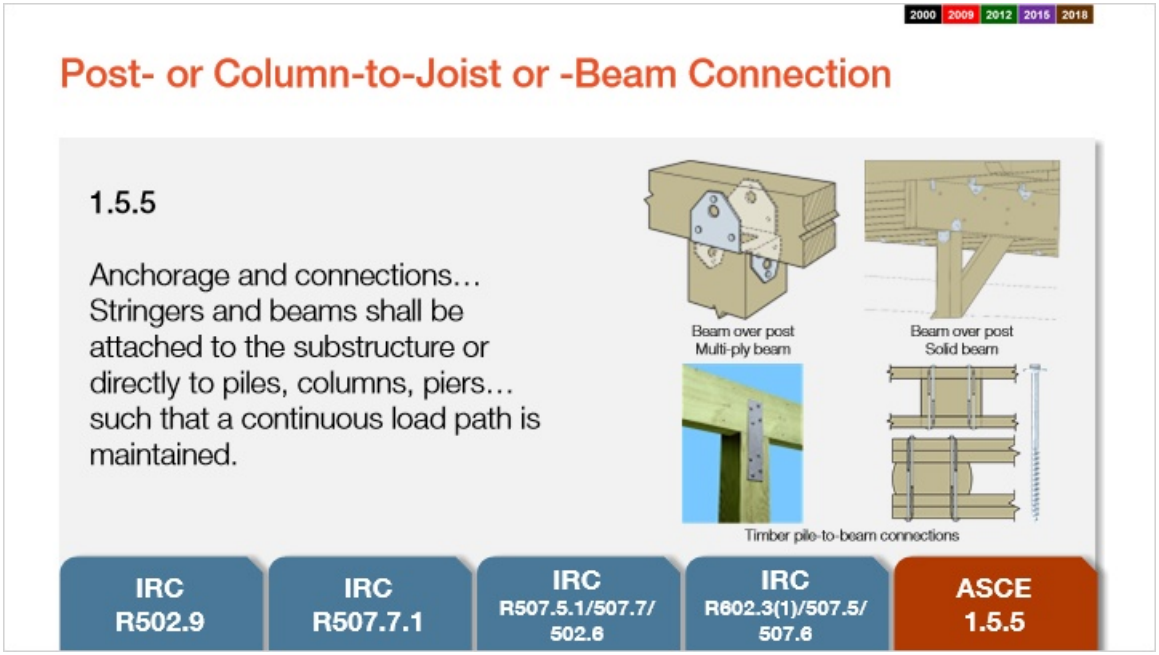
ASCE (Slide Layer)



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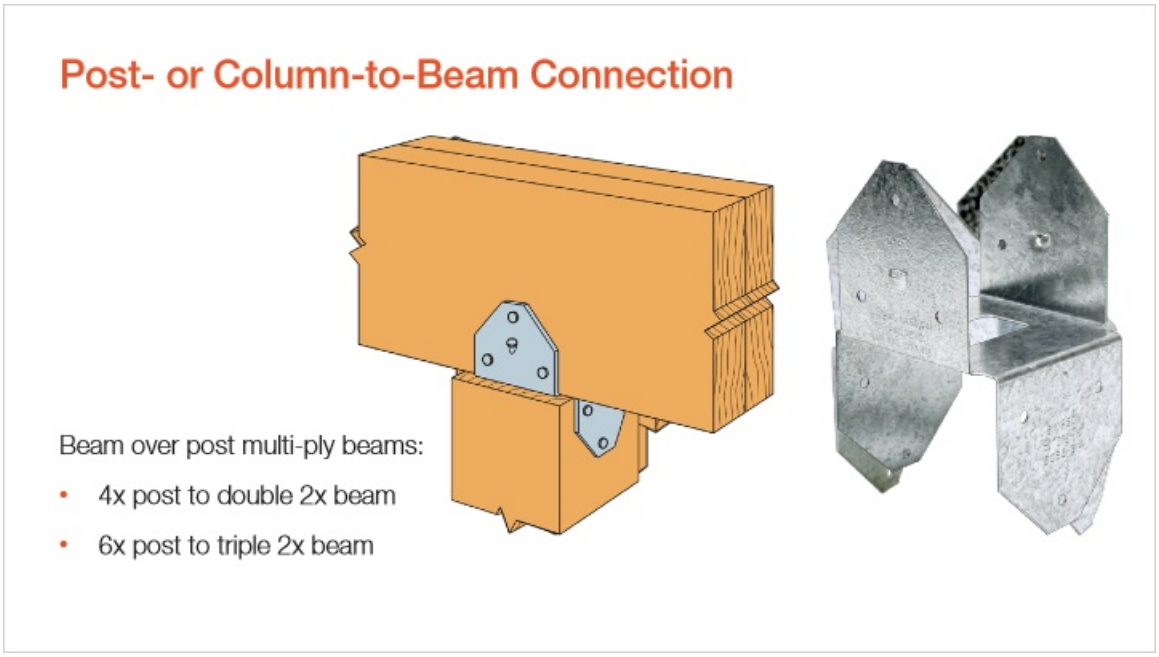
5.18 Inadequate Post Connection

Notes:

This porch collapsed because post connections (which consisted of screws only) were inadequate. A post connector should have been used.

5.19 Post- or Column-to-Beam Connection



Notes:

Beam over post multi-ply beams include:

- 4x post to double 2x beam, and
- 6x post to triple 2x beam.

And typical sizes for beam over post solid beams include:

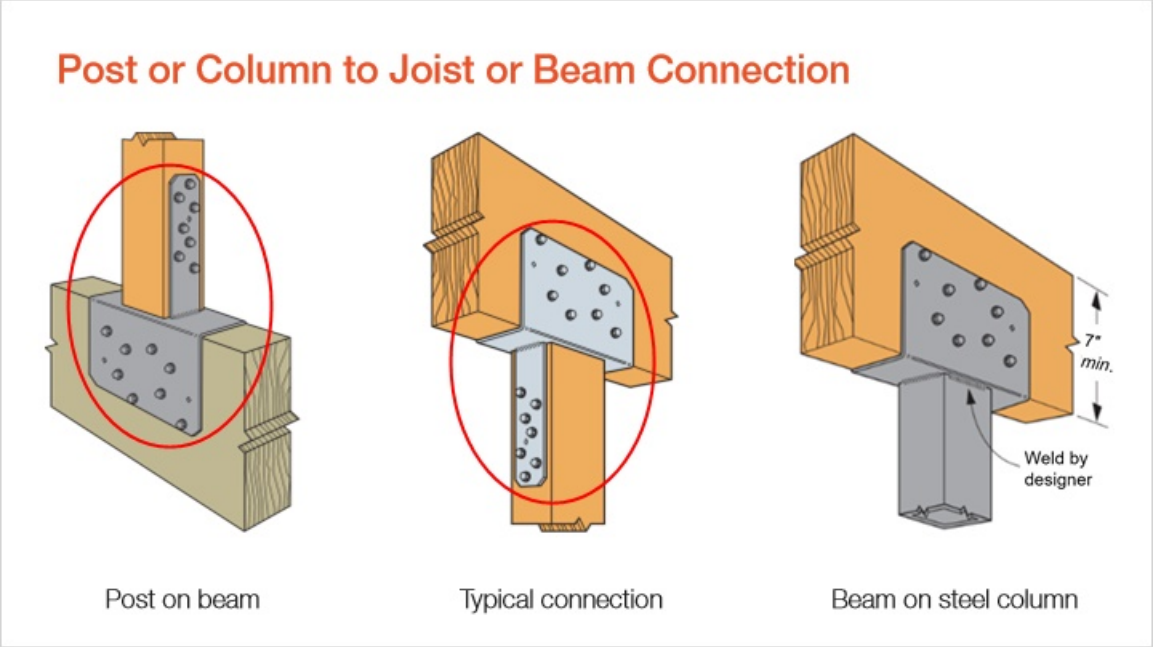
- 4 x 4 to 4x
- 6 x 6 to 6x, and
- 8 x 8 to 8x.

5.20 Post or Column to Joist or Beam Connection

Notes:

Here we see heavy duty column caps. The left column cap is for an end condition. Connectors are available in stainless steel or HDG.

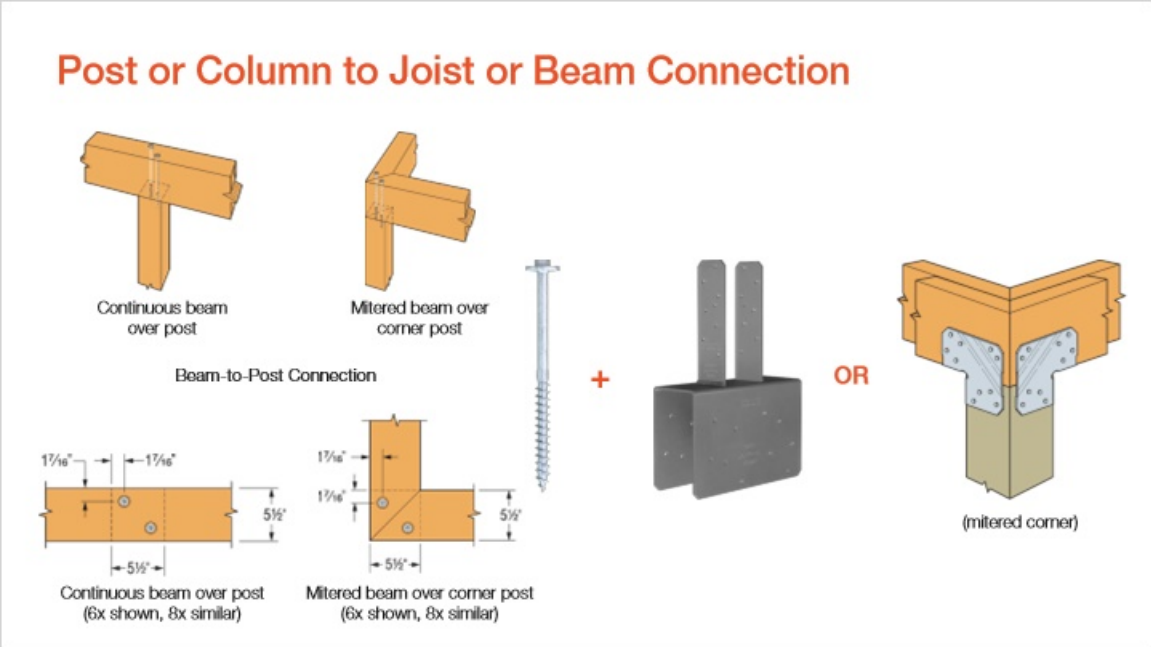
5.21 Post or Column to Joist or Beam Connection



Notes:

Pictured here is a post on beam connection, a typical connection, and a beam on a steel column connection. Notice the orientation of the connector; it can be used upside right or can be inverted.

5.22 Post or Column to Joist or Beam Connection



Notes:

If porch posts or decks are stacked so that the top post can attach on top of a beam and a bottom post can attach below to the same beam, then proprietary screws can be used to connect the beam to the bottom post and an inverted column cap can be used to attach the upper post to the beam.

OR

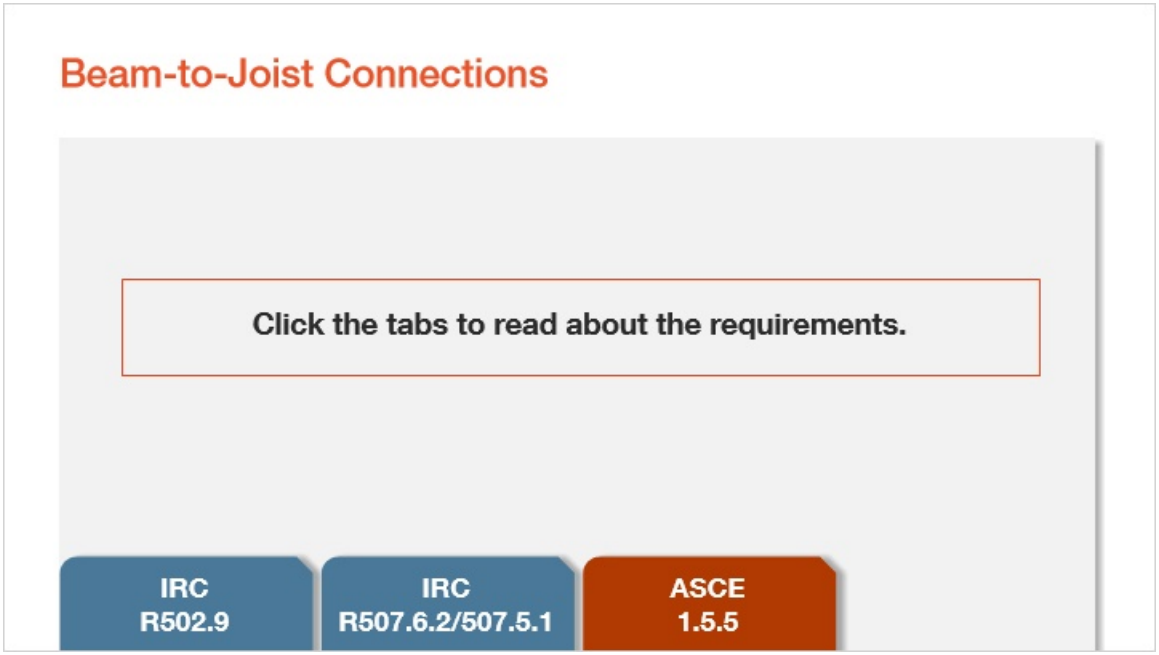
A corner post cap can be used to make the connection in all four corners.

5.23 Beam-to-Joist Connection Failures

Notes:

These decks failed because of inadequate lateral load joist-to-primary structure connections.

5.24 Beam-to-Joist Connections



Notes:

Review the code requirements for beam-to-joist connections.

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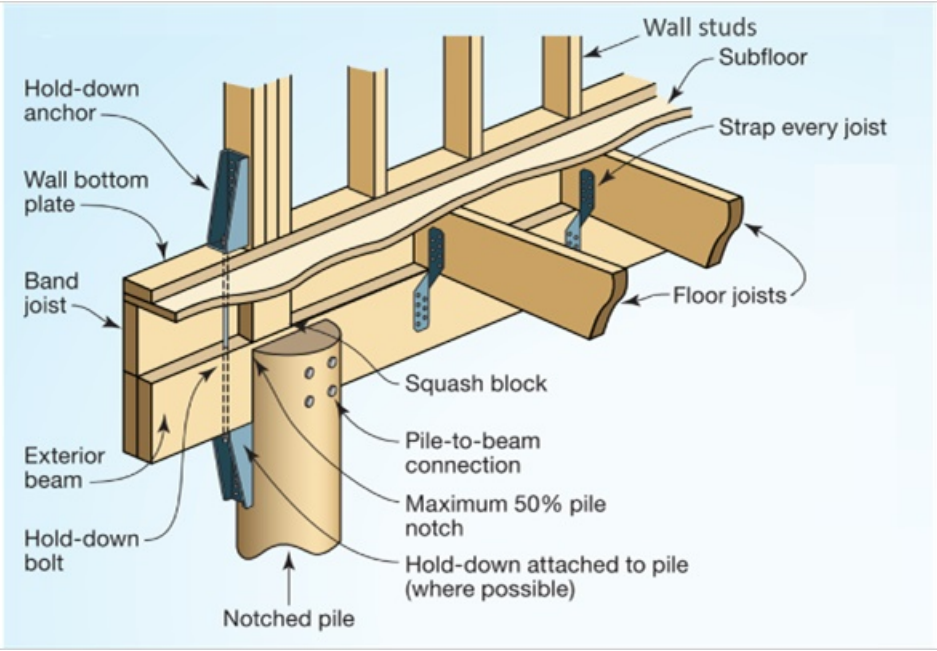
IRC (second) (Slide Layer)

No audio on this slide.

ASCE (Slide Layer)

No audio on this slide.

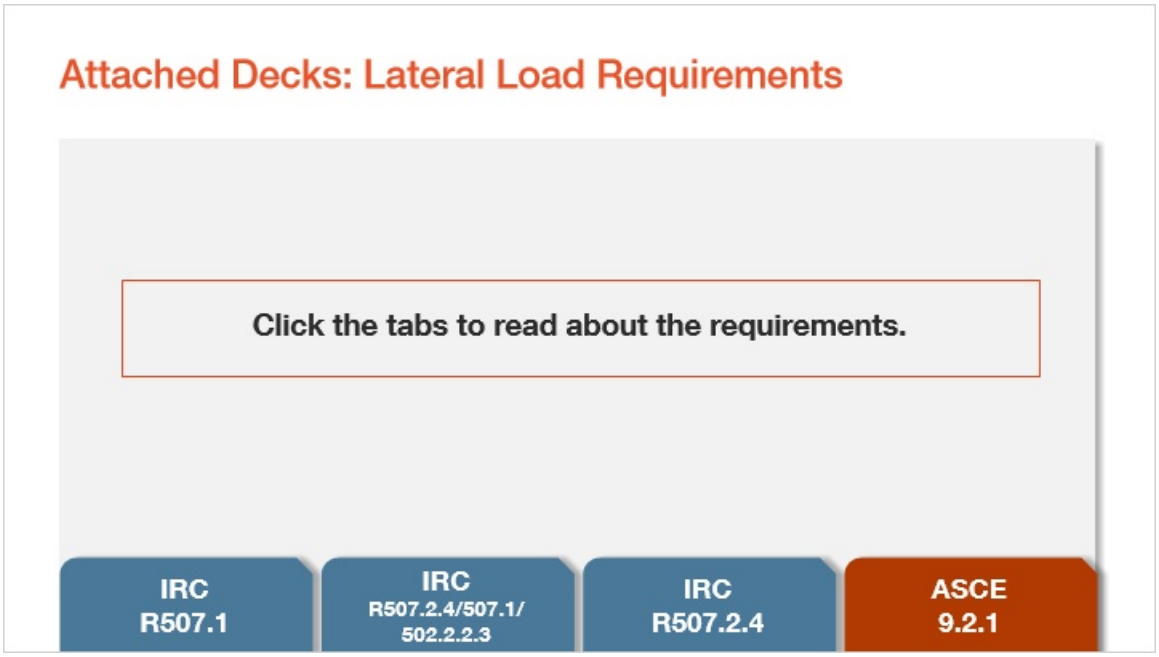
5.25 Beam-to-Joist Connections



Notes:

This is the FEMA improved connection system that was developed for elevated coastal residential buildings as a result of numerous failures during Superstorm Sandy. After reviewing the illustration, click *Next* to continue.

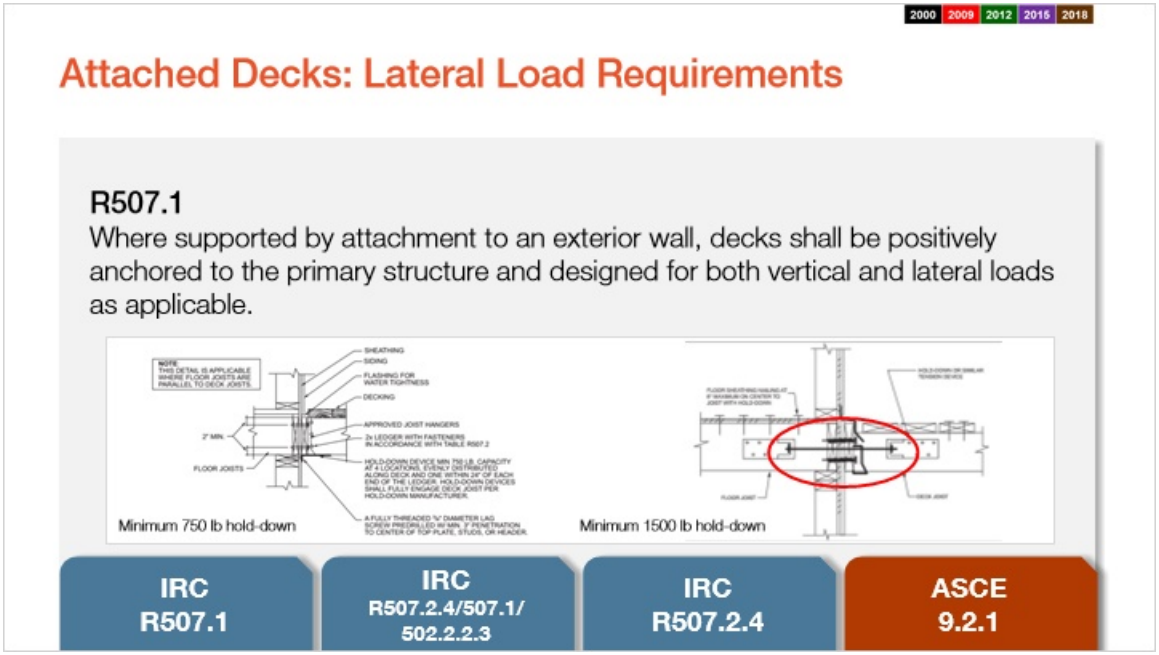
5.26 Attached Decks: Lateral Load Requirements



Notes:

Review the lateral load code requirements and click *Next* to move on.

IRC (first) (Slide Layer)



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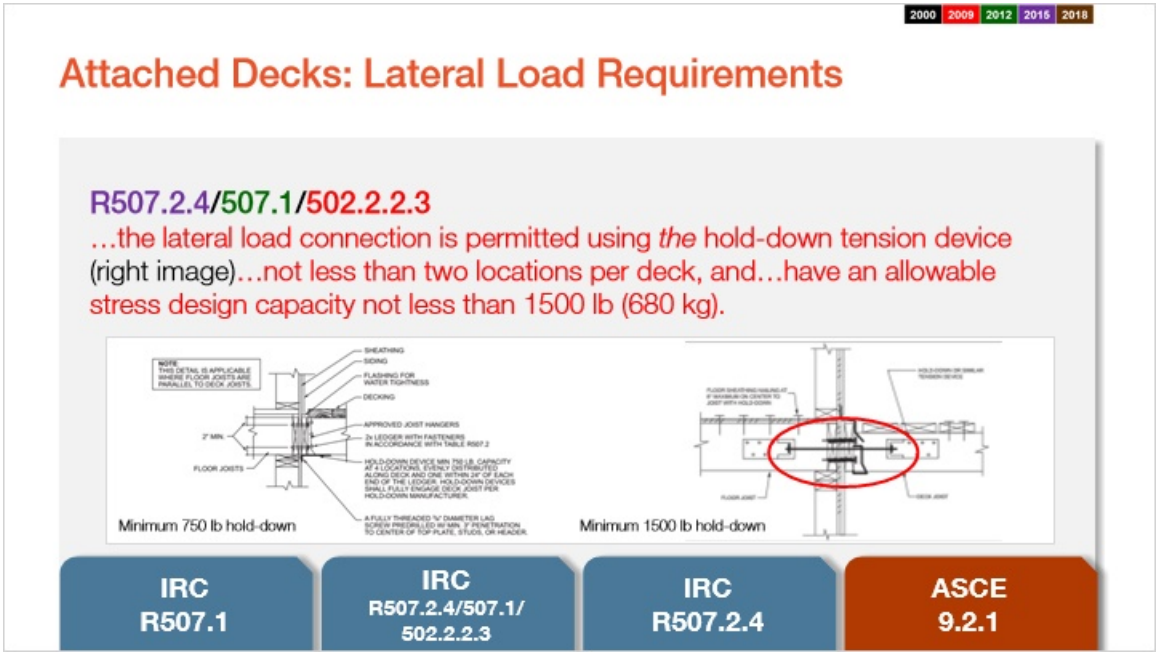
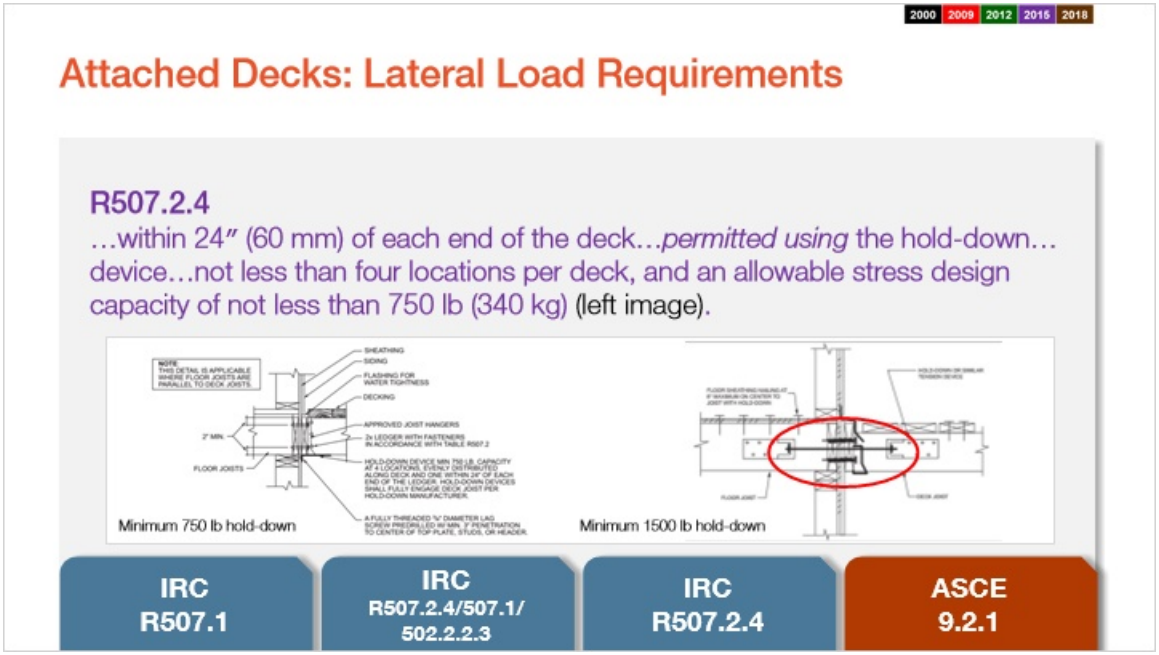
IRC (second) (Slide Layer)



No audio on this slide.

IRC (third) (Slide Layer)



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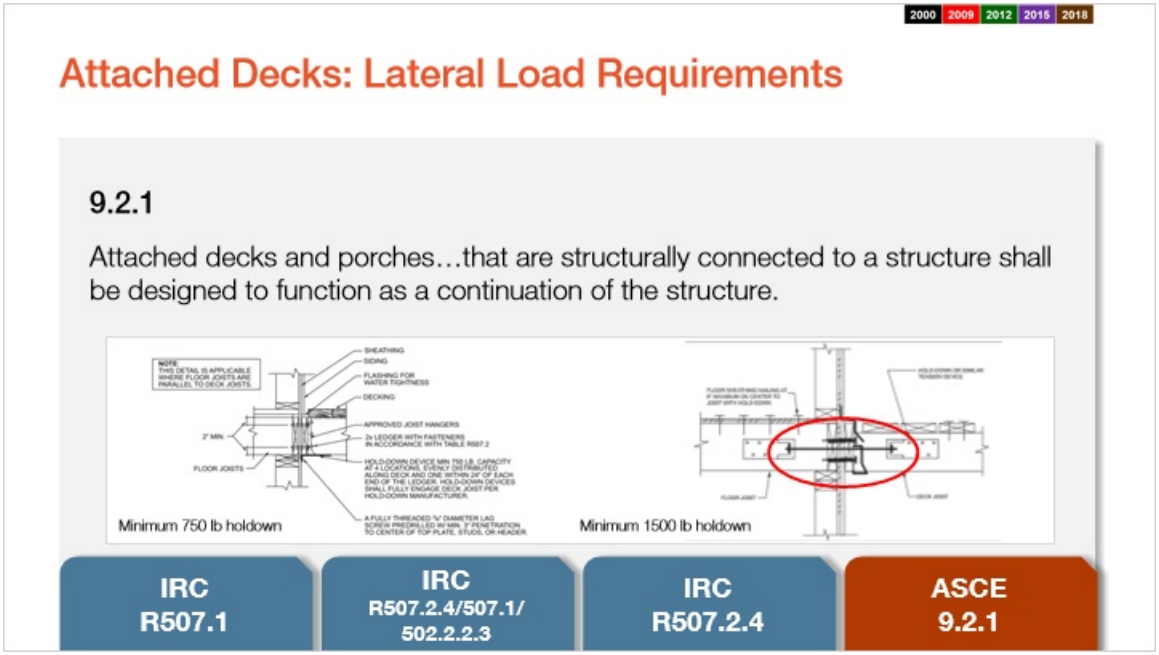
ASCE (Slide Layer)



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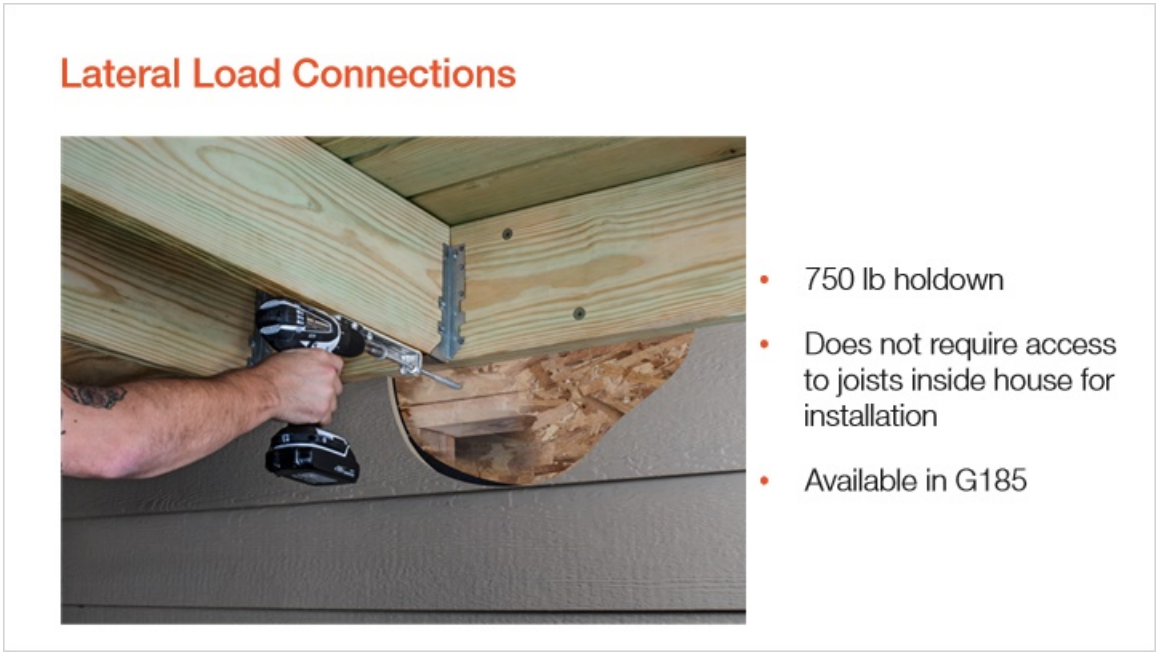
5.27 Lateral Load Connections

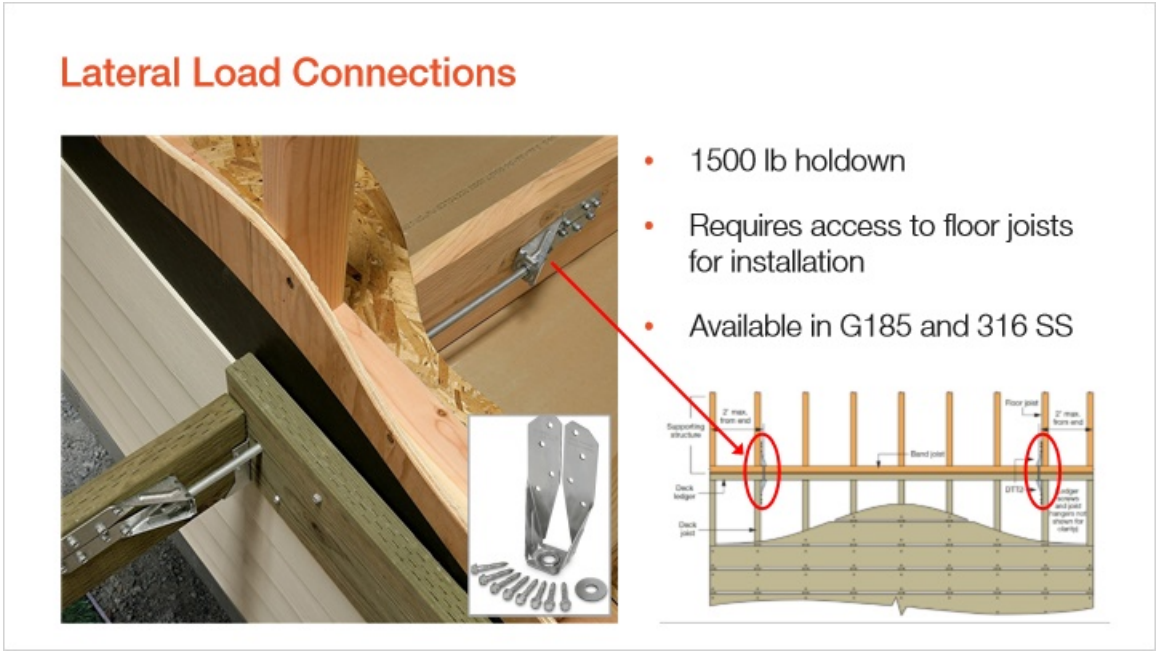


Notes:

Shown here is a 750 lb holdown. It does not require access to the joists inside the house for installation.

It is only available in G185 steel.

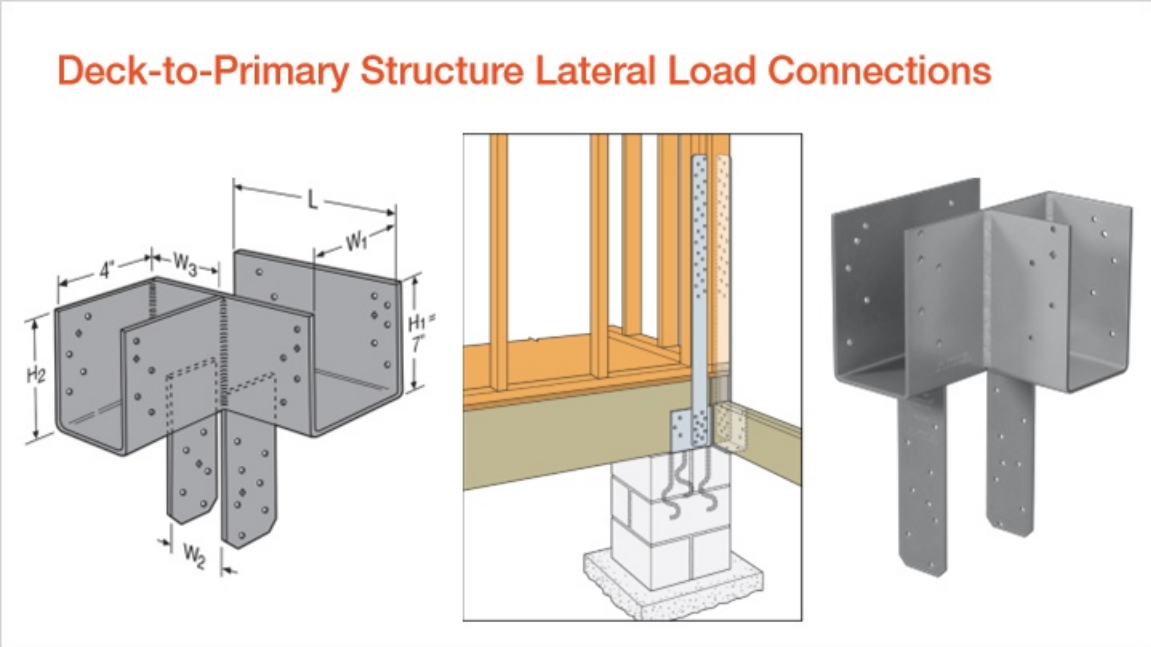
5.28 Lateral Load Connections



Notes:

Shown here is a 1500 pound holdown. It does require access to the floor joists for installation. It is available in G185 steel and 316 stainless steel.

5.29 Deck-to-Primary Structure Lateral Load Connections



Notes:

These connectors provide a positive connection from the deck to the primary structure. They are ideal when the home and deck are being built.

5.30 Attached Decks: Ledger Connection

Loading Condition	Nominal Ledger Size	Size (in.)	Model No.	Band Joist Material and Size	Maximum Deck Joist Span						
					Up to 6 ft.	Up to 8 ft.	Up to 10 ft.	Up to 12 ft.	Up to 14 ft.	Up to 16 ft.	Up to 18 ft.
					Maximum On-Center Spacing of Fasteners (in.)						
40 psf Live 10 psf Dead	2x	0.276 x 4		1" OSB	13	10	8	6	6	5	4
				1" LVL							
				1 1/8" OSB	18	14	11	9	8	7	6
				1 5/16" LVL							
				1 1/4" OSB							
				1 1/2" LVL							
				1 1/4" LSL							
				1 3/4" LVL							
				2x SP, DFL, SPF, HF	18	14	11	9	8	7	6

THDSS On-Center Spacing for 2x Deck Ledger Connection to Concrete Walls (40 psf Live Load, 10 psf Dead Load)

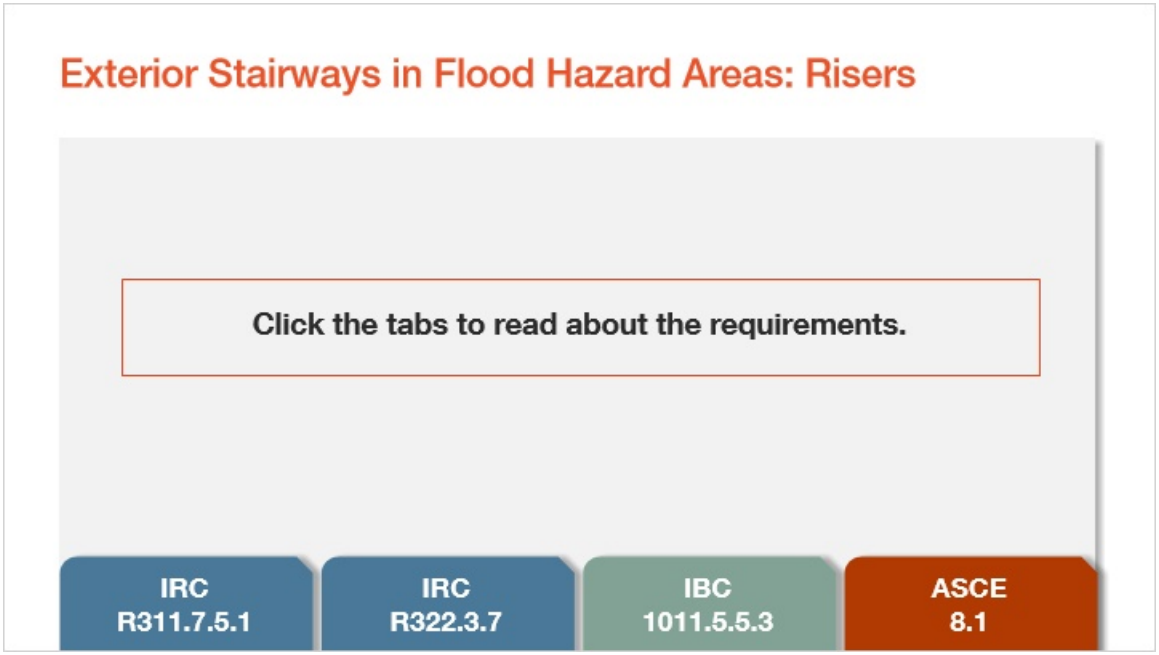
THDSS Model Number	Anchor Size (in.)	Min. Ledger Size	Deck Joist Span						
			Up to 6 ft.	Up to 8 ft.	Up to 10 ft.	Up to 12 ft.	Up to 14 ft.	Up to 16 ft.	Up to 18 ft.
			Maximum On-Center Spacing of Anchors (in.)						
Model 1	½x6	Single 2x8	36	36	34	29	24	21	19
Model 2	½x8	Double 2x8							

1. Sawn lumber ledger shall be minimum 2x8 Hem-Fir, Douglas Fir-Larch, or Southern Pine species.
2. Anchors shall be placed at least 2" from the top or bottom of the ledger, 4" from the end of the ledger with 3" min. between rows, 5" max. between rows and spaced per the table.
3. Multiple ledger plies shall be fastened together per code independent of the THDSS anchors.

Notes:

Please review the tables on ledger connections. When you are done, click *Next* to continue.

5.31 Exterior Stairways in Flood Hazard Areas: Risers



Notes:

The tabs reveal the code requirements for exterior stairways in flood hazard areas.

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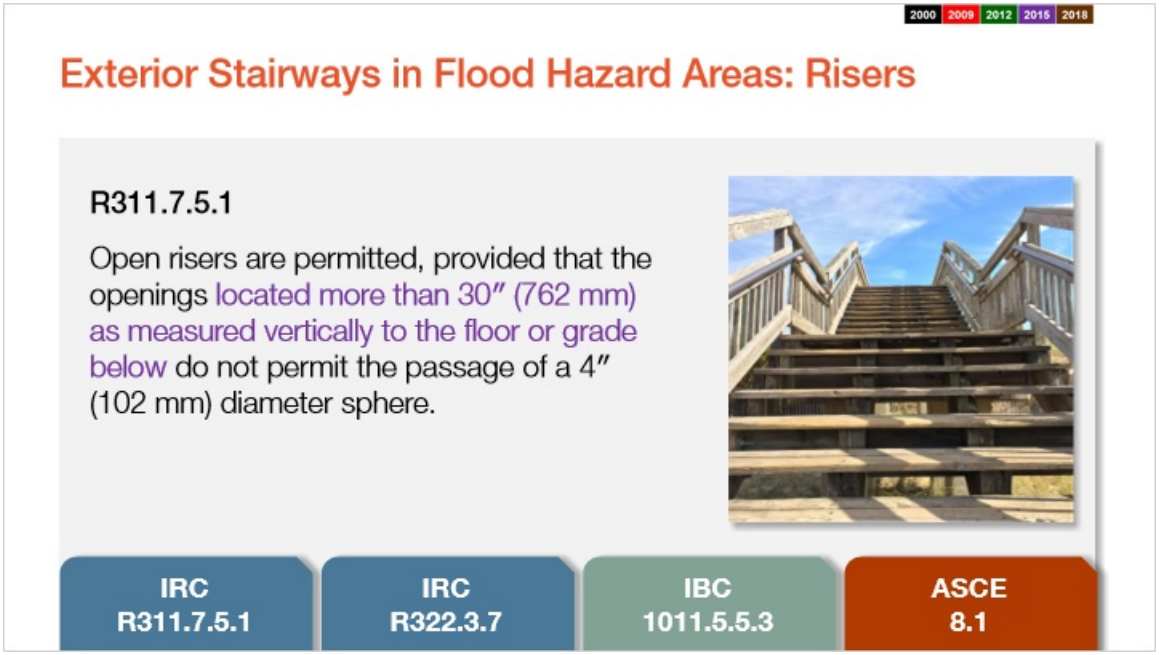

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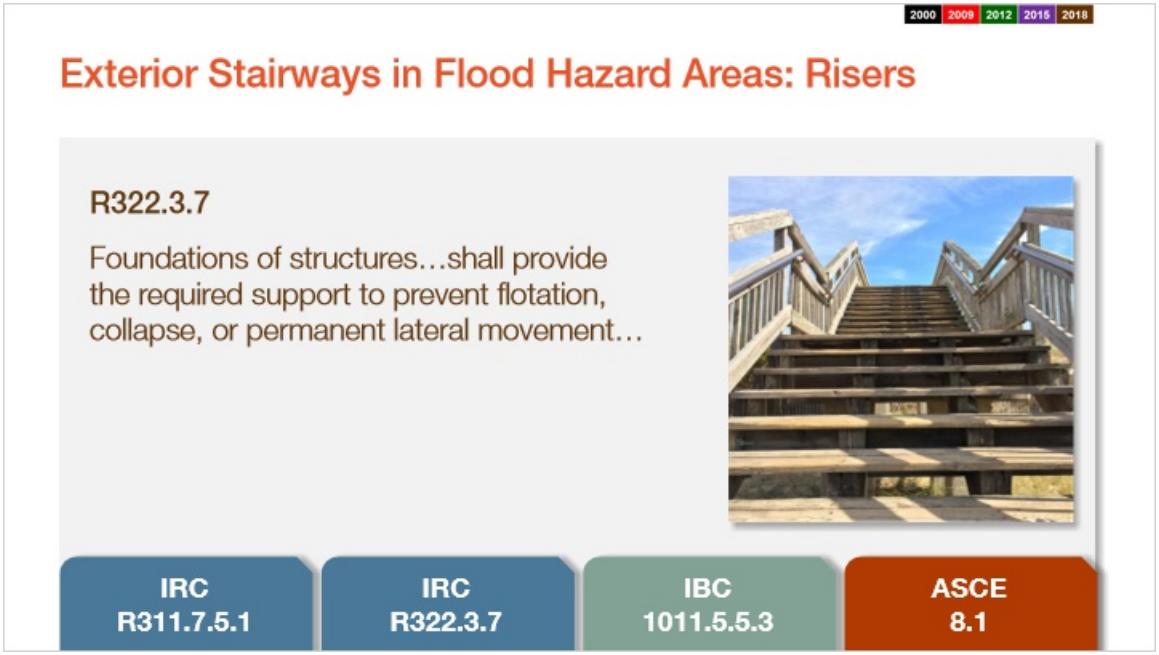

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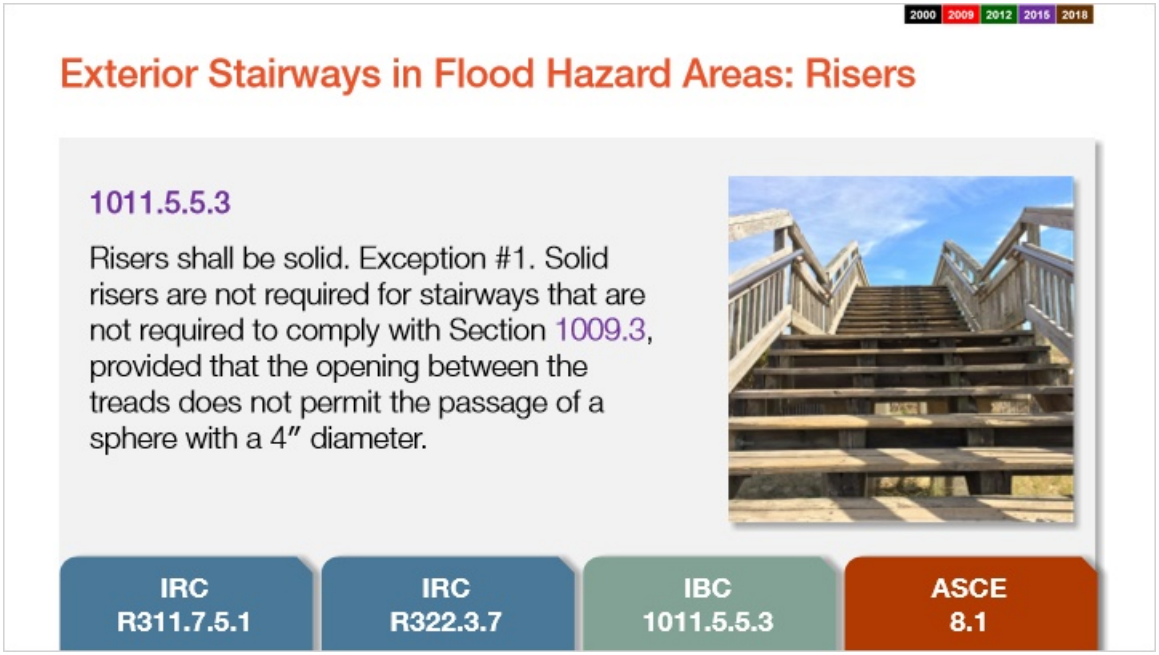

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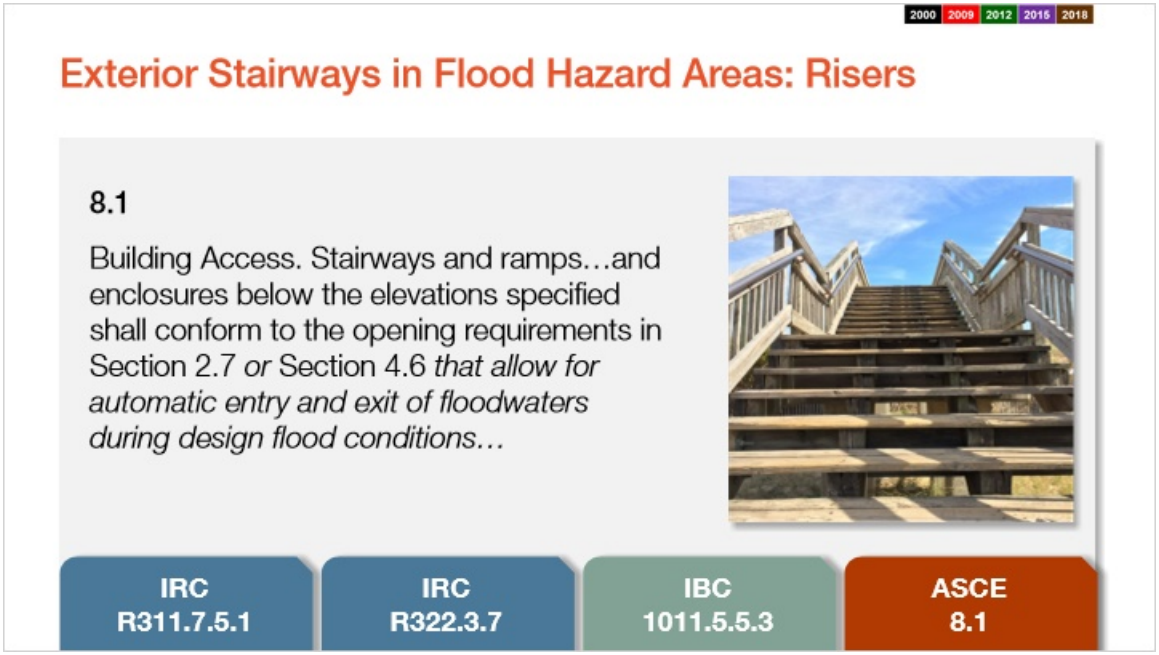

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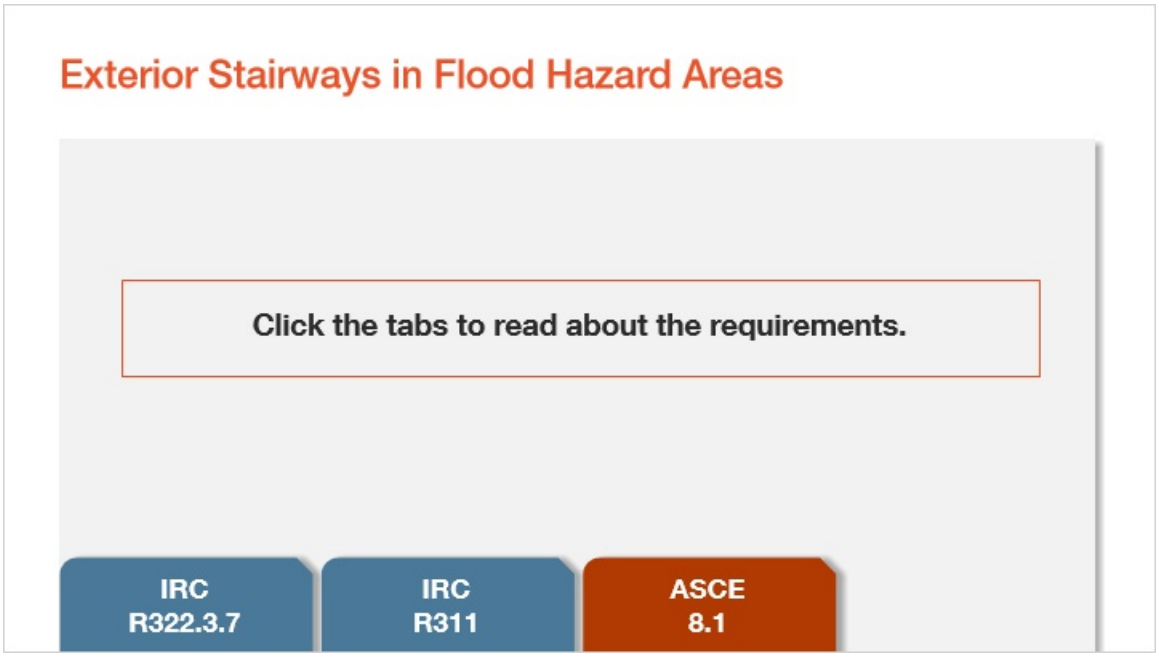
5.32 Exterior Stairways in Flood Hazard Areas: Riser Requirements

Notes:

Neither of these stairways complies with the requirements just mentioned. The left stairway has openings greater than 4” and the right one has closed risers. Risers must be open but not allow the passage of a 4” sphere.

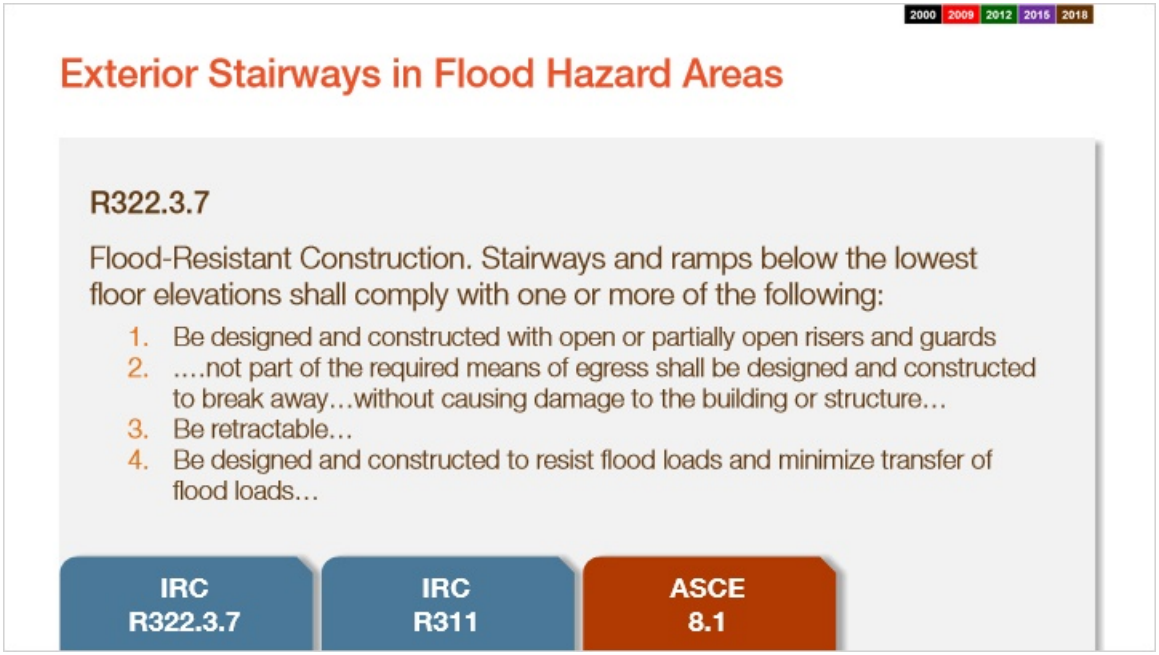
5.33 Exterior Stairways in Flood Hazard Areas



Notes:

Here's more exterior stairway code information to review.

IRC (first) (Slide Layer)



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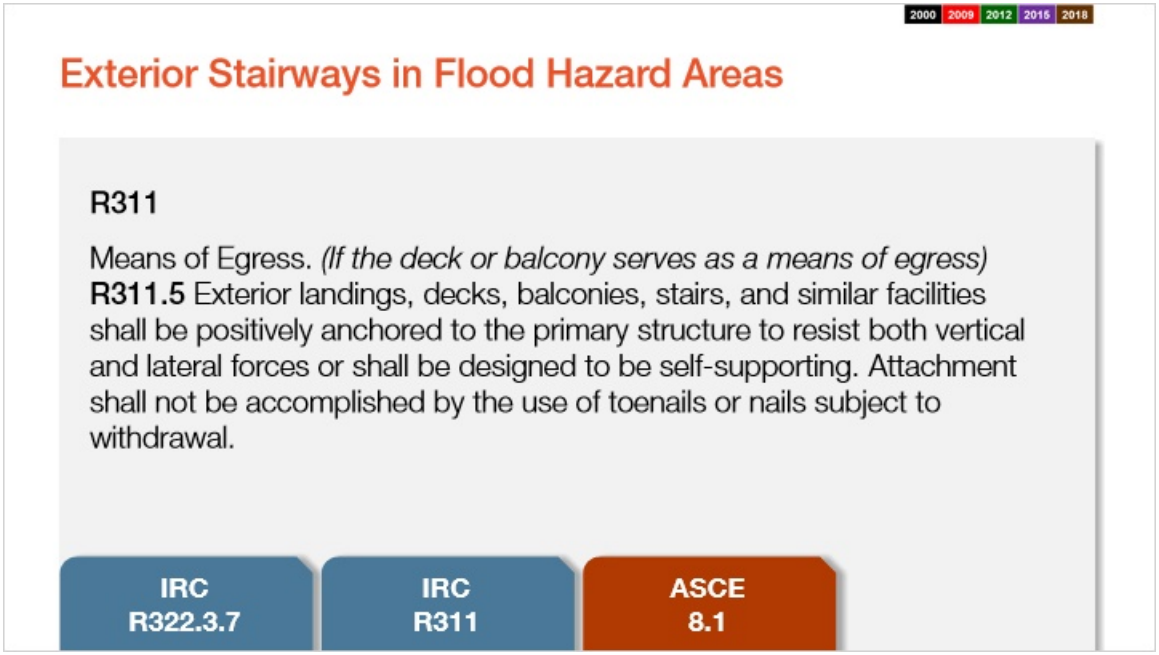

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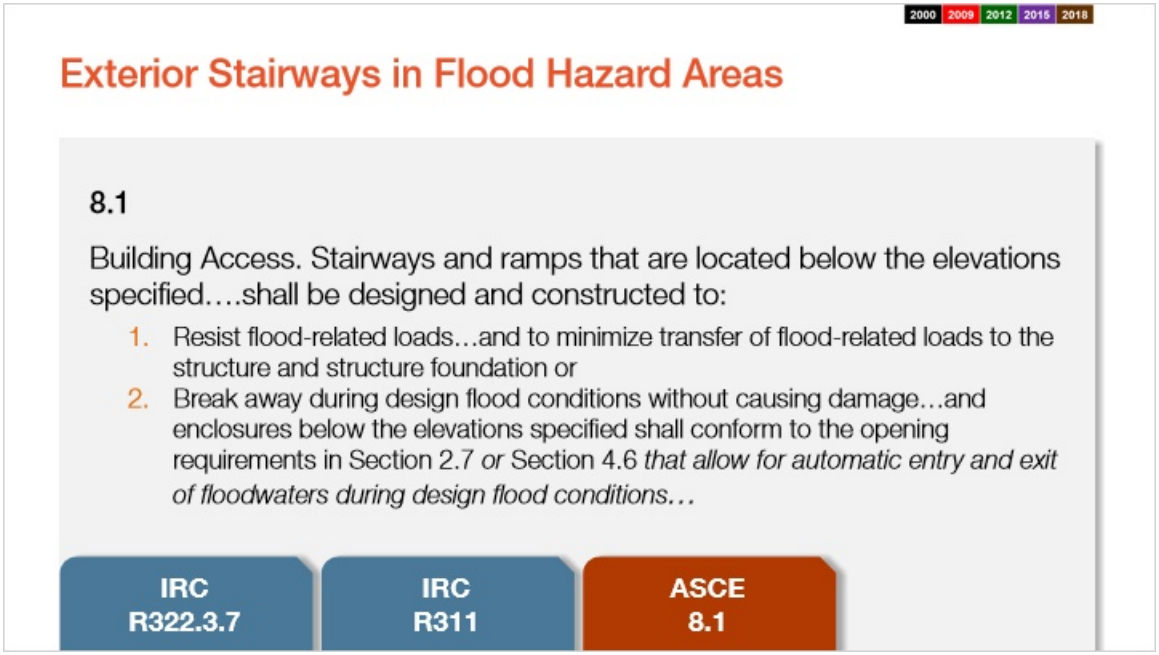

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5.34 Exterior Stairways in Flood Hazard Areas

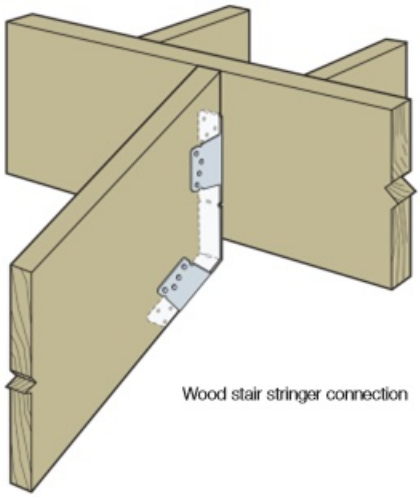
Exterior Stairways in Flood Hazard Areas

Is deck rim joist designed to carry stair live loads?

How is rim joist mounted to deck joist?

Is footing sized to handle additional stair loads?

If below DFE, do stairs require independent supports to minimize transfer of flood loads?



Wood stair stringer connection

Notes:

Designers should consider:

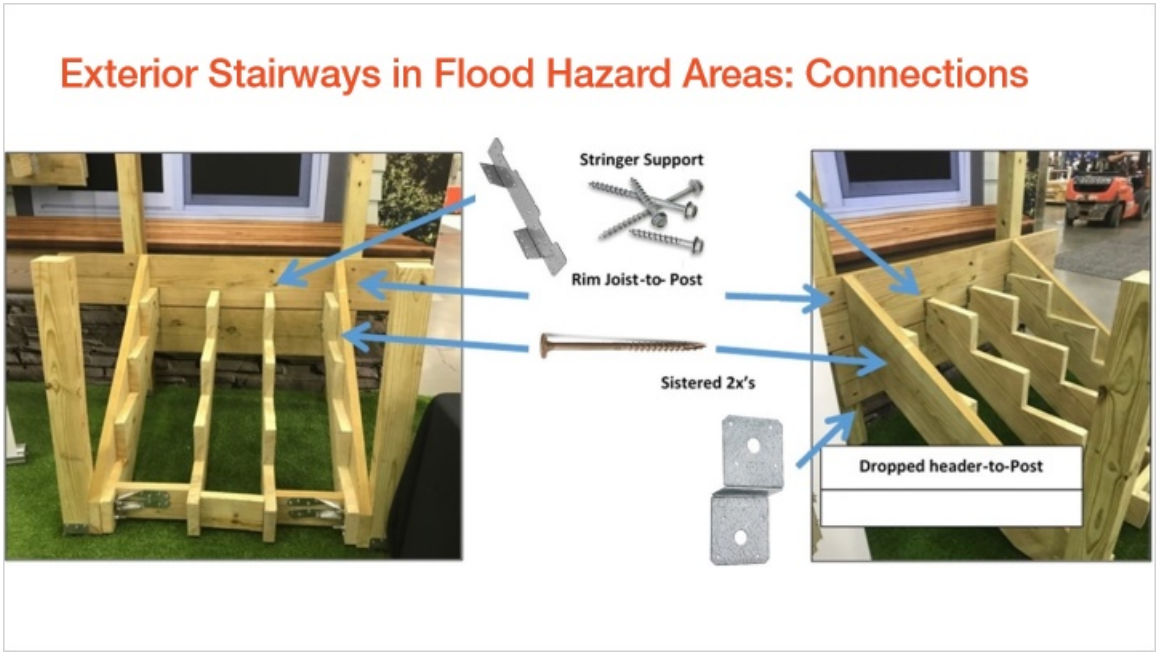
- whether the deck rim joist is designed to carry the live loads from the stairs
- how the rim joist is mounted to the deck joist (end-grain nails or screws)
- if the footing is sized to handle the additional stair loads, and
- if the stairs are below the DFE, whether they should be designed with independent supports to minimize transfer of flood loads.

5.35 Exterior Stairways in Flood Hazard Areas

Notes:

Use the stair stringer connector pictured here with an appropriate header where the first tread steps down.

5.36 Exterior Stairways in Flood Hazard Areas: Connections



Notes:

If you have concerns as to whether or not the stairs are designed to support the load properly in a flood hazard area, or if the stairs are required to be independent from the deck, then the pictures shown provide a method for building stairs with independent supports.

5.37 Review: Question 2

Notes:

Time for another review. Think about your answer then click *Next* to continue.

5.38 Review: Answer 2

Notes:

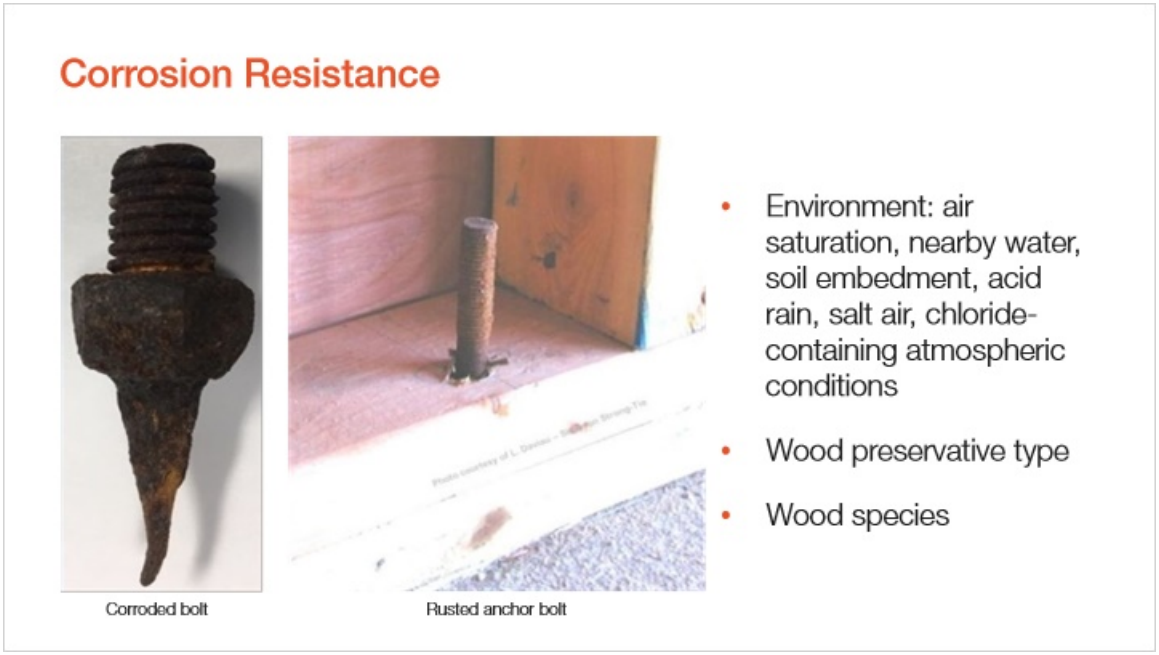
After reviewing the answer, click *Next* to continue.

6.1 Raised Foundations and Connections

Notes:

In this section of the course, we'll examine corrosion resistance.

6.2 Corrosion Resistance



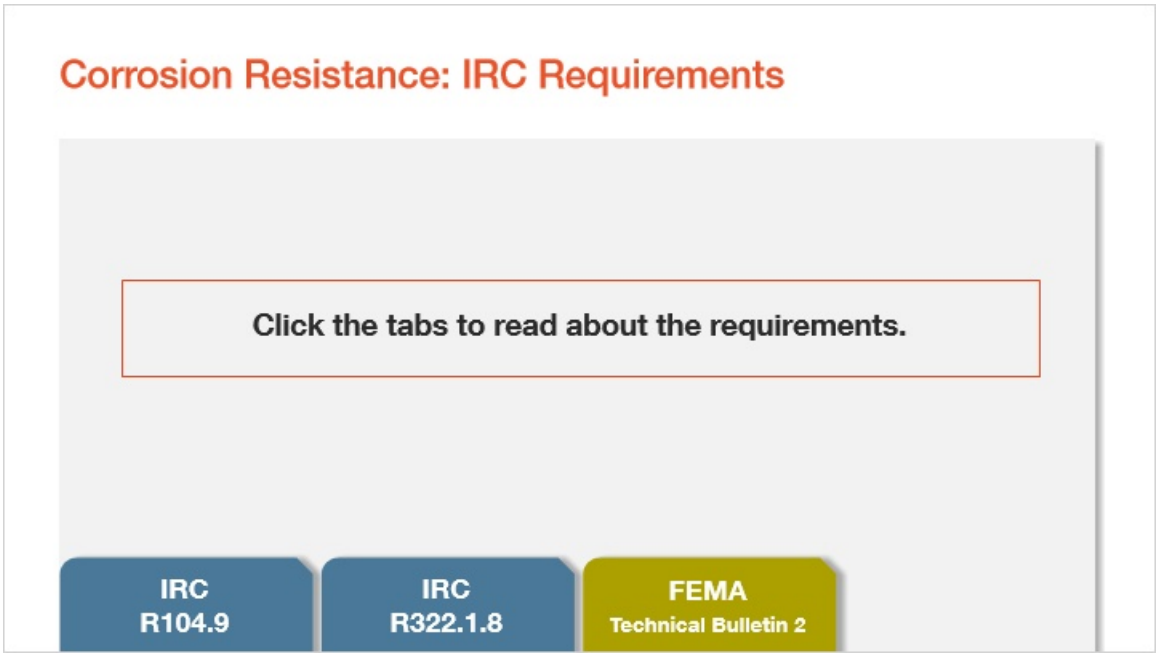
Notes:

Connectors, fasteners, and anchors need a level of corrosion resistance appropriate for the application.

It is important to consider:

- the environment/or exposure: For example: interior/exterior, industrial, air saturation levels, nearby large bodies of water, soil embedment, exposure to acid rain, and exposure to ocean salt air, spray, or mist or other chloride-containing atmospheric conditions
- Also consider the wood preservative type: some are more corrosive than others, and
- Think about wood species: Was an ammonia carrier used? (Douglas fir and wood with a high percentage of heartwood tend to be more acid).

6.3 Corrosion Resistance: IRC Requirements



Notes:

Review these corrosion resistance requirements and click Next to move on.

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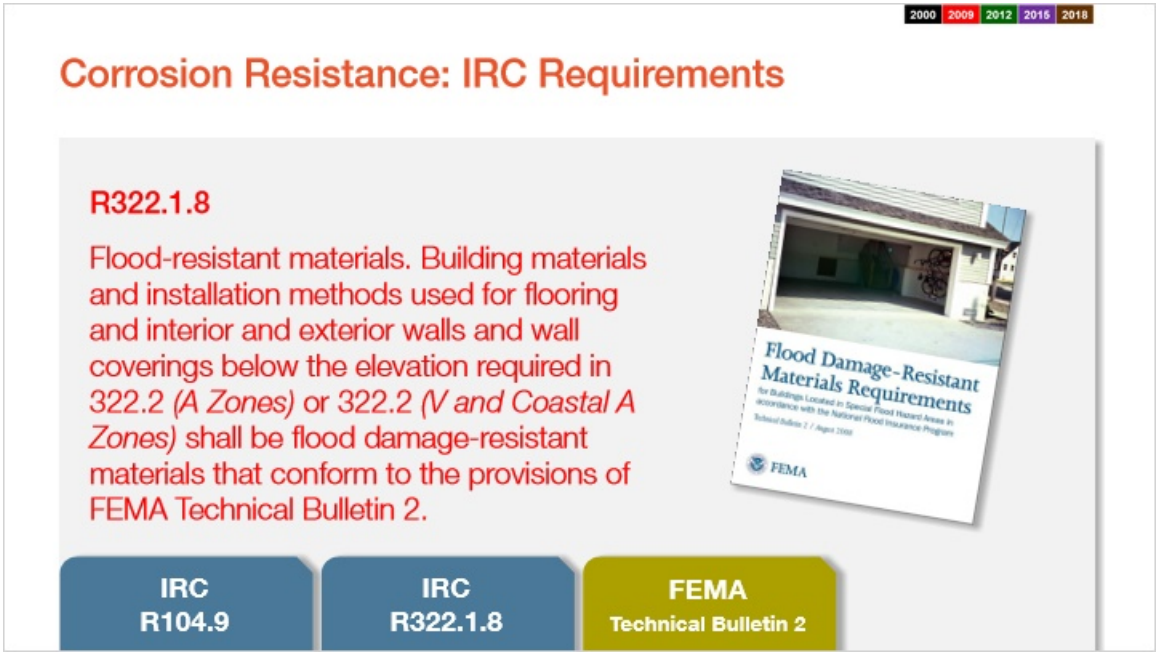
IRC (second) (Slide Layer)



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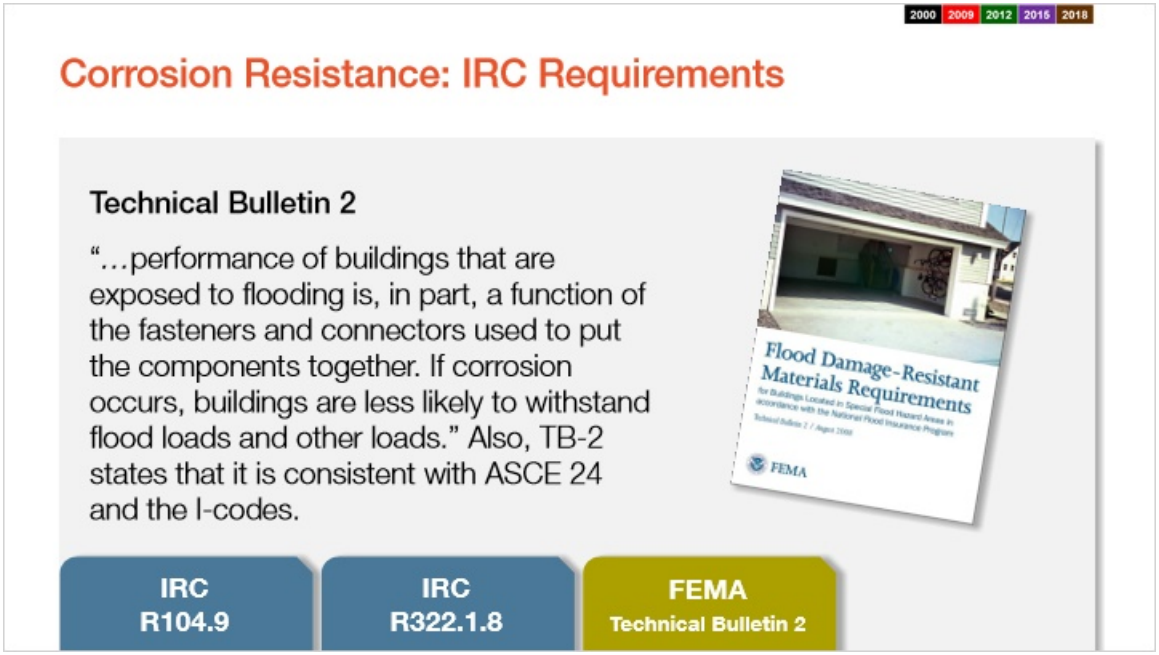
FEMA (Slide Layer)



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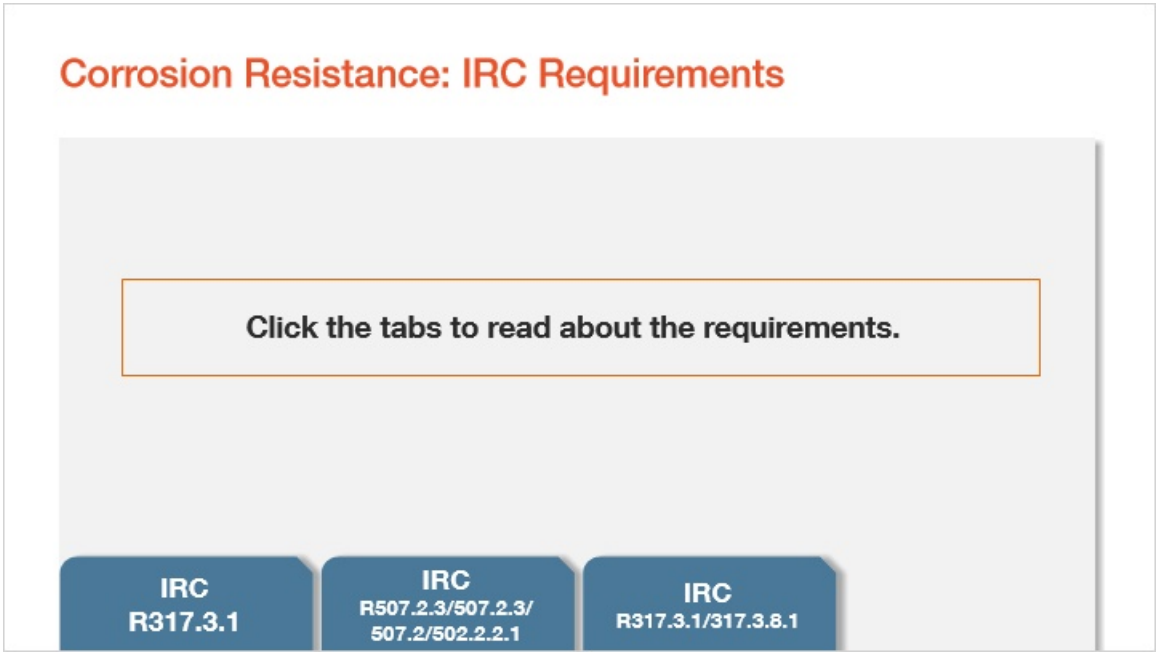
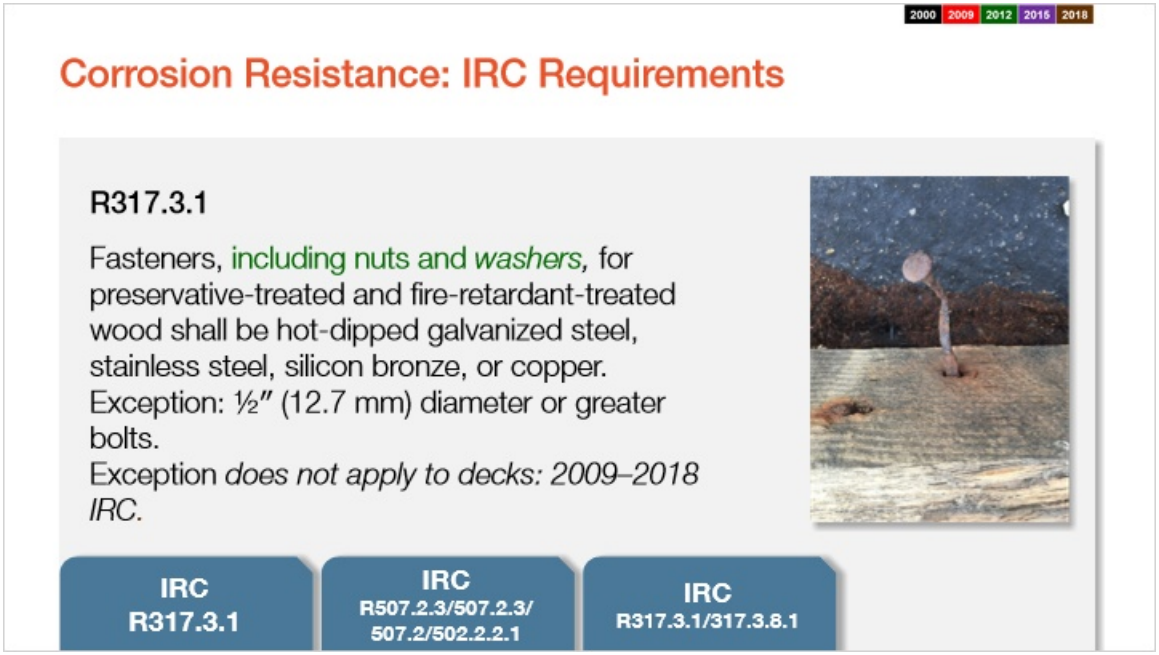
6.4 Corrosion Resistance: IRC Requirements



Notes:

More corrosion resistance requirements to review.

IRC (first) (Slide Layer)



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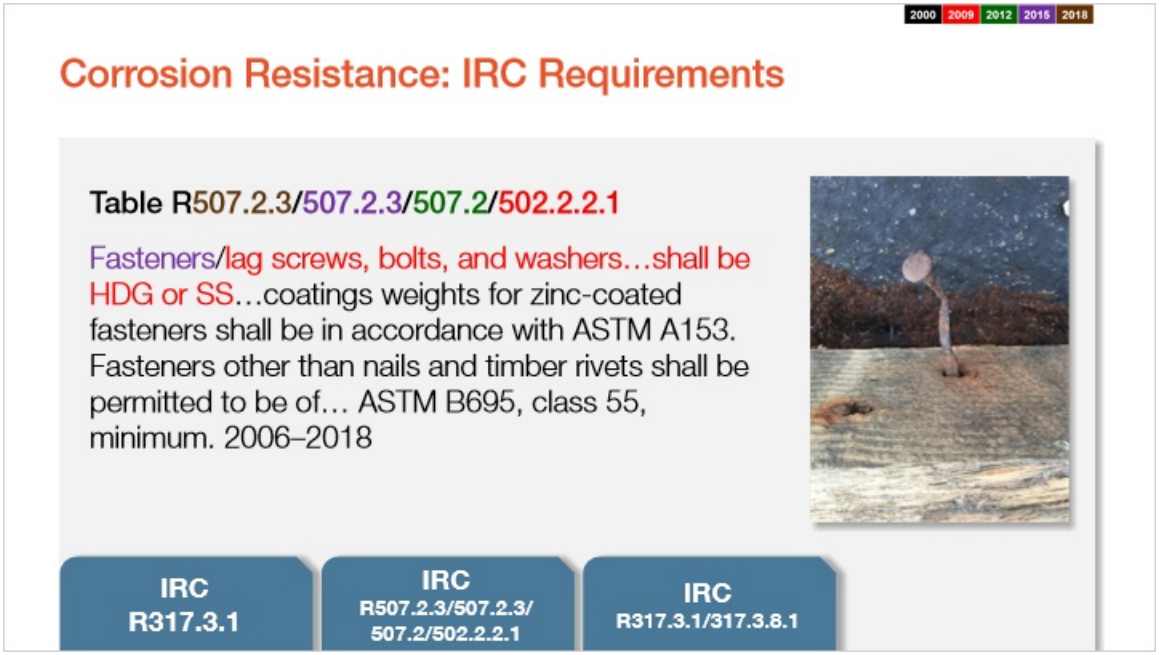

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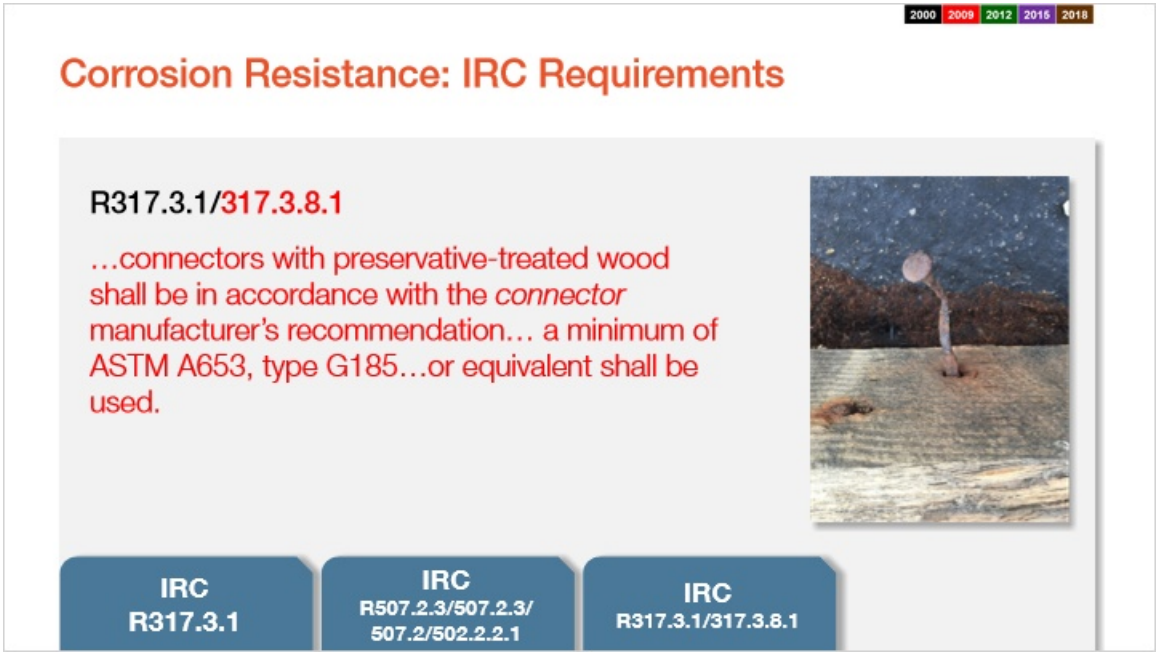
IRC (third) (Slide Layer)



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6.5 Corrosion Resistance: Manufacturer Recommendations

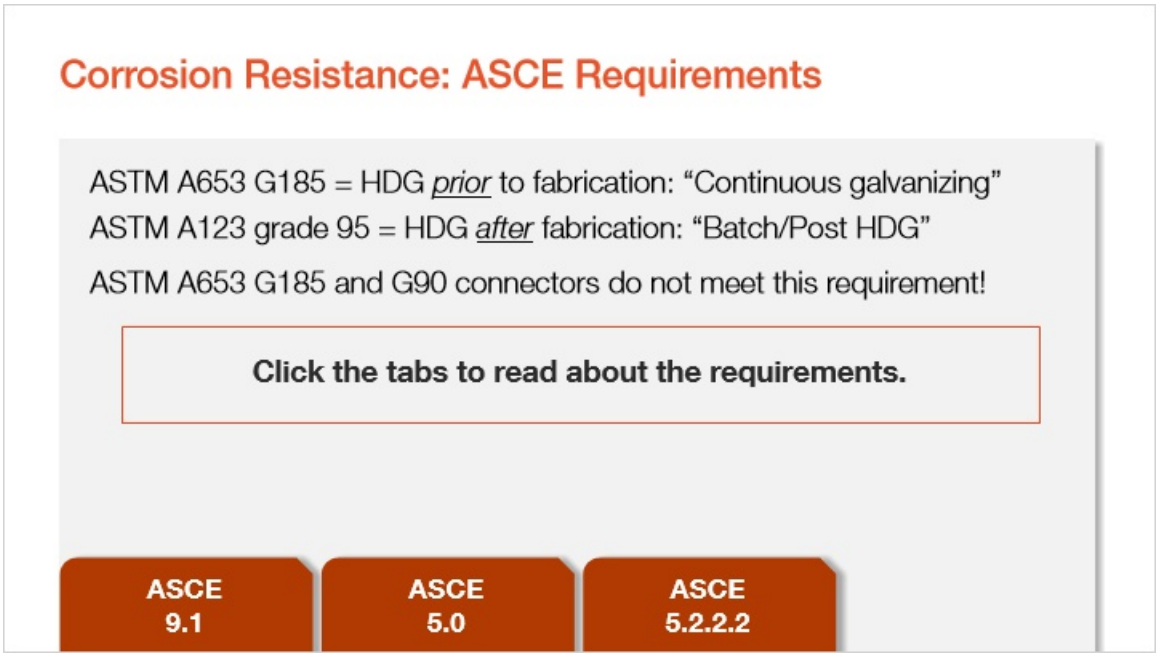
Notes:

It is recommended:

- To use stainless steel near large bodies of water, lakes for example, and in high humidity zones
- To use it with pressure-preservative-treated (PPT) wood greater than UC4A (which is lumber treated for ground contact)
- And to use it in acid rain/industrial zones

Use 316 stainless steel in ocean salt air, spray, or mist/chloride applications.

6.6 Corrosion Resistance: ASCE Requirements



Notes:

Note that ASTM A653 deals with G185, which is hot-dipped galvanized prior to fabrication, or continuous galvanizing, and ASTM A123 deals grade 95 HDG, which is hot-dipped galvanized after fabrication, or batch or post HDG. ASTM A653 G185 and G90 connectors do not meet this requirement, even though they are galvanized.

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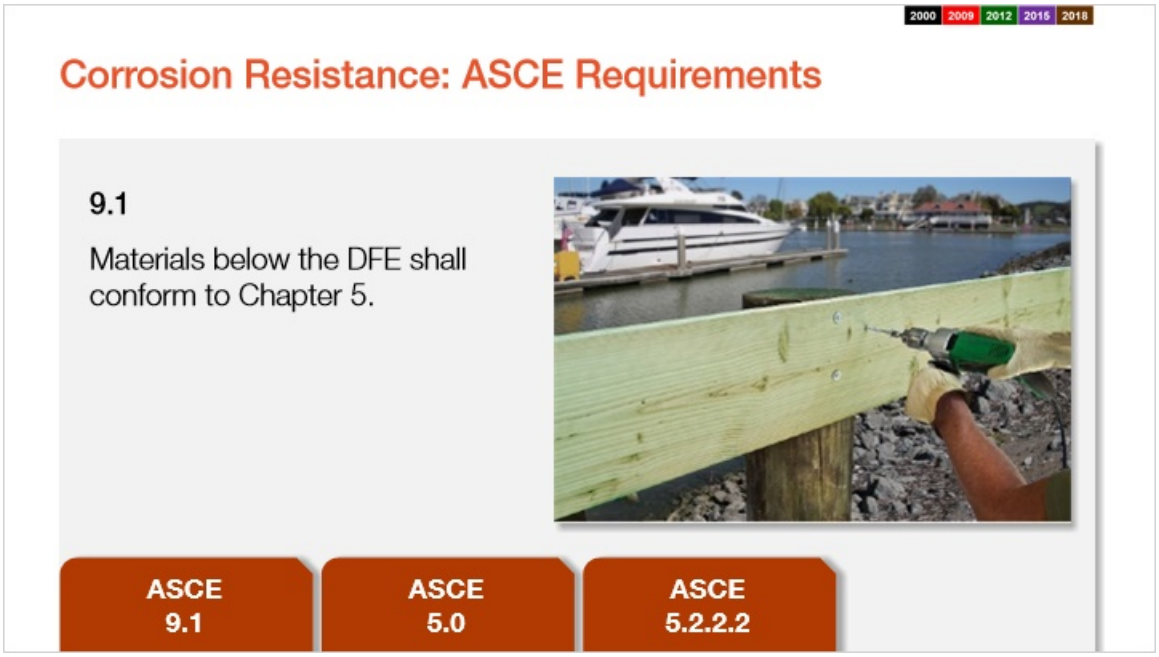

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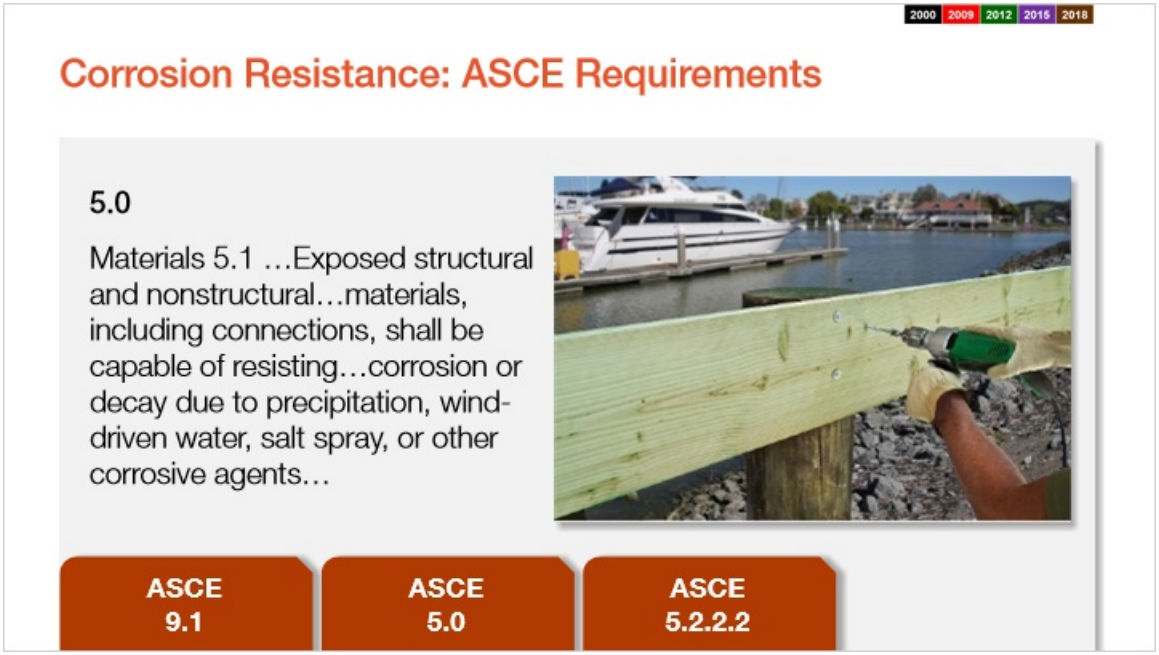

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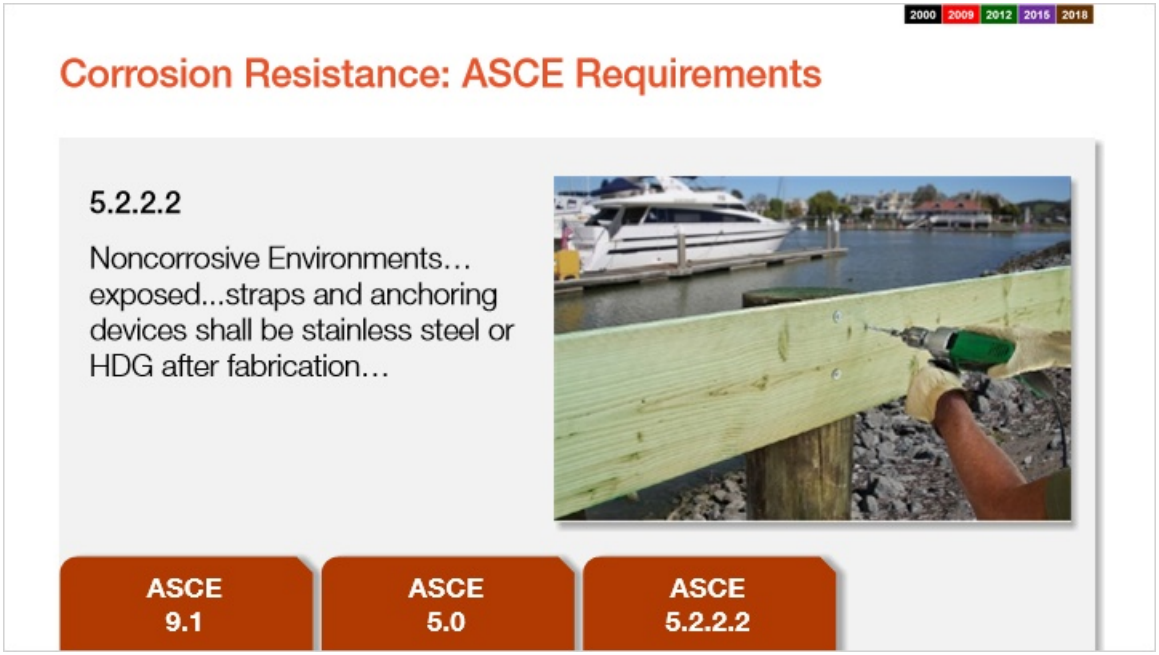

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6.7 Corrosion Resistance: ASCE Requirements

Notes:

Connectors with 100% pure zinc coating are galvanized before fabrication and are softer than the steel. The coating coverage around the edges and punched holes is minimal to none.

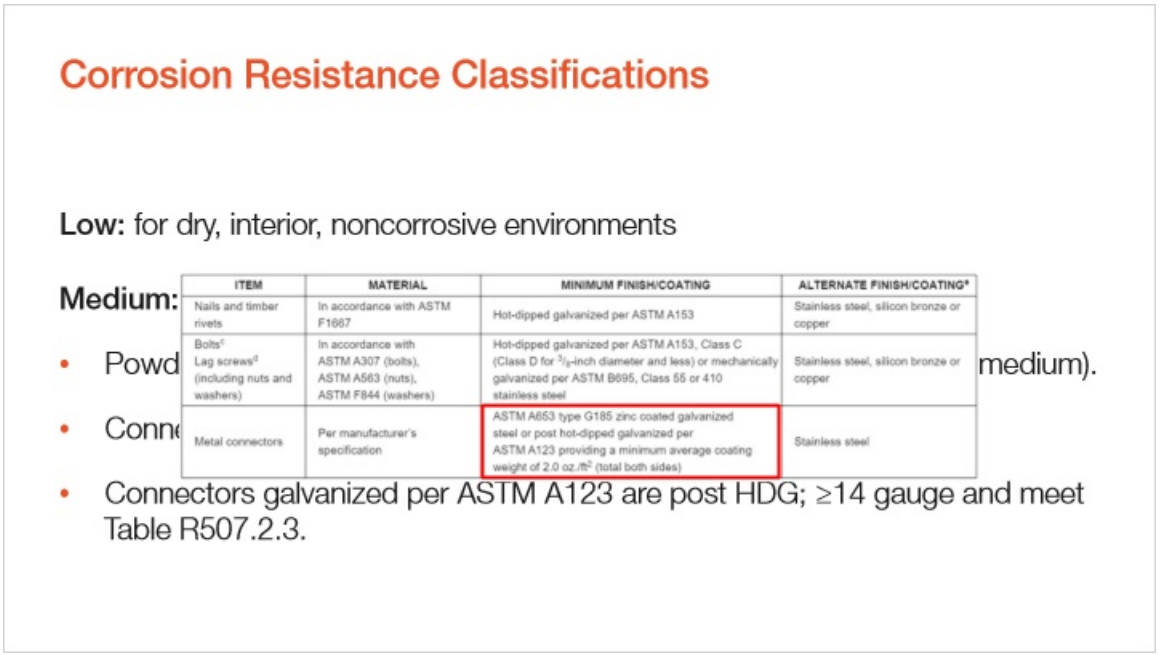
For HDG, or hot-dip galvanized after fabrication, the amount of zinc varies according to thickness of steel, but it must be ≥14 ga.

There are three zinc-iron alloy layers, all harder than the steel itself, plus a pure zinc layer. There is 100% coating coverage, including the edges.

Connectors must be batch/post HDG (ASTM A123, grade 95) or 316 stainless steel.

Fasteners and anchors must be HDG per ASTM A153, class C or stainless steel.

6.8 Corrosion Resistance Classifications



ITEM	MATERIAL	MINIMUM FINISH/COATING	ALTERNATE FINISH/COATING[a]
Nails and timber rivets	In accordance with ASTM F1667	Hot-dipped galvanized per ASTM A153	Stainless steel, silicon bronze or copper
Bolts[c] Lag screws[d] (including nuts and washers)	In accordance with ASTM A307 (bolts), ASTM A563 (nuts), ASTM F844 (washers)	Hot-dipped galvanized per ASTM A153, Class C (Class D for 3/8-inch diameter and less) or mechanically galvanized per ASTM B695, Class 55 or 410 stainless steel	Stainless steel, silicon bronze or copper
Metal connectors	Per manufacturer's specification	ASTM A653 type G185 zinc coated galvanized steel or post hot-dipped galvanized per ASTM A123 providing a minimum average coating weight of 2.0 oz./ft^2 (total both sides)	Stainless steel

Notes:

Corrosion resistance refers to the ease with which materials react with a given environment. Knowing the classifications and coating recommendations will aid in selecting the appropriate material.

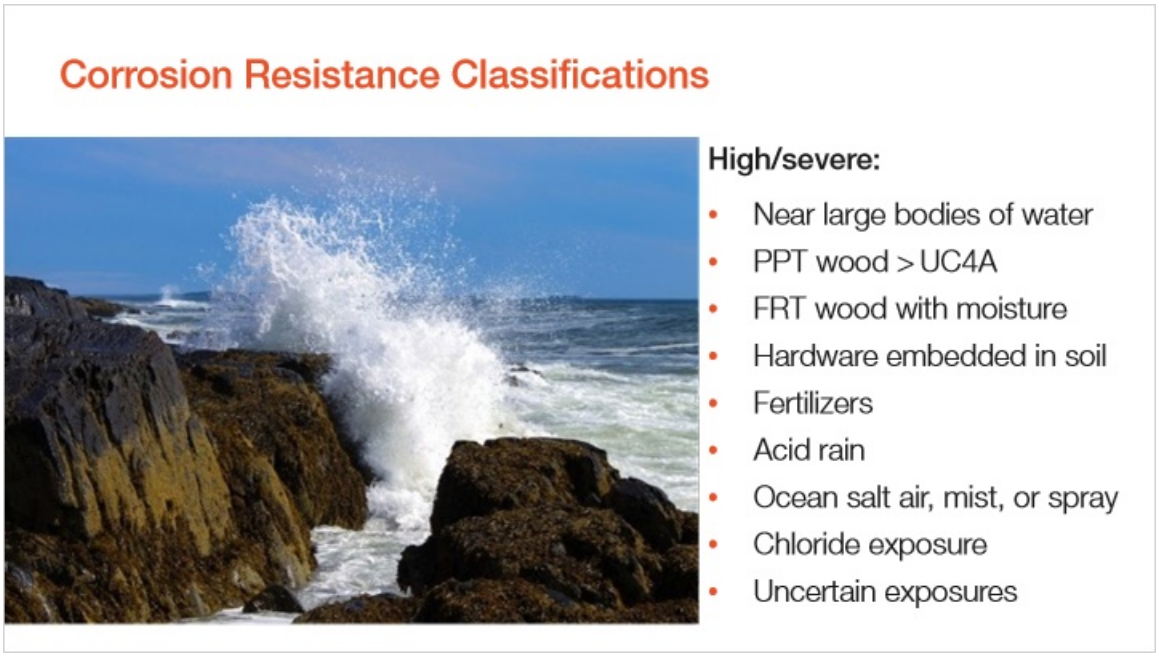
A coating rated for **Low** resistance is used in primarily dry, interior, noncorrosive environments and applications.

A coating rated for **Medium** resistance is used primarily when neither stainless steel nor a “low” level is recommended.

- Connectors with a powder coat over ASTM A653, G185 (outdoor accents for example), have the same level as ASTM A653, G185 (medium).
- Connectors hot-dip galvanized per ASTM A653 before fabrication.
- Connectors galvanized per ASTM A123 are post HDG; and must be ≥14 gauge and meet the requirements of Table R507.2.3.

Table **R507.2.3** indicates that if “post hot-dipped galvanized per ASTM A123…minimum coating weight of 2.0 oz./ft2 (total both sides).”

6.9 Corrosion Resistance Classifications



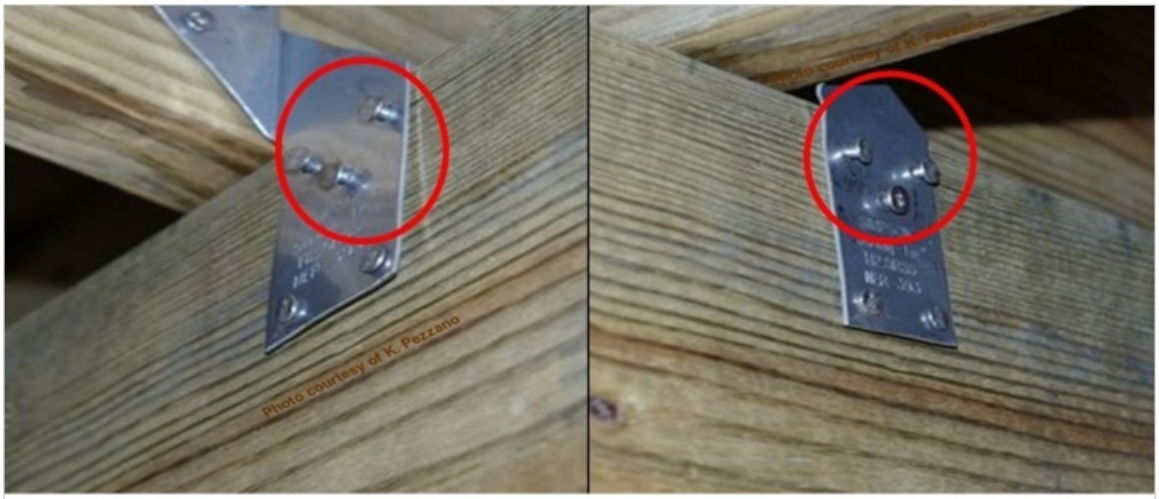
Notes:

The **High/severe** category includes a variety of exposures including:

- Near large bodies of water
- PPT wood > UC4A
- FRT (fire-retardant-treated) wood when moisture is present
- Hardware is embedded in soil
- Fertilizers
- Exposed to acid rain
- Exposed to ocean salt air, mist, or spray
- Other chloride exposure conditions
- Uncertain about the application or atmospheric exposure

Type 316 stainless steels are the best recommendation for ocean salt air and other chloride environments.

6.10 Stainless Steel Connectors and Fasteners



Average withdrawal strength of smooth-shank SS nails is 20% to 50% lower than smooth-shank carbon steel nails.

Notes:

Based on testing conducted by the Forest Products Laboratory, the average withdrawal strength of smooth-shank stainless steel nails is lower than smooth-shank carbon steel nails by 20% to 50%.

Due to moisture cycling (wet and dry cycles), smooth-shank stainless steel nails tend to withdraw from the wood more easily.

These images show smooth-shank stainless steel nails withdrawing from the wood only five months after installation.

6.11 Stainless Steel Connectors and Fasteners

Stainless Steel Connectors and Fasteners

Model No.	Ga.	Fasteners (in.)			DF/SP Allowable Loads			Uplift with 0.131" x 1½" Nails (160)	SPF/HF Allowable Loads			Uplift with 0.131" x 1½" Nails (160)	Code Ref.
		To Rafters/ Truss	To Plates	To Studs	Uplift	Lateral (160)			Uplift	Lateral (160)			
					(160)	F_1	F_2		(160)	F_1	F_2		
Model A	18	(6) 0.131 x 1½	(4) 0.131 x 2½	—	480	510	190	455	425	440	165	370	IBC, FL, LA
Model A in SS	18	(6) 0.131 x 1½	(4) 0.131 x 2½	—	350	335	195	330	300	290	150	260	—
Model B	18	(5) 0.131 x 1½	(2) 0.131 x 1½	(5) 0.131 x 1½	525	130	55	—	495	130	55	—	IBC, FL, LA
Model B in SS	18	(5) 0.131 x 1½	(2) 0.131 x 1½	(5) 0.131 x 1½	400	130	55	400	345	130	55	345	—

DF = Douglas Fir
SP = Southern Pine
SPF = Spruce-Pine-Fir
HF = Hemlock Fir

25% to 31% lower loads for stainless nails

Notes:

Testing of stainless-steel connectors with smooth-shank stainless steel nails showed an average of 25% to 31% lower loads for stainless nails.

Take a moment to review the table, then click *Next* to continue.

6.12 Stainless Steel Connectors and Fasteners

Stainless Steel Connectors and Fasteners

Hand Drive Common, Annular Ring Shank Nails

Shank Dia. x Length (in.)	Head Diameter (in.)	Carton Quantity	Model No.	Replacement for
0.131 x 1½	0.285	1,500		8d x 1½
0.131 x 2½	0.285	1,000		8d common
0.148 x 1½	0.285	1,500		10d x 1½
0.148 x 2½	0.285	1,000		10d x 2½

33° Paper Tape, Full Round Head, Ring Shank Structural-Connector Nails

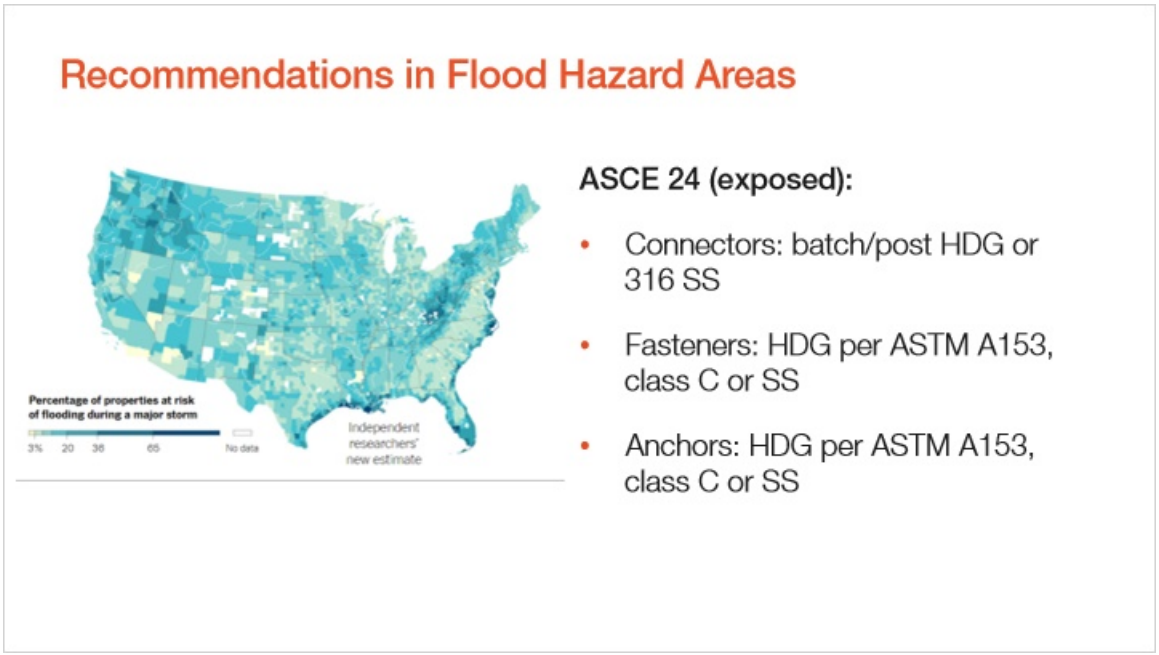
Diameter x Length (in.)	Gauge	Head Diameter (in.)	Approx. Count per lb	Retail Pack Count	Mini-Bulk Count
0.131 x 1½	10	0.28	150	150	750
0.131 x 2½	10	0.28	90	90	450
0.148 x 1½	9	0.31	120	120	600
0.148 x 3	9	0.31	50	50	250
0.162 x 3½	8	0.34	40	40	250

Notes:

The allowable loads of stainless-steel connectors match carbon steel connectors when installed with proprietary stainless steel, ring-shank nails.

After reviewing the tables, click *Next* to continue.

6.13 Recommendations in Flood Hazard Areas



Notes:

Manufacturers recommend:

- Connectors that are exposed should be batch/post HDG or 316 stainless steel
- Fasteners and anchors should be HDG per ASTM A153, Class C or stainless steel

For exposed materials, ASCE 24 recommends:

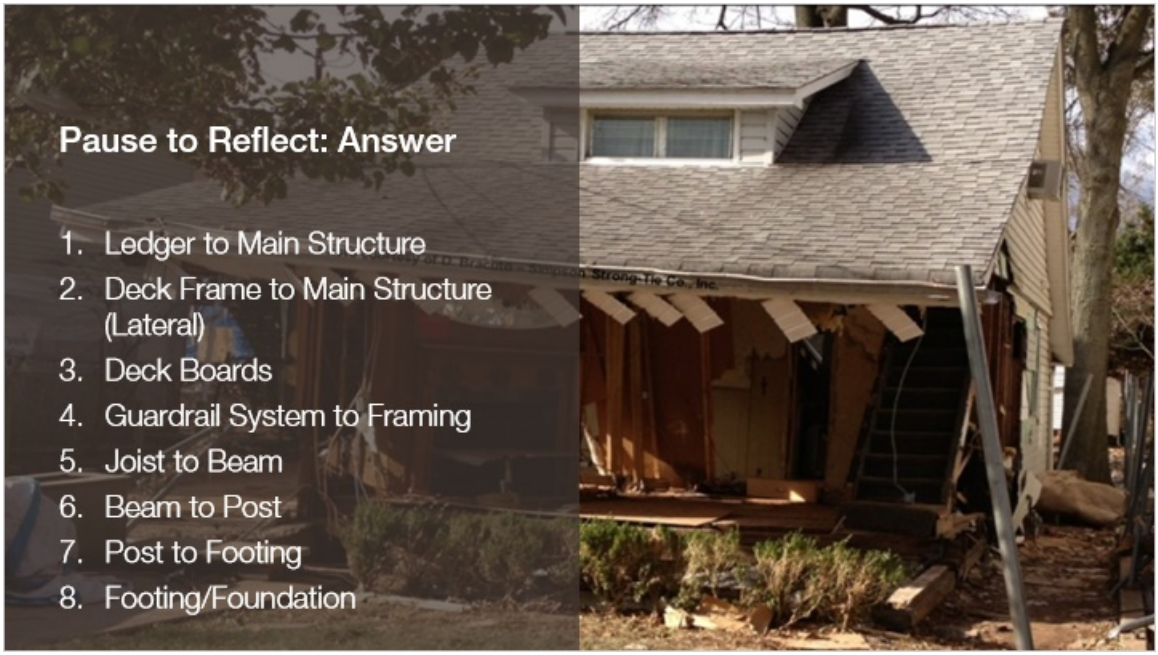
- Connectors should be batch/post HDG or 316 stainless steel
- Fasteners should be HDG per ASTM A153, class C or stainless steel, and
- Anchors should be HDG per ASTM A153, class C or stainless steel

6.14 Review: Question 3

Notes:

Time for a final review. Think about your answer, then click *Next* to continue.

6.15 Review: Answer 3



Notes:

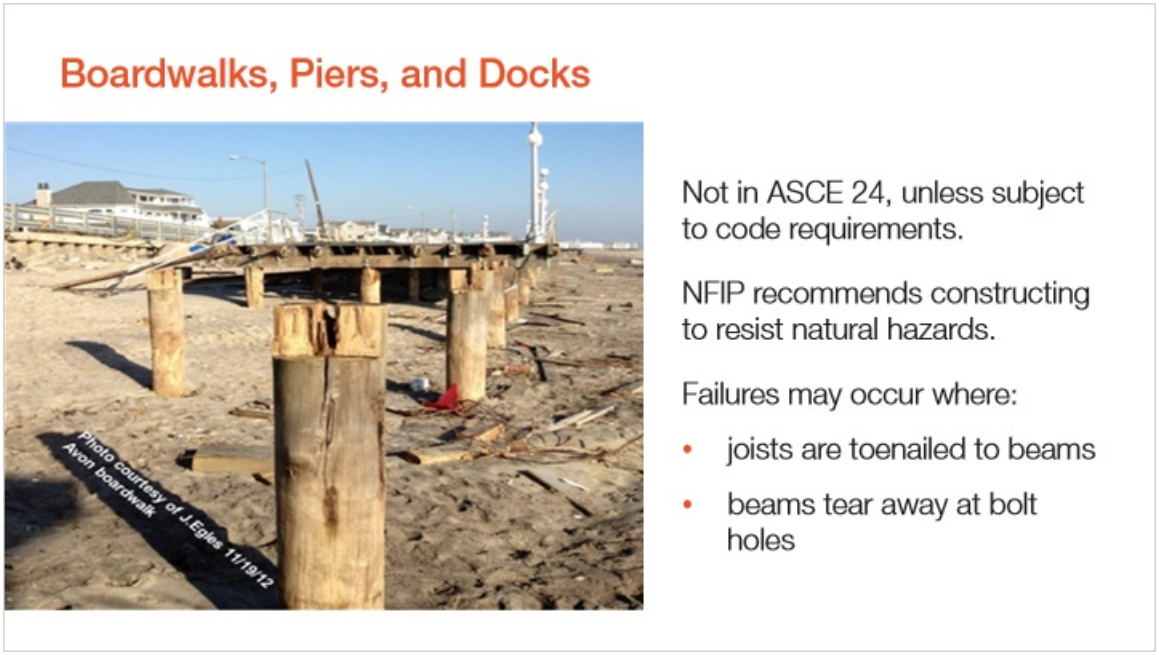
Review the answer, then click *Next* to continue.

7.1 Boardwalk Construction in Flood Hazard Areas

Notes:

And finally, we will address boardwalk construction in flood hazard areas.

7.2 Boardwalks, Piers, and Docks

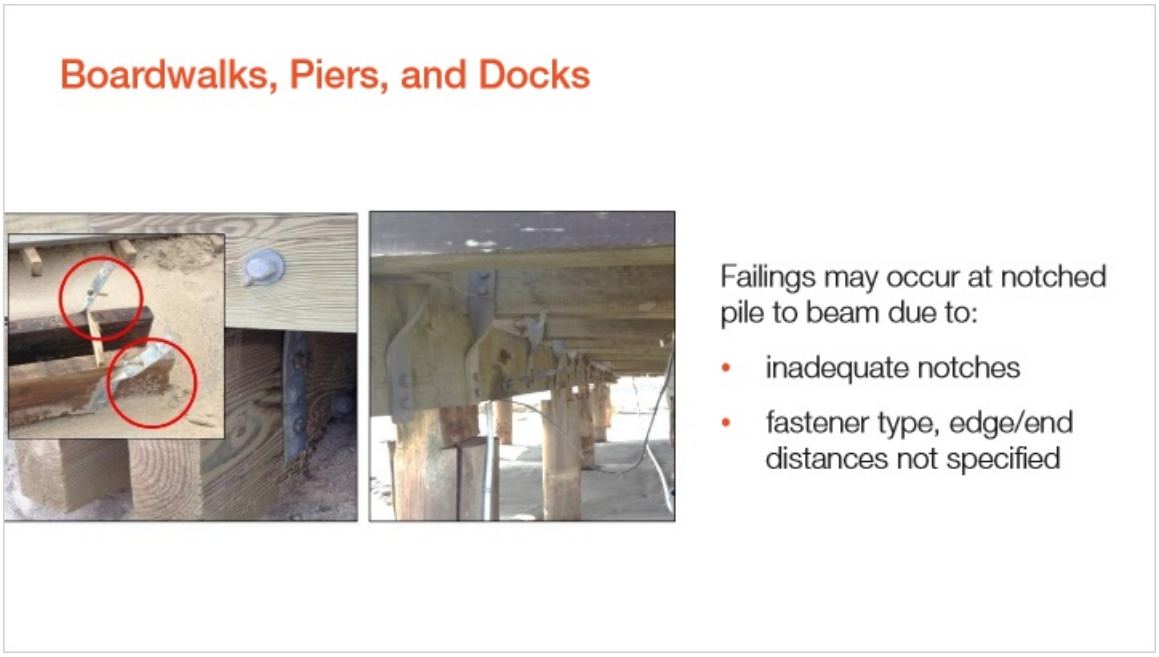


Notes:

Although the requirements for boardwalks and accessory structures are not in ASCE 24, unless the structure is subject to code requirements (Section 1.1), the NFIP recommends that constructing to resist natural hazards, including floods, reduces the need to rebuild and is considered a sustainable design approach.

Failures frequently occur where the joists are toenailed to the beams or the beams tear away from the pilings at the bolt holes.

7.3 Boardwalks, Piers, and Docks

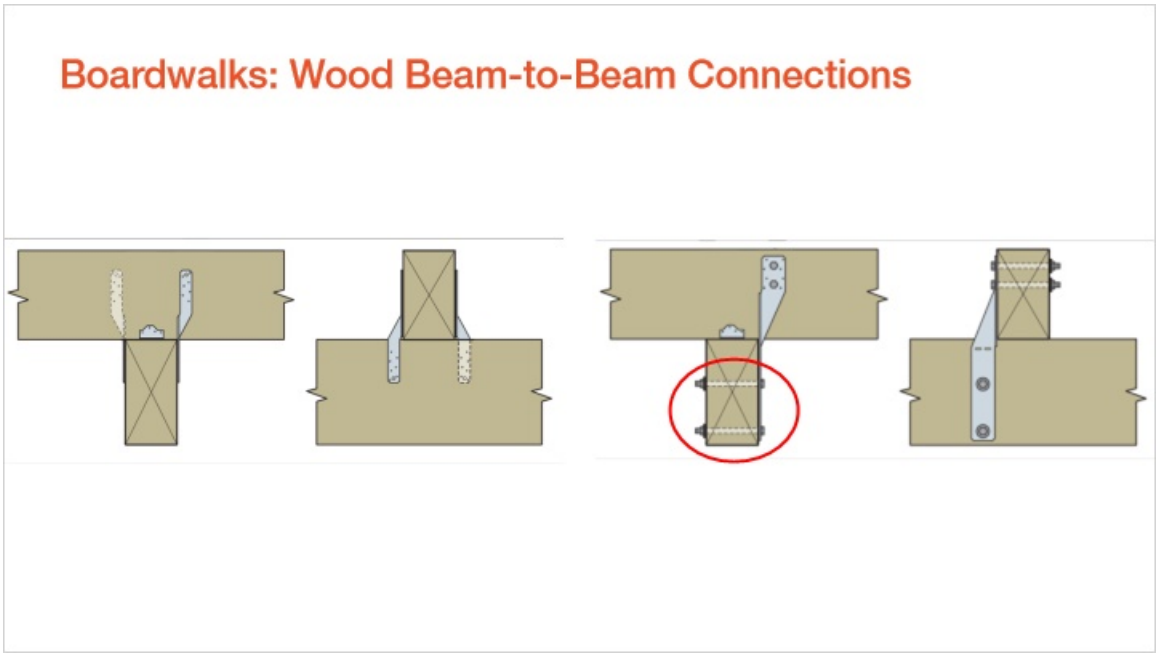


Notes:

Failings also frequently occur at the weakest connection, the notched pile to the beam.

When the fasteners fail, it is usually because they are inadequate, and the fastener type and edge and end distances are not specified.

7.4 Boardwalks: Wood Beam-to-Beam Connections

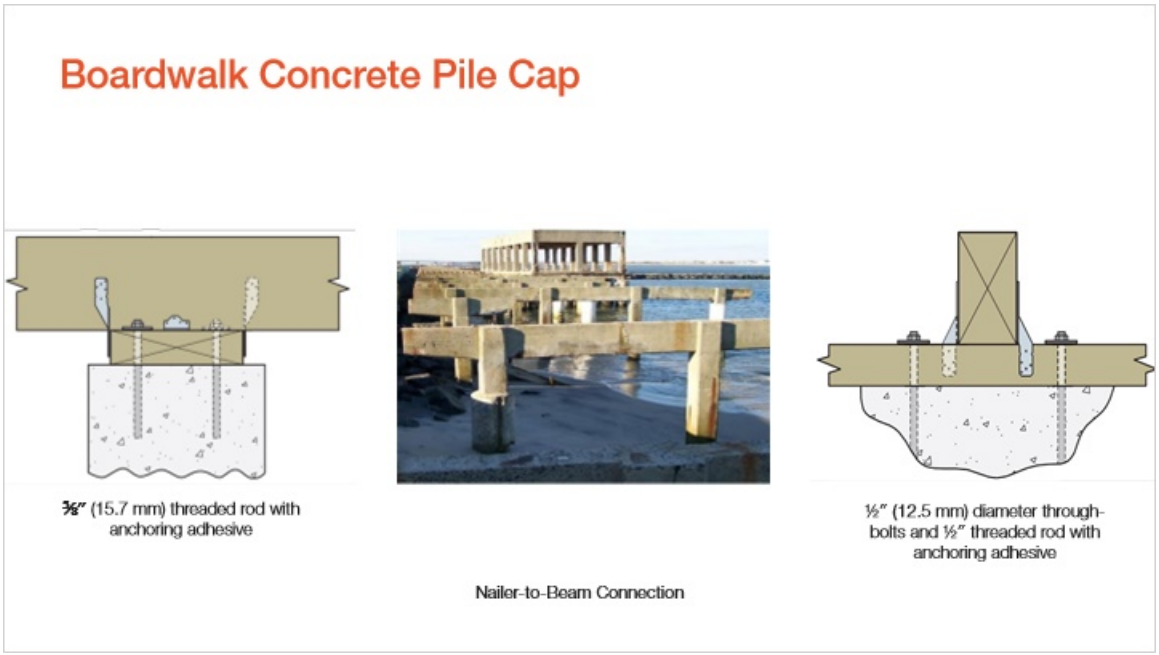


Notes:

These graphics illustrate how beam-to-beam connections should be made.

Note the use of through-bolts in this connection type.

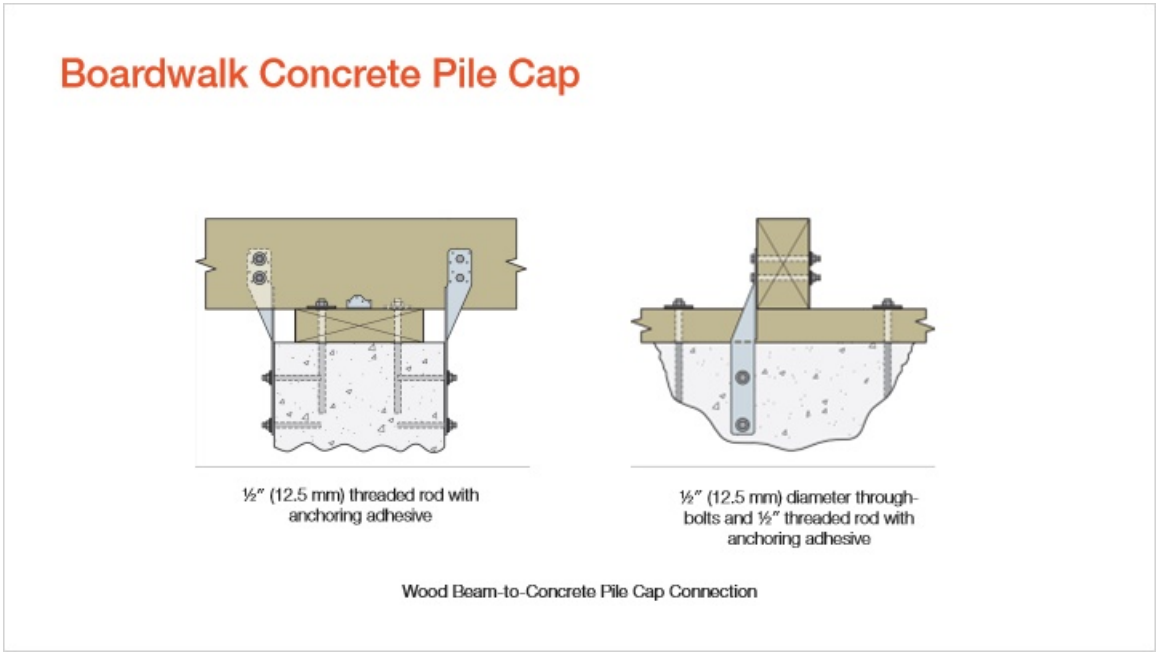
7.5 Boardwalk Concrete Pile Cap



Notes:

Shown here are a ⅝" threaded rod with anchoring adhesive, and ½" diameter through-bolts and ½" threaded rod with anchoring adhesive.

7.6 Boardwalk Concrete Pile Cap



Notes:

Shown here are a ½" threaded rod with anchoring adhesive, and ½" diameter through-bolts and ½" threaded rod with anchoring adhesive.

7.7 Boardwalk Concrete Pile Cap

Notes:

The far-left image shows a ⅜" x 8" (9.3 mm x 200 mm) HDG spike that corroded even with galvanizing (shown in the second image from left) that is being replaced with "load-rated" timber 316 stainless steel screws, as seen in the images on the right.

7.8 Boardwalk: Deck Screws

Boardwalk: Deck Screws

Wood SS Screw: Allowable Withdrawal and Pull-Through Loads

Size x L (in.)	Model No.	Thread Length (in.)	Head Dia. (in.)	Allowable Screw Tension (lb)	Reference Withdrawal W (lb/in.)		Reference Pull-Through for 1½" Side Member P (lb)	
					DFL/SP	SPF/HF	DFL/SP	SPF/HF
#12 x 2½		2.00	0.44	605	130	100	180	150
#12 x 3		2.16						
#12 x 3½		2.49						
#12 x 4		2.83						
#12 x 4½		3.16						
#12 x 5		3.49						
#12 x 6		4.00						

Notes:

Review the table about load-rated 305 and 316 stainless steel wood deck board screws and click *Next* to continue.

8.1 Conclusion

Notes:

We've reached the end of our course. Let's quickly go over what we've learned together.

8.2 Summary

Notes:

Flooding is becoming an increasingly frequent, serious, and expensive problem in many areas of the US.

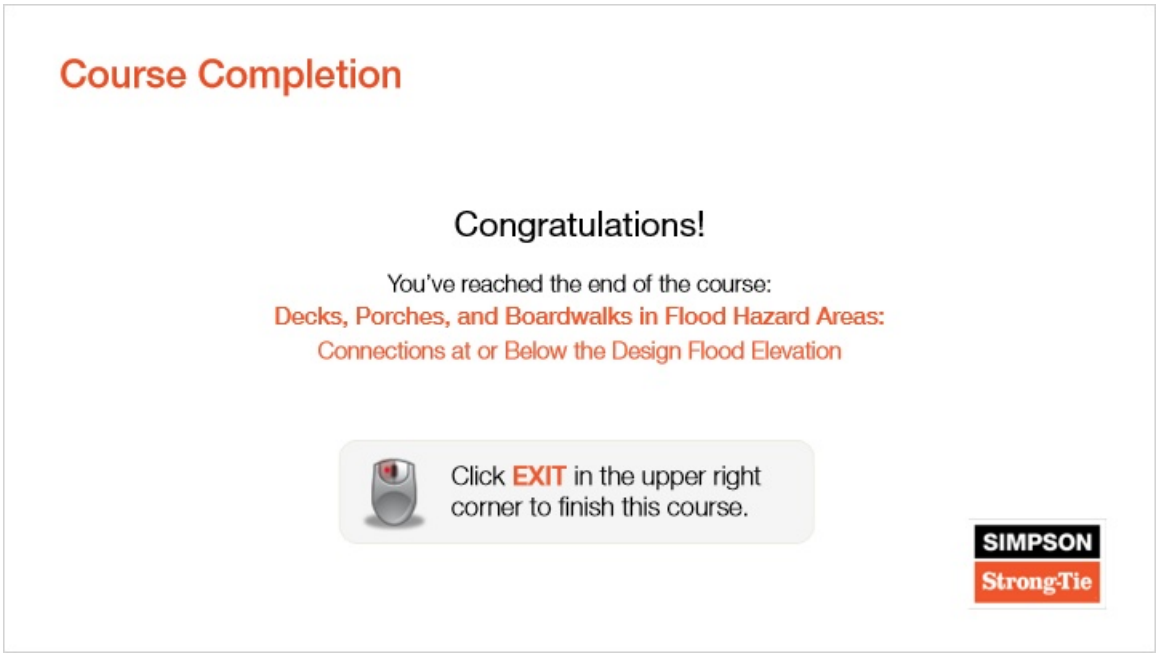
There have been many structural failures of buildings, decks, porches, and boardwalks as a result of flood-related loads, and these failures have resulted in many hard-learned lessons that are now encapsulated as updated and improved requirements in several codes and standards.

Manufacturers have also now developed flood-resistant connections that can tie together all the components of decks and porches into a safe, flood-resistant construction that will resist flotation, collapse, or lateral movement of the structure resulting from hydrodynamic and hydrostatic loads to meet or exceed these requirements.

There have also been a number of failures due to connectors corroding because they were not resistant to wood preservatives, acid rain, high humidity, or salty environments. Manufacturers have also now developed a series of appropriately protected connectors and connections that will resist those caustic influences and thus ensure the safety of the structure.

It is now feasible for designers to consult codes and standards in combination with manufacturer information to create safe, strong, and sustainable decks, porches, and boardwalks that can resist the steadily increasing threat and severity of floods and save homeowners the millions of dollars it would take to replace or repair them.

8.7 Thank You



No audio on this slide.

File Attachments for Item:

ER-9 Fire Pumps (Central Ohio Code Officials Association)

ESI, BO, MPE, BPE, EPE, FPPE, BI, FPI (2 hours)

Staff Notes: Recommend approval

ESIAC Recommendation: Recommend 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 Hunt (Contact Name)

Organization: Licking County Building Code Department (Organization/Company)

Address: 675 Price Rd. (Include Room Number, Suite, etc.)

City: Newark State: Ohio Zip: 43055

E-Mail: lhunt@lcounty.com

Telephone: 740-349-6671 Fax: 740-349-6672

Course Sponsor: Central Ohio Code Officials Association

COURSE INFORMATION:

Course Title: Fire Pumps

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

Purpose and Objective:

1. A better understanding of NEC Section 695, NFPA 20 Chapters 9 and 10 as well as the applicable provisions of the IBC.
2. A better understanding of how to use the NEC, NFPA 20, IBC and UL Product iQ to locate code requirements.

Number of Instructional Contact Hours that can be obtained upon completion: 2

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

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 x

Location of ESI Course: On Line - GoToMeeting Date(s) of ESI Course(s): June 8, 2021

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:		NA
Completed Application:		x

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

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.

Outline
Fire Pumps

Course Length: 2 Hours
Instructor: Jeffrey A. Fecteau
Phone: 952-838-5453
E-Mail: Jeffrey.Fecteau@ul.com

I. Course Description

Understanding the application of NEC, NFPA 20 and the IBC for Fire Pump installations.

1. Acceptable Power Sources
2. Power Source Reliability
3. Continuity of Power
4. Overcurrent Protection
5. Disconnecting Means
6. Circuit Conductors
7. Equipment Location
8. How to determine appropriate product certification

II. Course Competencies

At the completion of this class, students should have the ability to recognize and locate the code requirements of fire pumps.

III. Goals and Objectives

1. A better understanding of NEC Section 695 of the NEC, NFPA 20 Chapters 9 and 10 as well as the applicable provisions of the **IBC**.
2. A better understanding of how to use the **NEC, NFPA 20, IBC** and UL Product iQ to locate code requirements.

IV. Disclaimer Statement

"Course content may vary from this outline to meet the needs of this particular group"

V. Use of Cellular Phones and Pagers in Class

All mobile phones may be in the vibrate mode during class instruction, if they do not have a vibrate setting, **they must be turned off.**

JEFFREY A. FECTEAU

18158 W. Campbell Ave.
Goodyear, AZ. 85395
(952) 838-5453

OBJECTIVE

A responsible and a challenging position; where my extensive Electrical, Inspection, Plan Review, Supervisory and Regulatory experience can be utilized.

EXPERIENCE

UL SENIOR REGULATORY ENGINEER — APRIL 2012 – PRESENT
UL LEAD REGULATORY ENGINEER — NOVEMBER 2010 – APRIL 2012
UL STAFF ENGINEER ASSOCIATE — JUNE 2008 – NOVEMBER 2010
333 PFINGSTEN RD.
NORTHBROOK, IL

Provide Authority's Having Jurisdiction (AHJ) and UL Staff with technical support for product installations covered in various installation codes. Represent UL at AHJ and code development meetings by participating in code discussions and conducting technical presentations on code-related technical subjects. Provide technical expertise on equipment and standards within broad product classifications. Provide expert advice in all technical areas of all product categories common to the appropriate discipline. Represent UL on technical committees of national and/or international organizations. Provide leadership, technical advice and counsel to other professionals. Managing editor of a UL technical newsletter – The Code Authority Electrical Connections. Technical lead within UL Regulatory Services for alternative energy systems.

NEMA MIDWEST FIELD REPRESENTATIVE — MARCH 2007 – JUNE 2008
1300 N. 17th St.
Rosslyn, Virginia

Act as an advocate of safe electrical systems and installations. Convey NEMA positions to members of the International Association of Electrical Inspectors (IAEI). Participate in the local electrical code revision process. Serve as a NEC workshop instructor and promote the understanding of new product installation methods. Maintain contact with electrical inspection authorities. Communicate valuable feedback from installers, contractors, builders, and other end-users of electrical products to member manufacturers.

BUILDING INSPECTOR III — APRIL 2006 – MARCH 2007
City of Bloomington
Bloomington, Illinois

Inspect residential buildings for compliance with the model codes as well as local/state/county requirements. Perform plan review and issue permits for residential structures. Interpret the model codes, make field decisions, and consult with Architects, Engineers, Project Mangers, Superintendents, and Owners.

SENIOR BUILDING INSPECTOR — MARCH 1999 – MARCH 2006
BUILDING INSPECTOR — FEBRUARY 1998 - MARCH 1999
City of Peoria
Peoria, Arizona

Inspect Commercial/Industrial/Residential buildings for compliance with the model codes as well as local/state/county requirements. Perform plan review on the more complicated electrical systems being installed within The City of Peoria. Assist in the supervisory duties of the Inspection Supervisor, and assume the duties of the Inspection Supervisor in his/her absence. Interpret the model codes, make field decisions, and consult with Architects, Engineers, Project Mangers, Superintendents, and Owners.

ADJUNCT FACULTY — AUGUST 1998 – DECEMBER 2005
Gateway Community College
Phoenix, Arizona

Responsible for the instruction of the second year portion of a four year apprenticeship program for the Independent Electrical Contractors Association (IECA), Phoenix, Az. This class included trigonometric and vector math, alternating current theory, resistance/inductance/capacitance circuit theory, single and three phase transformer theory, transformer operation/connection/installation. National Electrical Code (NEC) requirements for transformers, motors, generators, motor circuit conductors, general wiring, conduit and box sizing, services and feeder calculations, grounding and bonding, hazardous locations, health care facilities and emergency systems.

ADJUNCT FACULTY — AUGUST 1998 – DECEMBER 2005
Glendale Community College
Glendale, Arizona

Responsible for the instruction of the National Electrical Code (NEC) requirements as they pertain to general requirements, motors, generators, service calculations, special occupancies, raceways, cables and conductors, cabinets and boxes, service equipment, utilization equipment, branch circuit and feeder calculations, grounding and bonding, overcurrent protection, pools, spas, hydro-massage tubs.

COMMERCIAL/INDUSTRIAL ELECTRICIAN (FOREMAN) — DECEMBER 1992 - FEBRUARY 1998
Corbin Service Electric
Phoenix, Arizona

Intel C-11 Remodel / Intel A4T11 Clean Room Expansion / Intel C-10 Military Test Equipment Relocation / Intel Chemical Warehouse HVAC Changeover / SGS Thompson Remodel and Clean Room Tool Changeover / Office Space Remodels / Service Electrician / Turf Paradise Electrical Distribution System Repair (12470 volts) / Sky Harbor Air Force Reserves Electrical Distribution System Repair (12470 volts) / US West Cellular Antenna Installation

CERTIFICATIONS

Certified Building Official ICC
Certified Electrical Code Official ICC
Certified Building Code Official ICC

Certified Housing Code Official ICC
Certified Electrical Inspector ICC/IAEI
Certified Electrical Plans Examiner IAEI/ICC
Certified Residential Electrical Inspector ICC
Certified Residential Building Inspector ICC
Certified Building Inspector ICBO/ICC
Certified Building Plans Examiner ICBO/ICC
Certified Mechanical Inspector ICBO/ICC
Certified Plumbing Inspector ICBO/ICC
Certified Combination Dwelling Inspector ICBO/ICC
Certified Combination Inspector ICBO/ICC
Certified Commercial Combination Inspector ICC
Certified Accessibility Inspector/Plans Examiner ICBO/ICC
Certified Property Maintenance and Housing Inspector ICC
Distinguished Member of Technical Staff, Underwriters Laboratories
State of Arizona Teaching Certificate #51425
State of Michigan Instructor #1748
State of Minnesota Instructor #I1640720
State of North Carolina Instructor #I711
Current Membership; IAEI #5040, ICC #0887086, NFPA #2295811
Past 3rd Vice President Southwestern Section IAEI
Past Education Chairperson Central Arizona Chapter IAEI
Past President Central Arizona Chapter IAEI

Outline
Fire Pumps

Course Length: 2 Hours
Instructor: Jeffrey A. Fecteau
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7. Equipment Location
8. How to determine appropriate product certification

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At the completion of this class, students should have the ability to recognize and locate the code requirements of fire pumps.

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IV. Disclaimer Statement

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V. Use of Cellular Phones and Pagers in Class

All mobile phones may be in the vibrate mode during class instruction, if they do not have a vibrate setting, **they must be turned off.**

Fire Pumps

1

NFPA 70 –National Electrical Code, 2020 edition
General Requirements:
Chapters 1 through Chapter 4
Chapter 6 Article 695

NFPA 20 –Standard for the Installation of Stationary Pumps for Fire Protection, 2019 edition
Chapter 9 –Electric Drive for Pumps
Chapter 10 –Electric-Drive Controllers and Accessories

2

NFPA 110

NFPA 20, Section 9.6.2.1 contains **mandatory** reference to NFPA 110 where a standby generator is provided.

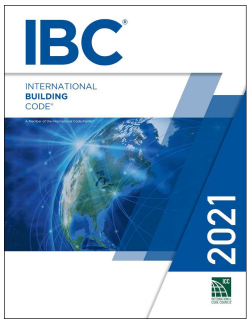
3

Adoption of NFPA 20 by Reference in the IBC

102.4 Referenced codes and standards. The codes and standards referenced in this code **shall be** considered part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections 102.4.1 and 102.4.2.

- 102.4.1 Conflicts.
- 102.4.2 Provisions in referenced codes and standards.

913.1 General. Where provided, fire pumps for fire protection systems **shall be** installed in accordance with this section and NFPA 20.



4

2020 IBC Fire Pump Requirements

403.4 Emergency systems. The detection, alarm and emergency systems of high-rise buildings shall comply with Sections 403.4.1 through 403.4.8.

403.4.8.4 Emergency power loads. The following are classified as emergency power loads:

1. Exit signs and means of egress illumination required by Chapter 10.
2. Elevator car lighting.
3. Emergency voice/alarm communications systems.
4. Automatic fire detection systems.
5. Fire alarm systems.
6. **Electrically powered fire pumps.**
7. Power and lighting for the fire command center required by Section 403.4.6.

5

2020 IBC Fire Pump Requirements

405.8 Standby and emergency power.
A standby power system complying with Section 2702 **shall be provided** for the standby power loads specified in Section 405.8.1. An emergency power system complying with Section 2702 **shall be provided** for the emergency power loads specified in Section 405.8.2.

405.8.2 Emergency power loads.
The following are classified as emergency power loads:

1. Emergency voice/alarm communications systems.
2. Fire alarm systems.
3. Automatic fire detection systems.
4. Elevator car lighting.
5. Means of egress and exit sign illumination as required by Chapter 10.
6. **Fire pumps.**

6

2020 IBC Fire Pump Requirements

902.1.2 Marking on access doors. …. fire pump rooms **shall be** labeled with an approved sign. The lettering **shall be** in contrasting color to the background. Letters **shall have** a minimum height of 2 inches with a minimum stroke of 3/8 inch.

902.1.4 Lighting. Permanently installed artificial illumination **shall be** provided in the fire pump room.

7

2020 IBC Fire Pump Requirements

913.2.2 Circuits supplying fire pumps. Cables used for survivability of circuits supplying fire pumps **shall be** protected using one of the following methods:

1. Cables used for survivability of required critical circuits **shall be listed** in accordance with UL 2196 and **shall have** a fire-resistance rating of not less than 1 hour.
2. Electrical circuit protective systems **shall have** a fire-resistance rating of not less than 1 hour. Electrical circuit protective systems **shall be installed** in accordance with their listing requirements.
3. Construction having a fire-resistance rating of not less than 1 hour.
4. The cable or raceway is encased in a minimum of 2 inches (51 mm) of concrete.

Exception: This section shall not apply to cables, or portions of cables, located within a fire pump room which is separated from the remainder of the occupancy with fire-resistance-rated construction.

UL 2196 (Tests for Fire Resistive Cables) is the standard used to evaluate products covered by UL Product Category FHIT (Electrical Circuit Integrity Systems).

8

8

2020 IBC Fire Pump Requirements

913.4 Valve supervision. Where provided, the fire pump suction, discharge and bypass valves, and isolation valves on the backflow prevention device or assembly **shall be** supervised open by one of the following methods:

1. Central-station, proprietary or remote-station signaling service.
2. Local signaling service that will cause the sounding of an audible signal at a constantly attended location.
3. Locking valves open.
4. Sealing of valves and approved weekly recorded inspection where valves are located within fenced enclosures under the control of the owner.

913.4.1 Test outlet valve supervision. Fire pump test outlet valves **shall be** supervised in the closed position.

913.5 Acceptance test. Acceptance testing **shall be** done in accordance with the requirements of NFPA 20.

9

2020 IBC Requirements for Fire Pumps

1008.3.3 Rooms and spaces. In the event of power supply failure, an emergency electrical system **shall automatically illuminate** all of the following areas:

1. Electrical equipment rooms.
2. Fire command centers.
3. **Fire pump rooms.**
4. Generator rooms.
5. Public restrooms areas greater than 300 (sq. ft.)

10

10

2020 IBC Fire Pump Requirements

SECTION 2702
EMERGENCY AND STANDBY POWER SYSTEMS

2702.1 Installation. Emergency power systems and standby power systems **shall comply** with Sections 2702.1.1 through 2702.1.7.

2702.1.1 Stationary generators. Stationary emergency and standby power generators required by this code **shall be listed** in accordance with **UL 2200**.

UL 2200 (Stationary Engine Generator Assemblies) is the standard used to evaluate products covered by UL Product Category FTSR (Engine Generators)

11

2020 IBC Fire Pump Requirements

SECTION 2702
EMERGENCY AND STANDBY POWER SYSTEMS

2702.1.3 Installation. Emergency power systems and standby power systems required by this code or the IFC **shall be** installed in accordance with the IFC, NEC, NFPA 110 and NFPA 111.

2702.1.4 Load transfer. Emergency power systems **shall automatically** provide secondary power within 10 seconds after primary power is lost, unless specified otherwise in this code. Standby power systems **shall automatically** provide secondary power within 60 seconds after primary power is lost, unless specified otherwise in this code.

12

12

Article 695 Background

- Article 695 first appeared in 1996 NEC.
- Prior to the inclusion of Article 695 in the NEC inspectors, designers and installers deferred to the requirements within NFPA 20 or in many cases installed according to the general requirements within the NEC.
- Concurrent with 1999 NEC revision cycle, NFPA Standards Council established a clear delineation of responsibilities between NFPA 20 and the NEC.
  - Performance of fire pump installations – NFPA 20
  - Installation of conductors and equipment for fire pump – NEC

13

13

695.1 Scope

(A) Covered:

(1) Electric power sources and interconnecting circuits

(2) Switching and control equipment dedicated to fire pump drivers

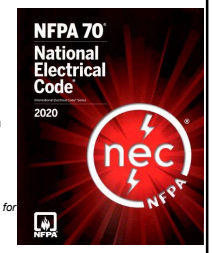
(B) Not Covered:

(1) The performance, maintenance, and acceptance testing of the fire pump system, and the **internal wiring** of the components of the system

(2) Pressure maintenance (jockey or makeup) pumps
[motors in general are covered in Article 430]

(3) Transfer equipment upstream of the fire pump transfer switch(es)

Informational Note: See NFPA 20-2019, *Standard for the Installation of Stationary Pumps for Fire Protection*, for further information.



14

14

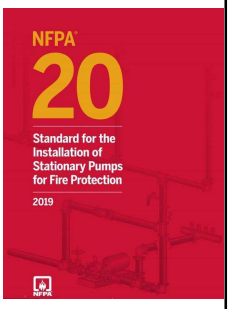
NFPA 20 –1.1 Scope

1.1.1 This standard deals with the selection and installation of pumps supplying liquid for private fire protection.

1.1.2 The scope of this document **shall include** liquid supplies; suction, discharge, and auxiliary equipment; **power supplies, including power supply arrangements; electric drive and control;** diesel engine drive and control; steam turbine drive and control; and acceptance tests and operation.

1.1.3 This standard does not cover system liquid supply capacity and pressure requirements, nor does it cover requirements for periodic inspection, testing, and maintenance of fire pump systems.

1.1.4 This standard does not cover the requirements for installation wiring of fire pump units.



15

15

NFPA 20 4.7 Pumps, Drivers and Controllers

4.7.1* Fire pumps **shall be** listed for fire protection service.

4.27.8 The controller for a pressure maintenance pump **shall be** listed, not required to be listed for fire pump service.

4.31 Packaged Fire Pump Assemblies.

4.31.1(3) A package fire pump assembly **shall be** listed for fire pump service.

16

16

Power Sources NEC and NFPA 20

NEC

• 695.3 -Electric motor-driven fire pumps **shall have** a **reliable** source of power.

NFPA 20

• 9.2.1 An electric motor–driven fire pump **shall be** provided with a normal source of power as a continually available source.

9.3 Alternate Power

• 9.3.1 Unless there is an installed power arrangement a described in 9.3.3, **at least one alternative source of power shall be** provided for high-rise buildings.

• 9.3.2* **Other Sources**. Except for an arrangement described in 9.3.3, **at least one** alternate source of power **shall be** provided where the normal source **is not reliable**.

17

17

NFPA 20 9.3.2* Reliability

- Power outages due to failures in generation or transmission have not **routinely** been experienced.
- The source power plant **has not** experienced any shutdowns of longer than 10 continuous hours in the year prior to plan submittal.
- If the normal source power plant has been **intentionally** shutdown for longer than 10 hours in the past, it is reasonable to require a back-up source of power.

18

18

NFPA 20 9.3.2* Reliability (Additional Switching & OCP Devices)

- **Only** the disconnect switches and overcurrent protection devices permitted by 9.2.3 are installed in the normal source of power.
- Power disconnection and activated overcurrent protection should **only occur** in the fire pump controller.
- If unanticipated disconnect switches or overcurrent protection devices are installed in the normal source of power that **do not meet** the requirements of 9.2.2, the normal source of power **must be** considered not reliable and a back-up source of power is necessary.

19

19

NFPA 20 9.3.2* Reliability (Overhead Conductors)

- Fire departments responding to an incident at the protected facility **will not** operate aerial apparatus near live overhead power lines, without exception.
- A back-up source of power **is required** in case this scenario occurs and the normal source of power must be shut off.
- Many utility providers will remove power to the protected facility by physically cutting the overhead conductors.
- If the normal source of power is provided by overhead conductors, which is not identified, the utility provider could mistakenly cut the overhead conductor supplying the fire pump.

20

20

Individual Power Sources 695.3(A)

(A) Individual Sources.

- Reliable,
- Capable of carrying **indefinitely** the sum of the locked-rotor current of the fire pump motor(s) and the pressure maintenance pump motor(s) and the full-load current of the associated fire pump accessory equipment when connected to this power supply.
  - Indefinitely - Having no exact limits
  - Source will allow motor to run or try to run to failure
  - Different approach than most motor installations in that the goal is reliability, however the equipment can be sacrificed for the greater goal of protecting lives and property

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Individual Power Sources 695.3(A)

(1) Electric Utility Service Connection.

- Separate service,
- Connection located a head of and **not within** the same cabinet, enclosure, vertical switch gear section or vertical switchboard section as the **service disconnecting means**.
- Connection located and arranged so as to **minimize** the possibility of damage by fire from within the premises and from exposing hazards.
- Taps a head of the service disconnecting means **shall comply with** 230.82(5)
- The service equipment **shall comply with** the labeling requirements in 230.2 and the location requirements in 230.72(B). [20:9.2.2(1)]

Remember:
Since this is a separate service for the fire pump as permitted by Section 230.2(A)(1), Section 250.25(C) requires the utility grounded conductor to be routed with the ungrounded conductors to each service disconnecting means and to be connected to the fire pump service disconnecting means grounded conductor terminal.

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Utility Service

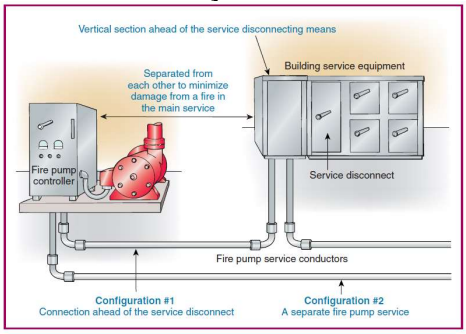

EXHIBIT 695.2 - 2017 NEC Handbook

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Individual Power Sources 695.3(A)

(2) On-Site Power Production Facility.

- Source facility located and protected to **minimize** the possibility of damage by fire. [20:9.2.2 (2)]

(3) Dedicated Feeder.

- A dedicated feeder where derived from a service connection as described in 695.3(A) (1). [20:9.2.2 (3)]

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On-Site Power Production Connection

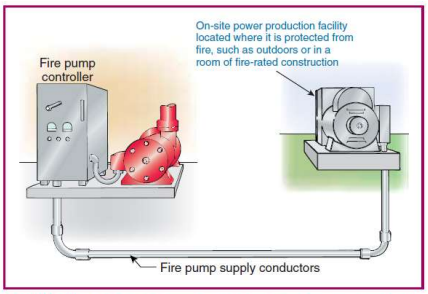

EXHIBIT 695.3 On-site power production facility as a power source for a fire pump installation.

Source 2017 NEC Handbook

25

25

Individual Power Sources
NFPA 20 9.2.2(5) & NEC Section 695.5

Dedicated transformer connection directly from the service meeting the requirements of Article 695 of *the NEC*.

- Covers a customer owned transformer to lower or raise fire pump supply voltage
- Transformer sized at 125% of fire pump and pressure maintenance pump loads and 100% of all other fire pump associated loads
- Transformer **primary protection** sized to carry locked-rotor current of fire pump and pressure maintenance pumps plus 100% of all other loads indefinitely
- Transformer is dedicated to fire pump installation unless it is part of a multibuilding campus-style arrangement.

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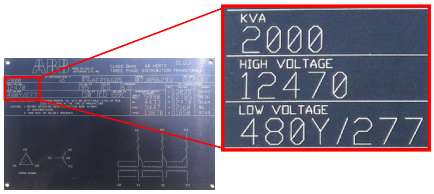
Transformers NEC Section 695.5

Transformer permitted where:

- The supply voltage is **different** from the fire pump and controller requirements, **and**
- It is protected by a disconnecting means and overcurrent protective device(s), **and**
- It is **dedicated** to fire pump installation unless it is supplying campus-style complex



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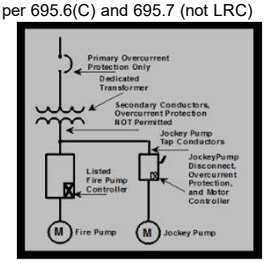
Dedicated Transformer Overcurrent Protection

- Primary side OCPD to carry LRC **indefinitely**
- Secondary side overcurrent protection (OCP) is **not permitted**
- Conductors sized per 695.6(C) and 695.7 (not LRC)



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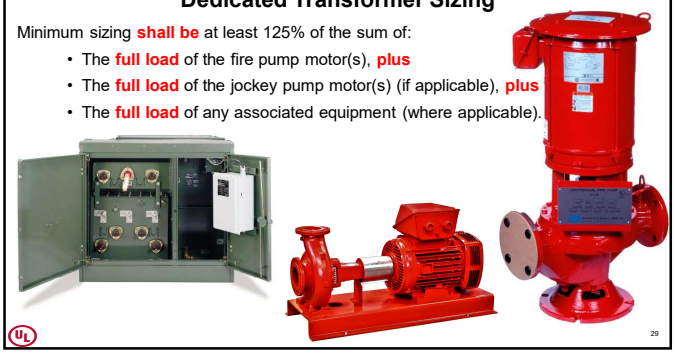
Dedicated Transformer Sizing

Minimum sizing **shall be** at least 125% of the sum of:

- The **full load** of the fire pump motor(s), **plus**
- The **full load** of the jockey pump motor(s) (if applicable), **plus**
- The **full load** of any associated equipment (where applicable).



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Campus-Style Complex Transformer Sizing

Not less than:

- 125% of **full load** of the fire pump motor(s), **plus**
- 125% of **full load** of the jockey pump motor(s) (if applicable), **plus**
- 100% of the **remaining load** supplied by transformer

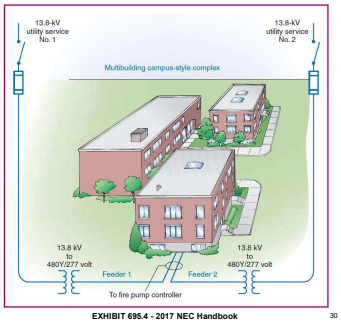

EXHIBIT 695.4 - 2017 NEC Handbook

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Campus-Style Complex Transformer Overcurrent Protection

Transformer, feeder conductors and overcurrent protection **shall be** coordinated so that :

- Transformer is protected per 450.3
- Feeder conductors are protected per 215.3
- Overcurrent protection devices will carry **indefinitely** sum of:
  - Locked-rotor current of fire pump motor(s)
  - Locked-rotor current of pressure maintenance pump motors
  - Full-load current of associated fire pump accessory equipment, and
  - Remaining load supplied by transformer at 100%
  - Locked-rotor requirement does not apply to feeder conductors

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Multiple Power Sources 695.3(B)

- Where reliable power cannot be obtained from a source described in 695.3(A), power **shall be supplied** from an approved combination of:
  - Two or more individual sources, or
  - From an **approved combination** of one or more of such power sources in combination with an on-site standby generator
  - From an **approved combination** of feeders constituting two or more power sources as covered in 695.3(B)(2)
- Additional electrical source **not required** where back-up engine-driven or back-up steam turbine-driven fire pump is installed

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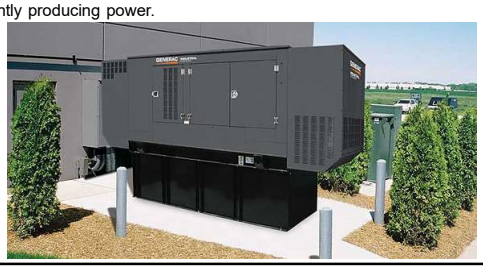
Multiple Power Sources On-Site Standby Generator 695.2

On-Site Standby Generator. A facility producing electric power on site as the alternate supply of electric power. It differs from a non-site power production facility; in that it **is not** constantly producing power.



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On-Site Standby Generator 695.3 (D)

(D) On-Site Standby Generator as Alternate Source. An on-site standby generator(s) used as an alternate source of power **shall comply** with (D)(1) through (D)(3). [**20:**9.6.2.1]

(1) Capacity. The generator **shall have** sufficient capacity to allow normal starting and running of the motor(s) driving the fire pump(s) while supplying all other simultaneously operated load(s). [**20:**9.6.1.1]

Automatic shedding of one or more optional standby loads in order to comply with this capacity requirement shall be permitted.

(2) Connection. A tap ahead of the generator disconnecting means **shall not be** required. [**20:**9.6.1.2]

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On-Site Standby Generator NFPA 20 9.6.2.1 & 9.6.2.3

- **Shall meet** the requirements of Level 1, Type 10, Class X systems of NFPA 110, Standard for Emergency and Standby Power Systems.
- Generator fuel supply capacity **shall be** sufficient to provide **8 hours** of fire pump operation **at 100%** of the rated pump capacity in addition to the supply required for other demands.

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On-Site Standby Generator NFPA 110

Chapter 4

- Level means the type of system, Level 1 has most stringent requirements for protection of life
- Type 10 identifies that it must provide power to load terminals of the transfer switch within 10 seconds
- Class X identifies the time of operation in hours without having to be refueled or recharged

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Multibuilding Campus Style Complexes NFPA 20 9.2.2(4) & NEC Section 695.3(C)

Feeder connection meeting the following conditions:

- Protected facility is part of a multibuilding campus-style arrangement.
- Backup source of power is provided from a source independent of the normal source of power.
- Impractical to supply the normal source of power through the arrangement in 9.2.2(1), 9.2.2(2), or 9.2.2(3).
- Arrangement **acceptable to the AHJ**.
- Overcurrent protection device(s) in each disconnecting means **selectively coordinated** with any supply side overcurrent protective device(s).

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Multiple Source Combinations for Reliable Power

Common combinations for single buildings

- One service **plus** an "on-site" generator.
- Two utility services.

Common combinations for multibuilding campus complexes

- One service **plus** a feeder.
- One feeder **plus** another feeder (supplied from different services)
- One feeder **plus** an on-site standby generator

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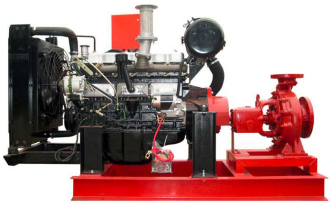
Multiple Power Source Combinations NFPA 20

Other permitted combinations:

- One of the approved power sources and a redundant fire pump **driven by a diesel engine** complying with Chapter 11
- One of the approved power sources and a redundant fire pump **driven by a steam turbine** complying with Chapter 13



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Continuity of Power 695.4

Direct Connection

- To a **listed** fire pump controller,

- To a **listed** combination fire pump controller and power transfer switch,

- To a **listed** fire pump power transfer switch.

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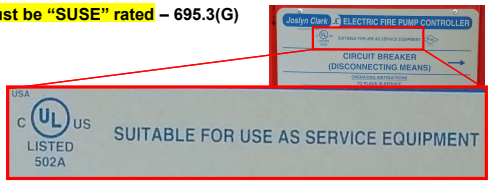
Direct Connection

Fire pump controller is the service disconnecting mean

- **Must be "SUSE" rated – 695.3(G)**



Service installation **must meet all** applicable rules of Chapters 1- 4 (i.e. installation of service conductors and grounding per 250.24)

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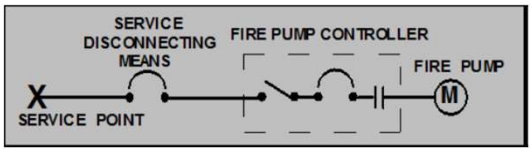
Connection Through Disconnecting Means and Overcurrent Device 695.4(B)

Single disconnecting means with overcurrent protection shall be permitted between power source and:

- A **listed** fire pump controller
- A **listed** fire pump power transfer switch
- A **listed** combination fire pump controller and power transfer switch [20.9.1.2]



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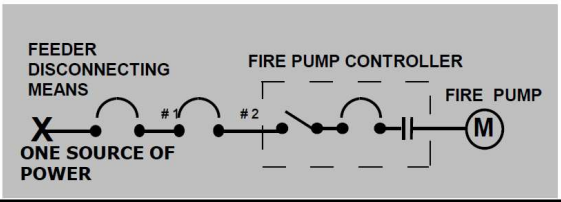
Multibuilding Campus Style 695.4(B)(1)(b)

- For campus style arrangements
- Multiple disconnecting means with overcurrent protection shall be permitted as required by other sections of the NEC
- Overcurrent protection device(s) in each disconnecting means **shall be selectively coordinated** with any other supply side overcurrent protective device(s).



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Connection Through Disconnecting Means and Overcurrent Device 695.4(B)(1)(c)

On-Site Standby Generator.

- Additional disconnecting means and an associated overcurrent protective device(s) shall be permitted.

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Overcurrent Protection 695.4(B)(2)(a)(1)

- Overcurrent protection **must be set** to carry **indefinitely** the sum of the locked rotor current of all fire and jockey pump motors plus all other load. [20:9.2.3.4]
- Limited to "next standard size per 240.6" above LRC
- Will impact meter disconnects for "cold sequence" arrangements
- Locked rotor requirement applies **only** to the overcurrent device, **not** to the circuit conductors
- Locked rotor currents are found in Table 9.5.1.1 of NFPA 20

Table 9.5.1.1(a) Horsepower and Locked Rotor Current Motor Designation for Three-Phase NEMA Design B Motors

Rated Horsepower	Locked Rotor Current Three-Phase 230 V at 60 Hertz (A)*	Motor Designation (NFPA 20, Locked Rotor Indicating Code Letter) "F" to and Including
1	30	N
1½	40	M
2	50	L
3	64	K
5	92	J
7½	127	H
10	162	H
15	232	G
20	290	G
25	365	G
30	435	G
40	580	G
50	725	G
60	870	G
75	1085	G
100	1450	G
125	1815	G
150	2170	G
200	2900	G
250	3650	G
300	4400	G
350	5100	G
400	5800	G
450	6500	G
500	7250	G

Source NFPA 20-2019

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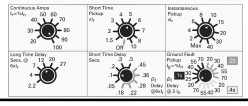
Overcurrent Protection 695.4(B)(2)(a)(2)

Second option for overcurrent protection is the use of an assembly **listed** for fire pump service with the following characteristics:

- Overcurrent protective device **shall not open** within 2 minutes at 600 percent of the full-load current of the fire pump motor(s).
- Overcurrent protective device **shall not open** with a re-start transient of 24 times the full-load current of the fire pump motor(s).
- Overcurrent protective device **shall not open** within 10 minutes at 300 percent of the full-load current of the fire pump motor(s).
- Trip point for circuit breakers **shall not be** field adjustable. [20:9.2.3.4.1]



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Generator Overcurrent Protection 695.4(B)(2)(b)

Overcurrent protective devices between an on-site standby generator and a fire pump controller:

- Selected and sized to allow for instantaneous pickup of the full pump room load,
- **Shall not be** larger than the value selected to comply with 430.62 to provide short-circuit protection **only**. [20:9.6.1.1]

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Disconnecting Means Requirements 695.4(B)(3)(a) & (b)

- **Identified** as "Suitable for Use As Service Equipment"
- **Lockable** in the "closed" position
- **Not be located within** the same enclosure, panelboard, switchboard, switchgear, or motor control center, with or without common bus, that supplies loads other than the fire pump.
- **Sufficiently remote** from other building service disconnecting means so that in advertent operation at the same time is unlikely
- For on-site standby generators disconnecting means **located per** 700.10(B)(5) and **lockable** in the "closed" position.

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Disconnecting Marking Requirements 695.4(B)(3)(c)

- Marking on the cover of the disconnect
- Letters **shall be** at least 1 inch in height, and they **shall be** visible without opening enclosure doors or covers.

FIRE PUMP DISCONNECTING MEANS

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Controller Marking Requirements 695.4(B)(3)(d)

Placard required adjacent to the fire pump controller, stating;

- The location of this disconnecting means
- The location of the key (if the disconnecting means is locked).

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Supervision Requirements 695.4(B)(3)(e)

Supervision of the disconnecting means by **one** of the following:

- Central station, proprietary, or remote station signal device
- Local signaling service that causes the sounding of an audible signal at a constantly attended point
- Locking the disconnecting means in the closed position
- Sealing of disconnecting means and approved weekly recorded inspections when the disconnecting means are located within fenced enclosures or in buildings under the control of the owner

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Instantaneous Trip Circuit Breakers 695.3(H)

- An instantaneous trip circuit breaker shall be permitted in lieu of the overcurrent devices specified in 695.4(B)(2)(a)(1), provided that it is part of a transfer switch assembly **listed** for fire pump service that complies with 695.4(B)(2)(a)(2).
- General requirement for use of instantaneous trip circuit breaker in 430.52(C)(3) limits the use **only** as component within a **listed** combination motor controller.

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Utility Service and On-site Power Production Source Conductors 695.6(A)(1)

- Physically routed outside the building and installed as service entrance conductors.
- Permitted to be routed through building **if installed** under, or enclosed within, not less than 2 inches of concrete [230.6(1) or (2)]

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Feeders 695.6(A)(2)

Applies to feeders on the load side of the final disconnecting means or conductors connected directly to output terminals of standby generator:

- **Shall be** kept entirely independent of all other wiring.
- **Shall supply only** loads that are directly associated with the fire pump system, **and**
- **Shall be** protected to resist potential damage by fire, structural failure, or operational accident.
- If routed through a building, the conductors **shall be** protected from fire for 2 hours
  - Encased in a minimum 50 mm (2 in.) of concrete.
  - A listed fire-resistive cable system. (UL 2196)
  - A listed electrical circuit protective system. (UL 1724)

UL Product Category FHIT (Electrical Circuit Integrity Systems)

Systems incorporating cable protected with electrical circuit protective materials is evaluated to UL 1724, "Investigation for Fire Tests for Electrical Circuit Protective Systems."

Systems constructed with fire-resistive cable is evaluated to UL 2196, "Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control and Data Cables."

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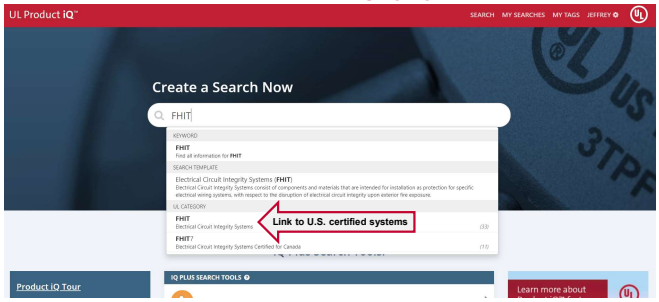
UL Product Category FHIT (Electrical Circuit Integrity Systems)



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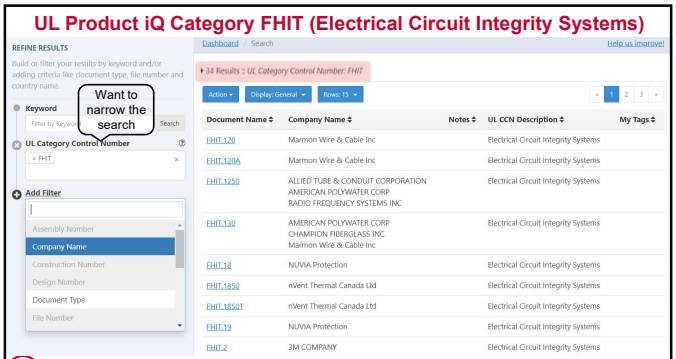
UL Product iQ Category FHIT (Electrical Circuit Integrity Systems)



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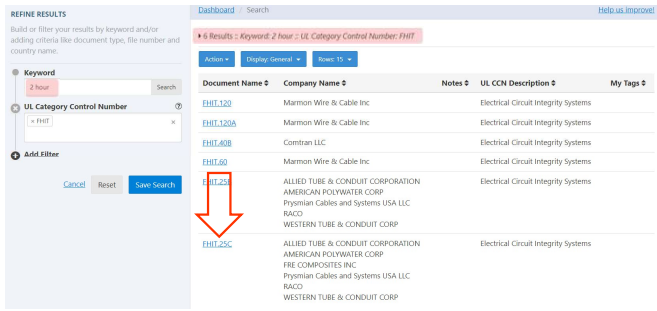
UL Product iQ Category FHIT (Electrical Circuit Integrity Systems)



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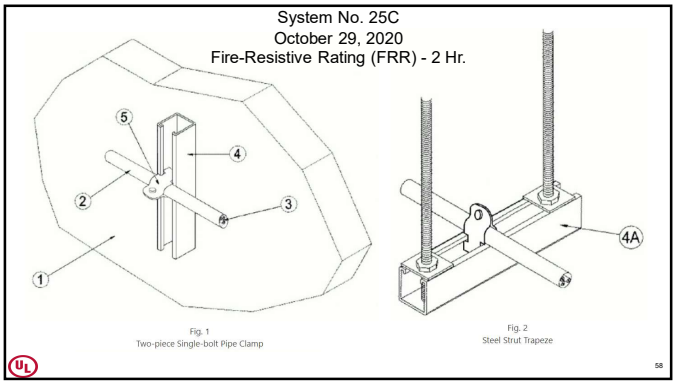

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1. Wall or Floor Assembly* — Minimum 2-hour fire rated concrete or masonry wall or concrete floor. Opening in wall or floor through which raceway passes is to be sized to closely follow the contour of the raceway. Through opening in wall or floor to be firestopped using a compatible firestop system. See Through-penetration Firestop Systems (XHEZ) category for presently Certified firestop systems.

2. Raceway* — Reinforced Thermosetting Resin Conduit, Horizontal or Vertical installation; or EMT type steel conduit, Horizontal installation,

FRE COMPOSITES INC — BreathSaver Brand Type XW Conduit and Type XW elbows as follows:

Minimum XW Raceway Trade Size, in.

Cable Size, AWG/ kcmil	Horizontal Installation: No. of Cables				Vertical Installation: No. of Cables			
	1	2	3	4	1	2	3	4
8	3/4	3/4	1	1	3/4	1	1-1/4	1-1/4
6	3/4	1	1-1/4	1-1/4	1	1-1/2	2-1/2	2-1/2
4	3/4	1	1-1/4	1-1/2	1-1/4	2	2-1/2	3
3	3/4	1-1/4	1-1/4	1-1/2	1-1/4	2	2-1/2	3

ALLIED TUBE & CONDUIT CORPORATION — Type EMT E-Z Pull Brand
WESTERN TUBE & CONDUIT CORP — Type EMT

Minimum EMT Raceway Trade Size, in.

Cable Size, AWG/ kcmil	Horizontal Installation: No. of Cables			
	1	2	3	4
8	1/2	1	1-1/4	1-1/4
6	3/4	1-1/4	1-1/4	1-1/2
4	1	1-1/4	1-1/2	2
3	1	1-1/4	1-1/2	2

2A. Raceway Coupling* — (Not Shown).
FRE COMPOSITES INC — BreathSaver Brand Type XW coupling. Trade size to correspond with the type XW raceway size
RACO — Steel (all components) EMT Compression Couplings. Trade size to correspond with the EMT raceway size.

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3. Fire Resistive Cables* — The hourly fire rating applies to cable passing completely through a fire zone and terminating a minimum of 12 inches beyond the fire rated wall or floor bounding the fire zone.
PRYSMIAN CABLES AND SYSTEMS USA LLC — Type RHW-2 Lifeline Brand of the following part numbers: G300 followed by 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78; or G31501 or G31496. To be installed as described herein and in accordance with the manufacturer's installation instructions SPL-FPT-0013 (TIS3011H) dated Sep 2020, SPL-FPT-0012 dated Sep 2020.

4. Supports — (Figure 1) — Min 12 gauge, by 1-1/2 in. wide or 1-5/8 in wide, painted or unpainted, slotted steel channels with hemmed flange edges. Channel bottom with or without holes. Lengths of slotted steel channels 5 ft and less shall be secured to the wall or floor with a min of two 1/4 in. diameter (or larger) by 2-1/4 in. min long concrete screws, or 1/4 in. diameter (or larger) by 1-3/4 in. long thin steel masonry anchors. One screw or anchor to be located at each end of the slotted steel channel. Lengths of slotted steel channel in excess of 5 ft require a min of three screws or anchors, one at each end of the channel and one centrally located within the length of the channel. The supports shall be spaced a maximum of 5 ft. OC. When installing cable(s) in vertical runs, the maximum distance of cable within raceway shall be 24 ft.

4A. Trapeze-type Supports — (Figure 2) — The raceways shall be installed on/from trapeze-type supports. The trapeze-type supports shall be secured from the surface of the floor. The supports shall be spaced a maximum of 5 ft. OC.

5. Clamps — Steel 1-1/4 in. wide two-piece single-bolt pipe clamps. Size to correspond with the outside diameter of the raceway and as follows: Trade size 3/4-2 in. conduit, min 14-gauge; Trade size 2-1/2 in. conduit, min 12-gauge; Trade size 3 in. and larger conduit, min 11-gauge.

6. Pulling Lubricant — (Not Shown) — When installing cables within a raceway, the cables shall be coated with pulling lubricant.
AMERICAN POLYWATER CORP — Polywater LZ

7. Pull Box — (Optional Not Shown) — Cables installed in the horizontal or vertical orientation within type XW raceway, or in the horizontal orientation within EMT raceway, may utilize a Resolve One NEMA-4X stainless steel industrial control panel enclosure. Refer to the manufacturer's installation instructions, for additional details.

7A. Box Connector — (Not Shown) - For installation with item 7.
FRE COMPOSITES INC — BreathSaver Brand Type XW box connector. Trade size to correspond with the type XW raceway size.

8. Pull Box — (Optional Not Shown) — Cables installed in the horizontal orientation within EMT raceway may utilize a Wiegmann NEMA-1 steel cutout box enclosure. Refer to the manufacturer's installation instructions, for additional details.

8A. Box Connector — (Not Shown) - For installation with item 8.
RACO — Steel (all components) EMT Compression Box Connector. Trade size to correspond with the raceway size.

9. Insulating Bushing — For installation with item 8A. Prysmian P/N CUSEMT. Refer to the manufacturer's installation instructions, for additional details.

*Bearing the UL Classification Mark

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UL Product iQ Category FHIT (Electrical Circuit Integrity Systems)

GENERAL

This category covers electrical circuit integrity systems consisting of components and materials intended for installation as protection for specific electrical wiring systems, with respect to the disruption of electrical circuit integrity upon exterior fire exposure.

Ratings apply only to the entire system assembly, constructed using the combination of components and materials specified in the individual system. Components and materials are designated for use in a specific individual system for which corresponding ratings have been developed, and are not intended to be interchanged between systems. Ratings are not assigned to individual system components or materials.

Electrical circuit integrity systems are intended to be fastened to a concrete or masonry wall or a concrete floor-ceiling assembly. The fire rating of the wall or floor-ceiling assembly is intended to be equal to or greater than the rating of the electrical circuit integrity system. This is to ensure that the complete electrical circuit integrity system will survive during fire and hose stream exposure.

Electrical circuit integrity systems installed in a raceway requiring an equipment grounding conductor uses the same cable described in the system, unless alternate equipment grounding conductors are included in the system.

SYSTEMS INCORPORATING CABLE PROTECTED WITH ELECTRICAL CIRCUIT PROTECTIVE MATERIALS

These electrical circuit integrity systems are investigated with respect to fire exposure and water hose stream performance. Performance criteria are based on temperatures within the enclosure and visual examination after the water hose stream.

These systems are intended to be installed in interior environments with representative heating and air conditioning, unless stated otherwise in the individual system.

Where indicated in the system, the ampacity reduction due to the electrical circuit protection system has been determined for normal ambient temperature operating conditions in accordance with IEEE 848, "IEEE Standard Procedure for the Determination of the Ampacity Derating of Fire-Protected Cables." If not specified in the system, the effect of the electrical circuit protection system on the ampacity of the electrical conductors has not been investigated. The specifications for the system and its assembly are important details in the development of the ratings. Information concerning these details is described in each system.

The products used in these systems are intended to be installed in accordance with all the provisions of NFPA 70, "National Electrical Code" (NEC), and as amended by the details of each individual systems (such as type of supports) and the accompanying instructions.

Authorities Having Jurisdiction should be consulted as to the specific requirements covering the installation and use of these systems.

61

61

Feeder Conductors 695.6(A)(2)(4) Exception

Supply conductors are exempt from fire-resistance ratings **only** were located in the electrical room of origin, and in the fire pump room unless otherwise required by 700.10(D).

62

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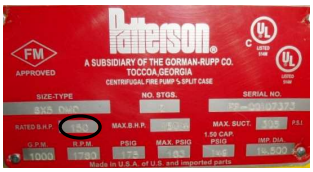
Conductor Size for Fire Pump 695.6(B)

- 125% of fire pump(s) FLC
- Plus 125% of jockey pump(s)
- Plus 100% of other equipment
- or, just 125% of fire pump FLC if only fire pump load(s)

In Part: Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts
50	—	150	143	130	65
60	—	177	169	154	77
75	—	221	211	192	96
100	—	285	273	248	124
[illegible]	—	359	343	312	156
150	—	414	396	360	180
[illegible]		552	528	480	240



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Overcurrent Protection 695.6(C)

General Rules:

- Short circuit protection **only**
- **No** overload protection
- Ground fault protection of equipment **not permitted** for fire pumps.
- Taps made to supply a fire pump **shall be treated** as service conductors in accordance with 230.6.
  - The applicable distance and size restrictions in 240.21 **shall not apply**.
- Conductors directly connected to generator with an output greater than 2.25 times the FLC of fire pump, conductors are to be installed per 695.6(B)

64

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Pump Room Wiring Methods 695.6(D)

Wiring from the controllers to the pump motors **shall be**

- Rigid Metal Conduit (RMC)
- Intermediate Metal Conduit (IMC)
- Electrical Metallic Tubing (EMT)
- Liquidtight Flexible Metal Conduit (LFMC)
- Liquidtight Flexible Nonmetal Conduit (LFNC-B)
- Metal-clad Cable with impervious covering (MC)
- Mineral Insulated Cable (MI)

65

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Motor Connections 695.6(D)

- Electrical connections at motor terminal boxes **shall be made** with a **listed** means of connection.
- Twist-on, insulation-piercing–type, and soldered wire connectors **shall not be permitted** to be used for this purpose.

66

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Listed Electrical Circuit Protective System to Controller Wiring 695.6(H)

- **Shall comply** with any restrictions provided in the listing of the electrical circuit protective system used
- Junction box **shall be** installed ahead of the fire pump controller **a minimum of** 12 inches beyond the fire-rated wall or floor bounding the fire zone.
- **If required** by the manufacturer of a listed electrical circuit protective system or by the listing, or as required elsewhere in this Code, the raceway between a junction box and the fire pump controller **shall be sealed** at the junction box in accordance with the instructions of the manufacturer. [20:9.8.2]
- Standard wiring between the junction box and the controller permitted. [20:9.8.3]

67

67

Junction Boxes 695.6(I)

- Junction boxes **shall be** securely mounted. [20:9.7(1)]
- Mounting and installing of a junction box **shall not** violate the enclosure type rating of the fire pump controller(s). [20:9.7(2)]
- Mounting and installing of a junction box **shall not** violate the integrity of the fire pump controller(s) and **shall not** affect the SCCR of the controller(s). [20:9.7(3)]
- As a **minimum**, a Type 2, drip-proof enclosure (junction box) **shall be used** where installed in the fire pump room.
- Enclosure **shall be listed** to match the fire pump controller enclosure type rating. [20:9.7(4)]
- Terminals, junction blocks, wire connectors, and splices, where used, **shall be listed**. [20:9.7(5)]
- A fire pump controller or fire pump power transfer switch **shall not be** used as a junction box to supply other equipment, including a pressure maintenance (jockey) pump(s).

68

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Junction Connections 695.6(I)

Wire connections for fire pump circuits **shall be listed**.

69

69

Junction Points 695.6(I)

- Controller and transfer switch **are not allowed** to be used as a junction box for other circuits.
- Jockey pump connections **are not allowed** to be made in fire pump controller.

70

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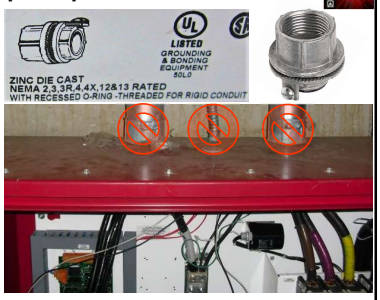
Raceway Connections to Controller Enclosure 695.6(J)

- **Listed** conduit hubs **shall be** used. [20:9.9.1]
- The type rating of the conduit hub(s) **shall be** at least equal to that of the fire pump controller. [20:9.9.2]
- The installation instructions of the manufacturer of the fire pump controller **shall be** followed. [20:9.9.3]
- **Alterations** to the fire pump controller, other than conduit entry as allowed elsewhere in this Code, **shall be approved by** the AHJ. [20:9.9.4]



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Voltage Drop 695.7

Performance requirements to assure the initial power circuit installation is satisfactory

At controller line terminals:

- During normal starting conditions, a 15% voltage drop is the **maximum** permitted.
- During 115% of run condition, a 5% voltage drop is the **maximum** permitted.

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Listed Equipment 695.10

The following equipment **shall be listed** for fire pump service;

- Diesel engine fire pump controllers
- Electric fire pump controllers
- Electric motors
- Fire pump power transfer switches
- Foam pump controllers
- Limited service controllers

[20:9.5.1.1, 10.1.2.1, 12.1.3.1]

73

Equipment Location 695.12(A)

Electric motor-driven fire pump controllers and power transfer switches **shall be located** as close as practicable to, and **within sight of**, the motors that they control.

74

Equipment Location NEC Section 695.12(D)

All energized equipment parts **shall be located** at least 12 inches above the floor level.

75

Equipment Location 695.12(E)

The fire pump controller and power transfer switches **shall be located** or protected so that they are not damaged by water escaping from pumps or pump connections.

76

Equipment Location 695.12(F)

All fire pump control equipment **shall be mounted** in a substantial manner on noncombustible supporting structures.

77

Fire Pump Control Wiring Methods 695.14(E)

- Rigid Metal Conduit (RMC)
- Intermediate Metal Conduit (IMC)
- Liquidtight Flexible Metal Conduit (LFMC)
- Electrical Metallic Tubing (EMT)
- Liquidtight Flexible Nonmetallic Conduit (LFNC)
- **Listed** Metal-clad Cable with impervious covering (MC)
- Mineral Insulated Cable (Type MI)

78

Generator Control Wiring Methods 695.14(F)

Control conductors installed between the fire pump transfer switch and the standby generator supplying the fire pump **shall be**;

- Separate from all other wiring
- Resist damage from fire and structural failure
- If routed through the building, protected by fore for 2 hours:
  - Encased in 2 inches of concrete, or
  - The cable or raceway is a listed fire-resistive cable system, or
  - The cable or raceway is protected by a listed electrical circuit protective system.

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Need More Information

UL Product Categories

QYZS (Fire Pump Controllers)
QZGR (Fire Pump Controllers Over 600 V)
QZKE (Fire Pump Controllers, Residential)
QXZF (Fire Pump Motors)
XNVE (Transfer Switches, Fire Pump Motor Circuits)
BXUV (Fire Resistance Ratings)
FHIY (Electrical Circuit Protective Materials)
FHIT (Electrical Circuit Integrity Systems)
– UL Product iQ (https://productiq.ulprospector.com/en)

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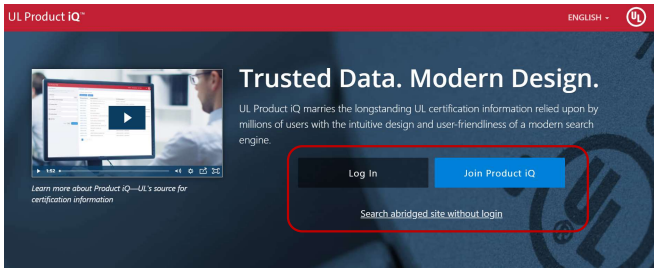
https://productiq.ulprospector.com/en



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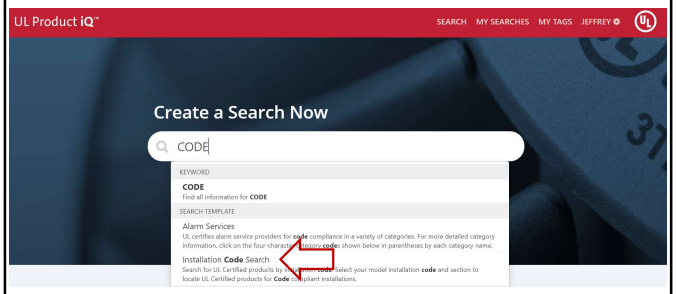

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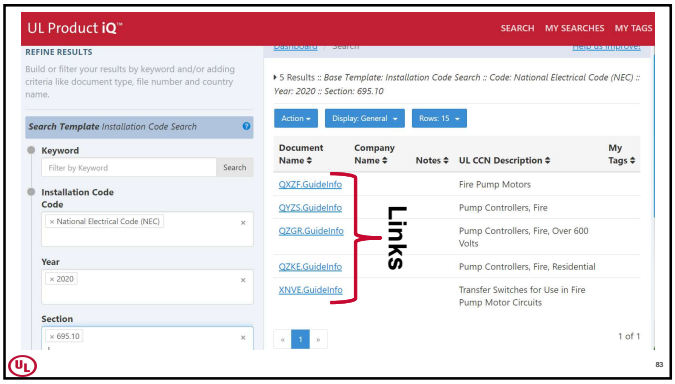

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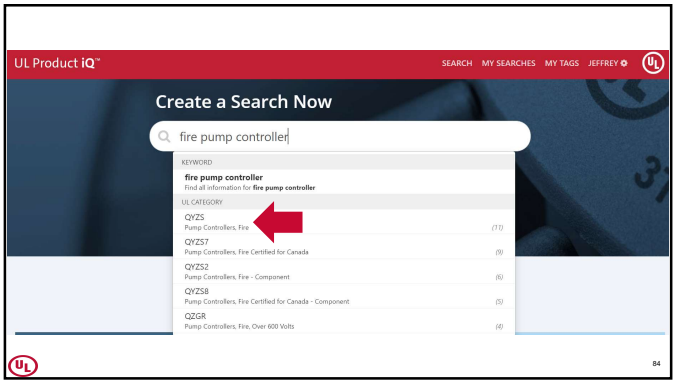

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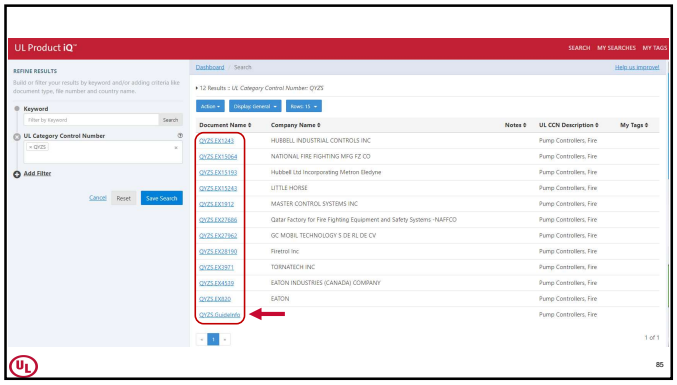
UL Product iQ™
SEARCH MY SEARCHES MY TAGS
REFINE RESULTS
Keyword
UL Category Control Number
Add Filter
Cancel Reset Save Search
Dashboard Search
Help us improve!
12 Results : UL Category Control Number: QYZS
Action Display General Rows: 15
Document Name Company Name Notes UL CCN Description My Tags
QYZS.EX1243 HUBBELL INDUSTRIAL CONTROLS INC Pump Controllers, Fire
QYZS.EX15064 NATIONAL FIRE FIGHTING MFG FZ CO Pump Controllers, Fire
QYZS.EX15193 Hubbell Ltd Incorporating Metron Eledyne Pump Controllers, Fire
QYZS.EX15243 LITTLE HORSE Pump Controllers, Fire
QYZS.EX1912 MASTER CONTROL SYSTEMS INC Pump Controllers, Fire
QYZS.EX27686 Qatar Factory for Fire Fighting Equipment and Safety Systems -NAFFCO Pump Controllers, Fire
QYZS.EX27962 GC MOBIL TECHNOLOGY S DE RL DE CV Pump Controllers, Fire
QYZS.EX28190 Firetrol Inc Pump Controllers, Fire
QYZS.EX3971 TORNATECH INC Pump Controllers, Fire
QYZS.EX4539 EATON INDUSTRIES (CANADA) COMPANY Pump Controllers, Fire
QYZS.EX820 EATON Pump Controllers, Fire
QYZS.Guideinfo Pump Controllers, Fire
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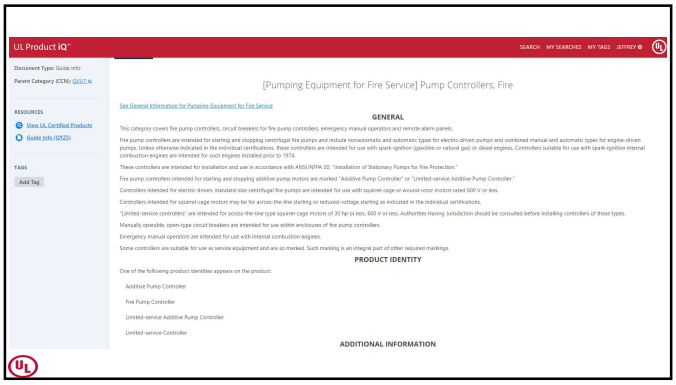
UL Product iQ™
SEARCH MY SEARCHES MY TAGS JEFFREY
Document Type: Guide Info
Parent Category (CCN): QYUT
RESOURCES
View UL Certified Products
Guide Info (QYZS)
TAGS
Add Tag
[Pumping Equipment for Fire Service] Pump Controllers, Fire
See General Information for Pumping Equipment for Fire Service
GENERAL
This category covers fire pump controllers, circuit breakers for fire pump controllers, emergency manual operators and remote alarm panels.
Fire pump controllers are intended for starting and stopping centrifugal fire pumps and include nonautomatic and automatic types for electric-driven pumps and combined manual and automatic types for engine-driven pumps. Unless otherwise indicated in the individual certifications, these controllers are intended for use with spark-ignition (gasoline or natural gas) or diesel engines. Controllers suitable for use with spark-ignition internal combustion engines are intended for such engines installed prior to 1974.
These controllers are intended for installation and use in accordance with ANSI/NFPA 20, "Installation of Stationary Pumps for Fire Protection."
Fire pump controllers intended for starting and stopping additive pump motors are marked "Additive Pump Controller" or "Limited-service Additive Pump Controller."
Controllers intended for electric-driven, standard-size centrifugal fire pumps are intended for use with squirrel-cage or wound-rotor motors rated 600 V or less.
Controllers intended for squirrel-cage motors may be for across-the-line starting or reduced-voltage starting as indicated in the individual certifications.
"Limited-service controllers" are intended for across-the-line type squirrel-cage motors of 30 hp or less, 600 V or less. Authorities Having Jurisdiction should be consulted before installing controllers of these types.
Manually operable, open-type circuit breakers are intended for use within enclosures of fire pump controllers.
Emergency manual operators are intended for use with internal combustion engines.
Some controllers are suitable for use as service equipment and are so marked. Such marking is an integral part of other required markings.
PRODUCT IDENTITY
One of the following product identities appears on the product:
Additive Pump Controller
Fire Pump Controller
Limited-service Additive Pump Controller
Limited-service Controller
ADDITIONAL INFORMATION
86

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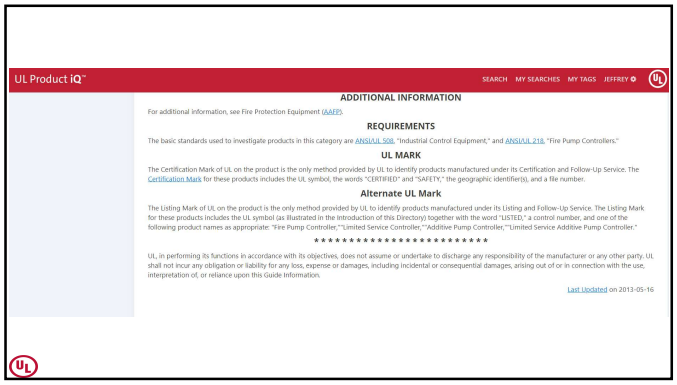
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ADDITIONAL INFORMATION
For additional information, see Fire Protection Equipment (AAFP).
REQUIREMENTS
The basic standards used to investigate products in this category are ANSI/UL 508, "Industrial Control Equipment," and ANSI/UL 218, "Fire Pump Controllers."
UL MARK
The Certification Mark of UL on the product is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.
Alternate UL Mark
The Listing Mark of UL on the product is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and one of the following product names as appropriate: "Fire Pump Controller," "Limited Service Controller," "Additive Pump Controller," "Limited Service Additive Pump Controller."
****
UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. UL shall not incur any obligation or liability for any loss, expense or damages, including incidental or consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Guide Information.
Last Updated on 2013-05-16
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Thank You
Any Questions?
Jeff Fecteau
Senior Regulatory Engineer
(952) 838-5453
Jeffrey.Fecteau@ul.com
88

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File Attachments for Item:

ER-10 Flexible Sprinkler Hose Systems (Victaulic)

ESI, BO, MPE, BPE, PPE, MechPE, FPPE, BI, FPI, RBO, RPE, RBI, RMI (2 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Flexible Sprinkler Hose Systems Outline

Purpose

- The purpose of this course is to provide students and professionals with an overview of the history of flexible sprinkler hose systems and how modern innovation is revolutionizing this fitting category with new technology.

Learning Objectives

At the end of this course, learners will be able to:

- Identify the various designs of flexible hoses and brackets, and comprehend the important differences in how they perform
- Recognize and inspect properly installed flexible sprinkler hose systems
- Comprehend the hydraulic performance of flexible hoses
- Locate technical support information for flexible sprinkler fitting systems
- Comprehend why flexible sprinkler hose systems are an important component in fire safety

Lesson Name	Time Allotted (Minutes)	Learning Objective	Tasks	Required Materials	Learning Method / Style	Assessment Method And Performance Criteria	Comments
• Welcome	5	• Provide the learner with an introduction to staff, and an overview of guidelines, expectations and course structure	• Define expectations and course structure	• Attendance Book • PowerPoint Presentation File • Learner Guide	• Lecture / Presentation – Auditory – Visual	• N/A	
• Introduction		• Provide the learner with an overview of lessons, materials, and objectives	• Describe program details and purpose	• PowerPoint Presentation File • Learner Guides	• Lecture / Presentation – Auditory – Visual	• N/A	
• Lesson 1: History Of Flexible Drop Technology	21	• Comprehend why flexible drops are an important component in fire safety	• Review the history of flexible drop technology	• PowerPoint Presentation File • Learner Guide	• Lecture / presentation – Auditory – Visual	• Q&A during lesson • Assessment at the end of the course – Passing score is 80%	

Continued on next page

Details, continued

Lesson Name	Time Allotted (Minutes)	Learning Objective	Tasks	Required Materials	Learning Method / Style	Assessment Method And Performance Criteria	Comments
• Lesson 2: Anatomy Of A Flexible Drop	60	• Identify the various designs of flexible hoses and brackets, and comprehend the important differences in how they perform	• Compare corrugated and braided hose designs • Examine UL Online Certification Directory listings to understand concept of equivalent length • Compare helical and annular corrugations in braided hose • Discuss corrosion concerns • Compare fixed and union end fittings • Introduce the use of ceiling brackets	• PowerPoint Presentation File • Learner guide • Hose with helical corrugations (if available) • Braided hose with a kink (if available)	• Lecture / presentation – Auditory – Visual	• Q&A during lesson • Assessment at the end of the course – Passing score is 80%	
• Lesson 3: Application Of Flexible Drops	76	• Identify the various designs of flexible hoses and brackets, and comprehend the important differences in how they perform • Comprehend the hydraulic performance of flexible drop systems	• Discuss the use of flexible drops in commercial suspended ceilings • Identify methods of positioning and securing sprinkler systems in commercial suspended ceilings • Identify ways to prove or prevent tampering with brackets • List applicable standards for commercial suspended ceilings • Explore installation in hard-lid ceilings • Explore installation in block walls • Explore installation in clean room ceilings • Explore installation in industrial duct systems	• PowerPoint Presentation File • Learner guide	• Lecture / presentation – Auditory – Visual	• Q&A during lesson • Assessment at the end of the course – Passing score is 80%	

			• Explore installation in freezers and coolers • Explore installation in closed conveyor systems				
• Lesson 4: Inspection And Commissioning	36	• Recognize and inspect properly installed flexible sprinkler fitting systems • Locate technical support information for flexible sprinkler fitting systems	• Summarize applicable codes and standards • Review examples instructions for attachments to ceilings • Explain how Design Guides help verify the adequacy of a hydraulic system • Identify number of bends and bend radii in flexible hoses • Understand and identify potential kinks, bending stress, and residual torque in flexible hoses	• PowerPoint Presentation File • Learner guide	• Lecture / presentation – Auditory – Visual	• Q&A during lesson • Assessment at the end of the course – Passing score is 80%	

Continued on next page

Details, continued

Lesson Name	Time Allotted (Minutes)	Learning Objective	Tasks	Required Materials	Learning Method / Style	Assessment Method And Performance Criteria	Comments
• Lesson 5: The Future Of Flexible Drops	17	• Comprehend the hydraulic performance of flexible drop systems • Locate technical support information for flexible sprinkler fitting systems • Identify the various designs of flexible hoses and brackets, and comprehend the important differences in how they perform	• Explore advancements in hose technology that address common concerns during inspecting and commissioning • Explore advancements in bracket technology that address common concerns like torque requirements and product tampering • Utilize manufacturer Design Guides to accommodate changes from design to actual installation	• PowerPoint Presentation File • Learner guide	• Lecture / presentation – Auditory – Visual	• Q&A during lesson • Assessment at the end of the course • Passing score is 80%	
• Review Session / Q&A	5	• Provide learner with a knowledge of additional resources • Answer all learner questions • Ask learners questions to check for comprehension of new skills and knowledge	• Discuss new knowledge and skills	• All materials listed above	• Discussion / review material and skills	• N/A	

Continued on next page

Details, continued

Lesson Name	Time Allotted (Minutes)	Learning Objective	Tasks	Required Materials	Learning Method / Style	Assessment Method And Performance Criteria	Comments
• Assessment	15	• Measure comprehension of new knowledge and skills	• Demonstrate new knowledge and skills	• Assessment – Hardcopy • Pen	• Application of new knowledge and skills – Knowledge – Comprehension – Analysis – Evaluation	• Assessment at the end of the course – Passing score is 80%	
• Course Close	5	• Review resources • Review assessment • Verify – All learner questions have been answered – All registration information completed and collected – All course evaluations completed and collected	• Present feedback on the learner's comprehension of new knowledge and skills • Communicate resource information • Present feedback on learning experience	• Learner guide – Course evaluation is the last page • Additional course materials as needed	• Discussion	• Q&A as needed	• The assessment is reviewed after all learners have provided their completed assessment to the facilitator • The facilitator is responsible for: – Collecting the completed assessments, course evaluations, and attendance book – Returning the above materials to the Training Administrator in the specified timeline

References

- This course references the following publications:
  - NFPA 13: Standard for the Installation of Sprinkler Systems, 2007 Edition
  - NFPA 13: Standard for the Installation of Sprinkler Systems, 2019 Edition
  - UL 2443 Standard For Flexible Sprinkler Hose With Fittings For Fire Protection Service
  - FM 1637: Approval Standard for Flexible Sprinkler Hose with Threaded End Fittings
  - ASCE/SEI 7-10
  - International Building Code (IBC) 1613.6.3 Automatic Sprinkler Systems
  - NFPA 25: Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems, 2019 Edition

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: Lyndsay Moore

Course Submitter: Lyndsay Moore (Contact Name)
Organization: Victaulic Company (Organization/Company)
Address: 4901 Kesslersvill Road (Include Room Number, Suite, etc.)
City: Easton State: PA Zip: 18040
E-Mail: lyndsay.moore@victaulic.com
Telephone: 484 735 1498 Fax: _____
Course Sponsor: _____

COURSE INFORMATION:

Course Title: Flexible Sprinkler Hose Systems

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

Purpose and Objective: The purpose of this course is to provide students and professionals with an overview of the history of flexible sprinkler hose systems and how modern innovation is revolutionizing this fitting category with new technology. Objectives: Identify the various designs of flexible hoses and brackets, and comprehend the important differences in how they perform.Recognize and inspect properly installed flexible sprinkler hose systems. Comprehend the hydraulic performance of flexible hoses. Locate technical support information for flexible sprinkler fitting systems. Comprehend why flexible sprinkler hose systems are an important component in fire safety.

Number of Instructional Contact Hours that can be obtained upon completion: 2 hours

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.

1

FLEXIBLE SPRINKLER HOSE SYSTEMS

2

LEARNING OBJECTIVES:

At The End Of This Course, You Will Be Able To:

- Identify The Various Designs Of Flexible Hoses And Brackets, And Comprehend The Important Differences In How They Perform
- Recognize And Inspect Properly Installed Flexible Sprinkler Hose Systems
- Comprehend The Hydraulic Performance Of Flexible Sprinkler Hose Systems
- Locate Technical Support Information For Flexible Sprinkler Hose Systems
- Comprehend Why Flexible Sprinkler Hose Systems Are An Important Component In Fire Safety

LESSONS:

- History Of Flexible Sprinkler Hose Technology
- Anatomy Of A Flexible Sprinkler Hose System
- Application Of Flexible Sprinkler Hose Systems
- Inspection & Commissioning
- Advancements In Flexible Sprinkler Hose Systems
- Review Session / Q&A

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Flexible Sprinkler Hose Systems

History Of Flexible Sprinkler Hose Technology

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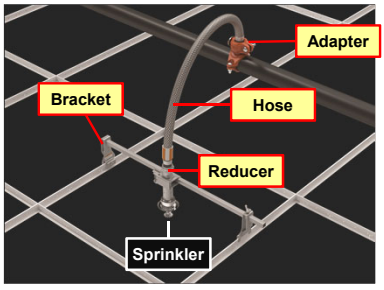
What Is A Flexible Sprinkler Hose System?



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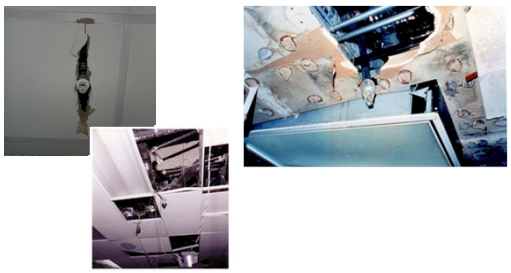
History Of Flexible Drop Technology

1980s | 1990s | 2000s | 2010s



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History Of Flexible Drop Technology

1980s | 1990s | 2000s | 2010s

8

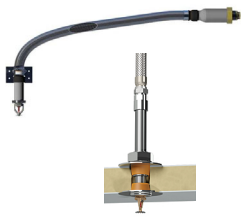
History Of Flexible Drop Technology

1980s | 1990s | 2000s | 2010s

9

History Of Flexible Drop Technology

1980s | 1990s | 2000s | 2010s



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Flexible Sprinkler Hose Systems

Anatomy Of A Flexible Sprinkler Hose System

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Flexible Drop Systems

- Hose Design: Corrugated Vs. Braided
- Corrosion Resistance
- End Fittings
- Brackets

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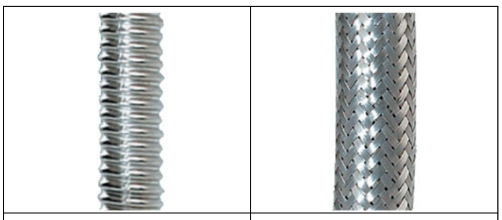
Hose Design: Corrugated vs. Braided



Corrugated (Non-Braided)	Braided

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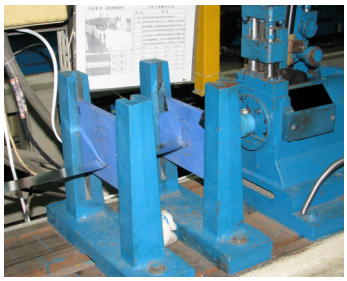
Corrugated / Non-Braided



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VENF.EX15217
Flexible Sprinkler Hose with Fittings

Page Bottom

Flexible Sprinkler Hose with Fittings

See General Information for Flexible Sprinkler Hose with Fittings

VICTAULIC CO EX15217
4901 KESSLERSVILLE RD
EASTON, PA 18040-6714 USA

Model	Rated Pressure, psig	Max Ambient Temp, °F	Nom Inlet by Outlet Size, in.	Assembly Length, ft (mm)	Max No. of 90° Bends	Min Bend Radius, in.	Equivalent Length of 1 in. Schedule 40 Steel Pipe (C = 120), ft	Flexibility Type
AH5-24H unbraided	175	225	1x1/2	2.3 (700)	2	4	18	Limited
AH5-31H unbraided	175	225	1x1/2	2.6 (780)	2	4	27	Limited
AH5-36H unbraided	175	225	1x1/2	3.3 (1000)	3	4	44	Limited
AH5-48H unbraided	175	225	1x1/2	4.0 (1220)	3	4	53	Limited
AH5-60H unbraided	175	225	1x1/2	5.1 (1540)	3	4	68	Limited

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VENF.EX15793
Flexible Sprinkler Hose with Fittings

Page Bottom

Flexible Sprinkler Hose with Fittings

See General Information for Flexible Sprinkler Hose with Fittings

AG FIRE SPRINKLER SL EX15793
C/ALFOZ DE BRICIA N 4
POL. IND. VILLALONQUEJAR
09001 BURGOS, SPAIN

Model	Rated Pressure, psig	Max Ambient Temp, °F	Nom Inlet by Outlet Size, in.	Assembly Length, ft (mm)	Max No. of 90° Bends	Min Bend Radius, in.	Equivalent Length of 1 in. Schedule 40 Steel Pipe (C = 120), ft	Flexibility Type
AG-FLEX.U-700 unbraided	200	150	1x1/2	2.3 (700)	1	5	26	Limited
AG-FLEX.U-1500 unbraided	200	150	1x1/2	4.9 (1500)	3	5	84	Limited

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Braided Hose

- Design Consists Of A Corrugated Hose With An Exterior Braid

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VENF.EX15910
Flexible Sprinkler Hose with Fittings

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Flexible Sprinkler Hose with Fittings

See General Information for Flexible Sprinkler Hose with Fittings

RELIABLE AUTOMATIC SPRINKLER CO INC EX15910
12121 N Stemmons FRWY 110
Dallas, TX 75234 USA

Model	Rated Pressure, psig	Max Ambient Temp, °F	Nom Inlet by Outlet Size, in.	Assembly Length, ft (mm)	Max No. of 90° Bends	Min Bend Radius, in.	Equivalent Length of 1 in. Schedule 40 Steel Pipe (C = 120), ft	Flexibility Type
RF150U2164 unbraided	200	150	1x1/2	4.9 (1500)	3	5	84	Limited
RF150B2164 braided	200	150	1x1/2	4.9 (1500)	3	5	84	Limited

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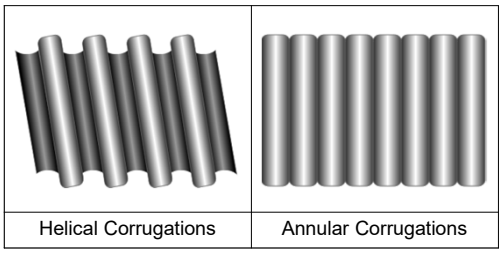
Braided Hose Using Annular Corrugations



Helical Corrugations	Annular Corrugations

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VENF.EX15217
Flexible Sprinkler Hose with Fittings

Page Bottom

Flexible Sprinkler Hose with Fittings

See General Information for Flexible Sprinkler Hose with Fittings

VICTAULIC CO EX15217
4901 KESSLERSVILLE RD
EASTON, PA 18040-6714 USA

Model	Rated Pressure, psig	Max Ambient Temp, °F	Nom Inlet by Outlet Size, in.	Assembly Length, ft (mm)	Max No. of 90° Bends	Min Bend Radius, in.	Equivalent Length of 1 in. Schedule 40 Steel Pipe (C = 120), ft	Flexibility Type
AH5-48H unbraided	175	225	1x1/2	4.0 (1220)	3	4	53	Limited
AH2-48 braided	175	225	1 x 1/2	4.0 (1220)	8	2	32	Limited

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Corrosion Resistance

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End Fittings: Branch Line Adapters

22

End Fittings: Reducers

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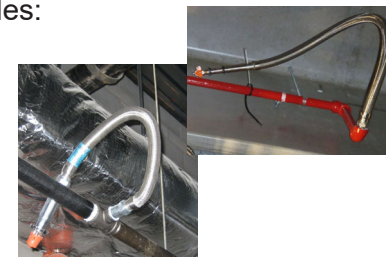
Connection To The Hose

- Two Styles:
  - Fixed
  - Union



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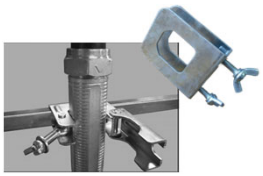
Brackets



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Flexible Sprinkler Hose Systems

Applications Of Flexible Sprinkler Hose Systems

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Applications

- Commercial Suspended Ceilings
- Hard-Lid Ceilings
- Block Wall / Surface Mount
- Cleanrooms
- Industrial Duct Systems
- Freezer & Cooler

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Commercial Suspended Ceilings

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Response Time

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Response Time

31

Response Time

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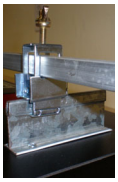
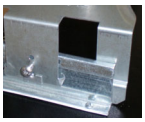
Methods Of Securing To The Grid

		
Clamp Method	Snap Method	Screw Method

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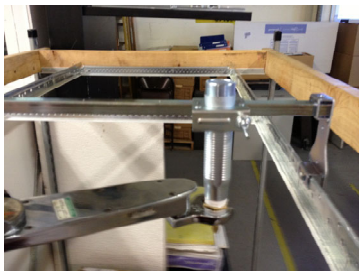
Mechanical Strength Testing



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Tamper Evidence / Resistance

	
Screw Secure to the Grid – Square Drive	Tamper Evident Label

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Applicable Standards

- ASCE/SEI 7
- ASTM International Standards
  - ASTM C635 / C635M
  - ASTM C636 / C636M
  - ASTM E580 / E580M
- International Building Code (IBC)
- NFPA 13: Standard For The Installation Of Sprinkler Systems
- FM 1637: Approval Standard For Flexible Sprinkler Hose With Threaded End Fittings
- UL 2443: Standard For Flexible Sprinkler Hose With Fittings For Fire Protection Service

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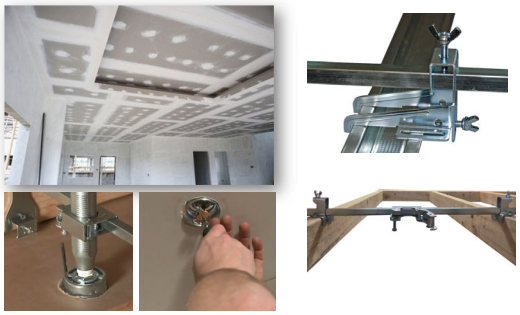
Hard-Lid Ceilings



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Block Wall / Surface Mount

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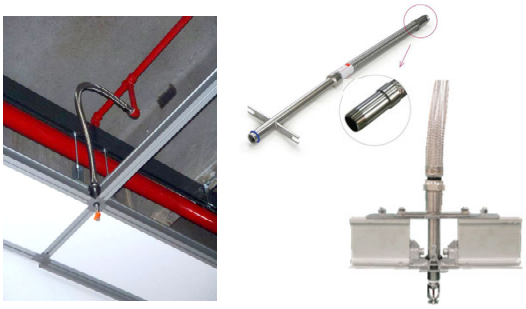
Cleanrooms



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Industrial Duct Systems

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Freezer And Cooler

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Flexible Sprinkler Hose Systems

Inspection & Commissioning

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Inspection And Commissioning

- Inspecting Mounting Brackets
- Inspecting Hoses
- Codes And Standards

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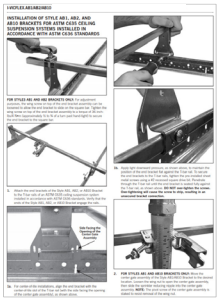
Inspecting Mounting Brackets



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Inspecting Hoses

- Number Of Bends
- Bend Radius
- Kinking
- Bending Stress
- Residual Torque

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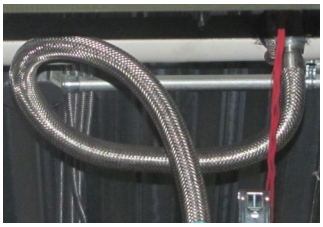
Hydraulic Calculations

- Design vs. Installation



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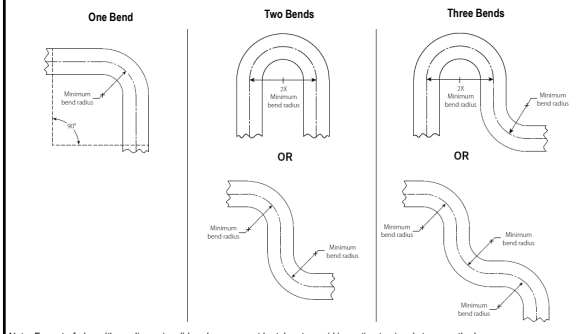
Number Of Bends



Note: For out-of-plane (three-dimensional) bends, care must be taken to avoid imparting torsional stress on the hose.

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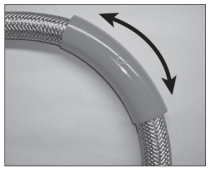
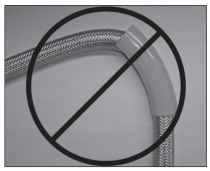
Bend Radius



7-inch/178-mm Minimum Bend Radius



7-inch/178-mm Bend Radius Guide Indicating an Incorrect Bend

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Kinking


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Bending Stress

- Stress Factors
- Function Of The Hose Design
- Manufacturers Installation Criteria

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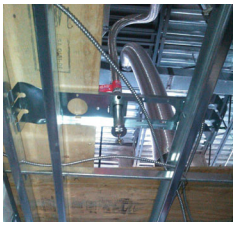
Residual Torque

- What Is Residual Torque?
- What Is The Danger Of Residual Torque?
- How Can You Determine If There Is Residual Torque?



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Codes And Standards

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Flexible Sprinkler Hose Systems

Advancements In Flexible Sprinkler Hose Systems

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Hoses

- Kink Less Or Not At All
- Meet The Industry Minimum Bend Radius
- Meet The Industry Maximum Number Of Bends

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Brackets

- Brackets Designed To Be Used Across Multiple Applications
- Brackets Designed To Accommodate Specific Ceiling Types
- Faster, Easier Installations Without Compromising Safety

55

End Fittings

- Products That Eliminate Small Diameter Threaded Connections
  - Faster, Easier To Install
  - Reduce Jobsite Mess
  - Reduce The Potential For Leaks

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Standardization

- Continued Testing, Direction, And Support For Flexible Hose Systems
- Improves The Level Of Technology
- Offers Guidance On The Installation And Adoption Of Products

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Flexible Sprinkler Hose Systems

Review Session / Q&A

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Learn More

- Manufacturer Websites
- Product Submittals
- Product / System Videos
- Installation Manuals
- Technical And Design Data
- White Papers
- Case Studies
- Approving Industry Organizations

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LEARNING OBJECTIVES:

At The End Of This Course, You Will Be Able To:

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- Review Session / Q&A

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Flexible Sprinkler
Hose Systems
Assessment & Course Close

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Instructions

- Complete Final Assessment And Provide To Facilitator
- Complete Course Evaluation And Provide To Facilitator
- Verify You Have Signed The Attendance Book

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Flexible Sprinkler
Hose Systems
Thank You!

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Victaulic At A Glance

since 1919

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Victaulic History

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- 100,000+ Products & Patented Technologies
- ½" - 144" | DN15 – DN3600 Diameter Solutions

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• Plastics
• Coatings / Linings
• Epoxy

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Diversity In Market Solutions

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